

## MODELING THE RE-EQUIPMENT OF THE ECONOMY WITH MANAGEMENT THROUGH ITS NATURAL MONOPOLIES

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In the article the author elaborates the algorithm of the rearmament of the country economics with the natural monopolies as the instrument of the state management of this process. The author supposes that the natural monopolies are under the state control and possess the effect of "economy of scale". On the basis of the model the author researches the possibilities of the state management of the process of rearmament. This process may be carried out in the modern Russian conditions, and the natural monopolies may be an effective means of state regulation of this process.

At the beginning of the XXI century the main problem of the economic development of the Russian Federation is the renovation of the economy, transition from the older production assets to the modern technological base. Economic crisis of the 2008 - 2009 years showed that without solving this problem it is impossible to secure the role of the leading world state Russia wants to be.

The government of the RF has recently announced the Concept of the long-term social and economic development of the Russian Federation for the period up to 2020. It was stated that the transition from the export of raw materials stage of the economic development to the innovation stage is the paramount problem. To compete successfully at the global level it is necessary to change the technological base of all the branches of the economy. This process is called the change of the technological base.

In Russia the last real change of the technological base occurred in the 30-th of the last century in the epoch of industrialization. Since that time the evolutionary development of the economy occurred in the different branches. Sometimes thanks to the special care of the country leaders some branches secured the leading positions in the world economy. So, nowadays Russia is present in the world hi-tech markets of aerospace equipment, armament, software and some others. However, it always concerned some branches only. A considerable part of all the production bases lags behind western analogues for many decades. Therefore the presence of the Russian hi-tech products on global

markets is very small. Thus changing the technological base is the main task of the transition to the innovative way of development.

The solution requires reforms in many industries of national economy. In the conditions of the planned economy such transformations may be carried out by directive methods. Just like in China, and it allowed this country to become one of the leading economic powers. However, such method is not suitable for modern Russia.

In the market conditions only indirect adjustment of the economy is possible. Such adjustment excludes directive methods of management. Therefore the state needs the instruments of implementing the decisions various industries of the economy. In this article it is suggested to use the sector of natural monopolies as the instrument of state management of country economy rearmament.

Natural monopolies possess a number of unique economic properties, which make these monopolies means of state regulation of the economy. Firstly, it is considerable effect of "economy on the scale", consisting in the decrease of average expenses per unit of production with the increase in the volume of output. Secondly, the produce of the infrastructural branches, including natural monopolies as the base, is consumed practically by all the enterprises. Electricity, railway and other kinds natural monopolies produce expenses are always a part of cost of any goods. Finally, the entire natural monopoly sector of the economy is under the control of the state. The major natural

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\* Mikhail I. Kuternin, PhD in Technical Sciences, associate Professor of State University of Management. E-mail: vestnik@sseu.ru.

monopolies of the Russian Federation are the joint-stock companies “Gazprom” in the gas branch, “Russian Railways” in the field of railway transportation, “Federal Network Company” in electric power industry, “Transneft” in the oil sphere and some other. In these companies the state is either the sole shareholder, as in “Russian Railway”, or the proprietor of the controlling interest as in the majority of other natural monopolies. The listed properties of natural monopolies can make them effective control facilities of the process of transition to an innovative way of development.

We will consider the model of changing the technological base. It consists of the main block in which the changes of macroeconomic parameters are described, and the block of management (the operating block) of the change of the base process. In the economy there are two sectors: the zero sector - the sector of natural monopolies and the first sector - the competitive sector of economy. Each sector in itself contains two ways of manufacture, called subsectors or technological ways. It is necessary to say that organizationally each sector is indivisible. The enterprises of different technological ways within the frames of one sector belong to the same persons. Moreover, the change of technological base can occur within the frames of the same enterprise.

For the sector of natural monopolies the effect of economy on scale takes place. In the competitive sector there is no such effect. Every subsector has its own production function. Thus, we have four production functions which can be expressed in such way:

$$\begin{cases} x_0 = \tilde{A}_0 k_0^{\alpha_0 + \frac{\Delta}{2}} \theta_0^{1+\Delta} \\ x_1 = A_1 \theta_1 k_1^{\alpha_1} \\ \hat{x}_0 = \hat{A}_0 \hat{k}_0^{\hat{\alpha}_0 + \frac{\hat{\Delta}}{2}} \hat{\theta}_0^{1+\hat{\Delta}}, \\ \hat{x}_1 = \hat{A}_1 \hat{\theta}_1 \hat{k}_1^{\hat{\alpha}_1} \end{cases} \quad (1)$$

where  $x$  is the subsector output;  $k$  is its fund-armament;  $\theta$  is the share of subsector manpower in the total number of the employed;  $\tilde{A}_0, A_1, \hat{A}_0, \hat{A}_1$  are the parameters of production functions;  $\Delta, \hat{\Delta}$  is an indicator of the scale effect of natural monopolies sector.

