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HERBERT SPENCER: THE UNRECOGNIZED FATHER OF THE THEORY OF DEMOGRAPHIC TRANSITION

ANATOLY VISHNEVSKY

It is believed that the central idea of the theory of the demographic transition from an equilibrium of high to an equilibrium of low mortality and fertility was formed and became generally recognized in the middle of the twentieth century. The article shows that this idea was developed by Herbert Spencer a hundred years before, although modern demographic transition theorists never refer to him as their predecessor. The main task of the article is to bring Spencer's arguments to the current debate about the present and the future of fertility, based on the premise that these arguments not only are not outdated, but are even today largely ahead of our time. The article does not deny Spencer's misconceptions about the mechanism of fertility decline in human society, but as to the causes of this decline, the higher level of generalization inherent in Spencer's scientific worldview predetermined an understanding of these causes deeper than that developed by modern theoretical demographers.

***Key words**: Spencer, demographic transition, mortality, fertility, ability to maintain life, ability to multiply, antagonism of reproduction and individualization, law of maintenance of races, equilibrium, causes of fertility decline, pro-natalist policy.*

As the famous Italian scientist and statesman Francesco Nitti claimed in the late nineteenth century, "Herbert Spencer only has the merit of being the first to formulate a broad sociological theory of the population, a theory which, though we do not accept it without completion and modification, is still, in the history of theories on population, a marvelous monument of the acumen and perspicacity of the great English sociologist "(Nitti 1894: 56-57).

Such a high estimation of Spencer's contribution to population theory contrasts sharply with the place that historians of demographic thought assign to him today. In a multi-volume compendium on demography, in a chapter on the history of demographic thought, out of 65 pages Spencer is given less than 6 lines - among other supporters of the disreputable "biological approach" (Vilquin 2006: 21).

Meanwhile, Spencer's views deserve much more attention from demographers, and not as a historical relic, but as a set of ideas far ahead of their time and capable of occupying an important place in modern demographic theory. This is especially true when it comes to the theoretical comprehension of what is almost the main problem of theoretical demography today - the problem of low fertility.

Spencer once remarked that "inquiring into the pedigree of an idea is not a bad means of evaluating its value" (Spencer 1891a: 108). The main explanatory construction on which the scientific interpretation of modern demographic processes rests has long been the theory of the "demographic revolution" or "demographic transition". It too has its own pedigree, of which, as I try to show in this article, Spencer's views are an important, but, unfortunately, undervalued part.

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The concept of demographic transition has grown, above all, from the desire to comprehend the nature of low fertility, a relatively new phenomenon that made itself felt for the first time in the nineteenth century, initially in France and later in other countries of European culture. The formation of this concept is usually dated to the first half of the twentieth century. Its pioneers are considered to be the Frenchman Adolph Landry and the American Warren Thompson, and its definitive formulation is associated with the name of Frank Notestein and his colleagues, who worked at Princeton in the 1940s-1950s. J. Caldwell believed that "modern demographic transition theory was born almost in mature form in a paper written by Frank Notestein in 1945" (Caldwell, 1976: 323). As for me, I think that the basic ideas of the concept of the demographic transition were formulated by Spencer a hundred years before Notestein and, most importantly, at a higher level of generalization. Meanwhile, the name of Spencer is not mentioned by theorists of the demographic transition, is never found even in thick books devoted to this important historical process (see, for example, Chesnais 1992, Caldwell 2006).

According to the views of the Princeton demographers, as formulated by F. Notestein in 1945, "the whole process of modernization in Europe and Europe overseas brought rising levels of living, new controls over disease, and reduced mortality," while fertility remained high, which led to rapid population growth. But by the end of the interwar period fertility in European countries had dropped even below the replacement level corresponding to the new level of mortality, while other countries had "scarcely begun their demographic transition" (Notestein 1945: 40-42), and "there is no reason that the writer knows for assuming that other regions can achieve their demographic transition without an analogous period of rapid population increase". Nevertheless, this period would be transient, because "the control of mortality without the control of fertility is impossible", and "fertility is to fall substantially to bring in sight the end of the epoch of growth." (Ibid.: 57).

It was then that the term "demographic transition" first appeared, in the title of an article whose author, K. Davis, had developed the same ideas as Notestein (Davis 1945). The industrial revolution and the changes that accompanied it had led to a rapid decline in mortality, followed by a decline in fertility and, ultimately, the establishment of a "new demographic balance." But as the decline in fertility lagged behind the decline in mortality, a gap appeared between them, which led to a huge increase in the European population. This stage turned out to be temporary, the decrease in fertility "catching up with" and sometimes even "overtaking" the decrease in mortality, so that the population in the countries of Western Europe again stabilized or began to decrease. But as the decline in mortality had now spread to countries of non-European culture, the demographic explosion shifted there too, due to the lag between declining mortality and fertility. However, here again this lag is a temporary phenomenon, and "it seems likely, then, that the next century will see the peak of the world's population growth reached and the new demographic balance spread throughout the world" (Davis 1945: 11).

All these ideas, generated by the attempt to understand the European and global demographic situation of the middle and second half of the twentieth century, seemed very new, yet here is what Herbert Spencer wrote almost a hundred years before, in the middle of the nineteenth century, when this situation did not exist, before even the word "Demography" had been coined.

“Evidently, so long as the fertility of the race is more than sufficient to balance the diminution by deaths, population must continue to increase... Hence, the change can never cease until the rate of multiplication is just equal to the rate of mortality; that is—can never cease until, on the average, each pair brings to maturity but two children” (Spencer 1852: 500). (In a later formulation: “until, on the average, each pair has as many children as are requisite to produce another generation of child-bearing adults, equal in number to the last generation” (Spencer 1891b: 504). In the very last formulation, it is a matter of “approaching an equilibrium between his nature and the ever-varying circumstances of his inorganic environment, and in approaching an equilibrium between his nature and all of the requirements of the social state, Man is at the same time approaching that lowest limit of fertility at which the equilibrium of population is maintained by the addition of as many infants as there are subtractions by death in old age” (Spencer 1910: 538)).

"Probably this involves that *each pair will rarely produce more than two offspring* (my emphasis, AV); seeing that with the greatly-increased ability to preserve life, which the hypothesis presupposes, the amount of infant and juvenile mortality must become very small” (Spencer 1852: 501). This conclusion of 1852 was also somewhat reformulated subsequently. “Though the number of premature deaths may ultimately become very small, it can never become so small as to allow the average number of offspring from each pair to fall so low as two. Some average number between two and three may be inferred as the limit—a number, however, which is not likely to be quite constant, but may be expected at one time to increase somewhat and afterwards to decrease somewhat, according as variations in physical and social conditions lower or raise the cost of self-preservation” (Spencer 1910: 535).

As we can see, Spencer's assessment of the level to which fertility may drop changed somewhat (although not fundamentally). But the general idea of the inevitability of a transition from an equilibrium of high mortality and high fertility to an equilibrium of low mortality and low fertility, that is, what is now understood as the "demographic transition", is expressed quite clearly.

This transition includes the most diverse aspects of changes in demographic reality, and, as a rule, quite important ones. They all draw the attention of theoretical demographers. But perhaps the most difficult have always been issues related to the understanding, interpretation and forecasting of fertility trends. In the most general form, they come down to two fundamental and interrelated issues, one concerning the *causes* of the decline in fertility, the other the *limits* of such a decline.

Spencer gave his own answers to both questions, but in this article only the first of them is considered – Spencer’s explanation of the *causes* of the decrease in fertility he predicted. His explanation, it seems to me, not only has not lost its significance, but can compete quite successfully with most of today's explanations of the decline in fertility in the process of demographic transition.

The second question is no less important, but requires separate consideration.

THE CAUSE OF THE DECLINE IN FERTILITY ACCORDING TO SPENCER

As D. van de Kaa rightly noted, the assertion that modern demographic transitions (he speaks of two transitions – the "first" and the "second") should be viewed as the result of social changes is a truism. Obviously, “at the heart of the matter can be nothing else than changes in the structure, culture, and technology of the societies experiencing the transitions. But what, precisely, is it that generated the demographic changes? What were the crucial factors involved?” (van de Kaa 2010).

Van de Kaa tried to catalog the available answers to these questions and came to the conclusion that there is a huge number of "anchored narratives" explaining the transition from different positions and pointing to different "factors" and "determinants" of declining fertility which, while not contradicting reality, do not add up to a general explanation. In this regard, he recalls the famous film of Akiro Kurosawa, "Rashomon", in which different people set out different versions of the same event they had observed.

More general narratives break up into sub-narratives, so that "the quest for the determinants of fertility behavior and change during the last half-century can best be interpreted as the development of a series of sub-narratives from different disciplinary perspectives and orientations" (van de Kaa 1996: 389). Van de Kaa does not deny the utility of a large number of sub-narratives for understanding specific features of place and time, but believes that it "is unlikely to be so in the search for the 'true' or 'fundamental' driving forces behind the transition" (Ibid.).

Many narratives have a hierarchical structure, and there is a connection between their place in the hierarchy and the degree of generalization contained in them: the higher the place, the higher the potential of generalization. "The extremes obviously lie between a choice for a very general explanation of levels and changes of fertility in terms of technology / biology, structure and culture, and a very specific explanation for a particular occurrence in a small area, where the effects of path-dependency and institutional change may well dominate" (Ibid: 429).

As concerns the highest levels of generalization, those claiming a greater or lesser universality in the explanation of the transition to low fertility, modern theoretical demographers, for the most part, associate this transition with the universal processes of "modernization" or "westernization," with the industrial revolution, industrialization, urbanization, the growth of education (including of women), the spread of wage labor, "post-materialistic values," the growth of gender equality and so forth. The observed facts universally confirm the existence of such links, which, as the researchers believe, proves that the decline in fertility was caused by all the above-mentioned social and economic processes. But how could Spencer come to the conclusion that “each pair will rarely produce more than two offspring” at a time when the social processes just listed – and not all of them at that - had barely taken shape?

The answer lies in the fact that the level of generalization of Spencer's "narrative" was the highest of all possible ones, and the conclusion he obtained did not need any sub-narratives.

Spencer's article "A Theory of Population, deduced from the General Law of Animal Fertility" (Spencer 1852), which formulates this conclusion, indicates already by its name that it relies less on the experience of human society than on that of nature. The article was published seven years before the appearance of Darwin's *Origin of Species*, but it clearly expresses the idea of the evolution of life forms from the simplest to the human, and accordingly, the evolution of

two inseparable fundamental functions of any of these forms: the reproduction of the species and the development of the individual. These functions are always in inverse relationship. In Spencer's terms, this is the "antagonism between individuation and reproduction". "When, from lowness of organization, the ability to contend with external dangers is small, there must be great fertility to compensate for the consequent mortality; otherwise the race must die out. When, on the contrary, high endowments give much capacity to self-preservation, there needs a correspondingly low fertility" (Spencer 1852: 476).

In this coordinate system, Spencer considers the processes of reproduction not only in nature, but also in society. The basic idea is that in the simplest organisms the processes of vital activity and reproduction are not differentiated; reproduction is the goal of life activity, and with it life ends. As the forms of life become more complex, reproduction becomes a separate function and occupies an ever-decreasing place in life activity, making room for the development of other specialized functions, and hence for the improvement of individual organisms.

Building on these considerations, Spencer came to profound generalizations concerning the relationship and development of all living things, and formulated his "axiomatic" law of maintenance of races. "Whilst any race continues to exist, the forces destructive of it and the forces preservative of it must perpetually tend towards equilibrium. If the forces destructive of it decrease, the race must gradually become more numerous, until, either from lack of food or from increase of enemies, the destroying forces again balance the preserving forces. If, reversely, the forces destructive of it increase, then the race must diminish, until, either from its food becoming relatively more abundant, or from its enemies dying of hunger, the destroying forces sink to the level of the preserving forces. Should the destroying forces be of a kind that cannot be thus met (as great change of climate), the race, by becoming extinct, is removed out of the category. Hence this is necessarily the law of maintenance of all races; seeing that when they cease to conform to it they cease to be" (Ibid: 475).

Although social life for Spencer is not the same as biological, it too is subject to general "laws of organization" including the law of maintenance of races. This law, according to Spencer, holds true for man, too.

The logic of his reasoning, at first glance, resembles the logic of Malthus, but in fact is very different. The difference is already in the starting point. Malthus proceeded from the fact that throughout the entire period of human existence mortality had not changed. "It may be fairly doubted whether there is really the smallest perceptible advance in the natural duration of human life since first we have had any authentic history of man". "With regard to the duration of human life, there does not appear to have existed from the earliest ages of the world to the present moment the smallest permanent symptom or indication of increasing prolongation" (Malthus 1998: III.1.14, III.1.18).This gives the population law of Malthus an extra-historical character. The population always grows faster than the means of subsistence, which, in fact, makes high mortality inevitable. His calls for a decrease in fertility are not tied to any historical changes, but are a universal recipe for all times.

For Spencer, this is not right, or in any case not quite right. For him the law of maintenance of races is a historical law because in society as well as in nature the ability to multiply is antagonistic to the ability to maintain individual life, and with the development of society, these

abilities vary inversely, so that due to the universality of laws of organization the contradiction between the reproduction of the species and the development of the individual at each new stage of evolution is resolved in an increasingly effective way (i.e., increasingly in favor of the *development* of the individual). “On the whole, civilization increases the ability to maintain life”, and “increased ability to maintain life in this case, as in all others, necessarily involves decreased ability to multiply” (Spencer 1852: 496) – and in the long run a decline in fertility.

What is important is that Spencer needs no "narratives" to explain the decline in fertility, no reference to *specific determinants or factors* of this decline. It is simply a manifestation of the *a priori* "law of maintenance of races", which initially assumes a dynamic equilibrium of "destructive" and "preservative" forces to which any living being is exposed. Spencer derived this law by generalizing the facts known to him about the evolution of life on Earth, and if we agree with this generalization, then we cannot ask *why* life is arranged just so, just as we cannot ask *why* two times two is always four. The existence of this objective law is the only *cause* of the decline in fertility. The antagonism of reproduction and individualization not only fully corresponds to the *a priori* law of maintenance of races, which is true for all "from monad to man", but, constantly evolving and taking on new forms, ultimately “ensures the final attainment of the highest form of this maintenance—a form in which the amount of life shall be the greatest possible, and the births and deaths the fewest possible” (Ibid: 475).

THE MECHANISM OF FERTILITY DECLINE ACCORDING TO SPENCER

If anything needs an explanation, it is not the *cause* of the decline in fertility, but its *mechanism*. Not *why*, but *how* there is a decrease in fertility, when it is required to maintain the necessary balance - that is the question Spencer is also trying to answer. What happens to a human being’s ability to reproduce when his ability to preserve life increases?

The chain of reasoning Spencer traces is as follows. A decline in mortality makes the former fertility excessive, and "excess of fertility entails a constant pressure of population upon the means of subsistence" (Ibid: 498). The growing pressure of the surplus population creates incentives for the development of production, education and science, generates "an increasing demand for skill, intelligence, and self-control" (Ibid.). “The contrast between a Pacific Islander, all whose wants are supplied by Nature, and an Englishman, who, generation after generation, has had to bring to the satisfaction of his wants ever-increasing knowledge and skill, illustrates at once the need for, and the effects of, such discipline. And this being admitted, it cannot be denied that a further continuance of such discipline, possibly under a yet more intense form, must produce a further progress in the same direction—a further enlargement of the nervous centres, and a further decline of fertility” (Ibid.: 499). Spencer understands "enlargement of the nervous centers" *ad litteram*, in the physiological sense, and to prove his idea even makes a comparison of brain sizes in representatives of "more civilized" and "less civilized" races. All of Spencer's arguments are essentially a continuation of his reflections on the fact that "throughout the vertebrate tribes the degree of fertility varies inversely as the development of the nervous system" (Ibid.: 493), "the ability to maintain individual life *is in all cases measured by the development of the nervous system”,* so that "if the nervous system varies directly as the ability to maintain life, it *must* vary inversely as the ability to multiply"(Ibid.: 496).

Today, hardly anyone thinks that the now widespread low fertility is explained by people's lowered physiological fecundity and an appeal to the capabilities of the nervous system of the human body suggests exactly this explanation. Perhaps this is why Spencer is labelled "a representative of the biological approach" and pushed to a distant shelf of the museum of the history of demographic thought.

But while one can agree that Spencer's explanation of the *mechanism* of the fertility decline does not stand up to criticism and has been forgotten for good reason[1], his explanation for the *causes* of this decline is another matter. It's too early to send him off to the museum.

"SPENCER'S LINE" IN MODERN DEMOGRAPHIC THEORY

According to Spencer, a decrease in fertility is a legitimate response to an "increased ability to maintain life", i.e. to reduce mortality. Now the connection between decreasing fertility and decreasing mortality is obvious, but it was not realized right away, just like the very fact of a steady decline in mortality - a phenomenon that only manifested itself in the nineteenth century. According to Chesnais, already in the mid-nineteenth century this connection drew the attention of the inventor of the word "demography", Achille Guillard, so that even then "the idea of the mechanism of the transition was thus already germinating" (Chesnais 1992: 3). Curiously, Chesnais does not mention Spencer, who had expressed this very idea with great clarity. But on the whole, ideas about fertility and mortality trends and their connection with each other remained for a long time quite vague.

As, for example, Nitti wrote at the end of the nineteenth century, "The increase of the German birth-rate has assumed the form and dimensions of real overpopulation (Übervölkerung) during the last past century, but still more so during the last twenty years. <…> The masses of people have become improvident, and have abandoned themselves by reason of an inevitable and fatal necessity to an abundant and disordered multiplication" (Nitti 1894: 40-41). Nitti was referring to German authors. Meanwhile, there was no growth in the birth rate in Germany in the second half of the nineteenth century. On the contrary, the birth rate was decreasing, but the mortality rate was decreasing even faster, which caused the acceleration of population growth (Figure 1). In the early twentieth century, when there was greater awareness of the demographic changes, "authors such as Wolf (Wolf 1912), analysing possible causes of the decline in German fertility, focused, in the first place, on improved trends in mortality" (Chesnais 1992: 3).

[1]However, here too it is necessary to make serious qualifications, in a certain sense rehabilitating Spencer. Although the main mechanism for reducing fertility in all developed countries has undoubtedly become a socially determined "birth control", researchers also note a significant decrease in physiological fertility in all countries that have made the demographic transition. In particular, recently a group of researchers from different countries, having carried out a meta-analysis of several thousand English-language publications from 1981–2013, concluded that the number of spermatozoa in the male sperm was systematically declining: It «declined significantly among men from North America, Europe and Australia during 1973–2011, with a 50–60% decline among men unselected by fertility, with no evidence of a 'leveling off' in recent years» [Levine et al. 2017: 654].

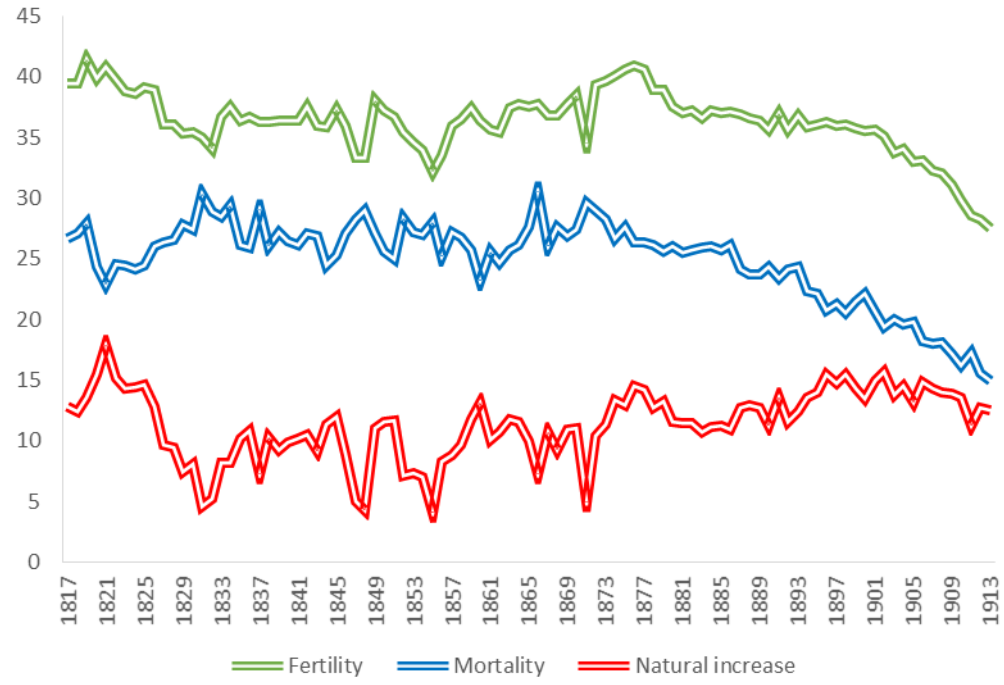

Figure 1. Fertility, mortality and natural population increase in Germany, 1817-1913, ‰

Source: (Chesnais 1992, Appendices 1, 3).

By the middle of the twentieth century, the dependence of the decline in fertility on the decline in mortality had become widely recognized. The transition from an equilibrium of high mortality and high fertility to an equilibrium with a low level of both is the main postulate of the concept of the demographic transition (demographic revolution), which ever since has been central to theoretical demography. This transition was recognized as an essential element of progress, because the new balance between fertility and mortality, "a balance less wasteful than the old" (Davis 1945: 1), had led to a sharp increase in the effectiveness of demographic and therefore all social reproduction. “The new type of demographic balance released a great amount of energy from the eternal chain of reproduction – energy that could be spent on other aspects of life” and thus signified an “astounding gain in human efficiency” (Ibid: 5). I do not know whether Kingsley Davis was familiar with Spencer's ideas, but the quoted words fully correspond to the latter's ideas about the historical development of the antagonism between reproduction and individualization and a change in their balance in favor of individualization.

DEVIATION FROM "SPENCER'S LINE" IN MODERN DEMOGRAPHIC THEORY

It would seem that the issue of lower mortality as the cause of the huge decline in fertility – from the traditional 6-8 or even more births per woman to the current 1-3 – is absolutely clear. Nonetheless, since the times of Landry there has existed – and it is much more widespread today – another approach, whose supporters, while not denying the significance of the decline in mortality, still consider it insufficient to explain the decline in fertility. "In the past, <...> births in the family could be numerous: so many children died that large families were far from frequent; today, with such fertility, large families would become the rule. But can this explain the decline in

fertility? Is it enough to argue that unfettered reproduction has now spawned not only a relatively low risk of greater family spending, but the probability of such a great strain that it would result in reproductive restraint? This appears not to be the case" (Landry 1982: 37-38). "Another explanation must therefore be sought" (Ibid: 39). Landry insistently stressed the insignificance of the effect of declining mortality. "It is commonly believed that it is possible to compensate for the effects of declining fertility with reductions in mortality. This idea is incorrect… What we can gain through mortality decline for reproduction – the most fundamental demographic factor – is limited, and quite severely so" (Landry 1987: 739-740).

It cannot be said that Landry's line of reasoning looks convincingly grounded, but more than one generation of demographers have followed precisely his logic, which in itself seems strange. Demographers are well aware of a decline in mortality as a prerequisite for a decline in fertility. But while most of them share the idea of a demographic revolution as a transition from one type of equilibrium to another, at the same time they consider the objective necessity of a new demographic balance to be an insufficient basis for the establishment of this equilibrium in all modern societies. Following Landry's advice, they are looking for "another explanation" of the fall in fertility, for causes not directly related to a decrease in mortality. As D. Kirk points out, "while mortality decline is usually cited as the *raison d'être* for fertility decline, it is not often accorded a primary place as a cause of fertility decline" (Kirk 1996: 368). Apparently, he considers this to be justified, as much of his article is devoted to discussing various lines of the "search for causality" of decreasing fertility. Van de Kaa, recognizing that "mortality decline plays a central role in explaining the FDT (first demographic transition)", immediately notes that "mortality is not the sole causal agent of fertility decline. Both mortality and fertility decline are likely to be responses to broad changes in society, such as improvements in standard of living, increased urbanization, rising aspirations and so on" (van de Kaa 2010).

In the hierarchical scheme of explanatory narratives proposed by van de Kaa, the narrative of declining mortality, paradoxically, not only does not hold a central place, but is among the many narratives of the lowest, third level, while at the upper level are found technological, structural and cultural determinants of fertility and its changes associated with social changes, modernization or westernization (van de Kaa 1996: 401).

This paradox may be due to the inertia of the scientific thinking of demographers who have so far failed to free themselves from the ideological burden of the eighteenth and nineteenth centuries, when questions about population size and growth were discussed mainly in economic literature and viewed, for the most part, through the prism of economic relations and interests. The entire nineteenth century was spent in disputes between supporters and opponents of Malthus, conducted in terms of the ratio of the number of people and the quantity of the means of subsistence. To explain the processes that we now call "demographic" meant, first of all, to link them with some non-demographic, most often economic, determinants.

As Hodgson assumes, by 1900 the causal relationships between fertility and socio-economic factors, in particular those such as the standard of living, social class and urban residence, were considered empirically established (Hodgson 1983: 5). These relationships have always been understood in the same way: such factors were assigned an active role, people's

procreative behavior was seen as a passive result of their impact, and the level of fertility as a "dependent variable".

Subsequent generalizations Hodgson, like many others, connects with the development of the theory of demographic transition as it had taken shape by the middle of the twentieth century. One of its main claims was that, as agrarian rural societies are transformed into industrial and urban ones, they make the transition from a regime of high to one of low mortality and fertility. In itself, this claim raises no objections, but does it clarify the issue of what *determines* the changes in fertility?

The influence on mortality of industrialization, urbanization and modernization is, in a broad sense, obvious. "The whole process of modernization in Europe and Europe overseas brought rising levels of living, new controls over disease, and reduced mortality" (Notestein 1945: 40). Fertility, as Notestein observed, was "much less responsive to the processes of modernization," but eventually it began to decline, gradually spreading to the whole of Europe, North America, Australia and New Zealand. "It is important," he writes further, "to understand something of the causes of this trend" which allowed the population of these regions to take control of their fertility "sufficiently to bring birth rates into balance with the low death rates that modern conditions permit" (Ibid.: 41).

It seems to me that at this point Notestein's reasoning came to a logical fork, from which it was possible to move in different directions. He essentially said that the modernizing changes that caused a decrease in mortality led to an imbalance of the system and required a decrease in fertility to restore the disturbed balance. With this, the search for *causes* of the decline could be ended. Indeed, this is precisely what Spencer did in his day, saying that the only cause requiring a decline in fertility is "the excess of fertility itself" (Spencer 1852: 498).

But, contrary to his own logic, Notestein began building a parallel explanatory series, trying to find the mechanisms of the *direct* (not through the reduction in mortality) impact of social and economic factors on the procreative behavior of people similar to those, easy to show, when it was necessary to explain the decrease in mortality. This path would lead him to the assertion that fertility declines "in response to drastic changes in the social and economic setting that radically altered the motive and aims of people with respect to family size" (Notestein 1945: 41).

From my point of view, this is claim is doubly contradictory.

First, there is ambiguity in the very usage of words, in the identification of fertility with family size; in essence, there is an elementary substitution of concepts[2]. Family size, that is, that regarding which people really can have motives and goals, depends not only on the number of children born, but also on their survival, i.e. on mortality; with a decrease in mortality, fertility *may* decline, but not because people's goals for family size change, but precisely because they *remain the same*.

[2] This identification is generally characteristic of the English-language literature, where the expression "family size" is often used almost as a synonym for fertility: "Family size (the mean number of children in the family) decreased by 61 percent from a high of 7.3 for women born in 1867–1870 to 2.8 for women born in 1951–1955" (Encyclopedia of Sociology 2018).

Secondly, from the central thesis of the theory of the demographic transition about *restoring* the balance of births and deaths at the level of the society, it follows that the new balance must be restored also at the family level, meaning that people's goals with respect to the size of the family *should* remain the same, and precisely for this reason fertility *should* fall. Curiously, this was very well understood by Spencer: “from the fact that, on the whole, civilization increases the ability to maintain life, we may perceive that there is at work some influence by which such diminution (of fertility) is necessitated” (Spencer 1852: 496).

Notestein, apparently, reasoned differently. He constructs his "narrative" by attempting to concretize those socio-economic changes that, in his opinion, *directly* induce people to give birth to fewer children. “Most of them center around the growing individualism and rising levels of popular aspiration developed in urban industrial living… All these developments made large families a progressively difficult and expensive undertaking; expensive and difficult for a population increasingly freed from older taboos and increasingly willing to solve its problems rather than to accept them” (Notestein 1945: 41-42).

Notestein’s argument, in keeping with the words quoted above by Landry, makes absolutely no mention of a reduction in mortality, and in this sense represents a step backwards from Landry, who at least links the ever-growing burden of family pressure to the increase in the number of surviving children. In Notestein's reasoning this connection is absent, as if there were no such fact at all, and it was solely a matter of changes in economic and social circumstances external to the family. Strangely enough, just this position was the most attractive for subsequent generations of theoretical demographers.

It is interesting to trace the evolution of the views of one of the main representatives of the Princeton demographic school, Kingsley Davis. He first turned to the issue of declining fertility in an article of 1937, where he explained the decline as the result of urbanization, industrialization and the growth of mobility destroying the family organization of society and undermining the role of the family as the main institution of population reproduction (Davis 1997). As for declining mortality, it is not even mentioned; clearly this argument had not then fallen within the author's field of view.

In an article of 1945 the emphasis shifts. On the one hand, it contains arguments close to those that Davis himself had made in 1937, or to those that we find in Notestein ("the competitive, individualistic, urban society that had risen made large families a handicap rather than a blessing"(Davis 1945: 5)). On the other hand, this article points to the huge decline in infant mortality, which, by increasing the number of large families, created independent incentives to reduce the number of births (Ibid).

Subsequently, this idea was developed in Davis' article "The theory of change and response in modern demographic history" (Davis 1963). This article is one of the most important publications in the entire literature on the demographic transition. In particular, it expressed with great certainty that a “mortality decline impinged on the individual by enlarging his family” and made the habitual behavior of families a hindrance in their desire to take advantage of the opportunities provided by the developing economy. Accordingly, they began to change their reproductive behavior (Davis 1963: 352).

It seems to me that in this article Kingsley Davis appears rather as an advocate of the first approach to explaining the changes in fertility, that he is, in any case, nearing recognition of the *demographic* logic of its decline. Unfortunately, he would develop this logic no further. At the end of his life, Davis reverted to his initial views that modern industrialism weakens the family, turns it into a "social rudiment" unable to provide the level of fertility necessary for population reproduction after, as in developed countries, this level has come into equilibrium with a new (low) level of mortality (Davis 1986: 59-63), i.e. after completion of the demographic transition.

The non-demographic logic of the explanation of the decline in fertility, as well as of the determination of the fertility level in general, prevailed not only in the views of American classics in the theory of demographic transition. It practically dominates in the works of the majority of demographers who adhere to this theory, not to mention those who disagree with it. As noted in a review of the theoretical understandings of low fertility that had taken form by 1990, "everyone agreed that the fertility decline was basically driven by the Industrial Revolution, much as Notestein (1945, 1953) had described" (Caldwell, Schindlmayr 2006: 355).

Van de Kaa adheres to the same logic. "The shift from family-based production to wage-paid labor that accompanied industrialization and urbanization reduced the economic utility of children. They could no longer serve as cheap labor for the parental farm or business but instead required investment in schooling and training to give them a reasonable chance in life... A large number of children could mean the dissipation of family assets like land after the parents' death, so birth control became a sound strategy. Secularization reduced the influence of the churches and increased couples' willingness to practice family planning" (van de Kaa 1987: 5).

Nearly the strangest thing in all such arguments seems to be the habitual one-sided interpretation of the long-known correlation between the fertility decline and the development of the most important social institutions of the modern world. For example, there is a well-known link between a decline in fertility and an increase in gender equality in terms of education and professional activity. This growing equality is invariably treated as the *cause* of the decline in fertility and is never regarded as its *consequence*. Meanwhile, if fertility did not decrease and the woman still had to spend her entire life in a state of pregnancy, feeding and caring for infants, there could be no question of gender equality. That became possible only when the survival rate of children rose sharply; the initial condition was a huge reduction in mortality.

The same should be said for many other changes often seen as the *cause* of declining fertility, such as changes in the role of the family and in the balance of a person's family and non-family interests, in family roles and morals, sexual morality, and much more. Particularly surprising is the "anchored" explanation of the reasons for the so-called "second demographic transition". The authors of the corresponding "narrative" see these causes mainly in "ideational and cultural changes". In their opinion, the second demographic transition differs from the first one in "the overwhelming pre-occupation of the populations experiencing the second transition with self-fulfillment, personal freedom of choice, personal development and lifestyle, and emancipation" (van de Kaa 2010). The close connection between the decline in fertility and the "ideational and cultural changes" is not in doubt by anyone, but which is the cause, and which the consequence, depends on the position of the researcher. If we proceed from the central thesis of Spencer, these changes are associated with a decrease in fertility, but as a *consequence*, not as a

cause – yet another step in the development predicted by him of the "antagonism of reproduction and individualization" in favor of individualization.

The reduction in mortality made the former high fertility unnecessary, which led to a series of changes that literally transformed the individual and social life of people. Everything would have to change, and did indeed begin to do so, including cultural norms and attitudes.

If we put the reduction of mortality in parentheses, then all other economic and social factors associated with a decrease in fertility are *not causes*, but only parts of the *mechanism* and at the same time *consequences* of this decrease. Their action brings the level of fertility into accordance with the new level of mortality and at the same time allows for an unprecedented social gain that becomes possible at this – final, from Spencer's point of view – stage of the development of the "antagonism of reproduction and development of the individual".

SPENCER'S PLACE IN THE PEDIGREE OF THE CONCEPT OF THE DEMOGRAPHIC TRANSITION

Although the beginning of the modern demographic transition is usually dated back to the end of the eighteenth century, it gained strength only later and was apprehended only in the first half of the twentieth century. Can one connect the demographic ideas of Spencer to this transition and fit them into the pedigree of today's ideas of theoretical demography?

Spencer based his ideas on generalizations relating to the entire history of life on Earth, and it would seem impossible that they could have been influenced by contemporary historical processes that had barely just begun. Nonetheless, his ideas were not and could not be torn away from the general movement of the European thought of his time. And this was a time when the transition was objectively already taking place, when Europe had begun to feel previously unknown demographic consequences, when the population of many European countries was growing at an unusually high rate and the growth was accelerating.

The new situation was not immediately perceived. Montesquieu, as early as the mid-eighteenth century, argued that "most countries of Europe were better peopled ... than they are even at present" (Montesquieu 2001: 457), and in "The Spirit of the Laws" there is a chapter "On the Depopulation of the Globe" (Ibid.: 447). But gradually the center of gravity shifts towards discussion of issues related not to the possibility of depopulation of the world, but, on the contrary, the possibility of its overpopulation. The idea of "equilibrium" appears and naturally there arises an effort to understand the nature of growth's *regulators*, capable or incapable of maintaining such an equilibrium.

The evolution of views on these issues can be illustrated by the example of three emblematic figures of the history of demographic thought: Süssmilch, Malthus and Spencer, each of whom lived about half a century after his predecessor.

Süssmilch: "Equilibrium is an equilibrium of the numbers of people. Overpopulation would lead to a general war" (Süssmilch 1998: 43). Equilibrium is maintained by Divine Providence. "Reproduction is a changing thing, so God can easily speed it up or slow it down, depending on the state of the world ... It is a simple thing for Divine Providence. To do this, you need only to let

a few more people die. And this can be done quite easily. ... Just as God can easily speed up reproduction by giving more vitality to children so that they do not die in such numbers and so quickly, he can just as easily slow it down by allowing more of them to die" (Ibid.: 100).

Malthus: Responding to those who claim "that the natural checks to the population will be sufficient to keep it within bounds, without resorting to any other aids", Malthus notes that "to a rational being, the prudential check to population ought to be considered as equally natural with the check from poverty and premature mortality which these gentlemen seem to think so entirely sufficient and satisfactory" (Malthus 1998, Appendix I, 1807: *6, *7). By "prudential check" he means the reduction of fertility. "If the resources of the country would not permanently admit of a greatly accelerated rate of increase in the population … one of two things would happen, either an increased mortality of some other diseases, or a diminution in the proportion of births… I have expressed my conviction that the latter effect would take place" (Malthus 1998, Appendix I, 1807: *5-*6).

Spencer: "In approaching an equilibrium between his nature and the ever-varying circumstances of his inorganic environment, and in approaching an equilibrium between his nature and all the requirements of the social state, Man is at the same time approaching that lowest limit of fertility at which the equilibrium of population is maintained by the addition of as many infants as there are subtractions by death in old age" (Spencer 1910: 538). "Excess of fertility, through the changes it is ever working in Man's environment, is itself the cause of Man's further evolution; and the obvious corollary here to be drawn is, that Man's further evolution so brought about, itself necessitates a decline in his fertility" (Ibid.: 501).

There is one very important, at least from the point of view of the demographer, trait that brings Malthus and Spencer closer together and distances them both from Süssmilch. For Süssmilch, the role of regulator is played by mortality, while for Malthus and Spencer it is fertility.

If I may express my own opinion on what constitutes the essence of the demographic transition, after so many bright minds have tried to do so, I will say that this essence consists precisely in the change of the regulator. The role of the regulator of demographic dynamics has shifted from mortality to fertility, and this is the main thing. All the rest is only a consequence of this unique event, which has happened only once, not only in the history of human society, but in the whole history of life on Earth.

The first to speak with unusual force about the change of regulator was Malthus. It was he who first publicly announced the need for a new regulator, and in every possible way propagated it – hence it is he, it would seem, who should be called the father of the theory of demographic transition. Yet there is one obstacle: Malthus did not see the *transition* at all. His demographic picture of the world was static, with no increase in the duration of human life since the creation of man. "With regard to the duration of human life, there does not appear to have existed, from the earliest ages of the world to the present moment, the smallest permanent symptom or indication of increasing prolongation" (Malthus 1998: III.1.14, III.1.18). Accordingly, his law of population was also timeless.

The demographic picture of Spencer's world, on the contrary, is historical. “From the fact that the human race is in a state of transition, we may suspect that the existing ratio between its ability to multiply, and its ability to maintain life, is not a constant ratio”, and “any change in the ratio will probably be towards a diminution of fertility” (Spencer 1852: 496).

Spencer's reference to a "state of transition" leaves room for interpretation. Most likely, he simply had in mind the whole history of mankind, considered the growth of the "ability to preserve life" as an accompanying continuous process and understood "transitionality" likewise, as a gradual process leading to a final equilibrium. But even in this case, the only step that separates Spencer's conceptual vision of a decline in fertility as an adaptive response to a decrease in mortality and the resulting imbalance from modern concepts of the demographic transition is its localization in time.

The modern theory of demographic transition links the decline in fertility to various kinds of modernization processes, among which a key place is given to industrialization and urbanization. This automatically identifies the starting point of the demographic transition as the time of the industrial revolution, sometimes of the political revolution in France, and includes the demographic transition in the series of fundamental changes characteristic of the new phase of history, at least of European history, that began with these two revolutions.

But in Spencer’s day this time boundary, which marked the entry into a new stage of history, was not yet apprehended. The expression "industrial revolution" was occasionally encountered in different authors, but did not lead to any generalizations. Such a generalization can perhaps for the first time be found in F. Engels: "An industrial revolution, a revolution which altered the whole civil society" and “is of the same importance for England as the political revolution for France, and the philosophical revolution for Germany” (Engels, 2010: 307, 320); but it did not then become famous. It is considered to be A. Toynbee who, much later, brought it into wide circulation (Bezanson 1922).

So it is not surprising that the step that separates Spencer from modern theorists of the demographic transition was also taken later – in the case of the Princeton demographers, a hundred years later. But if we ignore the question of temporal localization, the whole logical scheme of the transition – right up to its completion – was very clearly drawn by Spencer. In the middle of the nineteenth century he confidently predicted not only the growth, but also the cessation of growth of the world population and the demographic pressure generated by it. “After having caused, as it ultimately must, the due peopling of the globe, and the bringing of all its habitable parts into the highest state of culture – after having brought all processes for the satisfaction of human wants to the greatest perfection – after having, at the same time, developed the intellect into complete competence for its work, and the feelings into complete fitness for social life – after having done all this, we see that the pressure of population, as it gradually finishes its work, must gradually bring itself to an end” (Spencer 1852: 500).

It is precisely Spencer's predictions, which have come true or are coming true, about decreased fertility as a way of restoring a demographic equilibrium disturbed by a decline in mortality which give every reason to consider him the father of the concept of demographic transition, a theorist perhaps even much more astute than later, universally recognized ones, and in this sense still unsurpassed.

Spencer's strictly monistic interpretation of fertility decline is very consistent. Development leads to a reduction in mortality and the emergence of excessive fertility, the changes resulting from this lead to fertility's decline, and "the sole agency needed to work out this change is - *the excess of fertility itself*" (Spencer's emphasis) (Spencer 1852: 498), i.e., a disturbance of the equilibrium. This interpretation does not imply any other causality.

It is enough to know only what Spencer said to assert that, at first, the response to a decrease in mortality *must* always depend strongly on local characteristics and historical differences. No society can pass by the new opportunities that are opening before it, but the speed of their comprehension, the sequence of their use, the readiness for change, the strength of the opposition to them and many other characteristics will necessarily differ. The search for these differences is reflected in countless "narratives" which can be moderately useful for understanding various kinds of real situations.

But these "narratives" are by no means a search for the causes of the decline in fertility. What their authors are usually discussing is *NOT THE CAUSES* of the decline in fertility, but the *CONSEQUENCES* of the emerging possibility of its decline. These are *ways of realizing* the unprecedented gain brought by the reduction in mortality, which made possible and necessary a corresponding reduction of fertility and, ultimately, a transition to a new, much more efficient reproductive strategy for *Homo sapiens* (Vishnevsky 2014).

The logic of all the "narratives" constructed by van de Kaa, but understandable also without his impressive classification, can be summarized in one phrase: civilization in its modern forms and manifestations has made inevitable the decline in fertility. The logic of Spencer is the opposite: "the excess of fertility has itself rendered the process of civilization inevitable" (Spencer 1852: 500). I think that Spencer's logic is less evident but more profound.

LOW FERTILITY AND PRO-NATALIST POLICY

Landry's "Demographic Revolution" was an alarm signal. "Man restricts his child-bearing, more and more, to the point where humanity is no longer replacing itself completely" (Landry 1987: 740). "There are also selfish feelings, which make people consider the child as an expense and an inconvenience… And it can be observed that the role of selfish feelings is becoming greater and greater: we observe that among the lines of reasoning that one can follow, those that make the limitation of births more rigorous are increasingly pursued" (Ibid.: 739). Landry constantly emphasizes the danger of a discrepancy between the demographic interests of the individual and of society, and suggests the need for special measures aimed at eliminating this discrepancy.

For Süssmilch, it was God who took care of maintaining the equilibrium, while Malthus tried to put the responsibility on people themselves, and Spencer believed in the regulatory mechanisms of nature. As for Landry, he appeals to a legislator. He spoke with approval of the fact that France already had pro-family legislation, but considered it necessary "to continue the policy already begun, to develop and strengthen the legislation already shaped by this policy, and to go far beyond what has been done so far" (Landry 1982: 94). He spoke with enthusiasm of the pro-natalist measures of the Roman emperor Octavian Augustus, and with regret of how in modern conditions the introduction of "equally vigorous" 'population-based' laws like those that existed

under Augustus" would encounter great difficulties rooted in human egoism (Ibid.: 98). But he calls for overcoming these difficulties, for prevailing over public opinion and changing the behavior of people leading to depopulation. “When it comes to something as important as the life of mankind, no effort should be spared” (Ibid.: 105).

Developing the logic of Landry, A. Sauvy, who considered himself his disciple and follower, argued that this choice cannot be entrusted to people. "The complex phenomenon of demographic reproduction is much too imperfectly known for the sense of moral duty to ensure the equilibrium of the population" (Sauvy 1969: 368). “An equilibrium of a providential kind may appear to exist over a long span, but only if the many individuals appointed as its instruments do not betray their mission, and especially since only the survivors can write history” (Ibid.: 387).

