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Modeling of anti-crisis management of public joint stock companies of mining and smelting cluster region

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Abstract
In article models of anti-crisis management of the enterprise on the basis of an assessment of life cycle of the enterprise, bifurcations and system transformations are considered.
Keywords: CRISIS, MANAGEMENTS, BIFURCATION, CHAOS, TRANSFORMATION, ADAPTATION, SYSTEM

Introduction

Condition of sustainable and stable economic development is the balance between a social production and consumption, cumulative demand and the cumulative offer. At the same time in market economy the equilibrium state is periodically broken, thus there are crises. It is necessary to emphasize that fact that crisis is a

phase of a business cycle, which testifies about considerable contradictions in business management and its dependence on environmental conditions [1].

Management in the conditions of crisis is closely connected with the transformational transients, arising in system at the expense of indignations of an external environment and adaptation of the enterprise to innovative strategy of development. As crisis represents opportunity to change production structure, speed and level of social and economic development, the problem of crisis management consists not so much in elimination of consequences of crisis, and in morning recognition of crisis processes and preliminary definition of such point of bifurcation, which allows not to make negative changes and to come to a new level of development with the smallest negative consequences. [2]

For minimization of negative consequences of crises and maximizing the opportunities presented by them, it is necessary to diagnose, predict these crises and their possible consequences, in a target way to influence prevention of crisis tendencies, to supervise results of influences of an external environment, that is effective models pre-crisis, crisis and after crisis conditions of development of the enterprise [3] are necessary. At all levels of anti-crisis management the general task is timely warned managements of irreversible negative changes and an exit to a new level of development of system for what it is necessary to reveal a bifurcation point in due time. Known models of anti-recessionary management process are constructed by the corporate enterprise on representation that crisis has negative character as a result of which the enterprise becomes the bankrupt [3].

Other results of research of models of crisis process when crisis becomes incentive to enterprise [3] development are known. Studying of development of difficult open economic system shows that dynamics of pre-crisis, crisis, post-crisis development of the enterprise has difficult nonlinear and cyclic character and therefore modeling of developments offers to use the nonlinear character, considering aperiodic optimum economic growth [4]. The author [5] proved that optimum economic growth connected with endogenous fluktation can be identified by models on the basis of Hopf's theorem of bifurcation, which gives the chance to construct crisis models for operated transformation of social and economic system to a rack robust system. Separate theoretical and practical aspects of an assessment, crisis management by the enterprise found reflection in works of native scientists [1] S. Valdaytsev, V. Vasilenko, A.Goncharuk, N. Korvaukai, L.Ligonenko, O. Tereshchenko, N. Tyurinoi, Chernyavsky, Z.Sherginyuvoi.

Applied developments of O. Gradov, V. Samochkina, B. Ryan, R.Granta's, Zang are devoted to research of problems and modeling of process of crisis management by the enterprise on the basis of nonlinear.

The adduced arguments, to need of development of methods and tools for modeling of nonlinear anti-recessionary enterprise management systems and development of transformational adaptive systems of management by public joint stock companies testifies to relevance of this subject of research.

Problem definition

The purpose of the article is research of processes of anti-crisis management by the enterprise and justification on the basis of technique of system approach of the mechanism of anti-crisis management, to develop models of crisis transients on development of the enterprise and identification of bifurcations of a point and on the basis of the theory of random frac-jack to develop algorithm of transformational adaptation to a new steady condition of development of the enterprise.

Statement of the main material

Let's consider open social and economic system (enterprise) which functions in the conditions of difficult environment. The system (enterprise) consists of three parts - two production and consumption systems. Then a problem of optimum development of the enterprise we will write down in the form of the following model:

$$\max \int_0^{\infty} u[T(y,k)]\exp[-(r-g)t]dt, \quad (1)$$

Relative

$$\frac{dK_i}{dt} = y_i - qK_i \quad (2)$$

$i = 1, 2,$

where vector y and k represent respectively: production on the 1st working and costs of the capital of manufacturing of 1 ton of production, consumption is set by function $C = T(y_1\ k)$, and function U(T) – it is the advantage received from

consumption of production metallurgical plant production.

Coefficients $q(\geq 0)$ and $r(\geq 0)$–a speed of increase in labor productivity and profit interest rate respectively.

