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THE MODEL OF ECONOMIC GROWTH: NEOSCHUMPETERIAN ECONOMY

The paper discussed problem of modeling of economic growth and interpretation models with target by determinacy of economic policy, which stimulate of economic growth. Author presents the model of interaction economic agent: innovators and conservatives in developing schumpeterian model. Using of this method evolutionary viewing of economic growth let us takes for institutional factors development economic system and do new economic policy more efficiency.

Keywords: economic growth, innovator, conservator, Schumpeterian development.

1. «Innovators-Conservatives» system model and the development of the Schumpeterian viewpoint.

In the description of different groups of agents, in particular, of “innovators”, “conservatives”, “unemployed”, the problem of monetary rang within the limits of which an every model of economic behaviour is realized, becomes, as we see it, limited from the point of view of the working out and realization of the arrangements in economic policy.

Among three groups of agents which were named above there is such an interaction which creates economic dynamics and is not discribed by the classical Schumpeterian model. Schumpeter’s idea about “constructive distraction” has a line orientation and comes to the thing that “innovators”, when they appear, take the resources from “conservatives” and make bankrupt the latter. In informative and highly technological economics this effect can not work and “innovators” will appear at the expense of the broadening of some resourses possibilities (because the resource becomes virtual)without causing any appreciable damage to “conservatives”. An important circumstance is that the endogenous fluctuation in the model “innovator-conservative” itself is of great importance for economic development and the hypothesis that this fluctuation depends on the value of the monetary rang in the activity of “innovator” and “conservative”is offered. Hence, in the economic dynamics it becomes important to have a strategy when such a model as “innovator” is switched to “concerivative” or “inactive agent” model.

Below we give an evolutionary model of “innovator-conservative-unemployed” within the bounds of the combination of the limits in the monetary

rang of different agents. The point where, according to the model, "innovator" transforms into "conservative" and back has an institutional meaning. The parameters of the monetary rang can be dynamically changable values or they cannot change within the limits of some definite time interval (figure 1).

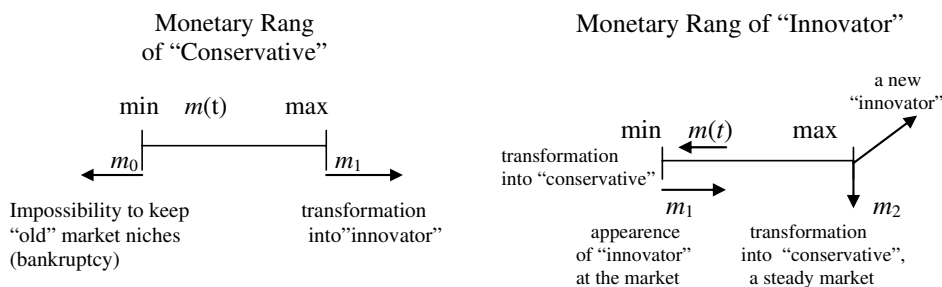


Figure 1. Monetary rang of the system "innovator-conservative"

In the preceding work, which we have just referred to, this model was formulated and scientifically grounded. The next mathematical conception has been obtained, where:

- $Y(t)$ – gross domestic product,
- $X(t)$ – index of configuration,
- $N(t)$ – number of "innovators",
- $K(t)$ – number of "conservatives",
- $U(t)$ – number of "the unemployed",
- $S(t)$ – able-bodied agents,
- $m(t)$ – the function of money to monetary rang,

n, k, u – correspondingly, the dole of "innovators", "conservatives", "the unemployed" in general quantity of "able-bodied" agents.

Now we must broaden the action of the model at the expense of special values and formal connection among them in order to give a complete notion about the evolution of an economic system by means of interaction of agents models- "innovators" and "conservatives". The model can be included in standard microeconomical schemes(models), if it will only be possible to show the connection of "innovators", "conservatives" with "the unemployed" category, which appears in the basic models of a labour market and of microeconomical system as a whole. It's not difficult to find out this connection if we'll imagine, that "innovators" and "conservatives" are the agents, which fulfil some activities and "the unemployed", at least from a position of the oficial statistics of labour, doesn't fulfil such an activity accordingly to his status.

