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REGIONAL ECONOMIC POLICY: STRUCTURED APPROACH AND TOOLS (The oretical formulation)[1]

The subject matter of the article is the development of a doctrine of coordinated regional development and the study of the structural quality of development of regional systems based on the theoretical analysis of institutional factors (parameters) that determine the technological efficiency of the regional economy.

The purpose is to show possibilities of technological changes and the shift of economic growth in a particular regional system, with strict limits for accelerated development, with emphasis on industrial regions. For this purpose, we generated a number of structural models, analyzed the impact of technological factors on parameters of growth of the regional economy and determined conditions for development of industrial regions.

We applied correlative and regression analysis to establish a statistically significant correlation between relevant parameters, used econometric models to show the possibility to estimate parameters of growth through control parameters, including technological factor. The structural aspect of regional economic growth is measured by dividing investments into two classes: old and new technologies.

It is possible to increase the technological efficiency of the regional economy by improving results with regard to used (old) technologies and applying new technologies. This approach fundamentally refines the priority queue algorithm for regional development, provides a choice of a strategy of regional technological development. When resources are directed only to the latest technologies, the disproportion in development of the regional economic system can dramatically increase, and parameters related to diversion of resources and creation of a new resource will determine the growth rate of the region.

The behavior of investment in old technologies has a major impact on the rate of regional economic growth in Russia, while investments in new technologies are minor and did not have an equivalent impact on the economic growth rate compared with old technologies. Institutional corrections that define parameters of resource diversion from old technologies and creation of a new resource for development, will determine the quality of new economic growth.

Keywords: region, regional economic policy, structure of the regional system, models of regional growth

1. Introduction. Regional Economic Policy: Basic Doctrines

As known, the scope of interests of the regional economy as a discipline comprises two main research themes: a comparative analysis of economic performance in different regions, which treats the regions themselves as homogeneous economic units, that is, as a whole; and an analysis of location and interactions of individual regional economic entities, which breaks the homogeneity principle.

The first approach is called macroeconomic, the second is called microeconomic (with respect to the regional economy). [1] Macroeconomic aspects of regional economics and, to some extent, regional microeconomics that was originally called an economic theory of space developed as applications of economic analysis. Regional macroeconomics focuses on issues of the regional economic policy, allocation of resources and economic activity in certain regions, as well as interaction of different regions. This approach is very similar to the macroeconomic analysis applied to the economy having strictly defined boundaries within a particular state.

Thus, problems of regional economic growth, unemployment rate, and movement of production factors between regions located at different distances from each other are subject to the regional

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macroeconomic analysis with its complex of econometric models helping to understand the processes occurring in the regions and to define an adequate regional economic policy [2]. Macroeconomic tools are applied at the level of the regional economy. For example, a version of macroeconomic expenditure multiplier is developed and widely used to analyze regional development of Western economies. It is called a regional multiplier. The regional multiplier is used to assess changes in income and employment in a region resulting from the increase (decrease) of autonomous expenditure. The mechanism of regional multiplier operation is as follows: the initial increase in demand leads to the regional income increase resulting in multiplication of expenditures in the economy of a region. The increased regional expenditures lead to regular saturation due to the presence of natural dampers in the form of imports (i.e. goods coming into the region from other parts of the country), the regional tax that differs from tax systems in other regions, investments made by economic agents of the region in other parts of the country, savings directed to regional and national banks. It is believed that the regional multiplier is considerably inferior to the macroeconomic multiplier, as the regional economy has a conditional (administrative) border. It means that the imports coming into the region in relative terms is quite high and there is constant demand leakage from the regional economy.

Due to historical circumstances a "standard" or "classic" regional economic policy is focused on two components: 1) government assistance to depressed regions; 2) elimination of interregional disequilibrium. However, the regional economic policy in Russia should be very different from the standard methods of regional policy established, for example, in Europe, and, in the opinion of the author, it should have a unique three-pronged orientation — the "classic" regional policy, a special internal economic policy pursued by authorities of a certain region based on the special conditions of its development and the policy of interregional relations and interactions conditioned by the length of Russia from east to west. This type of cooperation and specialization, where the geography of regions is an important factor, defines a number of regional problems in Russia.

The modern theory of regional development states the following fundamental problems [3-6, 1]:

— Fundamental changes in regional development and conceptual models of regions in the context of the "global community" and the slumping economy;

— Feasibility of transition from a social to a globally-oriented regional policy;

— Adequacy of the regional difference reduction theory in the context of existing regional disequilibrium;

— Search for new paradigms of regional integration and cooperation.

The possible solution can be given from the standpoint of the economic theory of regional policy according to the following approaches.

1. The neo-Keynesian approach to regional development involving government regulation of interregional disequilibrium by encouraging public and private investments in underdeveloped regions. The tools of this policy are credit facilities, changes in tax laws, government subsidies, etc.

2. The neoclassical approach to the regional policy formation stating the regions that interact, trade, share their resources without restraints will eliminate existing differences through the unregulated market. Now it should be noted that this approach is not applied and could not be applied anywhere in pure form under applicable legal systems, restrictions, regional specific features, etc.

3. The theory of regionalism focused on collision of political and economic regional interests, as well as on the associated conflicts. The emphasis is on the analysis of how the resources are distributed between regions, which is to be conducted together with the political authorities.

4. The so-called theory of unbalanced growth states that market interactions increase regional differences, strengthen prosperity of certain regions and poverty of others.

There is also an approach to the regional policy development from the perspective of the life cycle theory considering the life cycle of new commodities produced in the region, which combines with the cyclical patterns of regional development. The result of the regional policy activities developed on the basis of the life cycle theory is boosted creation of new products and technologies in the region and systematic rejection of aging products. It, undoubtedly, improves the economic structure of the region.

5. It is possible to use the investment programmable approach to development of the regional economy, which is largely consistent with the first approach. The idea is that the administration of a region, using its analytical services, is able to develop and combine two matrices of the regional economy which fell into a profound crisis: 1) the matrix of investment resources that can be mobilized in the public and private sectors (why are we talking about the matrix? Because the administration

has to be interested in the amount of these resources and appropriate channels of flow); 2) the matrix of products, more precisely, the key competitive parameters of the regional economy or its individual sectors. The formation of this matrix is a more difficult task because it involves the analysis of regional markets, inventory of production facilities, determination of high technologies at the disposal of industrial enterprises of a region, etc. By combining two matrices, it is possible to find points for potential growth of regional economic competitiveness and it will be required to develop an investment program for implementation of these possibilities. In order to ensure political stability during implementation of the investment program, it will also be required to take an extra set of actions, including revision of taxation, establishment of preferential placement of capital in the region, creation of barriers to movement of the profit from the regional resource base, etc.