In the system (1) the parameters of natural monopolies sector have the index of 0, and the parameters of competitive sector - the index of 1, thus the parameters concerning the new technological way are marked by a “cover”.

The output of the sectors is connected by the equation of interbranch balance:

$$x_0 = x_1 \quad (2)$$

The change of economy subsector fund-armaments are described by the differential equations:

$$\begin{cases} \frac{dk_i}{dt} = -\lambda_i k_i + \frac{s_i \rho}{\theta_i} x_i, \\ k_i(0) = k_i^0, (i = 0, 1) \\ \frac{d\hat{k}_i}{dt} = -\hat{\lambda}_i \hat{k}_i + \frac{\hat{s}_i \rho}{\hat{\theta}_i} \hat{x}_i + \\ + \frac{s'_i(t-\tau)\rho}{\hat{\theta}_i} x_i(t-\tau), \\ \hat{k}_i(\tau) = 0, (i = 0, 1) \end{cases} \quad (3)$$

where  $k$  is the subsector fund-armament;  $\rho$  is the norm of accumulation, i.e. a share of an investment component in output of competitive sector;  $s_i, \hat{s}_i$  are shares of investment resources of every subsector in the total amount of investment component of the first sector of old way output (investments are directed into both old and new ways);  $s'_i$  is the same share for new way (investments are directed only into the new way);  $k^0$  is the initial value of fund-armament of the old way. For the new way this value, naturally, is equal to zero.

The share of manpower and investment resources of all the subsectors at any moment are connected by the equations of labour and investment balances:

$$\begin{cases} \theta_0 + \hat{\theta}_0 + \theta_1 + \hat{\theta}_1 = 1 \\ s_0 + s_1 + s'_0 + s'_1 = 1, \\ \hat{s}_0 + \hat{s}_1 = 1 \end{cases} \quad (4)$$

The equations (1) - (4) form the main block of the model. This block is intended for working out the algorithm of transition to a new way

of manufacture. The algorithm offered in the present article is based not on the consumption level decrease, but on the use of available reserves of the old way. Thus, there are two stages in any process: the stage of accumulation and the stage of return of accumulation.

**Stage 1. Accumulation** ( $0 \leq t \leq \tau$ ). At this stage in both sectors only the old way operates. In the current state of Russian economy the old way has got some reserves for development. During this stage there is an escalation of a fixed capital of the new way of manufacture.

**Stage 2. Return of accumulation**

. At the second stage of the technological base change process the two technological ways of the economy operate simultaneously. The old way of manufacture continues to accumulate resources for the new way. Self-investments of the old way stop. All the potential of the old way gradually passes into the new way.

Thus, production assets of the new way come from two sources: from the old way (with a log) and from the new way (without a log).

For the realization of the described algorithm it is necessary to manage the investment and manpower streams by means of special indirect regulation measures. Such regulation in the present work is carried out through the sector of natural monopolies. The operating block of the model is developed for managing the streams of resources in the course of changing the technological way.

Let's consider the following parameters:

are the prices and rates of wages for each sector of economy. We will notice that these parameters are uniform in the sector of economy as it is a uniform producing unit even if the sector includes two ways of manufacture. The establishment of a uniform price for the first sector is the consequence of its competitive character. For sector of natural monopolies the uniform price means only the uniformity of its production. Identical level of wages in each sector is the consequence of the unity of each sector consisting of two ways of manufacture with various industrial bases and various levels of applied technologies.

Let's measure all the prices and salaries in relative indicators. The wages rate in zero sector will be used as the basis value, i.e.

One of the main difficulties is the possibility of managing investment streams between old and new technological ways. For this purpose we will use differentiated tax rates for the investment goods. So, let  $t_0, t_1, t'_1$  be the tax rates in the zero and the first sector, and taxes on investment goods differ, depending on the way manufacture investments are directed to. Therefore the investment goods of the old way

of manufacture are bought at the price ,

and the purchase of the goods for the new way

occurs at the price of  $\frac{\rho_1}{1-t'_1}$ . It is supposed

that the differentiated rates of investment taxes become a control facility for the distribution of investment between the ways of manufacture.

