Modern modeling technologies and methods of electronic control of high-tech territorial clusters

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Abstract: Our studies cited in this article refer to the cluster model of regional development, which contributes to the modernization and technological development of economy of the country (including the realization of socially important projects) and provides an implementation of innovative technologies and products. A realization of two alternative scenarios has been analyzed ─ either a provision of financial stability or an extension of investment activity for increasing an output of products and improving living standards of the population. Accordingly, the issues of optimization of relations between these two competing factors that determine the state of the economy as a whole has been discussed. A brief characteristic is given to the clustered nature of the regional economy development and its features. The role of the leading regional universities has been defined in this development. The problems of establishment of innovative economy in Russia have been discussed in terms of relations between the federal and regional levels. The perspective of practical application of software and computer resources for information and analytical support and the support of management of different-scale economic systems has been stated. The modeling and the forecasting of general laws and trends of economic system development depending on its basic control parameters has been fulfilled within the framework of nonlinear dynamics approaches, and a financial and economic interpretation of the results has been done. This article was prepared as a part of the state task № 2014/13 of VlSU for performing public works in the field of scientific activity.
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1. Introduction

One of the strategic challenges that Russia is currently facing is the implementation of priority directions of development of federal-regional sector of high-tech technologies, including energy saving technologies and objectives for the modernization of the military-industrial complex. It will provide an innovative development of the economy of the country as a whole to solve the problems in the socio-economic and humanitarian/cultural spheres.

However, in this process a potential conflict is arising in the implementation of two possible scenarios – to ensure financial stability, or to enhance investment activity for increasing an output of products and improving living standards of the population and, accordingly, there is a need to optimize the relationship of these two factors determining the state of the macroeconomy, that can be recognized as a key issue of formation and implementation of the strategy of development of innovative system of modern Russia. The processes of financial flows depend on the solution of this problem taking into account the budgets of different levels and inter-budgetary relations. It will ensure a high level of welfare of the population and reinforce the geopolitical role of the country and finally ─ will determine Russia's place in the global hierarchy of states as one of the global leaders.

In connection with these problems, it is required to examine different models for forecasting the effectiveness and the efficiency of investment of financial means in the development of the economy of the country as a whole as of its individual sectors in particular, in particular, its regions, following the final results within the program-target and design approaches. Such models may help to provide the forecast of the revenue side and the optimization of the expenditure side of the consolidated budget of the country.

In connection with these problems, specialized methods are now widely used: the methods of so-called financial mathematics, which evolved in a separate direction and which defines the conditions for the dominance of financial mechanisms in the

development of innovation-based economy, as well as accounting, control and financial flow monitoring procedures and their modeling are prescribed for the implementation of management and prognosis of various scenarios of the development of economic systems of different sizes.

In addition, the solution of these problems requires the use of the achievements of modern information and communication technologies in the context of e-governance at all levels of the state, as well as networking of the participants in the innovation process. Such interaction begins with a particular manufacturer in terms of regional economies and their relationship with the macroeconomy, including cross-sectorial cooperation, on the principles of integration of resources and capacities (both logistical and human) and diversification of the production.

To implement these fundamental projects it is necessary to do a key breakthrough in the national economy from the traditional business, in which the main motivation is the income, to the technology entrepreneurship, the main goal of which are new products and technologies, created on the basis of the latest scientific and technological achievements.

Although financial instruments, institutions of development and their management play a significant role in such processes ("money + management"), but without the creation of new products and technologies it is impossible to conquer new market niches. In this case, the concept of market relations must fundamentally change within the framework of the leadership of innovations - not demand creates a supply, but on the contrary, - the creation of new products and technologies gives rise to demand. This requires significant investments in the sphere of science and education (in the economy of leading technologically advanced countries, the share of expenditures for these purposes is a few percent of the total gross domestic product).

The projection of this strategy to the development of non-extractive economies of the regions that make up the majority in Russia may be provided in the framework of the cluster model. For different subjects of the Russian Federation, it is different and has its own specifics. However, its general principles suppose the implementation of the full innovation cycle.

It includes the following sequential stages: (1) research and development; (2) implementation in production; (3) manufacturing; (4) promotion to the market. In this respect, an increase of the share of modern/unique equipment (not older than a few years) shall be provided. As a result, it shall reach the level of 85% for a competitive economic system of high-tech industry sectors. But the new technology requires new staff. Therefore, the role of additional education/training (at all levels of professional education) and providing of generalist consulting/mediation services should also increase.

2. Material and Methods

Using the methods of nonlinear dynamics in the modeling of socio-economic systems can more objectively formulate key theoretical positions and do based on these practical conclusions. On the one hand, the mathematical formalism of nonlinear dynamics allows formulating meaningful and verifiable theoretical calculations for a wide range of complex phenomena, on the other - some economic phenomena are so inconsistent or not understood, that their study without the use of methods of nonlinear dynamics is almost impossible.

The use of methods of nonlinear dynamics in the modeling of socio-economic systems allow more objectively formulating key theoretical positions and doing practical conclusions based on them. On the one hand, the mathematical formalism of nonlinear dynamics allows formulating meaningful and verifiable theoretical calculations for a wide range of complex phenomena, on the other, ─ some economic phenomena are so inconsistent or not studied, that their study without the use of methods of nonlinear dynamics is almost impossible.