The regional policy should, firstly, provide conditions for the normal life of people living in the region, i.e. to satisfy the comprehensive needs of various layers in accordance with the generally accepted standards and concepts of decent or acceptable quality of life, and secondly, make the maximum possible contribution to the national and regional economic growth.

The federal government is obliged to establish the principles of regional cooperation, coexistence and assistance. It will be a new methodological paradigm of regional development — the paradigm of solidarity and coordinated regional development. In this system, the region is represented as a three-pronged model: a quasi-state, a quasi-company and an export — import flow [7, 8-10].

Within this model, it is required to define the economic development strategy. It is necessary to do the following:

— identify the competitive activities of the regional economy agents and ensure priority development (stimulation) of these activities, i.e. ensure specialization of the regional system;

— identify several activities, including less competitive, but required to be developed on the basis of certain political challenges of development — diversified specialization, thereat these undeveloped activities should constitute the development prospects of the regional system (future specialization);

— develop activities that improve parameters of regional system self-sufficiency without marking any priorities, but with orienting the strategy either outward, i.e. to export activities, or to the domestic regional market;

— use the regional policy tools for improvement of the basic social development indices when defining priorities, perspectives for development, or a model of self-sufficiency, or a model of "rational" autonomous region, or export-import openness.

The role of a region in the regional division of labor within the country depends on the specialization of the region: extraction of raw materials and/or their processing.

The evolutionary theory of regional development in substantiation of a particular development scenario (strategy) sets the following fundamental problems:

— Fundamental changes in regional development and conceptual models of regions in the context of the global community and the slumping economy;

— Feasibility of transition from a social to a globally-oriented regional policy;

— Adequacy of the regional differences reduction theory in the context of existing regional disequilibrium;

— Search for new paradigms of regional integration and cooperation.

The crisis of regional disequilibrium theory is conditioned by violation of the principle of heterogeneity within the interregional systems developed by evolutionary economics, not by the crisis of the Keynesian system based on the principle of full employment and social justice. Global regional structures that deny the two mentioned imperatives have no long-term prospects as they neglect the social direction of development and are inconsistent with the basic postulates of evolutionary economics.

However, the principle of heterogeneity, proclaiming the most effective adaptation of systems with different elements (regions), does not associate the problem of regional differentiation with immanent interregional features. This problem is explained by the lack of proper interaction between regions and appropriate consistency. The need for a coordinated regional development strategy based on the paradigm of representation of a region as a quasi-company [7], which uses corporate planning methods and serves as of a teleological component of evolution of economic regions, derives from the specified feature of the evolutionary type. Planning is an important function of the regional management and

leads to identification of the next pairs of variables to be analyzed within the framework of the regional development theory:

— Products (technologies) and markets (contracts, formal and informal rules);

— Projects (technical and economic procedures, routines) and investments in them (selection procedures);

— Intellectual resources (knowledge, organizational genotype) and their location (inheritance);

— Development of planning and corporate decision-making methods, as well as search for ways to improve their efficiency.

The analysis of the described components with the use of evolutionary ideas will create conditions for observance of the principle of heterogeneity, external supplement, recursiveness of the systems and required diversity in regional structures development.

The central idea of the concept of coordinated regional development [8, 11] is the consideration of a region as the three-component dynamic model: a quasi-state, a quasi-company and an export-import flow[2]. Three models of regional operation imply three systems of relations: "technologies — products — markets", "social standards — employment" and "projects — programs — investment". Each of them can be reduced to the problem of comparing the volume of investment required for creation of the average use-value of the regional product and the real income (per capita of the region) generated by the created use-value. Thus, it is possible to estimate the total investment resources required to meet the challenges of development (required resources are compared with actual resources that may be accumulated at a given time interval).

Promotion of the innovation component of regional development depends on resources, income differences of the residents, taxes and their structure, even on distribution of property, institutions. If the same level of innovation in the volume of the product is possible with less resources and with the same efficiency, then we can say that these innovations are intense, otherwise, innovations requiring more resources are called extensive innovations. It is important to choose either there will be a few innovations in the economy, say 0.5 % of GDP, but they will be highly effective, or, for example, their share will be from 7 to 10 % of GDP, but efficiency will be low. High taxes can reduce the propensity to innovate or enhance it. It depends on tax institutes and institutes of innovation stimulus, reaction of agents. If a government manages to reduce the innovation propensity and innovative activity with high taxes, later it is possible to enhance this propensity using expenditure multiplier.

The short- and medium-term profitability of simulating and product innovations exceeds even the long-term profitability of technological and fundamental innovations. Moreover, it should be noted that fundamental and technological innovations are able to preset the level of simulating and product innovations. In other words, knowledge, achievements and opportunities for innovations partially transfer to the lower level of hierarchy, together with the appropriate resources. If a financial system is unable to provide medium- and long-term loans to the industrial sectors, then the possibilities for the product, simulating and improving innovations eventually exhaust. The resource-based economy is focused on improving, simulating and just partially product innovations with the dominance of simulating innovations (other equal conditions).

2. Methods and Conditions for Regional Economy Restructuring

A variety of regional economic systems is determined by the specific conditions and often by the unique factors of their development [12, 13]. Therefore, attributes of the economic strategy and the policy in each region can differ from attributes of other regions. However, in spite of the mentioned circumstances, it is possible to define the general theoretical approach. We represent the economy of the region, where two sectors play prominent role in creation of the product, while one of the sectors dominates (Fig. 1).