Under the condition of economic changes and of high world economic dynamics it's rather narrow task to consider the object of economic development as the minimization of the function of social losses and the maximization of the func-

tion of well-being. The reason is that the quality of the development fixes already not the maximum of any showing per head and not minimum of expenses, but how the increase of the profit and of expenses are distributed, how well the agents are adapted and how they take in the changes, structural crises, which appear, not effective management, the changes of institutional connections. In order to get the aims of economic policy it is necessary to have, at least, not less number of the corresponding instruments (Tinbergen's principle)¹ and the content of economic policy must answer the purpose which it is adapted to (Mandell's principle of effective market classification)². However, the discussion within the limits of the terms "better-worse" demands to estimate the economic policy additionally, it's qualitative criterion, because, for example, monetary and fiscal policy as any instruments are not suitable for the solution of structural tasks and institutional problems and can only fulfil an auxiliary role, while getting these objects. During the stage when we choose instruments and realize arrangements, it's rather problematically to say that exactly this instrument will allow to achieve the aim because it will only be able to do after the aim had been achieved. Besides, many aims are connected among themselves and it's difficult to share the corresponding instruments, having a wide spectrum of influence, simultaneously aims which can be conflicted. So we consider that the non-admission of appearing of disfunctional in the subject of management and in the objects of a system of influence, which is described by the next parameters: of the aim of development, of the sphere of using of economic policy" of the functional varieties in a system of influence, of the expenses in functioning, and of the realization of the arrangement, of the period of time till the changing of the priority of influence, of the adaption and of the stability in the system to he changes is a necessary and sufficient criterion of realization of the state economic policy. By means of these parameters it's possible to give the level of the coordination in the aspect of realization of definite strategy in the economic policy and of the change in the priority of development.

2. Basic model of Schumpeterian economic growth.

Let's give a wider interpretation of a model, given above. Let's introduce the next values, characterizing the function of the system (institute).

$R(t)$ – the reserve of an institutional system (institute) in a ready form (monetary form) changing in the limits of some monetary rang of the system;

$I(t)$ – expenses of functioning of institution (system), including transactional ones;

$\sigma = R(t)/I(t)$ – index of liquidity (the reserve of profitability of the system);

β – velocity of adaptation of institution (of system).

¹ Tinbergen J. On the Theory of Economic Policy. Amsterdam, 1952.

² Mandell R. The Monetary Dynamics of International Adjustment Under Fixed and Flexible Exchange Rates // Quarterly Journal of Economics. 1960. Vol. LXXIV. P. 249–250.

So we can write down the next model of evolution in the parameters of an institutional system, which is offered by such differential equations:

$$dR/dt = m_2(t) - I(t), \quad (1)$$

$$dI/dt = \beta(R/\sigma - I). \quad (2)$$

The object of realization of such a model can be the next:

1. To describe the dynamic of institution by means of the expenses of their functioning
2. To describe the real departure of the liquidity from some standard.
3. To provide the connection of reserve and the velocity of adaptation of the system (of institution).
4. To give the process of adaptation either monotonous or cyclical.

Having made the necessary substitutions of (1) in (2), we get the equation of reserve changing of the system (institution):

$$\frac{d^2R}{dt^2} + \beta \frac{dR}{dt} + \frac{\beta}{\sigma} R = \frac{dm_2(t)}{dt} + \beta m_2(t).$$

While selecting the function m_2 and taking $\sigma = \text{const}$, we can get the solution. If the upper limit of the monetary rang isn't change, $m_2 = \text{const}$, then $dm_2/dt = 0$, the equation becomes:

$$\frac{d^2R}{dt^2} + \beta \frac{dR}{dt} + \frac{\beta}{\sigma} R = \beta m_2(t).$$

If we give conditions of a very slow adaptation, when the adjustment in the institutional system is performed monotonously without any fluctuation, the coefficient $\beta = 0$ and so the oscillatory dynamics appears, as it results from the theory of a differential equation, when $\beta > 4/\sigma$. In other words, when R is deflected from its acceptable meanings, which corresponds to a necessary or the most advisable structure of agents (index of configuration), the return of R to the former meanings, even if we mean clear mathematical logic, will last during the time which is equal to σ .