For existence confirmation in system of anti-crisis management by the enterprise of bifurcations of Hopf [5] we will allocate six problem situations:

C 1. All production is made within a year out of step, and production function linearly homogeneous curved at the integral values of factors;

C 2. If we denote K_{IJ} as set of factors, which define production of j-th production (concentrate, pellets), j-th production (pellets) cannot be made without K_{IJ}. Use of the principle of a maximum to the equations (1) - (2) drive in the system of the new equations[4]:

$$\frac{dk_i}{dt} = y_i - gk_i$$

$$\frac{dg_i}{dt} = -U^{"}\omega t + rq_i \qquad (3)$$

$q_i = U^{"}P_i$,P= - $\frac{QT}{Qy_i}$

$W_I = \frac{QT}{Qk_i}$, i=1,…,n,

Where P_i- price of 1 ton of production, W– constant expenses carried for one ton of production.

For $r\epsilon(q,r^*)$, where r^* is set and may be positive one.

C 3. In balance point matrix of coefficients of the capital is undeveloped;

C 4. In position of balance production has to be provided with capital investments and direct usage of expenses of work per 1 ton of production;

C 5. In a balance vicinity limit usefulness from the consumer is constant, i.e. $U^{"}$=0 and $U^{"} = 1$;

C 6. In a balance vicinity matrix of input parameters is nondegenerate. Let conditions of a situation (C1-C6) are satisfied then dynamics of system in a vicinity of balance is set by the look equations:

$$\frac{dk_i}{dt} = y_{i(k_1p)} - gk_i,$$

$$\frac{dp_i}{dt} = w_{i(k_ip)} + rP_i \qquad ,$$

(3) (4)

where y and w-differentiated, a balance point to system is defined (4) single image for $r\epsilon(q,r^*)$, where $< r^* < \infty$; all functions replaceable, namely $C(r), P(r), y(r)$ about a balance point positive and continuous for $r\epsilon(q,r^*)$ and the last condition at fixed K in balance vicinities function $T(\kappa,y)$ bent on y_i.

To guarantee existence of aperiodic fluctuations during crisis (close to chaos) we will make the assumption, there is such r (designated through r_0), that Jacobian near the point of balance has a couple of a complex - interfaced roots $Z_{1,2} = \alpha(r) \pm J\beta(r)$, which at $r = r_0$ satisfy conditions:

$\alpha(r_0) = 0; (\beta r_0) > 0$ i $\frac{d\alpha(r_0)}{dr} \neq 0$. Let's choose r as bifurcation parameter with critical value r_0, which meet the conditions $\alpha(r_0) = 0$; $\beta(r_0) > 0$i $\frac{d\alpha(r_0)}{dr} \neq 0$.

Let's choose as bifurcation parameter with critical value r_0. Let's enter designations $x = r - r_0$i

$Z(x) = \alpha(x) + J\beta(x)$. Let the system (4) has two couples of simple complex values noted respectively: $z_{1,2}(r)$; $Z_{3,4(r)}$

$$Z_{1,2(r)} = \alpha_{1(r)} \pm J\beta_{1(r)}$$

$$Z_{3,4(r)=\alpha_{2(r)}} \pm J\beta_{2(r)}, \qquad (5)$$

where α_i and β_i – real numbers (i=1,2,…). Let's consider that there is such value of profit $r = r_0$, when $a_{1(r_0)} = a_{2(r_0)=0}$, $a_{1(r)}a_{2(r)} > 0$, $r \neq r_0$, $\frac{da_{1(r)}}{dr} \neq 0$,

$\frac{da_{2(r)}}{dr} \neq 0$ (6)

In the conditions of crisis of profit, enterprises sharply decrease and correspond to situations, when $r \to 0$.

Let's consider a case when $|r - r_0|$ will be small enough and we will consider behavior of system (6) in the course of environment indignations.

If $|r - r_0|$ is small value, it means that Jacobian has two couples of purely imaginary own values, and control system when passing r through critical value r_0 unambiguously loses stability (the enterprise becomes the bankrupt). From the equations (6) there follows that the valid parts of own values always have identical sign. If x changes in such a way that $a_{1(x)}$ and $a_{2(x)}$ change the value from negative to positive, stability of system is lost, the system passes to a condition of chaos. According to the theory of bifurcations, at this moment from a branch (K_0, P_0) may arise new (possibly, very difficult decisions on adaptation of the enterprise to structure and strategy change and its developments for the period till 2020). As soon as x crosses border of area of stability and instability (x = 0), the linear theory of stability

[5] predicts loss of stability of a steady state of a control system by the public joint stock company (PJSC), in connection with the growth of profit and capital expenses in t time. Such exponential increasing function cannot describe real behavior of system in the conditions of environment change (change of requirements of consumers to quality of production of a concentrate or pellets) on considerable periods as nonlinear members of the equations (6) significantly start influencing. For this reason when studying unstable dynamic systems we have to take into account the nonlinearity, connected with production in the conditions of multiple-factor characteristics of the initial ore arriving on enrichment, competence of the personnel etc.

