UDC 330.4(045)

THE CATASTROPHE THEORY AS A CONCEPTUAL AND METHODOLOGICAL BASIS FOR ASSESSING THE STABILITY OF SOCIO-ECONOMIC SYSTEMS

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Sergienko O. A., Golofaieva I. P., Tatar M. S.

The Catastrophe Theory as a Conceptual and Methodological Basis for Assessing the Stability of Socio-Economic Systems

There has been proposed a conceptual approach to studying the instability of main indicators of socio-economic development of Ukraine's economy aimed at solving problems of assessment, analysis and forecasting the state of territorial systems and providing for the implementation of three major steps: assessment of the dynamics of socio-economic indicators of territorial development and the extent of their relationship, building catastrophe models of dynamics of socio-economic indicators of territorial development, analysis of instability of socio-economic systems. A study of the development dynamics of Ukraine's economy in terms of the most significant macroeconomic indicators characterizing the state of industrial production, construction, employment, and demographic processes have been carried out. There revealed the instability and non-linearity of their relationship, occurrence of bifurcations and a high probability of catastrophes in the following research areas: dependence of the GDP on the volume of construction works, which makes it possible to determine the presence of the construction crisis in the economy; dependence of the GDP on the level of migration and natural increase in the population of Ukraine, which presents objective information about the demographic crisis in the country. The analytical results obtained can serve a basis for of the concept of regional policy transformation, implementation of investment and strategic programs aimed at stimulating investment of progressive structural changes in the regional and territorial perspective and crisis management.

Keywords: *socio-economic system (SES), macroeconomic indicators, catastrophe theory, bifurcation theory, instability, assessment, analysis, forecasting, development trajectory.*

Fig.: *9.* ***Formulae:*** *13.* ***Bibl.:*** *16.*

Sergienko Olena A. *– Candidate of Sciences (Economics), Associate Professor, Associate Professor, Department of Higher Mathematics, Kharkiv Educational and Scientific Institute of the SHEI «Banking University» (55 Peremohy Ave., Kharkiv, 61174, Ukraine)*

E-mail: *ser_helenka@ukr.net*

Golofaieva Iryna P. *– Candidate of Sciences (Economics), Associate Professor, Associate Professor, Department of Finance, Simon Kuznets Kharkiv National University of Economic (9a Nauky Ave., Kharkiv, 61166, Ukraine)*

E-mail: *irinaa_g@ukr.net*

Tatar Maryna S. *– Candidate of Sciences (Economics), Associate Professor, Department of Finance and Audit, National Aerospace University «Kharkiv Aviation Institue» named after M. Ye. Zhukovskiy (17 Chkalova Str., Kharkiv, 61070, Ukraine)*

E-mail: *marina.sergeevna.tatar@gmail.com*

УДК 330.4(045)

Сергиенко Е. А., Голофаева И. П., Татар М. С. Теория катастроф как концептуально-методологическая основа оценки неустойчивости развития социально-экономических систем

Предложен концептуальный подход к исследованию неустойчивости основных индикаторов социально-экономического развития экономики Украины, направленный на решение задач оценки, анализа и прогнозирования состояния территориальных систем и предусматривающий реализацию трех основных этапов: оценку динамики социально-экономических индикаторов территориального развития и степени их взаимосвязи; построение моделей катастроф динамики социально-экономических индикаторов территориального развития; анализ неустойчивости развития социально-экономических систем. Проведено исследование динамики развития экономики Украины по наиболее значимым макроэкономическим индикаторам, которые характеризуют состояние процессов промышленного производства, строительства, занятости населения и демографических процессов; выявлена неустойчивость и нелинейность их взаимосвязей, возможность бифуркаций и высокая вероятность катастроф по следующим направлениям исследования: зависимость ВВП от объема строительных работ, что дает возможность определить наличие строительного кризиса в экономике; зависимость ВВП от уровня миграции и естественного приро-

УДК 330.4(045)

Сергієнко О. А., Голофаєва І. П., Татар М. С. Теорія катастроф як концептуально-методологічна основа оцінки нестійкості розвитку соціально-економічних систем

Запропоновано концептуальний підхід до дослідження нестійкості основних індикаторів соціально-економічного розвитку економіки України, що спрямований на вирішення завдань оцінки, аналізу та прогнозування стану територіальних систем і передбачає реалізацію трьох основних етапів: оцінку динаміки соціально-економічних індикаторів територіального розвитку і ступеня їх взаємозв'язку; побудову моделей катастроф динаміки соціально-економічних індикаторів територіального розвитку; аналіз нестійкості розвитку соціально-економічних систем. Проведено дослідження динаміки розвитку економіки України за найбільш значущими макроекономічними індикаторами, які характеризують стан процесів промислового виробництва, будівництва, зайнятості населення та демографічних процесів; виявлено нестійкість і нелінійність їхніх взаємозв'язків, можливість біфуркацій та високу ймовірність катастроф за такими напрямками дослідження: залежність ВВП від обсягу будівельних робіт, що дає можливість визначити наявність будівельної кризи в економіці; залежність ВВП від рівня міграції і природного приросту населення України, що являє собою об'єктивну інформацію про наявність демо-

ста населения Украины, что представляет собой объективную информацию о наличии демографического кризиса в государстве. Полученные аналитические результаты могут быть положены в основу концепции трансформации региональной политики, реализации инвестиционно-стратегических программ, ориентированных на стимулирование инвестирования прогрессивных структурных сдвигов в регионально-территориальном ракурсе и антикризисного управления.

