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TRANSITION PERIOD IN LATVIA AS A SOCIAL-ECONOMIC "SIMPLE CATASTROPHE"

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The paper describes the transition period of the social-economic system in Latvia in the 1990s. For analysis of the period the macroeconomic quality-quantity model of "simple catastrophe" of gather is offered. The flags of the catastrophe are analysed. The offered model permits to better understand the point of the course of events and show the most rational way out of the chaos and crisis state, which is an inevitable attribute of the existing complex systems in transition periods.

Keywords: *flag of the catastrophe, simple catastrophe of gather, bifurcational multitude, living standard of population*

For Latvia the period of the 1990s was a period of regaining independence of a sovereign state on the one hand, but on the other hand it was a transition period from a commanding-administrative system in economics and public life to market based relations in the conditions of democracy. During this period noticeable social-economic processes of restructuring took place in society of Latvia as well as formation of market economy. The transition period in Latvia (as in many other countries of Eastern Europe) adversely affected the welfare and living standards of a considerable part of the country's population: marked stratification of the society occurred due to the amount of their income, unemployment increased considerably, a great number of poor people and people on the brink of poverty [1; 2] appeared. Latvia faced also a deep demographic crisis, the death rate greatly exceeded the birth rate and tremendous decrease of the number of population of the country was observed. Demographic crisis was a direct consequence of the social-economic crisis in the country.

The social-economic situation of a country might be treated as a "soft" dynamic structure, the people themselves determine functioning and development of which to a great extent. Commanding-administrative system that existed in Latvia before the 1990s was relatively developed and stable: the dynamics of the growth of the gross domestic product in Latvia (see below) is indicative of that. Therefore restructuring of the system and transition to market economy using the methods of gradual continuous improvement of its functioning were not possible [3]. The complexity of the mathematical theory of restructuring social-economic systems is connected with their non-linear character: the results of their influence on the elements of the system are quite often disproportionate to the exerted effort. The following can serve as an example to this type of a conclusion – considerable amount of financial means invested into the national economy in the 1980s did not bring about great efficiency, did not improve the people's welfare. The aim of the present paper is to give analysis of the development of the social-economic situation in Latvia and its impact on people's welfare during the 1990s using modern mathematical theories, in particular topological dynamics.

In the period between 1980 and 1990 there was observed a steady growth of the gross domestic product (GDP) – an average of 5% per year: in 1990 GDP had increased 1.5 times as compared to 1980. In this case and further on the data from annual materials of the Central Statistics Bureau of Latvia (CSB) are used as well as materials from CSB reports on investigation of the budgets of family households in Latvia for the period 1990–2000. However, at the beginning of the transition period a substantial decrease of the volume of GDP is observed: in 1993 the volume of GDP of Latvia constituted about a half of that of 1990. Only beginning with 1996 GDP started increasing in Latvia again. With the purpose of analysing the dynamics of the basic social-economic data of the development of the country in the transition period basing on the statistical data of CSB of Latvia the author has made calculations of the basic indices with a constant basis for comparison. The values of the indices in the year 1990 – corresponding to 1.00 were taken as basis for comparison (see Table 1).

TABLE 1. Systems of the basic indices of the main social-economic data

No.	Name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	Gross domestic product (GDP)	**1.00**	**0.896**	**0.584**	**0.497**	**0.500**	**0.496**	**0.513**	**0.557**	**0.578**	**0.585**	**0.623**
2	**A** - quantity reverse of the percentage of people looking for a job to the number of economically active population of the country	**1.00**	**0.833**	**0.128**	**0.057**	**0.030**	**0.028**	**0.026**	**0.034**	**0.036**	**0.037**	**0.038**
3	**B** - the real wages of people working in national economy	**1.00**	**0.684**	**0.467**	**0.490**	**0.529**	**0.513**	**0.467**	**0.486**	**0.510**	**0.525**	**0.541**
4	**C** - proportion of the average income per one household member to subsistence minimum	**1.00**	**0.768**	**0.484**	**0.471**	**0.503**	**0.497**	**0.452**	**0.452**	**0.490**	**0.503**	**0.529**
5	Statical curtailment **S** of the data **A**, **B**, **C**	**1.00**	**0.757**	**0.249**	**0.138**	**0.081**	**0.075**	**0.069**	**0.090**	**0.093**	**0.096**	**0.100**

All data given in Table 1 are non-dimensional quantities. It is known that the notions “living standard” and “quality of life” are artificially created. It is a common opinion that if a person’s living standard basically depends on the proportion of expenses on purchasing foodstuffs then the quality of life depends on lots of factors. The author of the present paper uses statistical curtailment of the three basic values A, B, C as a generalised index of the quality of life of the population determining social-economic conditions of people in the country (Table 1). Summing the reverse of the value in this case performs calculation of the curtailment:

1/S = 1/A+1/B+1/C; S = ABC/(BC+AC+AB).

