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Topic
Regional and urban issues

POPULATION STABILISATION: MIGRATION VS FERTILITY (THE CASE OF RUSSIA)

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Introduction

Complicated demographic situation in Russia is characterized by negative RNI which is not compensated by positive net migration. Thus, the total population size has decreased during more than a decade resulting in numerous socio-economical problems. To resist negative demographic trends effective social policies are required. The latter should base on the clear understanding of effects of population reproduction components on population size and age structure dynamics.

Demographic processes have a great inertia, and among them migration is recognized to be the most suitable for regulation. Migration increase sometimes is considered as a solution for depopulation problem and a question concerning replacement migration is raised (UN, 2000) [6].

In many empirical studies replacement migrations streams are searched by making numerous projections based on different scenarios (see for example [5, 6]). In the paper an another approach is taken [2].

Within the framework of extended Leslie matrix model computer-based technique of modeling replacement migration is suggested. The paper aims at applying this technique to study possibilities of population non-decrease in the long-term perspective for low fertility countries (the case of Russia).

Long-term dynamics of Russia's female population is considered under different types of migration age distributions. Initial migration age profile has been found to affect significantly migration stream and thus the limit population size and structure. Under current fertility, for long-term stable dynamics implausibly big migration streams are required. Thus, we combine quite plausible TFR increase with corresponding migration which provide population stabilization. For each considered variant of the TFR and migration the corresponding limit population is computed. Effects of fertility profile on the limit population size and distribution are analyzed.

For computations Mathcad 2001 Professional has been used. Vital statistics given by Goskomstat of the Russian Federation, Centre D'Estudis Demographics UAB, Eurostat is used.

The model

It is assumed that the reproduction regime remains constant over time, and that 5-year age groups are considered.

Let $\boldsymbol{n}(t)$ represents female population at time t. Population dynamics is described by the equation $\boldsymbol{n}(t+1) = \boldsymbol{L}\,\boldsymbol{n}(t)$ (here $\boldsymbol{L}$ – the Leslie matrix). This model describes the reproduction of a closed population.

A model with migration may be formulated as follows. Let $\boldsymbol{R} = \mathrm{diag}(\boldsymbol{r})$ be a diagonal matrix, where $\boldsymbol{r}$ is a vector of age-specific net migration rates. Then the reproduction

of open population may be described by the equation $\boldsymbol{n}\ (t+1) = \boldsymbol{Ln}(t) + \boldsymbol{Rn}(t) \equiv \boldsymbol{L_m}\ \boldsymbol{n}(t)$.
Methods of computation Leslie matrix elements from given fertility and mortality rates and properties of Leslie matrices are well studied [1, 3, 4].

We start with modeling replacement migration. For Russia population increase seems neither plausible nor desirable, thus it presents interest to find such **r** which under a fixed reproduction regime ensures in the long run population size stability ($\mu_0 = 1$). This means finding **r** from the characteristic equation for $\boldsymbol{L_m}$ where μ_0 is assumed to be 1. Here μ_0 is the eigenvalue of $\boldsymbol{L_m}$ having the maximal real part.

To avoid non-uniqueness it is supposed that components of ***r*** should satisfy some additional reasonable equations and/or inequalities. First of all, as it follows from observed data $\boldsymbol{r}<\mathbf{1}$. Here the following types of age distributions of migration are considered:

- "uniform" migration ($\boldsymbol{r} = 1-\lambda_0$, where λ_0 is the maximal eigenvalue of $\boldsymbol{L}$) - **uni**;
- "observed" distribution (***r*** reflects a real (observed) migration age structure - **obs**;
- "youth" migration (for ages under 40 components of **r** coincide with the previous case, for older ages they are almost zero).

The described technique allows assessment of migration streams that could ensure stable population dynamics. For each considered variant of migration the corresponding limit population is computed.

Preliminary computations showed that under very low fertility only huge migration streams can ensure population stabilization, on the one hand [2]. It is trivial that the TFR at the replacement level (or higher) could ensure population non-decrease. But such fertility increase in the future does not seem plausible, on the other hand. Besides, measures encouraging childbearing are being introduced. Thus such combinations of the TFR increase and migration size is sought that could provide an asymptotic stationary state.

Application to Russia's population stabilization

Female population of Russia in the year 2001 is taken as the initial population.

Examination of numerous real migration streams showed a great diversity of migration age profiles (e.g. some components may be negative, drastic changes in sizes of adjacent age groups may take place etc).

Preliminary considerations showed that age profile of migration affects much the size and age structure of migration and thus it affects the limit population size and structure [2]. Distributions with higher proportions of children and reproductive age groups lead to smaller sizes of migration. "Youth" migration gives minimal values of migration size and the limit population size.