Our objective is to define the basic principles of innovative development of the economic system in the framework of modeling of general laws of nonlinear dynamic processes and their financial interpretation.

3. Results

3.1. The features of clustered nature of the development of regional economy. The role of the leading regional universities

In general, the cluster model of regional development contributes to the modernization and technological development of the Russian economy, including the realization of socially important projects, and provides the implementation of innovative technologies and products. This model also creates the most favorable terrain for the development of innovative educational programs at all levels of professional education. In this context, a diversification of activities of the participants/residents of the cluster and their partners shall be provided on principles of integration.

In modern terms, the discussed approach is consistent with a model of innovative development of the "Triple Helix" [1] when the state, the business, and the sphere of science and education start to take over the functions of each other, keeping a certain balance in the delegation of relevant authorities. Under these conditions, a particularly important role is given to leading regional universities, which become entrepreneurial (a big budget is intended for scientific research and development activities and its significant

proportion is intended for intellectual property) and are an integral part of the real economy of the region.

The work of the cluster will allow, on the one hand, modernizing the economic complex of participants/residents of the cluster, ensuring herewith an involvement of unused capacity; organizing and developing new sectors of production on the basis of high technologies; assisting in the implementation of investment projects aimed at creation of new perspectives and reconstruction of existing facilities [4]. On the other hand, it will help to ensure social stability, improve the efficiency of social and economic relations of the economy, and stimulate business activity in the real sector and employment of the population. Such socio-economic development of the territories, which unify the cluster, will enhance the efficiency and the effectiveness of the use of budget funds in terms of partnership between government and business.

One of the principal positions in the activities of the cluster is the creation of innovative infrastructure, including innovation and technology centers, technology parks, business incubators, centers of excellence, contributing to the formation of mutually beneficial relations between the participants of industrial, scientific and technical activities.

A particular attention will be given to the formation of the given infrastructure of free land parcels and on the basis of previously established industrial/scientific and educational complexes of members/residents of the cluster. This will allow using the measures of state encouragement to improve the performance of industrial sites with appropriately trained staff, as well as creating a replacement production, where it is needed, including the implementation of technologies of advanced education in remote access. This infrastructure of territories will enable to prepare the site for the arrival of investors; will help to solve the issues of technical re-equipment and modernization of the previously created productive base, to develop the services and the production demand, as well as to improve the living standards of the population involved in the work of the cluster.

An important element, determining the effectiveness and the efficiency of the cluster approach, is a continuously improving legislative and regulatory base, the system of preferences for stimulating innovative activities in the cluster.

A particular fundamental block of tasks that should receive an accelerated development in the cluster is to motivate today's young people to scientific research for the benefit of high-tech production.

Engaging young people to work on innovative platforms of cluster will allow fundamental basis and the required level of professional competence to be combined properly in the educational segment of the cluster.

The fundamental nature of vocational education provided by the universities associated with the innovation infrastructure of the cluster, firstly, will form the creativity basis of future researchers, and, secondly, will act as a guarantor of the demand for specialists in the rapidly changing labor market demands in the long term perspective.

Whereas, a level of competence implemented by the direct work of students and graduate students in the university innovation landscape with its business partners in specific areas and projects enables to provide with personnel the current demands of successfully functioning business community of relevant industry sectors and, as a result, its further development.

Principal directions of such cooperation in the cluster are implemented by the following principles in attracting leading regional universities.

1. The role of the university is determined not only in solving the staffing problems in relation to the requirements of the labor market but also in the implementation of plans to create new products, expansion of services, the new technologies development and their commercialization for the needs of the region's economy and the country as a whole, which are formulated by the state.

2. University fulfills material, technical, and methodological support of scientific and technological innovation projects of high-tech enterprises and organizations in the innovation development and their results have federal importance; university also coordinates the implementation of these projects, including the networking cooperation, for example, - the development of nanotechnology and nano-industry in the national nanotechnology network in regional clusters of high technology, the operation of a network of Russian centers for collective use, and others.

3. University is directly involved in the program of small and medium-sized businesses development with a focus on high-tech industrial sector as a cofounder of small businesses that can also attract young people to science and innovation to realize their entrepreneurial ambitions in accordance with existing legislation.

4. University tries to build its innovations in innovative development programs of state corporations / enterprises with state participation, in accordance with the priorities of the Russian system of technological platforms. Thus, obtaining significant results in promising and competitive areas of production (using new materials, new technologies, improved existing technology cycles and ensuring new qualities of products, etc.) requires collaboration of specialists in different areas of fundamental and

applied sciences and organizations of modern high-tech production. The most effective form of such collaboration is the discussion of relevant regional clusters of high technology.

Special aspects of cluster development of areas require a number of conditions. They come down to the following key factors.

The first is the combination of mixed innovation orientation of economy of the region and explicit priorities of its development for the medium / long-term prospect with broad involvement of investors.

The second is close coordination and cooperation of large strategic enterprises within the industry of federal level with the specialized small and medium-sized businesses under the assistance of the regional authorities.

The third is the presence of a large, leading in the region, research / innovation university with its techno park area, which provides personnel training / retraining of almost all levels of professional education in the area in accordance with the requirements of the labor market, including additional / advanced education.