This impassioned position seems very convincing and has a huge number of followers. Once France was the only country to consider introducing state pro-natalist policy, whereas now it is hard to find a country with low fertility which would not attempt to pursue such a policy. Nevertheless, as is known, fertility in all these countries remains below the replacement level, and the only thing that the initiators of such a policy can usually say in its defense is that if there were no such policy, fertility would fall even more – an assertion that cannot be verified.

It would seem that Spencer could never have foreseen the current general enthusiasm for pro-natalist policy. However, predicting a decline in fertility as a result of the interaction of oppositely directed forces, as he understood them, he remarks: “Provided that the actions and reactions which have been described are not artificially interfered with. I append this qualifying clause advisedly, and especially emphasize it, because these actions and reactions have been hitherto, and are now greatly interfered with by governments, and the continuance of interferences may retard, if not stop, that further evolution which would else go on” (Spencer 1910: 532).

This is not a casual remark, but a reflection of Spencer's general views on society as a self-regulating organism. Almost simultaneously with the 1852 article on the theory of the population, in 1853 he published in the same *Westminster Review* an article entitled "Over-Legislation", in which he was very skeptical about the regulatory capabilities of governments.

A society, he claimed, has many needs, and its successful functioning presupposes a certain hierarchical sequence of meeting these needs: the more important ones must be satisfied earlier than the less important. Always, therefore, there is a problem of choosing priorities. But it is in the matter of choosing priorities that "the judgment of a government is no longer to be trusted". It is "a task that no legislature can accomplish". "Society must be left to *feel* what it most needs. The mode of solution must be experimental, not theoretical". The search by citizens for ways to get rid of "evils and dissatisfactions of various kinds, affecting them in different degrees" can be hampered by “men's habits and prejudices”, but such searches are "far more trustworthy than are legislative judgments" (Spencer 1981: 308-309).

The low fertility in all developed countries and the multiple unsuccessful attempts to increase it with the help of state-led pro-natalist policy give grounds to assume that "the judgment of a government is no longer to be trusted" in this field too, which is, in fact, just what Spencer meant when he objected to "government interference".

CONCLUSION

The purpose of this article is to analyze Herbert Spencer's contribution to demographic theory, above all to the theoretical understanding of the phenomenon of low fertility. Our task has been not simply to fill the gap in the generally accepted ideas about the history of demographic thought. It seems to me more important to bring Spencer's argument to the current debate about the present and future of low fertility, based on the premise that his argument not only has not become a historical curiosity, but even today is far ahead of its time.

Spencer viewed human society as a single organism, thus giving grounds to reproach him for substituting biological explanations for social explanations. In some cases, as for example that of his explanation of the decline in fertility by the development of nervous centers, these reproaches are justified. But such cases are more the exception than the rule. In general, Spencer did not identify the social organism with the biological, did not deny the differences between them, but only assumed that this difference "does not result in a difference in the laws of the organization: the required mutual influences of the parts, not transmissible in a direct way, being, in a society, transmitted in an indirect way" (Spencer 1898: 462). In this argument, Spencer appears as one of the outstanding predecessors of the systemic approach, which would be developed only in the twentieth century.

This approach has still practically not found its place in demographic theory. But it was this which, if only in its early forms, allowed Spencer to rise to a very high level of generalization and predict the transition from an equilibrium of high mortality and high fertility to a demographic equilibrium with a low level of both. The "determinants" and "factors" used by modern theoretical demographers to try and explain the causes of this transition had barely appeared on the historical stage in the days of Spencer, many of them had not yet manifested themselves or been noticed. But Spencer didn't need them. He understood the *main*, or more precisely, the *only*, cause for the decline in fertility – its excess due to the "increased ability to maintain life", which he regards as the fruit of civilization, i.e. as a social process: "increased ability to maintain life… necessarily involves decreased ability to multiply" (Spencer 1852: 498)

Historians of demographic thought trace the pedigree of the concept of the demographic transition back to Adolph Landry and Warren Thompson, and sometimes point to their predecessors, for example Arsène Dumont with his idea of "social capillarity". But when it comes to understanding the true causes of the decline in fertility as an integral part of this transition, then the decisive word was Spencer's, and nothing new to it has ever been added.

It is to be regretted that this word was not heard by demographers. Spencer's ideas are not present in their work on the demographic transition. The only consolation is that demographers are not alone in their ignorance.

Spencer has been buried more than once. As Crane Brinton wrote in the 1930s, "Who now reads Spencer? It is difficult for us to realize how great a stir he made in the world... He was the intimate confidant of a strange and rather unsatisfactory God, whom he called the principle of Evolution. His God has betrayed him. We have evolved beyond Spencer" [*Brinton 1933: 226-227*]. Parsons, quoting Brinton, generally agrees with him, albeit with the proviso: "Not, of course,

that nothing in his thought will last. It is his social theory as a total structure that is dead" [Parsons 1949: 3].

However, is it really dead, and are Parsons' own systemic views on society independent from Spencer's "organismic" views? Is it accidental that the author of the preface to the posthumous reprint of Parsons' book "The Social System" found it necessary to emphasize that "in social theory, employing analogies and metaphors from biological sciences has been a common strategy in the development of theoretical frameworks on social systems" [Turner 1991: xvii] and that this strategy is characteristic, in particular, of Spenser's evolutionary sociology, while Parsons' views on the systemic qualities of social relations were also influenced by the ideas of the biologists Claude Bernard and Walter Cannon? What matters is not whether the researchers of the twentieth century went further than their predecessors, who lived a hundred years earlier – it could not be otherwise - but whether they went in the same direction.

As Jonathan Turner (not to be confused with the Brian Turner quoted above) asserts in his article "The forgotten theoretical giant: Herbert Spencer's models and principles," Spencer's methodological principles "have been used for decades in a wide variety of empirical contexts far more often than principles developed by Marx, Weber, and Durkheim. Sometimes this usage is acknowledged, but more often it is unknown, with the result that Spencer's ideas have often had to be re-discovered… Had sociological theorists and researchers begun the 20th century with Spencer's models and principles in hand, it is likely that sociology would be a more mature science" (Turner 1981: 95).

The same applies all the more to demography.

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RETHINKING THE CONTEMPORARY HISTORY OF FERTILITY: FAMILY, STATE, AND THE WORLD SYSTEM

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The paper highlights the drivers of contemporary fertility history in developed countries "forgotten" by theory: fundamental changes in the world system after the Second World War and in the late 1980s and early 1990s; competing ideas of the "right" family and family and demographic policy; centre-peripheral relations and their impact on the resource capabilities of such policy. Statistical analysis shows that the periods during which countries' positions by total fertility rates remained stable were disrupted by intervals in which significant changes in these positions occurred. Twice, due to the Second World War and the disintegration of the Soviet bloc, such intervals coincided with fundamental shifts in the world system. In addition, such intervals occurred in Western countries in the late 1980s and early 1990s, when the negative association between women's participation in the labour force and fertility became positive, and then in the 2000s in Russia, countries of Eastern and Central Europe and the former Yugoslavia during fertility "recovery". Contemporary fertility changes in the developed world are directed by "gravitational fields" of four attractors. Three of them are institutional traps created by low living standards, or contradictions between the "new" economy and "old" family relations, or, in varying proportions, both. The fourth attractor is an ideal condition in which generous family policy and men's participation in the home maintain fertility at the replacement level. Currently, France and the Scandinavian countries come closest to this. The question of whether the developed semi-peripheral countries will be able to approach this condition, or, due to resource constraints, it will remain a privilege accessible only to the core countries, remains open.

***Key words**: fertility, demographic policy, family policy, centre-peripheral relations, world system.*

Different, sometimes diametrically opposed interpretations of events are a characteristic feature of historical science. In contrast, interpretations of the modern history[1] of fertility are not so variable - all of them, according to D. Van de Kaa (Van de Kaa 1996), are "anchored" to the theory of demographic transition. The purpose of this article is to present a different interpretation of changes in fertility, partly as an alternative to these theories, and partly as an addition to them.

The main "engine" and "intrigue" of the modern history of fertility in our interpretation will be the state's desire to reconcile the economic and demographic functions of the family. Policy aimed at achieving this goal has been based, as we show below, on competing ideas about what the relationship between the family and the state should be. These ideas and the results of their implementation have been largely determined by the course of political history and its most important element - center-peripheral relations in the world-system, and if one views the course of events even more broadly, by the fragmentation of the world, including the developed world, into qualitatively different and often conflicting parts.

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[1] Modern history in this article means the period from the end of the Second World War to the present day.

INERTIAL DEVELOPMENT AND BREAKS IN GRADUALITY: STATISTICAL ANALYSIS

The periodization of history is one of the canonical approaches to its study. In our case, we construct such a periodization, dividing the historical flow into two types of periods: stable development and breaks in graduality. First, we will carry out such a division by the methods of statistical (mainly correlation) analysis, and then we will interpret the results obtained by placing them in a wider historical context.

Our statistical analysis covers two sets of countries from the developed world. The first consists of 22 countries that throughout the postwar period were either part of the US-led military-political bloc, or, while being formally neutral (such as Austria and Sweden), indisputably belonged nevertheless to the western cultural area[2]. The second set (19 countries) includes Russia, European countries that were previously part of the USSR or the Soviet military-political bloc, as well as the states that previously constituted Yugoslavia[3]. The total of the two sets is 41 countries.

The first set of countries includes only countries of the core and semi-periphery of the developed world. The second set, before the collapse of the USSR and its geopolitical bloc, was a relatively isolated part of the world-system. In the 1990s and at the beginning of the 21st century, some of these countries joined the periphery, and some the semi-periphery of the developed world[4]. The time horizon of the analysis covers the period from 1950 to 2016. The initial data used were on the period total fertility rates (hereinafter referred to as the TFR), published in the electronic publication Demoscope Weekly (Demoscope Weekly. Supplementary materials 2018).

Breaks in graduality in the historical dynamics of fertility occur when the countries' ranks by fertility within the set of these countries are subject to significant changes. Because of this, an analysis of the diagonal matrix of correlation coefficients between the TFRs in the populations of the countries here considered allows us to reveal the place of the breaks of graduality on the historical axis[5]. In other words, the matrices of correlation coefficients obtained by the method described above show how strongly the distribution of countries according to leaders, "average performers" and "underperformers" of fertility for a given year is determined by their previous history. High values of the correlation coefficients indicate that the order in which the countries

[2] Australia, Austria, Belgium, UK, Germany, Greece, Denmark, Spain, Italy, Canada, Netherlands, New Zealand, Norway, Portugal, USA, Finland, France, Sweden, Switzerland, South Korea, Japan. Due to the lack of necessary information on the GDR in the database we used during the correlation analysis, we used a time series of total fertility rates from 1950 to 2016 for Germany as a whole.

[3] Belarus, Bulgaria, Bosnia and Herzegovina, Hungary, Lithuania, Latvia, Macedonia, Moldova, Poland, Russia, Romania, Serbia, Slovakia, Slovenia, Ukraine, Montenegro, Czech Republic, Croatia, Estonia.

[4] As can be seen from the above, we use some concepts of I. Wallerstein's world-system theory, but we do not strive to copy its classification of states. In our opinion, in the developed world it is also possible to distinguish its core, semi-periphery and periphery. Per capita income in the peripheral countries of the developed world is much lower than in its core and semi-periphery, but at the same time significantly exceeds the values of this indicator in the world's least developed (according to the UN classification) states. No less important is the fact that negative population growth rates are characteristic of the periphery of the developed world.

[5] The initial data for the calculations were a matrix of values of the TFR, the rows of which were countries, and the columns - years. The correlation coefficients between the columns of such a matrix were calculated. The result of the calculations is a matrix, the elements of which are the values of the correlation coefficients $r(TFR_t,TFR_{t-k})$ between the TFR in the year t and the year $t-k$, which is k years ago from the year t. The correlation coefficients in such a matrix are measures of proximity between years, and not between countries.

are lined up is not very variable, and low values indicate a significant change. The statistical significance of the correlation coefficients (if it occurs) allows us to reject the null hypothesis that the similarity in the position of countries in the years under consideration is random.

The results of the analysis indicate that the position of countries by the size of the TFR showed, as a rule, a strong dependence on previous development (Figure 1). From 1950 to 1980, in both sets, the correlation coefficients between the TFR of the current year and the TFR observed a decade earlier significantly exceeded their critical values. The dependence of fertility rates on previous development during this period is explained, in our opinion, by a combination of three factors: the stability of formal and informal institutions closely related to fertility, the stability of circumstances external to them and the absence (with some exceptions) of a demographic policy aimed at radically changing both. The "perturbations" that emerged at the end of this period (the demographic policy of Hungary, the GDR and Czechoslovakia, the ban on abortions in Romania, the fall of the Spanish and Portuguese dictatorships and the decline in fertility that followed) were not strong enough to shake this stability.

At the same time, periods of inertial development, during which the position of countries in terms of the total fertility rate changed very slowly, were interrupted several times by "breaks in graduality", which led to a significant change in this arrangement. At the same time, the set of 22 countries as a whole was more stable than the set of 19 countries.

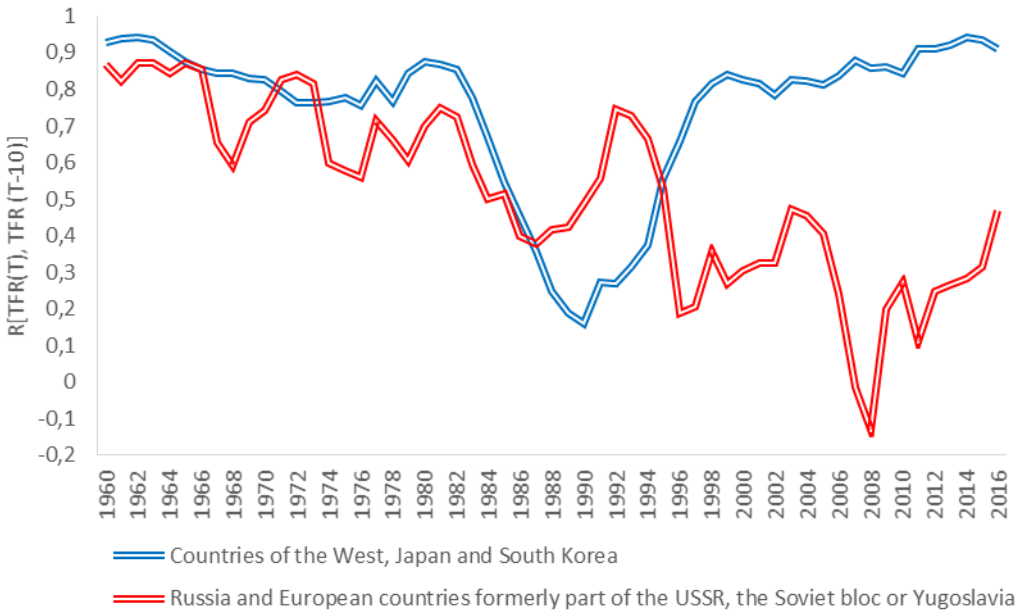

Figure 1. Correlation coefficients *r[TFR(t),TFR(t-10)]* between the value of the total fertility rates in years *t* and *(t-10)*

Source: Author's calculations based on (Demoscope Weekly. Supplementary materials 2018).

In the set of 22 countries, the period of the weakest dependence on previous development falls on 1987–1994, when the correlation coefficients between the TFR observed in the current year and a decade earlier fell below the critical 5% significance level (0.42). In all other years, the correlation coefficients calculated in a similar way were statistically significant at the 5% level.

The average TFR for the 22 countries considered in 2015 remained almost the same as in 2000 (1.62 and 1.61 respectively). Their ranks by this indicator almost did not change: the correlation coefficient between the values of the TFR in 2000 and 2015 was 0.83.

In the set of 19 countries, the correlation coefficients between the TFR observed in the current year and a decade earlier fell below the critical 5% significance level (0.46) three times: in 1986-1989, 1996-2002 and 2006-2015. The most pronounced breaks in graduality were those associated first with a sharp decline in TFR during the transformational shock, and then during their "restorative" growth, especially rapid in Russia[6].

For the two sets together (41 countries), the differences between the periods when the dependence on previous development was strong and the periods when it was disturbed are clearly seen in Figure 2. The statistically significant dependence on the TFR observed in 1950 remained not only in 1965, but also in 1980 (r = 0.61 and r = 0.51, respectively). In contrast, the dependence of the TFR on their values recorded in 1980 and 1990 disappeared much faster and in 10-12 years ceased to be statistically significant.

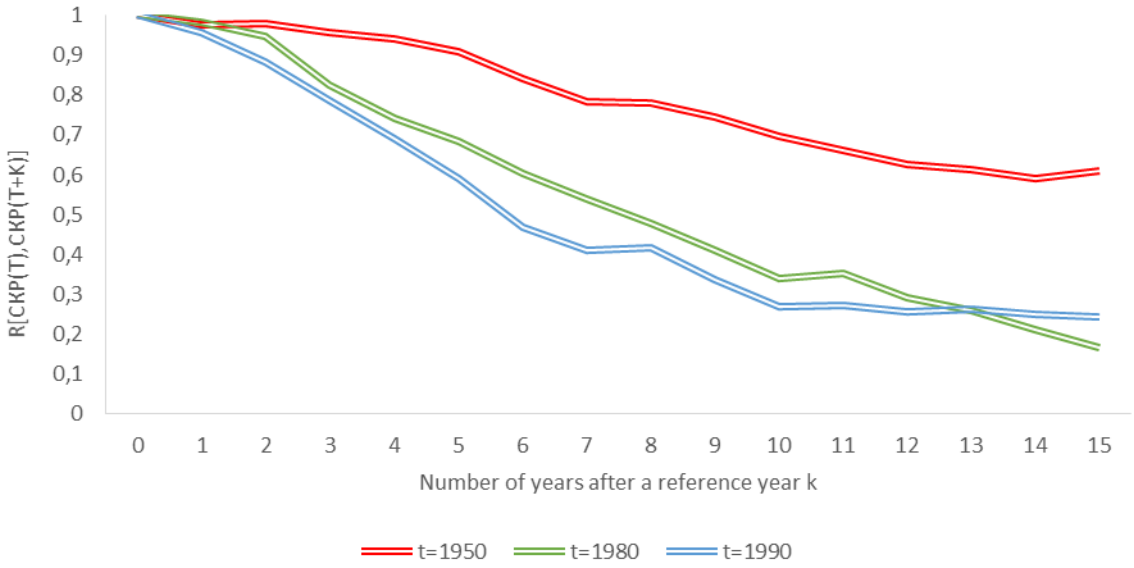

Figure 2. Correlation coefficients *r[TFR(t), TFR(t+k)]* between the value of the total fertility rates in the year *t* and the year that is *k* years ahead of it, for 41 developed countries

Source: Author's calculations based on (Demoscope Weekly. Supplementary materials 2018).

Dependence on previous development is also observed when the average total number of births in the cohorts per woman is used as an indicator of fertility. Thus, for 23 OECD countries, the correlation coefficients between the average number of births per woman in the corresponding cohorts were: for the cohorts of those born in 1950 and 1960, 0.816; for those born in 1960 and

[6] From 2000 to 2015, the average TFR in this set of countries (excluding data for Russia) increased from 1.36 to 1.51. In Russia, the value of the TFR grew much faster - from 1.20 to 1.78. At the same time, in the aforementioned set of 19 countries the dependence on the values of the TFR recorded in 2000 was, since 2007, no longer statistically significant.

1970, 0.898; and for those born in 1950 and 1970, 0.623. All the given correlation coefficients are statistically significant at the level $\alpha = 0.01$[7].

THE POSTWAR BABY BOOM

Let us now consider the above data in a broader context, including, along with political events and economic upheavals, the competition of ideas that underlie the demographic and family policy of the state. These ideas (which together we will also call family doctrine) can be divided into two large classes. The ideas relating to the first of them are based on the assumption that the family is capable of providing an acceptable level of generation replacement for society without any particularly generous state stimulation of fertility. Such a doctrine considers family assistance primarily as the fight against poverty and does not consider it necessary to pay special attention to material incentives for fertility. The second set of ideas, an alternative to the first, is that "just" family policy aimed at fighting poverty is not enough, and the demographic goals of society can be achieved only with active stimulation of fertility by the state. During the postwar baby boom, both ideas were expressed in political practice.

The dynamics of fertility in this period were to a large extent due to a complex of factors well described by the theory of the demographic transition. Another factor, to which less attention is usually paid, is the results of the Second World War. The mediating factor in the influence of these results was demographic policy, as a result of which France, which in the period between the two world wars had a lower fertility than Germany and Italy, in the postwar period overtook them both.

In the Western world, the ideological context of the baby boom included two opposing family doctrines. One of them dominated in France, the other in Germany, Italy and, in its extreme manifestations, in Francoist Spain. France continued its pre-war demographic policy, the characteristic features of which were officially declared pronatalism and generous assistance to families with children. General de Gaulle declared in a speech on March 2, 1945 that "the French population is not increasing, and France may turn into a dying great light. But even in this area, nothing is lost, if only we want to act. We need 12 million healthy babies to appear in the next ten years" (De Gaulle 2004: 502-503).

The defeat of fascism in the Second World War made pro-natalist demographic policy in the Federal Republic of Germany and Italy impossible, since in the Nazi ideology the promotion of the birth rate of "true Aryans" was inextricably linked with the genocide of other nations. The basis of the family doctrines of Italy and the Federal Republic of Germany were now religious and conservative principles. It was assumed that the "natural family", in which the father is the breadwinner and the mother takes care of the house and raises the children, is fully capable of providing an adequate level of fertility even without generous benefits like the French ones. The German labor minister believed, for example, that the size of French benefits discouraged

[7] Author's calculations based on (Family Database 2018: data for Chart SF 2.1.B). We also note that the predominant use in our analysis of period TFRs, rather than cohort indicators, is due to the fact that the latter are much more difficult to tie to certain political events, since each of the cohorts passed through many of them during their life course.

the fathers of families from wanting to work (Niehus 1995: 311). If in France in 1957 the appearance of a third and subsequent children reduced (compared to a childless married couple) the family's standard of living by only 9%, then in Germany this reduction was 36% for a third child, 39% for a fourth, 43 % for a fifth and 46% for a sixth (Niehus 1995: 311).

The family doctrine of Spanish Francoism was an extreme manifestation of religiously conservative views of the family. The work of women outside the family was interpreted as a social evil that distracts a woman from her natural purpose – having and raising children. Prior to the transition of Francoism to a more liberal economic policy, labor laws legitimized discrimination against women in employment. It was only in 1961 that the statutes were abolished according to which women, regardless of their wishes, could be dismissed from work when they got married. Women were forbidden to occupy leadership positions, and married women were allowed to get a job or engage in commercial activities only with the consent of their spouse (Nielfa Cristóbal 2003; Morago Garcia 2008: 247).

DEMOGRAPHIC POLICY AND FERTILITY IN THE 1970S AND 1980S

The USSR and the countries of the Soviet bloc. The stable distribution of countries by fertility, characteristic of the period of the post-war baby boom, began to break down already in the 1970s. This break in graduality was largely due to the dual fragmentation of the world in that era: on the one hand, into the West and the Soviet bloc opposing it, and on the other, into the core, semi-periphery and periphery of the West itself. The confrontation between the West and the Soviet bloc affected almost all spheres of public life at that time. The intensification of demographic policy in the USSR and the countries of the Soviet bloc was largely due to this confrontation.

T. Frejka wrote then in a journal, one not at all inclined to propagate the achievements of the Soviet bloc, that "young people in Czechoslovakia probably live in the context of the widest, most all-embracing and cost-intensive fertility policy in the world" (Frejka 1980: 89). As in France, such a policy was to a large extent a consequence of foreign policy factors. The population of the countries that formed at that time the "western outpost" of socialism inevitably compared their standard of living with the standard of living of their capitalist neighbors. To survive the constant competition with the geographically and culturally close West, the governments of Hungary, the German Democratic Republic and Czechoslovakia had to maintain fairly high living standards, and demographic policy was one of the methods for solving this problem. The ideological factor probably also played a certain role: the interpretation of low birth rates as evidence of the decline of the entire social system never completely disappeared from the political-demographic arena, and lingers on even now.

As a result of demographic policy measures taken in 1970–1973, the TFR in Czechoslovakia increased from 2.07 in 1970 to 2.46 in 1975, but then began to decline and by 1980 did not exceed the values of a decade before. The dynamics of the TFR in Hungary and the GDR were of a similar nature. Such dynamics are often interpreted as a textbook example of the ephemeral effect of demographic policy. However, if we consider the results of the demographic policy of these countries through the prism of the "competition of the two

systems", which then affected all spheres of public life, the picture is different. The Czech Republic, which in 1970 occupied 39th place in terms of the TFR among the 41 countries listed above, by 1990 had risen to 16th place, while Slovakia moved from 16th to 7th place, and Hungary from 36th to 20th.

The demographic policy of the USSR in the 1980s was determined mainly by the same motives as in the above-mentioned countries of the Soviet bloc. In addition, in Russia, with its vast territory, the claim about the need for population growth has always (with the possible exception of the short period of the 1990s) been perceived by both those "above" and those "below" as something natural, and justified not least of all by the need to protect their territory from external invasions. The TFR in Russia increased during this period faster than in developed countries. If, in 1980, Russia ranked 28th in this indicator among the 41 countries mentioned above, in 1985 it was 13th. In the conditions of constant information wars and the "competition of the two systems", this circumstance, regardless of whether it was actually connected with the demographic policy of the state or not, was perceived as an undoubted achievement[8].

The demographic policy of the USSR and the countries that were part of the Soviet bloc was thus quite adequate to the social system for which it was created, and to the political and ideological tasks that it solved. The sharp decline in fertility in the 1990s was no longer related to this policy and was caused by the transformation of all public, and indeed daily life.

Western countries. During the postwar baby boom, the influence of family doctrines on fertility in the countries of Western and Southern Europe seemed insignificant. However, since the 1970s, this influence has become increasingly apparent. The differences between the ranks of the 22 above-mentioned countries in terms of the TFR in 1975 and 1990 were striking: a statistical analysis suggests that both series are practically independent of each other ($r = 0.02$). A significant contribution to this difference was made by the rapid fertility decline in the countries of Southern Europe (Greece, Spain, Italy and Portugal), which (with the possible exception of Italy) were in that period in the semi-periphery of the developed world. The TFR in these countries decreased by 0.94, 1.44, 0.84 and 1.19 points, respectively, with an average decline of 0.40 points in the population of the set of 22 countries considered. Spain, which occupied 3rd place in terms of the TFR among these countries in 1975, had moved to the penultimate 21st place by 1990, and Italy from 7th to the last, or 22nd.

The modern history of fertility in the countries of Southern Europe has both its own distinctive features and similarities. In Spain and Portugal, the rapid decline in fertility was closely associated with the transition from autarchy to close integration into the Western world and a constituent part of it - the European Union. In Spain, the process of careful rapprochement with the Western bloc was observed already in the 1960s; it can be assumed that the same process gradually created the prerequisites for the subsequent decline in fertility. However, the trigger for such a reduction was the death in 1975 of the Spanish dictator F. Franco and the subsequent adoption in 1978 of a new Constitution, which legalized gender equality (Figure 3).

[8] We note a parallel, not usually noticed by demographers and statisticians, between the period TFR and indicators of financial markets. Both of these, regardless of what they actually reflect and whether they are correctly interpreted, influence their users' behavior and, consequently, political and economic life.

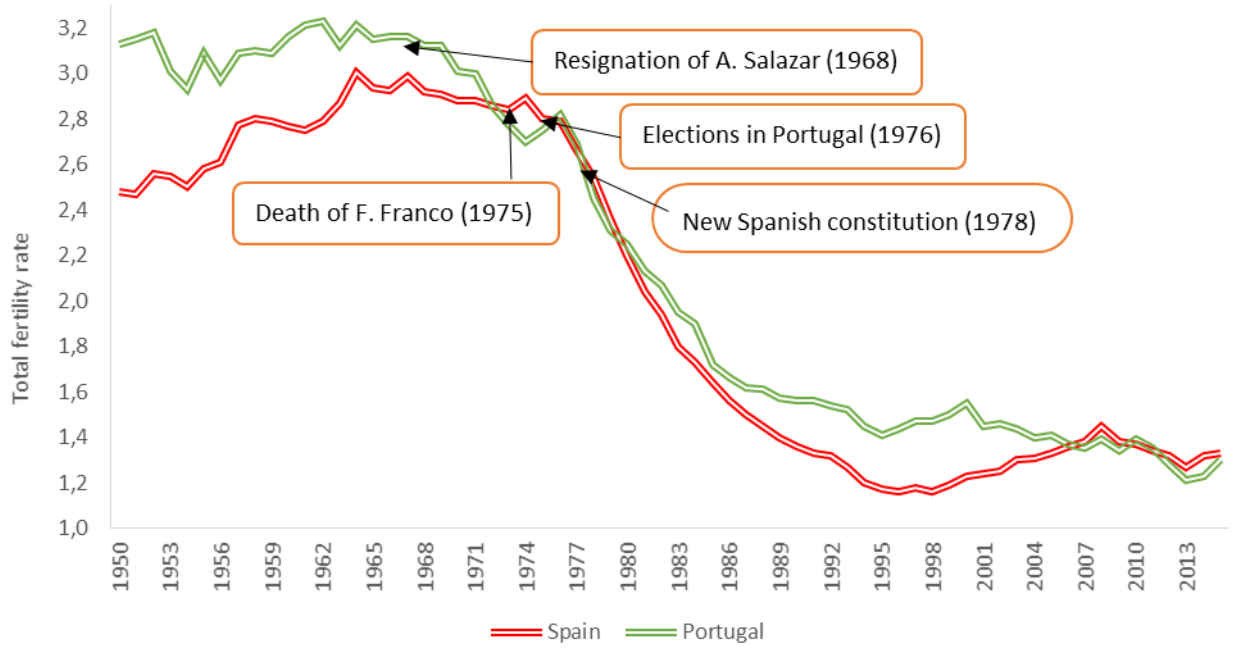

Figure 3. Total fertility rate in Spain and Portugal, 1950-2015

It should also be borne in mind that Spain's transition to a new form of government and the integration of this country into the European Union took place in an environment where the "old" family policy no longer existed, and the new one was significantly inferior to most Western European countries in terms of the scale of assistance provided to families. For example, in Spain in 2001, family spending was 0.1%, while in France it was 2% (Meil Landwerlin 1995: 75). In Portugal, events evolved according to a similar scenario: here, too, a rapid decline in fertility began shortly after the resignation of A. Salazar (1968), the overthrow of the dictatorship (1974) and the first free parliamentary elections of 1976 in half a century (Figure 3). In general, the rapid and deep decline in fertility in the countries of the Iberian Peninsula was, in our opinion, the "demographic price" of abandoning its isolated development and transitioning to the position of a semi-peripheral country in the Western world, and at the same time one of many illustrations of the fact that the family model with a breadwinner father and housewife mother can no longer provide for the simple replacement of generations.

In Italy, by contrast, the sharp decline in fertility was not associated with the radical change in the mode of political government that occurred in Spain and Portugal. Rather, it is a matter of certain significant political events testifying to the frame of mind in the country. Among them, of course, is the referendum of 1974, in which the majority (59.3%) of Italians opposed the repeal of the recently adopted law liberalizing divorce, as well as the referendum of 1981, in which 88.4% of voters voted against repealing the law liberalizing abortion.

Statistical analysis carried out by P. Rindfuss and his co-authors (Rindfuss et al. 2003) for 22 OECD[9] countries showed that the inverse relationship between the employment rates of women

[9] In our analysis, unlike (Rindfuss et al. 2003), we excluded from this set of 22 countries Luxembourg and added to it the Republic of Korea. Otherwise the sets here considered are the same. URL: https://stats.oecd.org/Index.aspx?DataSetCode=LFS_SEXAGE_I_R# (access date: 05/05/2018).

and fertility observed in 1970 had changed to a direct one by 1990. In Sweden and Norway, which were characterized by very high levels of employment for women (in 1990, 81.0 and 67.2% respectively of women aged 15-64), TFR (2.13 and 1.93 in the same year) was in 1990 close to the replacement level, whereas in Spain and Italy, low levels of female employment (31.8 and 36.2%, respectively) were accompanied by very low TFR values (1.36 and 1.33) (LFS ... 2018).

The fact that fertility in the Federal Republic of Germany was considerably lower throughout the postwar period than in France did not attract attention as long as fertility in both countries ensured simple replacement of the parental generation by the generation of children. However, by the mid-1970s the role of family doctrines became apparent: the German TFR (1.48) in 1975 was already significantly different from France's (1.93).

A significant contribution to the break in graduality in the period under review was also made by Japan and, especially, South Korea, which moved from 1st place in terms of TFR among these 22 countries in 1975 to 14th in 1990. Both countries, concerned after the end of the Second World War I by decreasing rather than increasing fertility, fell into an institutional trap: the contradiction between new economic realities and traditional family institutions led to the fact that women began marrying later and having fewer children.

Also contributing to this period's break in graduality was Sweden, where the so-called "speed premium" was introduced in 1986, making it economically beneficial for parents to reduce the interval between births (Andersson, Hoem, Duvander 2005). By 1990, the TFR in Sweden reached 2.13. If in 1975 Sweden shared 16th and 17th places in terms of TFR among the 22 named countries, in 1990 it was already in second place.

Summarizing the above, we note that the change that took place in the period under review in the positions of western bloc countries in terms of fertility had several causes. One of them was the fall of the Spanish and Portuguese dictatorships and the subsequent transition from isolation to integration into the semi-periphery of the capitalist world-system. The demographic price of this transition, which was not accompanied by the adoption of a new and fairly generous family policy, turned out to be a rapid and profound decline in fertility.

Another reason was that, on the European continent, the doctrine of a "natural" family with a breadwinner father and housewife mother, ideal from a religious and conservative point of view, suddenly turned out to be incompatible with maintaining an acceptable level of fertility. Such a course of events became a vivid example of the unintended consequences of politics: in Europe, by the end of the period under review, the countries where the ideal of a conservative family was put into practice by the state more consistently ended up lagging behind in terms of fertility. In countries that, like Sweden, have modernized their family policies so that they correspond to the new realities and support the combination of the parental and professional functions of women, fertility has been higher.

The history of fertility in the United States is different in this respect from that in Europe. Conservative white Americans, in families of which three or four children are not uncommon, make up a large part of the American population. In (Lesthaeghe, Neidert 2009), based on statistical analysis, it is shown that voting for the US Republican Party and rejecting the values underlying the second demographic transition are closely related. The victories of the Republicans

in the presidential and congressional elections in 2016 are indirect evidence that the population of this group of the United States is still very significant.

THE PAST QUARTER-CENTURY AND FUTURE PROSPECTS

The collapse of the USSR and the Soviet bloc entailed both new and very significant changes in the positions of countries in terms of fertility. By 2000, this position was significantly different from 1990 - the rankings of countries formerly belonging to the USSR, the Soviet bloc or Yugoslavia dropped sharply. Payment for integration into the world-economy, as in the case of Spain and Portugal, was a sharp decline in fertility. The mediating factors, the relative importance of which remains controversial to this day, were a sharp decline in living standards, changes in the life plans of young people (the practical expression of which often became emigration to the countries of the world-system core), later birth of children, and the degradation of population policy. Russia, which ranked 18th in terms of TFR in 1990, dropped to 39th by 2000; Hungary fell from 20th to 27th place, Poland from 10th to 23rd, and the Czech Republic from 16th to 40th. In 2000, the differences between the average TFR values for countries that underwent socioeconomic transformation (1.35) and the other countries of the set considered (1.61) were statistically significant by the *t*-test at $\alpha < 0.001$.

The political and economic restructuring of the world led to significant changes in the nature of the relationship between living standards and fertility in developed countries. If, in 1950, in countries with developed market economies no relationship between per capita GDP (PPP) and TFR was observed ($r = 0.07$), then by 1990 it was already quite clearly indicated ($r = 0.425$, significant at the level $\alpha = 0.05$)[10]. At the same time, it turned out that a high per capita income, while necessary, is an insufficient condition for a relatively high fertility (Table 1).

Table 1. Distribution of 22 countries with developed market economies by the total fertility rate in 1990

Countries with per capita GDP (PPP)	The number of countries with a total fertility rate of			Total number of countries
	less than 1.5	1.5-1.8	1.8 and higher	
Less than 17,000 dollars	6	3	2	11
17,000 dollars and more	-	7	4	11

Sources: Author's calculations based on (Demoscope Weekly. Supplementary materials 2018; Maddison 2010).

After the countries that had been part of the USSR, the Soviet military-political bloc and Yugoslavia, previously relatively isolated from the world economy, became the economic periphery and semi-periphery of the developed world, the direct relationship between per capita income and fertility for some time noticeably increased. In 2000, in the aggregate of 38 countries[11], there was a direct ($r = 0.59$) and statistically significant at $\alpha < 0.001$ link between per capita GDP (PPP) and TFR (Figure 4).

[10] Calculations of the author based on (Demoscope Weekly. Supplementary materials 2018; Maddison 2010) in 1990 for the 22 countries mentioned above, in 1950 for the same countries without South Korea.
[11] The totality of the 41 countries listed above, excluding Bosnia and Herzegovina, Serbia and Montenegro.

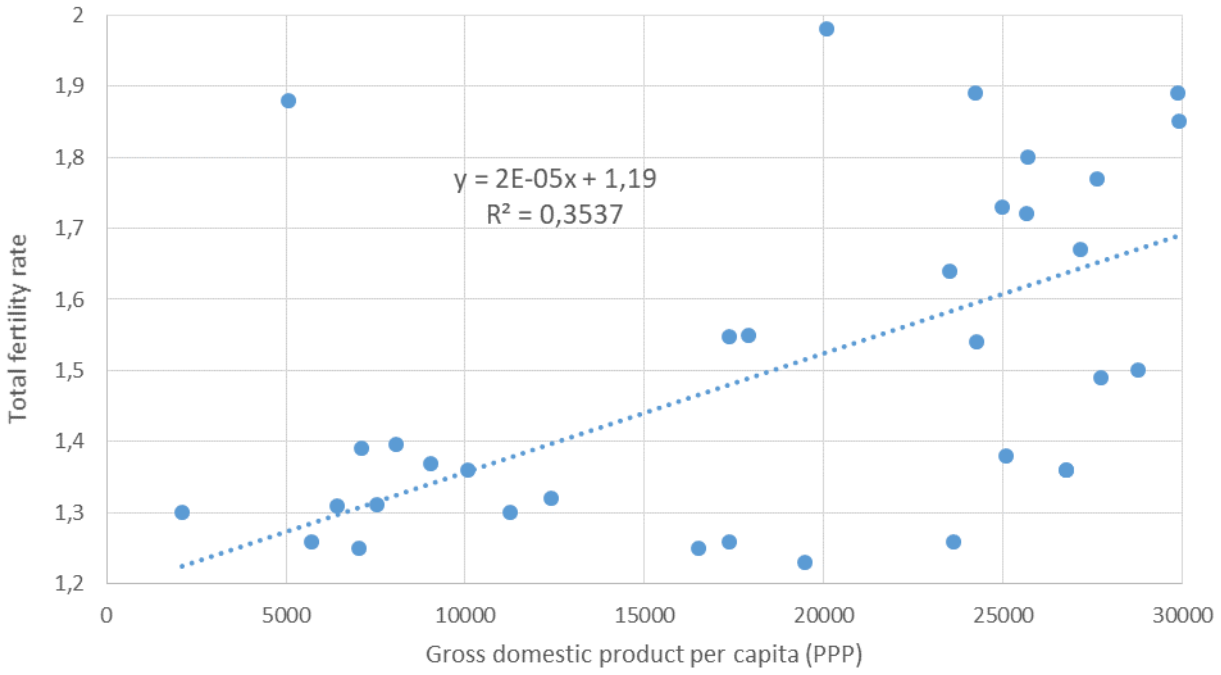

Figure 4. Gross domestic product and total fertility rate in 38 developed countries, 2000

Sources: (Demoscope Weekly. Supplementary materials 2018; UNDP 2002: 149-152).

In 2015, the relationship between gross national income (hereinafter referred to as GNI) per capita and the TFR for the 41 countries in question remained statistically significant at the 1% level ($r = 0.41$), although not as close as it was one and a half decades earlier. As in 2000, relatively high fertility was possible only for countries that had secured a place in the core of the world-system. Being in such a core was, as in 2000, a necessary but insufficient condition for achieving a fertility level close to replacement level (table 2).

Table 2. Distribution of countries in the periphery, semi-periphery and core of the developed world by the total fertility rate in 2000 and 2015, %

Year	Group of countries	GDP (PPP) per capita*. thous. dollars	Number of countries	Distribution of countries by TFR, %			
				Less than 1.5	1.5-1.8	1.8 and more	Total
2000	Periphery	Less than 10	11	90.9	-	9.1	100
	Semi-periphery	10-20	9	77.8	22.2	-	100
	Core	20 and more	18	27.8	38.9	33.3	100
2015	Periphery	Less than 20	9	33.3	66.7	-	100
	Semi-periphery	20-35	16	56.3	37.5	6.3	100
	Core	35 и more	16	12.5	56.3	31.3	100

*Note: * - in 2015, gross national income (PPP) per capita.*

Sources: Author's calculations based on (Demoscope Weekly. Supplementary materials 2018; UNDP 2002: 149-152; UNDP 2016: 198-201).

The consequence of the economic and political restructuring of the world, which occurred at the end of the 1980s and start of the 1990s, was the formation of four attractors[12]. The first of these is an institutional trap that "pulls" peripheral countries when they are integrated into the capitalist world-system. The vital needs of young people in peripheral countries in this case are formed on the basis of comparison with their more developed neighbors, and the impossibility of satisfying these needs leads to a decrease in fertility. An additional factor in this decline is the emigration of a significant part of the population of peripheral countries to the countries of the semi-periphery and the core of the world-system. Such a situation is observed, for example, in Moldova and Ukraine.

The second attractor is another type of institutional trap. A low standard of living is no longer in this case a factor in the decline in fertility, since its main cause is the contradiction between the rapidly changing structure of life outside the family and the more inert norms of family relations. This trap attracts the most developed countries of the world (examples are Germany and Japan). The third attractor attracts semi-peripheral countries, combining in some proportions the properties of the first and second attractors.

The fourth attractor also has magnetic power, but unlike the first three, it is not a trap, but an ideal. It is based on the idea that a generous demographic or family policy that helps women combine parental and maternal roles, together with more evenly divided household responsibilities between spouses than in a conservative family, can provide a birth rate that ensures simple replacement of generations. The "material basis" of this ideal, which makes it possible not to consider it a purely speculative utopia, is the current demographic situation in the Nordic countries and France, where fertility has come closer to reaching the replacement level than in other developed European countries.

The relatively high birth rate in France, for example, has been greatly facilitated by the timely transformation of family policy (Toulemon, Pailhé, Rossier 2008). This policy, originally focused on a single-breadwinner family model, was subsequently transformed in such a way as to facilitate women's combination of maternal and professional roles. The development of the situation in the Nordic countries, according to a number of authors, gives hope that the "second half of the gender revolution", expressed in the broader involvement of men in household chores, will lead to an increase in fertility (Goldscheider, Bernhardt, Lappegârd 2015: 229).

These attractors, which make up a system with four centers of gravity, have determined and will presumably continue to determine the dynamics of fertility in the developed world in the near future. In the 1990s, the first of these attractors "pulled" into trap countries, transforming their socio-economic system; Russia was one of them. With the improvement of the economic situation, most of these countries managed to get out of the gravitational field of this attractor, while, among former Soviet republics, Ukraine and Moldova remain closest to it.

Having escaped from the trap of the first attractor, the countries that underwent a transformation of their socio-economic and political structure at the end of the last century have nonetheless not reached the fourth. The demographic goal of most governments in countries

[12] The expediency of borrowing this concept from the synergetics is, in our case, due to the fact that it defines an object that attracts other objects to itself and is their limiting state.

belonging to the periphery and semi-periphery of the developed world is to achieve the fertility characteristic of such core-world countries as France or the USA. Realization of this goal is hampered, however, by a lack of sufficient resources due to their peripheral or semi-peripheral position. Moreover, the risk of returning to the former, extremely low birth rates remains quite real. The governments of this group of countries more often see a way out of the current situation in the redistribution of available resources in favour of demographic or family policy.