Here we can see a non-linear dependence, which characterises the saturation of the result of curtailment **S** in case separate values (**A**, **B**, **C**) being increased.

Taken as a whole Table 1 testifies that until 1996 the decrease of the value of GDP was observed, later it started to grow slowly. The values characterising the quality of life of the population of Latvia were decreasing until 1997: the year 1996 is the last year having decrease in the indices, there appeared “a delay” in changes of these values by one year compared with the changes in GDP. In the period up to 2001 the index of the quality of life (S) increased almost by 45% if compared with the level of 1996, but the GDP index increased by 25.6% during the same period if compared with its lowest level in 1995. However, in the year 2000 despite its excessive increase the indices of the quality of life of the population constituted only 10% of the 1990 GDP level. It indicates a very low decrease of the quality index, consequently also the living standard of the population of Latvia in the 1990s.

The social-economic system of a country, being a “soft” system, exhibits some certain features in case mathematical approach is applied to study it, which substantially differentiates it from the “hard” technical systems. Transformation of the parameters of a “soft” system basically occurs as non-linear dependences, the structure of the social-economic components is non-stationary and constantly changes under the influence of the managerial decisions made by people. The number of temporary and spatial feedbacks in the system is enormously large. On the other hand, in the conditions of transition of the national economy to new management principles and new technologies the human factor becomes highly significant: inertia of earlier models of behaviour and psychology of people quite often interferes with proper evaluation of the situation and making the optimal decisions on the part of managers. The main tasks of administrative bodies of any country are efficient functioning of national economy and optimum

protection of welfare of the population during transition periods. However, due to the above-mentioned reasons the adopted regulations in Latvia (as well as in other East European countries) concerning administration of the economy in the 1990s quite often lead to undesirable consequences, to changes to the worse in the life of the population. Application of the method of economic-mathematical modelling is aimed at minimising the harmful consequences of the adoption of inappropriate decisions in economy and social sphere: it is time to pass from experiments on real economics and consequently on people to a scientific prognostication.

It is known that within non-linear dynamic systems with non-stationary structure, a social-economic system might be referred to as such, there can arise negative destructive processes of "catastrophe" type in case stabilising feedbacks are impaired. Stable development of the social-economic system of the country is analogous to the notion of stability in Mathematics. The dynamic system is considered to be stable if it functions in prearranged conditions irrespective of the exerted influences. However, as it was known in the ancient world already, sometimes-even small changes destroying harmonious development, can lead to great cataclysms in society. In the second half of the 20th century the topological theory of dynamic systems was created, describing considerable leaps and transitions of the functioning systems in a mathematical way. One of its trends is the **catastrophe theory**.

There exist no theorems or generally recognised social theories in human society analogous to the rules of mechanics, for example. Therefore on the basis of sociological models there always lie certain paradigms [4]. Assumptions of linearity or convexity of the functions describing the condition of human society in sociological models are simplifying and do not correspond to the real situation in the world. As a matter of fact there manifests a constant non-linear character of behaviour of the basic values, which determine social-economic processes. In the simplest case such phenomena might be described through bifurcation of functions and we cannot do without using the simple catastrophe theory [5].

Certain indirect evidence is usually a sign of the approaching catastrophe – so-called "flags of catastrophe". These are some peculiarities of behaviour from which one can judge of the system approaching the critical point when a catastrophe starts. One of such "flags" was mentioned above: that is "critical slowing down" of the rate of growth of the country and improvement of people's welfare at the turn of 1980s and 1990s despite the increasing amount of investments in social economy of those days. In the given case the social-economic system is treated as a gradient dynamic system or as a movement in the field of potential forces [5]. The issues of the structural stability of such systems are dealt with by catastrophe theory.