Let's enter the parameter of decomposition of amplitude of change of profit of the enterprise in time

$$E^2 = \begin{cases} x\,, at\ \frac{da_{1(0)}}{dx} > 0 \\ -x, at\ \frac{da_1(0)}{dx} < 0 \end{cases} \quad (7)$$

Zang [4] proved that if the problem of optimization satisfies situations C1-C6 and, if $|\beta_i - 2\beta_2|$, $|\beta_1 - \beta_2|$, $|2\beta_1 - \beta_2|$ are within time limits $D(1)$ according to E, than $\begin{bmatrix} K(E\,,t) \\ P(E,t) \end{bmatrix} =$

$\begin{bmatrix} K_0 \\ P_0 \end{bmatrix} + E[C_1R(m)\sin F + C_2R(m)\cos F +$

$D_1S(m)\sin G + D_2S(m)\cos G] + D(E^2)$, (8)

Where C_i and D_i – constant four-unit vectors;

$A = (1 + W_2E^2)\beta_1 t + A^*(m)$,

$B = (1 + V_2E^2)\beta_2 t + B^*(m)$ (9)

$m = E^2 t$,

And $R(m), S(m)\,, A^*(m), B^*(m)$ is scalar functions which are defined from a ratio:

$$\begin{bmatrix} R^{"} \\ RA^* + \beta_1 W_2 R \\ SB^* + \beta_2 V_2 S \end{bmatrix} = N \begin{bmatrix} R \\ S \\ R^3 \\ Y \\ R^2 S \\ RS^2 \\ S^3 \end{bmatrix} \quad (10)$$

Here value $N = \left(n_{ij}\right)_{4\times 6}$, and values $C_i\,, D_i, W_2, V_2$,N– are defined by Zang [4].

Approach (8) it is fair for the periods of time of an order $D\left(1/_{E^2}\right)$.

Stability of an enterprise management system is defined asymptotic by behavior of functions $R(m), S(m)$ at $m \to \infty$. If they approach to steady value of production, bifurcation decision is steady. In case of changes of demand for production (the recession period) and high inflation there are not necessarily periodic decisions, which depend on complex own values of parameters (7). Very difficultly to predict behavior of such system, for example, if a difference between an existing rule of fixed capital on manufacturing of 1 ton of production and its equilibrium value consists of two parts:

$$C_{11}R_m \sin A + C_{21}R(m)\cos A$$
$$D_{11}S(m)\sin B + D_{21}S(m)\cos B \quad (11)$$

So, if sizes β_1 and β_2 come nearer to each other, at least during every period, the behavior of system is irregular.

From the fulfilled analysis there follows that balance points are variables, they characterize work of PJSC and move "in a random way", so such motion can be periodic or aperiodic depending on the set strategy of response to environment indignations.

In fig. 1 there is a model of development of the enterprise of MMC within the post-crisis period (2005-2012gg.).

Theoretical analysis of aperiodic models of development of public joint stock companies showed that dynamics of their development has difficult nonlinear and cyclic character. Therefore modeling of developments of the enterprise within the post-crisis period assumes the use of nonlinear control systems, consider system cyclisity. Thus the crisis is a transition condition from the current phase in the following phase of a cycle and is a cycle forming factor. Thus, for the purpose of formation of the effective mechanism of management by enterprise development which provides its survival and prosperity it is necessary to create effective tools of management of system transformations in the conditions of crisis. The scheme of the main problem points of management of transformation processes in the period of pre-crisis and after crisis stages of development of the enterprise is given in fig. 2. Earlier it is theoretically proved that in models (1-9) there arise bifurcation points in its development m, they reflect emergence of system crisis, which influences all levels of management of PJSC [6]. At the same time the indignant impacts of the external and internal environment on initial indicators of the enterprise create bifurcations.