The demographic policy of modern Russia is an example of such a strategy, but today it is no longer unprecedented - it has, irrespective of geopolitical orientation, been adopted by other countries. The most recent examples include Hungary and Poland. In 2016, the new Polish government announced the launch of the "Family 500+" program, previously promised to voters. This program provides benefits in the amount of 500 PLN (hence the "500+" in the title) to families with two or more children (Kulczyk 2016). Hungary announced that, starting from 2018, at the birth of a second child families will have half their student loans forgiven, and at the birth of a third - the whole loan, and that new tax breaks will be introduced and support will be given to families who buy housing on credit[13].

The problems of countries that have fallen into the gravitational field of the second and third attractors (typical examples are Germany and Spain, respectively) are not only or not so much in the lack of resources, but in the inertia of informal and formal institutions formed by the family doctrines that have prevailed for many years. The fourth ("ideal") attractor has been most closely approached by countries with a high standard of living. In the twenty-first century, if we are talking about the developed world, it has been possible to achieve a TFR value close to the replacement level only in countries with very high per capita income, which include France, Sweden, Ireland, the USA and, with some reservations, a number of other countries.

CONCLUDING REMARKS

A number of methodologists (Tilly, Goodin 2006) share research strategies aimed at finding common laws and mechanisms. The latter can be defined as chains linking the causes of events, the events themselves and their results. According to the expression of O. Yu. Malinova, "the mechanism is less than theory, but more than description, because it can serve as a model for explaining other cases" (Malinova 2013: 14). The study of mechanisms is closely related to diachronic or, as they are also called, "genetic" explanations, the purpose of which is to show how subsequent events grow from previous ones.

The analysis carried out in this paper gives grounds to talk about several mechanisms linking political and demographic history. One such mechanism consists of pronatalist demographic policies, often, though not always, arising as a response to an external threat. The chain of cause-effect relationships is sometimes very long. Thus, the Franco-Prussian war of 1870-1871, which had a great influence on the French political class, led to the emergence of

[13] URL: http://abouthungary.hu/blog/hungary-names-2018-the-year-of-the-family/ (reference date 04.08.2018).

French pronatalism, which in turn played a significant role in shaping demographic, and then modern family policy in France.

Another mechanism links integration into the capitalist world-system of states that were previously isolated from it with a decrease in their birth rate.

With all the obvious differences between countries that have moved from more or less pronounced autarchy to close integration into the capitalist world-system, inclusion in it in all cases was possible only as part of the semi-periphery or periphery. In this case, the mediating links between integration and declining fertility were new standards of quality of life and a lowering of the barrier functions of borders. The contradiction between needs and opportunities was resolved either by refusing to give birth to second and subsequent children, or by emigration of the population of reproductive age to the countries of the core, which again reduced the birth rate.

Although the period of transformational shock is now over, the nature of the effect of migration on fertility is still closely related to the position of countries on the center-peripheral scale. The countries of the core of the world-system are the most attractive for immigrants, while the peripheral countries become migratory donors and lose their reproductive contingents. In this respect, semi-peripheral countries occupy an intermediate and unstable position. A striking example is Spain, in which the economic and immigration boom at the beginning of the 21st century was replaced after the beginning of the 2008-2009 crisis by an outflow of qualified youth to the countries of the European core. The low birth rate observed on the periphery and semi-periphery of the developed world is thus the result of structural constraints built into the world-system, making relatively high fertility a privilege available only to the richest countries. The question of whether these limitations can be overcome by redistributing the resources of the semi-peripheral and peripheral countries of the developed world in favour of family and demographic policy remains open.

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GENERATIONAL ACCOUNTS AND DEMOGRAPHIC DIVIDEND IN RUSSIA

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The paper presents a modern methodology for estimating the impact of different age groups on the production and distribution of national income, called national transfer (generational) accounts. The human economic lifecycle is divided into stages defined by the ratio of labour income to consumption. In middle ages, gained income is higher than current consumption. The resulting surplus of resources is supposed to cover the income deficit in older and younger age groups. Estimates of the deficit or surplus at different ages are made for the Russian population for 2013 based on the results of age profiles taken from administrative sources and surveys. In the paper we also estimate the projected changes in the lifecycle deficit under different demographic development scenarios. Age profiles of labour income and consumption are used to calculate the effective economic support and the influence of demographic changes in Russia on economic growth rates in the near future.

***Key words**: economic lifecycle, national transfer accounts, income, consumption, ageing, effective economic support, demographic dividend.*

INTRODUCTION

In recent decades, the world has experienced significant demographic changes, which are manifested in a decrease in fertility, an increase in life expectancy, intensive international migration and, as a result, the transformation of the age composition of the population. In some countries where the demographic transition is close to completion or completed, a process of demographic aging is underway. A steady increase in the proportion of people at older ages in the total population is a challenge for these countries, whose social institutions were formed in the period of their "demographic youth". In other countries, where fertility decline began relatively recently, the proportion of young persons of working age is increasing and the proportion of children is decreasing. With other things being equal, such an optimization of the age structure may lead to a demographic dividend, as was recently the case in China or other countries of Southeast Asia.

According to some estimates, the demographic dividend in East Asia accounts for between one-fourth and two-fifths of economic growth in the 1980-1990s [Bloom, Canning, Sevilla 2003: 45]. But there is also a development scenario in which poor countries will not have time to take advantage of the opportunities provided by the demographic transition and reap the demographic dividend before the process of population aging begins.

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Finding answers to demographic challenges means overcoming possible problems and conflicts, on the one hand, and realizing new opportunities for development, on the other. This is one of the main tasks of socio-economic policy. But to provide a firm foundation for its implementation it is necessary to correctly measure the effects of changes in the age structure of the population. The search for such indicators is one of the important tasks of economic and demographic research. However, the standard indicators of economic development adopted in the modern world apply mainly to the population as a whole, and do not reflect the contribution of certain age groups or generations to total production and consumption. While data on the age characteristics of consumption, income, and labor productivity in a number of countries are systematically collected and developed, the patterns of redistribution of income and resources between generations are unacceptably little known. Transfer systems, the functioning of which is mediated by the family institution, the state or the market, are themselves in a state of reform under the influence of the above-mentioned demographic changes.

Interest in assessing the effects of demographic changes in Russia has grown substantially in recent years. Many issues related to the organization of education, social welfare and healthcare, unresolved in the past, in the context of an increasing aging process threaten to escalate in the near future. In addition, interest in economic and demographic issues is increased by the continuing decline in the population at working ages, the accelerated increase in the proportion of people in the elderly population and, against this background, a likely increase in migration flows. Thus, the task of building adequate indicators reflecting the consequences of an aging population in Russia is extremely important in the very near future.

In this paper we will focus on two indicators that allow us to assess the impact of changes in the age structure of the population on economic development and present estimates of their effect on the Russian Federation. We are talking about the “life cycle deficit” indicator and the “effective economic support” indicator. Both of these indicators are developed in the framework of a new methodology for analyzing the redistribution of resources between generations - the system of national transfer (intergenerational) accounts. The article briefly discusses the basic provisions of the methodology for their construction. This part of the work is complemented by estimates of a number of indicators of the system of national transfer accounts for Russia for 2013. The final part presents estimates of the life cycle deficit and effective economic support, which reflect the impact of changes in the age structure of the Russian population on the country's economy in the near future. The article begins with a brief overview of the history of the inclusion of age structures in economic models.

AGE POPULATION STRUCTURES IN ECONOMIC RESEARCH

The numerous studies of the role of age composition and its changes in economic development have over time been unified into a discipline called Generational Economics. According to one definition, the economics of generations studies: 1) social institutions and economic mechanisms by which generations or age groups produce, consume, redistribute, and save resources; 2) economic flows between generations or age groups; 3) explicit and implicit contracts that manage intergenerational flows; and 4) incomes and consumption of separate generations and age groups [Lee, Mason 2011: 7]. The initial period in the history of research on this subject was

distinguished by the fact that the work carried out by demographers remained largely unknown to economists, just as the work of scientists from former socialist countries was terra incognita for their Western counterparts.

The emergence of “Generational Economics” as a scientific field in Western literature is associated with the names of two Nobel laureates - Paul Samuelson and Franco Modigliani.

The macroeconomics of generations begins with the work of Samuelson and the overlapping generation model proposed by him [Barro, Sala-i-Martin 2004: 252]. In his study of the equilibrium rate of interest, P. Samuelson suggested that the life of a person is divided into two periods: working age (age 20 to 65 years) and retirement (age 65 and older). In the labor period, one part of a person’s means goes to consumption (including childcare), and the other part to savings, so as to ensure consumption in old age. At older ages, a person consumes using his savings, as well as repaid loans once provided to younger generations. P. Samuelson called consumption of savings "time transfers" [Samuelson 1958: 471].

Subsequently, the model of intersecting generations became more complex, coming to include various forms of intergenerational transfers. As examples, we cite a few studies. In the next outstanding work after Samuelson’s, Peter Diamond [Diamond 1965], another Nobel laureate, used this model to show the importance of national debt and a solidarity pension system for optimizing the level of consumption in society. In turn, R. Barro used the model of overlapping generations to express the hypothesis that intra-family transfers neutralize the redistributive effects of social transfers [Barro 1974]. In 1978 W. Arthur and J. McNicoll combined demographic models of the age structure with the model of Samuelson's intersecting generations, which allowed them to establish the significance of the growth rate and age composition of the population for savings and intergenerational transfers [Arthur, McNicoll 1978]. And in 1988 a collective monograph, “The Economics of Changes in the Age Structure in Developed Countries”, was published, which touches upon various aspects of population aging: economic growth, cohort effects in earnings, impact on the labor market and the household sector, demographic features of pension systems, etc.[Lee, Arthur, Rodgers 1988]. We especially note the chapter prepared by R. Willis, where he tried to integrate microeconomic models of the life cycle of an individual and a household and of demographic behavior into the model of intersecting generations [Willis 1988].

The work of F. Modigliani and R. Bramberg marked the beginning of the microfoundations of the economics of generations. It formulated the concept of the economic life cycle and provided a foundation for the thesis on the relationship between consumption levels, savings and transfers between generations [Modigliani, Brumberg 1954]. Problems of intergenerational interactions seen through the prism of the concept of the life cycle have been considered in many studies. For example, M. Feldstein, relying on the economic life cycle model, was one of the first to suggest that public pension programs reduce the propensity to save [Feldstein 1974: 910]. L. Kotlikoff and L. Summers [Kotlikoff, Summers 1981], turning to the age profiles of earnings and consumption, established that intergenerational transfers, which are made, in their opinion, to support children or parents, are an important factor in saving and accumulating wealth. A somewhat different point of view was expressed by one of the authors of the concept of the economic life cycle, F. Modigliani, who argued that the desire to maintain one’s level of consumption after retirement explains the accumulation of savings and capital in the United States [Modigliani 1988].

At the same time, it should be noted that as early as the first quarter of the twentieth century the outstanding Russian scientist A. Chayanov expressed and implemented the idea of building generational economic balances based on age profiles of production and consumption [Chayanov 1989]. Studying the budgets of peasant farms, he established a close relationship between the phases of the life cycle of a peasant family and the scale of its economic activity and consumption, revealing the contribution of particular generations to the development of peasant farms during certain phases of the life cycle.

In Europe, at the same time as in the United States, the process of analyzing the impact of demographic changes on economic development also went step by step. Thus, the ideas of the French economic and demographic school regarding intergenerational interactions and the consequences of population aging in the 1960s were summarized in the work of A. Sauvy, "General Population Theory" [Sauvy 1977]. It is necessary also to note the works of the Hungarian demographer E. Valkovich (1971), unique for their time (1960–1970s). To assess the influence of age structures, he proposed the method of economic age pyramids. According to the results of surveys, he determined the age profiles of income and consumption in Hungary and, based on them, periods of shortage or excess of resources at certain stages of the life cycle. Age pyramids or structures were calculated by multiplying the age indicators obtained by the population of the respective age groups. A comparison of economic pyramids over a number of years made it possible to estimate the effect of the changes in the age structure for aggregate indicators of production, consumption, savings, etc.

In the 1970-1980s, the Australian demographer J. Caldwell, based on the ideas of A. Chayanov, developed the theory of the demographic transition, a key element of which was the analysis of the directions of wealth flows between generations [Caldwell 1982]. Intergenerational relations in a traditional society took shape in favor of the older ages, since the system of kinship support was directed towards them, and economic activity began in childhood. According to the results of a number of studies by J. Caldwell and his followers, the economic value of children due to the "net flow of benefits" from them for parents was high. The transfer system for the redistribution of resources of a traditional society, which developed in conditions of high mortality, ensured high fertility.

In the USSR in 1986 a paper by E. Andreev and L. Darsky was published on economic and demographic processes in real generations [Andreev, Darsky 1986]. Based on the model of a stable population, as well as on some ideas of B. Urlanis [Urlanis 1971; 1976], they estimated the volume of goods produced and consumed by different generations, depending on the rate of increase in labor productivity, the level of mortality and the rate of population growth. Andreev and Darsky showed that a situation of negative economic balance between generations is possible, i.e. an excess of consumption over the volume of produced goods. This is due to the fact that the period of labor activity in the 1970-1980s decreased due to the lengthening of the period of education and the development of the pension system. They agreed with Urlanis that the systematic negative balance of generations is not necessarily associated with a decrease in national wealth. This balance can be covered at the expense of other generations, including younger ones with higher productivity. At the same time, the balance of the hypothetical generation remains positive. The concept of balance here actually corresponds to the concept of a life cycle deficit adopted in foreign literature.

The results of numerous and long-term studies ultimately led scientists to conclude that the task of assessing the effects of demographic changes on economics and public policy should be addressed through balance equations for the redistribution of resources between generations (age groups), combining analytical methods of demography and economic theory. Work on creating intergenerational balances within the framework of the system of national accounts began in the 1980s. The credit for creating a modern system belongs to two Americans – the demographer Ronald Lee and the economist Andrew Mason [D'Albis, Moosa 2015]. Thus, as early as 1980 R. Lee summed up the work of researchers over a twenty-year period. There he also made one of the first attempts to assess the effect of changes in the age structure through intergenerational transfers on economic growth [Lee 1980]. E. Maiso, in his 1988 paper, showed the value of an intergenerational approach to studying savings [Mason 1988]. In 1994, R. Lee, analyzing the consequences of population aging, attempted to combine models of population reproduction with economic models and research topics, including models of overlapping generations, optimal population growth, savings and the life cycle, generational accounting (to be discussed below), the study of the population's reaction to the introduction of public transfer programs, etc. [Lee 1994].

In their subsequent work, R. Lee and E. Mason developed a methodology for constructing and analyzing balances (accounts) of economic flows, taking into account the age composition of the population. They expressed the idea of building age balances of time budgets. Subsequently, this idea was implemented as part of a research project, "National Transfer Accounts". The age profiles of consumption and income were later used to build models of capital accumulation and the redistribution of wealth and the development of the system. Using age profiles of taxes and benefits, R. Lee and S. Tuljapurkar [Lee, Tuljapurkar 2000] built a long-term forecast of financial development of the US social security system in the context of demographic aging, and R. Lee and T. Miller estimated the long-term fiscal implications of immigration for the US [Lee, Miller 2000]. A group of researchers (A. Bomier, R. Lee, and others) determined which of the generations from 1850 to 2090 born in the United States are winners and which losers as a result of the redistribution of resources through a channel of public intergenerational transfers [Bommier et al. 2010].

Wide scientific and public interest in assessing the effects of demographic changes, as well as the results of numerous scientific studies led to the fact that in 2002, under the scientific leadership of R. Lee and A. Mason, an international project was launched to develop a methodology for constructing a system of national intergenerational (transfer) accounts and their application. The first participants in the project, in addition to the developed countries (USA, France, Japan), were developing countries (Brazil, Indonesia, Taiwan, Chile) which had experienced rapid changes in the fertility, mortality and age structure of the population. Initially, the project was supported by the US National Institute of Aging, but a few years later the United Nations Population Fund, then the European Commission, the Center for the Development of International Studies of Canada and the Population Division of the UN Secretariat joined the project. Currently, 94 countries are participating in the project, including Russia[1].

[1] Russia is represented by the National Research University Higher School of Economics

In the late 1990s and early 2000s the American demographer David Bloom and his colleagues showed that the "miracle" of the rapid economic growth of Asian countries (China, Thailand, Taiwan, South Korea) is largely due to changes in the age structure of the population [Bloom, Williamson 1998; Bloom, Canning, Malaney 2000; Bloom, Canning, Sevilla 2003]. As a result of the rapid decline in fertility, the proportion of people in working age has increased and the demographic burden has decreased. The resulting gain was called a demographic dividend. Since then, "demographic dividend" has become one of the central concepts in economic and demographic studies [Lee, Mason 2006]. New approaches to its assessment, as well as to the assessment of support ratios taking into account the age peculiarities of income and consumption, were developed within the framework of the system of national transfer accounts [Prskawetz, Sambt 2014; Mason et al. 2017].

Note that in addition to the national transfer accounts addressed by the authors of this article, there are other methods for assessing the redistribution of resources between generations. For example, in the early 1990s the American economists and demographers L. Kotlikoff, A. Auerbach, and J. Gokhale proposed a method, called Generational Accounting, to evaluate the effects of demographic aging and the financial efficiency of existing government programs that redistribute income between generations (primarily pension programs) [Kotlikoff 1992; Auerbach, Gokhale, Kotlikoff 1994]. In 2013, at the E.T. Gaidar Institute of Economic Policy, an economic and demographic study of the current and prospective state of public finances in Russia, "Assessment of the budget gap in the Russian Federation", was conducted with the participation of L. Kotlikoff[2]. According to experts, current fiscal policy cannot ensure the sustainability of the budget system over the long term, largely due to the aging of the population, which will increase the costs of pensions and medical services. As a result, the budget gap, according to which the stability of state finances was assessed, in Russia by 2015 should have increased to 11.8-14.1%. But the problem was not only in the aging of the population, but also in the likely decline in budget revenues from the export of hydrocarbons (the impact of which on the budget gap was about 2 times greater than the demographic one).

INTERGENERATIONAL ACCOUNTS

An economic system can be represented as flows of wealth between people and various institutions, among which an important place is occupied by flows between generations or intergenerational transfers. However, in the main system for describing and analyzing macroeconomic processes in the countries of the world — the system of national accounts (SNA)[3]

[2] Project website: URL: http://www.iep.ru/ru/ocenka-byudzhetnogo-razryva-v-rf-russia-s-fiscal-gap.html. The main results were published later in the article [Goryunov et al. 2015].

[3] The system of national accounts arose about 50 years ago in the most economically developed countries due to the need for information necessary for analyzing the state of the economy, formulating economic policies and taking measures to regulate a market economy. Conceptually, this system is integrated with the balance of payments and a number of other sections of macroeconomic statistics. The essence of the SNA is the formation of summary indicators of economic development at various stages of the reproduction process and the mutual linking of these indicators among themselves. Each stage of reproduction (production stage, primary distribution of income, secondary distribution of income, use for final consumption and accumulation, etc.) corresponds to a special account or group of accounts. The national accounts system reflects flow accounts, i.e. the movement of flows of goods,

— the redistribution of resources between age groups (generations) is not reflected. Thus, this system is in no way linked to the epoch-making demographic changes occurring at the turn of the twentieth and twenty-first centuries in both developed (with demographic aging) and developing (with declining fertility) countries of the world. The authors of the idea of linking the SNA with demographic processes are the already mentioned economist Andrew Mason and the demographer Ronald Lee. Finally, they developed the concept of building National Transfer (Intergenerational) Accounts (NTA), which in their full form represent a systemic and comprehensive display of existing economic flows as flows between age groups [Lee, Mason 2011; United Nations 2013].

Externally, the system of national transfer accounts in full form represents the distribution of a number of national accounts indicators by one-year age groups. But there are differences between the SNS and NTA systems. In particular, the unit of analysis in intergenerational accounts is the individual, not the household. Although household consumption is carried out jointly, according to the authors of NTA in most cases consumption is individual. At the same time, there are economic flows that cannot be directly distributed by age groups: a) flows between institutions, for example, between corporations and the state; b) a series of flows of public goods, for example, defense expenditures, the state apparatus, the judicial system; c) many flows which in statistics are not linked with an individual, but with households. In practice, when building national transfer accounts for the distribution of these flows between age groups, various assumptions and/or models are used.

Social institutions in the concept of national transfer accounts act exclusively as intermediaries for exchanges between age groups. For example, a firm's profit is viewed through the prism of the age of its owner, government transfers through the age of taxpayers and recipients of various kinds of benefits and privileges. In total, there are three groups of institutions: 1) private institutions: corporations, households, non-profit organizations; 2) public or state institutions; and 3) the rest of the world, which is associated with the inflow or outflow of wealth from abroad.

The system of transfer accounts uses the categories “labor income” and “income from assets”, which are not defined in the system of national accounts, but are defined on their basis. According to the methodology for building transfer accounts, labor income, capital income and consumption are estimated before taxes and subsidies on products and production are paid.

According to the methodology of building national transfer accounts, labor income is a source of resources for consumption. In contrast to national accounts, all other forms of individual incomes (rent, interest, pensions, etc.) fall into the category of reallocation, i.e. are the result of the redistribution of resources to meet current or future consumption. Labor income, in turn, has two components: the remuneration of employees (including various kinds of bonuses from the employer - for example, the cost of the social package) and income from self-employment. Income from self-employment is calculated as two thirds of the mixed income in national accounts.

The central feature of the concept of national transfer accounts is the economic life cycle, which primarily reflects the characteristics of age consumption and income models. At certain stages of the life cycle (in childhood and adolescence, in middle and older ages), the material needs

services and income through all stages (from production to use), as well as changes in non-financial assets and financial assets and liabilities (See: [System of National Accounts 2012]).

of a person and the possibilities of their satisfaction created by his work may not coincide. There thus arises a shortage of resources for consumption at the stages of childhood and old age and a surplus at middle ages. This deficit is covered through the redistribution (reallocation) of resources from age groups in which there is an excess of them to age groups in which there is a shortage, in the form of intergenerational transfers and asset-based reallocations [United Nations 2013: 26, 31]. Redistribution mechanisms and corresponding resource flows, depending on the institutions between which they are implemented, are divided into private and public.

Intergenerational transfers are material resources or services passed on gratis from the older generation to the younger (downstream transfers) and from the younger generation to the older generation (upstream transfers). The category of "transfers" in the system of national transfer accounts is interpreted very broadly. It includes all gratuitous flows of goods between individuals, including social payments and services from the state, tax payments and deductions for social insurance, transfers between households and within households. It should be noted that there are no analogues of the last two types of transfers in the system of national accounts, and they are evaluated using other sources of information. Accounting for transfers within households and methods for their evaluation are one of the important scientific and practical innovations that have been justified within the framework of the concept of national transfer accounts.

The age-based redistribution of assets is realized in time in the form of accumulation of savings and their spending, as well as income from assets as a person transitions to the older age group. Thus, savings are made throughout one's working life, and spent after retirement. In his youth, a person receives loans for education, which he pays back after graduation. Buying bonds, stocks, durable goods, housing, land, insurance, consumer loans, etc. are all examples of asset-based redistribution.

Economic flows in the NTA system, in addition to being divided into public and private, are also divided by the main goals of consumption and the purpose of transfers: education, health care, government pensions, etc.

In effect, the system of national intergenerational accounts is designed to answer the question of how the deficit arising at different stages of the life cycle is covered. The economic life cycle is expressed by the following balance equation linking the main flows of the system of intergenerational accounts (formula 1):

$$\underbrace{C(a) - Y^{l}(a)}_{\text{Life cycle deficity}} = \underbrace{Y^{a}(a) - S(a)}_{\text{Asset-based reallocation}} + \underbrace{\tau^{+}(a) - \tau^{-}(a)}_{\text{Net transfers}}, \quad (1)$$

where:

a – is age;
$C(a)$ – is consumption;
$Y^{l}(a)$ - is labor income;
$Y^{a}(a)$ – is income from assets;
$S(a)$ – is savings;
$\tau^{+}(a)$ – is received transfers;
$\tau^{-}(a)$ – is transmitted transfers.

A positive value of this equation indicates a shortage of resources at a given age, while a negative one indicates their excess or surplus. It should be noted that estimates of national transfer

accounts are constructed for individual calendar years, and age distributions of economic indicators are interpreted in terms of conditional generations. But recently, as more information accumulates, attempts are being made to build transfer accounts for real generations [Temple, Rice, McDonald 2017].

AGGREGATED TRANSFER ACCOUNTS

The construction of national transfer accounts begins with the collection of statistical information in three areas:

1) the number of age groups of the population. If transfer accounts are built for individual socio-demographic groups (sex, education, urban-rural, migrants, etc.), then in such cases an age-related composition of these groups is necessary;
2) national accounts containing basic information on economic flows which will be distributed by age. Based on the national accounts indicators, aggregated indicators (macrocontrollers) of income, consumption, transfers, income from assets and savings of intergenerational accounts are calculated;
3) nationally representative household surveys and administrative sources of information (tax services, treasury, ministry of education, etc.). According to data from these sources, age profiles of economic indicators are estimated (per capita) for distribution by age groups (generations) of aggregated indicators and the final construction of transfer accounts.

Based on the relevant data sources, the authors of the article have attempted to build national transfer accounts and assess the life cycle deficit in Russia for 2013. This year was not chosen randomly to start work on creating the NTA system: it was the last year before the financial and economic crisis that began at the end of 2014 and the introduction of a regime of sanctions against Russia by Western countries. Also taken into account was the fact that since 2011 Rosstat had switched to a modernized methodology for the construction of national accounts [System of National Accounts 2012; National Accounts of Russia 2013].

At the first stage, the values of aggregate indicators (macrocontrollers) of resource flows in the system of national transfer accounts[4] were estimated. The results of the evaluation are presented in table 1. By analogy with the system of national accounts and depending on the institutions involved, these results are presented in the form of the following accounts:

- life cycle account;
- account of public redistribution of benefits between age groups;
- account of private redistribution of benefits between age groups[5].

This article focuses on the life cycle account. Its components (age profiles of income and consumption) make it possible to proceed to refined estimates of support ratios and a demographic

[4] A detailed methodology for the transition from SNA to NTA is set out in the Guidelines for the construction and analysis of national transfer accounts [United Nations 2013].
[5] Table 1 does not provide estimates of the volume of transfers between and within households that are not counted in the SNA. They are made according to the results of surveys. Currently, work is underway to refine the model of these transfer flows.

dividend reflecting the impact of changes in the age structure of the Russian population on its economic development.

CONSTRUCTION OF AGE PROFILES

Next, the main task becomes the distribution of aggregated indicators of flows by generations, i.e. obtaining so-called age profiles of macro indicators of the system of national transfer accounts. Profiles are built by one-year age groups. This problem is solved in two steps.

Table 1. Aggregated indicators (macrocontrollers) of the system of national transfer accounts of Russia in 2013, billion rubles.

Deficit account (+) / surplus (-) of the life cycle		Public resources redistribution account		Private resources redistribution account	
name	volume	name	volume	name	volume
Life cycle deficit	3 473	Public redistribution	1 224	Private redistribution	2249
Consumption	43 010	Net public transfers:	245	Net private transfers:	-543
Public consumption:	13 552	for education: inflow	1 817	between households: inflow	Not in SNA
educational services	1 817	for education: inflow	1 817	between households: inflow	Not in SNA
healthcare services	2 050	for education: outflow	2 051	within households: inflow	Not in SNA
other	9 684	for healthcare: inflow	2 051	within households: outflow	Not in SNA
Private consumption:	29 458	for pensions: inflow	5 250	Redistribution based on assets:	2 793
educational services	244	for pensions: outflow	5 250	net income from capital	10 946
healthcare services	1 173	others in kind: inflow	9 684	imputed earnings of homeowners	5 287
other	28 041	others in kind: outflow	9 684	net income from property	-5 107
Labor income:	39 536	others in cash: outflow	3 595	net private savings	8 333
remuneration of employees	11	others in cash: inflow	3 350		
self-employment income	5 725	Redistribution in the form of assets	979		
		net income from capital	-51		
		net income from property	2 981		
		net public savings	1 951		

Source: Built by the authors together with the staff of the Institute for Development Center at the HSE University A. Nazarova A. and A. V. Chernyavsky.

The first is to construct, using data from surveys or administrative sources containing information about the age of respondents or users of services, primary age profiles reflecting the level of per capita consumption, labor income, transfers, or savings. As noted above, in surveys much of the information is tied not to individuals, but to the households in which they live. In this regard, the problem arises of the transition from household estimates to individual estimates, since the unit of observation in intergenerational accounts is the individual. To solve this problem, two approaches are often used: 1) household members are assigned consumer weights, or all resources

are attributed to the household head (for example, taxes or rent income); 2) statistical methods (regressions) are used to distribute a particular value among members of households.

To construct the primary age profiles the following data sources were used:

- household surveys (for obtaining income profiles, private consumption, including health care services): Russian Monitoring of Economic Status and Health of the Higher School of Economics National Research University (HSE); Survey of Incomes and Participation in Rosstat Social Programs;
- HSE survey in the framework of the monitoring of the economics of education, "Surveys in educational organizations implementing programs of various levels of education" (to obtain profiles of private consumption of education services);
- administrative data (for obtaining age profiles of users of public health and education services): the Federal Treasury, the Mandatory Health Insurance Fund, the Ministry of Education.

To assess public consumption differing from education and health care by the lack of a clear age component (defense, maintenance of the state apparatus, protection of public order, etc.), its uniform distribution per person by age groups was assumed. A similar approach was used when building transfer accounts, for example, in the USA.

The second step is to convert the primary profiles into a profile corresponding to the macrocontrollers obtained earlier (an aggregate figure derived from national accounts). A new, secondary profile is a direct part of national transfer accounts. This problem is solved by introducing a special coefficient of proportionality Θ, which "adjusts" the values of the primary profiles to the values of the macrocontrollers. The proportionality coefficient is calculated as the ratio of the size of the macrocontroller to the aggregated estimate of the value of the same indicator, calculated as the sum of the products of the number of age groups by the corresponding value of the indicator per capita from the primary profile (formula 2):

$$\Theta = \frac{X}{\sum x(a)N(a)}, \qquad (2)$$

where:

a – is age;
$N(a)$ – is the population of a;
X – is the macro controller;
$x(a)$ – is the age-specific primary profile of the indicator X (per capita).

Multiplying the proportionality coefficient (2) by the indicators of the primary age profile, we obtain the age profile of national transfer accounts (NTA) per capita (3) for a given value of the aggregate indicators of income, consumption or redistribution of benefits. By multiplying the per capita indicators thus found by the population size, it is possible to obtain the distribution of aggregated income or consumption across all age groups (4):

$$\bar{x}(a) = \Theta\, x(a), \quad (3)$$

$$\bar{X}(a) = \bar{x}(a)N(a), \quad (4)$$

where:

$\bar{x}(a)$ – is the NTA age profile (per capita);
$\bar{X}(a)$ – is the aggregated NTA profile at age a.

THE ECONOMIC LIFE CYCLE IN RUSSIA

Indicators of the economic life cycle can be studied at the micro level (individual behavior) and aggregated at the macro level. At the macro level, the most important factor determining the characteristics of the life cycle is the age structure of the population. Changes in the age structure lead to an increase in the number of a certain age group of dependents or workers. Depending on how the age structure changes, the population produces or consumes more or less resources.

The constructed age models (profiles) of labor income, consumption and life cycle deficit for Russia are shown in Figure 1. The aggregated indicators of labor income and consumption reflect the characteristics of the age structure of the population.

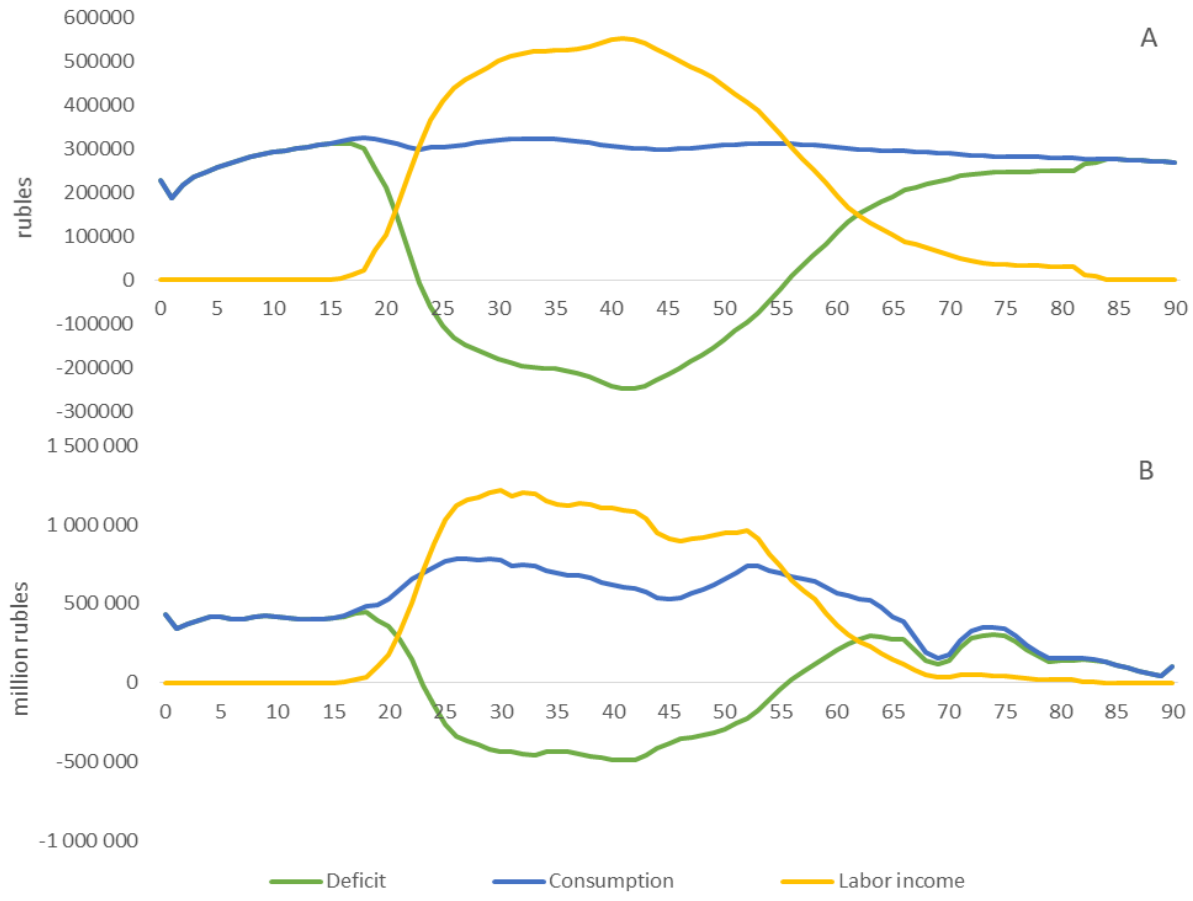

Figure 1. The economic life cycle in Russia: per capita (A), aggregated (B), 2013

Source: Authors' calculations.

Aggregate and per capita estimates of labor income and consumption make it possible to estimate the life cycle deficit and its features in certain periods of people's lives (Figure 1). For the Russian population, the "deficit-free period" begins at age 23 and lasts up to age 56. In most developed countries (Table 2), due to a longer period of study the "deficit-free" period begins later. In developing countries, it starts later due to the lack of permanent sources of income and the nature of relationships with heads of households. A later retirement in developed countries implies a later end to a "deficit-free" period compared to Russia. In most developing countries where there is no pension system, the end time of a "deficit-free" period is determined by the physiological abilities of a person — the average age up to which he can work.

Table 3 presents a brief account of the economic life cycle of the national transfer accounts of Russia. The high level of public consumption in relation to the private in children's ages draws attention. In total, the life cycle deficit in Russia in 2013 amounted to 3,473 billion rubles, or about 4.7% of GDP.

Table 2. Age limits of the "non-deficit" stage of the life cycle in different countries of the world

Country (year of assessment)	Lower limit, years	Upper limit, years
USA (2003)	25	60
Nigeria (2004)	31	62
Germany (2010)	27	57
Mexico (2003)	32	49
S. Korea (2000)	23	56
S. Korea (2010)	27	55
Russia (2013)	23	55

Source: NTA Database - URL: http://www.ntaccounts.org (appeal date: 12.22.2018), for Russia - the authors' calculations.

One of the important advantages of NTA is the opening up of opportunities for complex cross-country comparisons of income, consumption and redistribution of resources. To do this, the relevant indicators must be normalized. So, for the purposes of international comparisons, the age characteristics of the labor income of the population of Russia and the compared countries (Figure 2) were normalized by dividing by the average income in ages from 30 to 49 years inclusive. The results of these comparisons show that, in contrast to the developed countries, as well as some developing countries, the income peak in Russia is about 40 years old. In countries such as the USA or Germany, this peak is observed at pre-retirement ages. The age model for obtaining labor income in Russia in 2013 resembles the model for South Korea in 2003 (Figure 2).

As regards private consumption, with the exception of health care and education services it was also evaluated on the basis of the above-mentioned surveys.

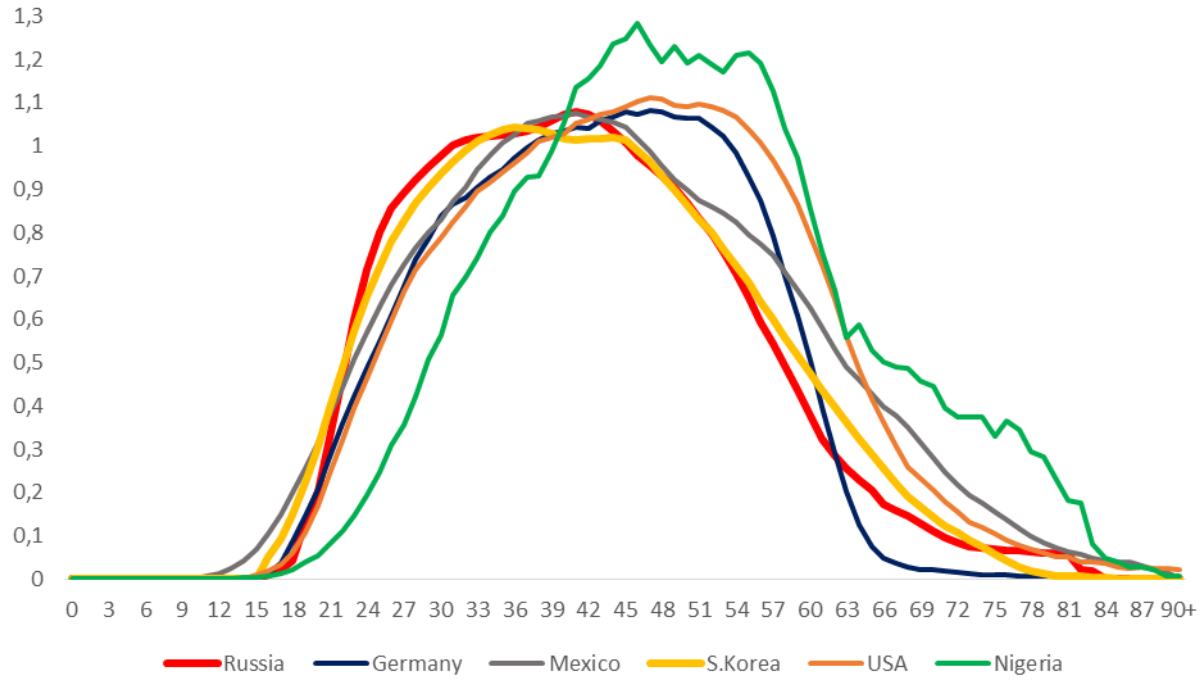

Figure 2. Normalized income indicators (average income [30-49 years] = 1) per capita for some countries of the world, 2003-2013

Source: NTA Database - URL: http://www.ntaccounts.org (appeal date: 12.22.2018), for Russia - the authors' calculations.

The age profiles of consumption per capita for some countries of the world are shown in Figure 3. The highest level of consumption in Russia falls on the younger working ages (Figure 3 and Table 2), and in developed countries on older, non-working ages, largely due to the high costs of health services (both private and public). The age model of consumption in Russia, as in the case of labor income, is similar to the South Korean model. But the reasons for this similarity must also be clarified.

Table 3. Life cycle deficit, income and consumption characteristics by integrated age groups, Russia, 2013

Categories	Aggregates for year, billion rubles				Per capital for year, rubles			
	All	0-19 years	20-64 years	65 years and older	All	0-19 years	20-64 years	65 years and older
Life cycle deficit	3 473	8 303	-9 282	4 452	24 203	275 335	-98 063	238 047
Consumption	43 010	8 320	29 355	5 335	299 706	275 898	310 146	285 255
Public consumption	13 552	3 997	7 900	1 656	94 434	132 538	83 463	88 520
Education	1 817	1 457	360	0	12 662	48 331	3 799	8
Healthcare	2 050	504	1 153	393	14 288	16 724	12 180	21 028
Other	9 684	2 035	6 387	1 262	67 484	67 484	67 484	67 484
Private consumption	29 458	4 323	21 455	3 680	205 271	143 360	226 683	196 735
Education	244	218	25	0	1 700	7 245	268	0
Healthcare	1 173	142	745	287	8 174	4 702	7 867	15 321
Other	28 041	3 963	20 685	3 393	195 398	131 413	218 547	181 415
Labor income	39 536	157	38 541	838	275 502	5 219	407 201	44 807
Earnings	33 811	149	32 871	792	235 606	4 930	347 291	42 331
Self-employment income	5 725	9	5 670	46	39 896	289	59 910	2 476

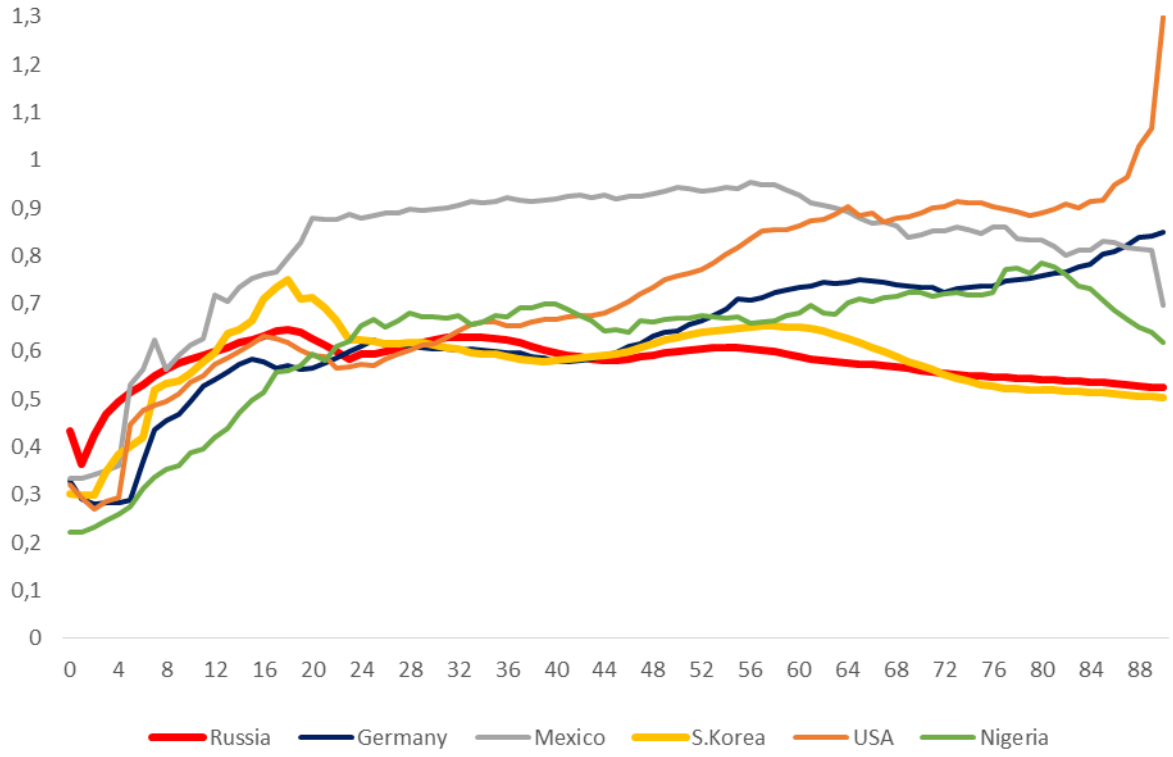

Figure 3. Normalized consumption indicators per capita (average income [30-49 years] = 1) for some countries of the world, 2003-2013

Source: NTA Database - URL: http://www.ntaccounts.org (appeal date: 12.22.2018), for Russia - the authors' calculations.