Ключевые слова: *социально-экономическая система (СЭС), макроэкономические показатели, теория катастроф, теория бифуркаций, неустойчивость, оценка, анализ, прогнозирование, траектория развития.*

Рис.: *9.* ***Формул:*** *13.* ***Библ.:*** *16.*

Сергиенко Елена Андриановна *– кандидат экономических наук, доцент, доцент, кафедра высшей математики, Харьковский учебно-научный институт ГВУЗ «Университет банковского дела» (пр. Победы, 55, Харьков, 61174, Украина)*

E-mail: *ser_helenka@ukr.net*

Голофаева Ирина Петровна *– кандидат экономических наук, доцент, доцент, кафедра финансов, Харьковский национальный экономический университет им. С. Кузнеца (пр. Науки, 9а, Харьков, 61166, Украина)*

E-mail: *irinaa_g@ukr.net*

Татар Марина Сергеевна *– кандидат экономических наук, доцент, кафедра финансов и аудита, Национальный аэрокосмический университет им. Н. Е. Жуковского «Харьковский авиационный институт» (ул. Чкалова, 17, Харьков, 61070, Украина)*

E-mail: *marina.sergeevna.tatar@gmail.com*

графічної кризи в державі. Отримані аналітичні результати можуть бути покладені в основу концепції трансформації регіональної політики, реалізації інвестиційно-стратегічних програм, орієнтованих на стимулювання інвестування прогресивних структурних зрушень у регіонально-територіальному ракурсі і антикризового управління.

Ключові слова: *соціально-економічна система (СЕС), макроекономічні показники, теорія катастроф, теорія біфуркацій, нестійкість, оцінка, аналіз, прогнозування, траєкторія розвитку.*

Рис.: *9.* ***Формул:*** *13.* ***Бібл.:*** *16.*

Сергієнко Олена Андріанівна *– кандидат економічних наук, доцент, доцент, кафедра вищої математики, Харківський навчально-науковий інститут ДВНЗ «Університет банківської справи» (пр. Перемоги, 55, Харків, 61174, Україна)*

E-mail: *ser_helenka@ukr.net*

Голофаєва Ірина Петрівна *– кандидат економічних наук, доцент, доцент, кафедра фінансів, Харківський національний економічний університет ім. С. Кузнеця (пр. Науки, 9а, Харків, 61166, Україна)*

E-mail: *irinaa_g@ukr.net*

Татар Марина Сергіївна *– кандидат економічних наук, доцент, кафедра фінансів і аудиту, Національний аерокосмічний університет ім. М. Є. Жуковського «Харківський авіаційний інститут» (вул. Чкалова, 17, Харків, 61070, Україна)*

E-mail: *marina.sergeevna.tatar@gmail.com*

Introduction. In the modern transformational economy of Ukraine there is a persistent trend of the review of basic approaches to choosing ways and tools for economy modernization and territorial reformation. The role and significance of the regional development policy as a system of coordinated control over development of territorial units aimed at damping crisis fluctuations and intensifying the domestic economy transition to a new progressive level is increasing. At the early transformation period the regional policy had a situational character and was only a component of the economic policy. At present the tools of socio-economic development irregularity are widely used in government regulation of Ukraine`s economy at the regional level [3; 6]. The experience of many European countries in regional development management and formation of a competitive national economy is being studied thoroughly. Thus, the analysis of some researches of both developed and developing countries showed that the adequate regional policy in their transition period was a key factor in the successful transformation, restoration and rapid modernization of the economy that essentially encouraged investments and innovations [4; 7].

Besides, new scientific concepts are put forward to the forefront of the modern science, in particular the system-synergetic ones, which allow enriching the development and management theories interpreting the role of the state in the economy in a new way and necessitating a new flexible management approach depending on the development phase of the controlled self-organizing system upon conditions of uniformity of all its local constituents.

Research methods. The close attention to the bifurcations and catastrophe theory is quite natural under conditions of the current economic crisis [5; 10]. The catastrophe theory reveals various aspects in studying qualitative changes and transition processes. It considers the transformation process in the context of organization of transition processes in time and space. The analysis directions, which open for studying the content side of quality transformation and transition processes in modern economy at using this concept, are considered important, too.

The catastrophe theory is a conceptual and methodological basis for studying and forecasting of volatility of different systems [1; 2; 4] and is considered as a component of such a modern scientific direction as synergetics. Speaking about the problems of socio-economic development of territories under the growing influence of the external environment, there should be mentioned two ways of using tools of the catastrophes theory: the first is associated with analyzing the mechanisms of loss of the system stability, the second is associated with the possibility of finding a new steady condition. Analytical tools for the development of each of the selected directions are not identical: in the first case the analysis is based on the developed in the catastrophe theory concept of critical levels, thresholds in the dynamics of individual indicators; in the second case the analysis is based on the studying of attraction properties [2; 7; 10]. In the first case the practical significance of the catastrophe theory is determined by the description of the basic parameters of a balanced territory development, identification of critical levels of these parameters and possible solutions for the efficient development at all hierarchical levels of the socio-economic systems (SES).

Since the loss of the system stability takes place in response to the action of spontaneous mechanisms of development, the conclusions of the catastrophe theory are fully applicable to the analysis of conditions under which the system ceases to grow sequentially in the dynamics and enters the bifurcation phase [12; 14]. Considered from this perspective, the conclusions of the catastrophe theory are the most relevant to the analysis of the conditions, which allow avoiding unwanted bifurcations and catastrophic loss of the enterprise stability that happens in the under the current crisis [8; 9].

In practice, predicting the loss of stability and change in the quality system using catastrophe theory approaches is carried out in various ways. One of them is building a catastrophe model in the investigated system based on the data on the interrelation of variables characterizing its behavior [6].