Substantial stratification of people according to the levels of their income, appearance of a large number of poor people, high unemployment level and a very low percentage of comparatively wealthy people in society at the beginning of the 1990s are indicators of the following two "flags of catastrophe": difference of the linear response and the anomalous dispersion of the living standard and the welfare of the country's population. The discrepancy is indicative of the fact that the system is in the vicinity of the critical point, and even small changes of the main parameters of the system can lead to destruction of stability and shifts in the development of social-economic situation in the country in one or another direction. During the research the author ascertained that there exists an expressed unevenness of the distribution of national wealth [1,2]. So for example, the coefficient of the funds characterising the correlation among the income of the 10% of the richest part of the country's population and the 10% of its poorest part constituted $K_D = 11.9$ in 1998. The coefficient of the concentration of the income according to Gini calculated on the basis of the average per capita income in Latvia constituted $K_L = 0.387$. This testifies to an unjust distribution of the income in society, practical non-existence of the middle class and indicates anomalous dispersion of the living standards of the population.

Modality and an ordinary discrepancy of the values of the parameters characterising the condition of the system are also standard "flags of catastrophe". Modality means that the potential function describing the system possesses more than one local minimum in a certain area of changes within the outer control parameters. In the case of the social-economic system under discussion it leads to bimodality under certain conditions: presence of a large number of people with a very low standard of living and a small layer of comparatively rich people in society, with actual absence of the middle class, which is a stabilising element of a system. By an ordinary discrepancy we understand instability of the processes in the system in case of changes within the trajectory of the control parameters when slight deviations of the trajectory lead to quite different final values of the variables of the condition than it was planned before. For example, in practice it means that the planned measures aimed at improvement the people's living

standard (increase of pensions, allowances and benefits, salaries and others) most often do not bring the desired results due to rise in prices and inflation.

As a sign of the "flags of catastrophe" also irreversibility of the system and unattainability of stability of the social-economic condition in society should be mentioned in the given situation. Irreversibility of the system lies in the impossibility to return it to the previous conditions, to planned economy. But the actual absence of the middle class during the period under discussion -in the 1990s – in Latvia, which stabilises the social-economic situation, indicates unattainability of stability in the system.

It is known that most systems of practical interest the presumption forming the basis of the simple catastrophe theory cannot reach fully [5]. It is connected with the fact that the control parameters are quite often dependent on the time, but variable conditions are subjected to fluctuations. However, following certain principles and acceptance of some assumptions make it possible to use the results of the simple catastrophe theory. Analysis of the evolution of the condition of the balance of the gradient systems is not the concern of the catastrophe theory. Therefore the present paper accepted an agreement that evolution is of quasi-static character, all time derivatives are very small.

In order to even partially describe the condition of the gradient system controlled by the potential a point is used, in which the potential takes the minimal value. Changes in the outer conditions cause changes in the control parameters that lead to the changes of the potential function. In this case the condition of the global minimum determining the condition of the system might experience changes, and the system might change from one minimum into another [5]. On the other hand, the considerable dispersion of the living standards and the welfare of the people, the marked difference of their income taken into consideration the present paper has accepted as a standard a relatively high level of the "noise" of the condition of the variables in comparison with the height of the inner transition barrier in the social-economic system. Therefore the transition point and the minimum corresponding to the stable condition of the system are determined according to Maxwell [5]. This principle implies that the condition of the system is determined by the global minimum of the potential function with the presence of marked fluctuations of the variables of the condition.

Also the histerezis phenomenon and so-called catastrophic leaps refer to the "flags of catastrophe" discussed above. However, on the basis of the agreement accepted before – Maxwell's principle, no hysteresis arises in the system under discussion. During the transition of one local minimum determined by the change of the control parameters into another there might be observed great changes of the values of the variables of the condition (people's living standard and their welfare). This is what should be called catastrophic leaps. Certain smoothness of the changes in social-economic sphere taken into account such leaps will be followed by smooth changes in the values of the potential. The set consisting of eight "flags of catastrophe" and discussed above is reasonably sound. Therefore, it can be claimed that there occurred a social-economic "simple catastrophe" in the 1990s in Latvia.

The present paper offers a suggestion that the processes of the transition period under discussion in the social-economic system of Latvia in the 1990s are described with the help of a certain number of control and inner parameters. In a general form the function of the elementary catastrophe Cat (l, k) can be written down in the following way [5]:

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

where CG (l) is a sprout of the catastrophe or non-Morsian function 1 of the condition of variables; Pert (l, k) – changes of the catastrophe with the number of control parameters equal to k. The sprout of the catastrophe is an organisational centre around which the lower forms of the catastrophe are arranged. This is a type of organisation that all canonical catastrophes have. Whitney's theory determining the geometry of catastrophes claims that any smooth reflection of the surface on a plane breaks into gather and pleat after some small change [3]. A characteristic feature of projecting the surface on a plane in the form of a gather (gather by Whitney) is stable and is widely used in practical applications of the catastrophe theory. Therefore it is this type of a simple catastrophe that was used in the present paper to create a model.