THE LIFE CYCLE DEFICIT IN RUSSIA UNTIL 2050 IN THE CONDITIONS OF DEMOGRAPHIC CHANGES

An increase in the life cycle deficit, ceteris paribus, means that total consumption increasingly exceeds total labor income. Consumption of young and older generations is provided by increasing amounts of transfers or at the expense of existing assets. In particular, the source of these revenues may be private savings, receipts from the state budget or external borrowings. Reducing the deficit suggests otherwise: more resources in the form of social transfers can be directed to education and health care, i.e. to investment in human capital. To assess changes in the life cycle deficit taking into account the "demographic factor", its relation to GDP was used. To estimate the future trends, it was assumed that the life cycle deficit changes under the influence of changes in the age structure. All economic parameters (labor productivity, economic structure, distribution relations, age profiles of income and consumption, etc.) were assumed to remain unchanged. The only exception made was for the retirement age, scheduled to be raised starting from 2019 (in this case, allowance was made for a change in the age profile of income).

The life cycle deficit in relation to GDP was estimated for the period from 2017 to 2050[6]. In 2017, this ratio was 4.5%. To assess the impact of changes in the age structure of Russia on the life cycle deficit we turned to three scenarios of demographic forecast made at the Institute of Demography in 2017. The following scenarios are included in the so-called "low" version of the forecast:

1) a slow decline in mortality compared with the level of 2017;
2) a decrease in the total fertility rate to 1.57;
3) a small migration increase (in 2050, about 100 thousand people per year).

Under such scenarios, in the period from 2018 to 2050 the proportion of the population aged 65 years and older increases from 14.5 to 23%, the proportion of children under 15 years old decreases from 18 to 15%, and the proportion of people in the working age range 15-64 years is reduced from 67.5 to 62%. According to the second, "medium" scenario, fertility rises to two births per woman, life expectancy at birth increases by more than 5 years and the net migration on average per year is 300 thousand people. Under such a scenario, the proportion of persons at older ages increases from 14.5 to 22.5%, the proportion of children up to 15 years old stays at 18%, and the proportion of the population at working ages drops to 59.5%. According to the high scenario of the forecast, the total fertility rate increases to a level that ensures simple reproduction of the population (2.1 births per woman), life expectancy increases by 7 years and the annual net migration increases by 2050 from 300 thousand to almost 500 thousand persons. As a result, the proportion of the child population approaches 17.7%, the proportion of persons at older ages is 23.8%, and the proportion of persons at working age is 58.5%.

The life cycle deficit was assessed under the condition that the age profiles of consumption and labor income were consistent. In assessing GDP, as mentioned above, it was assumed that labor productivity is constant. Therefore, GDP changed only as a result of changes in the number of the employed population (estimates were made in constant prices). The forecast of the employed population was also carried out at the Institute of Demography in 2017. As a result, GDP (at constant prices) under the low scenario of the demographic forecast will decrease by 24.5%, under the medium scenario by 18.8%, and under the high scenario by 15.9%.

The results of life cycle deficit assessments in relation to GDP are presented in Table 4. As can be seen, the deficit increases to the greatest extent in the case of a high (optimistic) version of the demographic forecast, and to a lesser extent, on the contrary, as a result of a low or worst scenario of demographic development. This is not surprising, since according to the low scenario of the forecast the share of persons in working age is the highest of the three scenarios of the demographic forecast. Due to the low birth rate in the population, the proportion of childhood ages decreases and relatively high mortality inhibits the growth of the number of people in retirement ages. In other cases, due to higher fertility and lower mortality the proportion of dependent groups increases. The paradox of the situation is that in pursuing an active demographic policy the country seems to be increasing the life cycle deficit: more private, public and, possibly, external resources

[6] Assessment of the life cycle deficit for 2017 was carried out by members of the Institute for Development Center at HSE A.G. Nazarova and A.V. Chernyavsky in the framework of the project TZ-148 of the Center for National Financial Institutions of the National Research University Higher School of Economics, "Inclusion of Russia in the international comparison system for national generation accounts".

are needed to cover it. But it should be remembered that, in the case of the low scenario of a demographic forecast, GDP (other things being equal, excluding changes in productivity and investment in capital) will decrease by a quarter, while under the high scenario it will be only 15%.

Table 4. The ratio of the life cycle deficit to GDP, %

Demographic scenario	Economic scenario	2017	2025	2035	2050
Low	Unchanged productivity	4,5	9,4	11,7	13,5
Medium	Unchanged productivity		10,0	13,7	16,5
High	Unchanged productivity		10,1	13,9	18,0
Medium	Increased retirement age		3,8	5,2	7,5

Source: authors' calculations.

How to resolve this paradox? The first remedy is economic growth. Moreover, the demographic scenarios embedded in the medium and high versions of the forecast hinder (retard) the decline in the population at working age. Preliminary estimates show that in conditions of even moderate economic growth, the increase in the life cycle deficit will decrease.

The second solution is raising the retirement age. The basis for this, from a demographic point of view, is an increase in life expectancy at older ages, an increase in the duration of the education period and, as a result, a lengthening of the period of dependency in relation to the working period in people's lives. To assess the impact of raising the retirement age, the medium scenario of the demographic forecast was used, as well as a forecast of the number of employed made at the Institute of Demography in 2017. It was assumed that the retirement age rises by one year every two years starting in 2019, until reaching the age of 65 for men and 63 for women (in accordance with the first draft of the Government of the Russian Federation, announced in June 2018). At the same time, a change in the age profile of labor income was allowed, since the period of labor activity increases and, with it, the income level in the new pre-pension and post-pension age groups increases accordingly. We assume that by the end of the transition to a new retirement age a new income model will be established. The new model was set by the average profile for countries in which the standard retirement age is 65 years for men, 60-65 years for women. It was assumed that the consumption profile throughout the entire forecast period remains unchanged. The ratio of the life cycle deficit to GDP will noticeably decrease in the period of raising the retirement age - to 3.8%. It will begin to increase only after the termination of this process. But even in 2050 the share of the deficit in GDP will be relatively small - less than in other forecast scenarios in 2025. Obviously, combined with economic growth, the positive effect of raising the retirement age will be even greater. Reducing the deficit provides additional opportunities for private and public investment in human capital, as well as the accumulation of assets.

SUPPORT RATIOS AND DEMOGRAPHIC DIVIDEND IN RUSSIA UP TO 2050

National transfer accounts, by viewing economic indicators through the prism of age, measure the impact of the age structure of the population on economic dynamics and macro indicators. According to trends in NTA indicators, one can indirectly judge the economic consequences of demographic shifts. In this section, we will illustrate the "price of an aging society" for the economy, based on the so-called support ratios.

In research practice, depending on the objectives of the study, several support ratios are used. The most common, due to the availability of data for calculating it, is the coefficient of demographic support, defined as the ratio of the number of persons in working ages to the number of persons in dependent ages. The economic support ratio can be defined as the ratio of the number of employed (or economically active) people to the number of unemployed. Due to heuristic possibilities, the *effective* economic support ratio has become very popular. It is a useful indicator for assessing the impact of demographic changes on economic growth and measuring the demographic dividend. The effective demographic support ratio integrates the characteristics of the age structure and age profiles of labor income and consumption.

To calculate the effective economic support ratio, two indicators are used: the effective employee and the effective consumer [Mason et al 2017: 6]. These use the average values of labor income and consumption per person in the age range from 30 to 49 years inclusive. Average values are calculated as arithmetic averages of the values of income and consumption levels in one-year age groups. The effective number of employees *L(x,t)* is calculated by the following formula (5):

$$L(t) = \sum_0^\omega \check{y}l(x)P(x,t), \quad (5)$$

$$\check{y}l(x) = yl(x,b)/yl(30-49,b),$$

where:

yl(x,b) – is the labor income per person at the age of x and in the base year b;
yl(30-49,b) – is the average per capita income between the ages of 30 and 49;
P(x,t) - is the population size at age x at time t.

The effective number of consumers is calculated according to a similar scheme (formula 6):

$$N(t) = \sum_0^\omega \check{c}(x)P(x,t), \quad (6)$$

$$\check{c}(x) = c(x,b)/c(30-49,b),$$

where:

c(x,b) – is the consumption per person at the age of x and in the base year b;
c(30-49,b) – is average per capita consumption at the age from 30 to 49;
P(x,t) - is the population size at age x at time t.

The effective support ratio *SR (t)* is calculated as the ratio of the number of effective workers to the number of effective consumers (formula 7):

$$SR\ (t) = \frac{L(t)}{N(t)}. \quad (7)$$

We made estimates of the three support coefficients until 2050 (Figure 4) for the medium scenario of the demographic forecast of the Institute for Demography at HSE. As can be seen, the support ratios go down. The rate of this decline will slow down due to the peculiarities of the change in the age structure in the 2030s. When calculating the demographic support ratio, the lower limit of the working age was set at the age of 20 years, the upper one - 64 years. In calculating the effective economic support, the age profiles of labor income and consumption did not change. It is obvious that the demographic support ratio exceeds all others. Indicators of economic and

effective economic support take into account the fact that a part of the population at working age is not employed or receives a small labor income.

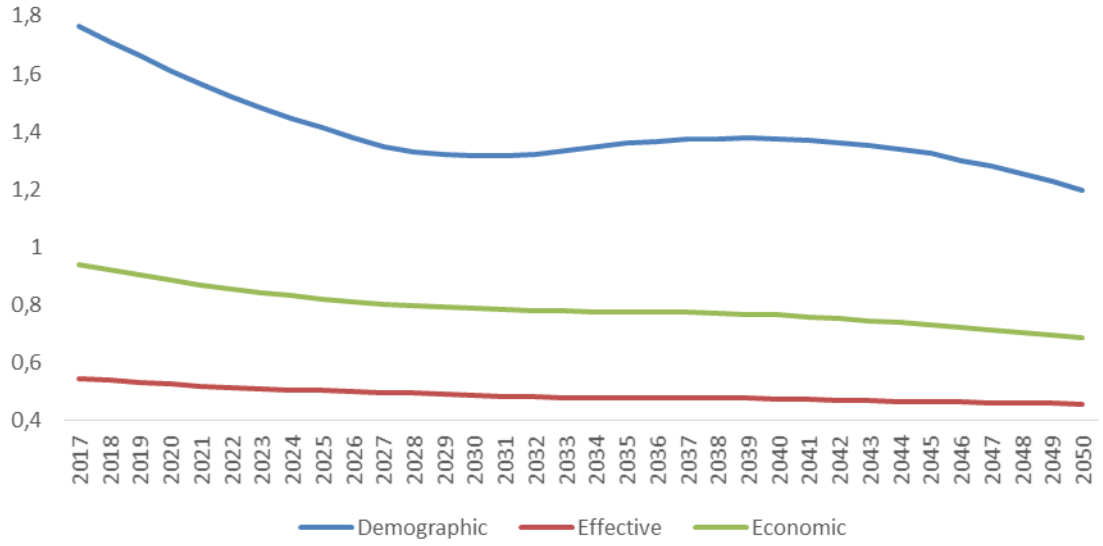

Figure 4. Support ratios, Russia, 2017-2050

Source: Authors calculations.

Using the effective economic support ratio, one can measure the first demographic dividend and determine its contribution to economic growth. The first demographic dividend is the gain that a country's economy can receive as a result of optimizing the age structure due to a decrease in the dependent (demographic) load on the working population as a result of a decrease in fertility. It appears with an increase in demographic and economic support and fades away as it declines. Optimization of the age structure is expressed in the achievement of the historical maximum of the share of persons in working ages in the total population or the historical minimum of the demographic load. To obtain a demographic dividend, institutional and economic conditions are necessary to ensure high employment and the possibility of earning labor income. According to Bloom and Williamson, about 30% of GDP growth in China and South-East Asia is associated with a demographic dividend (Bloom, Williamson 1998).

A simple model associates the effective support ratio with the first demographic dividend (formula 8):

$$\frac{Y(t)}{N(t)} = \frac{Y(t)}{L(t)} SR(t). \quad (8)$$

In this equation, revenue per effective consumer is equal to productivity, measured by the ratio *Y(t)* and *L(t)* and the effect of changing the age structure, which is measured by the support ratio [Mason et al 2017: 7]. If we assume that the share of labor income in total income does not change with time, then the relative changes in labor income will coincide with the relative (in percentage terms) changes in total income. In this case, you can write this expression in the form of formula (9):

$$gr\left[{}^{Y(t)}/_{N(t)}\right] = gr\left[{}^{Y(t)}/_{L(t)}\right] + gr[SR(t)], \quad (9)$$

where *gr()* indicates the growth rate of the factor, and *Y(t)* is the total income.

The first demographic dividend is calculated as the growth rate of the support ratio. Its value directly measures the contribution of changes in the age structure to economic growth. Figure 5 presents estimates of the increase in the effective support ratio, subject to the implementation of three demographic projections, as well as the rising retirement age from 2019. Up until the early 2030s, the age structure of the population will make a negative contribution to economic dynamics. Currently, due to negative changes in the age structure, the growth rates are being reduced by about 1.3-1.5%. At the same time, in 2019 the demographic dividend calculated by the above method will reach its minimum value. Further, the demographic dividend will increase. Moreover, in the mid-2030s the contribution of the age structure may even become positive, since the relatively numerous generations born in 2007–2016 will enter the labor market. The largest dividend is obtained under conditions of a low demographic forecast. With its implementation, the contribution of the age structure to economic growth almost throughout the 2030s will be positive. But at the same time, the effect of reducing the number of employed people must be taken into account. As was shown above, all other things being equal (excluding changes in productivity and investment in capital), GDP will decline by almost a quarter by 2050 compared to 2017. Particularly noticeable is the growth of the demographic dividend in the case of an increased retirement age. But after the end of this process, the demographic dividend sharply decreases, and then returns to the previous trend. Deviations from the trend, in particular, are related to the fact that the age profile of labor income at older ages is changing.

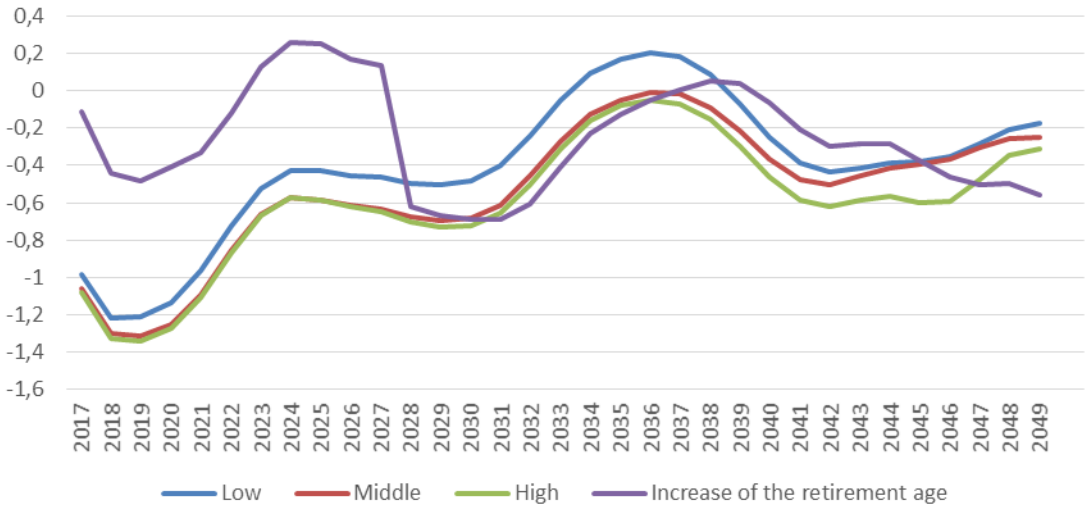

Figure 5. Demographic dividend for Russia, 2017-2049,%

Source: Authors' calculations.

The second demographic dividend is realized if demographic changes lead to an increase in the productivity of workers. Among the various factors leading to an increase in productivity, R. Lee and A. Mason focused mainly on increased capital [Lee, Mason 2006; 2017]. The basic idea is that, as the population ages, consumption in the retirement period depends less on labor income and more on age-related redistribution of assets and transfers. An increase in the volume

of transfers at older ages does not directly affect productivity, but an increase in assets, including the savings that older people have, can lead to an increase in investment in capital, and therefore to higher productivity. Thus, demographic changes may contribute to faster economic growth. But for this the population should actively participate in various kinds of savings projects, and the state should stimulate this participation and guarantee the safety of assets. Without these conditions, the implementation of the second demographic dividend in Russia will be impossible.

CONCLUSION

The aging of the population is creating many challenges for the social institutions of modern society that emerged during the period of "demographic youth". When making decisions in the socio-economic sphere, taking demographic changes into account is extremely important, and the assessment of their consequences is one of the key areas of modern research in economic demography. However, despite the importance of the demographic factor, the standard indicators of economic development adopted in the modern world have long been developed mainly in relation to the entire population, and do not reflect the contribution of certain age groups or generations to total production and consumption. The calculations made by the authors within the framework of this paper are the first attempt in Russia to estimate the contribution of various age groups to the production and distribution of national income using the system of national transfer (intergenerational) accounts (NTA). As a result, it turned out to be possible to calculate the life cycle deficit, the effective support rates and the demographic dividend in Russia until 2050.

National transfer accounts are a modern methodology for measuring the impact of demographic factors on a country's economy. In particular, they make it possible to assess the difficult role of the older population in economic development as consumers, producers, investors, recipients and sources of transfers, etc. It is currently not possible to carry out such an assessment using other methods of analyzing the effects of aging. In the framework of the standard model of national transfer accounts, economic flows are divided into age groups. The development of such a model makes it possible to disaggregate these flows also by gender, education level and other characteristics of the population. Moreover, modern approaches to their construction make it possible to overcome one of the limitations of the system of national accounts, namely, the underaccounting of services that households produce for themselves. With the help of indicators of age-related time budgets, non-market activities of household members can be included within the system of national transfer accounts. All this opens up new prospects for economic and demographic research in Russia.

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CITIES OF OVER A MILLION PEOPLE ON THE MORTALITY MAP OF RUSSIA

ALEKSEI SHCHUR

The problem of excess mortality in Russia has not lost its relevance. The situation is complicated by the high level of spatial inequality in health, which is usually measured at the regional level in our country. This work is one of the first attempts to look at the dynamics and extent of spatial inequality in health in Russia at the sub-regional level, by contrasting the "center/core" (in our case, represented by the largest Russian cities) with the "periphery" (the rest of the country). Cities with a population of over a million people were chosen based on the spatial hierarchy that exists in Russia, according to which the highest level of social and economic development is concentrated in the largest cities. As a rule, a higher level of development of human capital corresponds to lower mortality. Using data provided by Rosstat, we calculated life expectancy at birth for Russian cities with a population of over a million people in 1989-2016. The results fully coincided with our expectations: the polarization in the health levels between the largest Russian cities and the rest of the country has significantly increased in the last twenty-five years, which is a reflection of those centripetal processes that have been taking place in our country during this period. Russian cities with a population of over a million people are attractive destinations for both internal and external migrants, and thus acquire, among other things, a much more educated population. Since people with higher education take better care of their health, having a more educated population is undoubtedly an essential advantage of bigger cities over the periphery when it comes to the overall health level. Without solving the structural problems that restrain social and economic development outside the largest agglomerations, convergence in mortality rates between cities with a population of over a million people and the surrounding territories is hardly possible.

***Key words**: life expectancy, spatial inequality in mortality, cities with a population of over a million people, educational level, core and periphery.*

Inequality in health, like any other socio-economic, i.e. modifiable inequality, poses a serious challenge to the state and society [Shkaratan 2009: 556]. Studies of inequality consider two main types of differences: interindividual and intergroup [Andreev et al. 2001]. These include inequality between socio-demographic groups (depending on gender, race, nationality, level of education, economic status, marital status), and spatial (geographical) inequality between countries, types of populated areas (for example, urban and rural), regions and other units of administrative-territorial division.

The study of inequality in mortality is especially relevant for Russia, which is distinguished by significant gender differences in life expectancy (LE), significant regional differentiation, and one of the most significant differences in life expectancy between educational groups in the world (for countries with reliable mortality statistics) [Shkolnikov et al. 2006; Inequality and mortality ... 2000]. At the same time, Russia is far behind not only most developed countries, but also many developing countries in life expectancy at birth [WHO Mortality Database 2017]. The level of economic well-being of Russia should correspond to a much longer life expectancy [Andreev, Shkolnikov 2018].

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In this regard, studying the level of inequality in health and the factors explaining it should help shed light on the reasons for Russia's life expectancy lag behind other countries and highlight the "advanced" groups that can point to mechanisms for reducing mortality for the "rest of the population".

Russia's lag behind world leaders in life expectancy began to increase in the late 1960s and testified to the structural contradictions that had accumulated within the Soviet system [Eberstadt 1981; Vishnevsky, Shkolnikov 1997]. The USSR, like the entire Eastern Bloc, was not ready to confront new threats caused by the changed epidemiological situation - the increasing role of non-infectious causes of death. Moreover, unlike many other countries of Eastern Europe, in the 1990s the "young" Russia failed to enter a new stage of the epidemiological transition; in addition, there occurred a serious deterioration in the state of health in the country, forcing some researchers to speak even of a "reverse epidemiological transition" [Semenova 2005: 235].

The current stage of mortality reduction in Russia, which began in the mid-2000s, is interpreted by experts in different ways. Some demographers believe that the increase in life expectancy in the current period is of a restorative, "compensatory" nature and that so far there is no reason to talk about the beginning of a second epidemiological transition in Russia [Vishnevsky 2014]. Other scientists, on the contrary, note new trends in mortality in the country, which can be considered as signs of a cardiovascular revolution [Grigoriev et al. 2014]. In our opinion, the study of mortality trends in the territories that are in the vanguard of its decline in Russia can help answer the question of whether or not the changes in the mortality regime are precursors of the start of the second epidemiological transition.

Significant spatial polarization in the mortality rate, especially during periods of a sharp rise or, conversely, a rapid decline, has been observed in many Eastern European countries which, like Russia, experienced a "mortality crisis" in the second half of the 20th century. Thus, in Lithuania, the greatest life expectancy in 1988-96 was in the largest cities, and the gap in the mortality rate between urban and rural areas increased during the period of social and economic transformation [Kalediene, Petrauskiene 2000; Kalediene, Petrauskiene 2004]. A similar picture was observed in the two other Baltic countries [Krumins et al 2009]. In Belarus, perhaps the state most similar to Russia in socio-cultural terms, since the second half of the 1990s there has been a pronounced trend towards a divergence in the mortality rate between the capital and the rest of the country. In this same period a similar process took place in our country. An analysis of the intra-regional mortality rate conducted for Belarus by Pavel Grigoriev and co-authors showed that in all regional centers, as well as in other major cities which are separate administrative units of the second level (analogous to Russian regions and urban districts), the mortality rate is significantly lower than in the surrounding areas [Grigoriev, Doblhammer-Reiter, Shkolnikov 2013]. There is every reason to believe that a similar picture can be seen in Russia.

Due to Russia's large size and climatic, socio-economic, ethnic and other diversity, both Russian and foreign scientists pay special attention to studying the trends and scales of differences in the level of mortality in a regional context [Vasin, Costello 1997; Shkolnikov, Vasin 1994; Vallin et al. 2005; Timonin et al. 2017]. Even in Soviet times it was shown that there existed a southwest/northeast mortality gradient in Russia (RSFSR) [Andreev 1979; Shkolnikov 1987] which remains relevant to this day [Timonin et al. 2017]. In addition, there is a special "privileged"

place on the "mortality map" of Russia of St. Petersburg and especially of Moscow. Mortality levels and trends in these cities are often contrasted with those of the rest of Russia [Andreev, Kvasha, Kharkova 2006; Kvasha, Kharkov 2009]. At the same time, Moscow and St. Petersburg, despite all the recent successes in reducing mortality, lag significantly behind Western megacities in terms of life expectancy [Andreev, Kvasha, Kharkov 2016].

The socioeconomic situation and educational structure of the population do indeed distinguish the former and current capitals of Russia from the rest of its territory, while at the same time the country's other major population centers, above all cities with a population of over one million people ('million-plus cities'), are also very often considered as reference points of the country's modernization, its educational and economic centers, places of attraction of people [Zubarevich 2010]. In this regard, it is interesting to conduct a comparative analysis of the main mortality trends in the two capitals, along with other "non-capital" cities with a population of over one million, with their surrounding territories (regions whose administrative centers they are), as well as with the rest of the country. This will help to answer the question of whether the largest cities in Russia are in the forefront of its decreasing mortality, as well as to assess the dynamics and size of the gaps in life expectancy between them and their regions.

DATA AND METHODS

The object of study in this work are the cities of Russia in which the resident population exceeds one million people. The work is based on data of state statistics of Russia for 1989-2016 on the distribution of deaths by sex and five-year age groups (0; 1-4; ... 85+) for selected Russian cities whose population as of January 1, 2017 exceeded one million people (data on the resident population of cities within their administrative boundaries taken according to Rosstat). To calculate life expectancy at birth in million-plus cities and in the rest of the regions of which they are the administrative centers, brief mortality tables were constructed. It should be said that, in the opinion of many demographers, the quality of the censuses of 2002 and 2010 in Moscow causes great concern [Andreev 2012; Mkrtchyan 2012]. Particularly acute is the problem of overstating the number of Muscovites in the oldest age groups, which leads to an upward distortion of Moscow's indicators of life expectancy at birth [Papanova et al. 2017]. Following the work of Papanova and co-authors, in order to obtain more realistic estimates of life expectancy at birth we adjusted the mortality tables calculated for Moscow using the methodology used in the Human Life Table Database. The essence of the correction lies in modifying a_{85+}+ by selecting such a value a_{85} (=1/m_{85+}) which empirically (based on a comparison of the entire array of mortality tables constructed for countries with high-quality statistics) would correspond to the observed value of e_0 [Shkolnikov V.M. et al. 2017: Appendix 1].

As of January 1, 2017, there were 15 cities in Russia with a permanent population of over one million people[1]. Taking into account the significant differences in the population size between Moscow and St. Petersburg, on the one hand, and other largest populated areas of Russia, on the

[1] The number and composition of million-plus cities in Russia in 1989-2016 underwent certain changes (Appendix 1). For a time comparison we will look at all fifteen cities for each year, even if not all of them had a population exceeding one million during every one.

other (the total population of the two capital cities in recent years exceeds the total population of all other million-plus Russian cities), it seems reasonable to study Moscow and St. Petersburg separately and the remaining million-plus cities together. To do this, we introduced a new category – *the aggregate city*, the set of *non-capital* million-plus cities (i.e. all Russian million-plus cities except Moscow and St. Petersburg), for which all indicators are calculated by adding the numbers of the deaths and the population size of all cities in the set.

All Russian million-plus cities, with the exception of Moscow and St. Petersburg, are also the administrative centers of various regions (oblasts, republics and krays) and concentrate a significant part of the population and economic potential of the respective regions. To determine the mortality rate in these regions beyond the regional centers, we calculated the values of life expectancy at birth for these regions without including the population living in the centers of the regions (million-plus cities) and the deaths recorded in them. For convenience of comparison, the category of *aggregate region* was created analogous to the aggregate city. In addition, we calculated the life expectancy for *the rest of Russia*, which would not include the population of million-plus cities, as well as the population of the North Caucasian Federal District (NCFD)[2], i.e., in essence, for Russia without its biggest cities.

The main limitation of this work arises from a certain imperfection of methods for collecting and processing official data by Russian statistics, which can lead to the problem of numerator/denominator bias when calculating mortality rates and, therefore, when constructing mortality tables. Thus, a person's death can be registered not only at the place of his legal residence (where he is listed as the denominator - the permanent population), but also at the place of his death. This is especially true for large cities, which are centers of attraction for migrants who are not taken into account by statistics, as well as foother subjecsr patients who go for treatment to the large administrative center of their region or to Moscow and die there [Demographic Situation ... 2006: 264].

The "denominator problem" is even more acute. First, the inter-census population estimates for all million-plus cities except Moscow and St. Petersburg are not recalculated from the results of the last census, which is clearly seen in the graph of the size of the permanent population of the aggregate city for the years 1989-2017. (Appendix 2). Here you can also observe the impact of changes in the practice of statistical accounting at the end of the Soviet period: the populations of Samara, Perm, Nizhny Novgorod, Krasnoyarsk, Chelyabinsk, and Yekaterinburg as of January 1, 1989 included the population of CATE (Closed Administrative-Territorial Entities, a total of 200 thousand people), but starting from January 1, 1990 Rosstat excluded the CATE population from estimates of the permanent population of these cities. Another aspect is the quality of the 2002 and 2010 censuses conducted in Russia, especially in Moscow and the republics of the North Caucasus [Andreev 2012] (in many respects this is why the latter were completely excluded from our research). These two censuses are flawed by double counting of some groups ofwit the population (students, men of military age) and undercounting of others (foreigners, migrant workers), and by an abuse of administrative databases that do not always reflect the current situation (above all, they underestimate emigration), which leads to the problem of "immortal seniors", which can be clearly

[2] The NCFD is not included due to a number of doubts about the quality of data in the district.

observed in Moscow and St. Petersburg (Appendix 3). At the same time, the adjustments made in response to these limitations to the research methodology somewhat reduced the effect of these problems on the results obtained.

RESULTS

In Figure 1, beginning in the second half of the 1990s, a significant divergence of life expectancy at birth between Moscow and St. Petersburg (and to a lesser extent, other million-plus cities), on the one hand, and *the rest of Russia* on the other can be observed. The turning point was 1994[3], after which mortality in the largest cities of the country (and, especially, in the two capitals) began to decline at a faster pace. The increase in mortality in the early 2000s was also more intense in the rest of Russia[4], which only increased the gap in life expectancy between the "periphery" and the "center", represented in our study by the largest cities with a population of over one million people. The gap between the maximum and minimum life expectancy during this period (1994-2005) increased from 1.36 years for men and 1.05 years for women to 9.18 (8.98 according to adjusted data) and 4.67 (4.63) years, respectively (Figure 1). Particularly significant is the difference between Moscow and both the rest of the country and the other million-plus cities, including St. Petersburg, where mortality remains lower than in all other cities under consideration. The rise in mortality that took place in Russia in the first half of the 2000s affected the largest cities of the country to a lesser extent (as noted above) and almost did not affect Moscow, which strongly distinguishes it from the other regions of the Russian Federation[5].

The reduction in mortality which began in Russia in 2004 differs from the previous short periods of its reduction by its record (for the period from 1965) duration [Shkolnikov et al. 2013]. However, the increase in life expectancy observed in this period in all regions of the country was not accompanied by any significant reduction in inequality in mortality between the "capitals" (Moscow and St. Petersburg) and the rest of Russia. At the same time, the highest rates of increase in life expectancy in 2004-2016 were recorded in St. Petersburg, which allowed it to significantly break away from the *aggregate city* and reduce its lag behind Moscow. Moreover, the weak (relative to both capitals and the rest of the country) dynamics of life expectancy of the male population in the aggregate city in the 2010s draws attention. In most million-plus cities during this period, mortality from some of the causes of death due to alcohol abuse (poisoning, cirrhosis) stops or even increases, but similar processes occur in Russia as a whole. What really distinguishes the situation in the aggregate city from the rest of the country during this period is the much higher mortality rate from the disease caused by HIV [Shchur 2018: 109].

[3] The year with the lowest life expectancy at birth in Russia for at least the last 50 years.
[4] While the increase in mortality in the early 1990s was more pronounced in large cities [Shkolnikov et al 1998: 1995-2011].
[5] In addition to Moscow, the minimum increase in mortality was observed in the North Caucasian republics, as well as in the "oil and gas" districts (Khanty-Mansi Autonomous Okrug, Yamal-Nenets Autonomous Okrug).

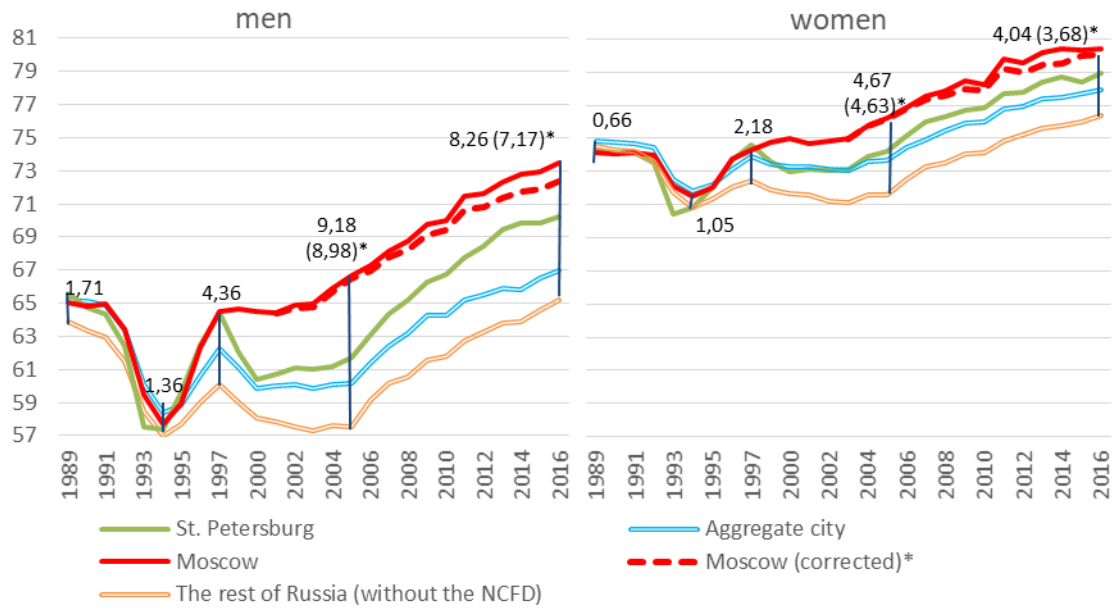

Figure 1. Life expectancy at birth in Moscow, St. Petersburg, the aggregate city and the rest of Russia (without the North Caucasus Federal District), 1989-2016, years

Note: The vertical lines in the graph show the range between the maximum and minimum values in the selected years.

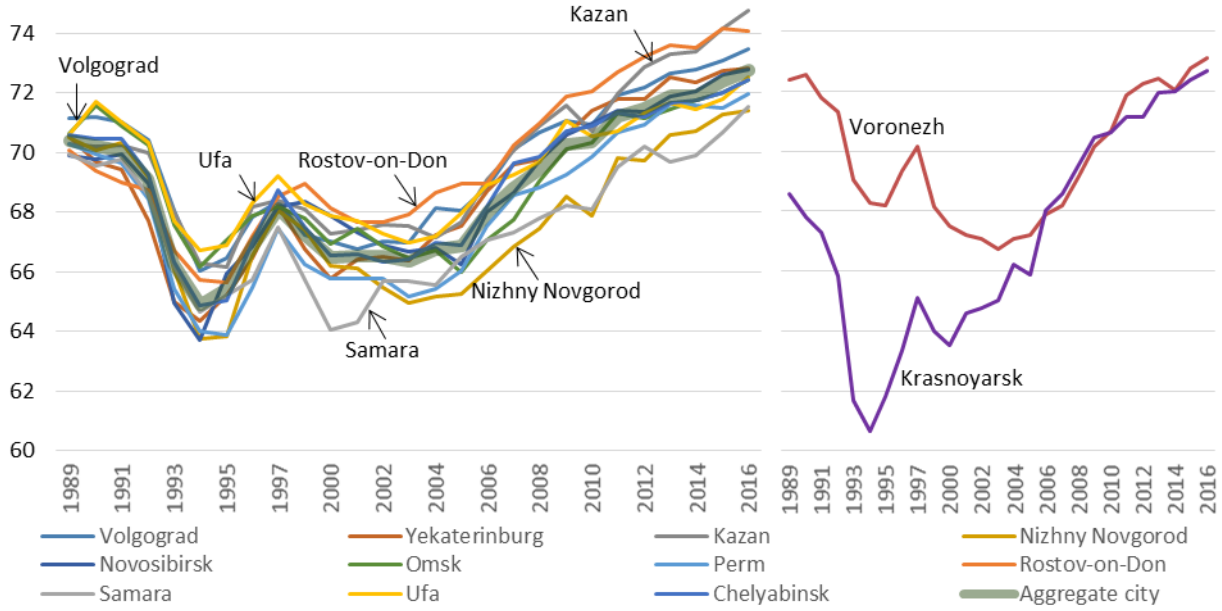

Figure 2. Life expectancy at birth in million-plus cities (except Moscow and St. Petersburg) and the aggregate city, 1989-2016, years[6]

Figure 2 shows the dynamics of life expectancy at birth in million-plus cities with the exception of Moscow and St. Petersburg. From this it can be seen that in the period under study million-plus cities showed the same fluctuations characteristic of Russia as a whole. Nevertheless, the range of these fluctuations was different for different cities, which determined the increase in

[6] See Appendix 4.

the gap between the maximum and minimum life expectancy from 1.26 years in 1989 to 3.37 years in 2016 (the standard deviation for 11 million-plus cities[7] for the same period increased from 0.37 years to 1.02 years - Appendix 5). In the 1990s, the highest life expectancy was noted alternately in Volgograd, Ufa and Omsk, and the lowest in Novosibirsk, Yekaterinburg and Perm. In the 2000s the picture changed: there was a group of "laggards" (Samara and Nizhny Novgorod), significantly lagging behind other million-plus cities, and a duo of "leaders" (Kazan and Rostov-on-Don) where mortality was significantly lower than the national one.

Traditional factors affecting the mortality rate, such as the level of education of the population or the level of socio-economic development of the territory, do not, as will be shown below in the Discussion section, fully explain the differences in life expectancy between Russian million-plus cities. Nor was it possible to find any connection between the size of the city (its population) or geographical location (belonging to one or another Russian macro-region) and the magnitude of life expectancy. If we turn to the group of cities in which a reduced mortality rate (relative to the aggregate city) is currently recorded, they are united either by more favorable climatic conditions (Volgograd, Voronezh, Rostov-on-Don), or by being among the leaders in the development of tertiary sectors of the economy with a corresponding employment structure[8] (Ekaterinburg and Novosibirsk, and partly Kazan and Rostov-on-Don).

I would like to look in particular at the comparison of Krasnoyarsk and Voronezh. Until the beginning of the 2010s neither of these was a million-plus city, and in the 1990s in terms of life expectancy they were poles apart, significantly better (Voronezh) and worse (Krasnoyarsk) than all other cities studied. In 1994, life expectancy in Krasnoyarsk lagged behind that in Voronezh by almost 8 years. But by 2006 Krasnoyarsk had overtaken Voronezh, and since then both cities have had a generally similar mortality rate. A possible explanation for such a strong gap in life expectancy in the early 1990s and its subsequent reduction to a minimum by the mid-2000s is the different reactions of the two populations to "shock therapy", as well as the different depths and speeds of market reforms in the "patriarchal" Black Earth Region , a former part of the "Red Belt", and in Eastern Siberia (a newly developed region with a large number of newcomers who turned out to be particularly vulnerable to a radical restructuring of the socio-economic system) [Walberg et al 1998].

Figure 3 shows the dynamics of life expectancy at birth in million-plus cities and in other populated areas of their regions in 1989 and 2016. During the period under consideration, the differences in life expectancy between the "centers" and the "periphery" increased significantly in all the regions studied. If in 1989 the life expectancy in the aggregate city was 0.8 years higher than in the *aggregate region*, in 2016 the gap increased to almost 2.5 years. In all the regions of the federation shown in Figure 3, including the two "capital regions" (Appendix 6), life expectancy in the administrative centers in 1989-2016 grew at a much faster pace than in other populated areas. In a number of regions, such as the Sverdlovsk and Chelyabinsk regions, life expectancy outside the regional centers in 2016 still had not reached the 1989 level.

[7] Without Voronezh and Krasnoyarsk

[8] A higher share of people engaged in mental work ("white collars") and a lower share of people engaged in manual labor ("blue collars").

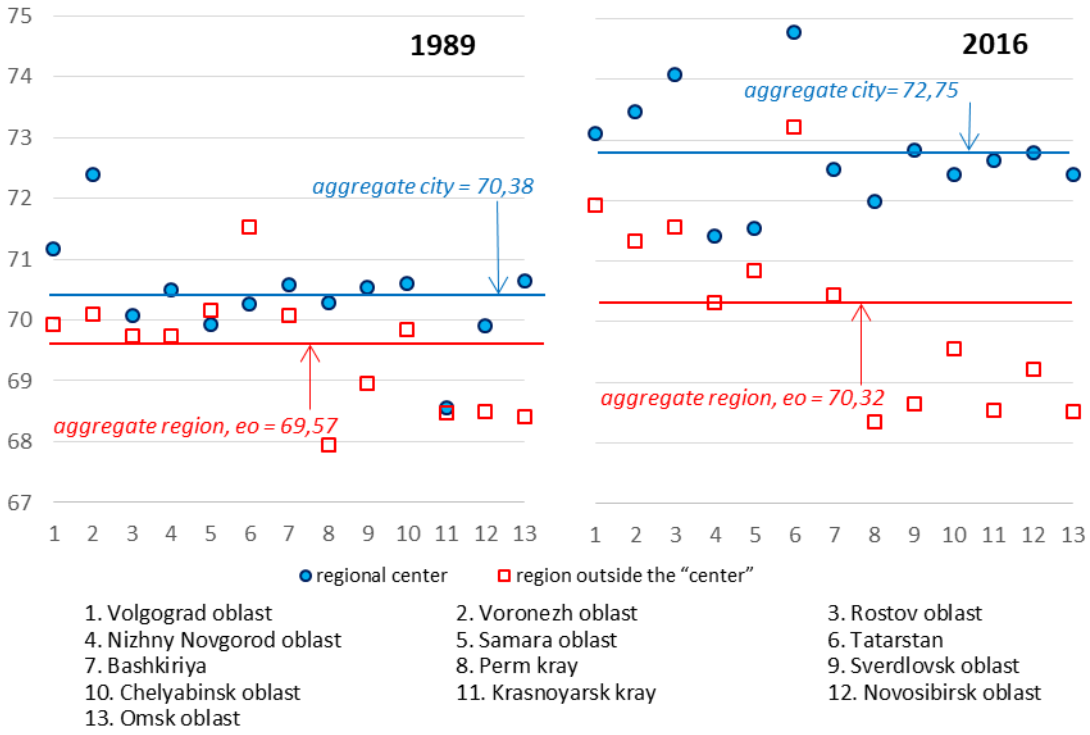

Figure 3. Life expectancy at birth in million-plus cities, in the rest of their regions, in the aggregate city and the aggregate region in 1989 and 2016, years

Possible reasons for the gap in life expectancy between million-plus cities and their surrounding territories include: different levels of socio-economic development and different professional and educational compositions of the population, inequality in access to modern medical technologies, and selection as a result of migration. The large gap in life expectancy might also be influenced by other factors determined by the settlement structure of a particular region: the degree of urbanization, the proportion of the population living in the agglomeration belt of the administrative center, and the presence of other large urban centers. The greatest differences in life expectancy between the "center" and the "periphery" in 2016 were observed in the regions of the Urals (Sverdlovsk and Chelyabinsk oblasts, Perm kray) and Siberia (Novosibirsk and Omsk oblasts, Krasnoyarsk kray), while the minimum difference, as in 1989, was recorded in the Volga region (Samara and Nizhny Novgorod oblasts).

DISCUSSION

Life expectancy at birth in most million-plus cities since the late 1990s has been higher than in the rest of Russia. At the same time, no other Russian million-plus city since the beginning of the 21st century has shown the same dynamics and indicators of mortality as Moscow, which confirms its unique position on the "mortality map" of Russia. How can we explain the differences in mortality between million-plus cities and the rest of the country, as well as between Moscow and other major Russian cities? We will focus our attention on two factors: the level of economic development (as a proxy indicator of the standard of living) and the educational structure of the population.