In connection with this concept, it is necessary to develop innovative technology parks zones of small innovative enterprises and independent high-tech companies («start-up»), and associated with the high-tech industry sector-specific (priority for it) directions («spin-off»). The emphasis should still be placed precisely on the promotion of small businesses such as "spin-off" in the relevant areas for a successful business. These companies are able to enter directly into the high-tech production under a flexible response to the market demands in contrast to the "seed" small businesses such as "start-up" operating in isolation, and which still need to fight for their place in the market. It is similar to the "spin-off" small companies should receive further development within the framework of the cluster.

The main priorities of the regional authorities within the framework of the cluster approach are to move to a larger scale of socio-economic processes in the region. This will provide a more successful implementation of innovative measures for the development and modernization of the economy as a factor for sustainable economic growth and ensure social stability, increase employment and increase the efficiency of the use of budget funds, as well as ensure the development of municipalities.

3.2. Problems of innovative economy development are the relationship of the federal and regional levels.

Solving of common problems of the country requires close interaction of multi-industry economies both at the federal level and under the implementation of the priorities of the state in economic entities and territories. Despite the generally recognized rules of coordinated work on these two levels, in accordance with the priorities of the state, its organization is a challenge in any country of the world. Correct / appropriate combination of administrative and economic instruments is determined by current realities and carries some risks.

At the macro level we are talking about the following risks, which act as external risks for the regional economy:

(1) legislative mis-regulating of inter-budgetary relations / budgets of different levels, relations between the state and the business community in modernizing and sharing of material and technical base, as well as the tax (and other) preferences for the business community, which is investing in innovation;

(2) the demographic situation (continuing decline in the number of potential subjects of professional activities, especially in technical areas);

(3) restrictions of the federal legislative framework of interagency cooperation in the innovation network optimization process;

(4) a low level of prestige of a number of engineering / working professions among young people and their parents;

(5) insufficiency of economic incentives and conditions for innovation activity at the level of the majority of non-energy regions;

(6) the entry into the World Trade Organization under low competitiveness of domestic producers.

There are also own / internal risks for the regional economy. These are the following positions:

(1) the lack of appropriate funding of basic infrastructure development activities of high-tech sectors of the industry;

(2) complex situations in the restructuring and diversification of production and its reorganization / consolidation on the one hand, and the development of small and medium-sized businesses on the other;

(3) low motivation of manufacturers to innovation activity and implementations;

(4) problems with engaging young people to science and innovation and their consolidation it in this area and personnel aging;

(5) the emergence of social and psychological tension in the creative community as a reaction to the involvement of employers and the authorities in the procedures for assessing the effectiveness of activity of employees in the implementation of innovative projects, especially in the dominance of narrow competence-based approach;

(6) focus on regional business "short money"; unwillingness to participate in the "long money" (budget allocations).

Due to the presence of these problems and their insolubility in the current activities, we often have to

switch to "manual control" (including at the highest national level) in the socio-economic sphere, even to relieve local and specific issues. This "position control" of complex (with many links) economic systems, especially in the conditions of market relations, of course, does not allow economic sectors to operate constantly at all levels, which should be based on self-regulatory processes and sustainable long-term predictable patterns in the innovation environment.

Therefore, the role of forecasting of the consequences of management decisions at all levels of functioning of the economic system is increasing dramatically. The main objective here is to develop adequate multifactor models and scenarios of economic/ macroeconomics development and analysis of its stability with respect to various destabilizations, including a one-time management decisions.

Scaling of these scenarios in federally-regional dimension should allow a clear division of responsibility of the federal and regional authorities both in terms of effectiveness in achieving its goals, as well as in terms of the effective interaction of all participants in the innovation process.

3.3. The prospects of practical appliance of the software for informational and analytical maintenance and support of management of economic systems of different rates.

This section of problems in its basic components can be classified in the following form.

The basic motivation under implementation the State's priorities relating to social and economic and innovative development of the country and modernization of its economy by using achievements of Information and Communication Technologies (ICT) includes:

- execution of the normative legal documents on development of information-oriented society and electronic government;
- application of informational technologies and development of electronic democracy;
- Providing regional segments for high technological sectors of economy and organization of interdepartmental cooperation.

The policy objective on intended use of public resources, its effectiveness and performance, includes registration, control, audit, analysis, model-based analysis which allows performing the total forecast of revenues and optimizing expenses.

The organization of collaboration and cooperation of various participants of business processes as well as control and auditing of expenditure of budgetary, non-budgetary and capital funds of private entities under implementation of projects requires carrying of special events.

It is about implementation of *decentralized distributed approach* relating organization of such informational and analytical system. This should allow, firstly, providing easy entry of new participants to a general dynamic process of online cooperation and, secondly, solving delicate problem of collaboration and hierarchy as well as access to information between various and self-sufficient participants (governance, business, science, education).

Basic components of such networking cooperation are centers of data-processing. The approved scheme of the networking cooperation is structured according to the principle of creation of the network of similar data-processing centers of different hierarchical level (with relevant authorized access to different types of information for users). They can be characterized as follows:

(1) Basic level. It is a central node of distributed information system. It provides collaboration both on federal and regional levels.

(2) Territorial level. District data-processing centers for providing of innovative process on a certain territory.

(3) Local level. Stationary and mobile working places can be located in any point and achieve access to network functions through public interconnection (Internet). They are affiliated centers under district data-processing centers and liable for collaboration with particular users.

The structure of any applying version of the ICT-complex for support of business processes and providing for financial control must include the following basic components: analytical data base, business logics layer, relevant application software.

