Application of Method of System Potential in Analysis of Economic System Evolution.

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I. Introduction.

The modern economic theory uses the system approach widely for modeling of economic processes. Understanding of economy as an indivisible system allows understanding better many laws of economic dynamics. But the problem exists that will be considered in this paper.

This problem is the absence of uniform set of terms by which the deep structure of a System could be fixed. Our object – Complex Adaptive System (CAS) - is the System that arouse spontaneously in course of evolution process[1]. Some universal structure lies in the base of such Systems. We want to fix this structure by means of some system of terms. This is term-system for CAS description.

Revelation of CAS-structure and its description is only the first task. The second task consists in formulation of regulating mechanisms that determine CAS-development. Four such mechanisms exist: (1) CAS-adaptation, (2) entropy influence, (3) CAS-mutations and (4) sharp external influences.

Economic system can be interpreted as the example of CAS. Description of economic CAS means that the following tasks must be solved: (1) construction of term system for description of CAS-structure and (2) formulation of mechanisms that regulate the change of CAS-structure.

We want to propose the method for solution of these tasks. This method is based on a new approach in system dynamics [12;13][2]. We call this method the Method of System Potential (MSP). Such name is connected with the basic idea of this Method that consists in simulation of system dynamics as change of some abstract property of a system. This property consists in ability of a system to react adequately on the external influences (i.e. the adaptation) and to accumulate the useful experience. We call this abstract property of a system the "potential" of a system. "Potential" can be interpreted as the measure of systems adaptive abilities. MSP operates by very abstract terms such as "potential of a system", "conditions of realization of potential", "activity of a system", "efficiency of a system", "conditions per unit potential (wealth-density) in a system" and some others. All these terms are interconnected and the system of these terms describes the common structure of Complex Adaptive Systems. All CAS have the identical structure since all these systems arouse spontaneously in the course of evolution process. Properties of its CAS-structure reflect the common history of origin of these systems. All these systems developed some identical properties since all these systems arouse in course of struggle against destroying external influences. In course of evolution separation only that systems kept (retain) which were able to develop adaptive abilities and create mechanisms for survival and accumulation of useful experience. MSP describes the structure of CAS and regulating mechanisms that determine changes in the structure. Our understanding of this structure is not complete of course. We consider only the most common and abstract properties of such structure and processes of CAS. We did not consider in this paper many peculiarities of structure such as hierarchy and relations (and feedbacks) between the different levels of this structure.

Thus MSP postulates the existence of some common universal structure in the systems that spontaneously arose in course of natural evolution process. Only such systems we call the Complex Adaptive Systems (CAS). MSP states that CAS-structure can be described by means of above-mentioned terms such as the "potential", "conditions of realization", "activity", "efficiency" and etc. Below we consider the definitions of these terms and its logical interconnection.

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[1] Let's call such Systems the Complex Adaptive Systems (CAS) since these Systems demonstrate the ability to adapt its inner state to changes in environment. All such Systems have some universal structure, which sustains its steady state, and accumulate the useful experience. Given paper contains the description of this structure and explanation of principles of work. Economic System can be considered as just such Complex Adaptive System.

[2] Web-site [1] contains the details of MSP-approach and its discussion.

MSP propose to consider these terms as mathematical quantities (values). Thus the logical interconnection of these terms can be represented as some system of mathematical relations between corresponding CAS-variables. Such approach allows describing the universal CAS-structure and its regulating mechanisms in a form of some mathematical dynamical system (mathematical CAS-model). The principal variables of this model are "potential", "conditions of realization" and "efficiency of a system". These variables determine the state of CAS at utmost abstract level. Each state of a system can be depictured as the point in three-dimensional state-space: "potential" – "conditions" – "efficiency". Development of a system is pictured as trajectory line in state-space.

MSP introduces the idea of the "normal evolution" as such development of a system that is regulated by only two basic evolution mechanisms: (1) mechanism of adaptation to changes in environment of a system and (2) mechanism of entropy influence on a system. The sharp changes in the structure of a system (systems mutations) and sharp external influences on a system break the "normal evolution" of a system. Such disturbances lead to sharp jumps of trajectory in state-space. We did not consider in this paper neither mutations nor sharp external influences.

Mechanism of adaptation describes how the activity of a system is connected with system "potential" and "conditions of realization" dynamics. It can be formulated as follows:

Mechanism of adaptation: CAS-activity is the process which:

- *Sustains* the accumulated adaptive CAS-abilities;
- *Gives increment in* adaptive abilities that were used in CAS-activity.

