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RESEARCH ARTICLE

Age structure of the population of Moscow and St. Petersburg: yesterday, today, and tomorrow

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Abstract

The article analyzes the dynamics of the aggregate age structure of the population of Moscow and St. Petersburg between 1990 and 2015, as well as in the long term up to 2045 in accordance with a number of scenarios of changes in the indicators of major demographic processes. Besides, the population pyramids of St. Petersburg and Moscow according to the following population censuses are considered: the First Census of Population of the Russian Empire of 1897, the All-Union population censuses of 1926, 1939, 1959, 1970, 1979, 1989, the All-Russian population censuses of 2002 and 2010, and a quantitative evaluation of their similarities and differences is given.

Keywords

population ageing; age structure of the population; comparative analysis; perspective calculations

JEL Codes: J11, J18

Introduction

The age and sex structure is one of the most important characteristics of the population. The analysis of the age composition allows for a deeper insight into the essence of natural population movement processes and, therefore, a mode of its reproduction. The age and sex structure clearly reflects the evolution of the population reproduction regime in the near and distant past. At the same time, the structure has a certain impact on future population development (Pirozhkov 1976; Pirozhkov and Safarova 1993; 2003).

The ageing of the population, which has a significant and increasing impact on the society, reflects the transformation of the age structure in course of demographic transition. This explains the special attention to the dynamics of the age group of the elderly (persons over working age, i.e. 60+).

Table 1. Principal demographic indicators for Moscow and St. Petersburg, 2015.

Indicator	City	
	Moscow	Saint Petersburg
Total population, million people	12.20	5.19
Total fertility rate (TFR, births per woman)	1.41	1.59
Life expectancy (LE) for men, years	73.0	69.8
Life expectancy (LE) for women, years	80.4	78.4
Balance of migration, person	112,211	25,263

Sources: data of Rosstat and Petrostat.

Indicators of the main demographic processes for Moscow and St. Petersburg in 2015, taken as basic for this research, are given in Table 1.

Prospects for the size and age structure of population in Russia in whole, Moscow, and St. Petersburg will be the focus of the last part of this paper. However, to demonstrate the influence of the age structure on demographic development, we give here the results of calculations of the long-term dynamics of the population size of Moscow and St. Petersburg up to 2045 in two scenarios: the first one assumes preservation of the regime of reproduction base 2015 and zero migration, which allows to see opportunities for population growth due to natural reproduction, as well as the initial age structure of the base 2015 (CC0 scenario); the second one also assumes a reproduction regime of 2015 and zero migration, but the reference age structure is the age structure of the population of the these cities in 1897, which had a high proportion of children and a low proportion of older persons (CC0-897 scenario). The age structures of Moscow and St. Petersburg according to the census of 1897 are presented below in the section dealing with population pyramids.

Figure 1 shows the dynamics of the total population of Moscow and St. Petersburg up to 2045 in accordance with these scenarios.

It is not surprising that the preservation of the current demographic situation with zero migration balance (CC0) leads to a reduction in the size of population — the population of Moscow may decrease by 16.8% relative to the 2015 level (up to 10.15 million people), St. Petersburg, respectively, by 15.5% relative to the 2015 level (up to 4.4 million people). At the same time, the CC0-897 scenario leads to an increase in the population of Moscow by 21% relative to the population in 2015 (up to 14.8 million people), and St. Petersburg, respectively, by 26% relative to the number in 2015 (up to 6.2 million people). Thus, if at present the Russian capital cities would have the population structure of the late 19th century, even with the modern mode of reproduction with birth rate below reproduction level, a "young" age structure by itself would ensure population growth. This example clearly shows what a significant influence initial age structure has on future population growth.

This paper analyzes the dynamics of the elderly population of Moscow and St. Petersburg between 1990 and 2015 (including relative to 1990) in comparison with the dynamics of the total population; the dynamics of the aggregate age structure of the population; the population pyramids of Moscow and St. Petersburg according to population censuses; the similarities / differences in age and sex structures of the two cities, as well as long-term prospects for changing the age structure of the population of Moscow and St. Petersburg.

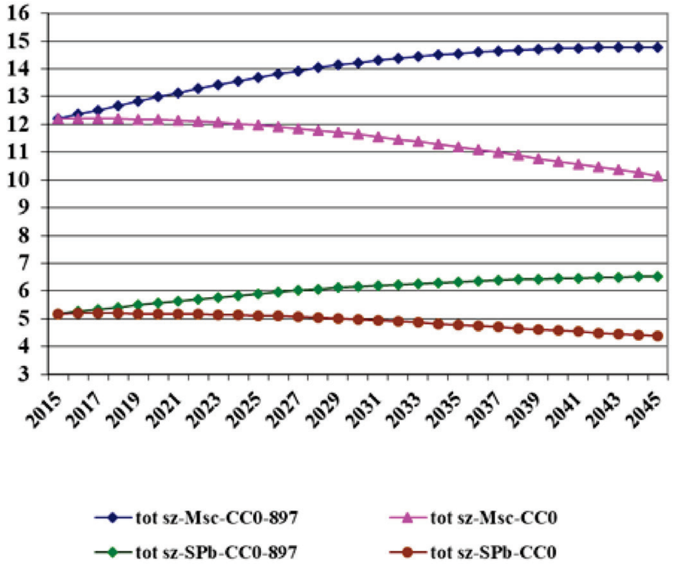


Figure 1. Dynamics of population size of Moscow and St. Petersburg up to 2045 according to scenarios CC0 and SS0-897, million people. Source: authors' calculations based on Rosstat data.

Dynamics of total population and elderly population of Moscow and St. Petersburg between 1990 and 2015

Figures 2, 3 and Table 2 represent the dynamics of the elderly population (relative to 1990), as well as the absolute number of older persons for Russia, Moscow and St. Petersburg between 1990 and 2015.

The total population of the two megacities, unlike Russia as a whole, increased during the period under review, but the dynamics of this indicator for Moscow and St. Petersburg varied. Since 1994 for Moscow there was monotonous growth of the total population, which amounted to 37.4% relative to 1990, largely due to administrative-territorial transformations. The population of St. Petersburg declined until 2003, when it reached 93.1% of the original population in 1990, followed by a slight monotonous increase: as a whole during the period under review, the growth was 3.8% relative to 1990.

The total number of the elderly population of megacities and Russia as a whole in the period under review had increasing linear trends. At the same time, in full compliance with numerous demographic perspective calculations in the first half of the first decade of the 21st century, there was a slight reduction in the number of the elderly population, after which its growth resumed.