As the adaptation velocity in the system is scarcely equal to zero and the institutional factors, creating the inertia of a system, the return of R to the acceptable meanings will require special actions of the government and will not certainly so quick as it can be if we have slow adaptation.

Below we give the extensive variant of the model of institutional system with "innovators", "conservatives" and "the unemployed".

$$\begin{cases} n + k + u = 1, \\ \frac{dx}{dt} = f(m(t)), \\ \frac{du}{dt} = -\alpha \left(\frac{dy}{dt} - k_0 \right), \\ \frac{dy}{dt} = \tilde{f}(y, t, x) - h(t). \end{cases}$$

$$\tilde{f}(y, t, x) = T(t)L_2^a K^b,$$

$$h(t) = l(t)y(t) = Z_L,$$

$$l = \frac{Z_L}{y},$$

$$\frac{dT}{dt} = l_1 y + H(c_1 y, L_1, x, T) - \mu T,$$

$$H = C_1 x y L_1^d T^w / (b_1 + c_1 y),$$

$$C_1 = \frac{y}{L_1}, \quad C_2 = \frac{y}{L_2}, \quad L_1 + L_2 = L,$$

$$Z_1 = \frac{L_1}{L}, \quad Z_2 = \frac{L_2}{L},$$

$$\frac{dK}{dt} = [1 - C_1 Z_1 - C_2 Z_2] y(t) - \sigma_1(t) K.$$

$$\begin{cases} \frac{dx}{dt} = \begin{cases} f \left(\frac{R}{m}(t) \right), & |x(t)| \leq 1, \\ 0, & |x(t)| > 1, \end{cases} \\ \frac{du}{dt} = \begin{cases} -\alpha \left(\tilde{f}(y, T, K) - h(t) - K_0 \right), & 0 \leq u \leq \frac{1}{3}, \\ 0, & 0.2u \notin \left[0, \frac{1}{3} \right], \end{cases} \\ \frac{dy}{dt} = e \frac{y}{N + K} + x \frac{y^2}{b_1 L_1 + y^2} L_1^d T^w - \mu T, \\ \frac{dk}{dt} = \left(1 - 2 \frac{y}{L} \right) y - \sigma_1 K, \quad \sigma_1 = 0, 2. \end{cases}$$

$$\tilde{f}(y, T, K) = T(t)L_2^a K^b,$$

$$h(t) = Z_L,$$

$$C_1 = \frac{y}{L_1},$$

$$\begin{aligned} H &= C_1 xy L_1^d T^w / (b_1 + c_1 y) = xy^2 L_1^{d-1} T^w / (b_1 + y^2 / L_1) = \\ &= xy^2 L_1^d T^w / (b_1 L_1 + y^2) = x \frac{y^2}{b_1 L_1 + y^2} L_1^d T^w, \end{aligned}$$

$$\frac{dk}{dt} = (1 - C_1 Z_1 - C_2 Z_2) y(t) - \sigma_1 K = \left(1 - \frac{y}{L_1} \frac{L_1}{L} - \frac{y}{L_2} \frac{L_2}{L} \right) y - \sigma_1 K = \left(1 - 2 \frac{y}{L} \right) y - \sigma_1 K.$$

$$\frac{dy_i}{dt} = f_i(y, t, x) - h_i(t).$$

The function of growth of economic system,

$h_i(t)$ – the function of restructure, it is in proportion to the value of the labour input. per unit of output and to the volume output $h = l_i y_i$;

L – common *employment*;

$L_{1i} = Z_{1i} L_i$ – workers of mental labour;

$L_{2i} = Z_{2i} L_i$, – manual workers exclusively;

$z_{1i} + z_{2i} = 1$;

$y_i(t) = T_i(t) L_{2i}^a \cdot K_i^b$ – production function of the system;

$T_i(t)$ – technological function of the system;

K – physical capital of the system (basic funds);

dK_i/dt – describes the process of accumulation of capital in the institutional system;

c_{1i}, c_{2i} – the norms of distribution of aggregate income among the workers of mental and manual labour;

σ_i – amortization standard which is fixed in a short space of time;

dT_i/dt – change in technology;

$ey_i(t)$ – describes the effects of training in the institutional system;

$H = c_{1i} y_i x L_i^a T_i^w / (b_{1i} + c_{1i} y_i)$ – function, reflected the contribution of workers in the accumulation of technological knowledges;

μ_i – quantity which characterises the rate of depreciation of knowledges and of earlier technology;

b_1, d and w ($d + w = 1$) – not negative parameters.