The second point means that adaptive abilities grow and improve through training in activity processes. Since the "potential of a system" is measure of its adaptive abilities these statements can be reformulated as follows: *activity of a system sustains the accumulated "potential" of a system (set of its adaptive abilities) and gives increment in that part of "potential" which is applied in activity of a system (realized part of potential).*

Mechanism of adaptation operates through activity processes. These processes act as the source of growth in realized part of potential. Activity of a system influence on "conditions of realization" also. This term fix all the internal and external factors that determine what part of potential will be applied in the current CAS-activity. Activity is the process of consumption and creation of "conditions". We consider only such systems in which creation of "conditions" in a unit of time more than consumption of its i.e. the propensity of a system to create "conditions" through activity processes is more than propensity of one to consume of its. We assume that activity is only source of change in "conditions". The simplest dependence of change in "conditions" on "activity" is the linear function, i.e. *increment in "conditions of realization" of a system is the linear function on activity of a system.*

Mechanism of entropy influence expresses the influence of disordering factors on system development. These processes lead to degradation and degeneration of structure of a system on account of random external and internal destroying influences on a system. Order in a system diminishing on account of such influences and it leads to diminishing of "potential" and "conditions" in a system. *Thus the "potential" and "conditions" diminishing on account of entropy influence.*

The mechanism of entropy is an expression of collapse processes in a system by uncontrolled influences of casual impacts. This mechanism could be interpreted as generalization of well-known the second principle of thermodynamics. According to the function of entropy principle the "potential" and "conditions of realization" of a system are decreasing if this system do not act.

Term "entropy" is applied in this paper in very wide sense as the index of the degree of disorder in a system. Such interpretation of this term is widespread in the modern science literature. For example physicists Hoaking, S.W. [5] and Penrase, R. [11] give the following definitions of this term:

"…entropy… measures the degree of disorder of a system. It is a matter of common experience that disorder will tend to increase if things are left to themselves." (Hoaking, S.W., p.102).

"…entropy of a system is a measure of its manifest disorder… the second law of thermodynamics asserts that the entropy of an isolated system increases with time…" (Penrase, R., p.308-309).

Of course the thermodynamic "entropy" means something more then measure of system's disorder degree. Peter Corning and Stephen Jay Kline [2; 3] indicate that the thermodynamic entropy could not be identified with the second law of thermodynamic with increasing of disorder in a system by uncontrolled influences of casual impacts. However we could use the second more broad meaning of term "entropy" because this meaning is widespread in contemporary System's Thinking.

MSP postulates that increasing of disorder in a system leads to decreasing of "potential" and "conditions of realization" of a system. That means casual impacts to a system as a rule decrease its adaptive abilities and conditions needed for the application of this abilities in activity.

"Normal evolution" of a system is controlled by this two evolutionary mechanisms: adaptive mechanism and mechanism of entropy. The first mechanism connects the development of "potential" and "conditions of realization" with the activity of the system. The second describes processes of system's degradation as effect of uncontrolled impacts.

We could say that *activity of Complex Adaptive System is a permanent fight against with its destroying activity of entropy principle.*

Unifying both evolutionary mechanisms gives the following **property of adaptive abilities dynamics**:

- *Only abilities in use (useful) are supported and increase;*
- *Abilities which are not in use (useless) die down because of entropy impact.*

It is evident that this property shows the close correlation with the ordinary meaning of "adaptation".

CAS abilities implemented (realized) in activity of a System determinate "realized part" of system's "potential". Share of "realized" part in "potential" characterizes the "efficiency of system work". Efficiency is "realized potential" per entire "potential" ratio. Such definition of efficiency corresponds to ordinary sense of this term.

"Potential", "conditions of realization" and "efficiency of system work" determine the state of a system. Change in these system variables subject to so-called "normal evolution" can be described by evolution equations formalizing act of 'mechanism of adaptation' and 'entropy principle' only. Derivation of these equations is considered bellow. *These are nonlinear equations even if only linear approximations of direct dependencies between variables are used. It means that CAS works as nonlinear dynamical system.* This nonlinearity of evolution equations is based on properties of structure of CAS and its regulating mechanisms. This fact is very important for understanding of CAS-development. Any linear models of CAS are no satisfactory models since dynamics of CAS is essentially nonlinear dynamics. This statement is fair regarding the economic system in particularly. That is why linear models of economical development we consider as too simplified approach. Therefore the linear economic models are far from reality.

II. Formalization of CAS-structure.

'Potential' and 'conditions of realization' are levels of CAS while activity of a system determine input-flows and entropy principle describes output-flows. Evolution equations can be interpreted as flows-levels balance conditions.

Let's introduce the following designations:

1) Φ - "Potential" of CAS,
2) Φ_R - "Realized part of potential" of CAS,
3) Φ_D - "Unrealized part of potential" of CAS,
4) U - "Conditions of realization" in CAS,
5) A - "Activity" of CAS,
6) $z = \frac{U}{\Phi}$ - "Wealth-density of a system", (1)
7) $R = \frac{\Phi_R}{\Phi}$ - "Efficiency" of CAS. (2)

The following equalities take place:

$$\Phi = \Phi_R + \Phi_D, \tag{3}$$

$$A = \varepsilon \cdot \Phi_R. \tag{4}$$

Expression (3) does not require explanations. Expression (4) formulates direct dependence of "activity" value on "potential" value involved (realized) in this "activity" as a linear connection.