The relationship between life expectancy at birth and the level of economic development, expressed in terms of gross domestic product (GDP) per capita, is described at the level of

individual territories (usually states) by the so-called Preston curve, which shows a strong connection between these two indicators [Preston 2007]. However, Russia, both at the level of the whole country (where life expectancy at birth, on the basis of GDP per capita, should be significantly higher than observed) and at the regional level (there is no connection between longevity and economic indicators in our country) does not follow this pattern [Andreev, Shkolnikov 2018]. At the same time, our country is characterized by a strong polarization of the economic space, including at the subregional level. Thus, in 2015, thirteen non-capital cities with a population of more than one million people comprised 37% of the total population of the regions whose administrative centers they are, while they produced 48% of the total gross regional product (GRP) of these regions (Appendix 7). In 2015, GRP per capita in eleven of the thirteen regions considered was higher in the center than in the rest of the region (by 1.4 - 3.2 times); only in Tatarstan (oil production and refining) and the Krasnoyarsk Kray (Norilsky Nickel, Vankor oil and gas field) the reverse situation was observed. On average, GRP per capita in million-plus cities was 1.6 times higher than in the residual areas of their regions.

Figure 4 (left graph) shows that in 2015 the highest GRP per capita, significantly higher than in other million-plus cities and the rest of Russia, was recorded in Moscow; the same is true for life expectancy at birth. In addition, the gross urban product per capita (GUP) was greater in all million-plus cities than in the rest of the country, as was life expectancy. At the same time, without taking Moscow into account, there was no connection at the level of million-plus cities between the gross urban product per capita and life expectancy at birth.

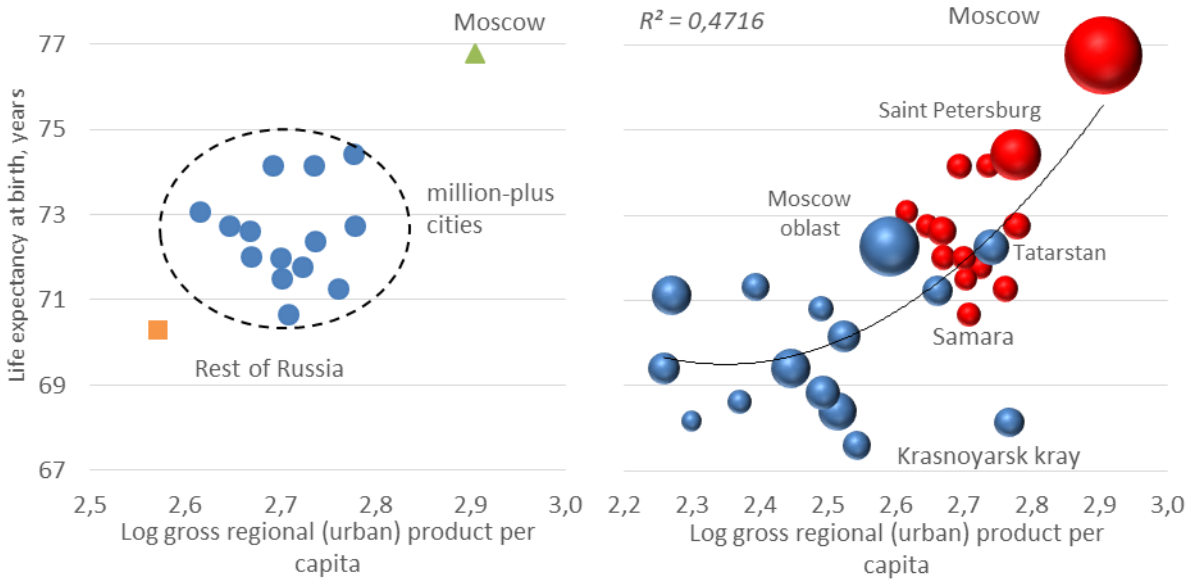

Figure 4. Relationship between life expectancy at birth and gross urban (regional) product per capita (in PPP) in Russian cities with a population of one million or more (red), the rest of their regions (blue) and the rest of Russia, 2015

In the right graph (Figure 4) one can observe, in addition to million-plus cities, GRP per capita and life expectancy at birth in regions whose administrative centers are million-plus cities, but excluding the latter, i.e. in the rest of the territory of the respective regions. The diameter of the circle on the graph is directly proportional to the population size of the region. As on the left graph, on the right graph one can see that there is a direct connection between GRP per capita and

life expectancy at birth, and this despite the fact that the gross regional product as an indicator of the level of economic development is not without drawbacks (the share of the economy attributable to small business, on which it is harder to gather statistics, as well as the share of the shadow economy, can vary greatly between regions). On the other hand, a high level of economic development is not always translated into good health of the population. A good example is the Krasnoyarsk kray outside the regional capital, where a very high GRP per capita is combined with a very low life expectancy. However, in general, it seems to us that at the subregional level in Russia the economic polarization (inequality) between the central cities and the rest of the territory of the respective regions and the resulting difference in the standard of living can serve as one of the explanations for the existing central-peripheral gap in the health (mortality) of the population.

Due to a higher level of economic development (and therefore a higher standard of living), almost all million-plus cities in Russia are centers of attraction for internal and external migrants, who, as a rule, due to selectivity (in order to move to another city and gain a foothold there, one generally requires good health) have lower mortality rates compared with both the host population and the population of the places from which migrants originate [Razum, Zeeb, Rohrmann 2000: 191-192; Marmot, Adelstein, Bulusu 1984: 1455-1457]. This is especially pronounced in Russia at the subregional level (and, in the case of Moscow and St. Petersburg, also at the interregional level), when the most goal-oriented, educated and, most importantly, healthy people from the periphery tend to move to the capital or regional center, while the less educated and ambitious are not inclined to migrate. All this leads to a negative selection for health in the periphery and to a positive one in the administrative center of the region. This undoubtedly contributes to the strengthening of the central-peripheral inequality in mortality in Russia.

One of the most important factors affecting the mortality rate is educational level. Numerous studies, including in Russia, show that people with higher levels of education live longer than those with lower levels [Shkolnikov et al. 2004; Kharkov, Nikitina, Andreev 2017; Pyankova, Fattakhov 2017]. An educational gradient is also observed in infant mortality (depending on the educational status of the mother) [Cochrane, Ohara, Leslie 1980: 95; Kvasha 2008]. Considering that almost all million-plus cities in Russia since Soviet times have been large university centers (in their regions, the largest and sometimes the only ones), and that the majority of non-resident students tend to remain in the place where they obtained their degrees (and, if they want to move, will go to an even larger city, usually to the capital or abroad), it is easy to suppose that in the largest cities of the country, compared with the rest of Russia, a greater share of the population has a higher education, which could also explain to a significant degree the differences between them in mortality. To test this hypothesis, we turned to the 2010 All-Russian Population Census, which contained a question about the level of education. We calculated the standardized (by one-year age groups, where the standard was the age structure of the Russian population according to the 2010 census) proportion of people over the age of 30 (the age after which the educational level of a person changes very rarely) with higher education for all million-plus cities, as well as for the remaining populated areas of regions whose administrative centers are million-plus cities, and for the rest of Russia, the aggregate city and the aggregate region. Those who did not indicate the level of education were distributed proportionally among all educational groups. The results are presented in Figure 5.

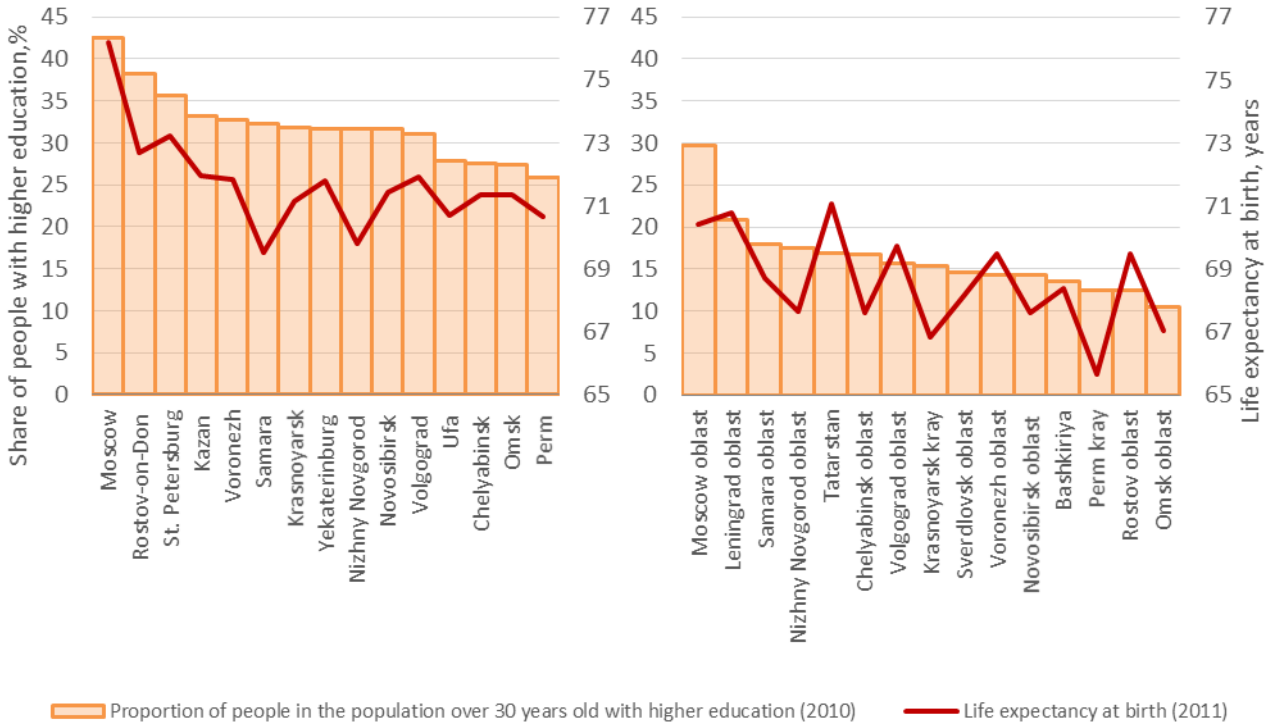

Figure 5. The proportion of people in the population over 30 years old with higher education (left scale) and life expectancy at birth in 2011 (right scale) in Russian cities with a population of over one million people and the rest of the territory of the respective regions

Indeed, million-plus cities in Russia are notable for a greater proportion of people with higher education (31% in the aggregate city, which, we recall, does not include Moscow and St. Petersburg, versus only 15.5% in the aggregate region and 19.6% for the rest of Russia). Moscow, in turn, as with GUP per capita, has a significantly greater proportion of people with higher education than other million-plus cities. Interestingly, in second place came Rostov-on-Don, not St. Petersburg, which ranked third. The Rostov region also recorded the largest gap in the educational level between the center and the rest of the region. We also note that in the population of the Moscow region, the proportion of people who graduated from high school (almost 30%) is higher than in four out of fifteen million-plus cities, while in the Omsk region outside Omsk only one out of ten people has a higher education.

Figure 6 shows three distinct clusters - Moscow, the other million-plus cities, including St. Petersburg, and their regions outside the center - differing from each other in terms of the proportion of people over 30 years of age with higher education and life expectancy at birth. At the same time, the relationship between educational structure and mortality is much stronger than between mortality and the level of economic development. In two cities - Samara and Nizhny Novgorod - life expectancy at birth is significantly lower than might be expected based on their educational structure (a high proportion of people with higher education). Perhaps in these cities the proportion of people with a very low level of education is higher than in others, and in the case of Samara it is worth noting that of all the million-plus cities it has the highest rate of mortality from HIV as well as from external causes [Schur 2018: 109] Interestingly, if for million-plus cities the level of education is quite strongly correlated with life expectancy at birth, then for their areas outside the center this factor does not matter much; far more important is the geographical factor

(south-west/north-east mortality gradient) and possibly also the ethnic one (in the case of Tatarstan and to a lesser extent Bashkiriya).

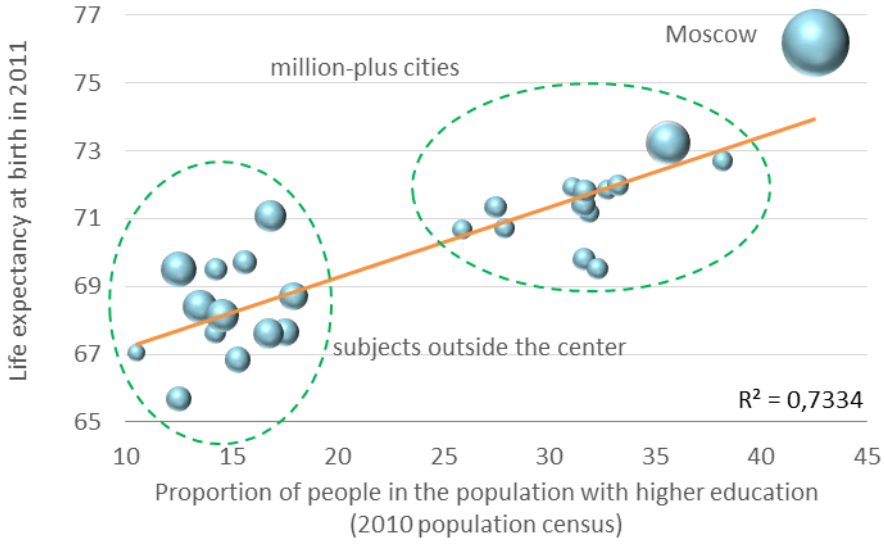

Figure 6. Relationship between life expectancy at birth and the proportion of people in the population with higher education in Russian cities with a population of over one million and in their areas outside the center

When explaining the higher level of life expectancy at birth in cities with a population of over 1 million, one should not ignore access to health care, especially involving modern medical technologies, which, due to population density and logistics (infrastructure), is significantly greater in the major agglomerations than in the areas outside them. As an example, if in million-plus cities the whole population lives within a one-hour ride from a PCI[9] center, then for Russia as a whole this figure is only 45% [Timonin et al. 2018]. It seems that geographical inequality in the level of accessibility of modern medicine is precisely what is most easily affected by government actors, while other (structural) factors, such as differences in the level of economic development or educational structure, as well as the central-peripheral direction of migration flows, are much harder to change, and their influence can hardly be completely eliminated.

CONCLUSION

Over the decades following the collapse of the Soviet Union the level of inequality in mortality between Russian million-plus cities and the rest of Russia has increased significantly. Standing apart from them all is Moscow, whose life expectancy at birth began in the 2000s to significantly outpace other Russian million-plus cities. St. Petersburg occupies an intermediate position between the capital and the "provincial" million-plus cities, among which, in turn, in the 2000s stand out both the group of “leaders” (Kazan and Rostov-on-Don) and the group of "laggards" (Nizhny Novgorod and Samara). Differentiation of million-plus cities in terms of life expectancy is not determined by their level of economic development (expressed in terms of gross urban

[9] PCI - percutaneous coronary intervention (in other words, stenting) is the most effective way to treat acute coronary heart disease.

product per capita), size (population) or geographic coordinates; however, one can see some connection between the educational level of a city's population (the proportion of people over 30 years with higher education) and life expectancy in it.

The life expectancy gap between million-plus cities and "their" regions not only increased significantly in 1989-2016 (on average, by almost 2 years), but, as a rule, increased relative to the rest of the country, too, i.e. Russia's central-peripheral inequality in mortality is more pronounced at the sub-regional level. Interestingly, the southwest/northeast mortality gradient, relatively unimportant at the level of million-plus cities, is a good predictor of differences in life expectancy in their areas outside the "centers". Thus, the maximum level of central-peripheral inequality in mortality is observed in the regions of the Urals and Siberia, where there is a very low life expectancy outside the regional capitals, while in the regions of the European part of Russia the difference between "centers" and "periphery" is significantly smaller (with the exception of the Moscow metropolitan region). The main cause of central-peripheral inequality in mortality in Russia, it seems to us, is excessive centralization both at the country level and at the level of individual regions, leading to the concentration in the regional centers of most of the human capital of the entire region, and in Moscow - of the entire country.

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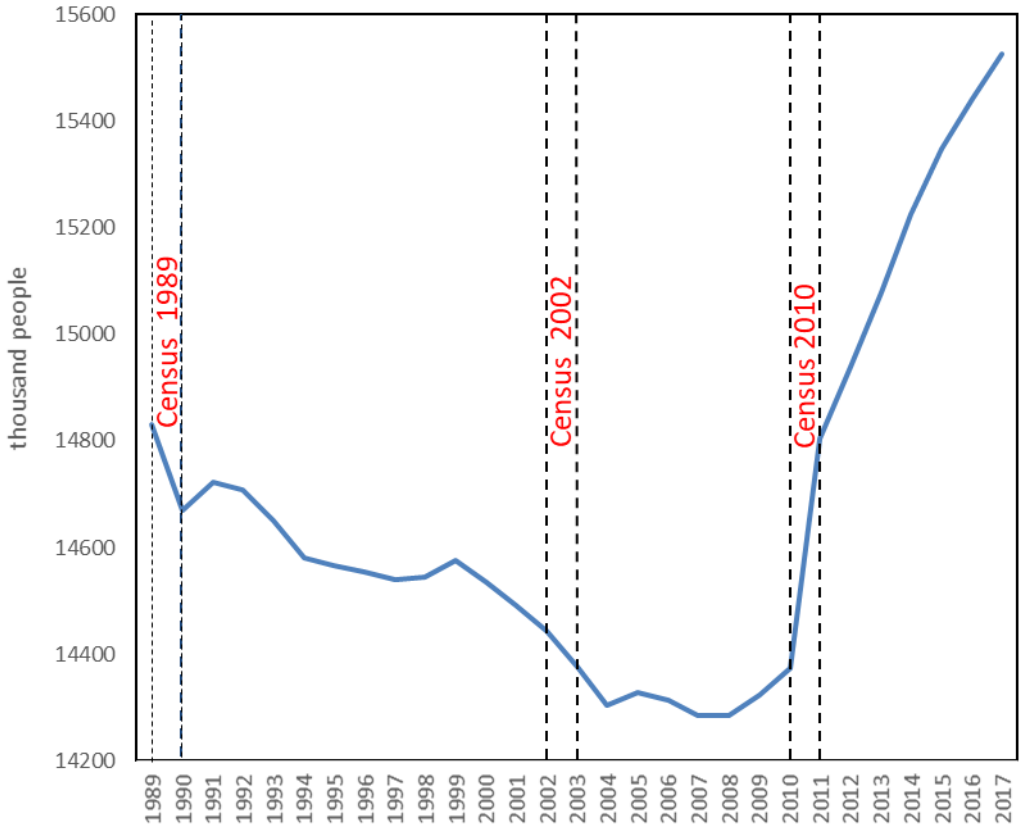
APPENDIX

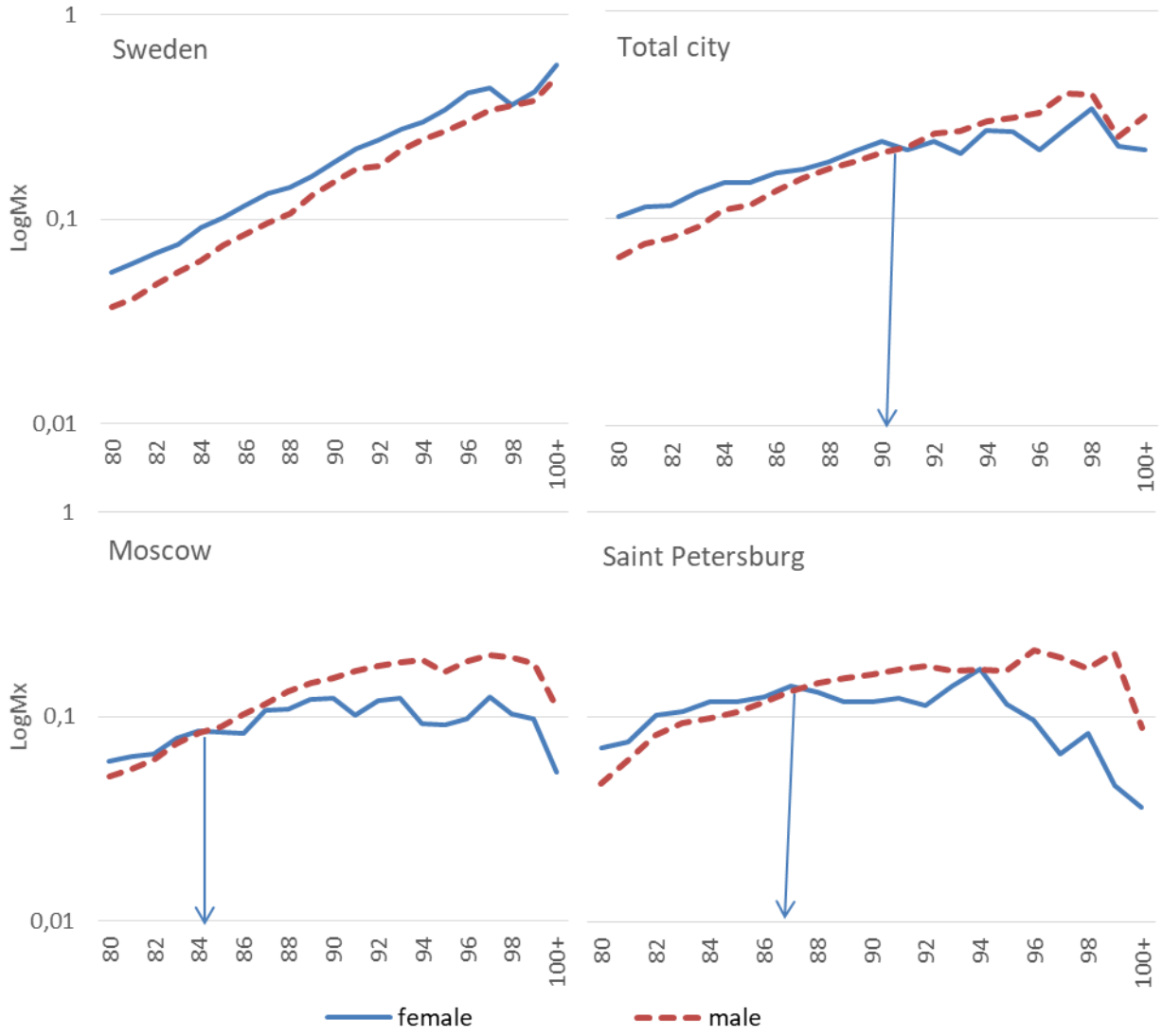
Appendix 1. Mid-year population estimates in Russian million-plus cities, except for Moscow and Saint Petersburg, 1989-2016, in thousand people

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Volgograd	998713	1005433	1008179	1007485	1006551	1008949	1014029	1019602	1023370	1022129	1018261	1015015	1011907	1007275	1001038	994775	989001	985126	982901	980763	1000217	1019778	1018765	1018388	1017718	1016794	1015862
Voronezh	885318	890136	890129	888211	886046	884987	883316	880272	876237	867716	862940	857780	852342	849741	849281	847550	843524	840310	841709	845558	913566	985390	997454	1009124	1019090	1027976	1036092
Ekaterinburg	1333036	1307079	1310049	1304995	1296945	1295149	1297649	1298817	1300898	1303535	1300429	1297765	1294699	1289798	1295629	1306346	1311769	1319026	1327609	1338052	1348316	1365266	1386906	1404210	1420194	1436241	1449977
Kazan	1087977	1092692	1095874	1094906	1090298	1085389	1082830	1083817	1086343	1103444	1104028	1104172	1105227	1106464	1108473	1111348	1114333	1118116	1125478	1133642	1140995	1153366	1168748	1183519	1198251	1211308	1224422
Krasnoyarsk	894807	879683	883445	883314	880433	880502	884298	889506	894252	901585	903295	905957	909622	912500	915011	919061	924041	931800	942123	955134	970636	988061	1006851	1025957	1043873	1059576	1074934
Nijni Novgorod	1419565	1403910	1400957	1394668	1386069	1378255	1370739	1363644	1358662	1348736	1338795	1327258	1315180	1302939	1293153	1286515	1280947	1276524	1273618	1271786	1261750	1253524	1257257	1261897	1265817	1267316	1264269
Novosibirsk	1431151	1430414	1433679	1429478	1421133	1416370	1417056	1419419	1423719	1432970	1431974	1430065	1426209	1418143	1409262	1401292	1394467	1391216	1393852	1403164	1442137	1487029	1511361	1535856	1557499	1575613	1593527
Omsk	1153978	1164017	1169505	1170531	1168008	1167285	1167961	1166643	1167318	1164484	1156024	1146348	1136374	1126833	1132546	1140798	1136798	1132937	1130110	1128398	1140898	1155352	1158627	1163381	1169973	1175967	1178235
Perm	1086093	1081773	1081757	1075838	1066504	1048614	1030682	1022263	1015281	1001963	998040	996344	997925	997367	992063	991409	991738	988695	986514	986146	989007	996094	1007280	1020182	1031473	1039173	1044941
Rostov-on-Don	1010255	1017746	1024977	1029808	1033940	1040371	1047075	1051684	1055533	1061249	1063323	1065250	1066713	1064867	1060051	1056412	1053248	1050172	1048853	1048558	1069539	1093701	1100091	1106784	1112321	1117341	1122587
Samara	1241242	1225344	1219375	1211164	1205258	1201247	1197350	1192801	1188080	1188620	1179220	1169350	1159939	1149822	1138832	1138382	1141170	1137208	1135069	1134235	1150127	1167842	1170391	1171973	1172084	1171365	1170315
Ufa	1080501	1084555	1087057	1085587	1082093	1080294	1081555	1074613	1068347	1072754	1072968	1070352	1055809	1041965	1038325	1032821	1026096	1022017	1023150	1027827	1048217	1068956	1075005	1087211	1101185	1108322	1113268
Chelyabinsk	1126939	1112653	1110432	1104114	1093095	1086144	1085001	1083908	1084637	1085522	1083335	1081633	1078282	1073486	1083030	1094006	1092223	1091992	1093097	1094804	1113509	1137283	1149830	1162817	1176410	1187691	1195426

Appendix 2. Combined population on the 1st of January of each year of Russian million-plus cities, except for Moscow and Saint Petersburg



Appendix 3. Mortality curves (log Mx) at the ages 80+ in Moscow, Saint Petersburg, the aggregate million-plus city and Sweden (as a country with some of the highest quality data on mortality)



Appendix 4. Life expectancy at birth in Russian million-plus cities, 1989-2016

Males

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Volgograd	66,3	66,5	66,2	65,0	62,3	60,0	60,6	62,0	62,5	61,3	60,7	60,5	60,5	60,8	62,0	61,9	62,7	64,3	64,7	65,2	65,3	66,0	66,3	67,3	66,9	67,7	68,0
Voronezh	67,4	67,9	66,6	66,0	63,4	61,9	61,7	63,4	64,8	62,1	61,2	60,4	60,3	60,2	60,3	60,6	60,9	61,3	62,8	64,2	64,5	65,6	66,2	66,2	65,5	66,5	67,1
Ekaterinburg	65,7	65,0	64,6	62,1	58,6	58,1	58,9	60,2	62,2	60,6	59,0	59,6	60,0	59,8	60,3	61,0	62,4	63,3	63,5	64,6	65,4	66,0	66,1	66,5	66,5	66,8	67,0
Kazan	64,8	64,5	64,7	64,0	61,5	59,6	59,3	61,9	62,1	61,5	60,5	60,6	60,7	60,7	59,9	60,6	62,4	63,6	64,7	65,7	64,4	65,8	66,7	67,4	67,5	68,4	69,4
Krasnoyarsk	62,9	62,0	61,3	59,2	54,7	53,7	54,4	56,3	58,8	57,4	56,3	57,5	58,0	58,3	59,5	58,9	61,6	62,2	63,7	64,6	64,7	65,2	65,3	66,2	65,9	66,9	66,7
Moscow	65,0	64,8	64,9	63,4	59,5	57,7	58,9	62,4	64,5	64,7	64,5	64,4	64,9	65,0	65,9	66,7	67,3	68,2	68,7	69,7	70,0	71,5	71,6	72,3	72,8	73,0	73,5
Nijni Novgorod	64,9	64,8	65,1	63,2	59,7	56,9	57,0	60,4	62,1	61,2	59,7	59,6	58,8	58,0	58,3	58,4	58,8	60,0	60,4	61,6	61,3	63,3	63,1	64,0	64,3	65,0	65,0
Novosibirsk	64,6	64,2	64,8	63,4	58,6	57,0	59,6	60,7	62,4	62,5	61,7	60,9	60,8	60,1	60,1	59,4	61,1	62,1	63,5	64,6	65,0	65,5	65,3	66,0	66,1	66,7	66,9
Omsk	65,6	66,6	65,7	64,7	61,6	59,9	61,0	62,0	62,3	61,6	60,5	61,2	60,7	60,1	60,2	59,1	60,3	61,3	62,7	64,2	64,4	65,4	65,2	65,4	65,5	66,0	66,5
Perm	65,4	64,9	64,8	63,2	59,7	57,7	57,5	59,3	61,5	60,3	58,9	58,9	59,2	58,7	58,5	59,2	60,9	62,3	62,4	62,9	63,3	64,3	64,8	65,4	65,4	65,3	66,1
Rostov-on-Don	65,4	64,7	64,3	63,6	60,9	59,5	59,4	61,4	63,4	63,9	62,3	61,9	61,7	62,0	62,9	63,4	63,6	65,1	65,8	66,9	67,2	67,6	68,3	69,1	68,5	69,6	69,7
Samara	64,6	64,0	64,2	62,7	59,9	58,0	58,5	58,8	61,1	58,8	56,8	57,2	59,0	58,9	58,6	59,6	60,3	60,6	61,1	61,8	61,7	63,1	63,8	63,4	63,2	64,4	65,7
Saint Petersburg	65,6	64,7	64,3	62,4	57,5	57,4	59,6	62,5	64,4	62,0	60,4	60,7	61,1	61,0	61,1	61,7	63,1	64,3	65,2	66,3	66,8	67,8	68,4	69,4	69,8	69,8	70,3
Ufa	65,6	66,5	65,3	64,7	61,5	60,0	60,5	62,5	63,5	62,2	61,4	61,6	61,2	60,7	60,8	61,7	62,6	63,1	63,7	65,4	64,8	65,0	65,3	65,6	65,3	65,7	66,7
Chelyabinsk	65,5	65,6	65,8	63,5	60,2	58,2	58,3	60,6	62,6	61,4	59,9	60,1	60,0	60,0	60,4	60,1	61,7	63,6	63,5	64,4	64,6	65,2	65,2	65,3	65,4	65,8	66,2

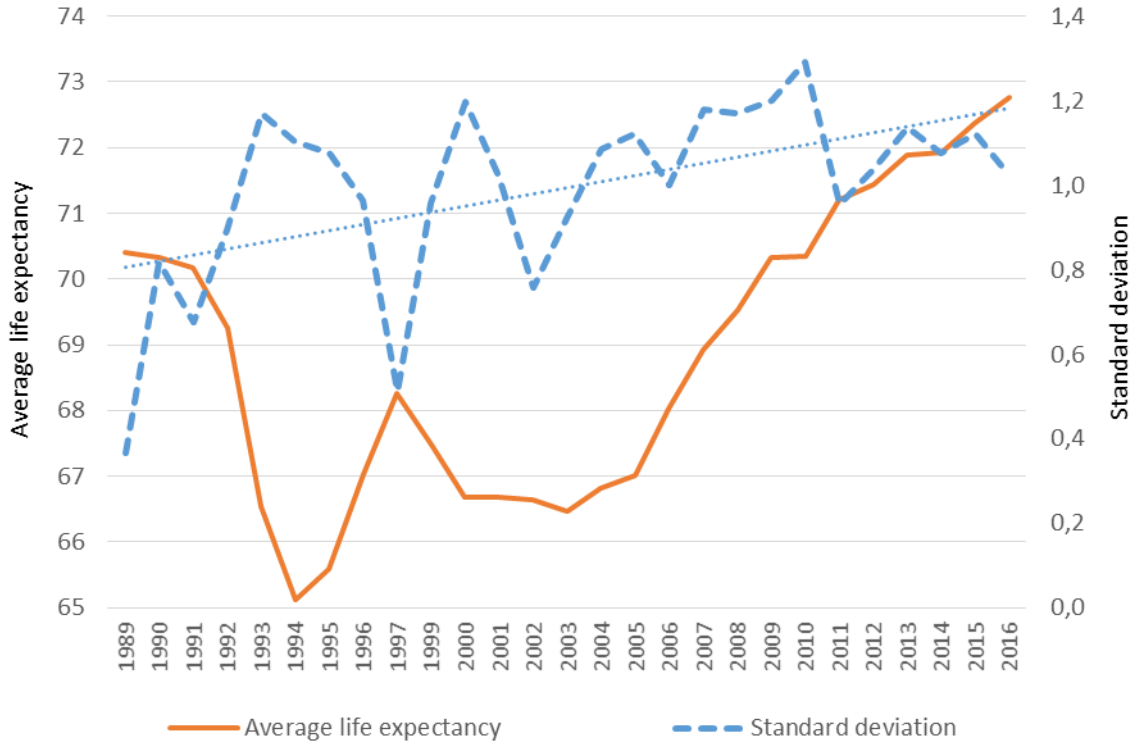
Females

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Volgograd	75,5	75,4	75,5	75,5	73,9	72,5	72,7	73,9	74,3	73,5	73,8	73,5	73,9	73,4	74,4	74,3	75,0	75,8	76,4	76,7	76,2	77,4	77,6	77,6	78,2	77,9	78,4
Voronezh	76,7	76,7	76,5	76,2	74,6	74,8	74,8	75,2	75,2	74,1	73,9	74,4	74,1	73,5	74,2	74,0	75,0	75,1	75,4	75,8	76,5	77,6	77,8	78,2	78,2	78,6	78,7
Ekaterinburg	74,7	74,0	73,8	73,1	71,6	70,8	71,6	72,7	74,0	72,8	72,7	73,3	72,9	73,0	74,2	74,0	74,7	75,5	75,6	76,0	76,8	76,9	76,8	77,9	77,5	77,9	77,9
Kazan	75,0	75,2	75,2	75,5	74,4	73,2	73,2	74,3	74,5	74,6	74,1	74,2	74,4	74,4	74,6	74,8	75,5	76,1	76,5	76,9	76,6	77,5	78,4	78,5	78,5	79,1	79,3
Krasnoyarsk	73,5	73,1	72,7	72,4	69,5	68,6	70,3	70,9	71,3	70,9	71,3	72,0	71,8	72,0	72,9	72,9	74,1	74,6	74,9	75,6	76,0	76,5	76,4	77,0	77,4	77,1	77,9
Moscow	74,2	74,1	74,2	74,0	72,1	71,5	72,1	73,8	74,3	74,7	75,0	74,7	74,8	75,0	75,8	76,3	76,9	77,5	77,8	78,5	78,2	79,8	79,6	80,2	80,4	80,4	80,4
Nijni Novgorod	75,5	74,8	75,1	74,8	72,7	71,6	71,4	72,8	73,9	73,6	73,0	73,0	72,5	72,3	72,3	72,3	73,5	73,7	74,5	75,1	74,2	75,8	75,8	76,5	76,5	76,9	77,1
Novosibirsk	74,5	74,6	74,5	74,0	71,5	70,8	72,4	73,0	73,8	74,1	74,1	73,9	73,1	73,4	73,7	73,4	75,0	75,3	75,8	76,2	76,6	76,9	77,1	77,4	77,5	78,2	78,2
Omsk	75,0	75,9	75,6	75,5	73,6	72,7	73,2	73,8	74,0	74,0	73,4	73,7	73,0	72,9	73,3	73,3	74,0	74,2	75,2	75,6	75,9	76,8	76,6	77,1	77,5	77,6	77,9
Perm	74,4	74,4	74,0	73,4	71,2	70,7	70,6	71,7	73,2	72,0	72,6	72,5	72,3	71,8	72,5	72,9	74,0	74,5	74,9	75,1	75,9	76,4	76,4	77,1	76,9	76,9	77,1
Rostov-on-Don	74,2	73,5	73,3	73,5	72,5	72,3	72,1	73,0	73,3	73,7	73,9	73,4	73,6	73,9	74,3	74,5	74,2	75,1	75,9	76,6	76,6	77,4	77,6	77,6	78,1	78,2	78,0
Samara	74,5	74,6	74,8	74,2	72,3	71,6	72,3	73,0	73,8	73,2	72,1	72,1	72,8	72,8	72,9	73,6	74,0	74,1	74,4	74,4	74,3	75,7	76,3	75,7	76,4	76,6	76,9
Saint Petersburg	74,3	74,2	74,1	73,5	70,5	70,8	72,1	73,7	74,6	73,6	73,0	73,1	73,0	73,2	73,9	74,3	75,2	76,0	76,3	76,7	76,9	77,7	77,8	78,4	78,7	78,4	78,9
Ufa	74,8	76,2	76,2	75,5	73,8	73,7	73,3	74,0	74,8	74,3	74,4	73,9	73,5	73,4	73,8	74,2	75,2	75,1	75,5	76,3	75,9	76,0	76,9	77,4	77,2	77,4	77,8
Chelyabinsk	75,0	74,8	74,7	74,8	72,7	72,0	72,3	73,4	74,7	73,5	73,4	73,2	72,8	73,0	73,6	73,7	74,5	75,3	75,9	76,6	76,7	76,9	76,6	77,6	77,6	77,6	78,1

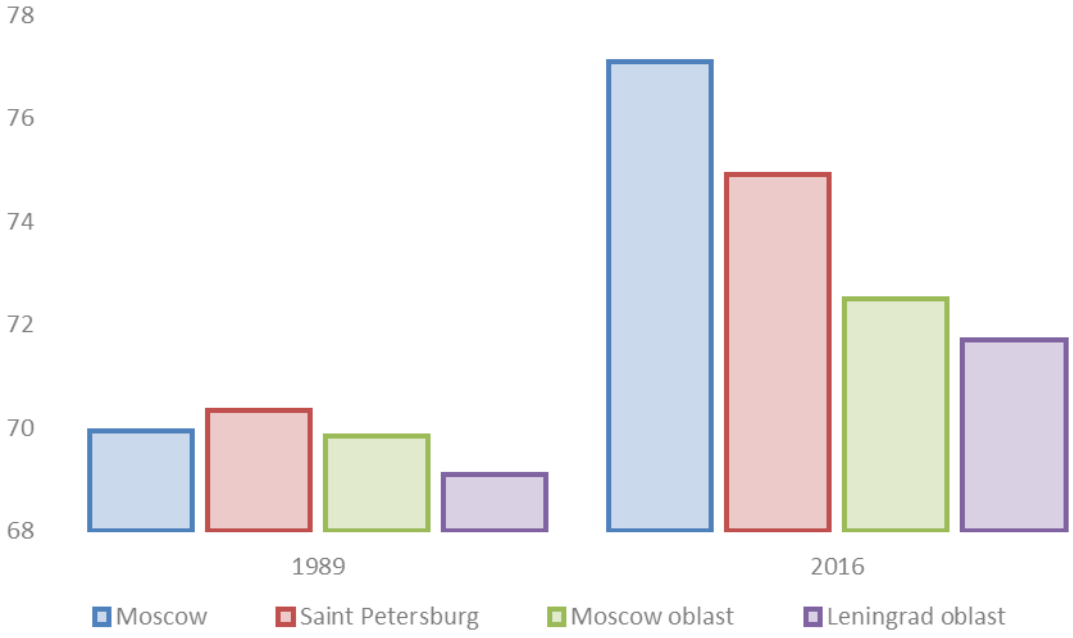
Both sexes

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Volgograd	71,2	71,2	71,0	70,4	68,1	66,0	66,5	67,9	68,4	67,2	67,0	66,7	67,0	67,0	68,1	68,1	68,8	70,1	70,7	71,1	70,9	71,9	72,2	72,7	72,8	73,1	73,5
Voronezh	72,4	72,5	71,8	71,3	69,0	68,3	68,2	69,3	70,2	68,1	67,5	67,2	67,1	66,7	67,1	67,2	67,9	68,2	69,2	70,2	70,7	71,8	72,3	72,4	72,0	72,8	73,1
Ekaterinburg	70,5	69,7	69,4	67,7	65,0	64,4	65,2	66,4	68,2	66,8	65,8	66,4	66,5	66,4	67,2	67,5	68,7	69,6	69,8	70,6	71,4	71,8	71,8	72,5	72,4	72,7	72,8
Kazan	70,3	70,2	70,3	70,0	68,0	66,3	66,2	68,2	68,4	68,1	67,3	67,4	67,6	67,5	67,2	67,7	69,1	70,1	70,9	71,6	70,7	72,0	72,9	73,3	73,4	74,2	74,8
Krasnoyarsk	68,6	67,8	67,3	65,8	61,7	60,6	61,8	63,4	65,1	64,0	63,5	64,6	64,8	65,0	66,2	65,9	68,0	68,6	69,6	70,5	70,6	71,1	71,1	72,0	72,0	72,4	72,7
Moscow	69,9	69,8	69,9	68,9	65,7	64,3	65,3	68,1	69,5	69,7	69,7	69,5	69,8	70,0	70,8	71,5	72,1	73,0	73,3	74,1	74,2	75,8	75,7	76,4	76,7	76,8	77,1
Nijni Novgorod	70,5	70,1	70,3	69,2	66,1	63,8	63,9	66,5	68,0	67,4	66,2	66,1	65,5	64,9	65,2	65,2	66,0	66,9	67,4	68,5	67,9	69,8	69,7	70,6	70,7	71,3	71,4
Novosibirsk	69,9	69,8	69,9	68,9	64,9	63,7	66,0	66,9	68,2	68,3	67,9	67,3	66,9	66,7	66,8	66,2	68,0	68,7	69,7	70,6	71,0	71,4	71,4	71,9	72,0	72,6	72,8
Omsk	70,7	71,6	70,9	70,3	67,6	66,2	67,0	67,9	68,2	67,8	66,9	67,4	66,8	66,4	66,7	66,0	67,1	67,8	69,0	70,1	70,3	71,3	71,1	71,4	71,7	72,0	72,4
Perm	70,3	69,9	69,6	68,4	65,4	64,0	63,9	65,5	67,4	66,3	65,8	65,8	65,8	65,1	65,4	66,0	67,5	68,6	68,8	69,3	69,8	70,7	70,9	71,6	71,6	71,5	72,0
Rostov-on-Don	70,1	69,4	69,0	68,7	66,7	65,7	65,7	67,2	68,5	68,9	68,1	67,7	67,6	67,9	68,6	69,0	69,0	70,2	71,0	71,9	72,1	72,7	73,2	73,6	73,5	74,2	74,1
Samara	69,9	69,6	69,8	68,6	66,1	64,6	65,2	65,7	67,5	65,7	64,0	64,3	65,7	65,7	65,6	66,5	67,1	67,3	67,8	68,2	68,1	69,5	70,2	69,7	69,9	70,7	71,6
Saint Petersburg	70,3	69,8	69,6	68,2	63,8	63,9	65,8	68,3	69,8	67,9	66,7	66,9	67,1	67,1	67,5	68,0	69,3	70,4	71,0	71,8	72,1	73,1	73,4	74,2	74,6	74,4	74,9
Ufa	70,6	71,7	71,0	70,4	67,7	66,7	66,9	68,3	69,2	68,3	67,9	67,7	67,3	67,0	67,2	68,0	68,9	69,2	69,7	71,1	70,5	70,7	71,3	71,7	71,5	71,8	72,5
Chelyabinsk	70,6	70,5	70,5	69,2	66,3	64,8	65,1	67,0	68,7	67,5	66,5	66,6	66,3	66,4	67,0	66,9	68,2	69,7	69,8	70,7	70,9	71,3	71,2	71,7	71,7	72,0	72,4

Appendix 5. The average life expectancy at birth and the standard deviation for 11 Russian million-plus cities, 1989-2016



Appendix 6. Life expectancy at birth in Moscow, Saint Petersburg, Moscow, Leningrad oblasts, in 1989 and 2016, (in years)



Appendix 7. Gross urban / regional product (PPP) per capita, share of regional centers in the population and economy of the regions (%), 2015

Regional center	Share in population	Share in economy	Per capita CUP (PPP)	Without regional center	Per capita CUP (PPP)	Ratio in per capita GUP/CRP
Voronezh	44	53	443415	Voronezh oblast	308789	1,4
Volgograd	40	52	412512	Volgograd oblast	247458	1,7
Rostov-on-Don	26	51	544149	Rostov-on-Don oblast	186162	2,9
Ufa	27	42	529585	Bashkiria	278678	1,9
Kazan	31	29	493054	Tatarstan	550379	0,9
Perm	39	48	503968	Perm krai	348356	1,4
Nizhny Novgorod	39	67	576344	Nizhny Novgorod oblast	181284	3,2
Samara	36	47	510516	Samara oblast	333787	1,5
Ekaterinburg	33	48	600234	Sverdlovsk oblast	326130	1,8
Krasnoyarsk	37	35	546445	Krasnoyarsk krai	585336	0,9
Novosibirsk	57	73	465241	Novosibirsk oblast	234433	2,0
Omsk	59	77	467445	Omsk oblast	199093	2,3
Chelyabinsk	34	45	501040	Chelyabinsk oblast	310423	1,6
Total city	37	48	509167	Total region	320640	1,6
Moscow	63	78	804822	Moscow oblast	389152	2,1
Saint Petersburg	75	79	598312	Leningrad oblast	458943	1,3
All millionare cities			633613	The rest of Russia (excluding Crimea and North Caucasus)	372607	1,7

Note: For Moscow and St. Petersburg, the share of the total population of these cities and their surrounding areas (Moscow and Leningrad oblasts respectively)

Sources: Gross urban product – Rating of capital cities of Russia from the Institute for Urban Economics Foundation[10]. Gross regional product - Rosstat data. Purchasing power parity by city - "Cost of living index for selected cities of the Russian Federation"[11]. The rest is the author's calculations.