Such dominance can be desirable, which removes the task to change the basic structure of the economy from the agenda, but it can be adverse as well, raising the problem of controlled changes in the structure. This aspect of the restructuring is interesting in the context of strategy development and analytical justification of its choice. As can be seen from Figure 1, there are several scenarios of flows in the economy — for curve I — directions *A*, *B*, *C*, for curve II — directions *D*, *E*, *F*, so that the distance $X = d_{II} - d_{I}$, representing the difference between the shares of sectors, and the change dX/dt

[2] Each mentioned model is known in modern regionology [4, 5, 13, 14, 20].

set the restructuring mode. There are nine scenarios of flow, each representing a particular economic development strategy (a characteristic of every strategy is given in the Table).

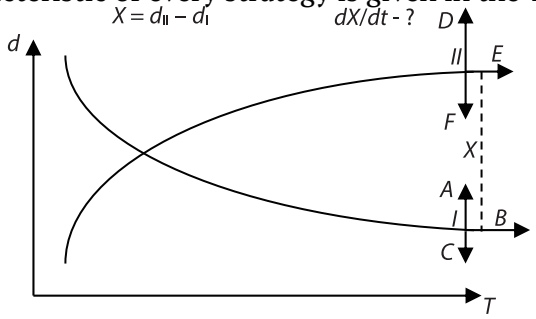

Fig. 1. *Challenge to change the economic structure*

If curve II represents the extractive (raw material) sector, and curve I represents the processing sector (mechanical engineering), or, respectively, the raw and the processed export or the total import (II) and export (I) for the system, then, in fact, the problem of restructuring is the choice of the flow strategy (a scenario in the Table), the speed of correction of a structural disproportion according to the political decision. Such problem definition involves a choice between industrialization and de-industrialization. Therefore, it is necessary to identify possible scenarios of changes in the regional system (the flow specifics are connected with economic policy tools), and also to note the system restructuring condition according to the changing parameter $X(t)$, that will be, in essence, the formal criterion of industrialization. If the gap shown in Figure 1 is reduced, while curve II represents the domination of an undesired sector and curve I represents the domination of a desired sector, it will mean a positive outcome of system restructuring, and, in the case of "non-extractive" development, it will mean its industrialization. All the regions of any country can be classified according to the parameters $X(t)$ and dX/dt, as well as nine possible restructuring scenarios. For some of them, the task

Table

Types of the Restructuring Strategy

Strategy	I — mechanical engineering (processing sector)	II — fuel industry (extractive sector)	Characteristics of strategies
1	*B*	*E*	The constant structural ratio of sectors $dX_1/dt = 0$
2(*)	*A*	*E*	The share of the processing sector increases $dX_2/dt < 0$
3	*C*	*E*	Reduction of the process sector with the same resource dependence $dX_3/dt > 0$
4	*C*	*F*	"The economic euthanasia", the share of two sectors is reduced (for services). $dX_4/dt = 0$, or $dX_4/dt < 0$, $dX_4/dt > 0$
5	*B*	*F*	Reduction of the raw material with the same share of the processing sector $dX_5/dt < 0$
6 (**)	*A*	*F*	Reduction of the "gap" $dX_6/dt < 0$, $(dX_2/dt > dX_6/dt)$
7	*C*	*D*	Increase of the "gap", strengthening of the raw material dependence, $dX_7/dt > 0$, with degradation of the processing sector
8	*B*	*D*	Growth in the share of the raw materials with the same share of the processing sector, $dX_8/dt > 0$, but $dX_8/dt < dX_7/dt$
9 (***)	*A*	*D*	Overall growth in the sectors, but the quality of the strategy is divided into three scenarios: 1) $dX_9/dt < 0$, when the processing sector grows faster than the raw materials sector — the gap reduces; 2) $dX_9/dt > 0$, when the raw materials sector grows faster than the processing sector, the gap increases; 3) $dX_9/dt = 0$, X — const, growth, with the same gap

will be to reduce the gap, while others will be challenged to increase it — the general definition of the task suggests the possibility of such solution.

We can write the above logic of the tasks in a formal way. Then, $X = d_{II} - d_I$, $K = d_I / d_{II}$, the very task formulation can be reduced to the criterion of $dX/dt < 0$. Furthermore, by converting these data, given that Y_I, Y_{II} are the volume of products in each sector, N is the number of employees, i_I, i_{II} are output (product per employee), reflecting the scale of the sector in the economy, we find:

$$X = (1 - K)\, d_{II},$$

$$d_I = Y_I / Y,\ d_{II} = Y_{II} / Y,$$

$$i_I = Y_I / N,\ i_{II} = Y_{II} / N\ (N \text{ is the number of employees}),$$

$$K = i_I / i_{II},$$

$dX/dt < 0$ is the condition of industrialization, $dX/dt > 0$ is the condition of deindustrialization,

$$dX/dt = 0,\ X = \text{const},\ X \neq 0,$$

i.e. $d_I \neq d_{II}$ is structural stability (industrialization can be fulfilled by changing the ratio between old and new technologies), $X = 0$, $d_I = d_{II}$, $dX/dt = 0$ is structural parity that may arise both in industrialization and de-industrialization.

Each strategy from 1st to 9th (Table), at directions I and II, is characterized by own combination (structure) of "old" (O_I, O_{II}) and "new" (N_I, N_{II}) technologies. Then, for each strategy, there is one of four scenarios according to the criterion of dominance or old or new technologies in each of two basic sectors: 1. $O_I - O_{II}$; 2. $O_I - N_{II}$; 3. $N_I - N_{II}$; 4. $N_I - O_{II}$.

Let $[1/d_{II}]\, dd_{II}/dt = s$ is a relative increment in the share of the raw materials sector and $[(1/i_I) \times \times di_I/dt - (1/i_{II})\, di_{II}/dt] = \lambda$ is a difference between relative increments in the scale of production in the processing and extracting sectors. Then, after easy substitutions, we obtain the condition of restructuring (industrialization, if the choice is between raw material and industrial orientation of the system):

