THEORETICAL BASIS FOR SYNERGETICS OF ECONOMIC PROCESSES

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Abstract

The article presents theoretical basis for the application of synergetic approaches in the economy. The meaning and essence of the concept of "synergetics" are given. The essence of synergetic approach to understanding processes in the economy and natural sciences is determined. The use of synergetic methodology for creating the nonlinear cognitive model is grounded. The development prospects of synergetic approaches for their use in the research of economic processes and recovery from the crisis state are presented.

Keywords: Synergetics, bifurcation, self-organization, nonlinear dynamics

Statement of the problem

The end of the 20th century has demonstrated the limitations of cognitive models, their incompleteness and inapplicability to many problems that have to be solved. The world-view of people is changing and expanding, they need new opportunities to have an influence on their own destiny. They solve different problems and they need new methods for solving the issues facing humanity.

The representatives of natural science, and especially those, who are engaged in mathematical modelling, felt it very strongly. Many of them have to deal with a wide range of problems, from the problems of strategic stability and projects of economic reforms to concrete physical processes or technical constructions. The euphoria concerning the possibilities of modern computers and computational experiments have changed into understanding of the limited possibilities to get answers using a computer and the ability to ask matters of principle.

The theoretical justification for these changes has been reflected in new approaches: the economic growth theory, the theory of business cycles and the synergetic economy.

The synergetic approach in studies of economic processes leads to the development of effective models of the recovery from the crisis state, which

makes it possible to find universal principles of self-organization and evolution of complex economic systems (formulation of the laws of self-preservation and evolutionary development) [Haken, 1980].

Analysis of the latest researches and publications

The new economic theory forms an idea of the essence of economic processes based on nonlinear dependence and loss of balance. Current studies ascertain the development of economic processes, based on the processes of self-organization and openness. The approach is based on the fundamental works of I. Pryhozhyn, H. Khaken, V. Zanh, I. Lukinov, M. Moiseiev etc., whose researches have substantiated the main stages of development and formation of open systems development by means of evolutionary changes through the bifurcation points, disasters and chaos. The researches have shown that the complex systems, to which the economic systems are referred, that have the characteristics of self-organization and openness are dissipative structures that can reproduce their actions and the further way of the existence based on internal potential, the implementation of which requires certain conditions, created naturally, or as a result of regulatory actions.

The researchers are focusing on the behaviour of systems at the points, far from equilibrium state, and system ability to remain in transition state for a while. As a result, the system shows itself the sensitivity to possible variants of development and carries out choice in favour of a trajectory with the best characteristics.

The received results formed a strong basis for further researches in the field of economics towards the synergetics. Among their main issues are the items of evaluation and determination of the components during the formation of economic mechanisms as an integrated concept of transitions between the equilibrium states and hold positions of sustainable development; search of synergetic potential in the internal structure of economic processes and the possibility of its reproduction by means of external disturbances; the formation of natural factors that counteract in the economic space, so as a result, the economy acquires the characteristics of nonlinearity and instability etc..

Statement of the aim

To consider theoretical aspects of the synergetics of economic processes.

Presentation of the main material

Our world is a complex system. But at the same time, the scientists can describe it and understand it, though on a quite basic level. Why do these

rather simple and primitive models work? We believe, the answer to this question suggested by the nonlinear science can be: the self-organization. The knowledge of such details of the universe has given new opportunities, turned out to be the huge force.

Nonlinear science, which is sometimes referred to post-nonclassical, is based on even more shaky basis. It is based on the results of a computer simulation and theoretical analysis of unusual phenomena in physics, chemistry, biology, and the social sphere. Many experiments, new algorithms, basic theory are even more frequently based on the forms and methods of the nonlinear world.

However, not only the pursuit of future force explains the resonance in the culture and social consciousness, associated with nonlinear science. In our opinion, a new cognitive model is formed in the nonlinear science.