In this case the system is in an unstable condition and goal-oriented transformational influence on it leads public joint stock company on qualitatively new (set) level of management

and development. Therefore, development of the corporate enterprise is inseparably connected with overcoming of the crisis phenomena (characteristic problem situations), phases of bifurcations in its activity. Bifurcations, which spontaneously arise in system have not predicted consequences and can lead enterprises to dissolution, that is to death of the system [5]. Contrary to it planned expected processes of transformations (introduction of innovative projects of production of innovative production) allow to pass to new level S - a curve of vital development of the enterprise. The case when top managers initiate bifurcations - crisis for the purpose of the accelerated growth and transition of system to the new set qualitative condition with the minimum losses and a positive gain of economic profit and enterprise [6] capitalization is even more interesting [6].

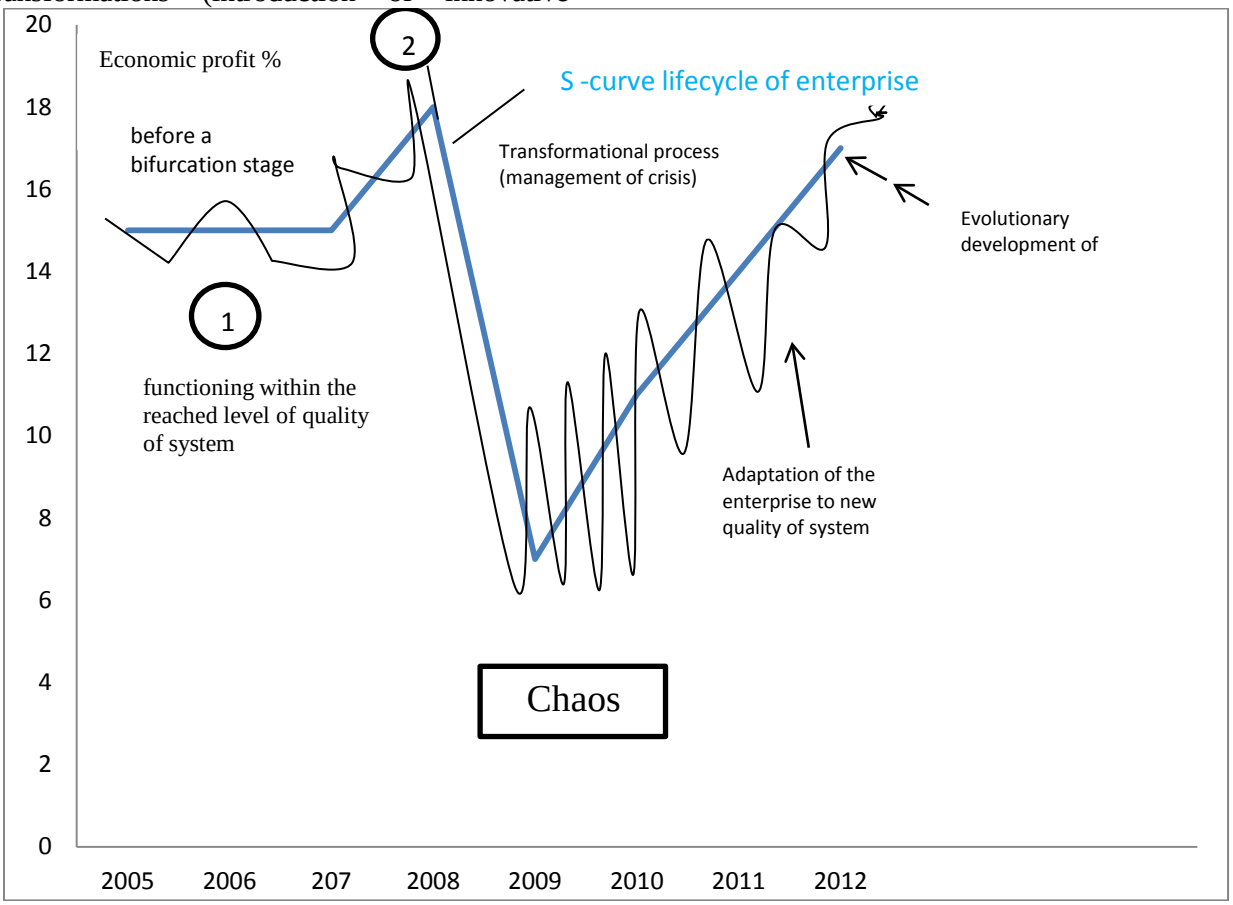

Figure 1. Model of development of the enterprise of MMC within the post-crisis period