The socio-economic system is a speed, multi-level system, and any uncertainty, randomness in the input parameters at its lower levels lead to uncertainties and contingencies in the output parameters of the higher subsystems and the system as a whole. By certain characteristic features in such a system it can be assumed that the system contains a catastrophe. The presence of a catastrophe is indicated by special critical points of the family of potential functions, which describe a system or phenomenon. However, these points can not be recognized immediately. Yet, catastrophes are inherent to all phenomena and processes and therefore, it's important to be able to recognize them on time. Catastrophes have their distinctive features — «catastrophe flags» [2; 4; 11].

As soon as one of these flags is identified in the cause of the study, i.e. a feature indicating the presence of a catastrophe in a system is defined, the control parameters of the system can be modified so as to discover other flags, which will necessarily become apparent under appropriate conditions. Identifying the presence and type of a catastrophe in the case of uncertainty in the system description allows to define:

- the simplified model potential function that depends only on significant state variables and control parameters;
- structurally stable part of the potential function, for which it is possible to predict how the process actually takes place;
- the type of equation for the system and the value of parameters of the potential function, which describes it.

Studying the basic characteristics and properties of catastrophic events allows formulating basic assumptions of the catastrophes theory, which can be applied to the modeling of development of complex socio-economic systems [5; 6; 8]:

- the system is a dynamic one, i.e., its state changes in time;
- the principle of maximum delay: the system seeks to maintain its state as long as possible;
- the current state of the system depends on the way by which the system has reached this state;
- the system trajectories are irreversible, i.e., when changing the control parameters of the system exactly in the opposite way, the system does not necessarily come to the initial state.

Catastrophes that occur in gradient systems are the most studied in economic applications [1; 2]. The gradient system is a system which dynamics is set by the equation:

$$\dot{x} = \nabla V(x,a) \quad (1)$$

where $V(x, a)$ – potential function;

a – vector of parameters;

x – vector of phase coordinates of the system.

In this case the catastrophe surface is a set of equilibrium points (equilibrium surface). It is set by the relationship:

$$M = \left\{ (x,a) \in \mathbf{R}^n \otimes \mathbf{R}^k : \left(\frac{\partial V}{\partial x} \right) = 0 \right\}. \quad (2)$$

The critical points at which the condition $\det\left(\frac{d^2V}{dx_i dx_j}\right) = 0$ is met are called non-isolated, degenerate or non-Morse ones.

Points (x, a) in the space of state variables and function parameters for which

$$\det\left(\frac{d^2V}{dx_i dx_j}\right) = 0, \quad (3)$$

are a set of singularity, i.e.,

$$S = \left\{ (x,a) \in \mathbf{R}^n \otimes \mathbf{R}^k : \ \det\left(\frac{d^2V}{dx_i dx_j}\right) = 0 \right\}. \quad (4)$$

Accepting the notation $V_{xx} = \left(\frac{d^2V}{dx_i dx_j}\right)$ for the stability matrix of the dynamical system, the projection of the singularity set onto the parameter space is a bifurcation set:

$$B = \{ a \in \mathrm{R}^k : V_{xx} = 0 \}. \quad (5)$$

If the potential function depends on one or more control parameters the matrix of stability V_{xx} and its own values also depend on these parameters. In this case it is possible that at some values of control parameters one or more eigenvalues of the matrix of stability may equal to zero. Then the representation of the potential function in a quadratic form is impossible. However, it is possible to find some splittance, which allows to determine the coordinates corresponding to zero eigenvalues and others:

$$V(x,c) = Cat(l,k) + \sum_{j=l+1}^{n} \lambda_j(c) {y_j}^2, \quad (6)$$

or, under certain additional conditions,

$$V = CG(l) + \sum_{j=l+1}^{n} \lambda_j y_j^2, \quad (7)$$

where $Cat\ (l, k)$ – catastrophe function:

$$Cat\ (l, k) = CG(l) + Pert(l, k),$$

where $CG(l, k)$ – germ of catastrophe,

$Pert(l, k)$ – disturbance,

l – the number of zero eigenvalues of the stability matrix.

The parameters of the potential function can also define the number and nature of its extremes. The classification of elementary catastrophes (kapsoid and umbilic) with their basic properties and behavior are presented in [2; 4; 6; 8].

However, the conclusions of the catastrophes theory can not be interpreted as clear-cut and straightforward for qualitative changes of the system related to its transition to a new steady state. The intermittent single-step transition to a new stable state hypothetically considered by the theory of catastrophes can serve a basis for recommendations on the transition to a new steady state and possibility to receive suggestions on how to make the system go into a state recognized as an optimal one on the basis of the theory of catastrophes. Thus, the theory of catastrophes considers the limiting states of the system development in the aspect of its stability and instability, so on this basis it is possible to get only a general idea of the conditions that accompany the transition of a system from one state into another.

Results of the research. The paper presents a conceptual approach to studying instability of main indicators of socio-economic development of Ukraine's economy, aimed at solving the problems of the assessment, analysis and forecasting of the state of territorial systems. This approach comprises the implementation of three main stages, which are presented in Fig. 1.

According to the proposed algorithm, modeling the instability of social and economic development of territorial systems should be considered in accordance with the relevant stages of transformational changes of Ukraine and its regional economy [3; 16]. The investigation of dynamics of the systems' development in terms of their most important macroeconomic indicators, which characterize the state of the process of industrial production, construction, employment, and demographic processes, increase in volatility and non-linearity of the relationship, an actual possibility of bifurcations and high probability of catastrophes have determined the following areas of research:

- the dependence of the GDP on the volume of construction works, which makes it possible to determine the presence of a construction crisis in the economy;
- the dependence of the GDP on the migration level