[10] URL: http://www.urbaneconomics.ru/centr-obshchestvennyh-svyazey/news/reyting-stolichnyh-gorodov-rossii-ot-fonda-institut-ekonomiki#_ftn1 (accessed: 27.10.2018).
[11] Rosstat. URL: http://www.gks.ru/free_doc/new_site/prices/isj/files/itogi_isj.pdf (accessed: 27.10.2018).

ARMENIANS OF RUSSIA: GEO-DEMOGRAPHIC TRENDS OF THE PAST, MODERN REALITIES AND PROSPECTS

SERGEIY SUSHCHIY

The article analyzes the quantitative growth, spatial dynamics, gender structure and form of resettlement of the Armenian population of Russia in the 18th-20th centuries. The demographic correlation of the largest regional communities at different stages of their development are studied, and the main historical periods of the geo-demographic dynamics of the Armenians of Russia are determined.

The first stage can be designated as "South Russian" (second third of the 18th century – 1920s). At this time, the overwhelming majority of the Armenian population of Russia was concentrated within the southern macroregion. In the second stage (mid-1920s – first half of the 1980s), Armenians resettled almost throughout the entire territory of the RSFSR, but represented internally weakly connected ethnic groups. The third period (the second half of the 1980s – the present) is associated with the transformation of these groups into developed regional communities.

Three centuries of quantitative growth allowed Armenians to become one of the largest ethnic groups in the Russian Federation by the beginning of the 21st century. In the medium term (by 2030), with a favorable scenario of demographic dynamics, Armenians will be able to take the third position in the demographic ranking of the peoples of Russia (after the Russians and Tatars).

***Key words**: geo-demographic dynamics, Armenian population of Russia, regional diasporas, migration processes, resettlement system, gender balance.*

Given the historically changing dynamics of the territorial limits of the Russian state, we will consider the geodemographic dynamics of the Armenian population within the spatial boundaries of the modern Russian Federation (as of 2018). Thus, we exclude from this study the analysis of the large centers of Armenians that existed not only within the Armenian or two other Transcaucasian republics, but also within all the other republics of the former USSR, as well as in a number of regions that were part of the Russian Empire until 1917. In some cases (specified in the text), however, we will talk about the entire Armenian population of the country, be it the Russian Empire or the Soviet Union. At the same time, by "the South of Russia" (the southern macroregion) we will understand the areas of the Don region, the lower Volga region, the steppe of the Pre-Caucasus, the North Caucasus and the Crimea, i.e. the territories currently constituting the two federal districts of the South and North Caucasus.

Individual immigrants from Armenia or local groups of its natives appear within the limits of the future Russia in antiquity and the Middle Ages. But only beginning with the incorporation into the Russian state of the lower Volga region (mid-16th century) do centers with large Armenian communities appear within the country (above all in Astrakhan, where Armenians had long resided). The number of such centers increases markedly in the 18th century, when a new Russian macroregion begins to form on the annexed lands of the Pre-Caucasus steppe.

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Armenian migrations organized (or encouraged) by the authorities at this time lay the foundations of a settlement network within the South of Russia. Starting in the second half of the century, the largest of these settlements become centers of attraction and concentration of new groups of immigrants. The specific composition of the focal points of the Armenian presence in the southern macroregion changes quite significantly. While in the 16th-17th centuries the main centers of Armenians are Astrakhan, Derbent, and the Adygo-Cherkessky mountain range in the Northwest Caucasus, in the mid-late 18th century the lower Don River (Nor-Nakhichevan with the adjacent Armenian villages) and the districts of Kizlyar and Mozdok also become significant. In total, the Armenian population of the South of Russia at the turn of the 19th century is about 23–24 thousand people (without the Cherkessogai, who, if included, could increase this number to 30–35 thousand). The southern macroregion accounts for up to 98-99% of the Armenian population of the whole of Russia, and for a long time it becomes their main center (Figure 1).

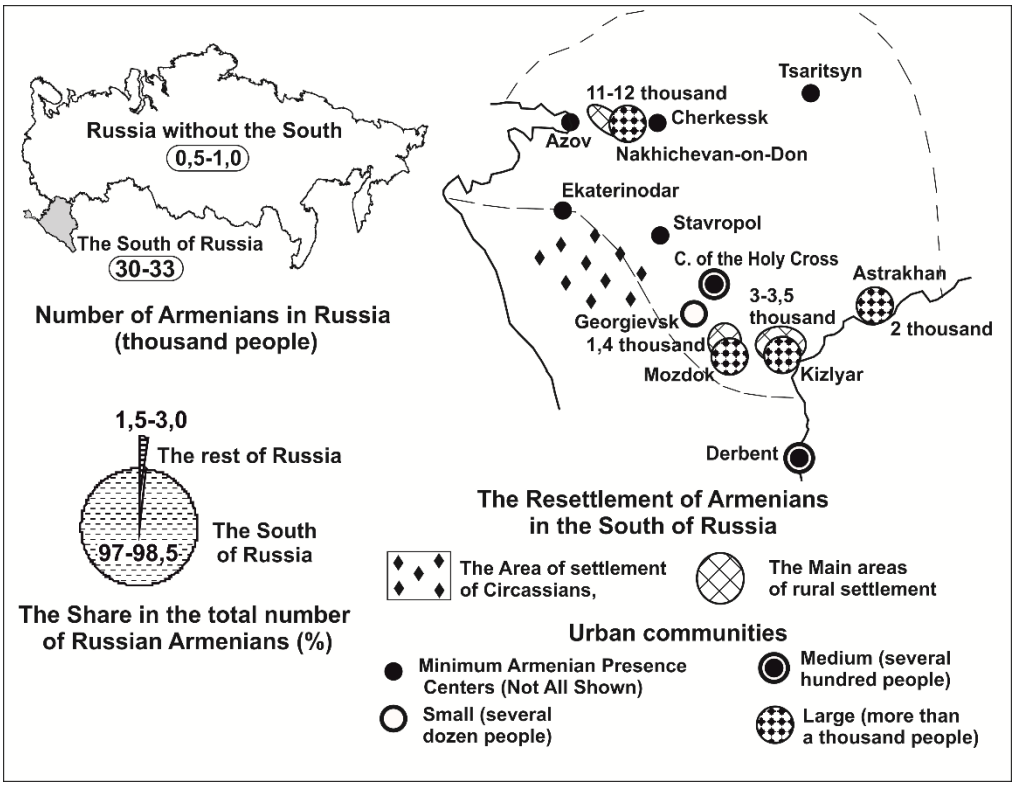

Figure 1. Armenians in Russia, 1800[1]

Even 100 years later, at the end of the 19th century, the system of settlement of Armenians within Russia had barely changed, despite the fact that Transcaucasia, which had a large Armenian population, had become a part of the empire. But the Armenians almost never left this region. Outside it they were few, and they continued to be concentrated mainly in Novorossia, which at that time, in addition to the steppe of the Pre-Caucasus (Don, Kuban, and Stavropol), included the Black Sea provinces and Bessarabia. As a result, the South of Russia still accounted for more than 95% of the Armenian population settled within the territorial borders of the modern Russian Federation (Figure 2).

[1] Maps compiled using data from (Avakov 2012; Aganesova, Suzdaltseva 2007; Hakobyan 2005; Arakelyan 1984; Volkova 1966; Cabuzan 1990, 1996; Ter-Sarkisyants 1998, 2005).

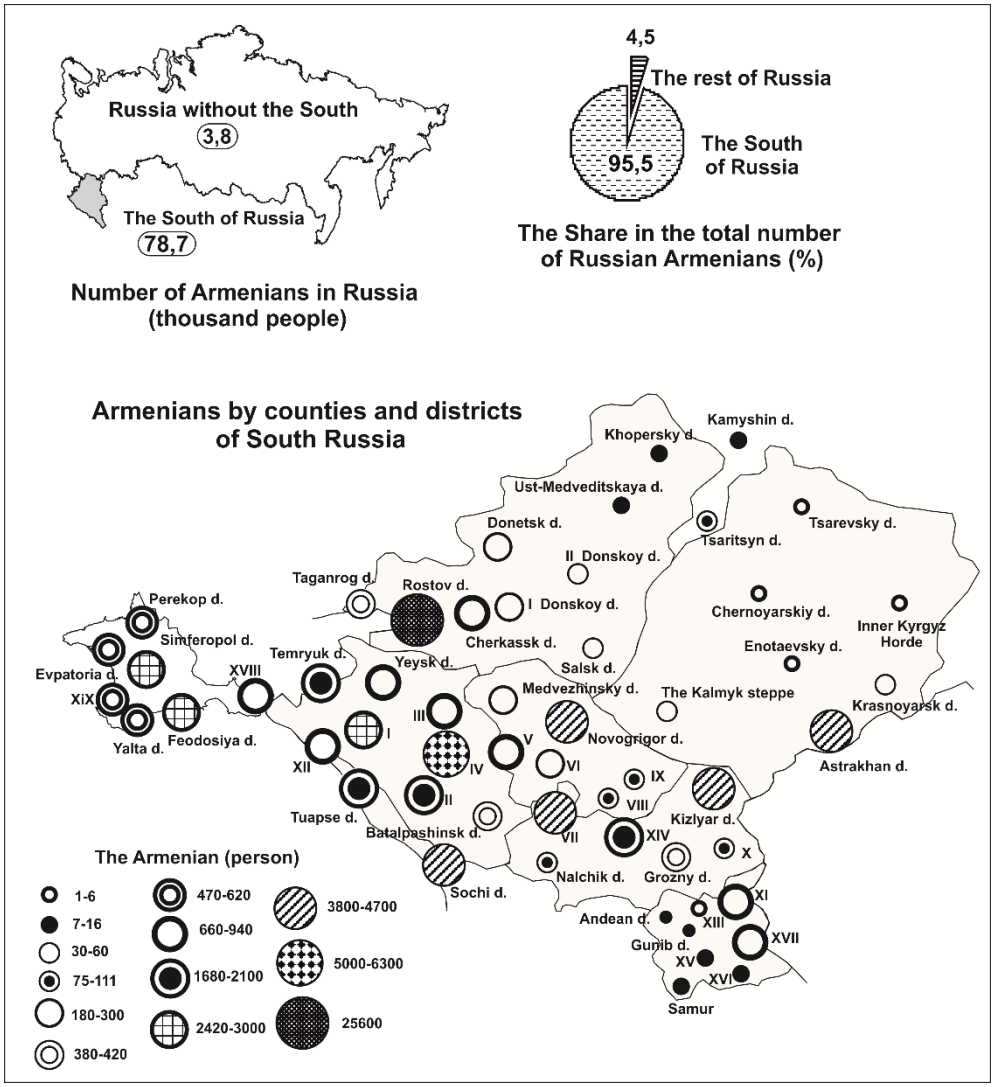

Figure 2. Armenians in Russia, 1897[2]

In the overwhelming majority of provinces of central, northern, or trans-Ural Russia, Armenians at the turn of the 20th century are extremely few. The first general census of the population of the empire in 1897 recorded their numbers here at 5-15 people per province. These small groups are distinguished by a very high level of urbanization by the standards of the time, and consist predominantly of men. In most provinces of the empire, the number of male Armenians was 3–4 times (sometimes 10–12 times) greater than the number of women. Given the minimal population sizes and gender imbalance, it's more likely that this is not a question of local

[2] Maps 2-3 and 5-17 use materials from the First General Census of the Russian Empire in 1897, as well as from the All-Union Censuses of 1926–1989 and the All-Russian Census 2002–2010. Geodemographic statistics of the Armenian population for 2002 and 2010 in Russian regions and urban centers were collected from the Rosstat website, and also, in part, from the sites of its regional offices. Electronic resources: 1897 census - URL: http://demoscope.ru/weekly/ssp/emp _lan_97_uezd.php; the 1926 census - URL: http://demoscope.ru/weekly/ssp/rus_nac_26.php?reg; 1939 census - URL: http://demoscope.ru/weekly/ssp/rus_nac_39.php; 1959 census - URL: http://demoscope.ru/weekly /ssp/rus_nac_59.php; 1970 census - URL: http://demoscope.ru/weekly/ssp/rus_nac_70.php; 1979 census - URL: http://demoscope.ru/weekly/ssp/rus_nac_79.php; 1989 census - URL: http://demoscope.ru /weekly/ssp/rus_nac_89.php; 2002 Census - URL: http://demoscope.ru/weekly/ssp/rus_nac_02.php; The 2010 Census - URL: http://demoscope.ru/weekly/ssp/rus_nac_10.php (access date: 03/14/2018).

ethnic groups, but of a dispersed settlement, of a certain number of single men living in cities, mostly large, at the level of the provincial center.

Among the demographic centers of the Armenian population within central Russia can be singled out the communities of the two capitals, Moscow and St. Petersburg (Figure 3). However, at the turn of the twentieth century they too are several times smaller than the urban Armenian communities of many southern Russian cities (and St. Petersburg does not even fall into the top ten).

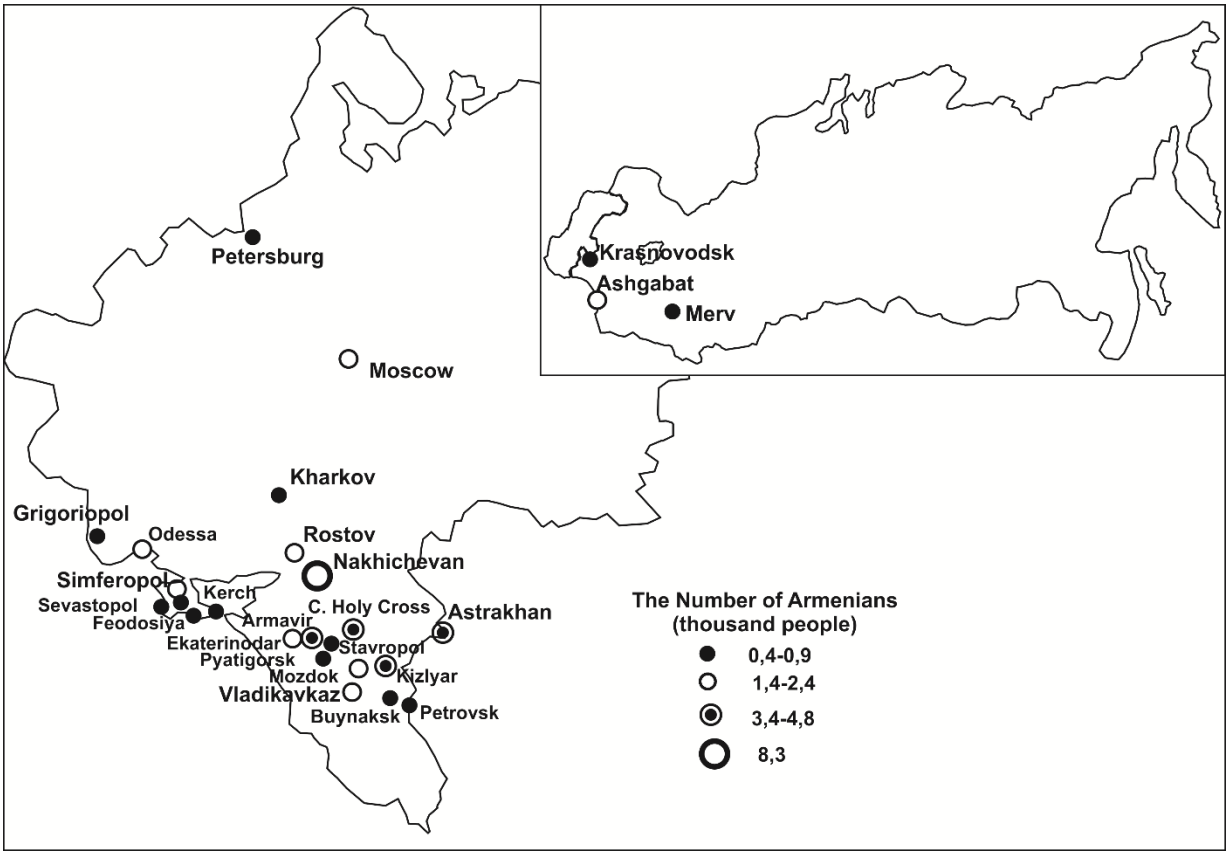

Figure 3. The largest urban communities of Armenians in the Russian Empire, 1897 (without Transcaucasia)

The beginning of the twentieth century, especially the period of the First World War, is a time of well-known tragic events for the entire Armenian people, which in geodemographic terms led to another cardinal change in their system of settlement. The genocide of 1915–1916, the mass migration of the following years and the collapse of the Ottoman Empire, which had lost a significant part of its territory, reduced the demographic potential of the Armenian population of Turkey by an order of magnitude. Within 15–20 years it ceased to be the main focus of the Armenian people. This role would be taken over by Soviet Russia, which in the early to mid-1920s had an Armenian population already several times greater than that of Turkey. (Figure 4).

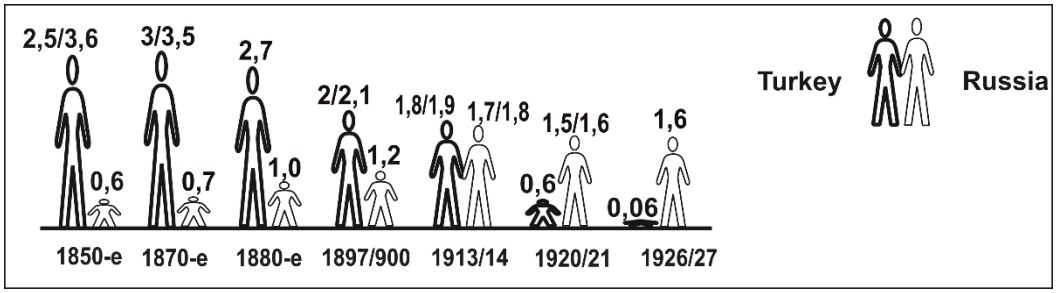

Figure 4. The dynamics of the Armenian population in the Ottoman Porte (Turkey) and in the Russian Empire (USSR), 1850s - 1920s, million3

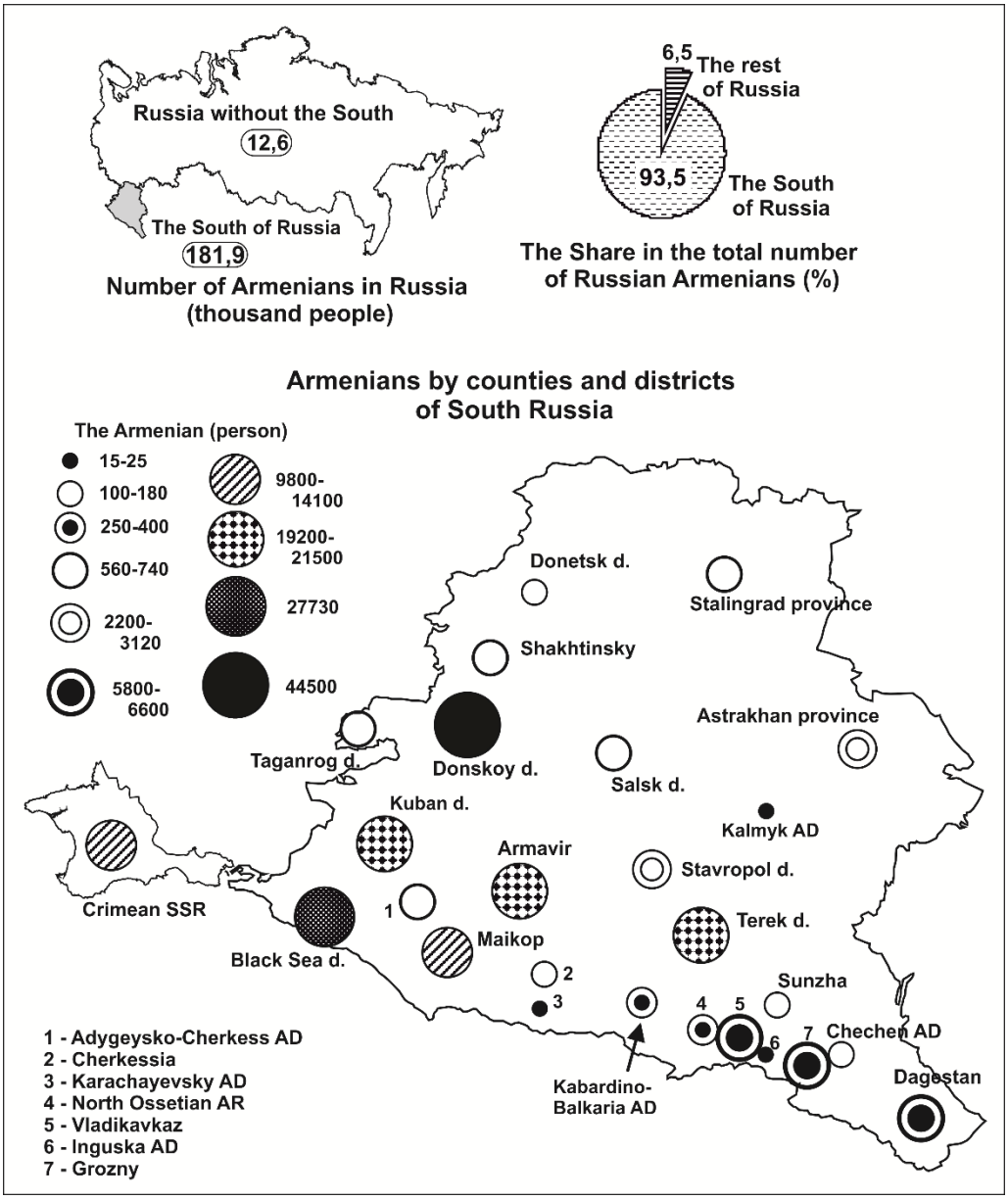

Figure 5. Armenians in Russia, 1926

The first region, however, to be filled with refugees and migrants in the late Russian Empire was Transcaucasia, followed, to a much lesser extent, by the South of Russia, within which by the

[3] Map compiled from data collected by G.G. Sargsyan (Armenians 2012: 81-87).

end of the 19th century and the beginning of the 20th century only a few tens of thousands of migrants had settled. This migration wave almost never reached central Russia, especially its Trans-Ural regions. And although the total number of Russian Armenians almost tripled in the first quarter of the century, the census of 1926 (Figure 5) found almost the same geography as in the late 19th century. More than 95% of Armenians in Russia (within the present borders of the Russian Federation) were still residents of its southern macroregion.

The process of spatial decentralization of the settlement system of the Armenian population within the RSFSR becomes obvious only in the 1930s. By the end of this decade, its share outside the South increases by 3 times and exceeds 20% of the total number. The explanation would seem to be clear: the interregional migration that was rapidly growing during the first five-year periods and nationwide labor brigades led to the spatial circulation of Armenians too. This is partly true. The number of Armenians of the RSFSR outside its southern macroregion increased by 3.5 times in the period 1926-1939 (Figure 6). However, in the South itself, their number in this period decreased. In absolute terms, the reduction was insignificant, but taking into account the natural increase of the local Armenian population, the extent of its outflow might have reached 15-20% (if not 25%) of the total number of Armenians in the southern macroregion.

Thus, the migration circulation between Armenia and the RSFSR in the 1930s was complex. On the one hand, a part of the migrants who had settled in the South of Russia during the World War I and the Civil War now returned to their Soviet republic. Among them at this time were small groups of the titular population who moved to other republics of the USSR, including the RSFSR, and often to the most distant regions from the Caucasus.

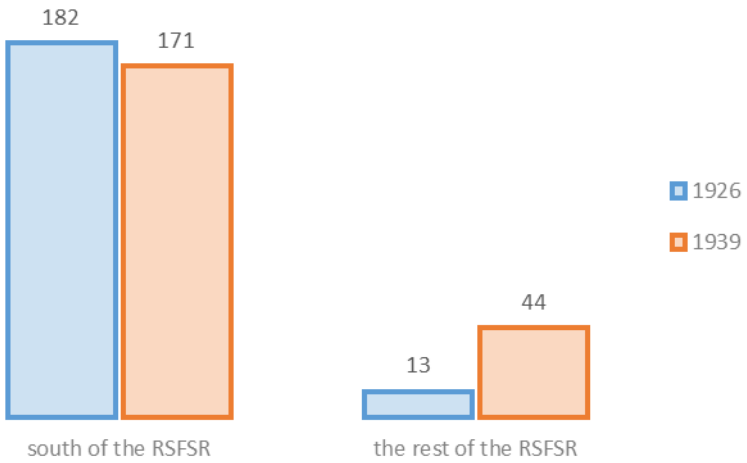

Figure 6. Dynamics of the Armenian population of the southern macroregion and the rest of the RSFSR, 1926-1939, thousand people

As a result, the size of the Armenian population in many Russian regions increased many times over. However, even this growth in the interwar period was not enough for the new regional groups of Armenians (they were still concentrated in the cities) to become large demographic centers comparable in size to the leading urban communities of southern Russia (Figure 7).

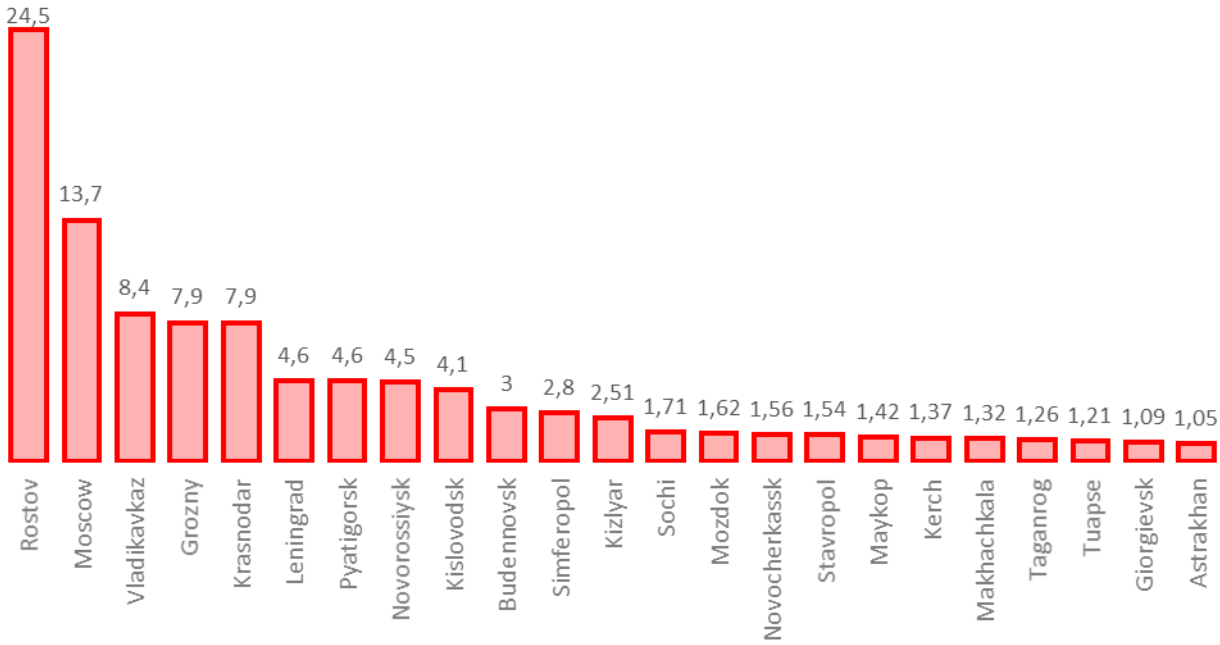

Figure 7. The size of the leading urban Armenian communities of the RSFSR, 1939, thousand people

In addition to an urban form of settlement, another sociodemographic feature of Russian Armenians is preserved - a significant gender imbalance. In most regions of greater Russia outside its southern territories, the Armenian population in the 1930s still consisted predominantly of men.

World War II had a dramatic impact on the geodemographic dynamics of the Armenian population of Russia. But the first post-war census of the population of the USSR was carried out only in 1959. 15 postwar years made up for the human losses suffered, masked shifts in the settlement system associated with the war and, in general, recorded some quantitative growth of the Armenian population of the RSFSR compared to the pre-war period (from 218,000 people in 1939, it increased to 256,000 by the end of the 1950s).

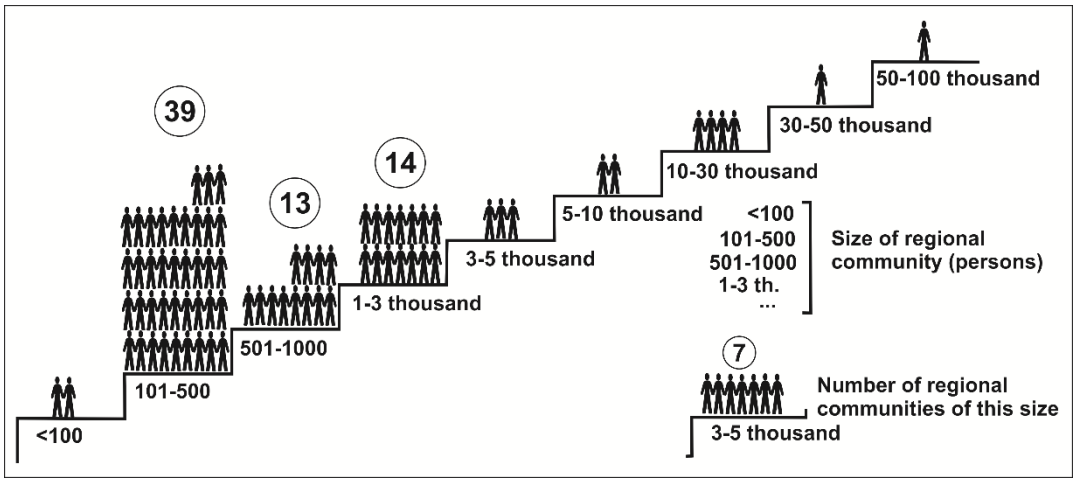

Figure 8. The size of the regional groups of the Armenian population in the RSFSR, 1959

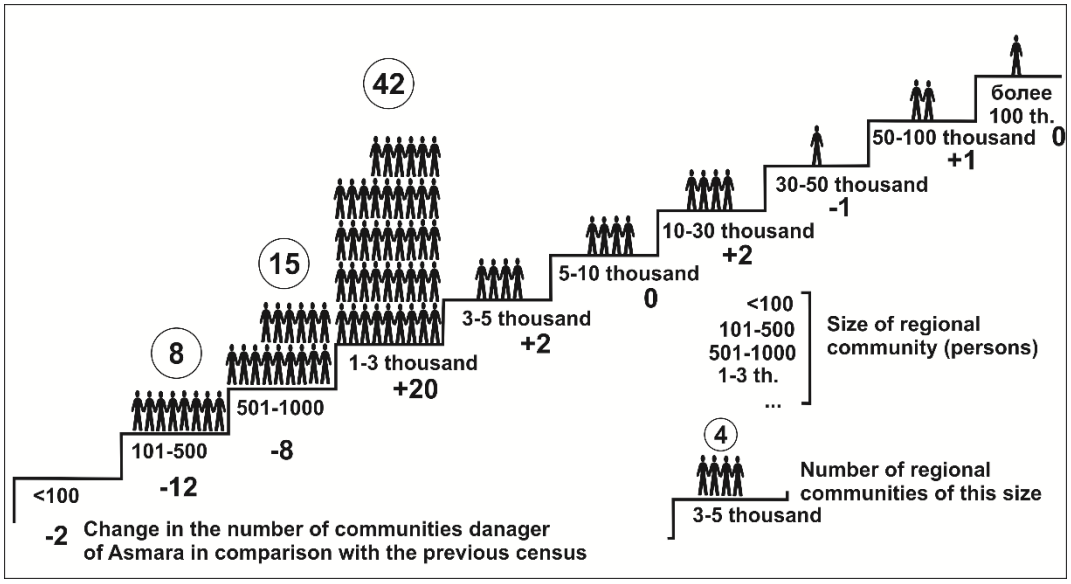

Figure 9. The size of the Armenian regional communities in the RSFSR, 1989

Henceforth, this upward demographic trend would not be interrupted. At the same time, communities in southern Russia and groups of Armenians in other macroregions of the RSFSR were growing in parallel. In spatial terms, this growth was almost ubiquitous. Moreover, if in 1959 the size of the majority of regional groups of Russian Armenians was in the range of 100-500 people, by the end of the 1980s they had risen to an average of 1-3 thousand (Figures 8-9). However, even such a significant quantitative growth for a long time turns out to be an insufficient condition for the transformation of this growing demographic set into a full-fledged network of territorial communities, as evidenced by the gender structure of most regional groups of Russian Armenians in 1970 (Figure 10).

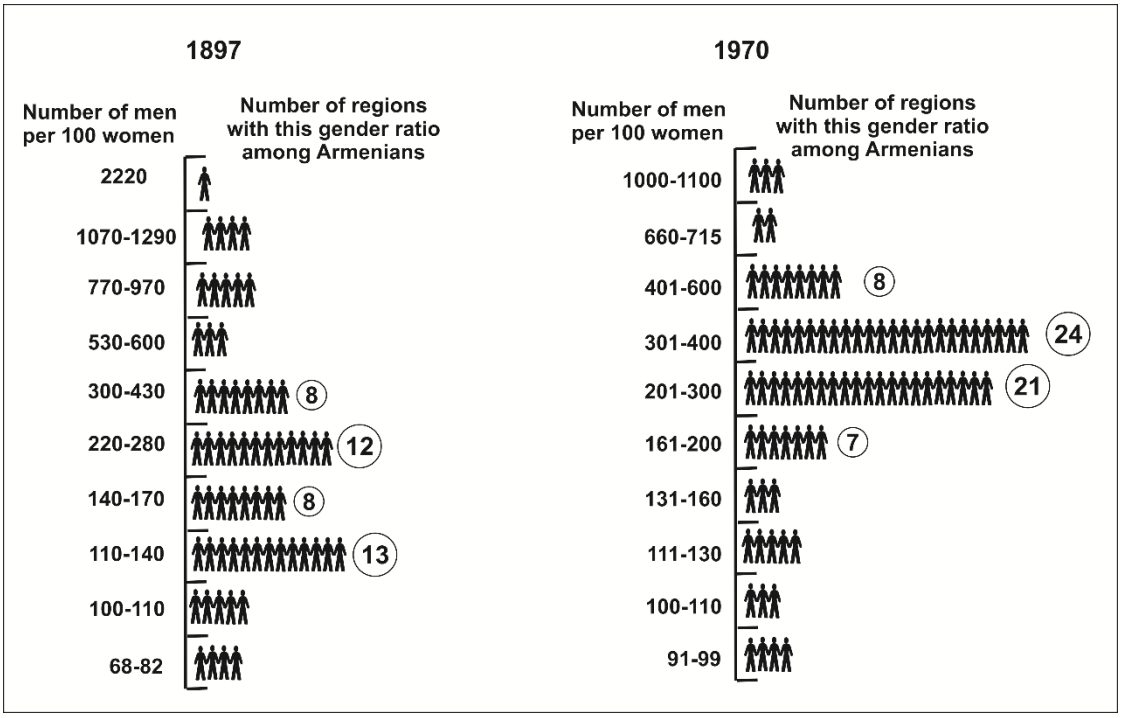

Figure 10. The level of gender balance in the Russian regional groups of the Armenian population, 1897, 1970

In comparison with the start of the 20th century, the level of gender imbalance has changed little. By the beginning of the 1970s, territorial groups of Armenians with 2 to 4 times more men than women still predominated in Russia outside its southern macroregion. In other words, the Armenian population of greater Russia, as in the interwar period, was made up predominantly of single men of young and middle age - students of universities and technical schools, military personnel, labor migrants, various kinds of specialists on assignment. It is not surprising that such territorial ethnic groups very slowly transformed into full-fledged regional communities.

The situation changes significantly only in the last Soviet decade. The rapid quantitative growth of the migration of Armenians into the RSFSR, associated with the tragic events in the South Caucasus, the systemic crisis, and then the collapse of the Soviet Union, significantly increases the size of the Russian territorial groups. In 34 regions of Russia, the number of Armenians more than doubled in the 1980s; in another 28 it increased by 50-100%. By the end of the Soviet period, in 58 Russian regions the Armenian population exceeded a thousand people (a decade earlier there were only 34 such regional groups; figure 11).

This migration wave, unlike the migrations of previous decades, was no longer so clearly tied to the urban system. The hasty nature of this resettlement flow, sometimes resembling an evacuation, forced new migrants to be modest in their demands. People fleeing from war and pogroms did not always have the material opportunities to settle in cities, where the cost of living was higher than in rural areas.

As a result, the level of urbanization of the Armenian population in the 1980s declined in almost 60 Russian regions, and in half of them it was very noticeable (by 10% or more). And the reduction in the share of citizens meant that the levels of the ethnic presence of Armenians in the urban and rural areas of the RSFSR, which were so noticeably different from the beginning to the middle of the 1970s, have now become significantly closer. For the most part, the forced nature of the Armenian migration of this time also determined major changes in the gender structure of the migrants. In contrast to the stable 1960s – 1970s, when mainly young single men went outside the Caucasus to study and seek work, the migration flow of the 1980s was made up primarily of families who were forced to leave their former place of residence forever.

Thus, the male advantage in the vast majority of Russian territorial groups declined. But most importantly, from a place of temporary residence (to get an education, earn money, pursue a profession) the regions of greater Russia began to turn into the new migrants' home, with all the ensuing consequences associated with the need to fit into the social environment that adopted them.

Plans and desires of forced migrants differed. Not all who came to the Russian "boondocks" intended to put down roots forever in the places where they had been brought as a result of a hasty departure from Transcaucasia. However, it was precisely the fact that they had landed in this new environment as full families which would often become the central factor ultimately determining their future and significantly accelerating their integration into the societies that had accepted them.

Thus, simultaneously in dozens of Russian regions begins a spontaneous process of transition from territorially dispersed groups of Armenians to regional communities (that is,

the transformation of isolated, predominantly male urban groups with a rapidly changing composition into well-structured, gender-balanced communities with a high proportion of permanent residence). Such communities were much more disposed to internal cohesion and interaction.

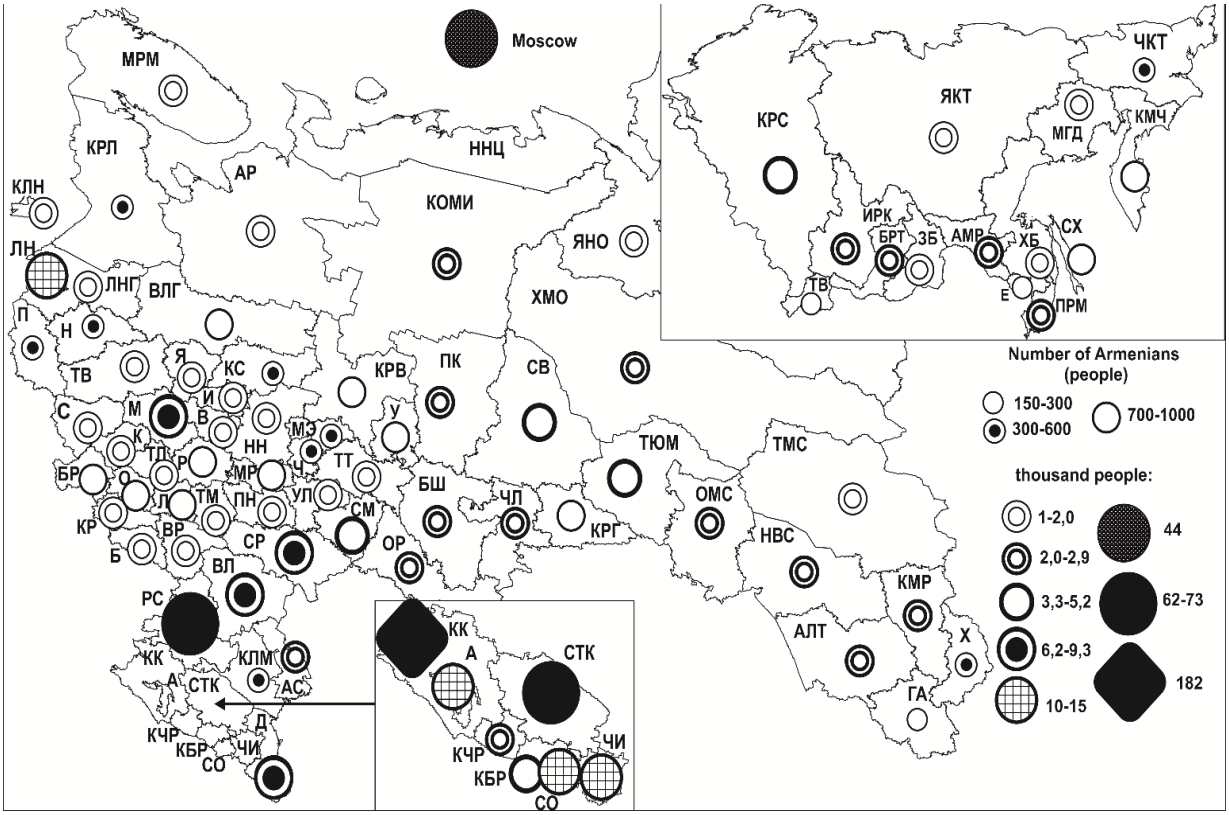

Figure 11. Regional groups of the Armenian population in the regions of the RSFSR, 1989

What we see is the acquisition of a new quality, which makes it possible to consider such territorial groups no longer just groups of people of the same nationality, but full-fledged regional communities. Again, individual elements of this systemic transition could be seen already in the social and geodemographic dynamics of Russian Armenians in the 1960s – 1970s. However, the sharp intensification of this process comes only in the mid- to late-1980s, and continues in the post-Soviet period (in a significant number of Russian regions this process is not fully completed even now, thus stretching out for many decades).

The first post-Soviet decade was associated with an even more impressive quantitative growth of the Armenian population of Russia. In 1989-2002 it increased from 0.53 million to 1.14 million people, allowing Armenians to rise eight positions in the demographic ranking of the peoples of the Russian Federation (from 15th to 7th).

In almost three dozen regions of the Russian Federation the growth of territorial groups in the 1990s was more than threefold; in another 26 the number of Armenians grew 2–3 times. In absolute figures, as one would expect, the greatest numbers went to the southern Russian regions, mainly the three leading communities of the Pre-Caucasus (Kuban, Stavropol and Don), whose total population grew by almost a quarter of a million people.

However, for the first time ever the combined demographic growth of the Armenian population of other macroregions of Russia was higher. In 1989-2002 the number of Armenians in the Russian Federation outside its southern macroregion more than tripled (from 167 thousand to 514 thousand). Thus, in parallel with the perceptible expansion of the geography of the Armenian people in Russia, a significant territorial "re-centering" of its settlement system took place.