$$K > s/(\lambda + s).$$

If to present both sectors through the parameters of raw materials and processed exports, the condition of structural independence of the regional system (from raw materials) can be represented as follows. Let us introduce the following parameters for a region: $e1$ and $e2$ are respectively the volume of processed and raw materials exports; P is the number of employees; Y is the output (generated income). The product can be represented as consisting of two components: internal consumption (processing and raw materials — $vp1$ and $vp2$) and exports (processing and raw materials — e1, e2), or $Y = vp1 + vp2 + e1 + e2$. Then, $K = e1/e2$ is the index of structural independence of a region. We can set the task to optimize the structure of production as follows: $K = e1/e2 \to \max$. Let's introduce the index of a closed economic region $Z = Y/(e1 + e2)$, output (product per employee) $y = Y/P$, and the value of processed and raw material exports per employee is respectively $i1 = e1/P$ and $i2 = e2/P$ (characterizes the level of raw material orientation, dependence). Then we can get $y = Z\,(i1 + i2)$ and $K = i1\ P/(i2\ P) = = i1/i2 = (y - Z\ i2)/(Z\ i2) = y/(Z\ i2) - 1 \to \max$. The test of $K(t)$ function for an extremum, given that $y = y(t)$, $Z = Z(t)$ and $i2 = i2(t)$, yields:

$$\frac{\partial y}{\partial t} = y[\frac{1}{Z}\frac{\partial Z}{\partial t} + \frac{1}{i2}\frac{\partial i2}{\partial t}];\ \frac{1}{y}\frac{\partial y}{\partial t} = \frac{1}{Z}\frac{\partial Z}{\partial t} + \frac{1}{i2}\frac{\partial i2}{\partial t}.$$

Having this ratio, we can formulate the theory of optimal structure of the regional economy.

The optimal production structure of the regional economic system (if $\frac{\partial K}{\partial t} > 0, t < t_0$, $\frac{\partial K}{\partial t} < 0, t > t_0$, we have the optimal structure of non-extractive development, and if $\frac{\partial K}{\partial t} < 0, t < t_0$, $\frac{\partial K}{\partial t} > 0, t > t_0$, we have the stable structure of raw materials, complete structural, resource dependence) is achieved when the change of the product per employee in this region (output) is proportional to the output with the proportion coefficient equal to the sum of the relative increments of the open (closed) sector index and index of raw materials dependence ($i2$).

This theorem can be formulated simpler: the optimal production structure of the economic system in the context of non-extractive economic development is achieved when the relative output increment is equal to the sum of the relative increments of the closed sector index and the raw materials dependence index ($\frac{\Delta y}{y} = \frac{\Delta Z}{Z} + \frac{\Delta i2}{i2}$). The same is true for the whole economic system, whether it is a resource-intensive economy or economy dependent on certain raw materials.

Thus, the structural analysis allows us to solve quite complex problems of intersectoral cooperation in the regional economy and to receive recommendations for improving financial and investment institutions. The impact of management tools on the branch structure of the regional economy should be the central issue of the economic policy planning. A concept of the optimal structure or optimization of the structure relates to reproduction of the most favorable development of the whole economic system. Thereat, the optimization problem may involve several criteria (target functions) and imposed restrictions, such as the total amount of resources used (including financial resources), expected revenue, environmental damage, etc. The above elementary model, in essence, gives the most acceptable ratio between the production of the regional, generally of any system, the level of disintegration, i.e. openness (closeness) of the system and its dependence on raw materials. Upon further analyzing the actual data for regions, we can determine the value $W = \Delta y/y - (\Delta Z/Z + \Delta i2/i2)$, i.e. determine how the economy of a region is far from this index that defines a high degree of processing at a low rate of dependence on raw materials export. Depending on factors that determine the position of the region in relation to the specified index, the industrial, scientific and technical policy of the regional government should be adjusted, as well as the general regional policy of the federal center.

With this purpose, we change the above model meeting the requirements necessary for production development according to two strategies: export orientation and import substitution. Let's introduce the following parameters:

$e1$ is the export production volume;

$e2$ is the import-substituting production volume;

P is the number of employees;

Y is the output (generated income);

K is the export orientation coefficient;

Z is the import substitution index.

The product can be represented as consisting of two components: import-substituting production (e_2), export (e_1) or $Y = e_1 + e_2$. Then, $K = e_1/e_2$ is the index of export orientation of the region. Thus, development of export orientation in the region will correspond to the coefficient growth.

The task of optimization of the production structure with a focus on the export component can be represented as the task of optimization of an export orientation coefficient:

$$K = e_1/e_2 \to \max.$$

Let's also introduce the import substitution index for an industry $Z = Y / e_2$.

Then, after the necessary conversions, we obtain the following equation:

$$Y = Z e_2,$$

$$K = e_1/e_2 = Ze_1 / Y \to \max.$$

The test of $K(t)$ function for an extremum, given that $Y = Y(t)$, $Z = Z(t)$ and $e_1 = e_1(t)$, yields:

$$\frac{\partial Y}{\partial t} = Y\left(\frac{1}{Z}\frac{\partial Z}{\partial t} + \frac{1}{e_1}\frac{\partial e_1}{\partial t}\right). \quad (1)$$

Having this equation we can formulate the theory of the optimal economic system.

The optimal economic system structure (if $(\partial K / \partial t) > 0$, $t < t_0$, $(\partial K / \partial t) < 0$, $t > t_0$ we have the optimal structure of the export, and if $(\partial K / \partial t) < 0, t < t_0$, $(\partial K / \partial t) > 0, t > t_0$ we have the stable structure of import substitution) is achieved when the change of production in the region is proportional to the volume of output with the proportion coefficient equal to the sum of relative increments of the import substitution index and export production index (e_1).

It should be noted that the link between exports and imports, import substitution and import, and ultimately between output and imports, characterized by the import elasticity of output, defines

also the interrelation between the index of the import elasticity output and the optimization model of export-oriented development.

If we rewrite the left-hand side of equation (1), taking into account the imports, we get:

$$\frac{\partial Y}{\partial t} = \frac{\partial Y}{\partial M}\frac{\partial M}{\partial t}.$$

The equation for the import elasticity:

$$\frac{\partial Y}{\partial M} = \mathrm{K}_э \frac{Y}{M}.$$

From these two formulas we obtain:

$$\frac{\partial Y}{\partial t} = \mathrm{K}_э \frac{Y}{M}\frac{\partial M}{\partial t}. \quad (2)$$

Inserting equation (2) into the left side of the formula (1), we obtain:

$$\mathrm{K}_э \frac{1}{M}\frac{\partial M}{\partial t} = \frac{1}{Z}\frac{\partial Z}{\partial t} + \frac{1}{e_1}\frac{\partial e_1}{\partial t}. \quad (3)$$

Now the theory of optimal structure of the economic system, for example, in the region, if it is export-oriented, can be reformulated as follows, taking into account the imports and the elasticity coefficient.