State of CAS could be described by six variables 1) –7) but because of four equations (1) – (4) only three of that variables are independent. Seems to be convenient to use of variables Φ, U and R.

Act of adaptive mechanism leads to reinforcing feedback process: "realized potential" $\rightarrow$ "activity" $\rightarrow$ " increment in realizable potential". In linear approximation:

$$\dot{\Phi}_+ = \mu \cdot A = a \cdot \Phi_R, \tag{5}$$

$$a = \mu \cdot \varepsilon. \tag{6}$$

Increment in "conditions" on account of activity of a system can be described as follows:

$$\dot{U}_+ = \eta \cdot A = \nu \cdot \Phi_R, \tag{7}$$

$$\nu = \eta \cdot \varepsilon. \tag{8}$$

(We use dot as the designation for derivative of time).

We use radioactive decay law as the mathematical model of diminishing of "levels" ("potential" and "conditions") on account of influence of entropy principle:

$$\dot{\Phi}_- = -d \cdot \Phi, \tag{6}$$

$$\dot{U}_- = -\Lambda \cdot U. \tag{7}$$

Signs "plus" in these formulas correspond to input-flows and signs "minus" correspond to output-flows. Let's call parameters, a, d, ν, Λ the "evolution parameters" of a CAS since they determine the evolution properties of a system.

Evolution equations in "normal evolution" case can be formulated as follows:

Increment in a unit of time	Input-flow through "activity"	Output-flow on account of "entropy influence"	
$\dot{\Phi} =$	$\mu \cdot A$	$-d \cdot \Phi$,	(1)
$\dot{U} =$	$\eta \cdot A$	$-\Lambda \cdot U$,	(2)

$$\dot{\Phi}_R = a \cdot \Phi_R . \quad (5)$$

$$A = \varepsilon \cdot \Phi_R , \quad (4)$$

This system of linear equations can be transformed into the following system of nonlinear equations for "potential", Φ, "conditions", U, and "efficiency", R.

$$\dot{\Phi} + d \cdot \Phi = (a + d) \cdot R \cdot \Phi , \quad (8)$$

$$\dot{U} + \Lambda \cdot U = \nu \cdot R \cdot \Phi , \quad (9)$$

$$\dot{R} = (a + d) \cdot R \cdot (1 - R). \quad (10)$$

"Efficiency index", R, is a function of "wealth-density" of a system, $R = R(z)$. The following first-order ordinary differential Yakobi-type equation can be derived from equations (8)-(10) and definition (2).

$$R'_z \cdot [(\nu - (a + d) \cdot z) \cdot R + (d - \Lambda) \cdot z] - (a + d) \cdot R \cdot (1 - R) = 0 \quad (11)$$

Algorithm of solution of this equation is described in [16], №22 (1.3.4) for example. Solution consists of two "branches":

Upper evolution branch:

$$z = z_0 \cdot R - C^{(-)} \cdot R^{-\chi} \cdot (1 - R)^{1+\chi} \text{ s.t. } z < z_0 \cdot R , \quad (12)$$

Lower evolution branch::

$$z = z_0 \cdot R + C^{(+)} \cdot R^{-\chi} \cdot (1 - R)^{1+\chi} \text{ s.t. } z > z_0 \cdot R . \quad (13)$$

$C^{(+)} > 0$ and $C^{(-)} > 0$.