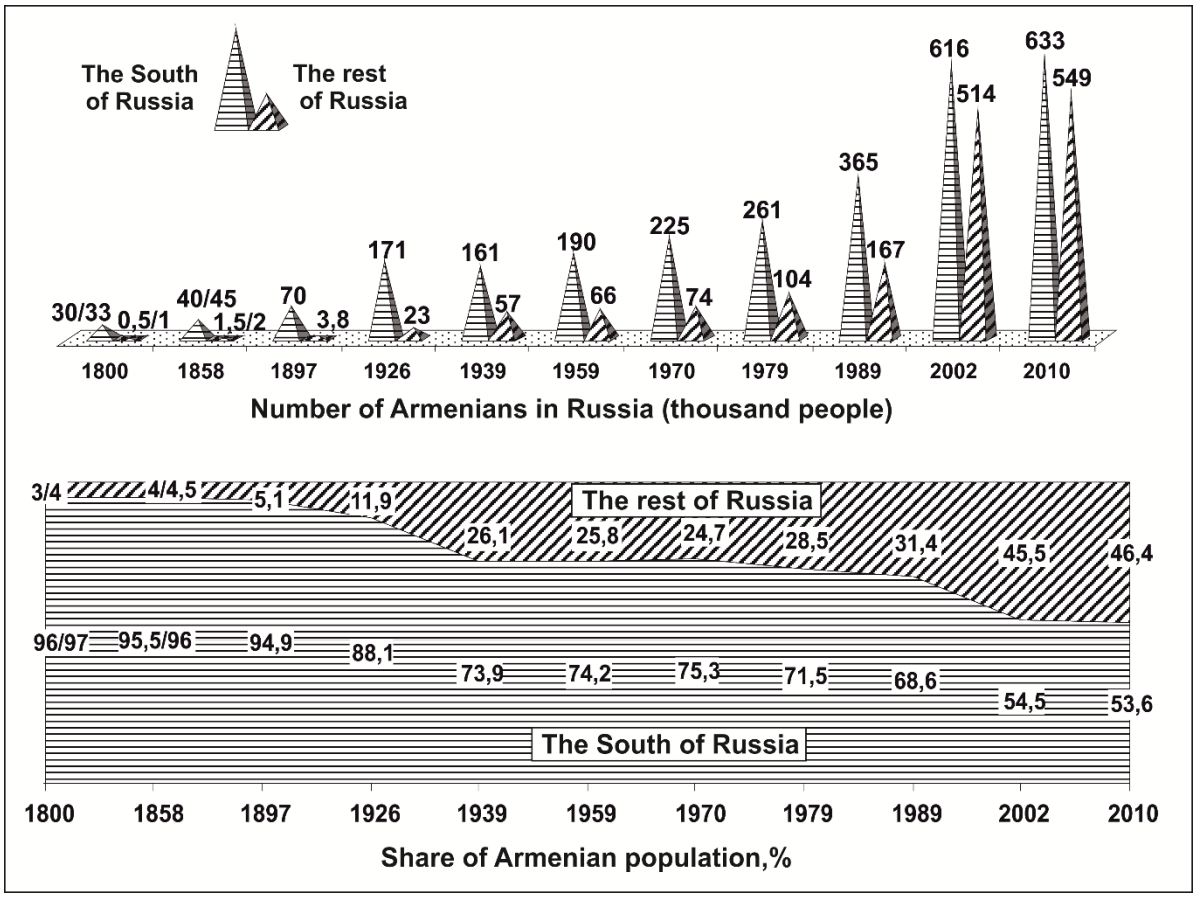

Figure 12. The ratio of the Armenian population of the southern macroregion to the rest of Russia, 1800-2010[4]

Despite retaining an obvious demographic superiority over other territories, the South of Russia saw the degree of its dominance markedly shrink, now including only a little more than half of all Russian Armenians (Figure 12). On the other hand, central Russia and the Volga region saw their own relative importance increase significantly: the cumulative share of the Armenian communities of the two federal districts (Central and Volga) grew over 1989–2002 from 18.6 to 29.5%. The share of the Ural and Siberian territorial groups increased in the general structure.

Such a rapid demographic growth of the Russian diaspora made possible a significant increase in the proportional representation of Armenians not only in hundreds of cities of the country, but also in vast rural areas. The gender balance continued to improve: the bulk of the migrant flow which spread throughout the Russian provinces consisted of complete families,

[4] Data for the South of Russia are shown without the Armenians of Crimea, and therefore differ somewhat from the indicators in Figures 1-2, 5.

which radically changed the age and gender structure of the local territorial groups of the Armenian population.

The first decade of the 21st century is a period of a certain quantitative stabilization and spatial optimization of the Russian Diaspora of Armenians, linked to the intra- and interregional flow of a part of post-Soviet migrants. In the years 2002-2010 the number of Armenians in the Russian Federation, according to the results of the last Russian census, grew by only 4.6%. However, a detailed analysis of their geodemographic dynamics during this period suggests that some members of the diaspora were not taken into account by the last census.

According to our calculations, the most probable size of the Armenian population of the Russian Federation in 2010 could be 1.35–1.45 million (that is, 15–23% more than recorded by the census). In other words, in terms of their demographic potential, the Armenians were quite comparable to the Chuvash and Chechens, who at that time were in 5th and 6th place in the ranking of the largest peoples of Russia, respectively.

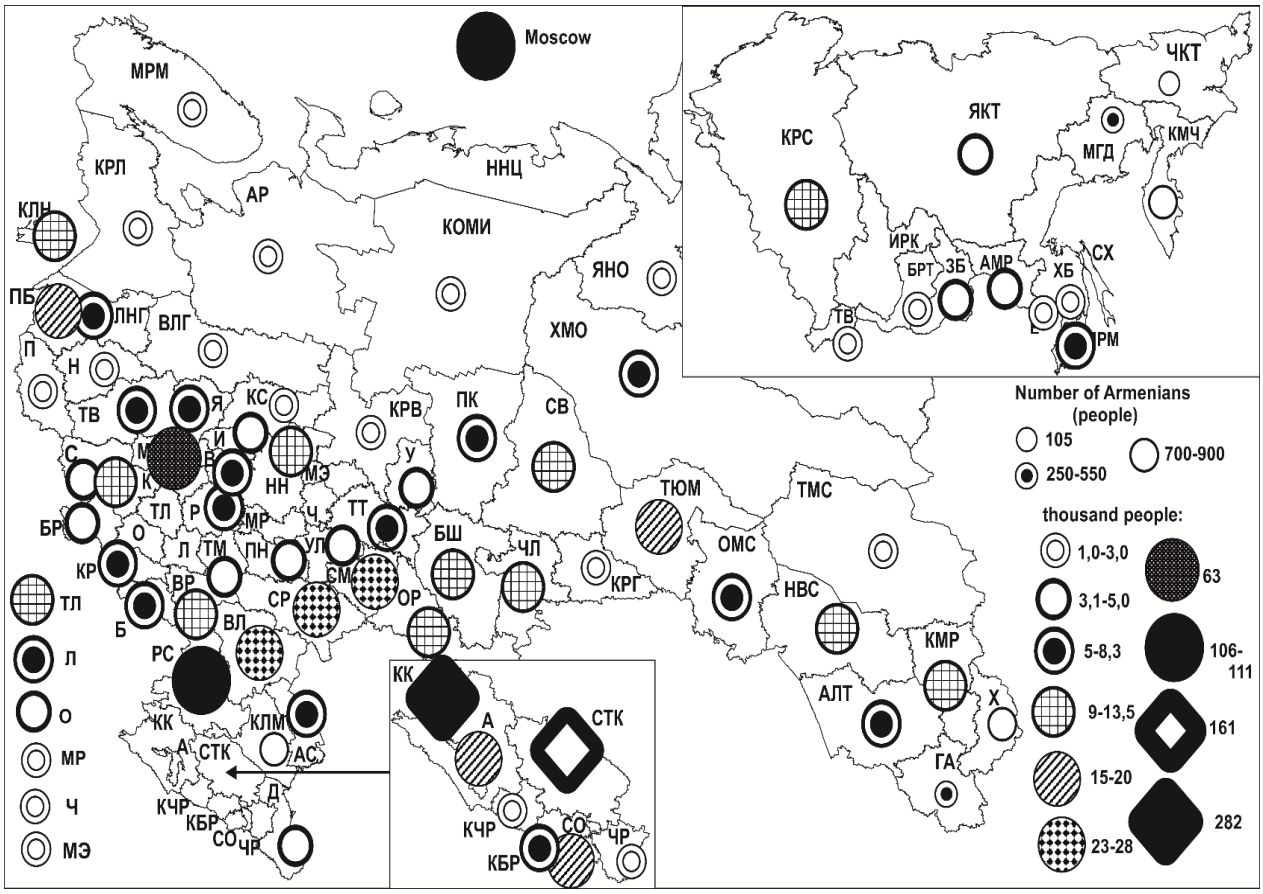

Figure 13. Regional groups of the Armenian population in the regions of Russia, 2010

However, this assumption does not contradict the conclusion made earlier about the gradual quantitative and spatial stabilization of the Armenian diaspora of the Russian Federation at the beginning of the 21st century, the growth rates of which in any case dropped significantly. The 2000s are a time of internal optimization of the new system of Armenian settlement that had taken shape during the period of their rapid and spontaneous demographic growth. Settling into the Russian regions that had accepted them, the immigrants begin looking for more comfortable and acceptable centers (districts) of residence and employment. There is a more or less intense

inter- and intra-regional flow of the Armenian population. The last census recorded a decrease in the number of Armenians in 28 regions of the Russian Federation, and a significant increase (by more than 20%) only in 14 (in 12 more regions the Armenian population grew by 10–20%).

It is obvious that the resources for further spatial expansion of the settlement system of Armenians within Russia, if not exhausted, are rather small. The most acceptable/comfortable territories of the country in terms of climate, culture and socio-economics have already been demographically settled by the diaspora. Further significant expansion of this ethnic geography is unlikely, and all other changes in it (in particular, inter-regional demographic "re-centering") will remain slow and gradual.

An illustration of such "gradualness" is the more than once mentioned trend toward the further territorial decentralization of the diaspora, a reduction in the demographic weight of the southern Russian communities. This trend continued into the 2000s. However, for 2002–2010 the share of the South of Russia in the total number of Russian Armenians decreased by less than 1% (from 54.5 to 53.6%). Three of the four largest regional communities of more than 100 thousand people still belong to the South of Russia (Krasnodar and Stavropol Territories, Rostov Oblast), as do all the six regions in which Armenians make up more than 1% of the local population.

But the aughts saw a new activization of another long-term trend - the rapid demographic growth of the capital community[5]. The total number of Russian Armenians living in Moscow and the region increased in the period between the censuses from 135 thousand to 170 thousand (an increase of 26% versus 5% for the entire Russian diaspora). There also appeared another geodemographic feature. For the first time in the entire history of the development of the Moscow community, the Moscow region came to the fore, with the number of Armenians there growing by 60% in the 2000s (the maximum figure among all Russian regions). Obviously, we are talking about the rapid formation of yet another (after that in the south of the Russian Federation) major demographic center of the settlement system of Russian Armenians. And there is every reason to believe that this process will continue, which means that not only the number, but also the proportion of "capital" Armenians will continue to increase in Russia at a faster pace (in 1989–2010 alone it grew from 10 to 14.4%).

Parallel to this, the post-Soviet period saw a significant increase in the share of Armenians in the Volga region (from 4.9 to 9.1%) and in the Central Federal District (from 3.4 to 8.5%). Thus, the decentralization of the settlement system of the Russian Armenian diaspora continued, interconnected with the demographic growth of a significant number of previously peripheral territorial groups. This process was directly connected with an increase in the proportion of Armenians in the ethnic structure of their regions. If, in 1989, there were 40 regions in the Russian Federation in which the share of Armenians was less than 0.1% of the local population, then by 2010 there were only two of them left (the Chechen Republic and Ingushetia).

[5] Which already in the 1970s had finally become the largest urban community of Russian Armenians, ahead of the Armenian population of Rostov and Nakhichevan-on-Don, which had been the largest for almost two centuries (these centers were united in the early 1920s)

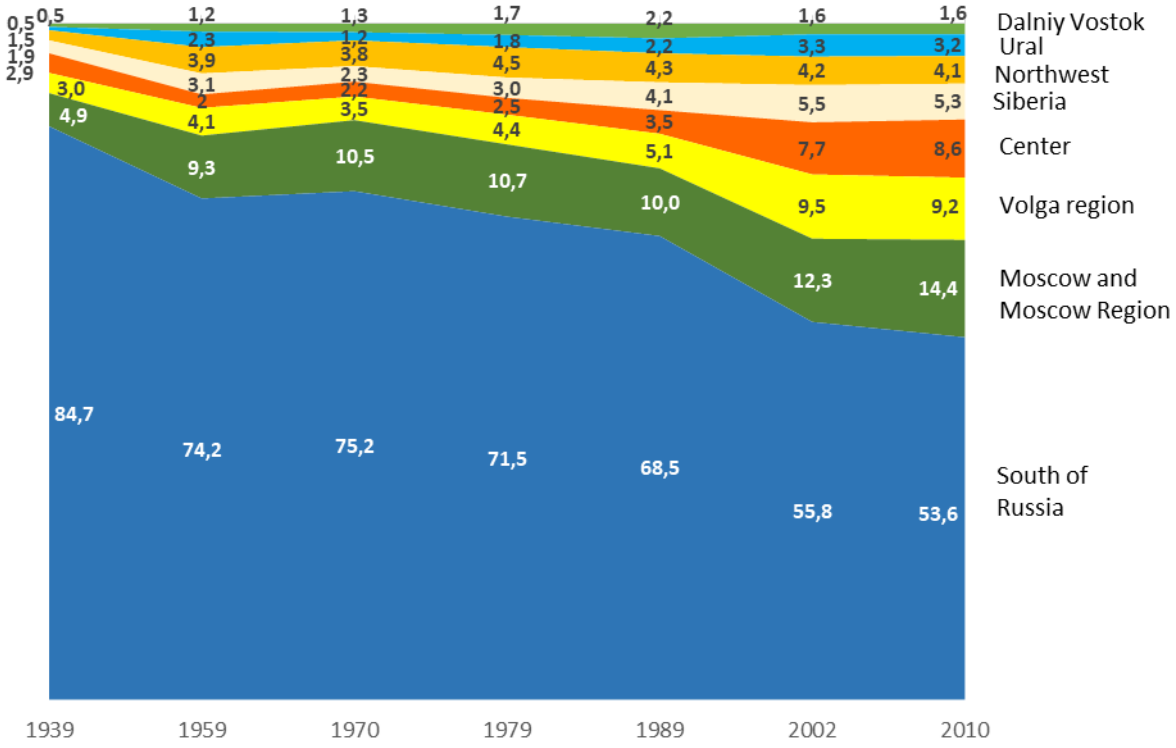

Figure 14. The share of macroregions in the distribution of the Armenian population of Russia, 1939-2010, %

But more important for the settling in of the territorial groups of Armenians in the host regional societies were their internal optimization and, above all, the further reduction of gender imbalance. If, in 1989, in 37 Russian regions there were over two times more men than women in the structure of the local Armenian population, in 2010 there were only 3 such regions left (Figure 15). At the same time, the number of communities with a balanced gender structure (gender ratio 1: 1-1.2) increased from 8 to 13 - evidence of a gradual increase in the systemic sustainability of the territorial groups of the Armenian population of Russia.

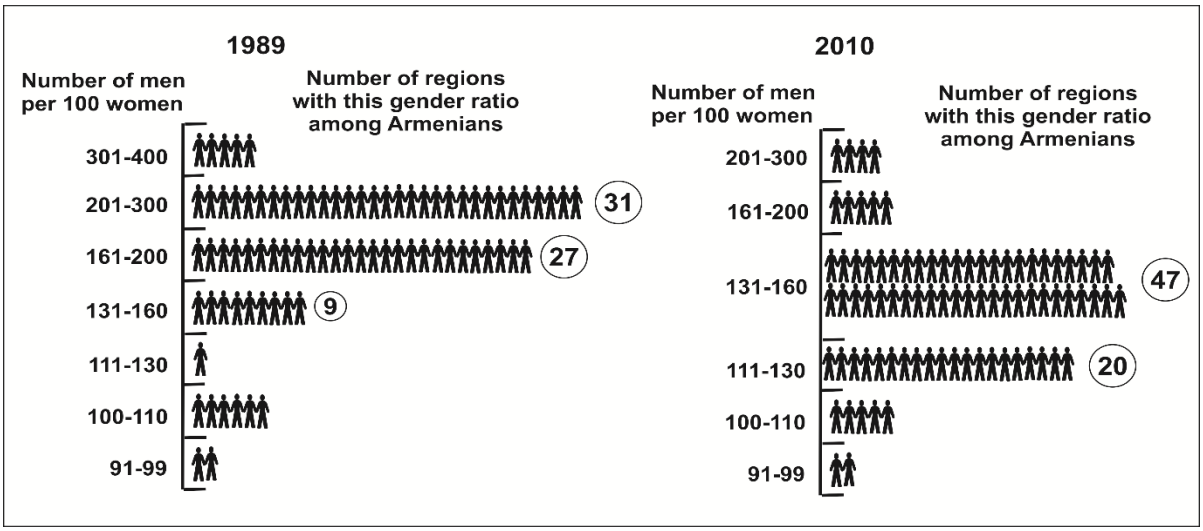

Figure 15. The level of gender balance in the Russian regional groups of the Armenian population, 1989-2010

Rural migration, which grew significantly in the post-Soviet period, reduced the overall level of urbanization of Armenians in Russia. In 2010, at 69% it was lower than that of the entire population of the Russian Federation (73.7%). But it is significant that in 70 regions of the Russian Federation the share of citizens among representatives of local Armenian communities exceeded the region-wide indicators of urbanization of the population. This is not surprising, given the demographic "boom" of many Armenian urban communities, primarily those belonging to the administrative capitals of the regions. In 1989–2010 the number of such communities of more than a thousand people in Russia increased 2.4 times (from 48 to 115). Moreover, most of them appeared outside the southern macroregion. And for the first time in the history of the Russian diaspora, the total number of Armenian urban communities in greater Russia surpassed their number in the South of the country (61 vs. 53; Figure 16).

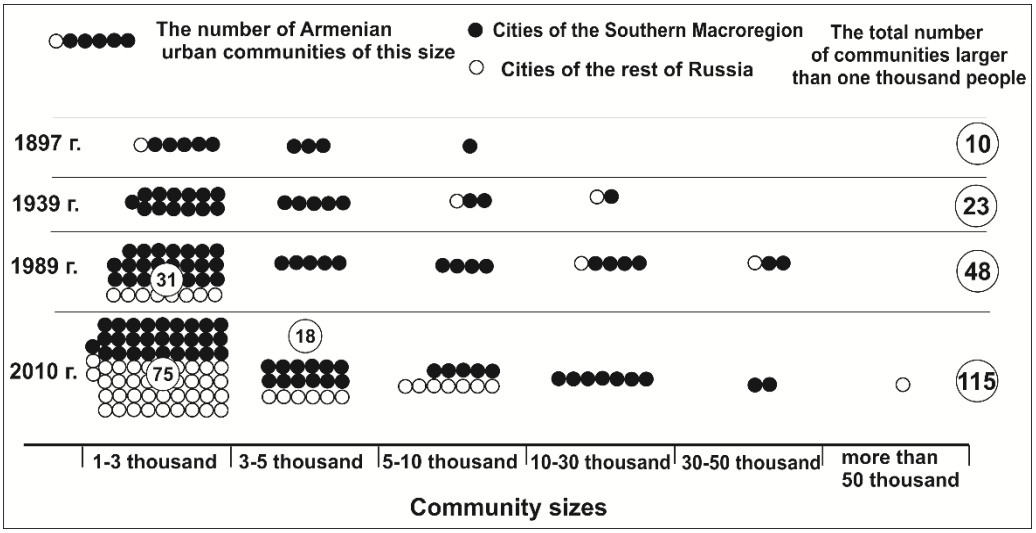

Figure 16. Dynamics of the number of large (more than a thousand people) urban communities of Russian Armenians, 1897-2010

CONCLUSIONS

So, the "new" history of the Armenian diaspora in Russia, which began in the Petersburg period, has not only continued for three centuries, but in recent decades has reached a higher systemic level, characterized not only by a rapidly growing demographic potential (Figure 17) and wide geography, but also by a significantly higher level of internal organization of most of its regional centers. The Armenian diaspora in Russia entered the 21st century on a systemic rise in all spheres of its activity, laying a solid foundation for positive geodemographic dynamics for the entire foreseeable future.

The present study makes it possible in a first approximation to distinguish three major periods in the geodemographic history of Russian Armenians, differing in their total number in Russia, the breadth of their geography and other central socio-demographic characteristics (including the form of settlement, level of urbanization, gender ratio; figure 18).

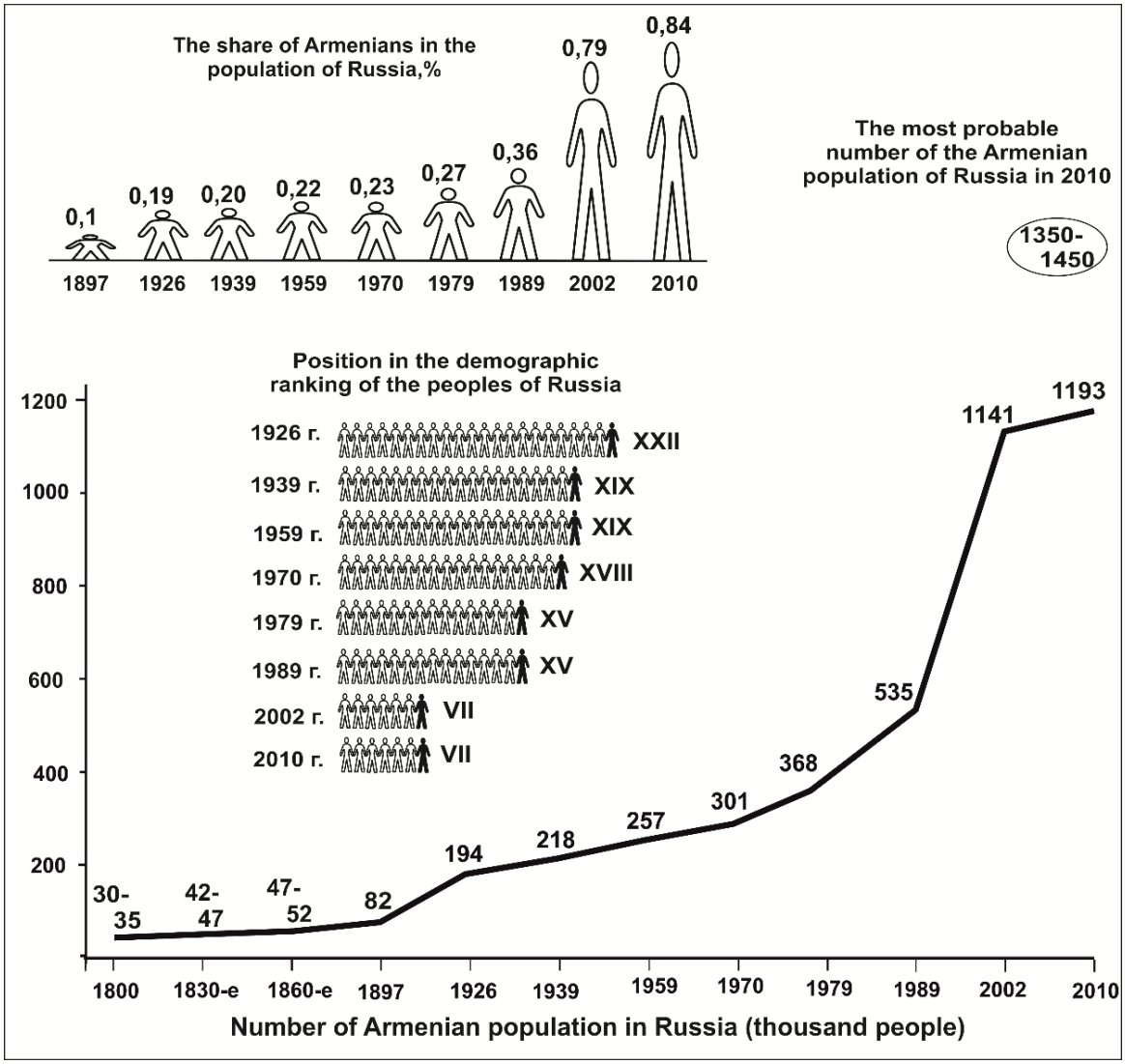

Figure 17. Dynamics of the Armenian population of Russia, 1800-2010

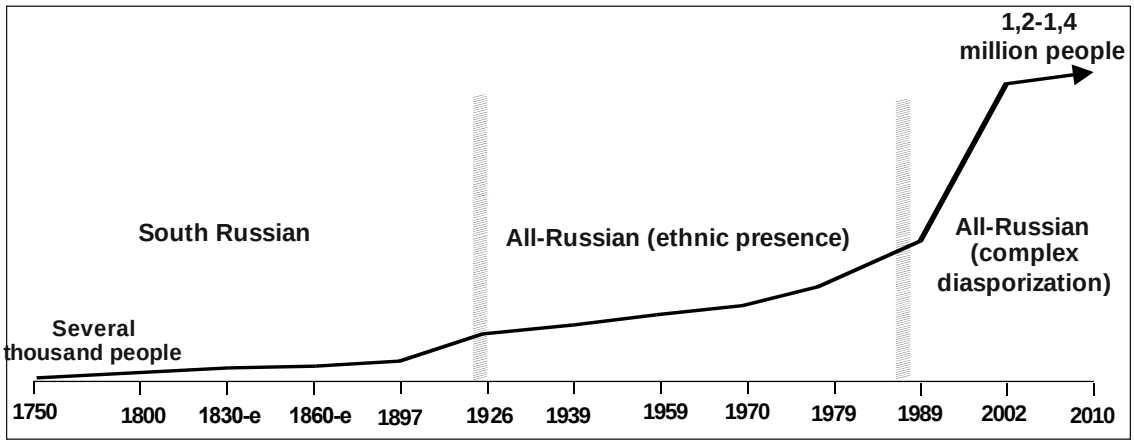

Figure 18. The major periods of historical phases of geodemographic dynamics of the Armenian diaspora of Russia

The first of these periods can be defined as “South Russian”. Its beginning dates back to the second third of the 18th century and is associated with the emergence in the south of Russia of a number of large regional communities / colonies. This period was the longest, stretching to the second quarter of the twentieth century. Throughout its duration, the vast majority of the Armenian

population of Russia (in its modern spatial contours) was concentrated within the southern macroregion, and even more precisely in the steppe of the Pre-Caucasus (the lower Don, Kuban, Stavropol). Throughout the rest of Russia, the presence of Armenians at this time remains minimal (if you do not take into account the communities in the two capitals, but here too it is very limited in size).

Thus, the central characteristics of this period include:

- maximum concentration (95% or more of the total) of Russian Armenians within the boundaries of the steppe of the Pre-Caucasus and other territories of the South of Russia;
- progressive quantitative growth and the gradual expansion of the geography of the Armenians within this macroregion;
- active participation of local communities in the process of regional urbanization, in the economic and cultural life of the southern macroregion; a high level of urbanization of most of the territorial groups of the South and a balanced gender structure;
- minimal presence of Armenians outside the South of Russia, represented in other macroregions of the country by "loners" or local groups of several people, consisting mainly of men concentrated in large cities.

The second period of the geodemographic dynamics of Russian Armenians can be conditionally designated as a stage of an *"All-Russian ethnic presence".* This stage almost completely coincided with the Soviet era, ending in the mid-1980s. Its main socio-geographical features are:

- a gradual increase in the number of regional groups of the Armenian population outside the South of Russia and the expansion of their all-Russian geography;
- growth of the aggregate demographic potential of Armenians in greater Russia (and their share in the structure of the local population), with the greatest numbers still remaining in the communities of the southern macroregion;
- a high level of urbanization of the majority of Russian regional groups;
- an unsustainable composition (constant population "rotation") and a significant (often by many times) preponderance of men in the territorial groups of Armenians outside of southern Russia are factors determining the low level of rootedness of these groups in the main areas of life of regional societies;
- a low level of internal co-organization and weak development of group (community) social structures in most Russian regional groups, which at the time do not represent diasporas / communities in the full sense of this concept.

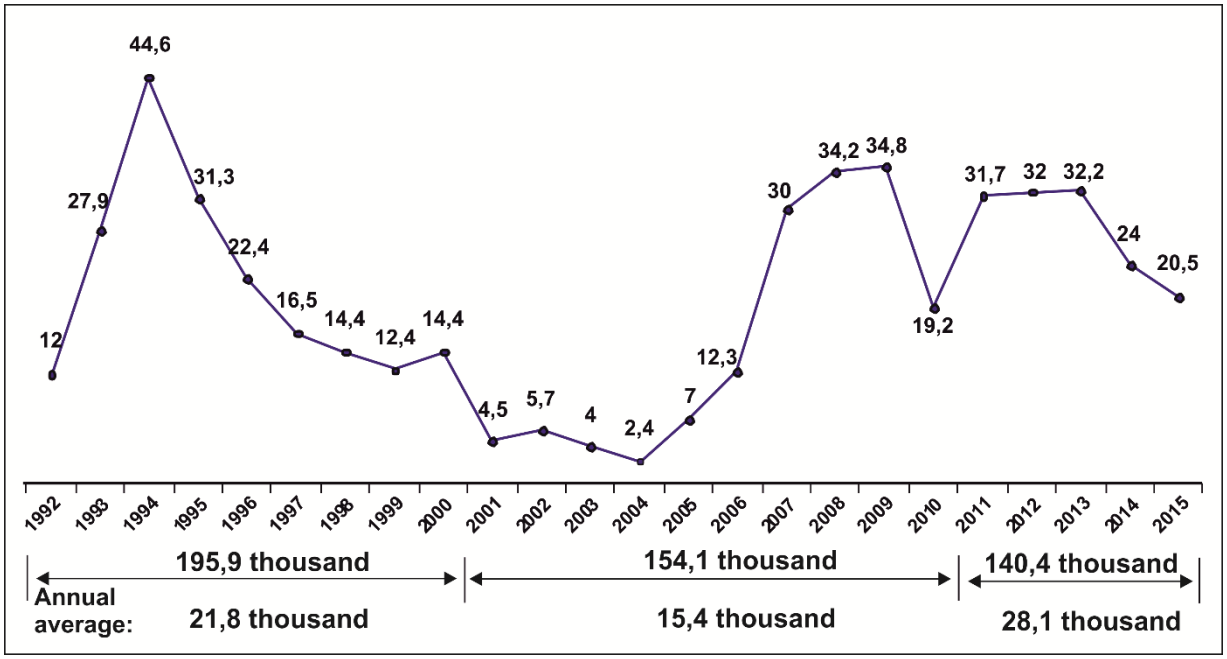

Figure 19. Net inflow of population (migration balance) from Armenia to Russia, 1992-2015, thousand [6]

The third period begins in the mid-late 1980s and can be defined as a period of *"All-Russian integrated diasporization"* of the Armenian population of the Russian Federation. It is characterized by rapid quantitative growth and spatial expansion of the diaspora, a correction of gender imbalance (a reduction of male preponderance) and active socio-economic and socio-cultural rooting of Armenians in dozens of Russian regions.

The main sociodemographic features of this period include:

- rapid demographic growth and rapid spatial expansion of the majority of regional groups of the Armenian population of the Russian Federation;
- rapid rates of geodemographic dynamics of Armenians in greater Russia, increasing decentralization of the settlement system of the Russian diaspora and a noticeable reduction in the demographic share of the communities of the southern macroregion;
- a significant decrease in the level of male quantitative dominance in most regional groups and a significant increase, in territorial communities, in the number of families and permanent residents;
- rapid growth in many Russian regions of the number and share of rural Armenians, which made it possible to significantly increase the indicator of their ethnic presence in the Russian rural "boondocks";
- active formation of community social structures and institutions; the transformation of many dispersed territorial groups of the Armenian population into well-structured regional communities;
- comprehensive integration of communities into the life cycles of host territorial societies, their socio-political, economic and cultural life;

[6] The figure uses data from (Demographic Yearbook ... 2001, 2006, 2012, 2017).

- rapid growth of the aggregate socio-economic potential of territorial communities; greater representation in all high-status professional communities and corporate hierarchies of their regions.

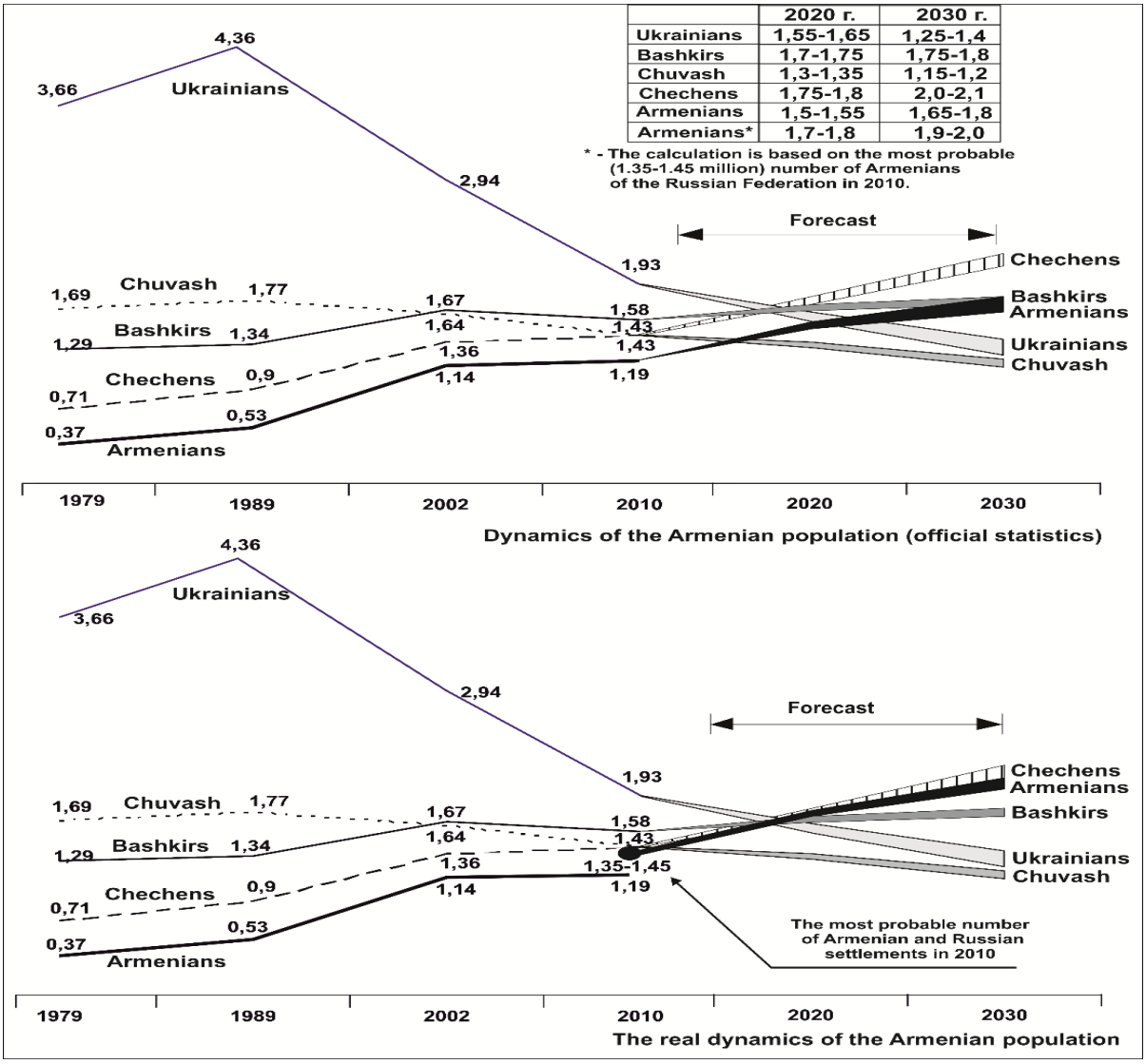

Figure 20. The most likely scenarios for the quantitative dynamics of a number of leading peoples of the Russian Federation in the short (2020) and medium (2030) term, millions

The stage of active diasporization of the Russian Armenians is not yet complete, and will, by all appearances, require quite a bit more time. However, this systemic transformation is not directly related to the demographic dynamics of the community, which depends on three factors: natural increase (decline), the direction and activity of migration processes and, finally, the scale of assimilation.

Given the existing parameters of the natural dynamics of the Armenian population of the Russian Federation (depending on the region, either simple reproduction or minimal growth), as well as stable migration replenishment and a limited extent of assimilation losses, there is every reason to predict further quantitative growth of the Armenian diaspora in Russia.

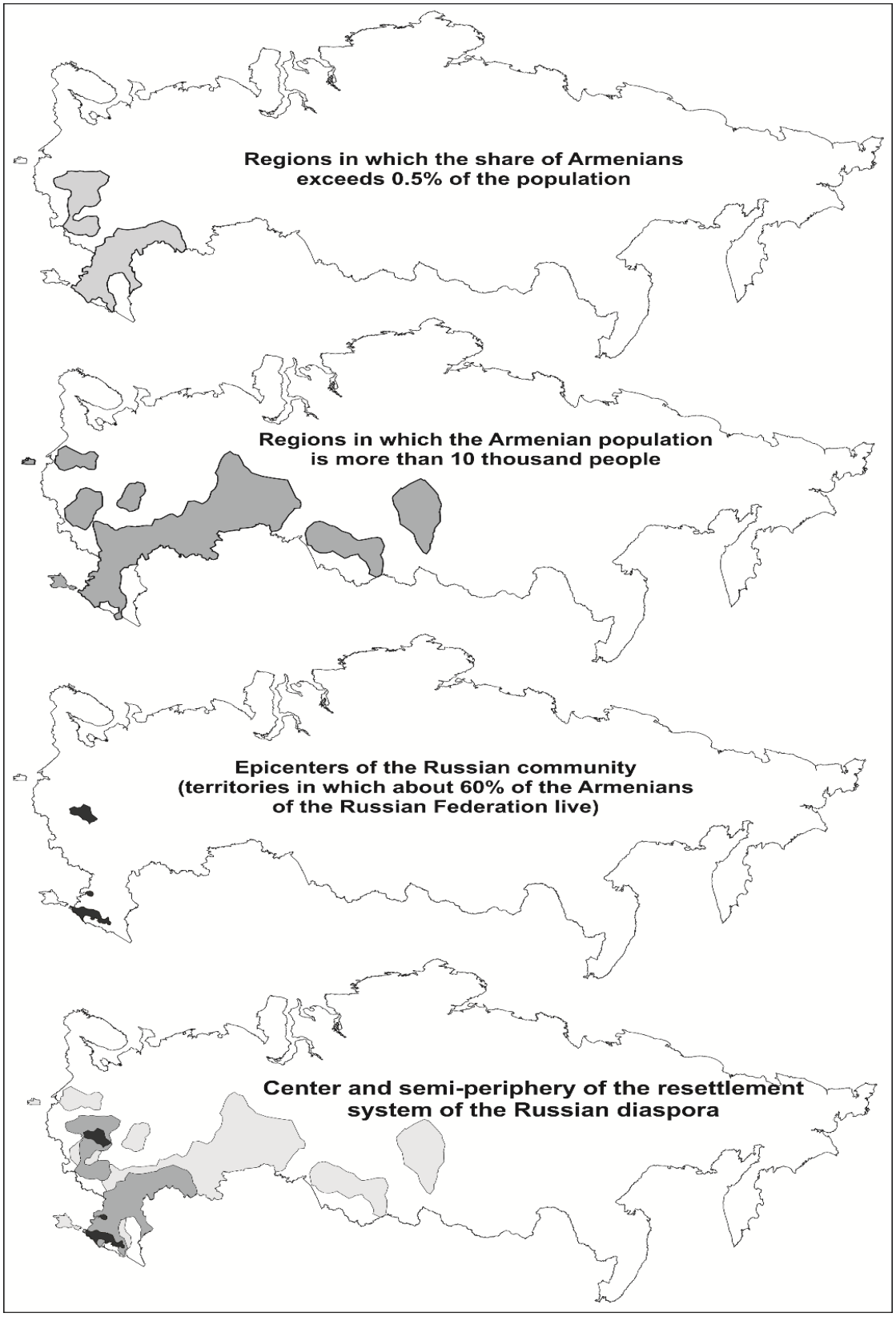

Figure 21. The central zones of the settlement system of Armenians of Russia

Even in the "official" demographic ranking of the peoples of the Russian Federation, Armenians in the current decade are likely to move up two places and enter the top five largest national communities of Russia (Figure 20). This will happen even if the hidden demographic component of the Armenian community does not come out of the shadow during the next two

censuses. If this component is taken into account, then Russian Armenians, whose numbers by 2030 could reach 1.85–1.95 million, become real contenders for a place among the top three largest peoples of Russia, after Russians and Tatars. In any case, their demographic indicator will be very close to those of the Chechens and Bashkirs, primarily to the former.

At the same time, there is little reason to expect noticeable changes in spatial terms - the geography of the central places of the Russian diaspora has generally taken shape already. The south of Russia (the steppe of the Pre-Caucasus), together with the metropolitan region (Moscow and the region) that joined it in recent decades, now account for about 60% of Russian Armenians, and will remain the leading centers for the foreseeable future (Figure 21).

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AN EVALUATION OF THE PREVALENCE OF MALIGNANT NEOPLASMS IN RUSSIA USING AN INCIDENCE-MORTALITY MODEL

RUSTAM TURSUN-ZADE

This paper aims to estimate Russian cancer incidence and mortality derivatives given limited access to medical and demographic data. We use the population model of cancer proposed by J. Duchêne, which is a special case of a well-known multiple-decrement life table that makes it possible to obtain otherwise inaccessible indicators, such as the prevalence of cancer in the population. Applying this model to the publicly available Russian cancer incidence and mortality data, we were able to estimate the following indicators: average age at disease onset, average duration of disease, prevalence of malignant cancer, and average age at death from malignant cancer in Russia. We aimed to determine whether the prevalence of cancer is on the rise in the Russian Federation and, if it is, whether this increase is occurring due to an expansion of morbidity.

It was found that the average age at disease onset and the average age at death from it in Russia are increasing, with the primacy of the latter. These processes are in turn resulting in an increase of the average number of years lived with cancer, thus justifying the hypothesis of an expansion of morbidity. This phenomenon, along with the increase in the incidence of malignant cancer, is what is causing the increased cancer prevalence.

Groups of cancer localizations with the highest and lowest prevalence were identified, as well as localizations with a visible tendency toward an expansion of morbidity. It was found that in Russia the general trend is towards the expansion of morbidity, expressed by an increase in the number of years lived in an imperfect health condition. Malignant neoplasms of the lip, oral cavity and oesophagus (C00-C15) in females is the only localization for which the expansion of morbidity does not occur. For this localization a compression of morbidity is observed that is an antipode to the expansion. The main limitations and drawbacks of the study are discussed in a separate section.

***Key words**: multiple decrement life-tables, incidence and mortality from malignant neoplasms, prevalence of malignant neoplasms, cancer incidence and mortality derivatives, oncological statistics, cancer mortality data analysis.*

Malignant neoplasms are the second leading cause of death in the world. According to WHO estimates, in 2015 the number of deaths caused by malignant neoplasms was equal to 8.8 million [WHO 2017], putting it behind only the number of deaths caused by cardiovascular diseases. Many experts believe that malignant neoplasms (hereinafter interchangeably referred to as "cancer") are already the leading cause of death in some high-income countries, and in the coming decades are set to become the main cause of death and disability worldwide [Bray et al. 2012].

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The Russian mortality structure has been mainly determined by the so-called "big four" group of causes: cardiovascular diseases, malignant neoplasms, external causes of death and respiratory diseases [Vishnevsky 2014]. In recent years (since 2006), diseases of the digestive organs have pushed respiratory diseases down to fifth place, thus moving into the fourth position in the Russian cause-specific mortality structure [Rosstat 2017; Shcherbakova 2018]. Since 2003, conditions favoring a life expectancy increase have been formed in Russia [Shkolnikov et al. 2013]. These conditions have been largely determined by declines in excess mortality caused by cardiovascular diseases and external causes of death [Andreev, Kvasha, Kharkova 2014].

In terms of age, this growth is primarily determined by two age groups: children under 15 years of age and adults age 65 and older [Andreev, Kvasha, Kharkov 2014]. For cerebrovascular diseases, the mortality rates are currently at a historical minimum in females and are close to that in males [Grigoriev et al. 2014]. These dynamics are sufficiently stable and sustained so as to speak of the beginning of the first stage of a cardiovascular revolution in Russia.