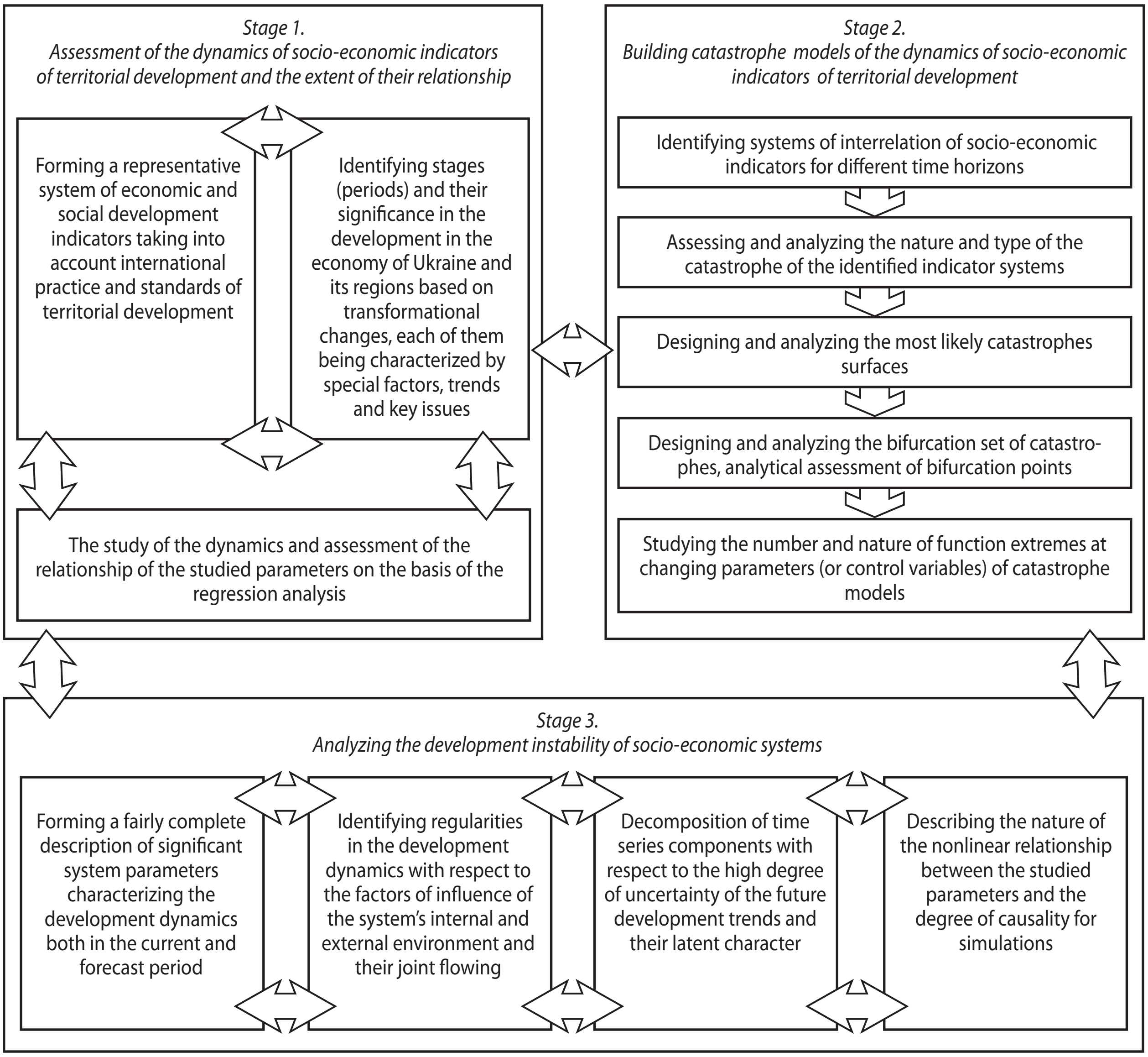


Fig. 1. Conceptual basis of studying the instability of socio-economic systems

and natural increase in the population of Ukraine. These indicators can provide some objective information about the presence of a demographic crisis in the country.

The most adequate model of kapsoid catastrophe of the «wigwam» type for the studied period of instable economic development of Ukraine's economy (2010-2015) built on the basis of monthly initial data [13; 16] (the coefficient of determination is R^2 = 0,92), the approximating relationship between the growth rate of the volume of construction works (x_1) and the rate of GDP growth (y) in the canonical form is as follows:

$$y = x^7 - 28.904\,x^5 + 96.993x^4 - 122.717\,x^3 + 58.964\,x^2 - 3.749\,x \quad (8)$$

The results of assessing the parameters of the catastrophe model of the "wigwam" type by means of the application software package (ASP) *Statistica* are shown in Fig. 2.

	Model is: v1 = v8^7 + a1* (v8^5) + a2 * (v8^4) + a3 * (v8^3) + a4 * (v8^2) + a5 * v (кур) Dep. Var.: GDP Level of confidence: 95.0 % (alpha = 0.050)					
	Estimate	Standard error	t-value df = 54	p-level	Lo. Conf Limit	Up. Conf Limit
a1	-28,904	0,469471	-61,5675	0,000000	-29,845	-27,963
a2	96,993	2,560107	37,8862	0,000000	91,860	102,125
a3	-122,717	4,924924	-24,9174	0,000000	-132,590	-112,843
a4	58,964	3,947930	14,9354	0,000000	51,049	66,879
a5	-3,749	1,162706	-3,2242	0,002145	-6,080	-1,418

Fig. 2. Assessing the parameters of the catastrophe model of the «wigwam» type

The catastrophe surface in the three-dimensional space is represented in Fig. 3.

The system of equations describing the bifurcation set of the catastrophe (the bifurcation set is a projection of the singularity onto the parametric space) is presented below:

$$\begin{cases} 7x^6 - 144.52x^4 + 387.972x^3 - 368.151x^2 + 117.928x - 3.749 = 0 \\ 42x^5 - 578.08x^3 + 1163.916x^2 - 736.302x + 117.928 = 0 \end{cases} \quad (9)$$

Graphically the bifurcation set of the «wigwam» catastrophe type in the three-dimensional space is shown in Fig. 4.

