

Mathematical modeling of Russian economy on the base of social stratification

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Abstract

Russia needs in modernization in order to develop its economy and achieve rapid economic growth. But almost all attempts of last twenty years for transition to modernization have not gone right. The good purposes do not lead to desirable result if we don't know who will carry out the transition and how different social strata will react on it. The further growth at the expense of increase in loading of old production capacities is already impossible, as their current loading is close to limit and can only decrease in process of capacities ageing. This paper presents a model of Russian economy based on explicit description of social stratification. Each stratum from ten allocated strata has its own demographic characteristics. Contribution of a stratum in gross national product is defined by its employment rate and volume of working force. One purpose of research consists in estimation of model parameters that give best fitting of economic macroindexes calculated by model to statistical time series for them. Identified model of Russian economy is used for forecasting of economic macroindexes.

1. Introduction

Transition to development requires a technological modernization for Russian economy and economy of its regions. The paper considers an actual stratification of the Russian society developed as a result of last transformations. The work describes economic functions of stratum, dynamics of their demographic structure, and interaction of stratum. On the basis of the stratum' description the national and regional economic models are built. They describe dynamics of gross national product and its regional macroindex. The constructed models are identified under the statistical data of Russian economy and the Kirov Region economy by parallel calculations on cluster supercomputers. The identified models are used for forecasts and allow answering such questions, as who? and how?, that can help in program of modernization.

To identify the model for comprehensible time we use parallel calculations on cluster supercomputer on C++ programming language with technology of message passing interface. We determined parameters of the model by indirect way comparing calculated time series of model macroindexes with available statistical time series for them in 2001 – 2009. The time series are considered similar if they are close as functions of time. The closeness is measured by Theil index.

The principal result of the paper is a new Russian economic model built here. Identified model is used to carry out scenario calculations and for the forecast of development of Russian economy. The similar pattern of social stratification is used in modeling of the regional economy based on the mathematical description of interactions between six strata of the Vyatka (Kirov) Region.

Further growth of Russian economy by increase in loading of old production capacities is already impossible, as their current loading is close to limit and can only decrease in process of capacities ageing. This paper presents a model of Russian economy based on explicit description of social stratification. Each stratum has its own demographic characteristics. Contribution of a stratum in gross national product is defined by its employment rate and labor force. One purpose of research consists in estimation of model parameters that give best fitting of economic macroindexes calculated by model to statistical time series for them. Identified model of Russian economy is used for forecasting of economic macroindexes. To identify the model for comprehensible time we use parallel calculations on cluster supercomputer on C++ programming language with technology of message passing interface. We determined parameters of the model by indirect way comparing calculated time series of model macroindexes with available statistical time series for them in 2001 - 2009. The time series are considered similar if they are close as functions of time. The closeness is measured by Theil index. Identified model is used to carry out scenario calculations and for the forecast of development of Russian economy. The similar pattern of social stratification is used in modeling of the regional economy based on the mathematical description of interactions between six strata of the Vyatka Region. Constructed model of economy taking into account social stratification allow not only do look-ahead calculations about development of Russian economy, but also allow to answer questions on who will be occupied in the program of modernization and how it will be done.

Russia needs modernization to improve standart of live of the population, to continue started economic growth of the country. The increase in the old produced powers using was stopped by the limit of their wear and tear. So, the economic growth could be possible by the involving of new powers. Who will do the modernization and how it will be done is determined by the connection between people in the present society. The modern Russia society consists of several social classes, or stratums, influence the economic situation in the country. It is necessary to consider difference between classes, their interests and wants to obtain the most effective results from the different innovation projects involve.

There are various opinions about the way of the modernization. But it is obvious that it should be done as soon as possible.

As Iosif Diskin suppose, the preparation for modernization should be done by taking into account the society dissociation. Thus each stratum will react (on) the modernization changes in one's own way because of the individual preferences. Besides the modernization can be met with the opposition to it's methods. We should also consider the correlation between new modernization methods and politic, economic and social features of Russian society. Therefore, the modernization will

need the strong encouragement among the active population which is able to carry out this modernization process.

Recently the income difference of the population had become the object of the interdisciplinary debates. So, the Dmitry Bykov article "The Mafia or the Sect" view the modern society organization and possible variants of the development of this structure. Bykov consider the problem or opposition solving in two ways of non-public activity – as mafia and as sect. But all of this types of development are incorrect in some way. And the existing social organization is rather complicated and nonlinear to do perfect forecasts before the detailed analysis of the system.