In this case, the system should be scalable and transfer to the new versions should be provided since the basic functional components for them are not changed but modified by applying new ICT achievements in hardware-software and program-analytical parts.

Speaking on the new world tendencies of ICT development which can be applied for implementation of electronic control in the field of financial activity and monitoring of cash flows, the priority tasks are as follows:

- organization of geographically-distributed operational points for access to Internet resources («Hotspot») including Wi-Fi, Wi-Max and other technologies;
- updating of the datacom network («Tripleplay») including simultaneous transmission of data, transmission of images (IP-TV) and telephony;
- optimization of internet traffic and its topology in the region, analysis of malicious software and dangers including feasibility study and ratification

of the services rendered by the government institutions and commercial organizations on financial indicators;

- application of social networks for solving tasks of territory development and commercialization of achievements in social and economic, cultural and educational, research and education, excursion and tourist directions including informing of citizens of core areas of activity of different structures;
- necessary events for organization of cloud computing profile segment including distribution of services and content for all the participants of innovative process.

Brief description of basic models of the required ICT-system is as follows:

Analytical data base should allow performing migration of analytical data base to the modern DBMS versions, e.g. MSSQLServer that is to provide:

- application of more effective requests to the Analytical data base;
- optimal using of hardware resources of modern computer systems on the ground of multicore processors.

Business logic layer allows transferring the business logic itself from the client application to the server that is to provide:

- speeding the work of application software;
- relaxation in the requirements to the parameters of client computers;
- availability of terminal decisions of the technology "thin client".

Application software should provide the usage of modern workbenches for development of software as well as technologies (1) "thin client" and (2) cloud technologies.

(1) "Thin client" technology provides:

- for the computer or client-program in networks with client-server or terminal architecture - transfer of all or the biggest part of tasks on processing information to the server.
- orientation to minimization of total cost of software ownership;
- implementation of computer with a browser for usage with web-application in work.

So, the essence of "thin client" technology results in the events when all the operations are performed at the server and the user's monitor opens only to show the result. In this case the connection with the server's desktop is carried thereby actually providing contact between the keyboard, the mouse pointing device and the monitor of user and the server through this adapter.

So, all information is stored at the server; as well as the list of required programs and user just receives "the image" of the desktop and the programs initiated through the network (e.g. MS Word, MS Excel, 1C, etc.).

(2) The cloud technologies being innovative decision provide dynamically scalable computing resources and applications through Internet as a server controlled by service provider. This allows to transit quantity to quality, due to the effect of scaling.

In that case, usage of the cloud technologies enables to apply software, hardware and other resources of «collective virtual computer". In addition, differences between the devices applying by user (computer, notebook, smartphone, pad, TV set, media player, television-game device, etc.) are blended. The work is carried through the web-browser which leaves concrete implementation of ICT workbench off-screen and it is practically invisible for user.

Concerning financial and economic aspect of the cloud technologies it is to be noted as follows:

In general, the total cost of ICT-decisions ownership remains a problem for a number of regional services which requires large investments to the infrastructure and hard management skills.

However, for cloud computing which is a new model of outsourcing under implementation of ICT decisions, the access through Internet is used to distribute computing resources and applications under control of service provider. In that case the clients pay only for usage of the ICT decisions without the need to invest to the development of infrastructure and they have the competence to manage it. However, in the implementation of the cloud technologies, a number of problems arise.

In particular, special attention should be paid to the issues of the cloud technologies application by public authorities including local authorities. It suggests that the hosting of critically essential applications/ data is located outside the jurisdiction of relevant organizations and it depends on the architecture of data of sole provider. That's why the problem of an adequate security of personal data owned by governmental structures, business and citizens arises. The main issue is to provide the security of personal/governmental/corporate data. All these problems should be analyzed and discussed and "political decision" should be made in each case of implementation of this technology in a certain field of power.

3.4. Basic principles of innovative development of economic system as a part of modeling of general regularities of nonlinear dynamics processes and their financial interpretation.

The dynamics of development of any complex multivariable system depending on various factors and their combinations is defined under relevant terms (internal and external) of competition of different processes. The central task for such systems is to

choose the dominate process and/or tendency (trend) of the development as well as the mechanisms of its management.

This fully pertains to the economic systems where a right choice of management parameters allows achieving the required result and / or at least appreciating the problems which prevent from achievement of this goal. So, it is required to analyze two factors of cooperation and competition: providing the implementation of cost-based processes including essential social investment projects, on the one hand, and carrying of financial events and operations on funds accumulation for the growth of capitalization, on the other hand. The modeling of these strategies can be carried under consideration of certain equations and a class of their solutions with a relevant degree of formalization of the economic task being discussed.

In terms of a mixed economy with participation of its core subjects represented by governance and private sector it is required to continuously balance between market mechanisms and governmental regulation. Therefore, the central problem is various domination degree of each of them in different time periods depending on the country's economic state in the whole and world conjuncture. It allows optimizing development of economy with expert assessment on each final result including in perspective with concern of competitiveness of various sectors of economy which are given the priority now.

The objects of modeling can be both macroeconomy objects (basic markets of funds, capital, benefits, labour, etc.) and the processes inside each of these markets with due regard for possible dynamic changes.

Anyhow, the question is appreciation/ achievement of a stable/ optimal state of economic system and identification of provisions which can make it possible. As a result, it becomes possible to forecast such macroeconomic indicators as national income and gross domestic product, prices degree and inflation, employment of population and unemployment rate, etc.

