

## DEMOGRAPHIC DYNAMICS: HISTORICAL, POLITICAL AND LEGAL ASPECTS AND STAGES OF SOCIO-ECONOMIC GROWTH

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**Abstract:** The vital needs of man are a system that functions in a stationary mode and is sufficiently stable. At the same time, the cultural forms of satisfaction are dynamic, improving and changing in accordance with economic opportunities, ethnic culture and the cultural era. To a large extent, the energy saturation of these cultural forms (means, conditions, methods) to meet the vital needs of individuals that make up society depends on social differentiation and the specifics of demographic dynamics. On the other hand, the historical stages of economic growth and state of the economy have an impact on socio-demographic processes and the natural movement of the population. All together is in a dense correlation and functional connection, the modelling of which is an important scientific task of practical importance. The examples given in the article illustrate the performance of this model, showing the congruence of the calculated and actual values of the demographic indices. The result of theoretical constructions, which are the basis for the formation of a unified economic and demographic theory, is the established connection between the growth of gross domestic product and the natural movement of the population with an increase in the totality of

consumed values and with their distribution in the direction of population growth or energy saturation of cultural forms, in which satisfy the vital needs of social individuals.

**Keywords:** vital needs, cultural forms of the life activity, economic processes, demographic dynamic, mathematical model, totality of consumed values, scenarios of demographic growth.

## INTRODUCTION

Despite significant advances in human biology, genetics, and physiology, the humanitarian notion of human needs remained at the level of mid-19th century views, with some additions, improvements, and systematization. At that time, reflecting on the rationale for the materialistic understanding of social processes, K. Marx in a joint work with F. Engels "German ideology" noted as the first prerequisite of human existence, that «...people should have the possibility to live... But for the life they need, above all, to food and drink, housing, clothing and something else». From this position followed another: «The second fact is that the very satisfied first need, the action of satisfaction and the already acquired instrument of satisfaction lead to new needs, and this generation of new needs is the first historical act» (Marx, Engels, 1969: 28-29). These provisions, aimed, in fact, only at determining the place of the economic factor in the sum of the causes of social change, seemed so axiomatic that they were in demand even by thinkers who stood on other, non-Marxist, ideological positions. On the other hand, they served as the basis for the formulation of the notorious law of the infinite growth of human needs, from which don't to save neither "reasonable needs of the individual", nor an attempt to lead them to strict system. Realizing that the concept of unlimited growth of needs lead into a dead end, Abraham Maslow made an attempt to curb them and build of the structured pyramid, the lower floor of which is represented by the physiological needs of quenching hunger, thirst, etc., above them are the needs for safety and comfort, even higher are needs for affection and care. The top is crowned with the needs of self-assertion and self-expression (Maslow A., 1954). Of course, "Maslow's pyramid" played a significant role in psychology (mostly theoretical, speculative psychology, but practical studies have not confirmed the existence of such a pyramid (Holliford and Uiddet, 2008: 119)), however, a careful analysis shows that, in fact, it is completely reduced to the vital needs that occur not only in humans, but in general in any biological organism belonging, at least, to the class of mammals. Even the needs which be at the top of the "pyramid" are reduced to the instinctive component of vital activity. For example, the need for a social environment, which Maslow places on the "third floor" of his pyramid, is nothing more than a herd instinct, and the need for knowledge, located at the very top of his pyramid, corresponds to the reflex of explore, without which it is impossible the existence of a biological organism in an aggressive environment (Danilova, Krylova, 1989: 220-221).

Significantly more successful solution to the problem of human needs suggest much earlier than Maslow, Bronislaw Malinowski, who, on the basis of the ambivalent – biological and social – of human nature, present the vital needs in the sum of as the process of organic metabolism. For example, it turns out that there is no need for clothing or home, but there is a need to maintain the temperature balance of the internal and external environment of the body (Malinowski, 1997: 698). This thesis will be adopted as extremely valuable, reducible to the fact that the social nature of man, according to Malinowski, determines the presence of cultural artifacts