The optimal economic system structure (if: $(\partial K / \partial t) > 0$, $t < t_0$, $(\partial K / \partial t) < 0$, $t > t_0$ we have the optimal structure of export development, if $(\partial K / \partial t) < 0$, $t < t_0$, $(\partial K / \partial t) > 0$, $t > t_0$ we have the stable structure of import substitution) is achieved when the relative increment of the export production is proportional to the difference between the relative increment of imports in the region, multiplied by the coefficient of import elasticity of output, and the relative increment of the import substitution index.

The analysis of the equation (3) allows to determine periods of the optimal economic structure development and, by comparing it with the desired period, to identify significant factors and trends which led to development of the optimal structure of the export-oriented production.

Mathematically, we can introduce a simple model linking the key parameters of the regional economic system development:

$$\frac{dx}{dt} = f(x,z), \quad \frac{dz}{dt} = s(x,z,t)\{v(x,z,t) - z\},$$

where x is the vector of variables of the economic system; z is the parameter of institutional conditions, technological incentives; f and v are continuous functions of given variables; $s(x, z, t)$ is the rate of institutional or technological changes.

With regard to the presented equations, the first equation describes economic variables, such as gross domestic product per capita or inequality, etc., depending on the parameter of institutional conditions and technological incentives; and the second determines the behavior of the government. It is challenging to describe institutional changes, conditions or technological incentives. Most probably, it is necessary to take a set of conditions, incentives, measure each of them and overwrite the model in the matrix-vector form. The parameter z can characterize, in particular, the level of openness (closeness) of the system, and $s(x, z, t)$ is the rate of establishment of an operation mode that determines the level of openness.

In any case, it is possible to identify some cause-and-effect relations between the sets of individual variables. In addition, the viable structure of the regional system can be determined.

The emergence of new combinations in the economy and promotion of this process by including necessary factors of regional development require appropriate formulation of objectives of economic structure management. The design of proportions between sectors, activities, available production and technological factors and resources is virtually a way to create conditions for emergence and replication of new combinations. This process unfolds in the course of interaction between old and new technologies.

No doubt, it is necessary to take into account other parameters of economic development, in particular, resistance to the growth of final products import in the economic region and deployment of required production facilities in the appropriate amount for the needs of the domestic regional (local) market and for export on the basis of reproduction of the existing resource base in the region.

The existing institutional constraints and structure of the regional system determine its competitive advantages, as well as the ability to develop and cooperate with other regions. A particularly important factor is the rate of development of certain sectors and activities, resource provision, and interaction between the regions is predetermined by the distance, i.e. the proximity and extension. The availability of resources determines the specialization, and the distance forms a model of competition and coordination of regional development.

Let's introduce a set of simple notations. If r is the natural resources per capita of the population living in a particular region, g is the standard of living (the quality of life, without regard to the quality of functions), P is the income (product) per capita, $S(t)$ is the function of performance, transformation of resources into products, N is the population of the regional economic system, i is the notation of a particular region, then:

$$r = \frac{R}{N};\ \ g = \frac{P}{N} = \frac{\sum_{i=1}^{m} P_i}{N}.$$

Actually, for some regions $g_j > g$ (relatively rich regions, often donors) is true, for others — $g_i < g$ (relatively poor regions, recipients). Or $P_j/N_j > P/N$ и $P_i/N_i < P/N$. The aim is to increase gi of certain regions to the standard of living P/N. At the same time, the standard of living of rich regions will still be higher, i.e. $P_j/N_j > P/N = P_i/N_i$.

The standard of living can be determined as follows:

$$g = \frac{P}{N} = \frac{R(t)S(t)}{N(t)};\ \ R(t) = r(t)N(t);\ \ g = r(t)S(t).$$

Thus, it depends on the amount of resources per capita and the function of processing (production) of these resources. If the resources per capita are still insufficient, then the overall quality of life can be maintained only by technical and technological changes that increase $s(t)$ function. The function of the potential for income (product) generation for 'i' region will be as follows:

$$P_i = \frac{R_i(t)}{N_i(t)} S_i(t).$$

$S(t)$ function is strongly dependent on institutional conditions, investments in education and science, the initial state of the stock base of the economic system (in a region) and the industrial (technological) efficiency. When $N(t)$ function substantially increases and $R(t)$ function decreases, the resources dwindle, therefore a technological leap by $s(t)$ will be required to maintain $P(t)$. At the same time, the population growth, even taking into account the growth slowdown, can dramatically increase the pressure of the demand function in the economy, however, for a system with the broad resource base it might encourage development, including technologies, and in case of the limited or decreasing resource base, it leads only to the depressed system. The strong demand remains unsatisfied and destabilizes the system. As experience of African countries shows, food shortage and hunger arise.

Taking the time derivative of "the standard of living", we obtain the equation linking the change rates for g, P, N (respectively υ_{gi}, υ_{Pi}, υ_{Ni}) for 'i' region:

$$g - g_i \to \min\ dg/dt = dg_i/dt,$$

$$\upsilon_{gi} = \frac{1}{N_i(t)}\upsilon_{Pi} - \frac{1}{N_i^2(t)} P_i(t)\upsilon_{Ni},$$

where $\upsilon_{Pi} = dP_i(t)/dt$, $\upsilon_{Ni} = dN_i(t)/dt$.

At the point of extremum, we have a mimic of small and large systems, as the changes in product of resource availability and resource performance of the system are similar by times for small and large systems. If to formulate such a task for all as $i = 1 \ldots m$, where m is the number of regions of the country, we get the multi-parameter optimization task, which can be solved with a lower value of $r(t)$

by $s(t)$ function, and for $r(t) = 0$ it has no solution, or, more specifically, the solution is identically zero. Therefore, $s(t)$ function should have such a form that it would be able to withstand the decrease of $r(t)$, in other words, $r(t)$ must generally depend on $s(t)$. These functions can be selected only empirically, based on the accumulated data on the whole economic system and its regions.