Synergetics (from the Greek synergeia – cooperation, assistance, participation) is an interdisciplinary direction of scientific researches, within the framework of which the general regularities of the transition from chaos to order and back (of self-organization and spontaneous disorganization processes) in open nonlinear systems are studied. The term "synergetics" was introduced in 1969 by H. Khaken. Synergy as a scientific direction is close to a number of other directions, such as nonlinear dynamics, the theory of complex adaptive systems, the theory of dissipative structures (I. Pryhozhyn), the theory of deterministic chaos or fractal geometry (B. Mandelbrot), the theory of autopoiesis (Kh. Maturana and F. Varela), the theory of self-organized criticality (P. Bak), the theory of non-stationary structures in the regimes with exacerbation (A.A. Samarskyi, S.P. Kurdyumov). The term "Synergetics" is used as a generalized name of scientific directions, within which the processes of self-organization and evolution, ordered behaviour of complex nonlinear systems, are investigated [Ivinu, 2004].

The essence of the synergistic approach is that the systems, consisting of a large number of elements that are in complicated interactions with each other and have a huge number of degrees of freedom, can be described by a small number of important parameters (the order parameters), while the others are "subordinate" (the principle of subordination) and can be expressed quite accurately through the order parameters. Therefore, the complex behaviour of systems can be described by means of a hierarchy of simplified models that include a small number of the most important degrees of freedom.

Being a multidisciplinary direction of researches, the synergetics involves the profound ideological implications. There arises a quality different picture of the world, different from the classical science. A new

paradigm is being formed; the whole conceptual net of thinking is being changed [Ivinu, 2004].

Some systems of physics, chemistry and biology provide the simplest examples of self-organization, that were better understood than others. Events in them are developing not only in time, but also in space. All of them have a common feature. Imagine a classic example of synergetics. Imagine the diffusion, resulted by a casual wandering of numbers of parts; imagine the strikingly complex trajectories of fluid particles or a myriad of chemical reagents that transform strangely into each other, or a lot of people, who use public transport. It would seem that everything here is completely casual, or, as physicists say, there is chaos at the micro level. And in all these cases the averages behave in a completely deterministic way. Chaos at the micro level can lead to ordering at the macro level. The study of these and some other structures is not a simple matter. It requires the development of new mathematical methods and the extensive use of computers, but sometimes it can be very instructive.

Dealing with the processes, expanded in time and space, we are faced with a new element of reality – the form of structures appearing. Opinions about the perfection of form, harmony proportionality were the key motivations in the knowledge of nature. It shows by which laws the simple structures can be combined into the complex. The form determines the existence of the structure. A wonderful fact is that for the creation of a complex structure that develops in time, it is necessary to determine correctly its form. Volumes of energy do not play any role here.

A great number of different configurations at first generated in the researchers an illusion that structures of any complexity can be built in this universe. And one of the key results of the analysis was the proof that only these structures and no others can be built in this environment. There are rules ban. The attempts to “obtrude” something of this system or operate by trial and error are doomed to failure.

There are many analogies, aren’t there? Economic, social, environmental systems, which attempts to “rebuild” or “re-create”, strikingly rarely lead to positive results.

Our world is too complex. There are many conservation laws. The events develop in it in a giant interval of spatial and temporal scales. The chance and regularity are combined impressive in it.

There are many examples of self-organization in chemistry, physics, biology, but the mathematical models of these processes are developed in very rare cases. Since, it refers to the understanding and copying the mechanisms of self-organization in models.

A lot of the most important discoveries in the science of the 20^{th} century are associated with the detection of the effects of coordinated

behaviour (synergism) at the macro level of totality of the separate elements (atoms, cells, individuals).

But how to explain and model the new creations, economic and natural processes around us? How to describe their structures, their size, form or perhaps range of forms; laws of their development, entering into the new integrities and causes of disintegration? Here the new possibilities in the understanding of these processes made use of nonlinear mathematical models and computing experiment. Unfortunately, the last is associated with the insufficient development of analytical research methods of nonlinear models even in modern mathematics. There is a very small part of works, illustrating the above and show the use of computer modelling of nonlinear processes.