The bifurcation set is a set of parameter values, which provides a possibility of a number of different system states, i.e. the same value of X may correspond to a set of values of Y. The presence of a range of such X values [X1; X2] leads to the possibility of catastrophic changes in the system state [5; 11].

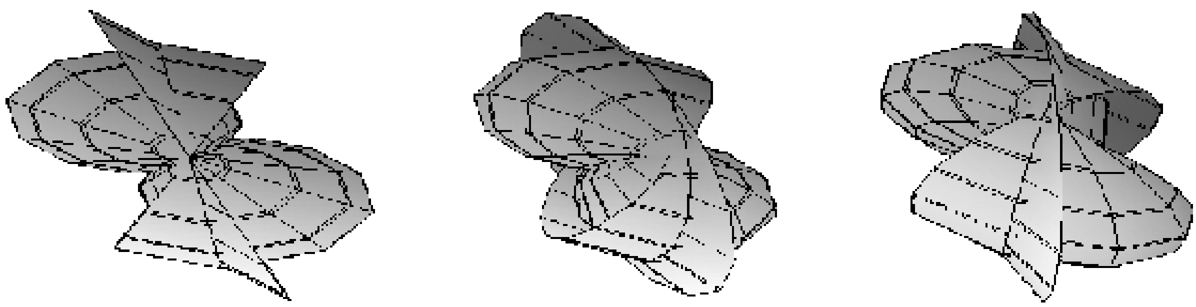


Fig. 3. The catastrophe surface of the "wigwam" type, the approximating relationship between the volume of construction works and the GDP

The analysis of the system of equations, which describe the bifurcation set, allows to draw the following conclusions:

- if the system describing the bifurcation set vanishes at the observed variables it indicates the catastrophe occurrence at the studied point;
- the closer is the equation system to the zero value, the closer is the system to the conditions of catastrophic jump, the system loses its stability.

The analytical solution of -the equation system describing the bifurcation set of the "wigwam" type of catastrophe in *Maple* is:

$$solve\,(7\cdot x^6 - 144.52\cdot x^4 + 387.972\cdot x^3 - 368.151\cdot x^2 + 117.928\cdot x - 3.749 = 0);$$

$$0.0356007582,\ 1.05951030628,\ 1.246493434,\ 1.754745756,\ 2.038019344,\ -5.670053255 \quad (10)$$

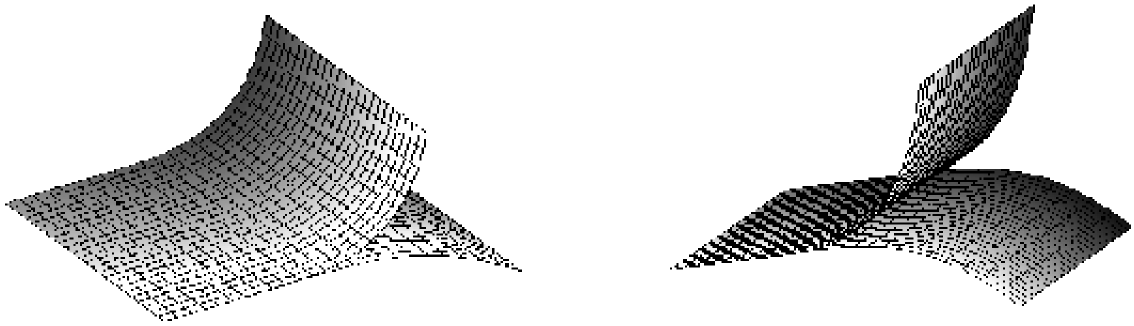


Fig. 4. Bifurcation set of the «wigwam» type of catastrophe

$$solve\ (42 * x\wedge 5 - 578.52 * x\wedge 3 + 1163.916 * x\wedge 2 - 736.302 * x + 117.928 = 0);$$

$$02410838579,\ 0.8848736845,\ 1.502436676,\ 1.924240179,\ -4.552634397 \qquad (11)$$

The system's behavior at a bifurcation point, which represents a breaking, critical moment in the system development (i.e., this is a branching point of development options at which the catastrophe occurs) has general behavior patterns, many of them being revealed on the basis of self-organization concepts [4]. Thus, the system development takes place during the movement from one bifurcation point to another. The system chooses the path of its development, the trajectory of its movement at each bifurcation point.

The occurrence of such catastrophic stage — a jump in the system development — is possible only when the system parameters reach their certain threshold (critical or bifurcation) values under the influence of internal and/or external fluctuations. Thus, the more complex the system is, the more bifurcation values it contains, i.e., the wider the range of conditions under which instability can occur.

When the values of parameters are close to critical, the system is particularly sensitive to fluctuations: small impacts are enough for the system to jump into a new state through the unstable area. For catastrophic transition of the system it is necessary that the system's parameters as well as environmental ones (control parameters) reached the bifurcation values and were in the attainability domain.

The frame-based animation of the dependence of the system's behavior on the control parameters, on the basis of analysis of which the structural stability of the system can be estimated, is presented in Fig. 5. So, at changing the parameters in the catastrophe model the potential function practically does not change the number and nature of its extremes, which confirms the relative stability of the structural features describing the process.

The most adequate for the studied period is the model of the umbilical catastrophes of the «elliptical umbilic» type, which is built on the basis of monthly data [15; 16] (the coefficient of determination is $R^2 = 0{,}83$) describing the dependence of the growth of the level of migration (x_1) and the growth rate of natural increase (x_2) on the GDP growth rate (y). The general view of the "elliptical umbilic" catastrophe model in the canonical form is presented below:

$$y = x_1^3/3 - x_1x_2^2 + 0.785(x_1^2 + x_2^2) - 3.669x_1 + 3.856x_2 \qquad (11)$$

Fig. 6 shows the results of assessing the parameters of the catastrophe model of the "elliptical umbilic" type in *Statistica.*

The surface of the catastrophe of the "elliptical umbilic" type is shown in Fig. 7.