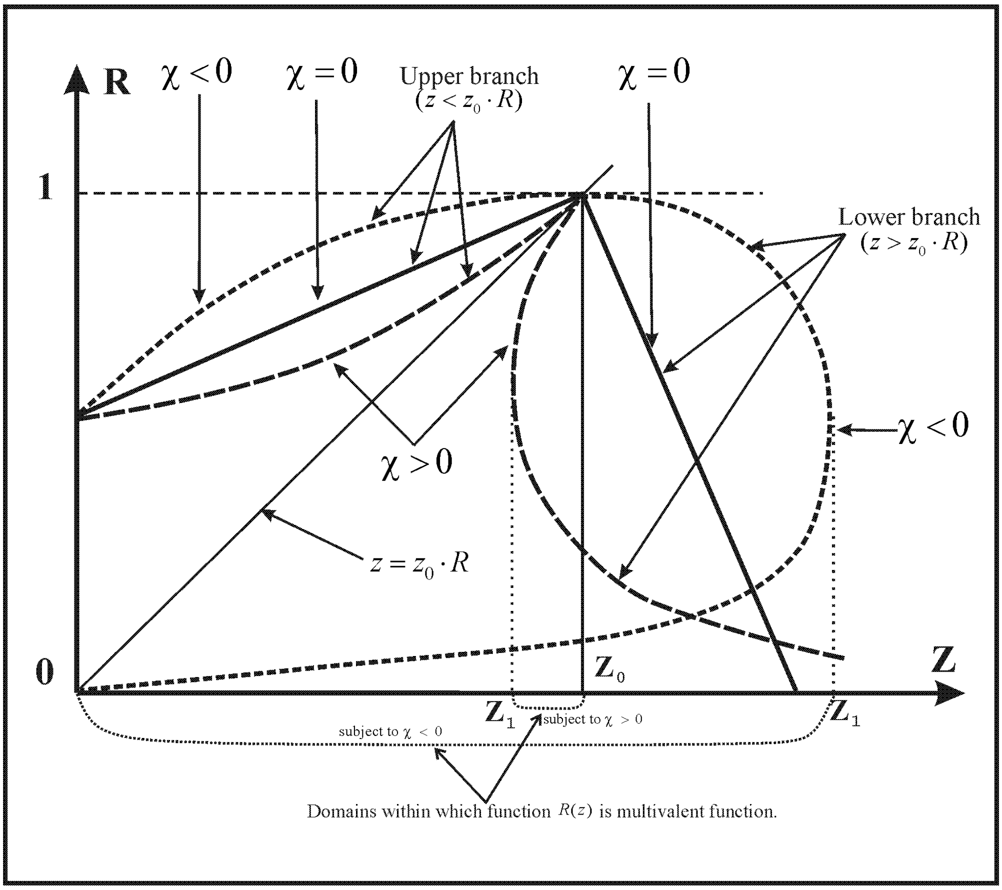
Here the following designations were introduced:

$$\chi = \frac{\Lambda - d}{a + d} \text{ и } z_0 = \frac{\nu}{a + \Lambda}. \quad (14)$$

To distinguish upper branch from lower branch the points on that branches are marked with "plus" and "minus".

$\left(z^{(-)}; R^{(-)}\right)$ - upper branch, $\left(z^{(+)}; R^{(+)}\right)$ - lower branch. (15)

Figure 1. Efficiency as the function of wealth-density of a system.



The following obvious limitations take place:

$$0 \le R \le 1 \text{ и } z \ge 0 . \tag{16}$$

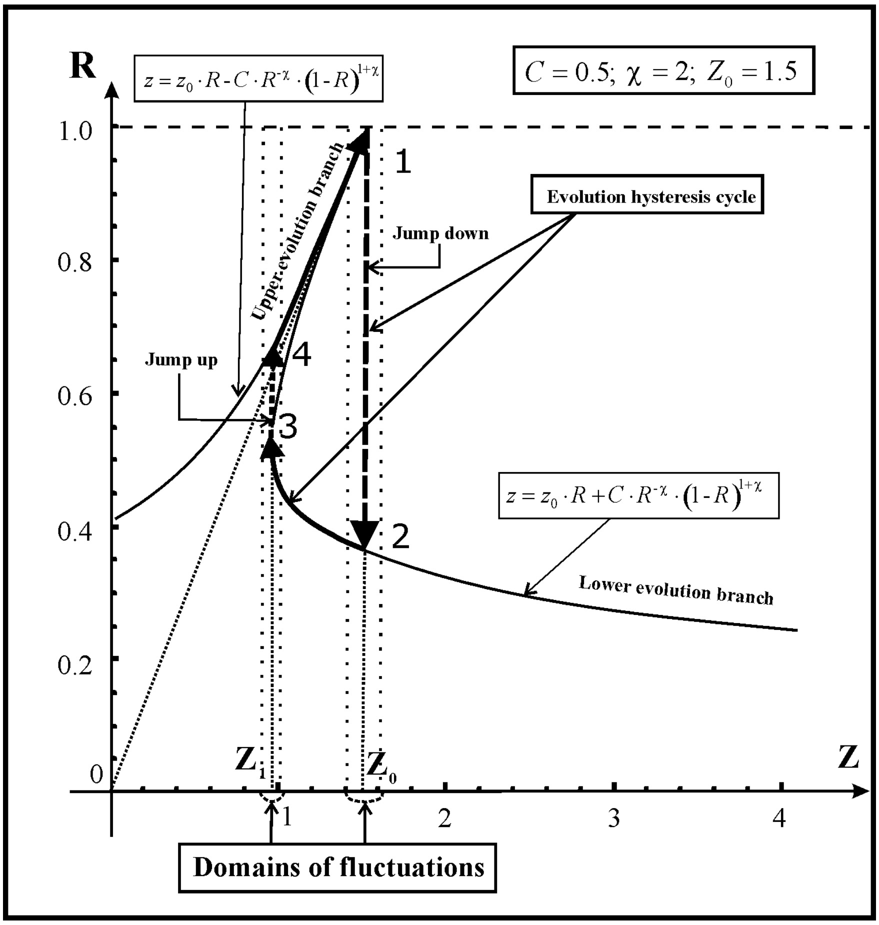
The function $R(z)$ is depictured in Fig.1. The form of graph depends on sign of parameter χ. Three possible cases are represented, $\chi > 0$, $\chi < 0$ and $\chi = 0$.