In the formal mathematical aspect the movement of financial flows from a centralized (at different rates) source (public programs, essential specific projects of infrastructure development, programs for the development of large corporations of all types of ownership, Institutes for development, international programs, etc) can be modeled by a certain type of dynamic process.

In the elementary case, at the initial cost-based stage, it is one-dimensional/unidirectional wave process (with intensity/amplitude of a definite characteristic/parameter u (t, x), time-varying (t) and staying in configurational space (x) with fixed tempus/speed v of change x that specifies the speed of change of the parameter itself) described by the equation

$$\frac{1}{v}\frac{\partial u}{\partial t}+\frac{\partial u}{\partial x}=0 \quad (1)$$

Under the configurational space where x is changed the definite field of variables which is liable for both address /functional direction of financial funds (in the sector, specialized clusters, under development of infrastructure) and territory-oriented (by regions and single/localized economic objects) financial support can be deemed. We will return to this issue later.

Moreover, the task generalized for a multidimensional event (there is a variable collection x_1, x_2, … instead of one variable). We are interested now in the definition of dominating tendencies and qualitative relations within comparatively simple and formerly developed models in other fields, and not just complication of the task (which decision can be related with great difficulties).

Solution of the linear equation (1) is well known [2] - this is wave/periodic process for the parameter u depending on "running coordinate" u=u(x-vt). This solution can be interpreted as a definite strategy of economy support, its certain characteristic/indicator including through enclosure and movement of financial flows with some cycling in time. It provides the periodicity of economy system operating pursuant to the marked characteristic (e.g., increase/decrease of investments to a field/direction and/or territory and, correspondingly, stimulating of development of the structure being researched).

The dominated process chosen should consider, firstly, certain distribution ("diffusion") of the characteristic u, namely, due to these flows, in time according to the different scripts, meanings of x, development of territories and sectors (dispersion effect in physic-mathematical terms). It can be formalized as a member $\sim\frac{\partial^3 u}{\partial x^3}$ which is added to the equation (1) with definite normalizing factor This member is liable for "items of expenditure", provides distribution of u according to x, and under certain turndown x defines ineffective low-oriented usage of funds on the principle "money down the drain").

The consideration of a lower derivative ($\sim\frac{\partial^2 u}{\partial x^2}$) degree results in diffusion process, characteristic overflow (through time) from the sector near its maximum value as a function from x (decrease takes place for it) to the sector near the edges (increase takes place for them). In the economic aspect this process complies with tendency to grading characteristic value, homogeneous distribution of u on x at every moment of time including through the mechanism of homogeneous distribution of financial funds (provides the principle of grading and averaging). This process is

characterized by the normalizing coefficient D, a coefficient of diffusion, but we will not consider it hereinafter.

Secondly, the parameter value itself can define the process of its dynamics i.e. can be recorded as a simple nonlinear member $\alpha u \frac{\partial u}{\partial x}$ (where α - is normalizing coefficient) which as well should be added to the equation (1). This member opposing to dispersive member in the financial interpretation is liable for including accumulative process (income part) and concentration of financial funds (nonlinearity provides than investment of funds according to the principle "money makes money").

As a result we come to fundamental equation (in nonlinear theory of waves it bears a name of hydrodynamic equation of Korteveg – de Vries [2]) that can be written down as:

$$\frac{\partial u}{\partial t} + v\frac{\partial u}{\partial x} + \beta\frac{\partial^3 u}{\partial x^3} + \alpha u\frac{\partial u}{\partial x} = 0 \quad , \qquad (2)$$

where included in it values were previously explained above.

As to order of vanishing of components in the presented approximate equation (2), dispersing and nonlinear terms have the same order of vanishing, and less (with the smallest in this equation order of vanishing) than the first two.

In the equation (2) under indication u(t,x) we mean any index/figure that characterizes economic situation. We do not specify this figure as far as it depends on actual setting of the problem and required/expected result. But basically this refers to well-known indices – for example, stock market index (Dow Jones, NASDAQ and other) both on the regional levels and countrywide, and on the level of macroeconomics. Here can be included also quantitative (volumetric) indices – output of products, expenditures for its output, cost and so on. It can be also a group of interlinked (consolidated) indices [3]. The other alternative (more difficult approach), − when for every functionally important index is written down the separate equation (2) with own coefficients and as a result, − on the multidimensional chart of significant indices the solution is being found. Exactly they allow using mathematical models, to interrelate them, to realize comparison, to identify the influence of key factor on the change of complex index and so on, and as a result – to realize process optimization.

Within the framework of this approach under variable t we understand, as usually accepted in the theory of wave processes, time (i.e. the dynamics of specified indices behaviour in time is examined).

Concerning variable x the only rational and restrictive condition imposed on it is continuous growth (wave process expansion in space in initially stated equation of Korteveg – de Vries). In our case it can be configurational parameter, responsible, for example, for human wellbeing (wage increase), output, investment volume, energy expenses (their upper value is adequate for economics) and so on. Its interpretation depends on setting of the problem. It is more preferable to introduce certain complex parameter that takes into account combinations of all similar key growth factors.

In such approach the variable x practically determines the model of considered economic growth, i.e. the demand of x growth is initially input (control parameter of the task). Then in the process of modeling we have the following result: how this demand affects key indices behaviour − u(t,x) that determine the economic condition and change of its parameters in time (including in the set pace).