The multitude of the canonical catastrophe of gather is a smooth sub multitude in a three-dimensional space of the conditions R^3 (Figure 1), where R – standard symbol for a set of real numbers [4].

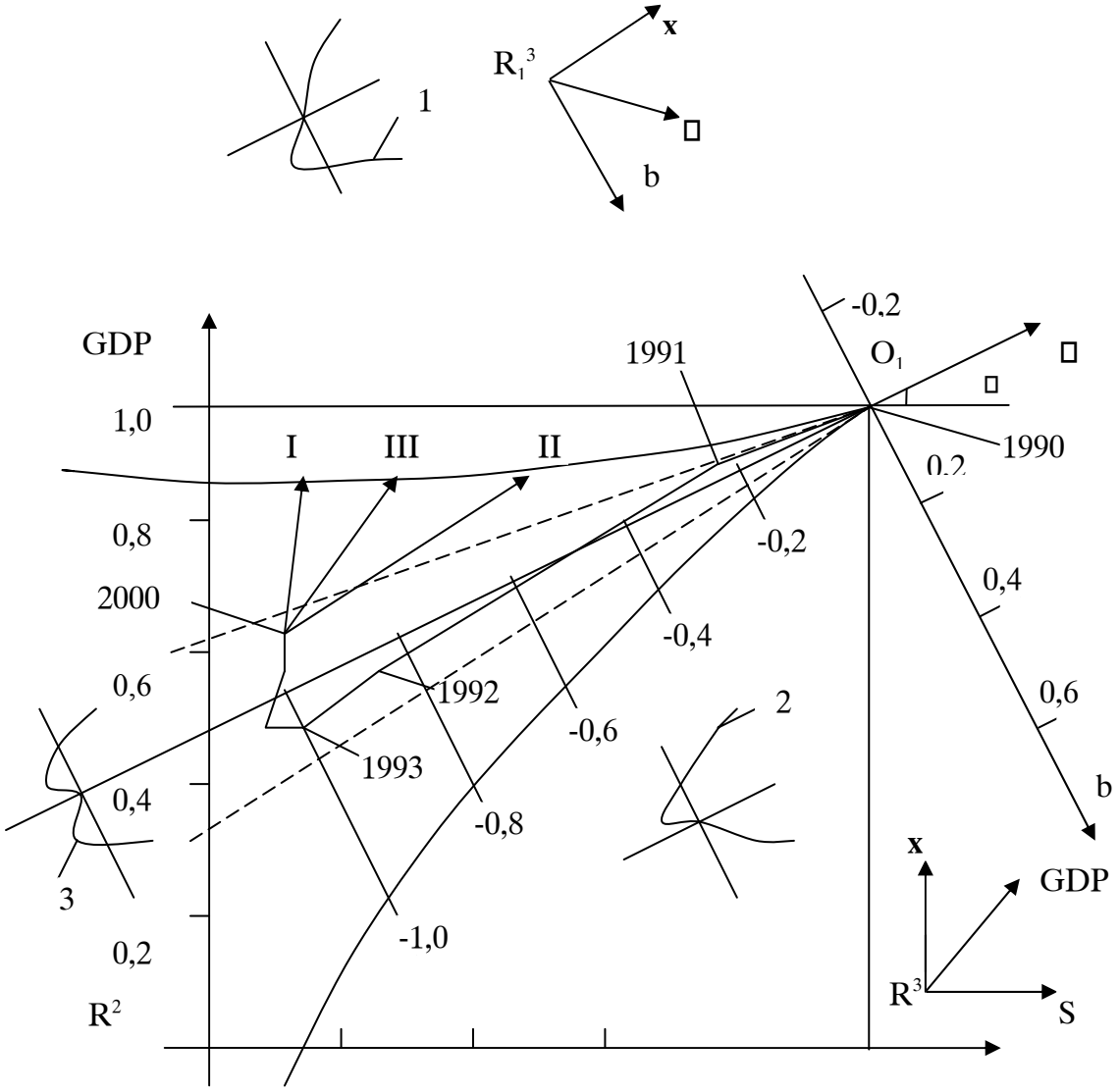

Figure 1. Projection of gather of "a simple catastrophe" on plane of the control parameters and empiric data