created as cultural means and conditions in which the organic metabolism of man as a biological individual. The need for these social conditions Malinowski defines as social needs (Malinowski, 1944: 174), derived from the vital needs. But here, it seems to us, he is a prisoner of linguistic hunger, since the languages we use have not produced a separate, independent concept to refer to cultural forms of satisfaction of vital needs, and the same concept applies to completely various phenomena. A person has no need for, say, «food in General», but there is a need for the body in certain chemical elements necessary for the normal functioning of his body. And so, in fact, in all other respects (Lukichev, 2012). Thus, the law of «unlimited growth» of needs collapses, and the stationary regime of organic metabolism remains, and vital needs acquire certain stability. In other words, they are relatively constant. At the same time, the cultural forms in which they are satisfied are dynamic, and it is not that they, these forms, are constantly growing, but that they are constantly changing along with the level of development of society and with the cultural era. The processes of organic metabolism are the implementation of the exchange carried out by a biological organism, which a person is primarily, substance, energy and information with the external environment. The cultural forms in which they happen, in turn, have a material expression, are energetically saturated and informative. Thus, both it and other according to its material content, as soon in their consideration we pass from the individual to society, turn out to be causally related with the demographic growth and economic condition of society. Thus, the problem of human needs turns into the problem of the sum of the needs of the totality of social individuals that make up society, and therefore leads to the two indicators – the numerical growth of the population and the nature of the functioning of the economic system designed to meet their vital needs in appropriate cultural forms.

## METHODOLOGY OF RESEARCH

Consideration of the problem of demographic growth inevitably leads to turn to the concept of Malthus, in the relation which many times sounded pejorative criticism. Nevertheless, it still has a heuristic attraction for demographers who think about the maximum possible population of the planet, about the carrying capacity of the ecological niche of the humanity, in other words, how much people the planet is able to provide by the necessary products for life. The essence of the idea of the Anglican presbyter is this: God gave man the Earth with all its riches, but these riches are not inexhaustible, so far as the numerical growth of the population, which occurring in a geometric progression, inevitably reaches its limit, and it generates hunger, wars and revolutions (Malthus, 1993). Leaving aside the conclusions and social prescriptions proposed by Malthus, which have always been criticized from the standpoint of humanism and philanthropy, we dwell for beginning on these two provisions: population growth and its limits. About the first, it should be noted that, whatever the point of view on the nature of the mathematical function of demographic dynamics [8], in fact, its trend always remains exponential (Kapitsa, 1996). So, if the population at the beginning of the year (has not of fundamental importance – of region, country or the whole world) is  $S_0$ , and for the year of measurement there were  $n$  births and  $m$  deaths, then at the beginning next year the population will be equally  $S_1$ :

$$S_1 = S_0 + n - m.$$

Simple transformations lead to the following equation:



$$S_1 = S_0 \left( 1 + \frac{n}{S_0} - \frac{m}{S_0} \right) = S_0 (1 + k_n - k_m) = S_0 (1 + k),$$

- where  $k_n = n/S_0$  - is the coefficient of fertility at the year of measurement;
- $k_m = m/S_0$  - is the coefficient of mortality per the same period;
- $k = k_n - k_m$  - is the coefficient of the population growth per year of measurement.

At the time, Euler proved the existence of the limit of such an equation

$$\lim_{z \rightarrow \infty} \left( 1 + \frac{1}{z} \right)^z = e$$

as an irrational number  $e = 2.71828\dots$ . Substituting  $k$  instead of  $1/z$ , we obtain

$$(1 + k)^{1/k} = \sqrt[k]{1 + k} = e$$

And, raising both parts of the equation into the power of  $k$ , we finally have

$$1 + k = e^k.$$

In other words, population growth is represented by an exponential function such that

$$S_1 = S_0 e^{kt}.$$

Obviously, the same formula reflects the dynamics of the numerical growth of any population, not only human, which, however, has limitations in the form of the carrying capacity of its habitat. This brings us to the second position – about the limit of demographic growth. However, in this respect, it makes sense to immediately stipulate that since the very first steps of the existence of *Homo sapiens sapiens* its ecological niche was extremely narrow, and its increase, unlike all other biological beings, is associated with intellectual and labor efforts. As a result, the specificity of the historical change in the nature of demographic dynamics is as follows. The era of the appropriating economy – the society of hunters and gatherers – was characterized by high mortality, which necessitated with an equally high birth rate for preservation of the specie. Accordingly, the population growth was extremely slow, so that only two or three children out of twelve or fifteen children born by a woman during the fertile period, reached puberty, and left offspring themselves. The transition to a productive economy – to the stage of agricultural-pastoral economy, which gave the opportunity to increase the energy saturation of the cultural forms of organic metabolism of social individuals ☐ led to a significant reduction in mortality. However, the dominance of the social attitude "the more children, the more provided old age" required the preservation high level of birth rate. Therefore, the stage of agricultural-pastoral economy was characterized by rapid population growth. The industrial stage of development of the economy to an even greater extent at the expense to material and lasting long existents cultural forms increased their energy saturation, but it not only led to an even more significant reduction in mortality, especially infant and child, but also caused a decrease in fertility (Borisov, 2001: 185-187). Thus, the function of demographic growth takes the shape of the logistic curve (Figure 1).