Consequently clear sense receive initial and boundary conditions that must be formulated (specify the task) for the processes that are described by differential equations. Indeed in the first case the issue is the economic condition – values $u(t_0)$ of indices – at the beginning of chosen time interval of modeling with forecasting aim, and in the second, − on the basis of attained level of x_0 (for example, average wage/investments) are input the characteristics of the desired level of x (wages/investments) in accordance with adopted managerial/expert decision. Then the solution of the equation must determine practical realizability of the set demand – in what time the expected value of u(t) index can be reached and/or not reached (depending on equation coefficients (2)).

In this regular equation the coefficients are considered to be constant values. But, modification of external conditions, where is particular economic system, can be taken into account considering the coefficients α, β as variates, moreover − even random variables. Such a generalization allows to describe not only regular (though periodic) conformities of economic systems development, but also to take into account the influence of sudden events (market condition change, economic crisis and so on).

This approach implies different level and scaling of the considered processes (it is reflected in the interpretation of function u(t,x)), when the issue is both macroeconomics (where the area of capital injection on the state level takes place in large directions − defense, education, social sphere, housing and public services and so on) and realization of certain projects by manufacturers. In this regard we speak for example about functional-interim consideration of capital flow u (as function of t) against determined priorities of x value.

Determining such qualitative considerations of financial flows below we will carry short formalized discussion – on the basis of standard physic-mathematical rendering – of the considered regular

nonlinear dynamic processes with the aim of detecting of main tendencies and conformities.

The equation alone (2) has several dozens of solutions classifications [2]. In our approach for every can be determined the defined model of economic development (in different levels on scale – from large scale global processes to vital processes of separate enterprise). The choice of acceptable model and conditions of its realization depending on problems facing the economics on the determined time interval of development is the target of the considered modeling. The main (and frequently fully not solvable) problem is adequate determination of equation coefficients that are control parameters of the task. They, as already stated, can change in time and be subject to different sudden factors (including on the level of determined above initial and boundary conditions).

Among the most essential classes of management decisions (2) can be distinguished the following 4 classes of process development: sole isolated wave, solitonic stable structure (particularly soliton), many solitonic modes and failure mode (blooming and/or flipping). It is not difficult to correlate every of them with corresponding economic development scenario (or separate its segments) in time t – from stable and growing (by index u depending on x), including with regular cycles u(t,x) to catastrophic – collapse/default. Furthermore principal are questions of stability of accepted (required) solutions to external disturbances of different nature. This standard for mathematics question presents the main difficulty in economic problems.

In connection with this it is interesting to note that to management decisions (2) with very ascendant amplitude corresponds scenario of rapidly growing economy (according to correspondent index u) that on the specified stage (as soliton) becomes unstable and can split into number of self-assembled isolated structures (subsystems) by every value of x, or collapse to low (homogeneous) level when $x \geq x_1$, when there is some level of value x_1 after which approaches devastating/unacceptable process.

It is not difficult to give examples of such economies (beginning from modern megaeconomies of China, Japan to small economies, including of European countries). The task is to make unacceptable development scenario – regulated and, as possible, to «wrap» it – switch to the other decision class. Economists sometimes associate it with necessity to reduce public expenditures and to contain the growth of production (due to occurring in reality «whipping» of inflation) toward financial solvency assurance of economic system. The like issues and detection of dynamics of economic cyclicality, inflationary developments and economic growth are determining in macroeconomics tasks.

Let's consider one of equation solutions (2) that is well-known (with accuracy to numerical coefficients) [2]:

$$u(x,t) = \frac{v}{2}\operatorname{sech}^2\left(\frac{\sqrt{v}}{2}(x - vt - x_0)\right), \quad (3)$$

where $u(x,t)$ determines change of unit of characteristic regarding equilibrium position that depends on configuration coordinate ($-\infty<x<+\infty$) and time ($-\infty<t<+\infty$), pace/speed change in the interval $0<v<+\infty$, indication sech means hyperbolic secant, x_0 – corresponds to characteristic condition at the moment of time t=0. For example in financial interpretation it is referred to dynamics of capital shift.

Solution (3) represents soliton – so called sole wave that locates without change of form and amplitude by different values of x, i.e. value x fixes the value u (x, certainly, changes in time).

The result of solution (3) is the fact that movement speed v wave block (of financial flow for example) is directly proportional to amplitude (by amount of finance) of soliton ($v \sim u$), «width» Δ is inversely proportional to square root of amplitude, i.e. speed/pace of change of variable x that determines the speed of v $\left(\Delta \sim \frac{1}{\sqrt{v}}\right)$.

This has essential importance for condition of soliton and determines all its demonstrations during performance of the economic system. The profile of such wave object represents bell-shaped disturbance with some maximal amplitude and (that can determine also amount of financing/ investments) time-independent for different x – sustainable economic development scenario on the grounds of u.

It is important to emphasize that the fact of soliton transformation in time means that only by defined x indication u has non-vanishing (higher than some level) value. Requested in this aspect values of x are realized only on defined time intervals.