The control space R^2 in the given case is a two-dimensional plane of the control parameters on which catastrophe of gather finds its representation. As the dimension of the deformation here is equal to 2, then on the basis of factorial analysis parameters GDP and S have been adopted as control parameters. GDP determines the condition of the country's economy taken as a whole; therefore it is adopted as a splitting factor. As a normal control parameter a generalised index of the quality of the life of the population – S is used. The variety of the given catastrophe gather will be sub multitude all over the space R^3xR^2, which is a surface of balance in the coordinates **x**, S, GDP where **x** is the inner variable of the condition of the system characterising the living standard and welfare of the population.

According to R.Thom's classification of simple catastrophes the catastrophe gather by Whitney under discussion refers to type A_{+3}[5]. The family of potential functions of energy serves as standard deformation:

$$\mathbf{F_{\alpha b}(x)=(1/4)x^4+(1/2)\alpha x^2+bx+C},$$

where C is some constant, α and b – are control parameters in the space R_1^3. The given expression determines the smoothness of the representation of a catastrophe gather in plane R^2 of the control

parameters as it is differentiated a sufficient number of times. The constant C is set equal to zero, as the analysis of the critical points with the purpose of getting useful information is performed on the derivatives. The two-dimensional multitude of the catastrophe gather placed in the three-dimensional space x, α, b is calculated by an equation:

$$\mathbf{d/dx(F_{\alpha b}(x))=x^3+\alpha x+b=0}.$$

This equation gives a possibility to determine the critical points of the potential function $F_{\alpha b}(x)$ with the given parameters α and b. Equalisation of the discriminant of the cubic equation determining the variety of the catastrophe with zero makes it possible to determine parametric connections between α and b:

$$\mathbf{D=(\alpha/3)^3+(b/2)^2=0}.$$

This is a semi cubic parabola with a return point at the beginning of the coordinates $\alpha O_1 b$ (Figure 1). It is a separatrix of the space R^2 of the control parameters and divides it into two open areas, representing potential functions $F_{\alpha b}(x)$ with a different number of critical points. The starting point of the coordinates O_1 or the point of gather represents the function $x^4/4$ (sprout of the catastrophe) having a critical point degenerated three times. The points with a smaller area (within the separatrix) each have three prototypes, as three points of gather of the conditions of catastrophe are projected in them. The points of the bigger part of the space of the control parameters (outside the separatrix) have one prototype and represent functions with one critical point. The points of the separatrix itself have two prototypes and parameterise the functions with critical points degenerated twice. On the approach to the beginning of the coordinates O_1 from the smaller area all three prototypes merge. In Figure 1 potential functions are shown (1,2,3) that correspond to some points on plane R^2 of the control parameters.

When depicting catastrophe gather on a plane of control parameters the separatrix of the space R^2 viewed in geometrical context is a projection of points, in which the tangents of the plane are situated vertically. The semi-cubic parabola viewed above – is "a shadow" of the pleat of the variety of the catastrophe when exposed to its rays, parallel to axis **x**. The functions parameterised by the semi cubic parabola are structurally unstable with non-Morsian critical points, as in case of changes the points might shift from the inner area of the separatrix to the outer area and vice versa. Therefore the given parabola in a number of cases is treated as a local bifurcational set, i.e. a number of points in which transition from one local minimum to another occurs.

As it was mentioned above when considering the social-economic system of Latvia in its transition stage an agreement was made to use Maxwell's principle. Therefore, in the case under discussion bifurcational set is non-local and represents Maxwell's set or non-local separatrix in the plane of control parameters [5]. This is a semi straight line $\alpha<0$, $b=0$ in the plane R^2 (Figure 1). Transition from one minimum to another occurring in the points of the bifurcational set is also called phased transition, which corresponds to qualitative changes of the qualities of the system. It should be noted that in certain cases with certain values of the control parameters GDP and S the level of the "noise" of the variables of the condition **x** might decrease. Then we can say that phased transitions will occur in the points of "indistinct" not strictly determined bifurcational set. It is natural that this will occur during the periods of some regulation, stabilisation of the processes in the social-economic system, when separation from the Maxwell's bifurcational set is taking place.