In general, for the considered 2.5 decades, the total number of the elderly population of Moscow increased from 1,647,400 pe in 1990 to 2,626,800 persons in 2015 (i.e. by 59.5%). In St. Petersburg the growth was from 875,400 persons to 1,131,000 persons (i.e. by 29.2%). Iin Russia in a whole the growth was from 23,262,300 persons to 29,064,200 persons (i.e. by 24.9% as compared to 1990). Such a large increase in this indicator for Moscow and an increasing excess of its values for Moscow in comparison with St. Peters-

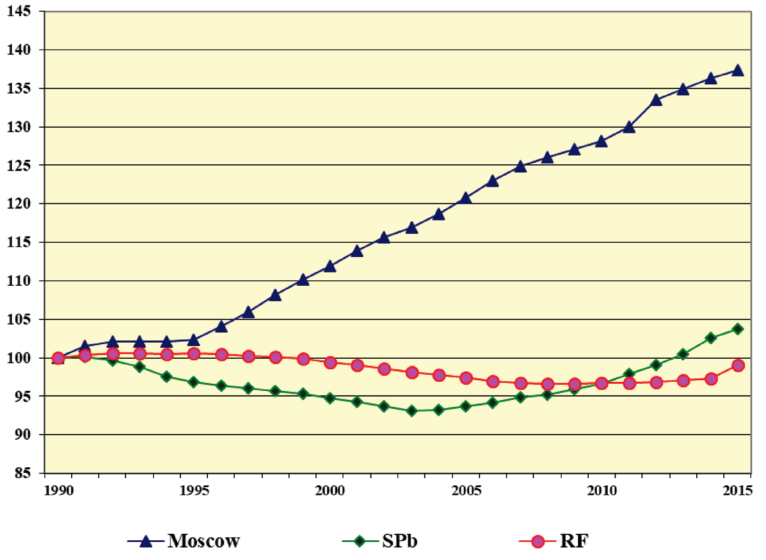


Figure 2. The number of the elderly 60+ population relative to 1990 in Russia, Moscow and St. Petersburg, 1990—2015, %. Source: authors' calculations based on Rosstat data.

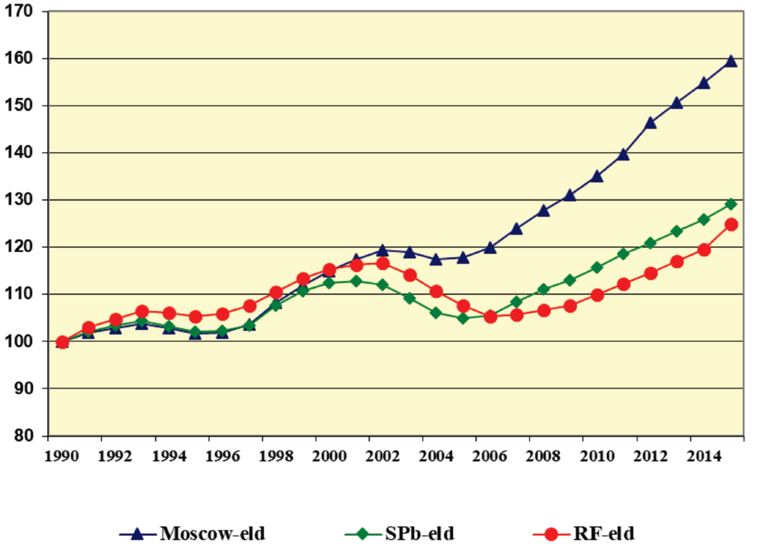


Figure 3. The number of the elderly 60+ relative to 1990 in Russia, Moscow and St. Petersburg, 1990—2015,%. Source: authors' calculations based on Rosstat data.

burg (see Fig. 3) since the beginning of the 21st century may be due to the fact that since 2005, the total fertility rate (TFR) for St. Petersburg was higher than for Moscow, and life expectancy (LE) in Moscow has been higher than in St. Petersburg since 1997. Both of these indicators — lower birth rates and higher life expectancy — lead to a faster growth of the elderly population.

Table 2. The number of elderly people (60+), Russia, Moscow and St. Petersburg, thousands, 1990–2015.

Years	Russia	Moscow	Saint Petersburg
1990	23 262,3	1647.4	875.4
1991	23 969,6	1677.3	893.7
1992	24 390,3	1695.2	905.2
1993	24 761,9	1709.8	914.0
1994	24 670,0	1693.8	903.5
1995	24 503,6	1674.8	894.4
1996	24 655,9	1680.1	894.6
1997	25 025,4	1706.0	904.9
1998	25 709,5	1782.3	941.9
1999	26 365,5	1841.5	969.0
2000	26 842,5	1893.6	984.2
2001	27 065,8	1935.3	987.2
2002	27 125,8	1967.5	981.1
2003	26 581,1	1959.3	955.7
2004	25 733,8	1935.3	929.2
2005	25 022,3	1940.9	918.9
2006	24 514,2	1975.2	924.3
2007	24 585,2	2041.9	948.6
2008	24 812,0	2106.0	972.5
2009	25 034,9	2158.2	989.8
2010	25 597,7	2227.0	1013.4
2011	26 113,9	2302.5	1039.0
2012	26 655,8	2411.6	1058.6
2013	27 242,1	2482.6	1079.8
2014	27 804,3	2550.2	1102.1
2015	29 064,2	2626.8	1131.0

Source: Rosstat data.

Dynamics of the aggregate age structure of the population of Moscow and St. Petersburg between 1990 and 2015

Dynamics of the proportion of the main population groups — children, working-age population and the elderly (according to the international classification) for Moscow, St. Petersburg and Russia in whole between 1990 and 2015 is presented in Fig. 4, 5 and 6.

Before the recent law on pension reform[1], men from 16 to 59 and women from 16 to 54 years of age were considered as people of working age in Russia. People above the working

[1] Federal Law No. 350-FZ dated 03.10.2018 "On Amendments to Certain Legislative Acts of the Russian Federation on Assignment and Payment of Pensions".

age are classified as the elderly, and younger - as the group of children. According to the international classification, the group of children includes persons under 15 years of age; working-age persons - men and women aged 15-59 years (or 15-64 years); and the elderly group - persons aged 60 (or 65) years and older respectively, which is labeled 60+ or 65+ for short (see, for example, Safarova 2006]. This paper uses the international classification of aggregated age groups, in which the working-age population includes men and women aged 15-59 years, and the group of the elderly population - persons aged 60+.

In Russia in whole, only the proportion of children in the total population is higher than in each of the capital cities, while for the proportion of the working-age population and the elderly population the reverse inequality is true.

Only in the first half of the 1990s the proportion of elderly people in the total population was higher in Moscow than in St. Petersburg. In the beginning of the 21st century proportion 60+ was decreasing, reflecting the consequences of the Second World War, and from the middle of the first decade, it began monotonous growth. In general, during a quarter of a century the proportion 60+ increased for Moscow from 18.6% in 1990 to 21.5% in 2015, for St. Petersburg — from 17.5 to 21.8%, and for Russia — from 15.6 to 19.9%.