Formulas (12) – (13) describe the dependence of "efficiency" on "wealth-density". Equation (10) describes the dependence of "efficiency" on the time. Logistic function is the solution of this equation.

$$R(t) = \frac{1}{1 + b \cdot \exp(-(a+d) \cdot t)}, \tag{17}$$

$$b = \frac{1 - R(0)}{R(0)}. \tag{18}$$

Figure. 2. Evolution cycle in Complex Adaptive System according to Method of System Potential.



Case $\chi > 0$ is the most interesting for studying dynamic properties of CAS. In this case the cyclical dynamic of index of efficiency is possible. Curve of graph $R(z)$ in this case has the shape of sharp lopsided ridge of wave, Fig.1 and Fig.2. "Efficiency" of CAS increases by logistical law. This is follow from the equation (10). Trajectory of a system $(z(t);R(t))$ describes one of branches (12) and (13) in the plane $(z;R)$ depending on initial state of a system $(z(0);R(0))$. If "evolutionary parameters" are strongly permanent values and external perturbations of a system are absent, a system is approaching asymptotically to the top of "ridge". However this supposition does not correspond to the reality. In any real CAS "evolutionary parameters" fluctuate near its average values and external perturbations are possible. Besides that there are always casual factors deviating the system from normal trajectory of evolution. Such trajectories could be for example external impacts to the system. In any case trajectory of real CAS will be fluctuate around trajectory (12) and (13). Comes out the question of stability of this trajectory because the function $R(z)$ is multivalent function within the range $(z_1;z_0)$ where z_1 is the point where derivative $R'_z(z)$ on the lower branch turns into infinity. Mathematical solution of this problem does not belong to the framework of this article. We indicate only the result. As the system approaches to the point z1 on the upper evolutionary branch the system becomes less stable to the little fluctuations in "wealth-density", δz, and small external perturbations of a system.

In ε-neighborhoods of points $z_{0;1}$: $|z - z_{0;1}| < \varepsilon$ could be enough any little fluctuation $|\delta z| > \varepsilon$ for the system's jump from upper branch to the low (or on the contrary). In the neighborhood of point z_1 the system jumps out from lower branch to the upper, and in neighborhood of point z_0 from upper to lower branch. These two jumps and smooth development along upper and lower evolutionary branches shaped the cycle dynamic of efficiency index of system's work. These cycles were called "evolutionary cycles" because they arise as an effect of functioning of mechanisms described above. The evolution of CAS is regulated by these mechanisms (Fig.2). Cycles of such type could be described by catastrophe theory methods. Jumps described above could be considered as the mathematical catastrophe of evolution of CAS. Cyclical changes of system's efficiency lead to "wavy" trajectory of system in the plane $(\Phi;U)$.

Let us list some of properties of evolutionary cycle.

1. **Evolutionary cycle (Fig.2) consists of four phases:** 1) Phase of system's movement along the upper branch (phase of prosperity, (4→1); 2) phase of jump from upper to the lower branch (phase of crisis or recession, (1→2); 3) phase of gradually growth on the lower branch (phase of depression, (2→3); and 4) phase of rehabilitation of normal order of system's work, upwards jump (phase of revival, (3→4).

2. **Duration of evolutionary cycle is a causal (random) value (variable).** Its mean depends on average of fluctuations δz in points of jump z_1 and z_0. Followed by the formula (16) duration of phase of depression and prosperity could be calculate via the formula:

$$T = \frac{1}{a+d} \cdot Ln\left(\frac{\frac{1}{R_{\min}} - 1}{\frac{1}{R_{\max}} - 1} \right); \tag{19}$$

where $R_{\min}$ and $R_{\max}$ are maximal and minimal values R in the definite phase of the cycle.

In depression phase:

$$R_{\min} \approx R^{(+)}(\tilde{z}_0); \qquad R_{\max} \approx R^{(+)}(\tilde{z}_1); \tag{20}$$

In prosperous phase:

$$R_{\min} \approx R^{(-)}(\tilde{z}_1); \qquad R_{\max} \approx R^{(-)}(\tilde{z}_0); \tag{21}$$

$$\tilde{z}_0 = \max\left[z^{(-)}(t) \middle| \; z(t) + \delta z > z_0\right]; \; \tilde{z}_1 = \min\left[z^{(+)}(t) \middle| \; z(t) + \delta z < z_1\right]. \tag{22}$$

3. **Duration of phase of crisis and revival** (jumps from one evolutionary branch to another) **much less than duration of phases of prosperity.** Jump by the definition is very rapid process. Durations of phases of jumps could not be determined by formula (19). Phases of jumps correspond to the process of new distribution of "potential" to realizable and not realizable parts of the "potential". These processes could be symbolically considered as spilling over the "potential" from reservoir of realizable part to reservoir of non-realizable part (crisis) or to the opposite side (phase of revival). In actual system (for example economical) there are complicated processes of retuning system to the new mode of work behind those processes of potential redistributing between two reservoirs (realizable - unrealizable).