We can look at this in another way: continued consolidation of indication role into developing economics/branch/region that was referred to above leads to increase of its rate of change. Such increase of pulse object rate leads to its significant modification: it becomes narrower (in x) and its amplitude increases, i.e. we can speak in financial aspect about localized capital increase during fixation of x – its concentration in indication terms – in definite points of time. To detect this area (x,t) and to get into it is the aim of carried analysis on the practical level. This implies that at first sight paradoxical result – quick economic growth needs very fine adjustment of control process parameters, otherwise failure/collapse can occur.

Separate discussion requires analysis of process stability regarding different external disturbances, for example, small variations of modulation of soliton profile. For economic system such fluctuations are ongoing process; it can also be considered within our approach but we will not dwell on this.

In such a way, for real conditions the soliton energy (proportional to integral value of index on the interval x) does not conserve because of energy dissipation effects and energy inflow at the cost of external influences (due to loss and/or flow of financial resources, for instance). The latter is crucial for the case of investment scenario of economic development.

Initially this process of system openness can be taken into account by means of methods of perturbation theory, when into the right side (2) is input additional term εR that is implicitly dependent on x, t, *u*, and also partial derivatives of *u* (where ε – small parameter).

The perturbation εR can be presented in the form (– ε*u*) that corresponds to gradual indication change. Therewith we have: ε>0 for losses and ε<0 for flow, for instance, capital.

The consideration of this factor (for small ε does not change solution type (3) but takes place wandering with passing of rate time v) leads to important result that soliton amplitude evolves in time in accordance with strong exponential relationship [2]:

$$u(t) \sim u(0)e^{-\varepsilon t}. \qquad (4)$$

In case of index increase (ε<0) its value will increase in time (at least at the beginning of its formation). The parameter 1/ε in (4) determines characteristic time of indication transformation, for example, of investment volumes – from the beginning of the process (t=0).

However the solution (4) is correct for small ε, the defined tendency displays in the right way the process subject matter in general case. We will additionally note that here appears interesting shelf effect (step) of finite «size» on scale x (~t) and constant amplitude (height ~ ε) − soliton spur, i.e. stable economic condition but on the low level that can be interpreted as «stagnant» condition according to constant small value of index u independent of value x.

Certainly the increase of investment volume, if it is connected with increase of soliton amplitude, cannot happen in time continually. That is why in the process of initially formed pulse/indication (particularly, soliton) with increasing amplitude (due to defined replenishment) should happen its splitting into several objects – secondary solitons (satellites) with own value of x for every of them – with smaller amplitude, and then can happen their splitting in certain time interval.

From the point of view of the theory of non-linear processes the given instability and such splitting happen, beginning from some critical value of soliton amplitude – degree of indication in the process of its evolution, i.e. this refers to threshold effect. Amount of emerging satellites is proportional to amplitude of initial soliton, and their partial rates of change are proportional to amplitude of every satellite. Moreover, solitons can overlap with each other without change of their form (nondestructive interaction of solitons). It corresponds to recovery in time the indication u for different x after happened localization u around some value of x in definite time moment. This process in greater degree can be referred to capital localization (resource mobilization), but only for a short period of time by defined value of x.

Though on its own the fact of existence of such solution class is known long ago for equation (2), but its practical detection for certain numeric parameters represents difficult enough task.

Especially important case when by such modelling the following approach to the problem is realized. For the known – interesting for us – solution class are found numeric values of corresponding coefficients in the Korteveg – de Vries equation (2) for which this solution class is realized.

The next stages connected with significant difficulties assume, firstly, determination of correlation between chosen numeric coefficients and real control parameters of the considered process (for example – financial) that must be taken on the assumption of condition of considered economic system. Theoretically from nowhere follows that they can lead to required coefficient values in analysed equation. But knowing the modes that are typical for studied process that are realized in happened real events, we can affirm that this operation can be fulfilled. Secondly, determination of such correspondence will allow understanding the cause of appearing and possible dynamics of process development during change of this control parameters, which happen in real economic system in accordance with considered mechanisms. Thirdly, such fulfilled procedure allows to carry mathematical modeling of the considered process and to forecast its stages in time and in different periods depending on evolving conditions. Such execution of the given full cycle scarcely is possible as a whole currently, but also its realized components are important in itself in the aspect of understanding of general/partial conformities of economic systems development of different ranks.

Coming back to solutions of Korteveg – de Vries equations, we should note that in many solutions the sequence of solitons in the given time moment with different amplitudes is lined in such a way that finally «ahead» (in configuration space x) is the highest, and «behind» – the smallest form of them. This can define the strategy of economic system development, when

the biggest effectiveness and performance of economic system is reached by determined value of x for certain development stage (maximum parameter of index u).

It should be noted also mentioned above important nonlinear effect – the process of soliton inversion typical for very nonlinear and non-homogeneous by x (as far as the rate v of soliton depends on its amplitude distributed by x) process. It can also be attained within solitonic approach, but needs higher approximations for accounting of non-homogeneous dependence of the rate of indication change from parameters of existing economic process. This effect can cause at the moment of appearance of special conditions (for example during dispersion decrease, during interrelation with other economic objects) additional phenomena, including collapse (splitting). The marked interrelation with other objects also is taken into account in equation (2) by introduction of «external nonlinear force» F(u,t) in the right part that can have also random nature.