3. Results and Discussion

Let's formulate a simple pattern of economic growth in the structural presentation. Let $\phi = I_s/I$, $I = I_s + I_n$ is the share of investments in old technologies in the total volume of investments, $i_s = I_s/Y$ is the share of investments in old technologies in the product, $i_n = I_n/Y$ is the share of investments in new technologies in the product. If the total investment in the system is a certain share of product $I(t) = \sigma Y(t)$, then, assuming that the share changes with time we obtain the system growth $g = dY/dt$:

$$g = \frac{1}{\sigma}[\frac{dI}{dt} - Y(t)\frac{d\sigma}{dt}].$$

As we can see, the growth rate increases with increase of the investment growth rate. However, the economic growth rate decreases with increase of the product and the change rate of the investment share in this product. For economic growth, the rate of investments (the investment growth rate) should be greater than the product of the current generated product in the system and the change rate of the investments share in the product.

Assuming that the specific investments in old and new technologies are linearly defined by the current technological level (h), we can write the following equation:

$$i_s = \frac{I_s}{Y} = a + bh, \quad i_n = \frac{I_n}{Y} = c - dh.$$

Having a structural link of specific investments in old and new technologies in the product Y, presented in the form $i_s = [\ \phi/\ (1 - \phi)\ ]\ i_n$ and expressing the technological level h using the above equations for specific investments, we obtain another equation linking i_s and i_n through the coefficients of the equation for the technological level:

$$i_s = a + \frac{bc}{d} - \frac{b}{d}i_n, \quad i_s = \frac{\phi}{1-\phi}i_n.$$

Here we get the equations for changing specific investments in old and new technologies:

$$i_n = \frac{(ad + bc)(1-\phi)}{\phi d + b(1-\phi)}, \quad i_s = \frac{ad + bc}{\phi d + b(1-\phi)}\phi.$$

Substituting the equation for i_s into the formula for the level of technological development, we obtain $h(t)$:

$$h(t) = \frac{\phi(t)(c + a) - a}{\phi(t)d + b(1-\phi(t))}.$$

We obtain similar solutions for I_n, I_s.

If we express the amount of total investment in the economic system $I = I_s + I_n = (c + a) + h\ (b - d)$, i.e. assuming that $I_s = a + bh(t)$, $I_n = c - dh(t)$, then

$$\frac{dI}{dt} = (b-d)\frac{dh}{dt},$$

Whence it follows that $g = \frac{1}{\sigma}[(b-d)\frac{dh}{dt} - Y(t)\frac{d\sigma}{dt}]$.

The above equation shows that the economic growth rate increases with increase of the degree of technological changes.

In economics, the problem of growth and technological development definition is that, on the one hand, the technology is a factor of growth, but on the other hand, the accumulated results of growth create the needs and potential for technology increase. This second point is not taken into account by most models [14].

Having wrote the equations for investments in old and new technologies, taken into account the obtained rate of resource diversion (α) and the rate of creation of a new resource (μ) filling up investment in new technologies ($I_n = \alpha I_s + \mu I_n$), let's make substitutions, assuming that these rates do not change with time, and obtain the equation for the economic growth rate [14]:

$$\frac{dI_s}{dt} = \frac{dY}{dt}(a + bh(t)) + Yb\frac{dh}{dt},$$
$$\frac{dI_n}{dt} = \frac{dY}{dt}(c - dh(t)) - dY(t)\frac{dh}{dt},$$
$$\frac{dI_n}{dt} = \frac{\alpha}{1-\mu}\frac{dI_s}{dt},$$
$$\frac{dI}{dt} = \frac{\alpha + 1 - \mu}{1-\mu}\frac{dI_s}{dt},$$
$$\frac{dI_s}{dt} = \frac{d\phi}{dt}I + \frac{dI}{dt}\phi,$$
$$g(t) = \frac{1}{\sigma}[\frac{dI}{dt} - Y\frac{d\sigma}{dt}],$$
$$1 - \mu = \tau,$$
$$\alpha,\ \mu - const.$$

Old technologies can represent adoption, then, the economic growth depends on a combination of two modes — creation and adoption of technologies. The economic growth rate will increase with increase of the rate of resources diversion and creation of a new resource, as well as with technological level increase.

We can graphically represent the change of investments in old and new technologies, depending on the rate of resources diversion from old technologies (α) and creation of a new resource (μ).

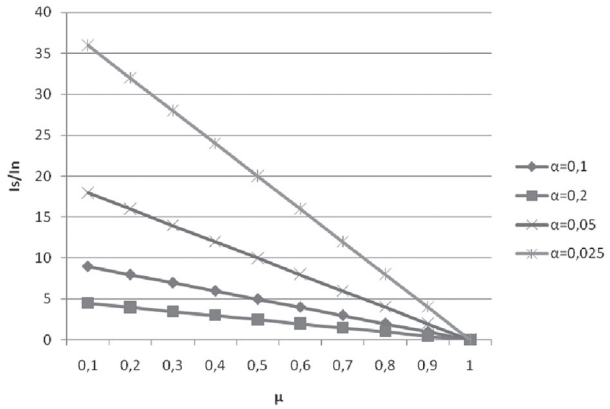

Fig. 2. *Change Is / In by parameters* α *and* μ

Figure 2 shows how to influence the investment structure by changing the institutional parameters b and m with the resulting impact of this structure on economic growth.

Let $g = (1/Y)\ [dY/dt]$, then, the economic growth rate will be as follows:

$$g(t) = (\frac{1}{\sigma}[\frac{dI}{dt} - Y\frac{d\sigma}{dt}]) / Y.$$

Taking into account the existing relationship between the share of investments in old technologies and the share of investment in new technologies in the form of $I_n = \alpha I_s / (1 - \mu)$, we obtain the equation for the growth rate depending on the structural parameters of the system:

$$g(t) = (\frac{1 + \alpha - \mu}{(1-\mu)\sigma(t)}[\frac{dI_s}{dt} - \frac{I_s(t)}{\sigma(t)}\frac{d\sigma}{dt}]) / Y.$$

Let's provide empirical results for the Russian economy as a whole[3]. As the observation period from 2008 to 2013 includes the crisis of 2009 (very sharp decline in the GDP rate and other parameters to the negative area), then the data on indices were processed using the smoothing procedure with simple moving averages[4].