4. **Duration of phase of depression should exist, as a rule, less than phase of prosperity.** It follows from this that duration of phase of depression tend to a finite quantity (limit, value), and duration of phase of prosperity if $\delta z \to 0$. It follows from formulas (19) –(20).

III. Business Cycle as Evolution Cycle of the Economic CAS.

Let's discuss bellow the hypothesis:

The business cycle could be described by mentioned-above evolutionary cycle.

Westley C. Mitchell [8;9] with colleagues from National Bureau of Economical Research have done enormous work of collection and analyses of large number of data about business cycles passing in different countries. Finally they found a row of properties of these cycles.

- They conclude that especially 4th phased scheme recession → depression → revival → prosperity is the best description of peculiarities of typical business cycle.
- They found that duration of phase of crisis (recession) and revival much less than two other phases – depression and prosperity. In the most cases the phase of prosperity is longer then phase of depression.

> "…The phases of recession and revival are relatively brief. Put together, they account for only one-quarter of the duration of business cycles on the average. On the remaining three-quarters, the prosperous phase occupies a somewhat longer time, than the phase of depression" ([8]; p.420).

- Willard L. Thorp found that phase of depression is getting longer in so-called long cycles. This fact could be explained by sudden (abrupt) change in evolutionary parameters of system. Such abrupt change in evolutionary parameters could be called a mutation of system. If as the result of mutation is location of point z0 at the moment of crisis quickly moved to the left than following by that phase of depression becomes longer (Fig.3). For example deepness and long duration of Great Depression in 1930th in the USA are explained by just such mutation.

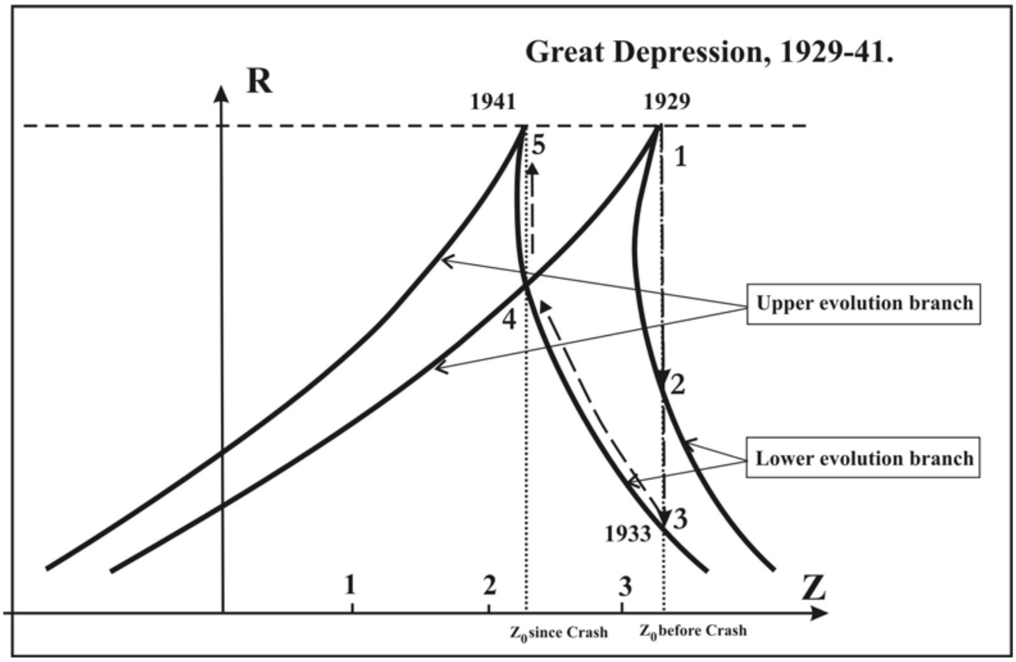
> "Dr. Thorp has made a special examination of these long cycles… The average phase of depression in these long cycles is nearly a year longer than the average phase of prosperity" ([8]; p.411-412)

- Bar graphs of distributions of cycle durations produced by Westley C. Mitchell (chart 24, [8]) testifies that duration of cycle has the property of casual value.

These properties of business cycles discovered by research of Westley C. Mitchell and Williard L. Thorp [8; 9], are completely correspond to mentioned-above properties of evolutionary cycle. This result confirms our hypothesis about evolutionary nature of business cycles.