In this case, Maxim Cantor points the disability of solving the coming to a head problems by the population revolution from the bottom because of the dissociation between people. Strong social stratification should be detected and eliminated immediately. It is necessary to produce the interdisciplinary valuation criteria, the new common aesthetics and use the brother's principle, which is very important to the competitive matters.

The stratification impact on the social-economic development can be evaluated with the mathematical-economic methods using the explicit form of the social stratification description.

This issue takes into account ten social strata, which were detected conditionally among the existing society on the income and education level of people. Each stratum consists of all the family of the active person.

The first stratum includes the Government: President and Government administration, the Head of the Department and Agencies and so on. This stratum presents the decision-makers who primarily influence the changing of economic processes, mainly different output of other countries and many other important macroeconomic indexes. Solved by this stratum members are influence all other society. The decision-making process on this level is often accomplished on the basis of the experience of the members of this stratum and the real economic situation in the country. The highest income in this stratum is tied with the high responsibility for the decisions, determined the economical future of the country.

The second stratum is called Elite. It is the complicated class, included such man as the Elite in the enterprises management, in politic sphere, in health protection, in education, science and culture. One of the main functions of this stratum is to detect the idea trends of the population. And also Elite can help the Government to find the solution if it is necessary in some ways. In common way this stratum isn't separated from the Government, but in Russia this classes are divided nowadays.

The third stratum is called Businessman. This stratum consists of the men who was successful in business but who hadn't become the main owners of the biggest enterprises. This stratum is the main motive power of the economic growth. Its members invent new projects, which are led high income not only to the creators but also to the country in all. Undoubtedly, it is the creative part of the economy. And they only can help to realize the transfer to the innovation way of the economic development. But it is most important to have Government suggest to this stratum.

They are risks by its own resources and therefore tier social status is very unstable, so their amount is so small and inconstant.

The forth stratum is the Globalists. It includes the men with the highest qualification level knew some foreign languages: off-shore-programmers, members of the international markets and so on. Members of this stratum can work as in the foreign enterprises in Russia as in other countries. This people has many connections with foreign employers, their experience helps to provide new technologies and could be used to increase the common level of education in Russia. The main function of this stratum is to keep up the educational level in the country. But the brain-drain situation is very problematical and should be solve as soon as possible.

The fifth stratum is called Workers of mass professions. Economic-activity members of this stratum output goods and services which is demanded on the country market. This people have special treatment and education. This stratum also includes industry workers, bank, financial and office employees and so on. Main function of this stratum is to make and to convert goods and services. Just here there are the creation of the value added on the high-quality labor basis happens. As the social instability the members of this stratum can easily become unemployed so they should be able to retain in accordance with the market demand.

The sixth stratum is called The workers of trade and service. The members of this stratum have possess the minimum required qualification to execute their work good. They suggest the most important goods and services needed to all community. Therefore their income is very high in some way, but this profession is considered of no prestige sometimes. This stratum shows shady side of economy in the most graduate. This problem can be solved by the produced square taxing and by order-making in the government. The development of this stratum is possible if the Government will support this sector.

The seven stratum is called Intelligency – workers of a science, education, medicine and culture.

The eight stratum is called Workers of subsistence economies – agricultural workers, the handicraftsmen self-occupied.

The nine stratum is called loner Idle pensioners, jobless, refugees.

The nine stratum is called Underground– criminals, drunkards, addicts, tramps, vagabonds and another underground.

2. A Model of Russian Economy Taking into Account Social Stratification

2.1. Parallel Calculations in Modeling of Economy

Parallel calculations allow accelerate performance of labor-consuming calculations which arise at the decision of some problems of mathematical modeling in economy. For carrying out of such calculations it is possible to use natural parallelism of the investigated system consisting of rather independent processes (for example, at calculation of processes in different sectors of economy or processes in different

levels of population), calculation on each of which is made independently. Natural parallelism does not give essential acceleration on cluster supercomputer to achieve difficultly if processes often pass messages each other. In present work it is considered splitting of societies on social strations rather independent in the economic plan that gives the chance to receive acceleration of calculations if they use parallel calculations.

Model parameters are defined in parallel by stratum. Thus, the most part of parameters of model can't be defined directly from the statistics data. These parameters we define model verification under the statistical data, that is indirectly, comparing affinity of settlement and statistical time series for macroindexes.