Furthermore, when input into economics financial volumes is insufficiently powerful, then the financial flow dies out very quickly (is determined $\varepsilon>0$ in correlation (4)), leaving on the final stage definite «calm» mass. In this case we can speak about (economically) dying scenario of system development. This type of solution is that what usually call long wave of standstill in dynamics of economic condition. In the used dynamic theory «pulse» of indication u with its initially small value (lower than threshold value for explosive growth) determines the process, which is not already solitonic, but represents usual wave/additive process for dynamic system – without strengthening. In this case the process demonstrates poorly oscillating character at low level of indication u.

The carried discussion of economic development, − including through financial flows within the given concept – for sure has good prospects regarding receipt of the most qualitative forecast for the development of such processes in different time intervals. Therewith must be evaluated the key values – resource and potential of financial assets, and also possibility of their localized (at value of indication) involvement into critically dangerous branches/regions (by value of x) under conditions of actually evolving situation with consolidation of influence of different events of economic or other nature.

But the main difficulty that causes the biggest problems by such analysis is how to bind equation coefficients (2) with real economic parameters that are fixed in practice for considered economic system in the process of its monitoring.

The further specification of mechanisms of emergence and display of such events (especially in the aspect of modeling and forecasting of the admissible risk during economic development) must be connected with transfer from regular nonlinear equations to stochastic nonlinear dynamic equations.

Significant difficulties of numerical modeling (mathematic and simulation) within this latter approach with stochastic functions are connected with big volume of computations and need (in practical aspect of accounting of quickly changing external economic conditions) usage of supercomputer with high-performance computing.

4. Discussions

There are many problems that hamper development of innovative economy and in the long term must be solved in existing economic environment. Among positive trends of its development it can be marked the following.

Firstly, the improvement of economic condition takes place thanks to high-tech industrial sectors that as a result improves social standard of living and permits to formulate the development priorities.

Secondly, significantly improves the situation with ensuring higher level of national security. It is reached by success in space, nuclear branch and so on. As a result the place of country in the world in different branches is determined and becomes possible realization of its strategic concerns/geopolitics.

Thirdly, increase of level and pace of development of education, science and culture leads to spiritual and moral population education, especially youth. This also enables to realize networking technologies of cooperation and partnership in different branches in remote access.

Fourthly, the implementation of socially oriented trends in development priorities of the state leads to development of infrastructure and social security system of population, especially of its special groups (retired, disabled and others).

Fifthly, is improved legal and regulatory framework for optimization and enhancement of efficiency of all spheres of activities business agencies, enterprises, banks and other, and the population as a whole. The issue is targeted allowances, preferences, and tax holidays primarily for small and medium business. Therewith increases the role of personified responsibility of managers of different ranks and implementation of methods and technologies of electronic government/electronic counties within responsible social networks. It should allow, primarily, reaching results rather than stopping only on processes structuring.

Sixthly, the creation of positive climate in the society and healthy lifestyle promotion contributes to education by population of optimism and success orientation, and also creates confidence in the future for all groups and ages of population.

But there are crucial problems on this way. Primarily this refers to dominance of mining/raw material industries in the state economics to the prejudice of development of modern processing branches. Still the percent of underdevelopment and poverty of population is very high (families with children, the aged/retired, doctors/teachers). In the aspect of economic activity freedom there exist significant artificial obstacles to development of free-standing business, especially due to ineffective management and high level of corruption.

Among human aspects can be underlined the creation of adverse environment of different life sides: «consumer society morale», perverse incentives, wrong motivation, unfavourable country image and priorities that are highlighted in mass media and in cultural and educational spheres (including film and television). Besides there are challenges on the side of aggressive representatives of pseudoscience and obscurantism, falsifiers of history.

All this leads to decrease of level of economic activity of population and reduction of influence of its most creative part on the state development.

One of possible ways to solve all these problems in common complex, primarily on the regional level and it means in whole country – cluster model of state development.

The arrangement of such specialized clusters sets the objective, firstly, to solve tasks concerning formation of unified database of engineering development and ensuring standardization in the sphere of creation and assimilation of new technologies in high-tech branches of industry with corresponding staff assistance.

Secondly, the cluster arrangement will allow to realize unified scientific-technical and manufacturing policy, and also implementation of innovative education programs of different levels with corresponding staff training (including in remote access with usage of information-telecommunication technological advances) in the sphere of development of new/ground-breaking and improving technologies, batch manufacturing of high-tech and remotely controlled complexes of special and industrial purpose.

Thirdly, the tasks of import substitution and local manufacturing content will be solved that will give possibility to native developers and creators of high-tech products enter the international arena concerning quality of developments, production time and support services of high-tech products that is produced by members/residents of existing clusters.

Finally, fourthly, will be realized measures and investment projects concerning development of transport, energetic, engineering, housing and social infrastructure on the territory of cluster location, including measures of territorial planning of location of cluster infrastructure objects that allow to reach the defined aims of cluster development, including solution of socially important tasks for population involved in cluster activity, especially with regard to youth engagement into high-tech sphere and consolidation there.

Continuous monitoring of economic condition, its analysis, accounting and control allow fulfilling correct and adequate modeling and forecasting on the ground of modern advances in mathematics and information technologies. This is an integral part during solution of different economic problems within program oriented methods and during implementation of difficult process of management and regulation both on world macrolevel and in the country, and in separate economic structures of different scale. Such analysis and forecast can have direct social and state consequences during adoption of corresponding managerial decisions on respective level, and also determine development dynamics of economic systems of different levels, including in scale of responsibility of separate final manufacturers.

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