We suggest to identify evolutionary cycle of economical system and the system with business cycle. It is known that dynamic of economical indexes demonstrates evidence of several cyclical components with different periods: Kondratief' long waves, construction cycles, inventory cycle, agricultural cycle. Seasonal cycles and some other of cyclical oscillations of economical system could be added. Economic System is a very complicated system consisting of large number of subsystems which could be also considered as autonomic systems. The stronger interdependence of all of these systems the more Economic System in general is a holistic CAS regulated by described-above mechanisms of entropy and adaptation. There is a level of interdependence of parts Economic System begins work as a single whole (wholeness). This single whole develops by general law of cyclical evolution and all parts of system involved to this common cyclical process. Phases of evolutionary cycle are covering all subsystems of Economic System. As a result *each subsystem of economics besides its own cyclical dynamic participates in united (entire) cyclical process of economical system as a single whole.*

Figure 3. Mutation of Economic System as the cause of prolongation of depression phase of evolution cycle – the Great Depression of 1930-s.



This impact of economical system to dynamic of its subsystems becomes evidence when Economics gains properties of holistic organism. That means absence of administrative barriers (red tapes) for goods (production) movements, resources and information within the country, high level of division of labor, existence of developed net of transport and information communications, flexible system of storage and trade, presence of highly developed markets of goods, services, resources, capital, etc. Such degree of unity of Economic System reaches because of capitalistic mode (way) of production (manufacture). Processes of formation of holistic Economic System took place in different periods of time in different European countries. United Economic System has formed before the beginning of 19 century in the majority of different developed European countries. History of general economical crises in fact began from that time.

General economical crises were completely new phenomenon that was unknown neither in 16 nor in 17 century. Their peculiarity is they are begin usually suddenly without any visible causes. Crises of old times usually connected to some unlucky concourse of circumstances – war, bad harvest, natural adversities, discoveries of new deposits of resources of new trade ways (paths). Crises of old times usually covered only one (special, individual) of units (parts) of Economics. The causes of them are known. That is why to overcome those crises was enough to remove the reasons of them.

Crises of the New Time could not be overcome in just simple way. These crises mention thunderclap in broad clear sky (like a bolt from the blue). They suddenly begin when business goes fine (in common opinion), industry is prospering, and profits and incomes are rising. They usually begin from not significant event; at first site could not be a reason of collapse in Economics. For example it could be abrupt failure of actions at stock exchange. At the other places and times such event although affects to the state of business but do not lead to the such crisis as took place in Economic of USA after New York stock exchange's failure in October 1929. Financial collapse not always gives birth to the general crisis and could not be a reason for it. Event which crisis could begin from might be a lateral but able to stimulate the crisis development. It could be a change in bank rates, unsuccessful government regulation, bad news from abroad (foreign countries), etc. Such events play roles of impulses, which deregulate economical system, upset the balance and activate the mechanism of general crisis development. Those events do not impact to the

Economics while the state of the system is stable (the system is in a stable equilibrium). But their influence could be enough to offer a irreversible consequences in unstable system. The time before the crisis is the time when the system is loosing its stability.

At this time not significant in country scale unpleasant event could be an impulse leading to general crisis.

From the position of Method of Systems Potential the general crisis is a failure of economical system as a single whole from upper branch to the low (1→2). Could be suggested that evolutionary cycle presents itself in an economical system as a business cycle of economical system as a single whole. Mentioned-above phases of evolutionary cycle correspond to (coincident with) known phases of business cycles: crisis → depression → revival → prosperity. Typical business cycle reproduces the qualitative pattern of all main peculiarities of evolutionary cycle.

1) Typical economical crisis begins suddenly on the background of general prosperity, i.e. when effectiveness of economical system is close to maximum, and system becomes low stable (left neighborhood of point z0 on the upper evolutionary branch).

2) Impulse that put out the system from low balanced state activates the process of failure of system from upper branch to lower. Any fluctuation, for example a collapse of stock market could become such impulse. Jump from upper branch to lower is really a phase of crisis. Mathematically those jump means the catastrophe existence in evolutionary cycle. Processes of accumulated potential redistribution between two reservoirs - "realizable" and "unrealizable" potential – correspond to that phase. Neither quality of conditions in a system, U, nor potential value, Φ, in phase of jump do not change essentially (too much). Wealth-density, $z = \frac{U}{\Phi}$, still constant, and jump reminds a fall of system from upper evolutionary branch to lower. Reduction of realizable part of potential accumulated by system appears in abrupt reduction in employment and output. Out-of-work (standing) equipment and unemployment means that part of not realized potential rises steeply. A result of new division of potential by realizable and unrealizable is abrupt failure of system's work efficiency index, $R = \frac{\Phi_R}{\Phi}$.

3) After phase of jump downwards follows long enough period of stagnant course of affairs - depression. This is phase of movement on lower evolutionary branch. This is the time of new ways of conduction on affairs, implementation of new technologies and innovations. As system approaches to the point z_1 the state of system on the lower branch becomes less and less stable. This gradually loss of stability of system's position on the lower branch means more and more increasing ability of business to conduct affairs in a new ways with those new technologies and methods which were implemented during phase of depression. Finally abrupt and quick reanimation of economics begins and a new phase of prosperity comes. Jump up is realized by increasing of realizable part of potential. Distribution of accumulated potential comes into being again. By the difference from jump down potential pours to reservoir of realizable potential of system. Out-of-use equipment and human potential are involving to the production process again but on the new technical and organizational base.