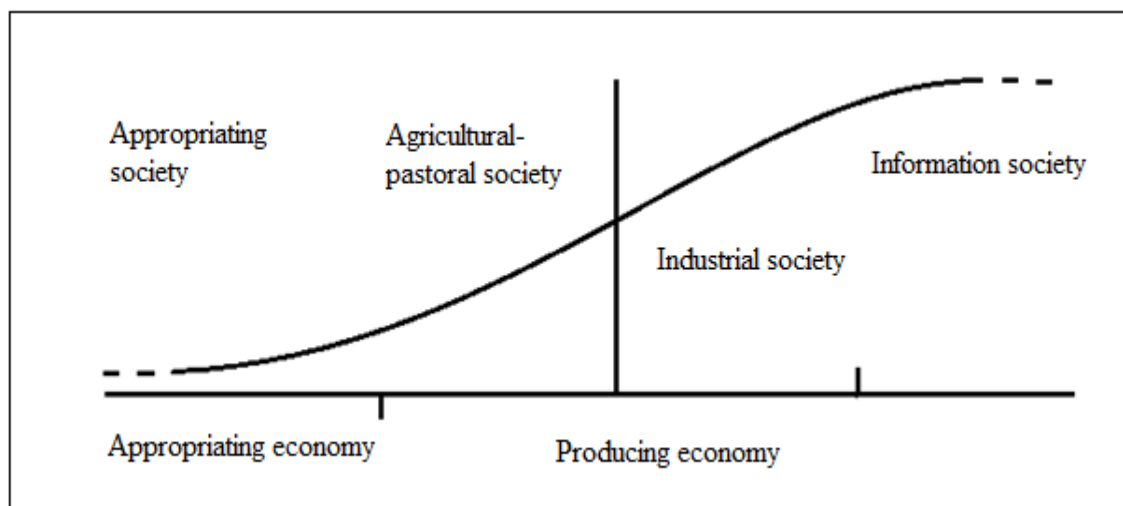


Figure 1. Logistic curve of population growth

The logistic curve occurs if the coefficient, at which the exponential function grows, is constantly decreasing. Algebraic expression of decreasing values of this coefficient as applied to population dynamics is the modified formula Verhulst:

$$k_1 = \ln C_2 \cdot \left( 1 - \frac{S_0 e^{k_0}}{S_{\max_1} e^{q_1}} \right), \quad (1)$$

- where  $k_1$  – is the expected coefficient of population growth in the current year ( $t_1$ );
- $C_2$  – the second constant of social stability, characterizing the ratio of fertility and mortality, corresponding to the stationary mode of functioning of society, and  $C_2 = 1,56...$  (Lukichev, 2017: 204);

- $\left( 1 - P_0 e^{k_0 - q_1} \right)$  – free remainder of ecological niche, and  $P_0 = \frac{S_0}{S_{\max_1}}$ , but

$P_1 = \frac{S_1}{S_{\max_1} e^{q_1}} = \frac{S_0 e^{k_0}}{S_{\max_1} e^{q_1}}$ , accordingly, the value of P can also be characterized as the

value of demographic pressure, and  $P e^{k_0}$  – demographic pressure at the beginning of the year  $t_1$ , and  $P e^{k_0 \ominus q_1}$  – demographic pressure at the end of the year  $t_0$ :

- $k_0$  – coefficient of population growth over the past year ( $t_0$ );
- $S_{\max_1}$  – the volume of the ecological niche of society at the end of the year  $t_0$  or, what is the same, at the beginning of the year  $t_1$ , this volume also has an exponential character of growth, and, in fact, it is the exponentially increase of the volume of the ecological niche of society for the year  $t_1$  that provides the same extended reproduction of the population with the growth coefficient  $k_1$ ;
- $q_1$  – the coefficient of increase of the volume of the ecological niche, which determines the coefficient of growth of the population  $k_1$  in the current year  $t_1$ .

On the other hand, there is a relationship between the coefficient's fertility and mortality (Lukichev, 2017: 229-235) such that

$$(\vartheta - \tau) = \frac{1}{k} \ln \frac{k_n}{k_m} \quad (2)$$

This value, which is the inverse to the average logarithmic value of the coefficient of fertility and coefficient of mortality, is very sensitive to changes of cultural forms in which realises the interaction of social individuals, i.e., in other words, of cultural forms of satisfaction their vital needs and of the level of cultural development in general.