In addition to the migration profile of Russia 2001 that of Spain 2000 is used as it seems “favorable” from the point of view of reproduction (there is a high proportion of children and age groups in reproductive ages and a very low proportion of the elderly). Fig. 1 shows migration age profiles for Russia 2001 and Spain 2000. Effects of value and age profile of the TFR on the limit population size and structure is studied as well.

In developed countries TFR varies in a rather vide range and may have various age profiles. Fig.2 demonstrates age-specific fertility rates for Russia and selected European countries representing different European regions (France, Greece, The Netherlands, Spain, Sweden, Bulgaria, Poland). Fig. 2 shows that East European countries have higher fertility rates in young age groups <20 and 20-24 than the rest of Europe. Bulgaria has highest values in the younger age groups, and Spain, to the contrary, has the maximal rate in the age group 30-34.

At first, the TFR for Russia 2001equal to 1.243 is considered with different age distributions corresponding to the mentioned countries, and corresponding migrations and limit populations are computed (for both migration profiles – Russia 2001 and Spain 2000). Then similar computations are made with real TFRs for the selected countries and their age profiles.

Some population forecasts suggest that as a result of effective population policies the TFR in Russia may increase till 1.6 – 1.8. So, for the TFR=1.6 and TFR=1.8 (with different age profiles) replacement migration streams, limit population size and structures are computed. Annual migration sizes for different migration profiles (Russia 2001 and Spain 2000) and for different values and age profiles of TFR are given in Table 1. For each variant from Table 1 corresponding limit population size and structures are computed.

Fig. 3, 4 show a number of variants of population stabilization. Limit age structures and more variants of stabilization will be given in the final version.

Conclusions

“Youth” distribution of migration is more favourable as it results in smaller migration streams and limit population sizes as compared with types **uni** and **obs**.

The lower is the TFR (and thus λ_0) the more migration and the limit population sizes are sensitive to fertility profile.

Computational experiments could be helpful in assessing migration streams and effects of migration distribution on the size and structure of limit populations. Thus, results of the study may be used when defining more exactly directions of social policies.

Table 1.

AVERAGE ANNUAL NET MIGRATION FOR THE FIRST STEP FOR DIFFERENT AGE PROFILES OF MIGRATION AND DIFFERENT VALUES AND AGE DISTRIBUTIONS OF TFR (thousand)

		λ_0	Age profile of migration – Russia 2001			Age profile of migration – Spain 2000	
TFR	**TFR - age profile**		**uni**	**obs**	**you**	**obs**	**you**
1.243	**RUSSIA 2001**	0.905	1458.0	1720.0	860.3	992.2	789.8
	FRANCE 2001	0.915	1310.0	1514.4	751.9	863.6	684.9
	NETHERLANDS-2001	0.917	1277.0	1467.4	725.7	835.1	661.3
	SPAIN 2000	0.918	1262.0	1440.3	712.4	823.7	652.3
	SWEDEN 2001	0.916	1287.0	1480.7	734.0	844.8	669.6
	BULGARIA 2000	0.902	1505.0	1780.2	892.5	1032.8	823.2
	POLAND 2001	0.910	1382.0	1615.5	805.8	925.9	736.0
1.6	**RUSSIA 2001**	0.950	768.5	972.0	459.7	526.6	443.4
	FRANCE 2001	0.955	694.4	866.7	404.2	450.5	378.6
	NETHERLANDS-2001	0.956	677.4	841.8	390.4	460.0	353.6
	SPAIN 2000	0.956	670.6	828.3	383.8	454.5	349.2
	SWEDEN 2001	0.956	683.0	849.2	394.9	465.2	358.0
	BULGARIA 2000	0.948	793.4	1003.9	476.7	563.7	438.4
	POLAND 2001	0.952	731.1	919.3	432.2	507.6	392.7
1.8	**RUSSIA 2001**	0.971	446.2	617.6	270.0	328.8	245.9
	FRANCE 2001	0.973	407.5	560.8	240.2	292.8	216.3
	NETHERLANDS-2001	0.974	398.9	547.4	232.8	284.4	209.6
	SPAIN 2000	0.974	395.6	540.3	229.3	281.7	207.4
	SWEDEN 2001	0.974	401.8	551.5	235.3	287.3	212.1
	BULGARIA 2000	0.970	458.7	634.0	278.8	340.5	255.4
	POLAND 2001	0.972	426.4	589.1	255.2	310.2	230.7
Real (observed)							
1.243	**RUSSIA 2001**	0.905	1458.0	1720.0	860.3	992.2	789.8
1.889	**FRANCE 2001**	0.981	285.3	429.9	170.0	214.6	152.3
1.709	**NETHERLANDS-2001**	0.966	525.8	681.7	304.7	364.4	275.2
1.239	**SPAIN 2000**	0.917	1271.0	1449.7	717.4	829.4	657.0
1.567	**SWEDEN 2001**	0.952	740.9	910.3	427.7	501.8	388.0
1.301	**BULGARIA 2000**	0.910	1381.0	1646.5	820.8	951.9	756.8
1.288	**POLAND 2001**	0.916	1294.0	1521.9	755.5	869.5	689.6