Search of these concepts, new paradigms, and new cognitive models is conducted in different directions. One of the approaches is a fundamental change in methodology. Perhaps, while analyzing the complex systems, the classic Hegelian "black and white" triad: "thesis antithesis – synthesis" must give way to more complex schemes, for example, based on "not clear logic" or Trinitarian methodology. Within the last, which R.H. Barantsev is actively developing, the ratio between not pairs of categories, but between the three, is considered. The accuracy, simplicity and universality (application area) can be distinguished while analyzing the method or algorithm. These requirements are contradictory, and the third category is frequently the "arbiter" in "dispute" between the first two categories [Kurdjumov, 1996].

Another approach is developed by O.V. Chaikovskyi, Yu.Yu. Tunytsia and I.M. Syniakevych, who offer a new cognitive model, based on the environmental imperative, on change of the ethical standards. The attitude towards the world, as the garden, in which the harmony should be, is their basis.

Finally, it is possible to build a new philosophical and methodological concept, referring to the experience of the implementation of large scientific and technological projects and understanding of the historical path of human development. Perhaps, M.M. Moiseiev develops this approach deeply and consistently in approach, called universal evolutionism [Moiseev, 1995].

However, the nonlinear dynamics, the synergetics, is not on this level of generalizations for today. It still gives some examples, images of behaviour of complex nonlinear systems and methods of their study. It may be compared with the peculiar natural philosophy of the computer age. Myths gave the patterns at the time, examples of typical situations, the recommendations of how to act when an attempt to rely on logic and rational consideration fails.

The nonlinear dynamics offers basic models, new concepts and methods that can be applied in this situation, or can be not. They can become the basis of building a new nonlinear cognitive paradigm, and can remain as some findings in various disciplines.

Here is an example. The favourite image of the synergetics is the bifurcation diagram. Now imagine that the parameter is time, and the variable A characterizes the key variable, determining system status. The choice and processes of different level, not shown in the diagram, are at the bifurcation points (noise, chance, control actions can play a key role). It means that the way of development is not the only one, that it is possible to intervene at the right time in the course of events and change it. The future turns out to be not the only. Will this image remain a metaphor, become a guide to action for those, who will determine the bifurcation point and the affect the system, and will be the basis of a new algorithm or technology – all these depend on the professionals, who will apply the general ideas of nonlinear dynamics in their specific field. It remains to state that these general ideas are very useful sometimes.

One of the reasons of resonance, which nonlinear dynamics received, is that it gives a new view on the development of science, on the possibility to describe the natural phenomena. The fundamental question is why, having a very modest resources, we orient ourselves well and have had a good understanding of a lot matters for the last 20 centuries? Why sometimes among a myriad of complex interacting factors and hundreds of thousands of variables, the most important processes and key factors are succeeded to select? The answer of nonlinear dynamics is that there is a self-organization, associated with the allocation of the order parameters. The nonlinear environment that potentially has an infinite number of degrees of freedom, may be described by means of dynamic system with a limited and sometimes a small number of variables. Market with hundreds of thousands of agents and millions of goods may be modelled by means of supply and demand curves. (A look at the economy, as a system that is self-organizing and self-developing, appears rather prolific, as the works of A.A. Petrov scientific school show [Petrov, 1996].)

Conclusion

Seemingly, despite the inter-scientific nature of the problem of selection of the order parameters, it turns out to be extremely important. The approaches, developing be means of nonlinear dynamics, give the hope that one can successfully operate in the ocean of existing knowledge, projects and information that “information gin” can be tamed. The biblical wisdom interprets about the time to “throw stones” and “time to gather stones”. If the 20th century have passed under the sign of “throwing the stones”, the birth of

hundreds of research directions at the junctions of scientific disciplines, then in the 21st century the future of science will be determined by how successful will the multidisciplinary synthesis be, how successfully will the "stones" be "gathered".

The nonlinear science provides a good chance for that. The chances that a huge potential accumulated by means of math and science, will be popular and useful, when answering the key questions concerning our existence. It gives a chance to humanitarian sciences that we, finally, will learn to do the lessons from the history and use mind where it is most needed.

Today it is difficult to define the contours of the "nonlinear paradigm" or "nonlinear cognitive model". Sometimes it seems to be a giant funnel, which absorbs the objectives, methods, ideas of many different disciplines, bringing the new models and ideas to the scientific stage. However, it is often difficult to separate the new from the well-forgotten old.

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