Thus integrated systems of adaptive management of public joint stock company have to include subsystems of recognition of problem crisis situations, on the basis of algorithms of indistinct logic and recognition of images [7]. The last ten years of realization of strategy of corporate development of the enterprise of Metinvest Group, work in the conditions of uncertainty and instability of environment, high competition, gave positive results only at the expense of creativity of managers and motivation of the personnel. System updating of the enterprises PJSC "SEVGOK", JSC TsGOK, PJSC "INGOK" carried out by managers of Metinvest Group, induced to change of views of management on environment both world crisis of 2008-2010 and modern world recession. Management of the Metinvest Group enterprises during this difficult period is connected with high risk and uncertainty of possible results. In fig. 1 the graphic model of development of the corporate enterprise is given to the pre-crisis, crisis and post-crisis periods. This model contains not only some stages, but also two key moments of movement to new qualitative levels of development: before bifurcation stage and transformative -adaptive stage after anti-crisis management. The chaos stage - the period when movement of dynamic system (enterprise) cannot be predicted on a big interval for time. Such phenomena are called chaotic [4] when the

motion path of systems depends on entry conditions.

At design of the modern integrated enterprise management systems, it is necessary to consider emergence of bifurcations, i.e. the accounting of nonlinear working hours of system. Chaotic fluctuations in systems arise not only due to uncertainty of demand for production, and also due to technological uncertainty of nonlinear textural and mineralogical characteristics of fields of iron ores and high requirements to dispersion of the maintenance of a mass fraction of iron from consumer system. Chaotic link has new geometrical properties, which we will call fractal structures.

Fractals are objects which are similar each other [5] as certain parts are connected with the whole system difficult feedback. It is possible to present emergence of chaos as result of a set of bifurcations. Therefore chaos of system we will describe fractal set [5]. The MMC enterprise, which uses the abilities to self-preservation and survivals, always experiences transition or expansion bifurcations through integration processes of the enterprises of Metinvest Group, or enterprise destruction.