Combining the two formulas, (1) and (2), results in

$$\begin{aligned} \frac{1}{(\vartheta - \tau)_1} \ln \frac{k_{n_1}}{k_{m_1}} &= \ln C_2 \cdot \left( 1 - \frac{P_0 e^{k_0}}{e^{q_1}} \right); \\ \ln \frac{k_{n_1}}{k_{m_1}} &= (\vartheta - \tau)_0 e^{\gamma_1} \cdot \ln C_2 \cdot \left( 1 - \frac{P_0 e^{k_0}}{e^{q_1}} \right); \\ \ln \frac{k_{n_1}}{k_{m_1}} &= (\vartheta - \tau)_0 \cdot \ln C_2 \cdot \left( e^{\gamma_1} - \frac{P_0 e^{k_0}}{e^{q_1 - \gamma_1}} \right), \end{aligned}$$

what is obvious that  $q \approx \tau$  equal to a certain value of  $g$ , or vice-versa  $q = g + \tau$ .

## RESULTS AND DISCUSSION

Thus, formula (1) can be rewritten as

$$k_1 = \ln C_2 \cdot \left( 1 - \frac{S_0 e^{k_0}}{S_{\max_1} e^{g_1 + \gamma_1}} \right)$$

and the values of  $e^q$ ,  $e^g$  and  $e^\tau$  should be interpreted as follows:

- $e^q$  – the rate of energy saturation of each cell of the ecological niche  $S_{\max} = GF$ , including each newly created cell, or – the rate of increase in the volume of the ecological niche, and  $e^q = e^g e^\tau = e^{g + \tau}$ ;
- $e^g$  – the rate of growth of means of organic metabolism of individuals that make up society, and hence the reproduction and expansion of the ecological niche in the form of creating its new cells. Actually – the rate of expansion of the ecological niche of society, the rate of creation of its new cells. That is,  $G$  is a simple reproduction of the achieved level of provision with the necessary product of organic metabolism and the product of turnover used for the next economic period of reproduction, and  $g \approx \tau$  the coefficient of increase in the product of stock, which can be used as a necessary product or product of turnover in the event of such a need or other- materialize in the exercise of reproductive functions in the form of population growth;
- $e^\tau$  – the rate of growth of energy provision for the improvement of cultural forms of organic metabolism, i.e. the rate of increase in excess product, which ensures the development of the integrity of the social system through the process of differentiation of labor, and hence the rate of change of all that provides the growth of excess product – education, science, art, technology, medicine et cetera. Actually – all that is fixed in the material and spiritual form (Bykov, 2017), ensuring the integration of society in the process of organizing social ties and the exchange of

excess product, the production of which it just causes. Ultimately, it is the exchange of excess product that is the condition for improving cultural forms of life activity, representing the deepening of the cells of the ecological niche, their energy saturation, and ensuring the integration of society into an united social system. I.e.  $\bar{I}$  - this is the level of achieved energy saturation of cultural forms of organic metabolism of the individuals that make up society. and  $\gamma$  - the coefficient of growth of the excess product produced by the society, which is converted into cultural forms of life activity.

In the case of the functioning of the social system in a stationary mode, i.e. while maintaining the population growth coefficient constant value ( $k = const$ ), respectively, have  $g = \bar{I} = 0,5k$ . As an example, we give a prognostic calculation of coefficients fertility and mortality for 1913, based on the Zemstvo statistics for 1890-1897. At the time in 50 Orthodox provinces of Russia (Russia: 93) the average annual coefficient of population growth was equal to  $k = 0,01296$  (in shares from unit or 12,96‰):

$$\bar{k} = \frac{1}{t} \ln \frac{S_{1890}}{S_{1897}} = \frac{1}{(1897-1890)} \ln \frac{95126000}{86875000} \approx 0,01296...$$

The calculate value ( $\vartheta - \tau$ ) in 1897 had

$$(\vartheta - \tau)_{1897} = \frac{1}{k} \ln \frac{k_n}{k_m} = \frac{1}{0,01775} \ln \frac{0,0486}{0,03085} \approx 25,6$$

Accordingly, for 1913 we receive

$$(\vartheta - \tau)_{1913} = (\vartheta - \tau)_{1897} \times e^{0,5kt} = 25,6 \times e^{0,5 \times 0,01296 \times (1913-1897)} \approx 28,397...$$

From that we derive the value of the coefficient of mortality in 1913:

$$k_m = \frac{\bar{k}}{e^{(\vartheta - \tau)\bar{k}} - 1} = \frac{0,01296}{e^{28,397 \times 0,01296} - 1} = 0,0291$$

and the value of the coefficient of fertility

$$k_n = \frac{\bar{k} e^{(\vartheta - \tau)\bar{k}}}{e^{(\vartheta - \tau)\bar{k}} - 1} = \frac{0,01296 \times e^{28,397 \times 0,01296}}{e^{28,397 \times 0,01296} - 1} = 0,0421$$

The actual values are: the coefficient of mortality  $k_m = 0,0291$ , and the coefficient of fertility  $k_n = 0,0455$  (Stat. yearbook, 1987: 404). In other words, the reduction of mortality occurred in accordance with the proposed model, but there was no reduction in fertility, it remained at the same level, submitting to the reproductive traditions of the agricultural society. As a result, the rate of branching of the social structure, which under the stationary regime of the demographic process should be in a stable connection with the parameters of population growth, was significantly lower than the required level. Of course, this fact is not the exclusive one cause for the revolutionary events of 1917, but it is one of the factors that caused the social explosion, but the point of the inflection of the logistic function of population growth happen to the second decade of the twentieth century (Figure 2), which is associated with the transition to the industrial stage of development.