Fig.1. Age distributions of migration, Russia 2001and Spain 2000

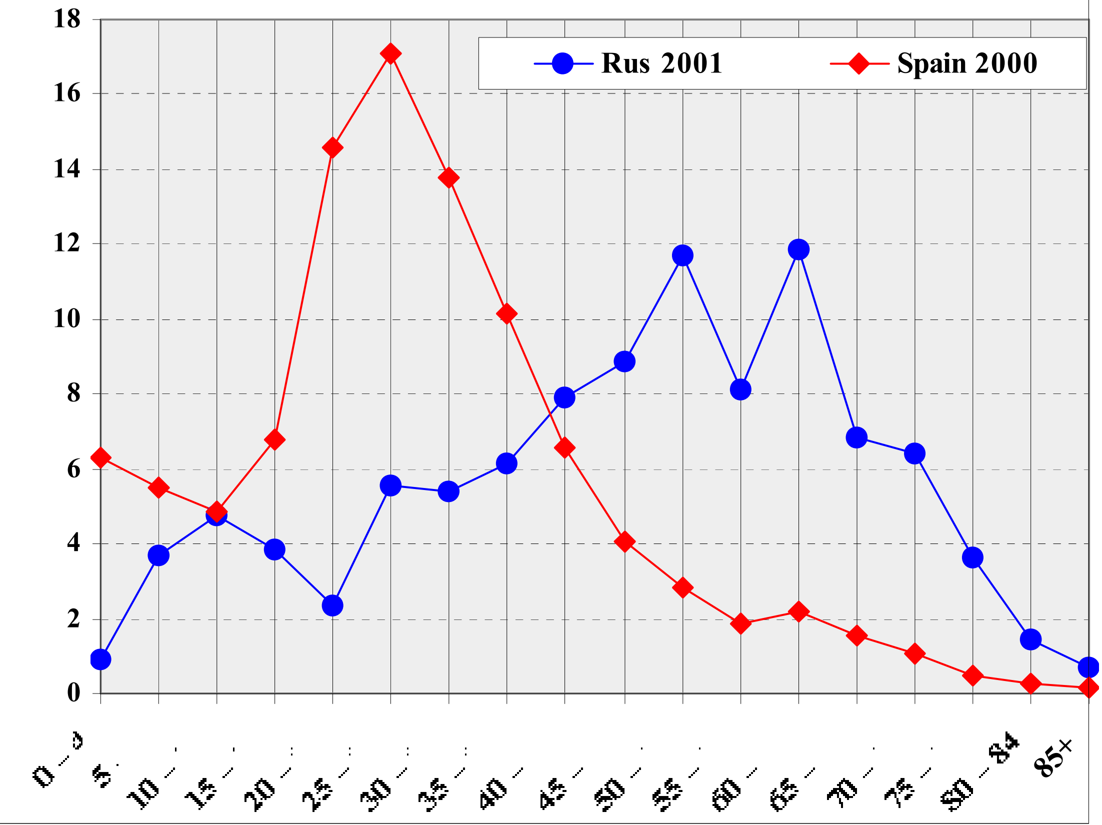


Fig 2. Age distribution of the TFR for selected European countries (%)