Parameters and elementary conditions for models:

$$\begin{array}{lll}
 L_1 = 0,4L & a = 0,3 & x = 0,325 \\
 L_2 = 0,6L & b = 0,7 & u = 0,1 \\
 \sigma_0 = 1 & b_1 = 1 & y = 6 \\
 \beta = 0,8 & l = 0,01 & T_z = 0,5 \\
 a_0 = -0,4 & \mu = 0,2 & K = 1 \\
 k_0 = 1,2 & d = 0,4 & t = 0 \\
 e = 0,01 & w = 0,6 & L = 65,5 \text{ mln. of men} \\
 \sigma = 0,8 & \sigma_1 = 0,25 & U = 6,1 \text{ mln. of men}
 \end{array}$$

As in our model $m_0 = 1$, $m_1 = 2,3$ and $m_2 = 4,5$, the function $f(x_i, u_i, k_i)$, after the solution of the corresponding equations, will be:

$$f(x) = \{ \text{sh}(2x - 6,8) - (x - 1,9)\text{ch}(2x - 6,8) \} 0,13 + 0,9.$$

The results of evolutionary model in the given system are submitted to the diagrams.

It's interesting to note that by the lowering of the upper limit of monetary rang is the reserve size of the institutional system with different meanings of liquid is changed in the same way, in other words it is come down too, and in case of broading of the upper limit it is increased (figures 2–5).

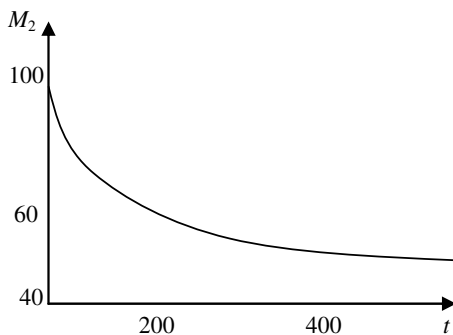


Figure 2. The law of changing of the upper limit in a monetary rang

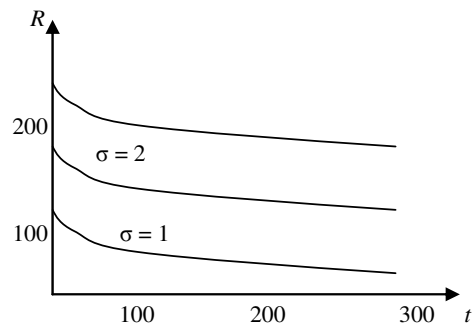


Figure 3. The dynamic model of the reserve (R) of an institutional system ($\beta = 1, 4$)

As we can see, our method of approach may be added to the microeconomical models and may be used for the explanation of economic development of economies, where the unemployment and the lag in technology are of great importance. Besides, it may be used when we analyse the problems of innovative-technological development of poor countries (Africa, Latin America and etc.), but

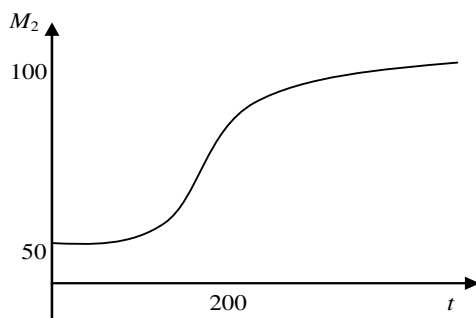


Figure 4. The law of change in the upper limit of monetary rang

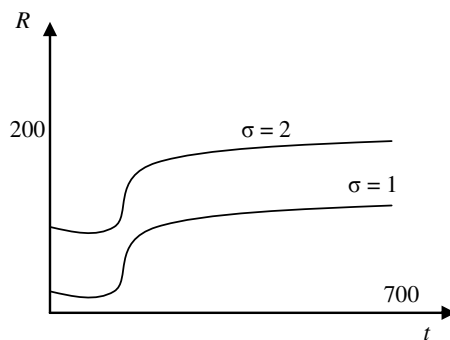


Figure 5. The dynamic model of the reserve (R) in institutional system ($\beta = 1, 4$)