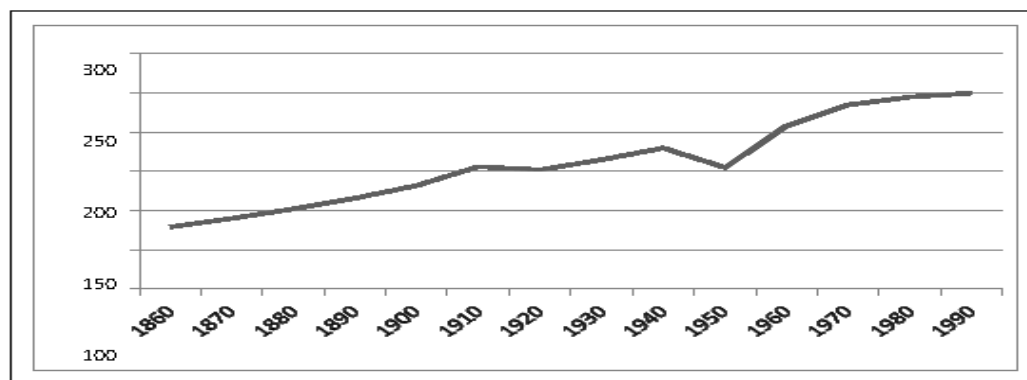


Figure 2. The curve of the demographic growth of the Russian Empire and the Soviet Union.

In fact, the revolutionary dictatorship of the proletariat was aimed at the transition of Russian society to the industrial stage. The idea that improving living conditions should lead to an increase in the population has proved to be an illusion. Reproductive behavior is not associated with either improvement or deterioration of living conditions. It is determined by the social component of culture, in the terminology of Leslie White (White, 1959), which, unlike material and spiritual culture, has the only material carrier the matter of the human brain, i.e. is represented by value norms, attitudes and guidelines, assimilated by individuals in the process of socialization. The factor of their formation is the social environment corresponding to a certain stage of economic growth and the nature of the dominant culture. In the given example of predictive calculation of coefficients of fertility and mortality, we proceeded from the ideal representation of the functioning of the social system in a stationary mode. However, in reality, the coefficients of expansion of the ecological niche of society ( $g$ ) and its deepening due to the improvement of cultural forms ( $\Delta$ ) can strongly deviate from the ideal equality  $g = \Delta = 0,5k$  and even acquire a negative value. So, a negative value of  $g$  can occur when the already created product of reserve turns into an excess product and is subjected to other-materialize in the process of further social differentiation and the production of cultural conditions and means as the forms in which is carried out the organic metabolism of individuals that make up society. However, it may be and so that more than the mortality rate over the birth rate, the energy of the liberated cells of the ecological niche is directed to an increase in the value  $\Delta$ .

On the other hand, the negative value of the coefficient  $\Delta$  may arise, firstly, because of the demographic wave, when a larger at number the generation, reaching puberty, produces more children. In this case, the coefficient  $g$  incorporates the value  $\Delta$ , and new cells of ecological niche created by the negative value of the coefficient  $\Delta$ , i.e. by reduction of requirements to the cultural forms of life activity, or rather - due to deferred «for later» of satisfaction of these requirements. This coincides, in fact, with Kondratiev's economic cycles (Menshikov, Klimenko, 2014), since such a demographic wave rolls every 25-28 years. Second, a negative value  $\Delta$  cause during the economic crisis by dense relations of demography and economy (Lukichev, 2015), however, while maintaining positive values  $g$ . Another example of the efficiency of the proposed model is the prognostic calculation of fertility and mortality coefficients for Russia on 2017 (Gerasimov, Dyatlov, Lukichev, 2018: 70-71). The article containing the disclosure of the model of connection between economic and demographic indicators, based on Rosstat data on gross domestic



product growth and demographic indicators for 2016, was written in early 2017. Calculated according to the model, the coefficient of mortality had a value  $k_m = 0,01290$  and fertility rate  $k_n = 0,01289$ . Accordingly, the coefficient of the population growth rate was negative and equal to  $-0.01\%$ . Real values of coefficients published in 2018, had the values:  $k_n = 0,01289$  and  $k_m = 0,01290$ . Let us return, however, on the other hand to the content of the concepts of necessary and excessive product, referring to the French physiocrats (Kene, 1960; Tyurgo, 1961) and Russian socialists and sociologists of the late XIX early XX centuries (Michailovsky, 2010; Kovalevsky, 2012) as a source of ideas and definitions. «Necessary product» should be considered in a broad sense as:

- actually necessary product consumed during the year for the simple reproduction of social individuals (without taking into account their age and sex difference, i.e. in the form of some average value; as an example, for the temperate zone it is 2 700 kcal per day consumed in the form of food and drinks);
- the product of turnover necessary for the reproduction of production (i.e., this is the part of the product that provides the next production cycle);
- the reserve product which necessary for the realization of production purposes and returning to the production process as a necessary product and a product of turnover in the case of lean years, when the result of labor is not enough to cover the organic reproduction of social individuals and the creation of the product of turnover.

Thus, excessive product is a product that arises due to the impossibility of storing the reserve product indefinitely in its natural form without losing the original quality. For this reason, it requires its other-materialize, including and primarily in cultural means and conditions, providing, for example, cooking and an acceptable balance of temperatures of the external and internal environment in the form of clothing and heat (or cooling), etc. In relation to this concept excess product must also say the following. First, for it to appear, a certain technological level of development must be achieved, in which the product of the reserve turns out to be some of its excessive part. However, society cannot afford such a luxury as its aimless spoiling and the disappearance of the invested in its production of human labor. Secondly, the introduction of this concept makes it possible to explain why, with the low technical equipment of agricultural labor, its products can be sold at their cost and even below it. The fact is that at this level of production, when manual labor is mainly used in the prevailing natural economy, its result is used almost exclusively as a necessary product, a product of turnover and a product of reserve, and remains periodically the excess product which for its direct producer has not consumer value. Therefore, it may even be alienated from it for legal reasons or through violence (for example, in the form of a payment or tribute) without any compensation at all, or with compensation in the form of a guarantee of protection against any external threat without significant material damage to the producer. Third, the need to preserve the human labor invested in the excess product makes it necessary to transform it from its natural state into a form that has a longer existence. For this to be realized, a part of social individuals must be excluded from the process of direct production of the necessary product (in the broad sense of this concept that is, including the product of turnover and the product of reserve). For these individuals, the excess product is, in fact, a necessary product that provides their organic metabolism in the cultural forms accepted by society, but through their labor craft (industrial), intellectual and emotional (scientific, pedagogical, medical-

pharmacological, administrative, in the field of art, etc., etc.) the excess product is transformed into cultural forms (means, methods, conditions) of the organic metabolism of all individuals that make up society.

Thus, the presence of excess product provides social differentiation, both «horizontal» by types of professional activity, and «vertical» by hierarchy of social strata. This approach gives the opportunity to introduce another concept the total of the consumed values (TCV) and to compare it with the generally accepted today, the concept of gross domestic product (GDP). And if the GDP includes the entire amount of goods and services produced by the society (Kuznets, 1926), then the TCV entire volume of values consumed for the purpose of expanded reproduction of the society. This concept, therefore, includes all the factors necessary for the reproduction of production, reproduction in all their diversity of connections of the social system and, of course, its constituent individuals as biological and social subjects of life activity. In this case, all means of society are taken into account, including those that went to cover imports, as well as investments from outside as included in domestic consumption for the country, and even the export of material (and not only) values in the amount of financial resources extracted from this, which remain in domestic circulation. The only exceptions are funds withdrawn from circulation within the country and are not involved in further ensuring the needs of the population, trade and production. They either represent a another-out-materialized excessive product stored as the product of reserve or exported abroad, and mostly for this society lost forever. In other words, the TCV (the total of the consumed values) is represented by its two parts. One of them goes to ensure the organic metabolism of individuals that make up society. The other provides the conditions and means that as cultural forms are involved in the processes of organic metabolism. In other words, TCV in its incremented part, i.e. as TCV, includes an increase in the necessary (in the broad sense) and excess product. And what is more, in a closed society will take place equality  $\Delta \text{GDP} = \Delta \text{TCV}$ , i.e. for each fraction of the increment of GDP take place the corresponding share of the increment of total consumed values. Naturally, in an open social system, although the correlation remains, but the degree of correlation will be much lower. The difference between the increment of the totality of consumed values and the increment of gross domestic product in this case is significant. So, if there is a positive value of their difference  $\Delta \text{TCV} - \Delta \text{GDP} \geq 0$ , then, therefore, in the GDP does not consider the funds introduced into the internal turnover. On the contrary, if the difference is negative, i.e.  $\Delta \text{TCV} - \Delta \text{GDP} \leq 0$ , then there is an outflow of capital or the conclusion of circulation such that it is already temporarily or never involved in the process of reproduction of society. Thus, the value  $\Delta \text{TCV}$  appears as the sum of the coefficients of  $g$ - of the coefficient of growth necessary (in the broad sense) of the product and  $\Delta \text{TCV}$  of the coefficient of growth of excess product taken in absolute values:

$$\Delta \text{TCV} = \pm(|\gamma| + |g|).$$

The value of the coefficient  $g$  is set as the difference between the coefficient of expansion of the ecological niche of the population  $q$ , determined by the previous and subsequent coefficients of population growth and the natural logarithm of the «second constant of social stability», equal to  $C_2 = 1,56$ :

$$g = q - \gamma;$$

$$q = k_0 - \ln \frac{\ln C_2 - k_1}{\ln C_2 - k_0},$$

where  $k_0$ - is the coefficient of the population growth in the previous year  $t_0$ ;  $k_1$ - is the coefficient of the population growth in the following year  $t_1$ . In turn, this enables to determine the critical value  $\Delta TCV_{critic.}$  by the assumption that the coefficient of the population growth in the following year  $t_1$  is equal to zero. Then, if  $\Delta TCV \geq \Delta TCV_{critic.}$  the coefficient of the population growth in the next year  $t_1$  will be positive, if  $\Delta TCV < \Delta TCV_{critic.}$  the coefficient of the population growth will be negative. By cause correlation  $\Delta TCV$  and  $\Delta GDP$  in all cases but one

$$\Delta TCV_{critic.} = k_0 + \ln \frac{\ln C_2 - k_0}{\ln C_2} - 2\gamma_1.$$

However, when positive  $\gamma$  and when a positive value  $\Delta GDP$  ( $\Delta TCV \geq 0$ ) then

$$\Delta TCV_{critic.} = 2\gamma_1 - \left( k_0 + \ln \frac{\ln C_2 - k_0}{\ln C_2} \right).$$

Table 1. Comparison of the data GDP growth and  $\Delta TCV$  changes

Year	$\Delta GDP$ %	$\Delta TCV$ %	$\Delta TCV - \Delta GDP$ %	$q_1$ in fractions of «1»	$\gamma_1$ in fractions of «1»	$k$	$\Delta TCV_{critic.}$ %
1990	- 2,8	-4,5	- 1,7	0,00005067	0,02270428	0,0022	-5,03
1991	- 4,9	-8,8	- 3,9	-0,0011842	0,04333111	0,0007	-8,94
1992	- 14,5	- 5,8	8,7	-0,0042429	0,02700205	-0,0015	-5,49
1993	- 8,8	- 4,8	4,0	-0,0095360	-0,0287656	-0,0051	5,94
1994	- 14,9	- 9,8	5,1	-0,0073208	-0,0524211	-0,0061	11,11
1995	- 1,6	- 8,4	- 6,8	-0,0052123	0,03927318	-0,0057	-7,10
1996	- 3,6	- 10,4	- 6,8	-0,0048115	0,04977193	-0,0053	-9,25
1997	1,4	-7,5	-8,9	-0,0048554	0,03511088	-0,0051	6,37
1998	- 5,3	- 0,9	4,4	-0,0044323	-0,0067037	-0,0048	1,97
1999	6,4	2,3	- 4,1	-0,0083533	-0,0154456	-0,0064	3,68
2000	10,0	7,9	- 2,1	-0,0068433	-0,0431343	-0,0066	9,42
2001	5,1	4,5	- 0,6	-0,0066000	-0,0259386	-0,0066	6,00
2002	4,7	10,3	5,6	-0,0063784	-0,0547474	-0,0065	11,76
2003	7,2	5,4	- 1,8	-0,0058349	-0,0297147	-0,0062	6,74
2004	7,2	-1,4	- 8,6	-0,0048684	0,00442940	-0,0056	0,12
2005	6,3	-1,7	- 8,0	-0,0062660	0,00557393	-0,0059	-0,42
2006	8,2	$\Delta$ 4,7	$\Delta$ 12,9	-0,0034557	0,02173721	-0,0048	-3,62
2007	8,5	3,5	$\Delta$ 5,0	-0,0014573	-0,0181243	-0,0033	4,22
2008	5,2	6,4	1,2	-0,0015126	-0,0328628	-0,0025	6,98
2009	$\Delta$ 7,9	$\Delta$ 0,5	7,4	-0,0009334	0,00226019	-0,0018	-0,14
2010	4,5	0,6	$\Delta$ 3,9	-0,0015760	-0,0038587	-0,0017	1,00
2011	4,3	$\Delta$ 4,3	$\Delta$ 8,6	0,0000938	0,02175862	-0,0009	-4,14
2012	3,4	3,4	0	0,0011218	-0,0164402	0	3,40
2013	1,3	1,0	$\Delta$ 0,3	0,0004498	-0,0046305	0,0002	0,93
2014	0,7	0,02	$\Delta$ 0,7	0,0002	0	0,0002	0,02
2015	$\Delta$ 2,8	$\Delta$ 0,02	$\Delta$ 2,8	0,0002	0	0,0002	-0,02
2016	$\Delta$ 0,2	$\Delta$ 0,72	$\Delta$ 0,52	0,0004250	0,00382057	0,0003	-0,79