It should be noted that since the middle of the first decade of the 21st century there has been an increase in the proportion of children, which is associated with the increase in the number of births. The growth of the share of children and the elderly resulted in the corresponding decrease of the proportion of the working-age population.

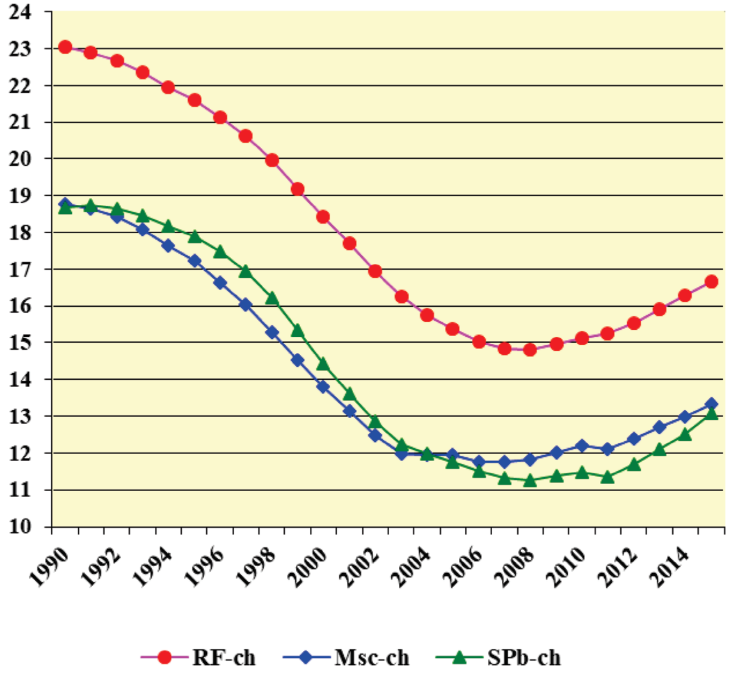


Figure 4. Proportion of children in the total population of Russia, Moscow and St. Petersburg, 1990—2015, %. Source: authors' calculations based on Rosstat data.

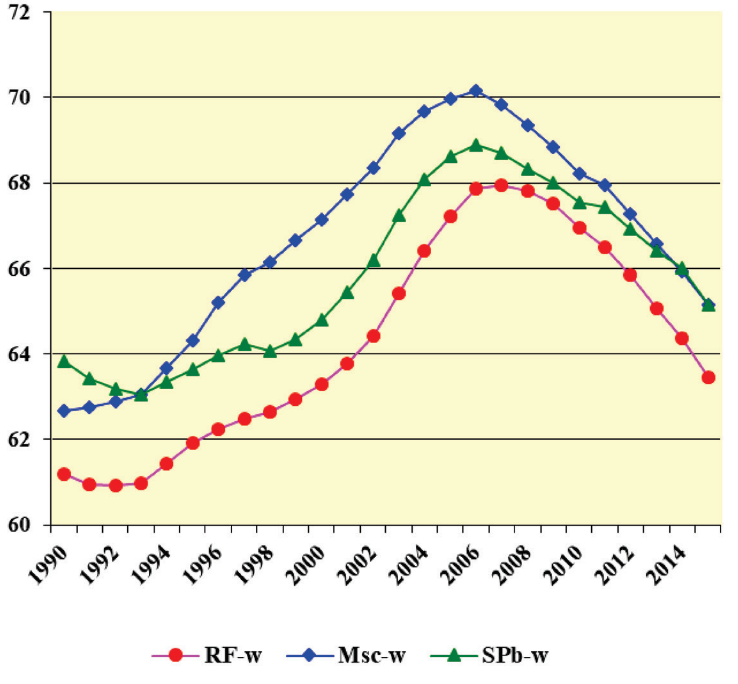


Figure 5. Proportion of the working-age population in the total population of Russia, Moscow and St. Petersburg, 1990—2015, %. Source: authors' calculations based on Rosstat data.

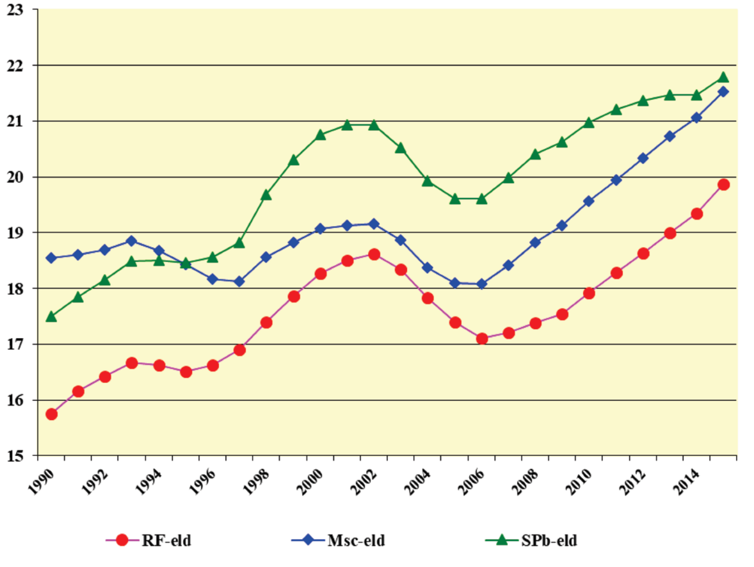


Figure 6. Proportion of elderly persons in the total population of Russia, Moscow and St. Petersburg, 1990—2015, %. Source: authors' calculations based on Rosstat data.

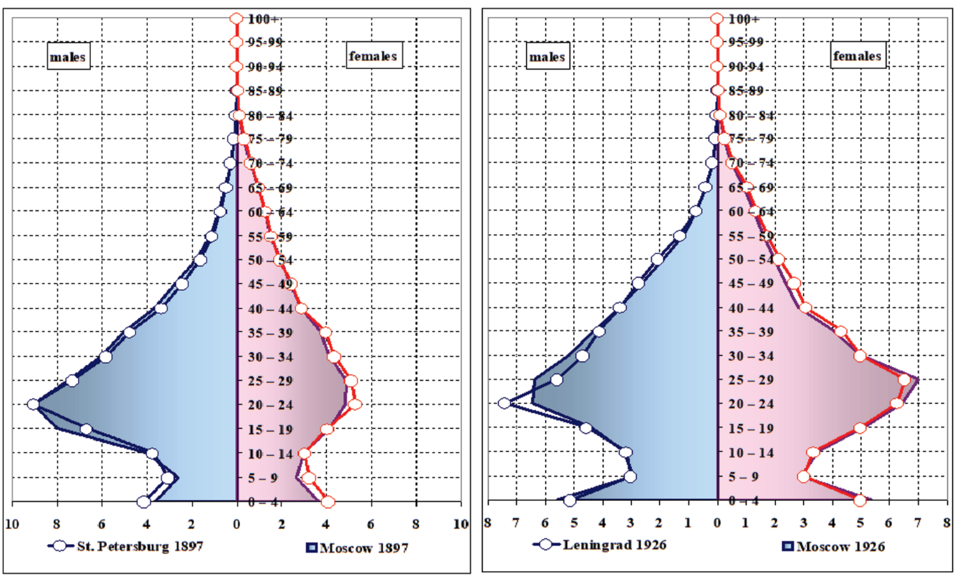
Age pyramids of the population of Moscow and St. Petersburg