this can be rather difficult to do in the modern stage of development of evolutionary economic theory, because it takes a great interest in modelling and so can't take into account, in a necessary volume, the institutional peculiarities in different countries and the problems of lag, given by specific institutes.

Below we give the result of the model by the constant quantity in the upper limit of a monetary rang, when the index of the configuration is positive, in other words, "innovators" predominate over and the reserve size systematically grows. Below two cases are shown: reserve size in its initial point, exceed the limit of transformation of "innovator" into "conservative" and "conservative" into "innovator" $m_1 = 2,3$, and the reserve range in the initial moment is less than this limit meaning.

The analysis of the results of computer imitation, shown on picture 6 (time curve is directed from the left to the right), the solution of the system of differential equations allows to draw some important conclusions.

Firstly, the improvement of index in the configuration of the system, the other words, the increase in manpower of "innovators" over "conservatives" is possible by the lowering of Gross Domestic (figure 6).

Secondly, the subsequent growth of the institutional system occurs with the worsening of the index of configuration at the expense of growth of the number of "conservatives". The growth of number of the "conservatieves" goes till the index of configuration becomes negative. In this case "conservatives" prevail and the economic growth occurs at the expense of their activity exclusively.

Thirdly, in connection with the fact that the number of "innovators" grows, simultaneously with the growth of "innovators", we can see the lowering of the level of unemployment.

However, how can we explain such an outcome on condition of the lowering of Gross Domestic?

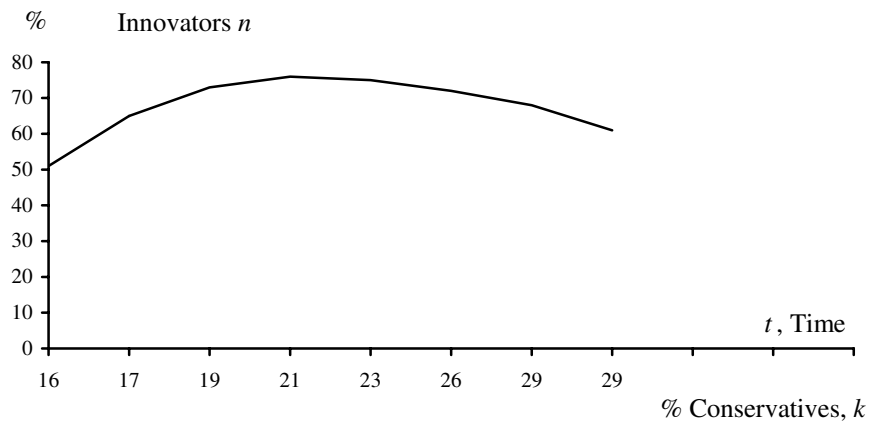
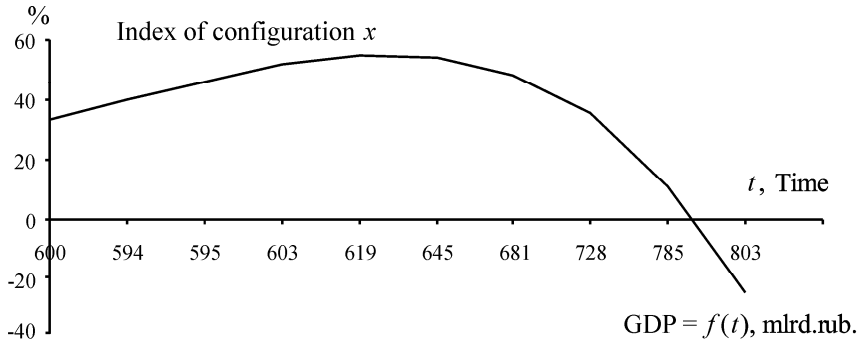


Figure 6. The result of imitation of the model $m_2 = 4,5$ (const)
 $R = 3,5$ grows to M_2 and more than y (Gross Domestic) = 645 mlrd. rub.