The set of equations that describes the bifurcation set of catastrophe is:

$$\begin{cases} x_1^2 - x_2^2 + 1.57x_1 - 3.669 = 0 \\ -2x_1x_2 + 1.57x_2 + 3.856 = 0 \\ x_1^2 + x_2^2 - 0.616 = 0 \end{cases} \qquad (12)$$

The analytical solution of the equations describing the bifurcation set of the catastrophe of the "wigwam" type in the ASP *Maple* is:

$$solve\ (x^2 - y^2 + 1.57\cdot x - 3.669 = 0);$$

$$\{x = x, y = 0.01000000000\sqrt{10000x^2 + 15700x - 36690}\},$$
$$\{x = x, y = -0.01000000000\sqrt{10000x^2 + 15700x - 36690}\}$$

$$solve\ (-2\,x\,y + 1.57\cdot y + 3.856 = 0);$$

$$\left\{x = \frac{0.001000000000(785y + 1928)}{y},\ y = y\right\} \qquad (13)$$

$$solve\ (x^2 + y^2 - 0.616 = 0);$$

$$\{x = 0.04000000000\sqrt{-625y^2 + 385},\ y = y\},$$
$$\{x = -0.04000000000\sqrt{-625y^2 + 385},\ y = y\}$$

Graphically the bifurcation set in the three-dimensional projection is shown in Fig. 8.

The animation of the changes in the system's behavior under the insignificant changing of the control parameters to a greater or a lesser extent is presented in Fig. 9.

On the basis of the model analysis it can be concluded that the behavior trajectory of the studied parameters moves from the points of possible catastrophic transitions and does not get into of the bifurcation set, i.e. during the given time interval the dynamics of the studied parameters can be considered as relatively stable. Thus, it may be noted that despite the probability of the construction crisis in Ukraine's economy, the probability of the demographic crisis in the studied time interval is absent.

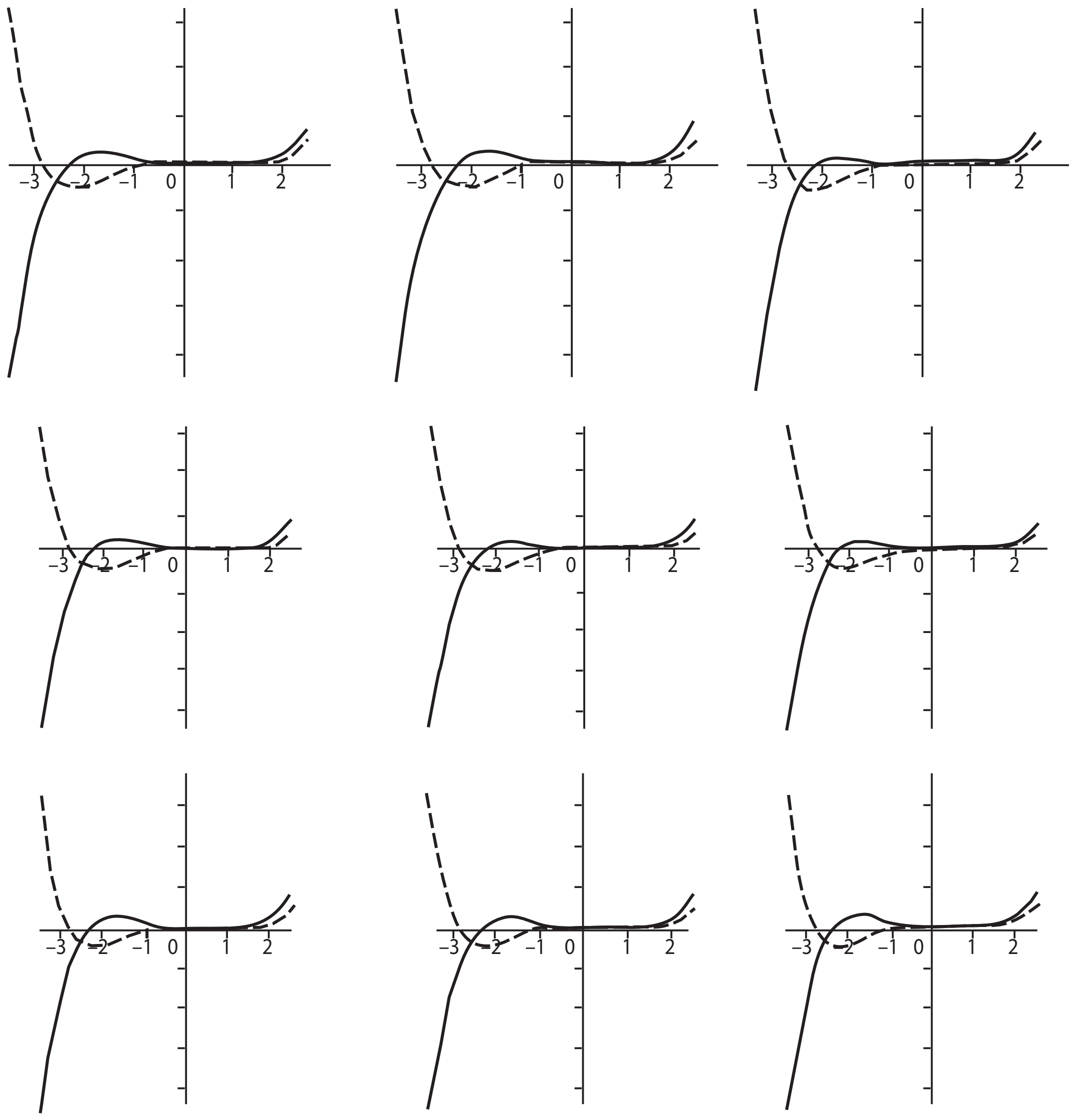


Fig. 5. The frame-based animation of the dependence of the system's behavior in the model of the «wigwam» catastrophe type on the values of the control parameters