The age structure of the population of Moscow and St. Petersburg was formed under the influence of similar historical and demographic events occurring simultaneously in both capitals. The changes in the age structure of these cities from the end of the 19th century to the present can be seen in the age pyramids of St. Petersburg and Moscow according to population censuses: The First Census of the Russian Empire of 1897, the All-Union population censuses of 1926, 1939, 1959, 1970, 1979, 1989, the All-Russian population censuses of 2002 and 2010 (Demoscope Weekly. Annex). The corresponding population pyramids are shown in Fig. 7–16. They enable seeing a significant similarity between the age structures of Moscow and St. Petersburg. In addition, Fig. 17 and 18 show the change in the age structures of Moscow and St. Petersburg over the last quarter of a century. These graphs confirm that the population pyramid is a mirror of demographic (and not only) history of the country.

The age pyramids of Moscow and St. Petersburg according to the 1897 Census are typical for age structures before the beginning of the demographic transition; they have a large proportion of children and a small proportion of the elderly population. Thus, according to the 1897 Census in Moscow there were 19.6% of children under 15 years of age and only 5% of elderly people (60+), in St. Petersburg — 21.3% of children and 5% of elderly people.

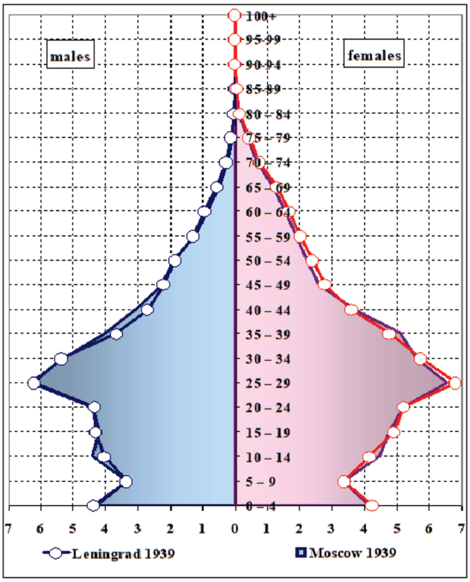
The age pyramids of 1926 indicate a decrease in the proportion of children of 10-14 years due to the decline in the number of births during the revolution and the First World War.

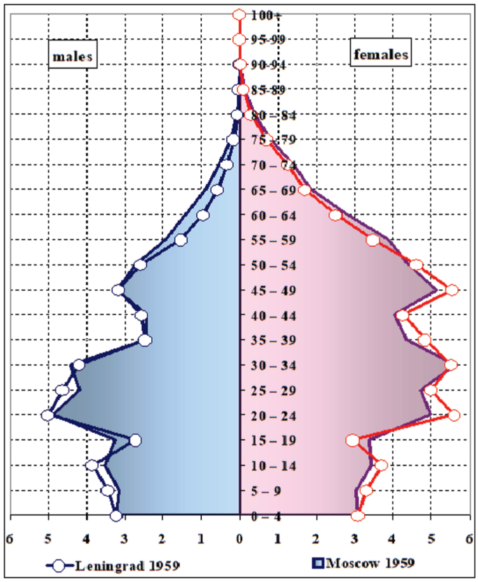
Age pyramids according to the 1959 census reflect the time and conditions of formation of the main demographic “waves”, the influence of which is still in effect today (Fig. 10). Through a system of intergenerational relationships (parents - children), these “waves” form a demographic “echo”, i.e. a repetition of pits and juts on the pyramid shape.



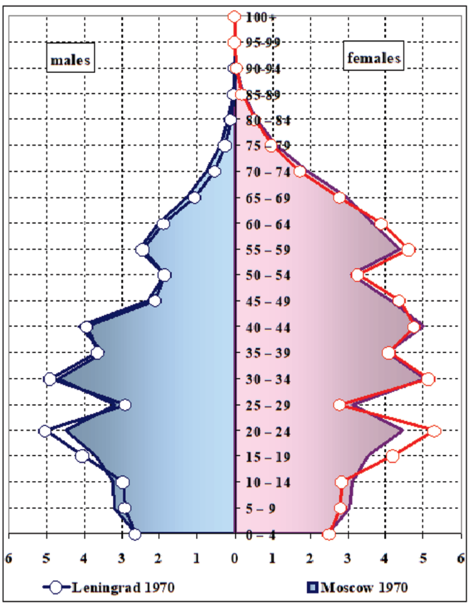
Figures 7, 8. Age pyramids. **7** Moscow and St. Petersburg, 1897, %. **8** Age pyramids, Moscow and Leningrad, 1926, %. Source: data of population censuses (Demoscope Weekly. Annex).

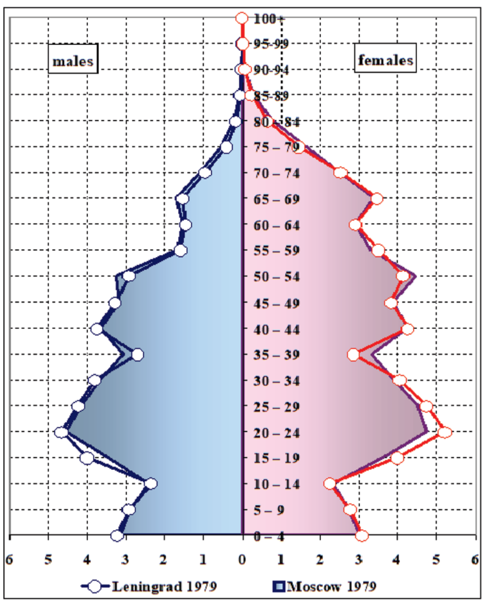
The demographic "waves" determined not only the changes in the actual age structure, but also the change in quantitative indicators of the natural movement for half a century. These "waves" will also affect overall population and vital movements over the coming decades.