2.2. Russian Economy Model with Social Stratification

As a result of social and economic transformations of last two decades there was a deep stratification of the Russian society. Democracy gives all equal possibilities on start, but people have different abilities, preferences, get different education, therefore in entry on economic scene instead of equality not crossed strata which characterize the basic social agents of a modern society turn out almost. If to represent strations on a plane where on an axis of abscisses the educational level, and on an axis of ordinates income level is specified, we will receive an original pyramid (See Fig. 1). The specified pyramid characterizes developed stratification of a modern Russian society which, from our point of view, consists of ten strata described in introduction:

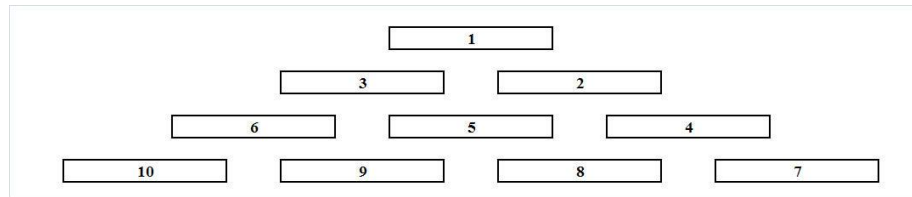


Fig.1. Stratification of modern Russian society on an educational level (from left to right on an axis of abscisses) and to income level (from below upwards on an axis of ordinates). Short names of strata: 1) Power, 2) Elite, 3) Management, 4) Globalists, 5) Workers of mass trades, 6) dealers, 7) intelligency, 8) village workers, 9) idle pensioners, 10) underground.

2.2.1 Dynamics of economical and demographic structure of Stat

We consider that strata differ not only an income level and an educational level, but its also differ by demographic characteristics. For simplicity we lower the index of stratum in this section. During each moment of time t we will consider dynamics of density of distribution of the population $x_{s,t,a}$ a sex s ($s = f, m$) on age a . Let $\beta_{s,t,a}$ is a force of death rate, i.e. a share of people of a sex s not lived before the following birthday among that people that were alive in age a in a year t . Then by definition of force of death rate we have:

$$x_{s,t+1,a+1} = x_{s,t,a} (1 - \beta_{s,t,a}) \quad (1)$$

Let $\gamma_{t,a}$ is a birth rate, i.e. number of the newborns who were born from women, having in a year t age a counting on one woman. In the model we consider that these characteristics are equal to zero at age $a < 15$ and $a > 45$. Statistical data are corrected by appropriate way having transferred the external data to extreme age cohorts. Also we will assume that rate $\gamma_{t,a}$ doesn't depend on density. Then we can write down a following parity for number of newborns in a year t :

$$\Gamma_t = \sum_{a=15}^{a=45} x_{f,t,a} \gamma_{t,a} . \quad (2)$$

Thus the number of newborn boys and girls is defined by a share μ_t of boys among newborns:

$$x_{m,t,0} = \mu_t \Gamma_t, \quad x_{f,t,0} = (1 - \mu_t) \Gamma_t .$$

So that knowing density of distribution of the population on age, initial year, and also dirth and birth rate, it is possible to give the forecast of evolution of this density of distribution. For a characteristic of age dynamics of death rate we use the Gompertz-Makeham function:

$$\beta_{s,t,a} = A_{s,t} + B_s e^{\delta_s a} . \quad (3)$$

where a is age, $A_{s,t}$ is social part of mortality which essentially depends of stratum and can change by time with changes of income. Biological potential of a stratum is characterized by parameters B_s and δ_s (sex $s = m, f$). Let social part of mortality depends of sex and current income level d_t . If income is greater than its minimal level d^0 than the social part of mortality begins to decrease:

$$A_{s,t} = A_s^+ \exp(-\lambda_s (d_t / d^0 - 1)_+), \quad (4)$$

where A_s^+ is a maximal level of social mortality. Hereinafter we use designation $(x)_+ = \max(0, x)$.

Number occupied in economy it is considered proportional to population of able-bodied age, and work capacity limits depend from stratum: a more educated stratum start to work later because of greater education period. If a_1 is age of the work enter for the population in given stratum, and a_2 is age of exit from work than the population occupied in economy L_t of this stratum is defined by the next formula:

$$L_t = \sum_{s=f}^m \chi_s \sum_{a=a_1}^{a=a_2} x_{s,t,a}, \quad (5)$$

where non-negative parameters χ_s are shares of workers a corresponding sex from people of able-bodied age.