	Model is: v1 = (v10^3) / 3 – v10 * (v11^2) +w * (v10^2 + v11^2) – u* v10 – n * v11 (Д) Dep. Var.: GDP Level of confidence: 95.0 % (alpha = 0.050)					
	Estimate	Standard error	t-value df = 54	p-level	Lo. Conf Limit	Up. Conf Limit
w	0,78570	0,060264	13,0376	0,000000	0,66432	0,90708
u	3,66936	0,354578	10,3485	0,000000	2,95521	4,38352
n	-3,85623	0,264097	-14,6016	0,000000	-4,38815	-3,32431

Fig. 6. The results of assessing the parameters of the catastrophe model of the «elliptical umbilic» type

As a result of building the complex of relationship models of Ukraine's macroeconomic indicators, it can be concluded that the dynamics of the main indicators has been in a crisis state since 2010, which proves the hypothesis of a strong influence of the transformational changes taking place in Ukraine. These models describe the real dynamics of macroeconomic indicators in the period under review, therefore, can be used for predicting and preventing catastrophic jumps in the socio-economic development of territorial systems that will improve the quality and efficiency of the development of the state anti-crisis policy to mitigate the consequences of the crisis at all hierarchy levels of the socio-economic system.

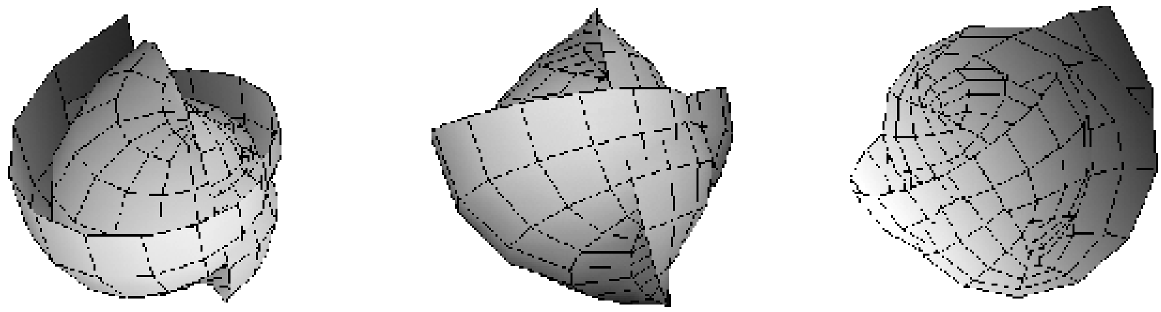


Fig. 7. The surface of the catastrophe of the «elliptical umbilic» type describing the dependence of the migration level and natural increase on the GDP

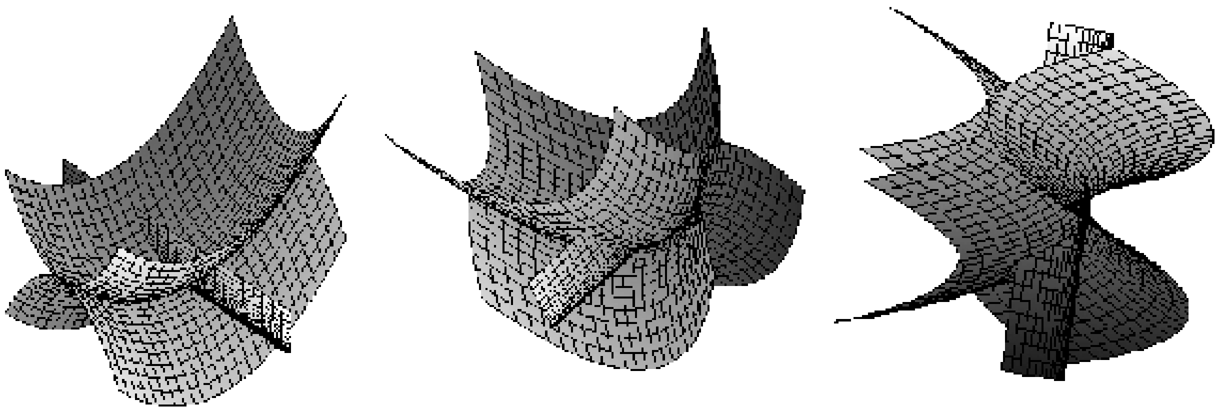


Fig. 8. The bifurcation set of the «elliptical umbilic"»catastrophe type

Conclusions and recommendations. The results obtained in this work are essential for studying transition mechanisms both at the stage of instability (bifurcation and crisis) and for achieving a new stable state, i.e., in order to break the stability of the system development it is enough to influence separate indicators of its economic development, since the theory of catastrophe is a research tool for studying and predicting the instability of systems of different hierarchical levels and the loss of stability can be critical even if it does not lead to the system destruction but causes the transition to another development trajectory.