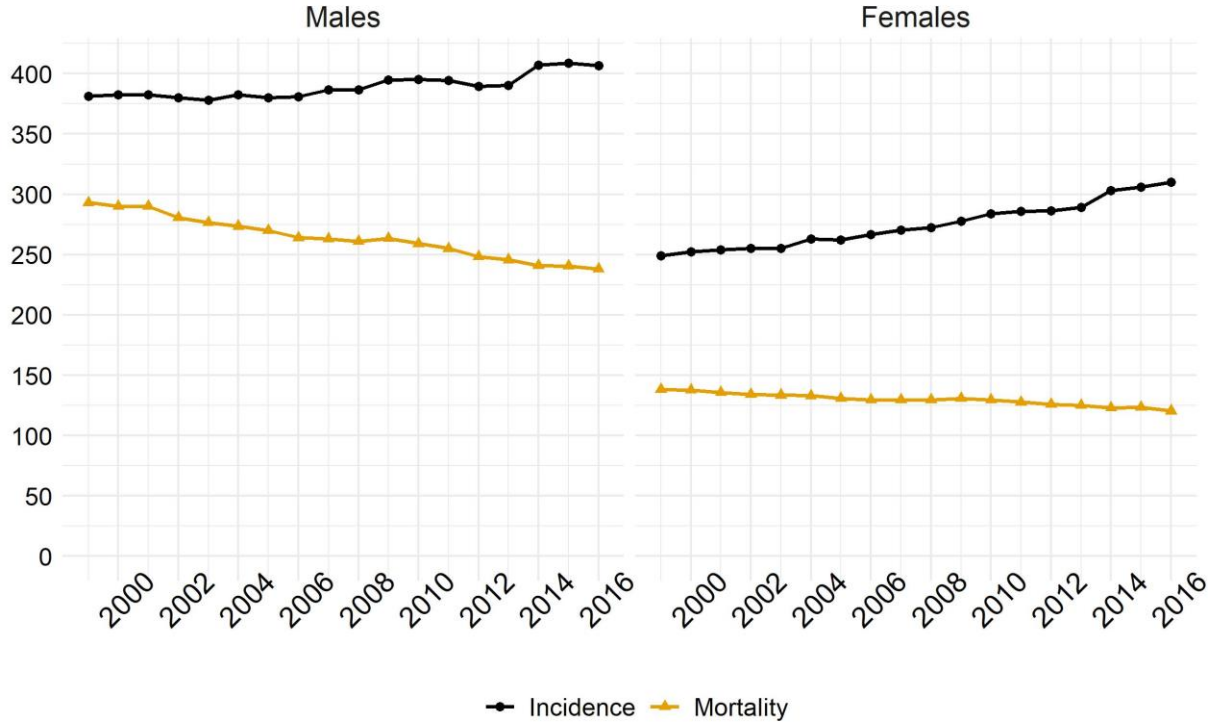

Figure 1. Age-standardized incidence and mortality rates for all malignant neoplasms, per 100,000 population, 1999-2016

Source: Author's calculations based on the data described in the Data and Methods section. Standardization is performed by a direct method using the European standard population.

Malignant neoplasms are the second leading cause of death in Russia. In 2016, 15.6% of all deaths registered in Russia were caused by malignant neoplasms [Kaprin, Starinsky, Petrova 2018a]. Figure 1 shows the dynamics of Russian age-standardized death and incidence rates for all malignant neoplasms combined for 1999-2016.

From Figure 1 the trend towards an age-standardized death rate decrease is evident. But the age-standardized incidence rate was increasing at the same period particularly around 2014.

Since the incidence of cancer is known to be increasing with age and is mainly concentrated among the elderly (the largest number of registered cases in 2016 falls within the 65-69 age group) [Kaprin, Starinsky, Petrova 2018a], given the aging of the Russian population there is no reason to expect a change in the observed cancer incidence trend. This development may cause an increase in cancer prevalence, making cancer an even more important factor of disability in Russia.

Unfortunately, despite a well-developed system for collecting and processing statistical data on cancer incidence in Russia (data have been collected since 1953, and in 1996 an order on the establishment of a Federal Cancer Registry was adopted[1]), contemporary practices do not provide for the full publication of data on the prevalence of cancer in the population. Yearbooks called "The state of oncological care for the population", published since 2007 by the P. A. Gertzen Institute, a supervisory body for the Federal Cancer Registry, contain only the prevalence rates calculated per 100,000 population without the corresponding age and sex distribution [Kaprin, Starinsky, Petrova 2018b]. Cancer prevalence data could be obtained from population-based cancer registries, although some doubts exist regarding the ability of the Russian oncological service to carry out lifelong monitoring of registered patients and to remove them in a timely fashion from the register in the event of their death. The registries' capability to conduct a complete registration of all cases of cancer diagnosed posthumously, as well as to provide a robust link between incidence and mortality data, are also questioned. In particular, to the best of our knowledge, after the ratification of the law "On Personal Data" in 2006[2] the Federal Cancer Register lost the ability to conduct personalized data checks, and currently relies on an array of depersonalized aggregated data[3]. Thus, it has been quite difficult for registries to obtain reliable data on deaths of cancer patients that were previously recorded in the register [Petrova, Starinsky, Gretsova 2016]. This may result in unreliable data on the "contingent's accumulation" (and prevalence) due to the late removal of patients from the register. This problem was particularly acute in the first years after the ratification of the law on personal data; however, currently the situation has improved somewhat. Population-based cancer registries are establishing new ways of coordination, but the problem is still far from being resolved [Petrova, Staritsky, Gretsova 2016].

In its annual statistical reports "Malignant neoplasms in Russia: incidence and mortality" [Kaprin, Starinsky, Petrova 2014, 2015, 2016, 2017, 2018a; Chissov, Starinsky, Petrova 2009, 2010, 2011, 2012, 2013] the P.A. Gerzen Institute indicates that it uses mortality data obtained from Rosstat's statistical table C51, "Distribution of deaths by sex, age group and cause of death", a data source which is de facto independent of the Ministry of Health, while incidence data is gathered by a different state entity (the Ministry of Health). Table C51 is used in spite of the fact that mortality is recorded according to the short version of the ICD-10 list with a limited number of localizations. At the same time, the prevalence of cancer at regional level relies on the database (records on cases of incidence and death) of the registry itself, which may result in an inaccurate estimate of the cancer prevalence due to possible late removals of those patients who either left

[1] Order of the Ministry of Health of the Russian Federation dated December 23, 1996 No. 420 "On the establishment of the State Cancer Registry"
[2] Federal Law dated July 27, 2006 No.152-FЗ "On personal data".
[3] Order of the Ministry of Health of the Russian Federation dated April 19, 1999 No. 135 "On improving the system of the State Cancer Register".

the region or died in a region not accountable to the cancer registry while still being kept in the database. Due to difficulties of comparing the completeness of registration of incidence and mortality data carried out by the two independent entities, as well as the possible underestimation of deaths by cancer registries on a regional level, it can be assumed that the data on cancer prevalence contained in both the Federal and regional population-based registries may be incomplete.

If there is indeed an increase in cancer prevalence, it is important to identify the factors causing this increase. Is it solely an effect of an increase in incidence, or are we dealing with an increase in the duration of disease expressed in an increase in the average number of years lived in a state of ill health (a phenomenon called the expansion of morbidity) [Fries 1980, 2005]?

We use the demographic method of multiple-decrement life tables developed by J. Duchêne [Duchêne 2002] to estimate the unpublished derivatives of cancer incidence and mortality data in the Russian population. These derivatives (average age at disease onset, average duration of disease, the prevalence of cancer and the average age at death from cancer) will allow us to determine whether the prevalence of cancer is increasing in the Russian Federation and whether this increase results from an expansion of morbidity.

While we recognize that data modeled for a life-table stationary population cannot be considered a full-fledged substitute for real data, these data can nevertheless be used to assess the dynamics of population processes.

DATA AND METHODS

We use the population model of cancer (hereinafter referred to as the "Duchêne model" [Duchêne 2002]) to estimate the unpublished cancer incidence and mortality derivatives in the Russian population. This model is based on the balance between age-specific incidence and mortality rates and is calculated by the multiple-decrement life table method. We use the Duchêne model to obtain the prevalence of cancer and other indicators: average age at disease onset, average age at death from cancer, and the average duration of disease. Note that this method was further developed and described in detail in a technical report of the Max Planck Institute [Andreev, Shkolnikov, Jasilionis 2018].

Assuming that incidence and mortality before a certain year *x* were equal to those observed in year *x*, we can calculate the prevalence of cancer in the stationary life-table population in year *x*. To do so, we calculate the proportion of the life-table population living with cancer in a certain age interval *x* using the following formula:

$$Pi_x = \frac{L_x^c}{Lx}, \quad (1)$$

where L_x^c is the number of years lived with cancer in the age interval *x* and L_x the number of years lived by the entire life-table population in the same age interval.

By multiplying the obtained coefficients $Pi_x$and the real mid-year population living in the corresponding age interval, we estimate the prevalence of cancer in the population living in the same age interval:

$$C_{pr} = Pi_x * P_x, \quad (2)$$

where Pi_x is the proportion of the population living with cancer in the age interval *x* and P_x is the mid-year population living in the same age interval.

To calculate the model, we used the age-specific (by 5-year intervals) death rates for all causes of death combined, M_x, the cause and age-specific death rates for the disease under study, M_x^c, and the age-specific incidence rates for the disease under study, I_x^c. The model is calculated for 5-year age intervals, ranging from 15-19 to the open age interval of 85+ years.

In this paper, the following groups of localization are considered (corresponding codes of the International Classification of Diseases, 10th revision (ICD-10), are given in parentheses):

- All malignant neoplasms (C00-C97);
- Malignant neoplasms of lip, oral cavity, pharynx and oesophagus (C00 - C15);
- Malignant neoplasms of stomach (C16);
- Malignant neoplasms of intestine and rectum (colorectal cancer) (C17 - C21);
- Malignant neoplasms of trachea, bronchus and lungs (C33 - C34);
- Malignant neoplasms of female breast (C50);
- Malignant neoplasms of female genital organs (C51 - C58);
- Malignant neoplasms of prostate (C61);
- All other malignant neoplasms.

Data on cancer incidence were extracted from state statistical reports form No. 7, "Report on Malignant Neoplasm Incidence," published in the statistical yearbooks of the P.A. Gerzen Institute, "Malignant neoplasms in Russia" [Kaprin, Starinsky, Petrova 2014, 2015, 2016, 2017, 2018a; Chissovsky, Petrova 2009, 2010, 2011, 2012, 2013], as well as in the statistical review "Malignant neoplasms in Russia in 1993-2013" [Petrova et al. 2015]. Data on cancer mortality was derived from table C51 of Rosstat. Data on mid-year population by 5-year age intervals was used for the calculation of rates. Note that before 2014 the incidence and mortality data do not take into account the Republic of Crimea and the city of Sevastopol.

This paper examines the time period of 1999-2016. The choice of 1999 is justified by Russia's transition to the International Classification of Diseases of the 10th revision (ICD-10), hence we face no possible inaccuracies due to reclassification of causes when switching from one revision of ICD to another. It should also be noted that incidence and mortality for almost all localizations considered is virtually nonexistent at ages below 15-19, which justifies the choice of this interval as the starting point for the model. All events occurring at ages below 15-19 are not taken into account when calculating the population model of cancer.

RESULTS

The dynamics of the average age at cancer onset in Russia are exhibited in Figure 2. It should be noted that for "all other malignant neoplasms" in males the Duchêne model gives uninterpretable results for the average age at disease onset and death from it, as well as for the average duration of disease prior to 2007, due to the features of the input data.

From Figure 2 we see that for "all malignant neoplasms" the average age at diagnosis in males is higher than in females. In recent years (after 2004), there has been a pronounced tendency towards divergence, resulting from the continuing increase in the average age at cancer onset in males and a plateau observed in females. For this diagnostic category the average age at onset in males was approximately equal to that in females prior to 2004, but from 2005 to 2007 males experienced a sharp increase in the average age at onset, which slowed down in 2007 and 2008 and subsequently increased until 2016. After 2004 the average age at cancer onset in females continued to grow, but with a slower pace compared to that in males. This gap further widened starting in 2008. In recent years no significant increase in the average age at cancer onset has been observed in females. Given that for all other diagnostic categories the average age at cancer onset in females exceeds that in males, it can be concluded that this difference can be determined by localizations that are not characteristic of the male sex.

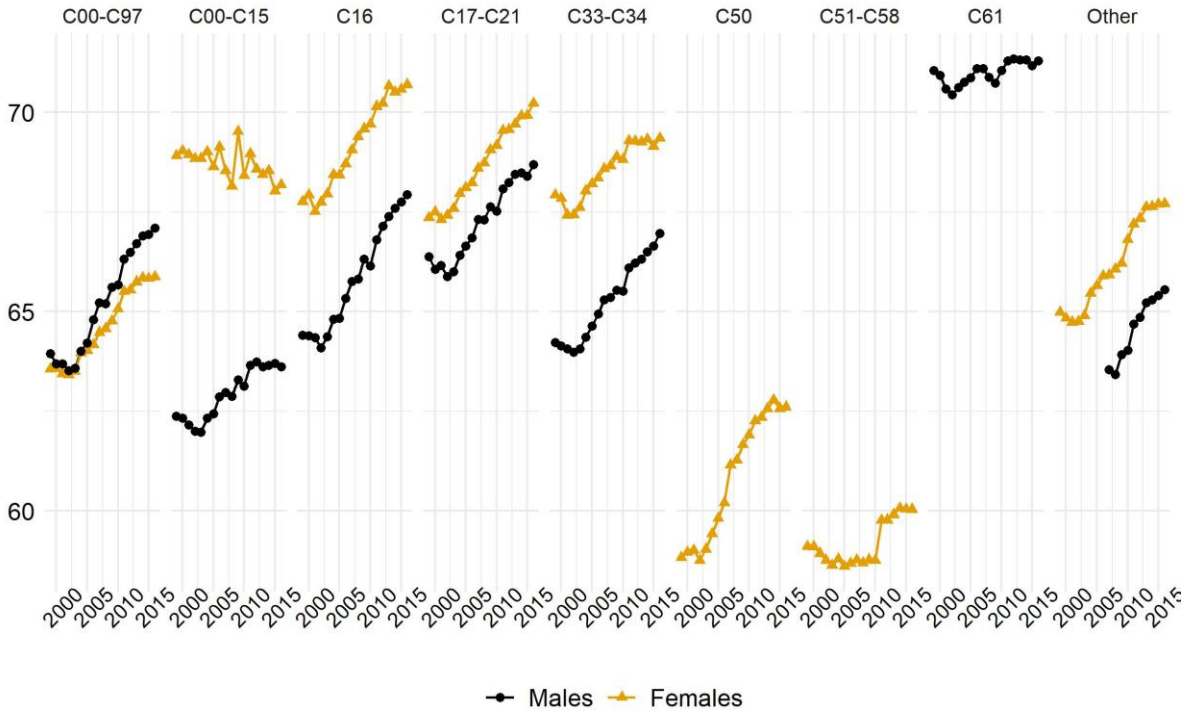

Figure 2. Average age at cancer onset, 1999-2016

C00-C97– all localizations; C00 - C15 - MN of lip, mouth, pharynx and oesophagus; C33 - C34 - MN of trachea, bronchus and lungs; C16 - MN of stomach; C17 - C21 – MN of intestines and rectum (colorectal cancer); C50 - MN of female breast; C51 - C58 - MN of female genital organs; C61 – MN of prostate.

Source: Author's calculations based on the data described in the Data and Methods section.

For stomach cancer, average age at onset begins to grow in 2003 in males and in 2002 a noticeable increase can be observed in females, followed by a slight decrease in 2014.

For “colorectal cancer”, age at onset increases starting in 2003 in males and in 2001 in females. In females a steady growth follows a slight decline observed between 2000 and 2001, while in males a steady increase has been observed since 2002.

For cancer of the trachea, bronchus and lungs, an increase among males has been observed since 2003, while in females - since 2001. For female breast cancer there has been a significant increase since 2002. For all other cancers an increase is observed since 2002 in females and since 2008 in males.

Attention should be paid to cancer of the female genital organs and to prostate cancer, since their dynamics are different from those observed for other groups of localizations considered. The average age at onset for cancer of the female genital organs decreased until 2003, then after some increase in 2004 and a subsequent decrease in 2005 it reached a plateau, fluctuating at around 58.7 years up to 2011, when significant growth followed by yet another plateau is observed. The average age at onset for prostate cancer grew slightly, fluctuating at around 71 years.

For cancer of the lip, oral cavity, pharynx and oesophagus in males, after a period of decline observed in 1999-2003 a consistent increase is observed up until 2016. In females the dynamics of the average age at onset for this diagnostic category are an exception to the general upward trend. Prior to 2006 it fluctuates at around 69 years, then in 2007-2008 there was a sharp decrease followed by a significant increase in 2009, when it reached 69.5 years, and a further decrease to 68.2 years in 2016. This value is lower than that registered in 1999 (68.9 years).

The most significant increase in the average age at cancer onset in males is observed for stomach cancer, cancer of the trachea, bronchus and lungs, colorectal cancer, all other cancers and cancer of the lip, oral cavity, pharynx and oesophagus. The smallest growth is observed for prostate cancer; however, it should be noted that this diagnostic category was initially the category with the highest recorded age at disease onset, while the localization with the lowest recorded age at onset in males is cancer of the lip, oral cavity, pharynx and oesophagus. The most significant increase in the average age at cancer onset in females is observed for cancer of the female breast and stomach, for colorectal cancer, all other cancers, cancer of the trachea, bronchus and lungs, and for cancers of the female genital organs. For cancer of the lip, oral cavity, pharynx and oesophagus in females, a decrease in the average age at disease onset is observed. The localization with the lowest recorded age at onset is cancer of the female breast, while the localization with the highest age is stomach cancer.

The increase in the average age at disease onset in males was generally more significant than in females for almost all groups of localization considered, with the exception of colorectal cancer and all other cancers. This growth is largely determined by stomach cancer and by cancer of the trachea, bronchus and lungs. In females, cancer of the female breast, stomach and colorectal cancers are leaders in terms of growth. The greatest difference in the average age at onset in males and females is observed for cancer of the lip, oral cavity, pharynx and oesophagus, stomach cancer and cancer of the trachea, bronchus and lungs, while the smallest is observed for colorectal cancer.

The dynamics of the average age at death from cancer are exhibited in Figure 3.

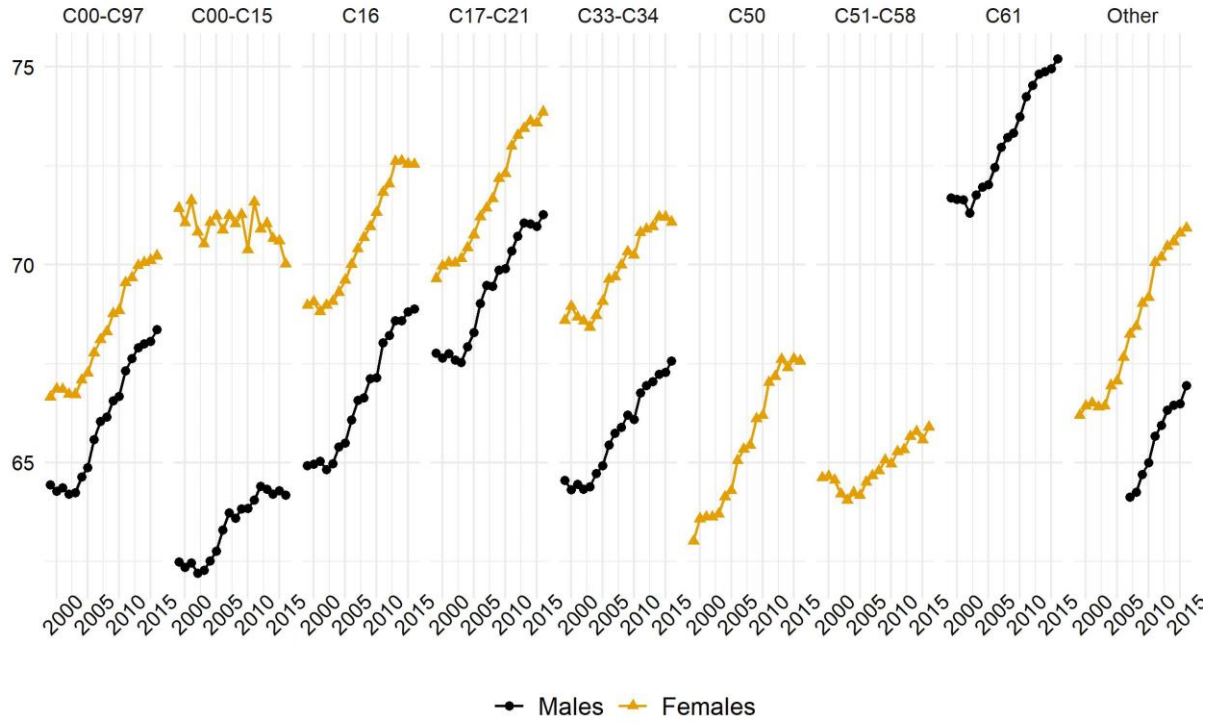

Figure 3. Average age at death from cancer, 1999-2016

C00-C97– all localizations; C00 - C15 – MN of lip, mouth, pharynx and oesophagus; C33 - C34 - MN of trachea, bronchus and lungs; C16 - MN of stomach; C17 - C21 – MN of intestine and rectum (colorectal cancer); C50 - MN of female breast; C51 - C58 - MN of female genital organs; C61 – MN of prostate.

Source: Author's calculations based on the data described in the Data and Methods section.

Figure 3 shows that the average expected age at death from cancer in females exceeds that in males for all groups of localizations considered. A steady upward trend is observed. The only exception to this trend is cancer of the lip, oral cavity, pharynx and esophagus in females. Localizations with the highest recorded age at death include prostate cancer in males and colorectal cancer in females, while the lowest values are observed for cancer of the lip, oral cavity, pharynx and esophagus in males, and for the female genital organs.

An increase in the average age at death from cancer in males is observed since 2002 and since 2003 in females. For stomach cancer this growth has been taking place since 2002 in males and since 2001 in females; for colorectal cancer - since 2003 in males and since 1999 in females; for cancer of the trachea, bronchus and lungs - since 2003 in males and since 2004 in females; for all other cancers an increase has been observed starting with the first years of observation for both males and females; for female breast cancer, an increase has been observed since 1999, and for cancer of the female genital organs, it began after a period of decline in 2000–2003. The average age at death from prostate cancer has increased since 2002. The average age at death from cancer of the lip, oral cavity, pharynx and oesophagus in males increased up to 2012, reaching a plateau. In females, the dynamics of this indicator are an exception to the general trend towards an increase in the average age at death from cancer; it fluctuated at around 71 years with two periods of sharp decline observed in 2001-2003 and in 2010, with an increase in 2011 and a subsequent decrease until 2016. In 2016, the indicator reached a value of 70.1 years, which is lower than the value

observed in 1999 (71.4 years). The greatest difference in the average age at death between males and females is observed for cancer of the lip, oral cavity, pharynx and oesophagus and cancer of the trachea, bronchus and lungs, and the smallest - for colorectal cancer. The localization with the highest observed average age at death in males is prostate cancer, and in females - colorectal cancer. The lowest values are observed for cancer of the lip, oral cavity, pharynx, and oesophagus in males, and for the female genital organs.

An increase in the average age at death exceeded that of the average age at onset. However, if the average age at onset for all cancers in males was higher than in females, for the average age at death from cancer the opposite is true. Despite the fact that the average age at death in males has increased more than in females, females nevertheless die from all cancers 1.9 years later than males. In males, the increase in the average age at death is largely determined by stomach cancer, colorectal cancer and cancer of the trachea, bronchus and lungs, while in females - by all other cancers, cancer of the female breast, colorectal cancer and stomach cancer. Similar to the age at cancer onset, the maximum age at death for almost all locations is observed in 2014-2016. However, the significant exception here (as in the case of onset age) is cancer of the lip, oral cavity, pharynx and oesophagus in females, for whom there is a tendency towards a decreasing average age at death.

The average duration of disease represents the difference between the average age at death and the average age at onset and is shown in Figure 4. The logical consequence of the increase in the average age at death, which grew faster than the average age at onset, is an increase in the average expected duration of disease, or in other words, an increase in the number of years lived in a state of incomplete health (in our case, of illness with cancer). From Figure 4 it follows that the duration of disease increases for all groups of localizations considered, with the exception of cancer of the lip, oral cavity, pharynx and oesophagus in females. The duration of disease in males is much shorter than in females, and for “all malignant neoplasms” there is a tendency towards a further convergence in the values of this indicator between males and females. A significant increase in the average number of years lived with prostate cancer is observed. The shortest average duration of disease in males is observed for cancer of the lip, oral cavity, pharynx and oesophagus, as well as for cancer of the trachea, bronchus and lung, with mean values of about 0.5 years, while in females the shortest duration is observed for cancer of the trachea, bronchus and lungs (1.3 years) and for stomach cancer (1.5 years). Localizations with the most fluctuations are cancer of the female breast and female genital organs; for cancer of the female genital organs the greatest values are observed in 2009-2010. In males, for all groups of localizations considered there is a tendency towards an increase in the number of years lived with cancer. The most significant increase in this indicator in males is observed for prostate cancer, while in females, with the exception of “all other malignant neoplasms”, for colorectal cancer. However, it should be noted that a tendency to a slight decrease in the average duration of disease has emerged in recent years, most pronounced in females for the following groups of localizations: stomach cancer, colorectal cancer, cancer of the trachea, bronchus and lungs.

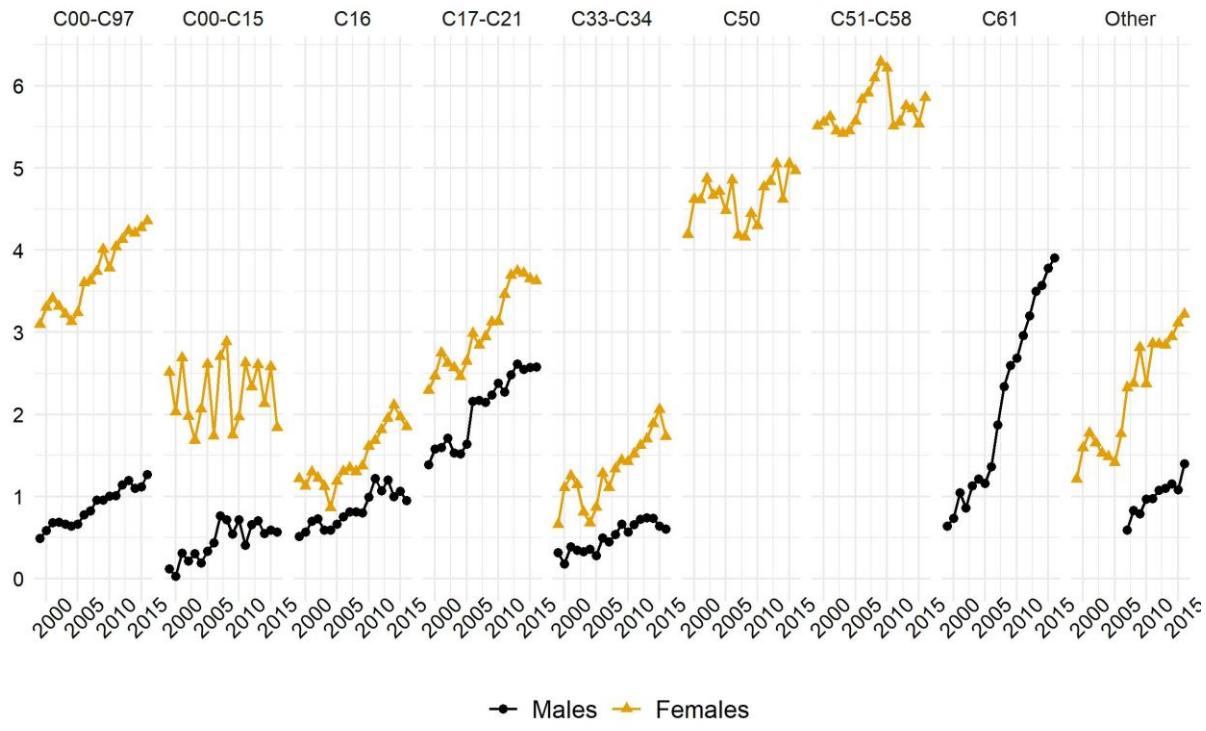

Figure 4. Expected duration of disease, 1999-2016, in years

C00-C97– all localizations; C00 - C15 - MN of lip, oral cavity, pharynx and oesophagus; C33 - C34 - MN of trachea, bronchus and lungs; C16 - MN of stomach; C17 - C21 – MN of intestines and rectum (colorectal cancer); C50 - MN of female breast; C51 - C58 - MN of female genital organs; C61 – MN of prostate.

Source: Author's calculations based on the data described in the Data and Methods section.

An increase in the average duration of disease, expressed in an increase in the number of years lived with cancer, may lead to an increase in the prevalence of cancer in the population. Figure 5 presents the age-standardized prevalence rates for all groups of localizations considered. In males, with the exception of "all other malignant neoplasms", which has the highest prevalence in the Russian population, the most common localization is prostate cancer, followed by colorectal cancer, cancer of the trachea, bronchus and lungs, and cancer of the lip, oral cavity, pharynx and oesophagus. Stomach cancer is the least common form of cancer in males, due to its high lethality. The only localization in males for which a slight decrease in prevalence is observed is cancer of the lip, oral cavity, pharynx and oesophagus. The highest increase in cancer prevalence is observed for prostate cancer and colorectal cancer, while for the prevalence of stomach cancer and cancer of the trachea, bronchus and lungs the dynamics are relatively stable.

Cancer prevalence dynamics in females, also presented in Figure 5, are more stable than in males. An increase in cancer prevalence in females occurs for all of the localizations considered. Apart from "all other malignant neoplasms" the most common are cancers of the female breast and female genital organs, for which the highest growth rate is observed, followed by colorectal cancer, stomach cancer and cancer of the trachea, bronchus and lungs. The lowest prevalence is observed for cancer of the lip, oral cavity, pharynx and oesophagus.

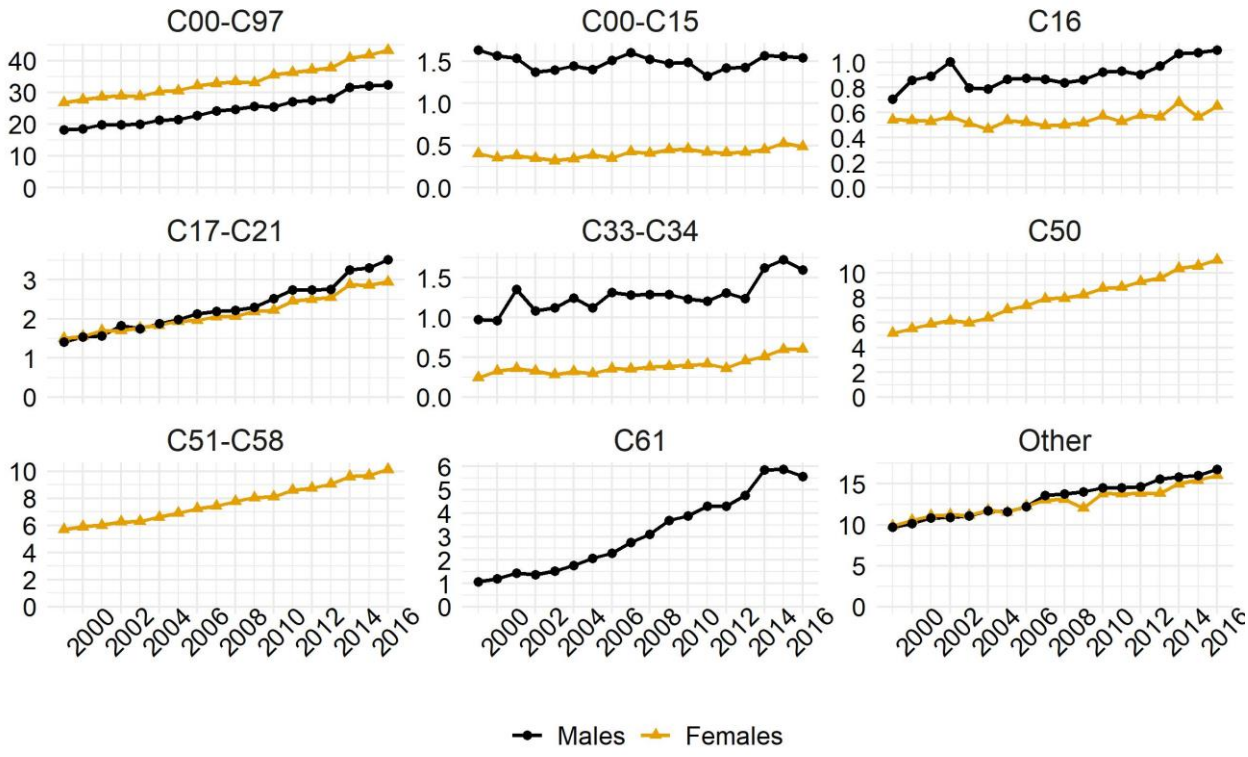

Figure 5. Age-standardized cancer prevalence rates of in the Russian population, per 1000 population, 1999-2016

Standardization is performed by a direct method using the European standard population.

C00-C97– all localizations; C00 - C15 - MN of lip, oral cavity, pharynx and oesophagus; C33 - C34 - MN of trachea, bronchus and lungs; C16 - MN of stomach; C17 - C21 – MN of intestine and rectum (colorectal cancer); C50 - MN of female breast; C51 - C58 - MN of female genital organs; C61 – MN of prostate.

Source: Author's calculations based on the data described in the Data and Methods section.

Apart from localizations unspecific to both sexes, we observe the following structural differences in prevalence of malignant neoplasms in males and in females. While among males cancer of the trachea, bronchus and lungs is more common than cancer of the lip, oral cavity, pharynx and oesophagus, and stomach cancer is the least common localization, among females the most common localization is stomach cancer, followed by cancer of the trachea, bronchus and lungs, with the least common being cancer of the lip, oral cavity, pharynx and oesophagus. In general, the prevalence of cancer in females exceeds that in males, despite the fact that the incidence of cancer in males is much higher than in females. In recent years a trend towards acceleration in growth of the age-standardized prevalence of cancer has been observed in Russia and is more pronounced in males. Cancer of the trachea, bronchus and lungs and prostate cancer are good illustrations of this phenomenon.

Let us examine prevalence rates by comparing the figures for 2016 and 1999. In this period, the dynamics of age-standardized prevalence rates were as follows.

In males:

- All malignant neoplasms - an increase of 1.8 times;
- All other malignant neoplasms – an increase of 1.7 times;
- Malignant neoplasms of the prostate - an increase of 5.2 times;
- Colorectal cancer - an increase of 2.5 times;
- Malignant neoplasms of lip, oral cavity, pharynx and oesophagus - a decrease of 0.1 times;
- Malignant neoplasms of trachea, bronchus and lungs and MN of stomach – an increase of 1.6 times.

In females:

- All malignant neoplasms and all other malignant neoplasms – an increase of 1.6 times;
- Malignant neoplasms of female genital organs - an increase of 1.8 times;
- Malignant neoplasms of female breast - an increase of 2.1 times;
- Colorectal cancer - an increase of 2 times;
- Malignant neoplasms of stomach - an increase of 1.2 times;
- Malignant neoplasms of trachea, bronchus and lungs - an increase of 2.5 times;
- Malignant neoplasms of lip, oral cavity, pharynx and oesophagus - an increase of 1.2 times.

Based on the model's output we conclude that an increase in the prevalence of cancer for all groups of localizations considered is occurring in Russia. The only exception is the prevalence of cancer of the lip, oral cavity, pharynx and oesophagus in males, for which a slight decrease in values is observed.

DISCUSSION

The prevalence of cancer in Russia is on the rise, thus cancer is becoming a more important factor of disability. In recent years in Russia there has been a tendency towards an acceleration of age-standardized cancer prevalence increase that is more pronounced in males. Illustrative examples are cancer of the trachea, bronchus and lungs (C33-C34), cancer of the prostate (C61) and stomach cancer (C16). Within this period there has been no significant acceleration in average duration of disease increase, but for all cancers there was a tendency towards the age-standardized incidence increase (Figure 1) that is more pronounced in males. Thus, it can be assumed that in Russia the increase in incidence has an important role in prevalence increase, at least in the context of the localizations considered. Despite the fact that the average duration of disease in females is longer than in males, the prevalence of for some cancers such as those of the trachea, bronchus and lungs (C33 – C34) and stomach cancer (C16) in males is higher than in females.

The highest prevalence increase is observed for prostate cancer (C61), although this is most likely caused by overdiagnosis following the introduction of the PSA (Prostate Specific Antigen) test [Bray, Parkin 2009]. The only localization for which a slight decrease in prevalence observed is cancer of the lip, oral cavity, pharynx and oesophagus (C00-C15) in males. Despite the fact that the incidence in males is significantly higher than in females, the prevalence of cancer in females

is higher, testifying in favor of the hypothesis of better female cancer survival. It should also be noted that there is a threat of future increase in female cancer mortality. Since the number of deaths from cancer is partly a function of an increase in incidence, the growth of the latter observed in females could later on lead to an increase in cancer mortality.

The average age at cancer onset and the average age at death seem to have grown independently of each other. Male age at disease onset has shifted to older ages, exceeding that of females and confirming the hypothesis regarding the possible shift of the modal age at cancer onset to older ages. At the same time, an increase in the average age at death is observed that is more significant than the increase in the average age at disease onset. Consequently, modal values of the age at death are also shifted towards the older ages. In this regard, males and females display similar dynamics. Average age at disease onset growth is inferior to that of the average age at death. The only localization for which the reverse dynamics are observed is cancer of the lip, oral cavity, pharynx and oesophagus (C00-C15) in females, for which a decrease is observed in both the age at death and the age at onset, with a greater decrease in the age at death. Despite the fact that the minimum age at cancer onset falls on certain periods, the maximum value in all cases considered occurred either in 2016 or one of the years just before. The result of the dynamics of the observed processes is an increase in the average duration of disease that is recorded for all the localizations considered in both males and females, with the exception of cancer of the lip, oral cavity, pharynx and oesophagus (C00-C15) in females.

Nowadays, the compression of morbidity concept is popular in papers aiming to study chronic disease onset and subsequent mortality. The author of the concept [Fries 1980, 2002, 2005] puts forward the following assumption: if a population experiences an increase in life expectancy, a so-called compression of morbidity should also occur. This will be expressed in a reduction in the number of years lived in a state of imperfect health. According to this concept, a decline in incidence of chronic diseases should occur by analogy with the previously observed decline in mortality. The author also suggests that there will be a shift in the average age at disease diagnosis towards the older ages - in other words, the time between the disease onset and death will be decreased (a compression of morbidity will occur) [Crimmins, Beltrán-Sánchez 2011]. We see that in Russia the average age at cancer diagnosis is indeed increasing. At the same time there is a much more pronounced increase in the average age at death from it. These developments, reinforced by decreases in cancer mortality and by increases in cancer incidence, are driving the increase in cancer prevalence, which is determined by an increase in the duration of disease or better survival of cancer patients, and by an increase in standardized incidence rates for the diagnostic category “all malignant neoplasms”. This allows us to conclude that in Russia for all localizations considered the phenomenon of compression of morbidity is not occurring. In contrast, an expansion of morbidity expressed in the increase in the average number of years lived in a state of ill health due to cancer is occurring. An exception is cancer of the lip, oral cavity, pharynx and oesophagus (C00-C15) in females, for which a compression of morbidity expressed in a decrease in the number of years lived with the disease is occurring. In males, no compression of morbidity is observed for this localization, despite a slight decrease in the standardized prevalence, since at the same time the average number of years lived with cancer is increasing.

A further increase in cancer prevalence may be a consequence of the observed dynamics, thus making cancer a more important factor of disability in the Russian population.

In conclusion, a few words on the limitations of this study should be said. When interpreting the model's results, it should be remembered that the Duchêne model used by us is not fully multi-status per se, but rather is approximate or artificial. This model has two features that may result in negative return values of the survival function. Having limited access to data, we were forced to estimate the incidence rate for the entire population rather than for healthy people, i.e. to use not an indicator of the incidence intensity but a so-called second order coefficient. Mortality in the model applies also to the entire population, not just to patients diagnosed with a certain cancer. The results are approximate figures. However, since all indicators are calculated using an identical method, an analysis of their dynamics and a comparison of the two sexes makes sense.

It is also important to note one of the fundamental features of the Duchêne model. Within this model, the synthetic cohort is initially divided into 2 groups: ill with cancer and cancer free. It is assumed that a person may leave the first group not only by contracting the disease under study, but also following an impact made by other causes. The model itself consists of two partial morbidity-mortality models that do not take the possibility of remission into account. These are the double decrement models, in which synthetic cohort members either remain in the healthy group or leave it by contracting the disease, dying from the disease or dying from any other cause. Thus, members of the cohort contracting the disease are susceptible to death from both the cause under study and from any different cause.

Three interrelated states are taken into account: the absence of the disease, its presence, leaving the cohort due to death. The hypothetical cohort mortality from causes other than that under study is set to be equal to that in a healthy population (i.e. in a population not suffering from the disease under study). Such an assumption is undoubtedly a weak side of the model, since it is obvious that the mortality structure of those ill with cancer differs from that of a healthy population, due to the influence of specific risk and behavioral factors. The model includes the possibility of death from a cause other than the one under study, thus a cohort member considered with regard to a particular cancer localization that dies from another, falls into the group "all other malignant neoplasms".

Another problem is the comparability of incidence and mortality data. Incidence and mortality report forms were altered in 2011 (before this, the mortality reporting form was changed in 1999) [Petrova et al. 2015]. Thus, the data published by the P.A. Gerzen Institute before and after 2011 differ in the number of localizations provided. For example, the incidence data published by the institute up to 2011 has no ICD-10 codes corresponding to cancer of the small intestine (C17), as well as to a number of localizations belonging to the class "malignant neoplasms of female genital organs": cancer of the vulva (C51) and cancer of the vagina (C52). This factor should be taken into account when interpreting the model's results. It should also be remembered that, in Russia, data on incidence and mortality are gathered independently by two different entities (the Ministry of Health and Rosstat). This fact can also affect the data's completeness and comparability.

Combination of these two factors, i.e. the lack of incidence and mortality data comparability, as well as the fact that the model is not fully multi-status, explains the problem of negative survival obtained for the diagnostic group "all other malignant neoplasms" in males that

arises when calculating the model prior to 2007. It should also be noted that due to these facts the average duration of disease is the least reliable indicator provided, since it represents the difference in indicators calculated based on the data obtained from two independent sources (Form C51 and Form No. 7).

CONCLUSION

It should be emphasized that cancer prevalence analysis is uninformative by itself, since its increase can be both a function of the incidence increase and a consequence of better survival of cancer patients. Obviously, if an increase in prevalence is observed largely due to an increase in incidence, then it should be given a generally negative assessment, but if the same occurs due to better survival of patients already diagnosed with cancer, it is undoubtedly a positive trend. Unfortunately, the analysis of cancer prevalence by itself will not allow for an unambiguous answer to the question posed this way, and therefore it is necessary to analyze it in combination with other population characteristics of cancer.

In this paper, we have applied the J. Duchêne model to assess a number of otherwise inaccessible characteristics of cancer in the Russian population for chosen groups of localizations. We estimated the cancer prevalence, average age at cancer onset and of death from cancer, and the average duration of disease. Based on the results, it can be assumed that, despite the fact that an increase in cancer prevalence in Russia results, among other things, from an increase in incidence, it results also from an increase in the average expected duration of disease, thus indirectly confirming the hypothesis of better survival of cancer patients. The observed shift in the average age at disease onset and at the average age at death from cancer to older ages, with the primacy of the latter, results in an increase in the average duration of disease, calculated as the difference between the average age at death and the average age at cancer onset. This tendency determines the phenomenon of expansion of morbidity that is observed for all groups of cancers considered, with the exception of cancer of the lip, oral cavity and oesophagus (C00-C15) in females, for which a reduction in the average duration of disease or a compression of morbidity is observed. Thus, not only is a confirmed shift of cancer onset and death to older ages occurring in Russia, but also indirect evidence of improved prognosis for cancer survival exists which is reflected in an increase in the prevalence of cancer. Thus, based on the observed dynamics of population processes, it is possible to put forward a hypothesis that in the near future cancer may become an even more important factor of disability in the Russian Federation.

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