Cost balances are equality of incomes and expenses. They are carried out for each sector of the economy entirely and the change of technological base can occur within the frames of the same enterprise if there is a gradual re-equipment in this enterprise at the expense of investing the new goods even if the means for acquisition of these goods are earned at the the expense of selling the old way production. Cost balances in dimensionless indicators for both sectors are the following:

$$\left\{ \begin{aligned} & \rho_0(x_0 + \hat{x}_0)(1-t_0) = \\ & = \rho_0(a_0x_0 + \hat{a}_0\hat{x}_0) + \\ & + \frac{\rho_1}{1-t_1} s_0 \rho x_1 + \\ & + \frac{\rho_1}{1-t'_1} \rho(s'_0x_1 + \hat{s}_0\hat{x}_1) + \\ & + \theta_0 + \hat{\theta}_0 \\ & \rho_1(x_1 + \hat{x}_1) = \rho_0(a_1x_1 + \hat{a}_1\hat{x}_1) + \\ & + \frac{\rho_1}{1-t_1} s_1 \rho x_1 + \frac{\rho_1}{1-t'_1} \rho(s'_1x_1 + \hat{s}_1\hat{x}_1) + \\ & + w_1(\theta_1 + \hat{\theta}_1) \end{aligned} \right. \quad (5)$$

The left parts of these two equations look differently because  $\rho_0$  is the real price of the

$\frac{\rho_0}{1-t_1} \leq T$

zero sector production, but  $\rho_1$  is the profit the first sector receives per unit of production after the payment of taxes.

Based on the kind of production functions of the first sector (the second and fourth equations of the system (1)), it is possible to deduce the condition for the maximization of the sectoral output:

$$\frac{\theta_1}{\hat{\theta}_1} = \frac{x_1}{\hat{x}_1} \cdot \frac{1-\alpha_1}{1-\hat{\alpha}_1}. \quad (6)$$

As far as the sector of natural monopolies is concerned, the level of salaries in both subsectors is identical and the movement of manpower between the old and the new ways of manufacture occurs according to the strategy which the state chooses for this sector. Therefore the parity of manpower in the two subsectors of natural monopolies sector is the operating parameter of the model. Let

$$\theta_0^* = \frac{\theta_0}{\hat{\theta}_0}. \quad (7)$$

be the parity of the number of manpower in the two subsectors of natural monopolies sector. Then  $\theta_0$  and  $\hat{\theta}_0$  are the model internal variables, and  $\theta_0^*$  is the management parameter.

Finally, the developed model incorporates the equation describing the specificity of the competitive sector of economy. Taking into account the equation (7), this condition can be expressed only through the parameters of one of the ways of manufacture (for example, the old one):

$$\rho_1(1-\alpha_1)A_1\left(\frac{K_1}{L_1}\right)^{\alpha_1} = w_1. \quad (8)$$

The equations (5) - (8) form the management block of the model. One more equation describing the distribution of investments between the subsectors of the first sector will be added later.

The entire model (1) - (8) is intended for the research of the process of re-equipment of the economy with management through the sector of natural monopolies. Managing parameters of the model are:

◆  $\rho_0$  - the prices for the produce of natural monopolies;

◆  $t_0$  - the tax rate for the produce of natural monopolies;

◆  $t_1, t_1'$  - the differentiated rates of taxes of the competitive sector for the production directed at both the old and the new way of manufacture;

◆  $s_0', \hat{s}_0$  - share of the output of the old and the new ways in the first sector, directed at the new way of natural monopolies sector.

Let's notice that all operating parameters are under the state control. The state can always offer the enterprises of the competitive sector the price which differs from the market price for the investments, but only for purchase of the investment goods for the zero sector in the demanded volume. Thus, the state can provide the purchase of the investment goods in the necessary volume, therefore (or ) may be considered as the operating parameters of model.

Thus, by means of the differentiated tax rates the state can provide the direction of investments into the new way of manufacture in spite of the fact that it yet has not started to operate. It is possible to show that the formula describing the distribution of investments in the first sector is as follows:

$$s_1 = \begin{cases} \frac{\lambda_1 k_1 \theta_1}{\rho x_1}, & (t_1 > t_1') \\ 1 - s_0 - s_0', & (t_1 < t_1') \end{cases}. \quad (9)$$

The first line of this equation means that, if the tax to the investment goods in old way is greater than in the new one the investment into the old way is at the minimum, defined by the amortization of the available funds. The second line means that otherwise the investments into the new way are equal to zero, i.e.  $s_1' = 0$ .