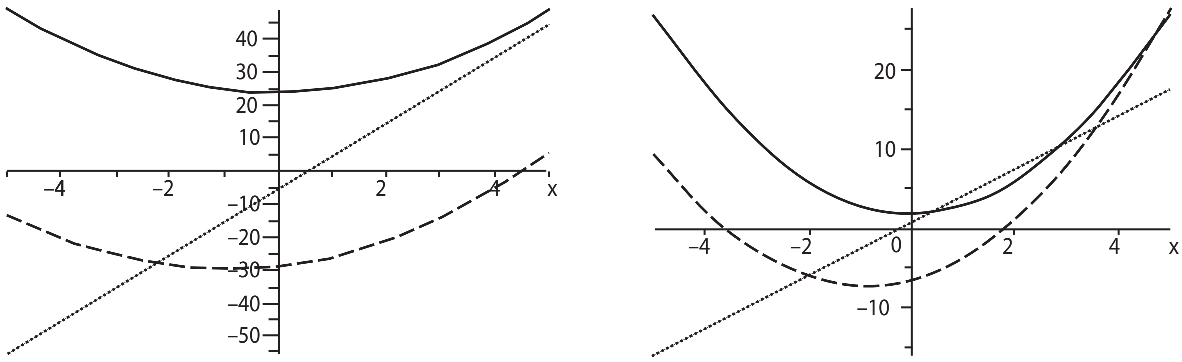
An important component is also determination of the degree of the system instability.

Thus, stability and instability, adaptation and disadaptation are necessary in any system development. An absolutely unstable system can not resist fluctuations, is not able to adopt and breaks down quickly, while a super stable system preserves its structure and behavior by neutralizing any fluctuations. Both types of systems come to chaos, with the difference between them being in time, which passes till the explosive increase of entropy. The problem of stability in the development of territorial systems is closely connected with the issue of the results it leads to. Is it a convergence or divergence? The most part of researchers and their work results prove that the system divergence (divergence development spiral) takes place in the development process. As a result of the development nonlinearity, its polyvariety and the cycling of evolutionary and bifurcational processes in the development of territorial systems there take place divergence and convergence development processes for some system states, which define the development trajectories of the system studied. Besides it is proved that the divergence prevails at the bifurcation stage while convergence – at evolutionary one.

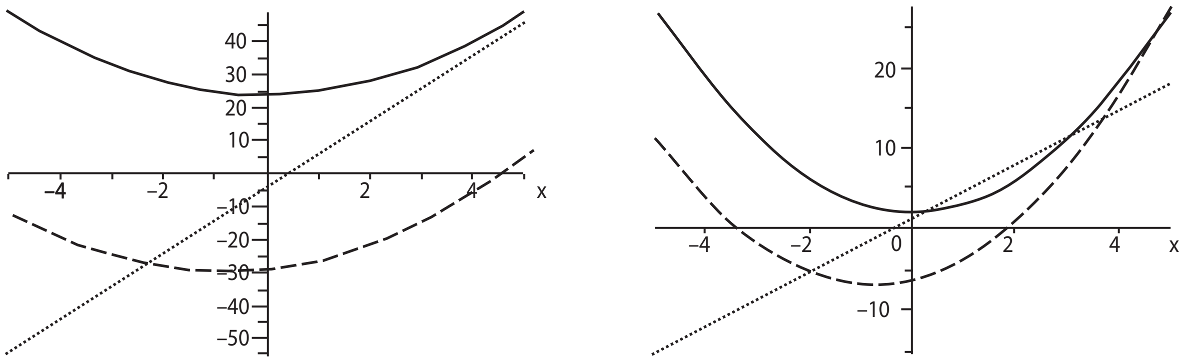
This research allows to draw the following conclusion as to the scenario of the economic development of Ukraine:

- the system can become stochastic, i.e., uncontrollable and unpredictable as the development dynamics of basic indicators has a great degree of uncertainty and includes microperiods of chaotic behavior but still in short time periods. It is obvious that dynamics of unconstrained growth will lose its steadiness when approaching the final attractor point. The probability of this scenario realization is too high because there are inner mechanisms that can launch it and it will be impossible to stop these processes.
- the main force that temporarily slows down the unlimited system development is crises, which act as a self-organizing and stabilizing factor (at large time scales), i.e., catastrophes in the system behavior should be considered as an appropriate evolutionary process, which takes place with definite recurrence.

Under increasing the parameter w:



Under decreasing the parameter u:



Under decreasing the parameter n:

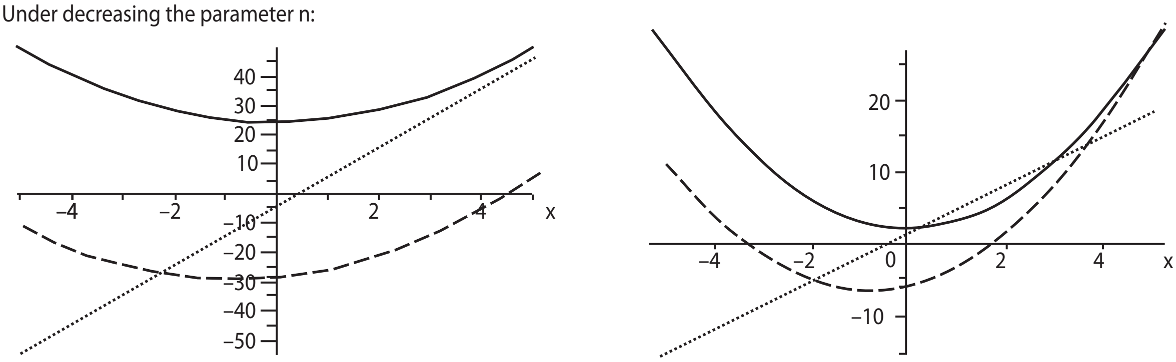


Fig. 9. The frame-based animation of sequential changes in the control parameters

Adaptation of research tools of territorial system development dynamics on the basis of the catastrophe theory will allow the decision-makers to define the strategy of stabilization and further development of the state economy, the quality of which is determined by the close nonlinear asynchronous connection of its basic components and socio-economic indicators that characterize them. The practical significance of the paper is in application of findings at forming the regional policy, realizing strategic investment programs aimed at stimulation of investing in progressive structural changes in terms of regional and territorial systems.

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