Nothing remains, but to suppose that the situation which has been got after the realization of this model, corresponds to fact that by the primary prevalence of “innovators” their following increase demands of additional resources, which are provided by the growth of the reserve of system R , it is achieved with the growth of conservatives, by means of the cutting down of the unemployed and is expressed by the lowering of the rate of growth or zero growth.

At the same time, the renewal of the economic growth is conditioned by the liquidation of the redundant by number of “innovators” and is expressed by the growth of number of agents the conservative model of behaviour and of the unemployed. So, the growth is in progress by releasing of material resources and is directed to the conservation of the gained positions, in other words, it confirms by the conservative model of the economic behaviour. The change of the tendency in dynamics of the index of configuration is observed, when the quantity R of monetary providing (reserve of the system) growth to the upper limit of monetary rang M_2 and exceeds it.

On figure 7 the result, when the value of monetary guaranteeing of institutional system is below of point m_1 and grows, is presented. However, till the point of braking the number of “conservatives” will be increased at the expense of the reducing the number of “innovators”, but the unemployment will be appreciably fallen’ as the increase of number of “conservatives” will exceed the reducing of “innovators” which constantly becomes slower because growing R .

Undoubtedly, the given explanation needs in empirical verification and forms only model interpretation. However, when the model is clear and when the tests are recurring we get the instrument by means of which the evolution of an institutional system in the presence of three pointed groups of agents gets an original filling and it cannot but reflects on the existed effects, connected with the variants of fiscal and credit monetary policy.

A valued conclusion, after the model has benn tasted, is to the effect that M. Fridmen’s monetary rule can’t be applied without taking into account the structure of agents, following the showing models of behaviour- innovatory or conservatory. Monetary growth (in our case it is quantity R) can be accompanied by the increasing of an index of configuration at the expense of growing of the number of “conservatives”. For all this the unemployment will come down both in one and in the other case by some lowering of gross domestic, and then it will grow together with increasing of the tempo of economic growth. In one case the growth occurs at the expense of “innovators”, but in the other case it occurs at the expense of the conservative model of behaviour, though in both these variants “innovators” prevail. If in the start point we take the index of configuration as negative (and it corresponds to the prevalence of “conservatives”), then the situation can be characterized by rather slump of Gross domestic and everything will be determined by other parameters and started conditions.