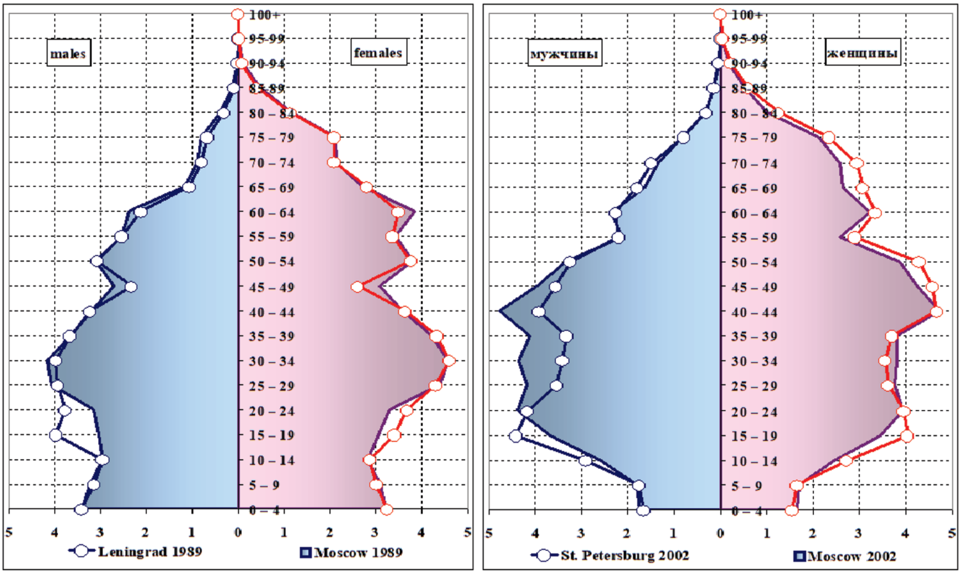


Figures 9, 10. Age pyramids. **9** Moscow and Leningrad, 1939, %. **10** Moscow and Leningrad, 1959, %. Source: data of population censuses (Demoscope Weekly. Annex).

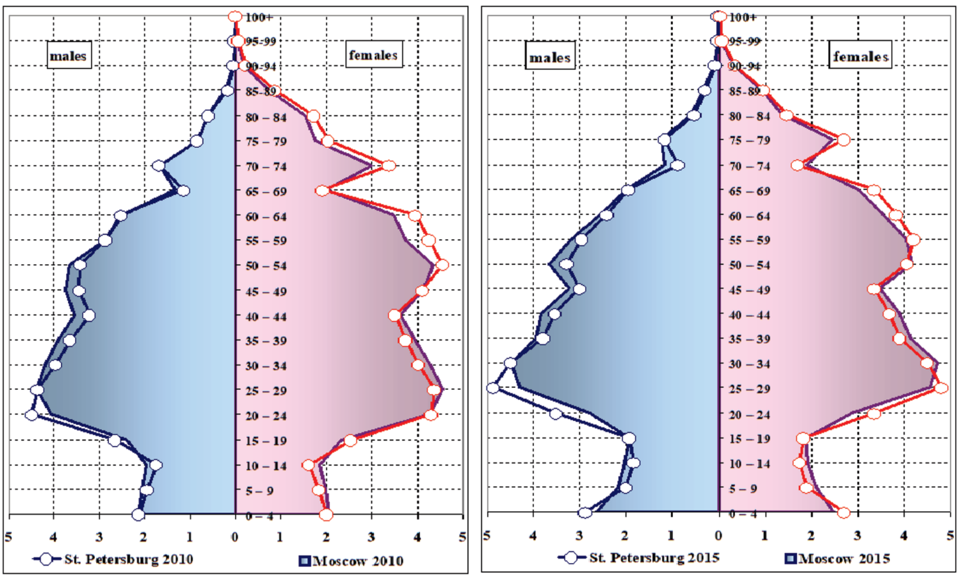




Figures 11, 12. Age pyramids. **11** Moscow and Leningrad, 1970, %. **12** Moscow and Leningrad, 1979, %. Source: data of population censuses (Demoscope Weekly. Annex).

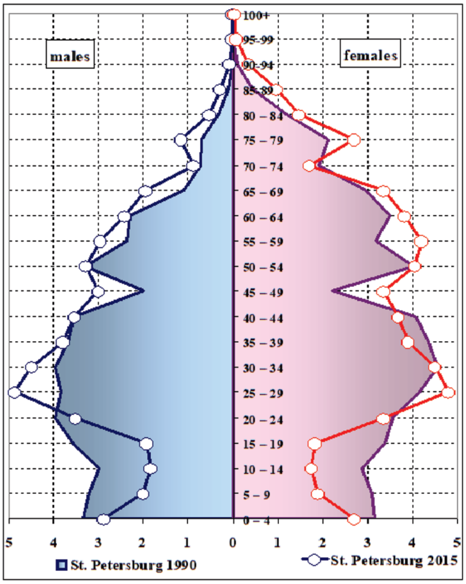


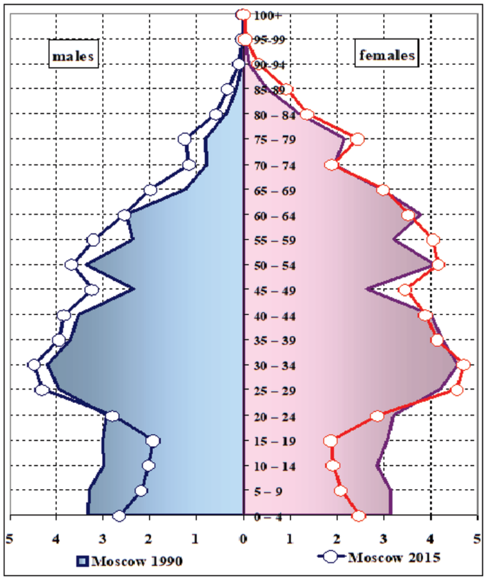
Figures 13, 14. Age pyramids. **13** Moscow and Leningrad, 1989, %. **14** Moscow and St. Petersburg, 2002, %. Source: data of population censuses (Demoscope Weekly. Annex).



Figures 15, 16. Age pyramids. **15** Moscow and St. Petersburg, 2010, %. **16** Moscow and St. Petersburg, 2015, %. Source: data of population censuses (Demoscope Weekly. Annex).

As shown in Fig. 10, age groups of 30-44 years are the lowest specific weight (especially in the male population). They suffered the greatest losses during the Second World War. In the age pyramid of 2015 the anomaly of these age groups has been smoothed out in the course of time.





Figures 17, 18. Age pyramids. **17** St. Petersburg, 1990 and 2015,%. **18** Moscow, 1990 and 2015,%. Source: Rosstat data.

The system of "compressions" on the age pyramids of 1959 begins with relatively small in number of age groups of the population born in the years of war, this is especially noticeable on the age structure of the population of Leningrad, which had endured the blockade (at the time of the 1959 census it was 15—19 years old (Fig. 10). By the 2010 census, they had moved to the 65-69 age groups (Fig. 15).