In the system of coordinates the life quality index of the population of Latvia – S and GDP adequate points have been inserted on the plane of control parameters beginning with 1990 and the year 2000 including (Table 1, Figure 1). The points are joined by segments of straight lines. The broken line that we obtain crosses the Maxwell's bifurcational set three times, and all of its points are situated near this set. Thus, the above taken into consideration we can say that the area within which fluctuations of the inner variable **x** of the condition of the system occur is the area on the plane of the control parameters including Maxwell's set and the "indistinct" set. Dotted semi straight lines originating from the critical point 0_1 which denotes the year 1990 limit this area. The system fluctuates within the bifurcation set of the catastrophe gather, alternately "jumping" from the top plane of the multitude of the catastrophe to the bottom plane and vice versa. The peculiarities of these processes connected with the change of the form of property and privatisation were considered above when the "flags of catastrophe "were described. Projection of the area of pleats of catastrophe gather are superimposed on the empiric data, it is a

separatrix of the space R^2 of the control parameters. The equality of the separatrix within coordinates $\alpha O_1 b$ was given above. Transformation of the coordinates with the help of simultaneous shift and bend of the axis of the coordinates allowed expressing coordinates α and b of the separatrix through GDP and S (angle θ=90°-β):

$$\alpha = \frac{S-1}{Sin\theta} - \frac{ctg\theta(Sctg\theta - ctg\theta - GDP + 1)}{Sin\theta + Cos\theta ctg\theta} \quad , \quad b = \frac{Sctg\theta - ctg\theta - GDP + 1}{Sin\theta + Cos\theta ctg\theta} .$$

It is known that instability of development of extensive complex systems, social-economic system of people's society is among them, does not make it possible to predict their behaviour for long periods [6]. The analysis of the above quantity-quality macroeconomic model of such a system exhibited the following. The model of "simple catastrophe" in itself cannot replace the study of complex social-economic processes and prompt a recipe of a rapid solution of a crisis. It gives an opportunity to deeper understand the developments, their latent regularities and help in finding the ways out of the chaos and a crisis situations. Chaos and crisis are inevitable attributes of transition periods during the existence of complex systems, as it is through them that new order and new relationships come into society.

As Table 1 and Figure 1 above show up to 1996 the GDP and the index of the quality of life of the population kept decreasing; after that a gradual growth of these indices took place. Improvement of the situation in the country shows that the process of straightening out, self-organisation of the social-economic system, stabilisation of the economy and overcoming the chaos has started [6]. During such periods when getting out of the crisis has started it is important to start a stable trajectory of development, to define the desirable trend. First of all the way out of this dangerous zone should be found, as far as possible from the bifurcation set. It is known that formulation of a problem and a unique solution of the optimisation task of managing macro economy is entirely impossible. However, there always exists a possibility to discuss different versions of development of the social-economic situation in the country, among other things using the model of "simple catastrophe" gather the present paper is dealing with.

In the diagram in Figure 1 we can distinguish three feasible directions of prospective development in the nearest future. The first direction (I) leads to rapid growth of GDP and fast withdrawal from the zone of the bifurcation set. However, it is fraught with social cataclysms due to the slow growth of the index S of the quality of life of the population and accordingly low living standard of the people. On the contrary, the second development of growth (II) establishes social protection of the population, improving the living standard of people as priority, but with slower rate of the growth of GDP. The danger here lies in the fact that this direction goes concurrent with the bifurcation set and at an inadequate volume of GDP the bifurcation process might start again and the system is likely to return to the state of chaos, as there will not be sufficient economic resources to increase the index S. The third direction in the development (III) occurring with paralleled balanced growth of GDP and S is the most rational. The development trend existing today more likely corresponds to direction I. To pass over to direction III certain measures should be taken aimed at improving the standard of living, social protection of people, such measures which the government of Latvia is not giving much attention to at present.

Conclusions

- The complex social-economic processes of the transition period in the 1990s in Latvia can be visually depicted as a model of "simple catastrophe" gather (type A_{+3}), which is substantiated by the presence of adequate flags of catastrophe.
- It has been ascertained that that bifurcation set of the catastrophe gather for the social-economic system under discussion is determined more precisely as a complex of Maxwell's set and "indistinct" set.
- In case the continuity of the processes is broken the model of catastrophe gives an opportunity to point out the most rational ways out of the of chaos and crisis state: development of economics and raising GDP is not an end in itself, but a balance should be maintained with the growth of welfare of the population and people's living standard.

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