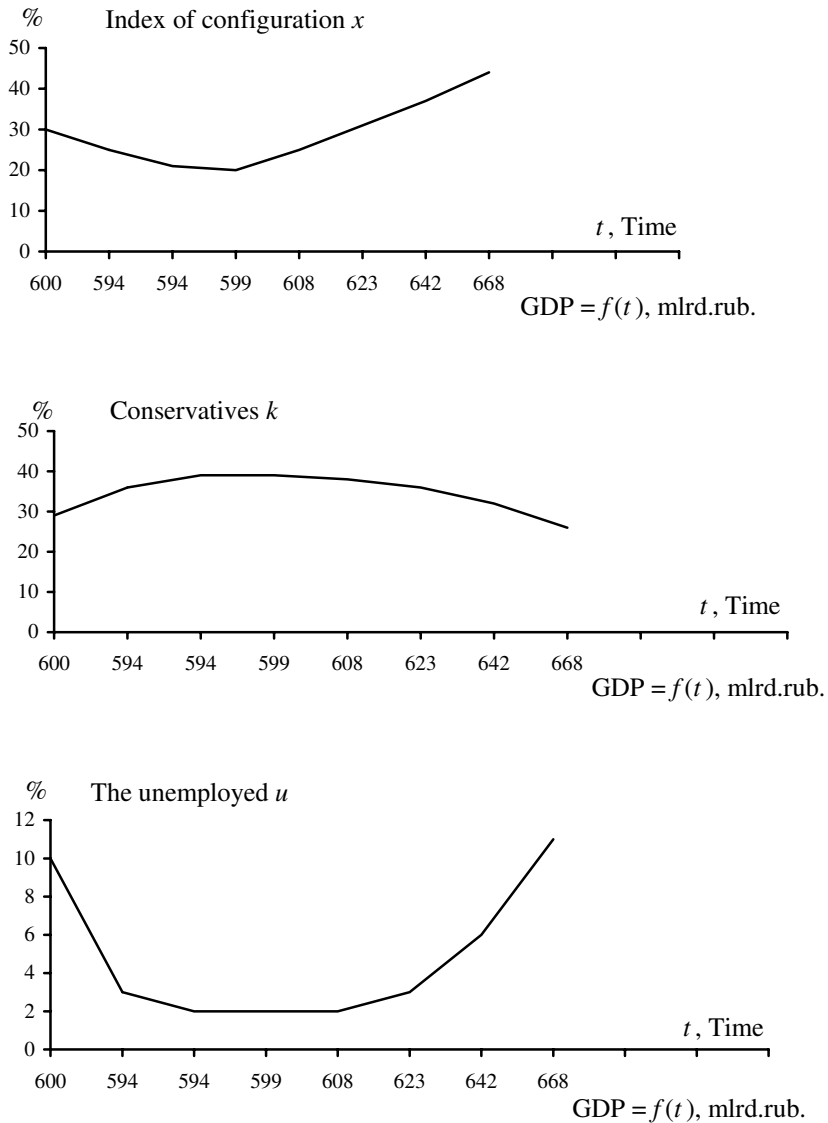


Figure 7. The result of imitation of the model with $m_2 = 4,5(\text{const})$ $R = 1,5$ grows to $M_1 = 2,3$ and more, corresponds for y (Gross Domestic) = 599 mlrd. rub.

Now we can draw a conclusion for the planing of economic policy: its measures must be distributed between the necessary of the lowering of unemployment, including the way of the encouragement of the conservative model of behaviour, and the stimulation of the development of innovatory potential but not to lead to over-accumulation of the resourses in innovatory sector at the expense of the con-

centration of the efforts on the encouragement of “innovators” exclusively. So we manage to go from the offered differential measurements of economic policy, having a local zone of setting over to the long-term oriented economic policy, which spreads the influence on the different types of agents in their systematic totality.

In the given model it’s not evidently supposed that the other agents can play not less role, than “innovators” can. The structures which had become bureaucratic (transnational corporations, financial groups and the state itself) begin to carry out the role of Schumpeterian employer-innovator in the postindustrial society. For example, in Russia the state in the person of the government as a matter of fact trades with its own state property, and it reduces the sphere of application of the efforts and reduces the own functional potencial instead of care of growth in the efficiency of exploitation and of management of this property.

So, a dangerous substitution of important functions of the state takes place – its “transaction” becomes grower and the administrative and organizational “abilities” or in other words – the level of compensation.

The “minimization” of an administrative subject is a variant of effective strategy of lowering of the given expenses, when the decisions and the responsibility for them rests with the local association as with a small organization, which demonstrates the most stability and viability. The present model of distribution of power and of responsibility for the economic policy must not be examined within the limits of mistaken doctrine “minimum state” (when state takes minimum part in economics) but it demands the perception as a system of measures for enhancing the responsibility of the Central Government for the organization and for the achievement of the specific aims of social development of a country.

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ЭВОЛЮЦИОННЫЙ ПОДХОД К МОДЕЛИРОВАНИЮ ИЗМЕНЕНИЙ В ЭКОНОМИЧЕСКОЙ СИСТЕМЕ

Рассмотрены подходы к моделированию эволюции экономических систем с позиций процесса их реструктуризации, т.е. изменения пропорций между элементами системы. Показаны возможности агрегатного подхода, метода биологических, химических аналогий, социоконфигураций, а также предложена модель управления процессом реструктуризации на основе функции силового формирования экономической структуры и сравнительной оценки влияния инвестиционных потоков.

Ключевые слова: *эволюционные модели, инвестиции, изменения, популяция фирм.*