By the means of the described model the algorithm of management by the process of re-equipment of the economy through its natural monopolies has been developed. The values of all the external parameters of the model came up close to the values which are characteristic for the modern Russian economy. The duration of the stage of accumulation is 4 years. The schedules of parameters change at the second stage of the process are shown on fig. 1 - 2.

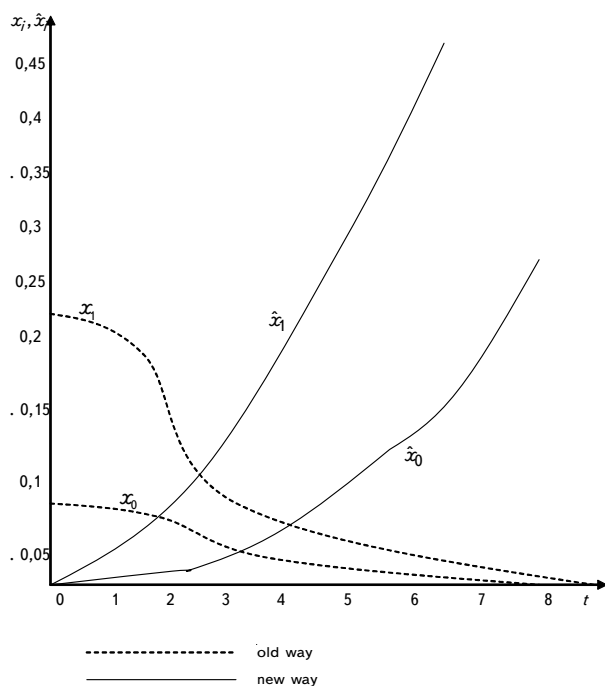


Fig. 1. Change of subsectors output in the course of changing the technological base

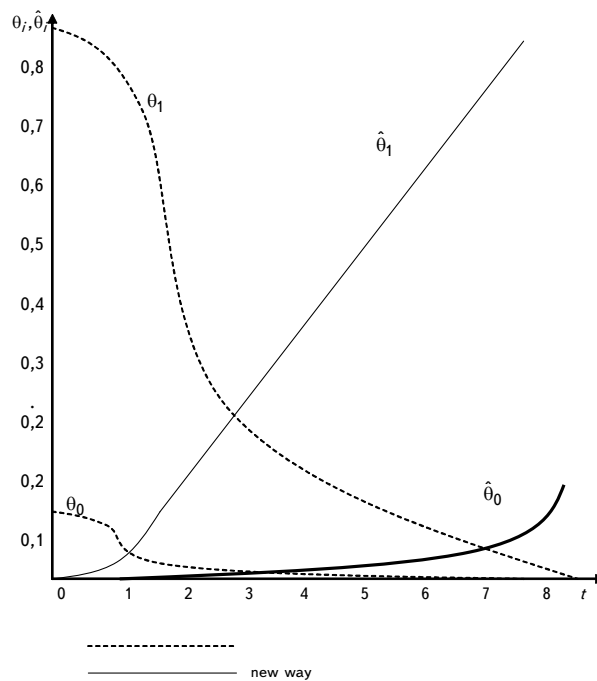


Fig. 2. Redistribution of manpower between the economy subsectors in the course of technological base change

**Dependence of technological base change time on the natural monopolies production prices**

$p_0$	1	2	3	5	7	10
$T$	9	8	8	11	14	19

In table the dependence of the duration of the process of technological base change (including the first stage) on the zero sector production prices is shown. The rate of taxes in the sector of natural monopolies is established at the level of 20 %, the rates of taxes on investments are differentiated, which corresponds to the accepted strategy of management:  $t_1 = 25\%$ ;  $t'_1 = 15\%$ .

From table we see that in case of the reduction in the prices on natural monopolies produce in 3-4 times in comparison with the existing level which by the beginning of 2009 was equal in relative units to approximately 9,6. The process of technological base change can be carried out for 8 - 10 years. At a present price level this process can last about 20 years.

Thus, the research has shown that the process of technological base change can be carried by the government through the sector of

natural monopolies. The basic measures which should be carried out are the state purchases in the necessary volumes of the investment goods for the new technological way of the natural monopolies sector, the reduction of prices on their production, the establishment of the lowered tax rates on the investment into the new way of manufacture. In case these measures are taken, the change of technological base in modern conditions can happen within approximately 10 years. Thus natural monopolies can become the driving force of the economy transition to the innovative way of development.

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