Since the length of the generation (the average time interval between the generations of parents and children) varies within the limits of 25-30 years, the formation of a "demographic echo" – descendants of cohorts born in the years of war — becomes clear. Fig. 15 clearly shows the "compression" of the population pyramids of Moscow and St. Petersburg, formed by those born in the second half of the 1960s.

The age pyramids of 1989 (Fig. 13), in addition to the above-mentioned influence of the Second World War, demonstrate a widening of the basement associated with the effect of stimulating population policy measures of the mid-1980s.

The age pyramids of 2002 (Fig. 14), demonstrate the significant decline in the basement (the decline in the proportion of children's ages) due to the decline in fertility in the 1990s. Compared to the pyramids of 2002, the pyramids of 2010 (Fig. 15) have a broader basis, which has been linked to an increase in fertility for almost 10 years.

Fig. 16 shows the 2015 population pyramids. They reflect both the results of the birth rate growth over the last decade, and the consequences of the Second World War ("pits" corresponding to the ages of 70-74 and their descendants - ages of 45-49), and the impact of accelerating population ageing. In 2015, the proportion of children in Moscow was 13.3%, and the elderly - 21.5%, in St. Petersburg - 13.1 and 21.8% respectively.

The change in the age structure of the population of Russian capitals from 1990 to 2015 is shown in Fig. 17 and 18, which obviously demonstrate the population ageing process.

Table 3. The similarity of age structures (s) of the population of Moscow and St. Petersburg (Leningrad) in the population censuses of 1897, 1926, 1939, 1959, 1970, 1979, 1989, 2002 and 2010, as well as in 2015, %

Year	*s*	Year	*s*
1897	96.6	1979	97.1
1926	96.7	1989	97.4
1939	97.9	2002	95.1
1959	95.8	2010	96.8
1970	96.2	2015	96.2

Source: authors' calculations based on census and Rosstat data (Demoscope Weekly. Annex).

To measure the proximity (differences) of age-sex structures of the population of Moscow and St. Petersburg, as well as age-sex structures of these megacities in 1990 and 2015, we shall use the indicator *s* (Table 3).

Let $X = (x_1, x_2,..., x_n)$ and $Y = (y_1, y_2,..., y_n)$ are vectors of the share composition (age structures). As a measure of comparison of age structures, we use the indicator:

$$s(X,Y) \equiv 1 - \frac{1}{2}\sum_{i=1}^{n}|x_i - y_i|.$$

Obviously, $0 \le s \le 1$. Since $s(X, X) \ge s(X, Y)$, i.e. the values of the indicator for identical equity structures, are higher than those for non-identical structures, the introduced indicator should be classified as measures of similarity. The value of s shows how much the age structures in question coincide in their structure.

Calculations of proximity measures s showed that the similarity of age structures of the population of Moscow in 1990 and 2015 was 91.3%, and for St. Petersburg - 89.4%.

A quantitative assessment of the similarity of the age structures of the population of Moscow and St. Petersburg enable concluding about their proximity, since the values of the coefficient *s* exceed 95%.

Dynamics of the aggregate age structure of the population of Moscow and St. Petersburg in the long term

This section deals with the analysis of the long-term prospects of the age structure of the population of Moscow and St. Petersburg. On the basis of a number of existing forecast scenarios we estimate the possible changes in the size and structure (with special focus on population ageing) of megacities up to 2045 and in comparison with all-Russian trends.

Population projections are now an integral part of the management of socio-economic development at various levels. They can serve as a means of quantifying the expected impact of the various economic and social programmes aimed to achieve certain results.

For decades, many organizations in Russia were engaged in development of demographic forecasts. We shall note the projections, divided by two decades, made at the Department of Demography of the Institute of Statistics and Economic Research of Goskomstat Russia (Demograficheskie perspektivy... 1993) and in the Institute of Demography of Research University Higher School of Economics (Vishnevsky 2012; 2014).

Rosstat calculates the estimated population by 2030 in three variants (low, medium, high) on the basis of data of the number of permanent population of the regions of the Russian Federation by sex and age as of 1 January 2010 and taking into account the Concept of Demographic Policy of the Russian Federation for the period up to 2025, approved by Presidential Decree No. 1351 of 09.10.2007. The medium variant of the forecast is considered the most realistic; it takes into account current demographic trends and population policy measures.

Official retrospective and prospective estimates of the world population used in the UN have been prepared since 1950 by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (DESA). UN Prospective Estimates (World Population Prospects 2017) are updated every two years (as a rule). The great advantage of WPP is their comparability — they are carried out according to a single methodology and allow reliable cross-country comparisons.

The specific projections, which will be presented below, are based on a methodology called prospective analysis. It is based on the possibility of implementing a variety of population development scenarios depending on different external and internal conditions. The practical value of the results of prospective analysis is determined not by the degree of their proximity to the actual values (which can be determined only post-factum), but by the value of the forecast for decision-making process in various areas of political or socio-economic activity.

Even more definite evaluation on this approach was given by E. Andreev and T. Kharkova: "Since the beginning of the 1990s the scenario method became the basis of Russia's population projections. It is practically the only possible approach to determining the future dynamics of fertility, mortality and migration in crisis conditions" (Andreev and Kharkova 1998/1999).

Prospective scenarios calculation

DemProj, a computer program for demographic forecasting developed by the American firm The Futures Group in 1987 (DemProj 1987) was used for calculations. The modern version of DemProj is part of the Spectrum 5 package. The forecast is carried out by the cohort-component method, the program also allows to take into account external migration. The DemProj program is based on the matrix model of population reproduction.

To implement the forecast (the projection horizon is up to 150 years) without taking into account migration and differentiation on urban and rural populations, it is sufficient to introduce an initial number of five-year age groups (men and women), as well as to set predictive hypotheses on fertility, mortality and migration. Hypotheses on fertility trends are given by the total fertility rate (TFR) and by the proportions (in percentage) of age-specific birth rates for women of reproductive age by standard age groups (15-19, 20-24,..., 45-49) for the entire projected period. Recall that the TFR shows how many children would have been born by a woman during the entire reproductive period (15-49 years), with the current birth rate at each age of the year, for which the factors are calculated.

The forecast hypothesis of mortality changes is introduced in the form of life expectancy (LE) at birth (for men and women) for the entire projected period. Life expectancy at birth is the number of years that a person from the generation born would have to live on average, provided that throughout the life of this generation the age-sex death rates remain at the level of the year for which the indicator is calculated. The age distribution of mortality can be determined by the survivorship ratio or by model distributions. In the latter case, the

Coale-Demeny model life tables (Coale and Demeny 1983) or UN model life tables are used. In this paper, we apply Coale-Demeni life tables. Migration is characterized by the migration balance and age distribution.