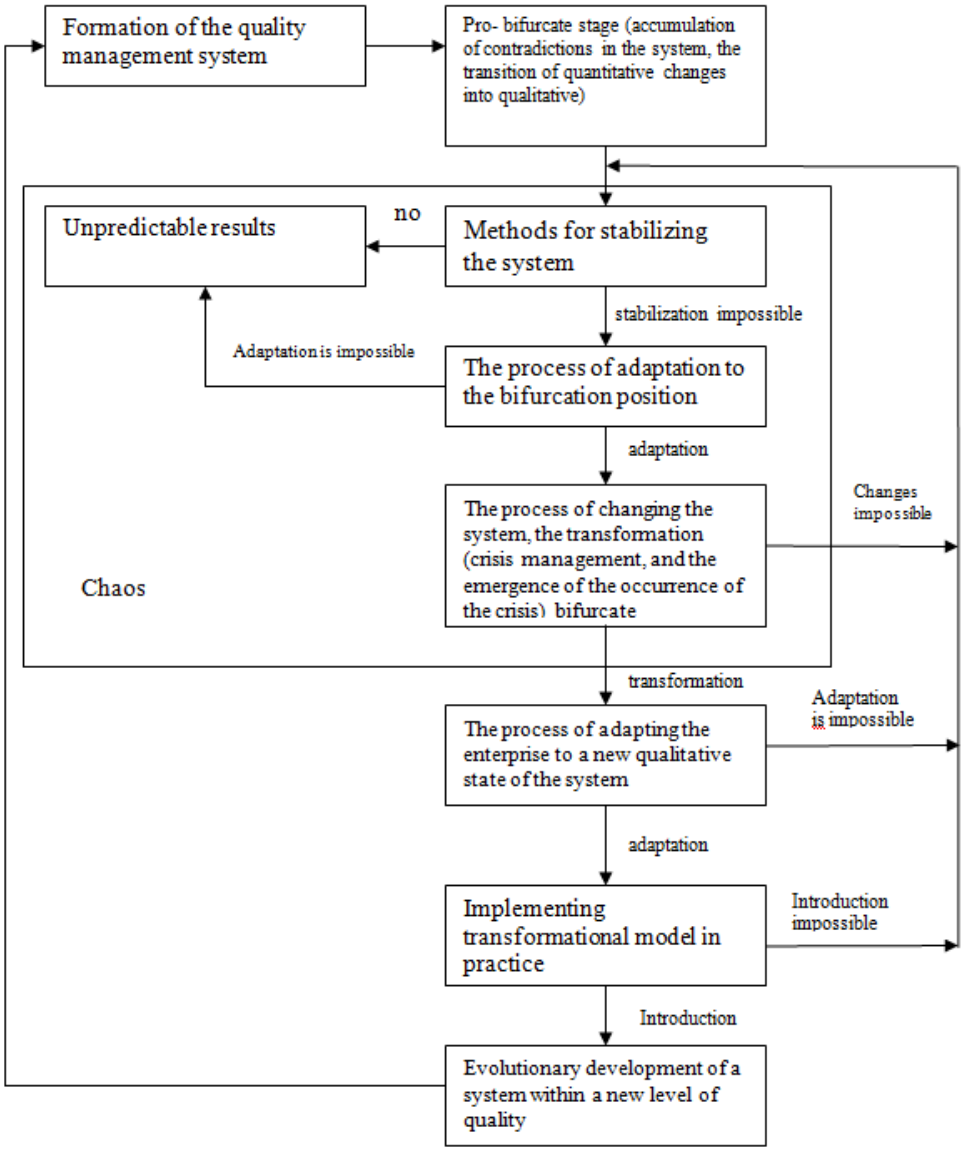

Figure 2. The main problem points in the course of system transformation of an enterprise management system of MMC

Let's consider six possible conditions of system.

1. Functioning within the reached level of quality of system.

2. Before bifurcation stage (accumulation of contradictions in system, transition of quantitative changes into qualitative).

3. Chaos.

4. Transformational process (crisis).

5. Adaptation of the enterprise to new conditions after crisis managing.

6. Evolutionary development of system within a new level of quality and strategy of innovative development.

To these six conditions of system there correspond five graphic fractals, which can describe a configuration of the following system transformations in the conditions of post-crisis management.

1. Fractal, describes a situation which is characterized by that the enterprise - as the system from an initial condition passes in new one and unambiguously defines a condition of system. This transition is possible only according to one path, the system has to experience one defined crisis. The main task of management of PJSC is its adaptation to a new qualitative condition.

2. Fractal, which is typical for a situation when the new qualitative condition of system can be reached as a result of experience of n - possible crises, as a result exists a number of possible paths of achievement of a desirable condition of system. The main objective of joint stock company in this situation is reduced to a choice of a path, which provides achievement of the planned qualitative condition with the minimum losses (it is necessary to carry out a problem of optimization of criterion of a minimum of expenses).

3. Fractal for situation at which one defined can lead crisis to a set of new qualitative conditions of PJSC. The main objective of management of PJSC is definition of such new qualitative condition which provides the greatest possible effect gained from activity of the enterprise (in our case it is necessary to calculate optimizing tasks of criterion of achievement of the greatest possible result).

4. Fractal characterizing a situation where the enterprise as socially - economic system can potentially passes in the new m-possible qualitative conditions, each of possible conditions to realization will be reached as a result of experience by system of n-crises. Thus, definition of such path of development, which will lead to achievement of the maximum result at minimization of expenses for realization of transformations (i.e. solutions of an optimizing task on criterion of a minimum of expenses at a result maximum) becomes the main objective of PJSC.

5. Fractal for a situation when each of possible n-crises can translate the enterprise in m-different new qualitative conditions, thus arises imposing of crisis paths achievement of qualitative conditions and the most possible strategy of development before achievement of stabilization of output parameters (economic profit and maximizing joint-stock cost of PJSC). Business management as difficult socially - economic system on the basis of strategy of prejudiced management with use of tools of self-organization and adaptation to environment changes at all levels of management becomes the main objective of management.

Conclusions

The model of functioning and enterprise development on the basis of an assessment of aperiodic optimum economic growth of socially - economic system, in which during crisis there are the irregular fluctuations caused by indignations of environment, is developed. Possible models of crisis transients, on development of the enterprise and a path of crisis management by the enterprise in pre-crisis, crisis and after the crisis period in the form of five fractals that allow to operate development by means of adaptive intellectual control systems of PJSC are investigated.

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