The function of investment to GDP ratio is $\sigma(t) = -0.001t + 0.164$ (the Pearson coefficient $R^2 = 0.728$; the value of the Student's t-test $t_R = 3.27$ exceeds the critical value of 2.45 at a significance level of 0.95; the Fisher criterion value $F_R = 10.70$ exceeds the critical value of 7.71); where the derivative $d\sigma/dt = -0.001$.

The function of expenditures for old technology is $I_s(t) = 64.56\ t^2 - 519.1t + 6774$ (the Pearson coefficient $R^2 = 0.920$; the value of the Student's t-test $t_R = 6.78$ exceeds the critical value of 2.45, with a significance level of 0.95, the Fisher criterion value $F_R = 46$ exceeds the critical value of 7.71); the derivative is $dI_s/dt = 129.12t - 519.1$. The function for GDP is $Y(t) = 222\ t^2 - 1473\ t + 42221$ (the Pearson coefficient $R^2 = 0.780$; the value of the Student's t-test $t_R = 3.76$ exceeds the critical value of 2.45 at a significance level of 0.95 ; the Fisher criterion value $F_R = 14.18$ exceeds the critical value of 7.71).

Based on the obtained regression relationships, we can represent graphically some of the possible combinations of α and μ, as well as the corresponding rate of economic growth (theoretical) for the period from 2008 to 2013. Then we can find the theoretical curve that most closely corresponds to the available empirical data on economic growth (Fig. 3 left and right sides).

The best match of the estimated and actual economic growth rates for the Russian economy is observed when $\alpha = -0.4$ and $\mu = -0.05$ (Figure 3).

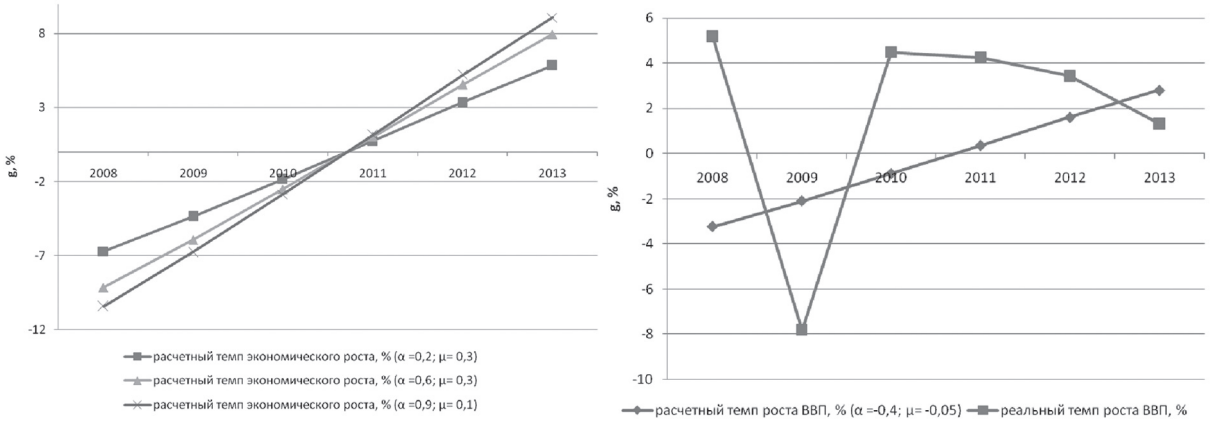

Fig. 3. *Theoretical (left side — for different α and μ) and actual (estimated) economic growth rates of the Russian Federation from 2008 to 2013 (right side $\alpha = -0.4$, $\mu = -0.05$)*

As shown in Figure 3 (left side), for the area of positive growth, the higher the value of α increases, with the same value of μ, the more the growth rate increases, with other equal conditions. For the area of recession (negative growth rate), the smaller recession will be at the lower value of α.

The minus in indices α and m means that the investments in new technologies are not only absent, resources are diverted from this line of investment, but "old" technological capabilities are subject to disinvestment as well. The main concern within the issue of technological growth in the economy is not the growth of necessary investments in technologies, but their proper distribution.

The expenditures for old technologies stabilize in the period from 2012 to 2014, subject to the downtrend, the rate of investments also decreases during these years. The result is the downward trend of GDP growth. Thereat, the best match of the theoretical results and empirical data will be when $\alpha = 0.2$ and $\mu = 0.2$. (See Fig. 4, right side)

[3] We use data from Rosstat: data of the Federal State Statistics Service http://www.gks.ru/free_doc/new_site/technol/1-2.xls, http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/economydevelopment, as well as materials of statistical compilations of Rosstat (Russia in Figures. 2008. M., 2008. P. 510; Russia in Figures. 2010. M., 2010. P. 558; Russia in Figures. 2012. M., 2012. P. 573; Russia in Figures. 2014. M., 2014. P. 558)

[4] The values of GDP and investment in the calculations are given in prices for 2008.

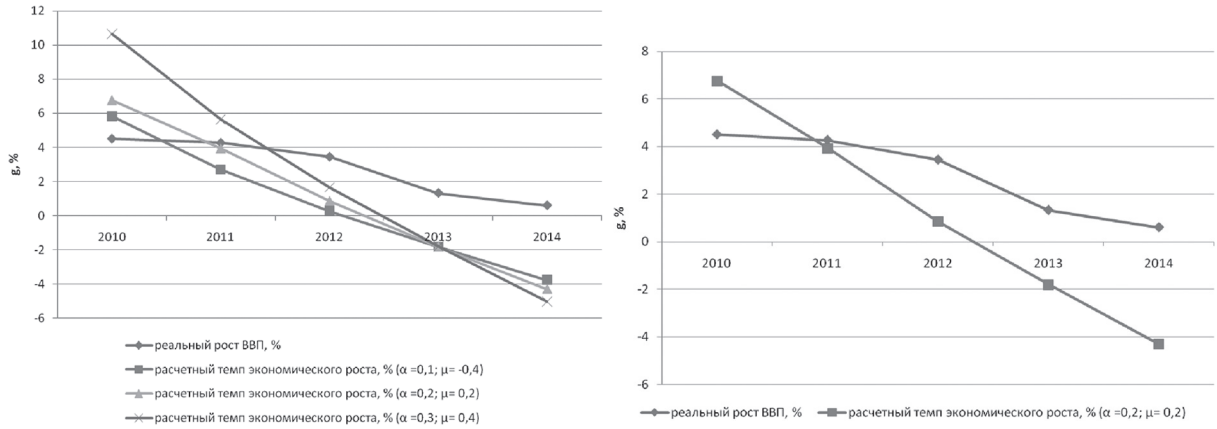

Fig. 4. *Actual and estimated economic growth rates from 2010 to 2014*

As seen in Figure 4, the higher the value of m increases, i.e. a new resource (technology) is created in the economy with the same value of resource diversion from old technologies, the more the growth rate increases and its decline rate is slower in the positive area of the economic growth rate. In the area of negative growth (recession) rate, the decline is more intensive with more significant value of m (Fig. 4, left side).