By using the DemProj program, the following prospective population indicators can be calculated: total population; number of population of certain ages; number of five-year age groups (pyramid and sex); number of births and deaths, crude birth and death rates, and population growth rates. All these indicators are calculated for the entire projected period in step of five years, while the total number, number of given ages, number of births and deaths are calculated in step of one year (DemProj 1987).

Our calculations are based on the data of the Regional Body of the Federal State Statistics Service for St. Petersburg and the Leningrad oblast (Petrostat[1]) and Rosstat.

With the help of the DemProj program, we have calculated prospective size and age and sex structure of the population of Moscow and St. Petersburg up to 2045, and on their basis - indicators of population ageing, in particular, the proportion of persons over working age (60+) in the total population.

2015 was taken as the base year. Indicators of the main demographic processes for Moscow and St. Petersburg in the base year were given earlier in Table 1.

This work is not aimed at calculating as many scenarios as possible, but we have attempted to determine the possible borders of changes in the total number and indicators of ageing of the population of the Russian capital cities up to 2045. In addition, the effects of maintaining the current demographic situation and demographic development in the absence of migration were investigated.

As a result, three types of scenarios were developed (i.e. three levels of of major demographic indicators):

C (Constant rates) — assuming the preservation of the TFR, LE and the balance of migration at the level of the base year;

1. L (Low) — assuming the lowest values of corresponding indicators observed between 1990 and 2015.;
2. H (High) — assuming the highest values of the TFR and migration balance observed between 1990 and 2015, and LE calculated for 2045 for Moscow and St. Petersburg based on Rosstat (H^R) forecast. In addition, the case of zero migration (0) is considered.
3. On the basis of these assumptions scenarios of prospective calculations are elaborated. In this paper 10 main scenarios (out of 36 possible combinations) are considered:

1. CCC.	2. CC0.
3. LLL.	4. LL0.
5. HH^RH.	6. HH^R0.
7. HLC.	8. HL0.
9. LHC.	10. LH0.

Analysis of the results of prospective calculations

Table 4 shows the values of the total population and the aggregate age structure of the population for the prospective scenarios for Moscow and St. Petersburg for 2045.

[1] petrostat.gks.ru.

In the final year, 2045, the total population of Russian capitals can vary widely: from 7.8 million to 14.4 million for Moscow and from 3.3 million to 9.5 million for St. Petersburg. At the same time, the LH0 and HH^RH scenarios lead to the lowest and highest values for both capitals respectively (Fig. 19 and 20). Four scenarios lead to the growth of the total population of Moscow (SSS, HH^RH, HLC, LHC), while only two scenarios (SSS, HHRH) provide growth of the population of St. Petersburg.

Fig. 19 and 20 represent the dynamics of the total population of metropolitan areas for the LH0 and HH^RH scenarios, shaping the range of possible values of the total population, as well as for the SSS and HLC scenarios, the latter of which holds the population almost unchanged. Fig. 21 and 22 show proportion 60+ dynamics for these scenarios.

Almost all scenarios promise an increase in the proportion of elderly people. The only exception is the HH^RH scenario for St. Petersburg: proportion 60+ is down 11% relative to 2015. In general, the growth of proportion 60+ relative to the base year for St. Petersburg va-

Table 4. Total population and aggregate age structure for prospective scenarios, Moscow and St. Petersburg, 2045.

Indicator / Scenario	Total population (millions)	Aggregated age structure (%)		
		children (0-14 years)	*working-age population (15-59 years)*	*elderly (60+)*
		Moscow		
1. CCC	14.06	12.7	56.9	30.4
2. CC0	10.15	11.0	51.9	37.1
3. LLL	8.19	8.4	56.9	34.7
4. LL0	7.80	8.1	56.1	35.8
5. HH^RH	14.42	12.6	55.9	31.5
6. HH^R0	10.47	10.8	50.8	38.4
7. HLC	12.39	13.6	60.5	25.9
8. HL0	8.70	12.0	55.9	32.1
9. LHC	12.82	9.0	57.7	33.3
10. LH0	9.19	7.5	51.5	41.0
		Saint Petersburg		
1. CCC	5.61	16.4	57.1	26.5
2. CC0	4.39	12.4	55.1	32.5
3. LLL	3.45	8.1	59.1	32.8
4. LL0	3.29	7.5	58.4	34.1
5. HH^RH	9.53	21.7	58.9	19.4
6. HH^R0	4.60	12.0	53.5	34.5
7. HLC	5.05	17.1	59.6	23.3
8. HL0	3.87	13.0	58.0	29.0
9. LHC	4.75	9.9	58.6	31.5
10. LH0	3.77	7.0	54.9	38.1

Sources: authors' calculations based on Rosstat data.

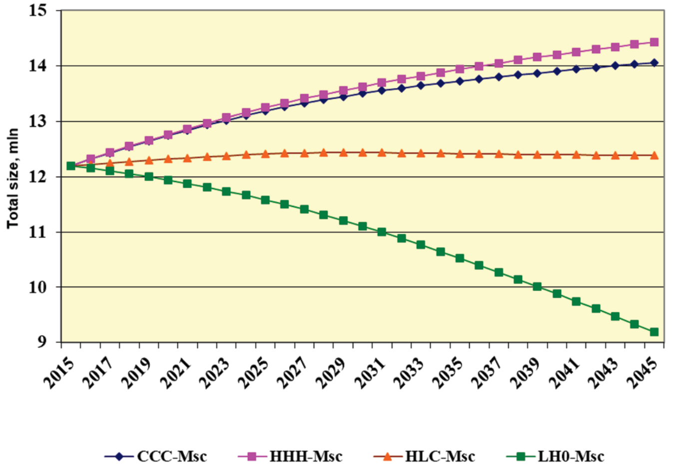


Figure 19. Total population of Moscow for scenarios LH0, HH^{R}H, SSS and HLC, 2015—2045, million persons.

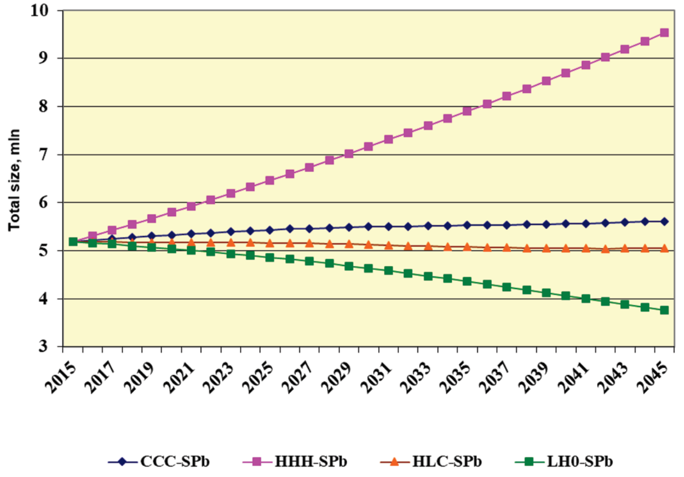


Figure 20. Total population of St. Petersburg for scenarios LH0, HH^{R}H, SSS and HLC, 2015—2045, million persons.

ries from 7 to 75%, for Moscow — from 20 to 90%. For Moscow and St. Petersburg, the HLC and LH0 scenarios lead to the lowest and highest values of this indicator respectively. Thus, under the assumptions made about possible changes in the main demographic indicators in the long term, the spectrum of proportion 60+ change for St. Petersburg is somewhat wider than for Moscow.