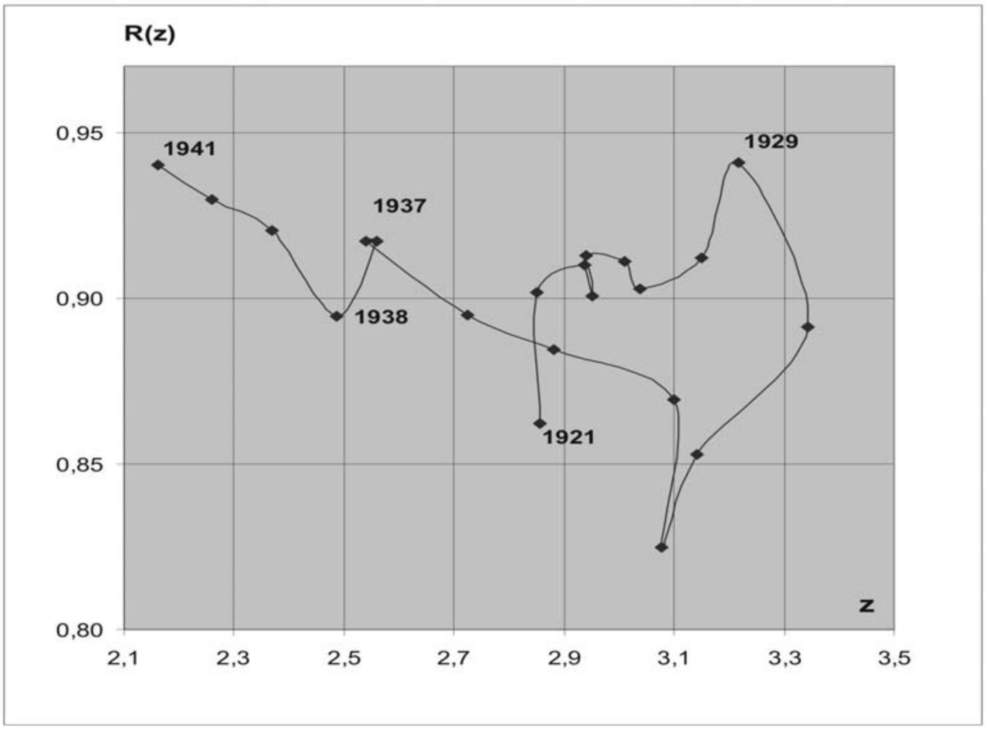
4) Dynamics consisting from phases of smooth determinate development along definite evolutionary branch and system's jumps from one evolutionary branch to another in a quality pattern are the same as dynamics described by George G. Malinetsky [7]. Phase of smooth development along definite evolutionary branch has the property of "channel flow", and phase of jump has the property of "joker". MSP predicts a possibility of three

kinds of jumping modifications of the system's state: 1) jumps of evolutionary cycles, 2) jumps caused by abrupt outer impacts to the system, 3) jumps connected to system's mutations (abrupt changes of its evolutionary parameters). In all three cases the position of system in space changes steeply. It is probably impossible to predict this change although in some cases approximately the most possible direction of jump could be indicated (pointed out).

Suggested here way of understanding of evolution of CAS and in particular of Economic System could be verified on the base of statistical data. To the terms "potential", "conditions of realization", and "efficiency" might be given the simple and clear meaning. These values depend on macro-economical parameters of system and that is why they are measurable.

Evolutionary parameters, a, d, ν and Λ of Economic System are well-known economic values and in broad use of contemporary economical theory. At the first approximation parameter Λ describes the depreciation rate of fixed capital, parameter ν - rate of investment, parameter a – rate of growth of output. "Potential" of Economic System in the first approximation might be evaluated by use of total costs in economics subject to maximal profit rate (cost-function). In this approximation "conditions of realization" is the fixed capital of nation. Detailed description of MSP application in economics is overcoming the frames of this article. The result of statistical data processing for Economics of the USA in period of 1922-1941 on the basis of MPS-approach is presented in the **Diagram 1.** Several sources of data were used in calculations [4,6,10,14,15]. Although accounts were completed on the base of simplified suppositions obtained results generally fit to the MSP. Apparently that period of 1922-1929 is a period of economical system's movement on upper evolutionary branch. Period of 1929-1933 is period of failure from upper branch to the lower. This failure was accompanied by abrupt removal of maximum point, z_0, mutation of economical system. Fact of mutation is confirmed by abrupt change of rate of investments (parameter ν), and rate of growth of output (parameter a) after 1933 year. Formula (14) for value z_0 is confirmed with a good degree of accuracy.

Diagram 1. Trajectory of economical system of USA in plane $(z;R)$ in the period of 1921-1941.



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