Thus, the problem of restructuring of the regional economic system resolves into creation of a competitive core of industries (sectors) and an infrastructure to serve this core. Institutional corrections should facilitate this process as much as possible to encourage it to the highest degree, taking into account the general regional development objectives, for example, reducing inter-regional divergence, regional development disequilibrium. Each region, regardless of its specialization, should provide for development of own advantages, i.e. the factors it possesses, as it will be the base of the development strategy. Thereat, the economic policy of the government should facilitate the changes in the cost structure in order to increase the share of labor costs, reduce material production costs, change the tax burden from labor to capital, especially financial capital, bank transactions, and real estate. In other words, it is necessary to fundamentally change the sources of budget revenues at all levels and, consequently, expenditures, by focusing the budgetary mechanism on formation of incentives for productive activities and introduction of new results.

The regional system of Russia is unique [15] and its specific features are not only the geographical extent, inequality of resources, different population density in the regions, but also the fact that, in the market economy conditions, certain regions neither cooperate, nor compete and nor cooperate with each other in the course of their development. The economic development of the country is characterized by spatial and geographical localization of regions, "rupture" of markets with emergence of specific features of regional and territorial development. Such features require differentiated approaches to the regional development objectives.

In particular, the regions of Siberia are located in the special climatic environment. They are characterized by a great extent, low population density, high costs of production and processing of resources. Therefore, the economic development of these areas will be determined by staff and large infrastructure projects of national importance, which will economically connect these regions to ensure their cooperation and interaction. Such projects may include the building of transport corridors, deployment of specific industries within the framework of special state programs, transport systems, field development. However, the basis for development of these regions is professionally trained staff living in these areas and planning to live in the region in the future. Therefore, the important projects will be provision of necessary facilities, infrastructure — houses, transport, information, etc. Of course, the development of environmental science and industry for resource base development is also the main trend. The personnel policy should provide for a system of incentives relating to living conditions and wages, staff attraction and retention in these regions, especially in Siberia and the Far East, as the basis of technological development.

References

1. Hoover, E. M. (1971). *An Introduction to Regional Economics.* Knopf, New York, 395.

2. Armstrong, H. & Taylor, J. (2000). *Regional Economic Policy.* 3 ed. (1-ed. Philip Allan, Oxford, 1978) — Wiley-Blackwell, 437.

3. Tatarkin, A. I., Romanova, O. A., Chenenova, R. I. & Makarova, I. V. (2012). *Regionalnaya promyshlennaya politika. Ot makroekonomicheskikh usloviy formirovaniya k novym institutam razvitiya [Regional industrial policy. From macroeconomic conditions of formation to new institutes for development].* Yekaterinburg: Izd-vo IE UrO RAN [IE UB RAS Publ.], 360.

4. Tatarkin, A. I. & Mayevskaya, V. I. (Eds). *Teoriya evolyutsii sotsialno-ekonomicheskikh sistem [Evolution theory of the socio-economic systems].* Moscow: Economika, 486.

5. Shvetsov, A. N. (2009). Obshchesistemnaya i selektivnaya komponenty regionalnoy politiki [System-wide and selective components of regional policy]. *Problemnyy analiz i gosudarstvenno-upravlencheskoye proektirovanie. Politologiya. Ekonomika. Pravo [Problem analysis and state-managing design. Politics. Economics. Law],* 2, 47-50.

6. Boisier, S. (1992). *Regional Management in a New International Order. Quasi States and Quasi Firms.* Santiago, 1992. Boisier S. La gestión de las Regiones en el Nuevo Orden Internacional: cuasi-Estados y cuasi-empresas, Instituto Latinoamericano y del Caribe de Planificación Económica y Social-ILPES, 21.

7. Sukharev, O. S. (2014). *Regionalnaya ekonomicheskaya politika; instituty, strukturno-organizatsionnyye izmeneniya, reindustrializatsiya [Regional economic policy; institutions, structural and organizational changes, reindustrialization].* Moscow: Lenand, 144.

8. Tatarkin, A. I. & Doroshenko, S. V. (2011). Region kak samorazvivayushchayasya sotsialno-ekonomicheskaya sistema [Region as a self-developing socio-economic system]. *Ekonomika regiona [Economy of region],* 1, 15-23.

9. Tatarkin, A., Lavrikova, Yu. & Vysokinskiy, A. (2012). Razvitie ekonomicheskogo prostranstva Rossiyskoy Federatsii na osnove klasternykh printsipov [Development of economic space of the Russian Federation based on the cluster principles]. *Federalizm [Federalism],* 1, 45-60.

10. Sukharev, O. S. (2000). *Metodologiya i ekonomicheskaya politika restrukturizatsii promyshlennosti [Methodology and economic policy of the industry restructuring].* Moscow: AMZ, 180.

11. Gizatullin, Kh. N. & Rizvanov, D. A. (2005). *Problemy upravleniya slozhnymi sotsialno-ekonomicheskimi sistemami [Problems of managing complex socio-economic systems].* Moscow: Economika.

12. Sukharev, O. S. (2014). *Ekonomicheskiy rost, instituty i tekhnologii [Economic growth, institutions and technologies].* Moscow: Finansy i statistika [Finance and statistics], 438.

13. Sukharev, O. S. (2015). *Ekonomicheskaya dinamika. Institutsionalnyye i stukturnyye faktory [Economic dynamics. Institutional and structural factors].* Moscow: Lanand, 140.

14. Tatarkin, A. I. (Ed.). (2008). *Region v novoy paradigme prostranstvennoy organizatsii Rossii [Region in a new paradigm of the Russian spatial organization].* Moscow: Economika.

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