Maintaining the values of the main demographic indicators at the level of the base year (the SSS scenario) leads to an increase in the total population of Moscow by 15% relative to 1990, and St. Petersburg by 8%. This scenario leads to proportion 60+ growth for both capitals.

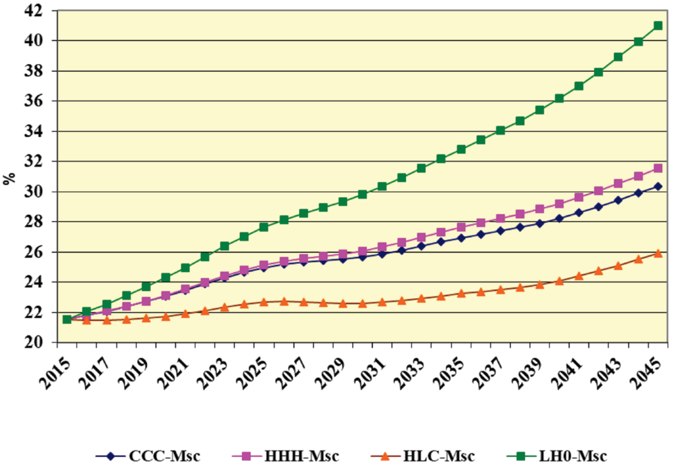


Figure 21. Proportion 60+ for Moscow for LH0, HH^{R}H, CCC and HLC scenarios, 2015-2045, %.

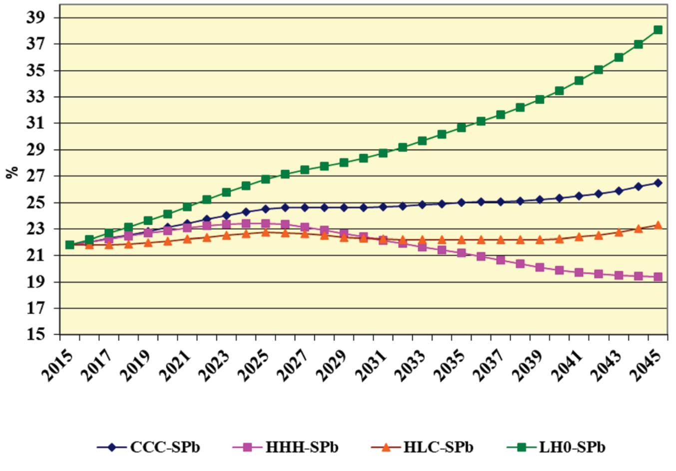


Figure 22. Proportion 60+ for St. Petersburg for LH0, HH^{R}H, CCC and HLC scenarios, 2015-2045, %.

The results of the calculations show the important role of migration in reproduction of the population of the two largest megacities of Russia. Without exception, zero-migration scenarios lead to a reduction in the total population: for Moscow the decrease is from 14% (scenario HH^{R}0) to 36% (scenario LL0), for St. Petersburg — from 11% (scenario HH^{R}0) to 37% (scenario LL0) relative to the base year. In addition, for all zero-migration scenarios, proportion 60+ values are higher than those scenarios with positive migration balance for both Moscow and St. Petersburg (Table 4).

The results of the prospective calculations calls for more detailed analysis of the impact of migration in the context of population ageing.

Conclusion

This research on Moscow and St. Petersburg, demonstrates significant influence of the initial age structure on population reproduction in the long term.

Since the First Census of the Population of the Russian Empire in 1897 the age structure of the Russian capital cities is strikingly "aged": in 1897 the proportion 60+ for Moscow and St. Petersburg was 5%, by 2015 this figure was 21.5% for Moscow and 21.8% for St. Petersburg. If the values of indicators of the main demographic processes are at the level of 2015, by 2045 the proportion 60+ could reach 30.4% for Moscow and 26.5% for St. Petersburg.

The results of long-term prospective calculations of population size and age structure show that almost all scenarios bring to an increase in proportion of elderly people (60+). In addition, the need for an in-depth study of the impact of migration in the context of population ageing has been identified.

For all censuses, including that of 2015, the proximity of age structures in Moscow and St. Petersburg exceed 95%. By definition, the proximity value s is between 0 and 1 (or from 0 to 100, if moving to percentages). Thus, $s > 95\%$ means a great similarity of the structures considered. It should be noted that the value of the indicator s for the age structures of 1990 and 2015 for both Moscow and St. Petersburg has smaller values.

In the future, we plan to analyze age structures of a wider range of regions of Russia. Here we would like just to outline a comparison of the age structures of Moscow and St. Petersburg with any region of Russia, which has similar LE but significantly different TFR, for example, the Republic of Dagestan (Naselenie Respubliki Dagestan, no year). In 2015, in the aggregate age structure of the Republic of Dagestan there were about a quarter of children (24.8%) and only 9.7% of the elderly (while these numbers amounted to 13.3 and 21.5% for Moscow and 13.1 and 21.8% for St. Petersburg). Therefore, there is no doubt that the similarity of the age structures of Moscow and St. Petersburg with that of Dagestan will be much smaller than that of the age structures of the megacities between themselves.

Age structures are the ground for calculating population ageing indicators. It suggests (even without making calculations) that the similarity in age structures is to result in proximity of population ageing characteristics.

In the Russian Federation, social and demographic policy aimed at creating conditions for active longevity is based on the Strategy of Actions in the Interests of the Older Generation until 2025 approved in 2016 by order of the Government of the Russian Federation №164-r. This document is aimed at creating conditions for active longevity, i.e. preservation of health, physical activity, development of cultural interests, and provision of conditions for participation in social life. In 2018, the Ministry of Labour and Social Protection of the Russian Federation, together with the Ministry of Health of the Russian Federation and other federal executive bodies, have elaborated the National Project entitled "Demography", consisting of five federal projects, including the "Senior Generation" (National Project... 2018). Regions of Russia differ not only by demographic indicators, but also by economic, social, cultural, religious and other realities, which requires the regional specificities to be introduced in development of nationwide projects. As to Moscow and St. Petersburg, the above-mentioned proximity of age structures suggests that socio-demographic policies in the field of population ageing, which have had positive results in one of the capitals, can be effective in the other.

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