Let's notice that all indicators and parameters depend from stratum.

Mobility of the population from one stratum to other is defined by set specifications and carried out at the age of reception of a corresponding educational level.

1.2.2. Calculation of GNP

Stratum value added is defined as

$$y_t^i = \theta_t^i L_t^i, \quad (6)$$

where θ_t^i in stratum i depends of working capital k_t^i and education level q_t^i :

$$\theta_t^i = \theta(k_t^i, q_t^i). \quad (7)$$

$$k_t^i = \kappa^i s_t^i, \quad q_t^i = \rho^i \sum_{a=0}^A s_{t-a}^i, \quad (8)$$

where $\theta(k_t^i, q_t^i) = \min(k_t^i, q_t^i)$.

Budget income:

$$D_t = \sum_{i=1}^{10} (r^i - (r^i - m^i) q^i) y_t^i, \quad (9)$$

$$R_t = \sum_{i=1}^{10} r^i D_t \quad (10)$$

Gross national product

$$Y_t = \sum_{i=1}^{10} y_t^i. \quad (11)$$

3. Identification results

i	$A_f^{+,i}$	$A_m^{+,i}$	λ^i	$d^{0,i}$, Th.Rubles/year
1	0.005 ± 0.001	0.006 ± 0.001	0.015 ± 0.001	6000 ± 200
2	0.007 ± 0.001	0.007 ± 0.001	0.011 ± 0.001	3000 ± 100
3	0.007 ± 0.001	0.007 ± 0.001	0.011 ± 0.001	3000 ± 100
4	0.008 ± 0.001	0.010 ± 0.001	0.017 ± 0.001	600 ± 20
5	0.008 ± 0.001	0.010 ± 0.001	0.017 ± 0.001	600 ± 20
6	0.008 ± 0.001	0.011 ± 0.001	0.017 ± 0.001	600 ± 20
7	0.011 ± 0.001	0.016 ± 0.001	0.015 ± 0.001	198 ± 5
8	0.012 ± 0.001	0.017 ± 0.001	0.015 ± 0.001	183 ± 5
9	0.015 ± 0.001	0.019 ± 0.001	0.015 ± 0.001	145 ± 5
10	0.025 ± 0.001	0.025 ± 0.001	0.015 ± 0.001	120 ± 5

i	χ_f^i	χ_m^i	κ^i	σ^i	q^i
1	0.5 ± 0.1	0.7 ± 0.1	0.2 ± 0.1	15.0 ± 0.5	0.5 ± 0.1
2	0.5 ± 0.1	0.7 ± 0.1	1.5 ± 0.1	17.0 ± 0.5	0.5 ± 0.1
3	0.4 ± 0.1	0.7 ± 0.1	2.5 ± 0.1	0.5 ± 0.1	0.5 ± 0.1
4	0.7 ± 0.1	0.7 ± 0.1	1.5 ± 0.1	5.0 ± 0.5	0.6 ± 0.1
5	0.7 ± 0.1	0.7 ± 0.1	1.0 ± 0.1	0.5 ± 0.1	0.4 ± 0.1
6	0.6 ± 0.1	0.7 ± 0.1	0.5 ± 0.1	0.5 ± 0.1	0.9 ± 0.1
7	0.7 ± 0.1	0.7 ± 0.1	1.5 ± 0.1	5.0 ± 0.5	0.3 ± 0.1
8	0.7 ± 0.1	0.7 ± 0.1	1.3 ± 0.1	0.5 ± 0.1	0.5 ± 0.1
9	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.5 ± 0.1	0.1 ± 0.1
10	0.5 ± 0.1	0.5 ± 0.1	0.1 ± 0.1	0.5 ± 0.1	1.0 ± 0.1

4. Conclusions

Obvious stratification of the population in addition allows do conclusions how carry out large economic transformations, having answered questions: who and as them will do.

The work is in part supported by the Russian Foundation of Basic Research (Grant no. 08-01-00377, no. 09-01-90201-Mong_a); by Program of Basic Research of Presidium of the Russian Academy of Sciences no.14, and by Program of Basic Research of Section for Mathematics of the Russian Academy of Sciences no.3.