You can put also that the developed model can serve as a way to check the statistical data on growth of gross domestic product, and to help the formulation and implementation of economic policy, which involves the integration of society and not provoke the conflict of the civil society and the state and the clash of interests of different social strata. On the other hand, these provisions make it possible to build a forecast and appropriate possible scenarios for the development of the demographic situation, based on the available data and their connection with economic growth.

## CONCLUSIONS

The logistic curve of population growth means that not only does the coefficient of the growth ( $k$ ) decrease, but also that it occurs with a constant decrease of the coefficient of the expansion of the ecological niche of the society ( $q$ ). With the constant growth of GDP and, accordingly TCV, this is possible only under the condition that in most cases there will be a positive value of the coefficient  $\square$ , i.e. there will be further improvement and complication of cultural forms of life activity at the expense of the numerical growth of the population, which in many countries can become negative. As an example of the decline in the total fertility rate with industrial development, the following data can be cited: in 1897 in Russia it was equal to 7.46 children per woman of the fertile period, in 1925 in the USSR - 6.78, in 1955 - 2.99, in 1980 - 1.87, in 1999 - 1.17. The current value of the total fertility rate in Russia does not look as bad as in 1999. Thus, in 2017 it was equal to 1.62 and in 2018 - 1.58. The same is true for TFR in other countries of the world. For example, in the United States in 2007, it was equal to 2.12 children per woman of the fertile period, which in principle is the demographic norm for simple demographic reproduction, but in 2014 it has already decreased to 1.86. In Muslim Iran, the total fertility rate in 2018 was 1.6. In Japan, the most advanced information society, the total fertility rate in 2015 was 1.41. A feature of the information stage of civilization development is a significant energy content of the cells of the ecological niche, i.e., in fact, the complication of cultural forms of life activity. This, on the one hand, provides a sharp reduction in infant and child mortality, which makes "demographically meaningless" the presence of many children in the family. On the other hand, the interiorization to the individual in the process of socialization of cultural norms, values and knowledge necessary to take a worthy place in life in the future, requires from the parents of the child incredible efforts and means, and in fact more efforts than of material funds and financial means, which infringes on their own cultural forms of life activity and professional growth, and this makes it impossible for them have a large number of children. As a result, indigenous populations in post-industrial countries and countries in transition to the information stage of development will be reduced by 20-30 per cent by the end of the twenty-first century. This means that if the same social structure is maintained, 20-30% of its places will be freed. This trend allows us to talk about at least three scenarios for the future of civilization.

The first variant is that the demographic growth of the ethnically indigenous population keeps the character of the logistic curve. However, migrants from areas with shorter life expectancy will perceive the free remainder of the ecological niche of the area, of populated by a population with longer life expectancy and low fertility, as larger in volume. In force that, the first scenario is combined with the second scenario. The second scenario is that the function of demographic growth remains logistical, but only because the empty toposes (places) of the social structure will be

occupied by migrants. Migration in this case will occur from regions with greater levels of fertility and lesser life expectancy in countries and regions with a lower birth rate and higher life expectancy. And it will be both internal and external, but due to the difference in cultures and norms of behavior of indigenous and migratory populations will lead to increased ethnic and religious conflicts, which, in turn, will be accompanied by an increase in extremism. The third scenario will be characterized by a change in the logistic curve of demographic growth on downward part of the parabolic function with a constant decrease in the population of the countries of the information stage of development. In this case, the replacement of the empty toposes of the social structure will be carried out by technical devices that replace social individuals in the performance of social functions. However, it will be not only the CF-society (in the terminology of A. Asimov), but also the society of the CHF, in which consumerism, hedonism and feminism will be in the first place among the life values (the latter will be determined by the «liberation of women» from the functions of childbirth and infant care). This scenario does not exclude conflicts, on the contrary, there will be an increase in the conflict of traditional values with the values of the so-called «liberalism». These scenarios do not exclude, but rather complement each other, but only mean that we are entering an era of prolonged confrontation of spiritual, moral and cultural values, a crisis of family and social organization in general.

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