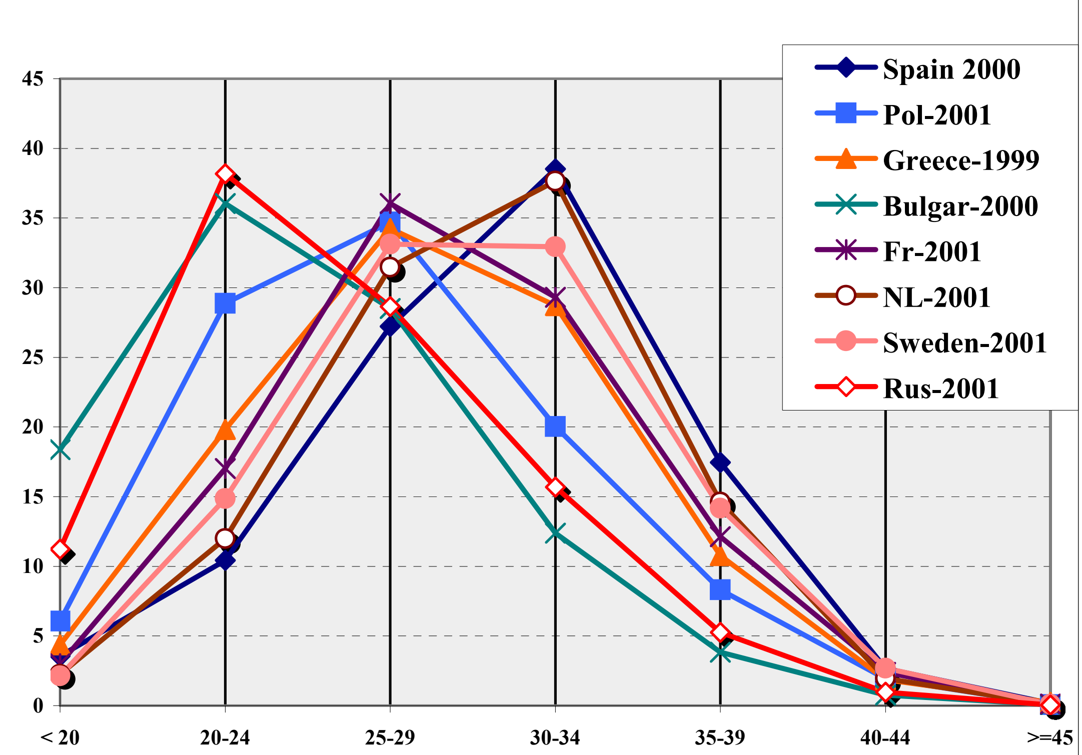


Fig.3. Dynamics of the population size for selected scenarios: age profile of migration - Russia 2001, TFR - oobserved values and profiles for selected countries (relative to the initial year 2001)

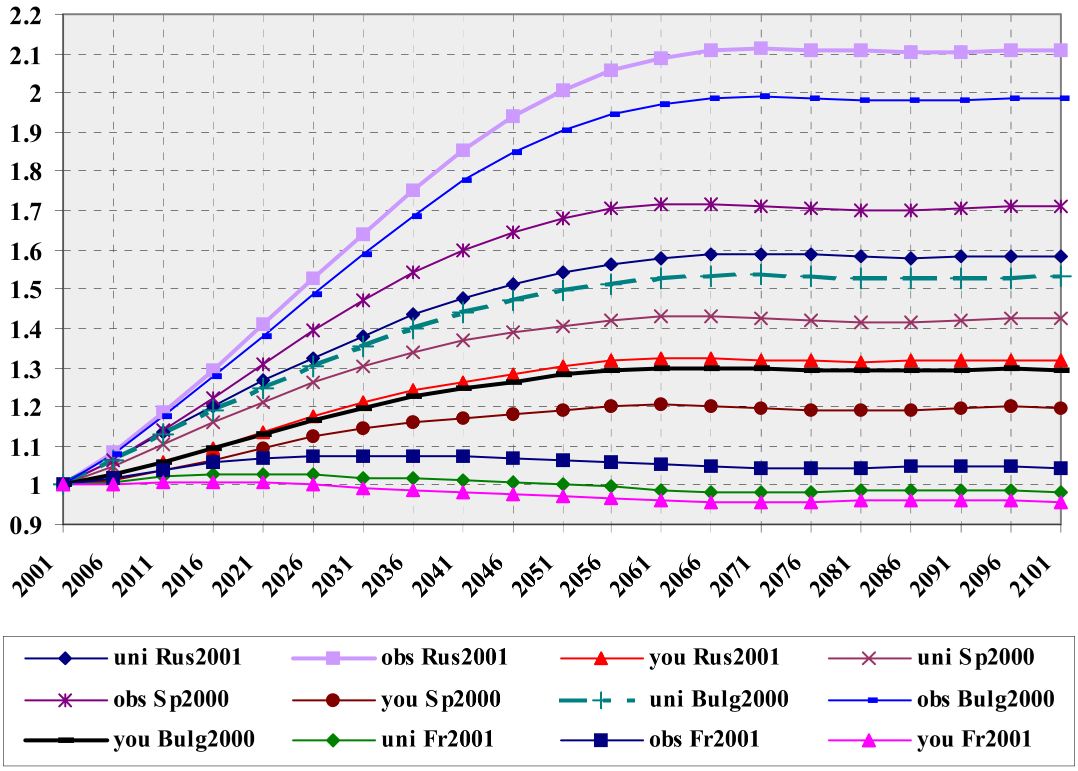
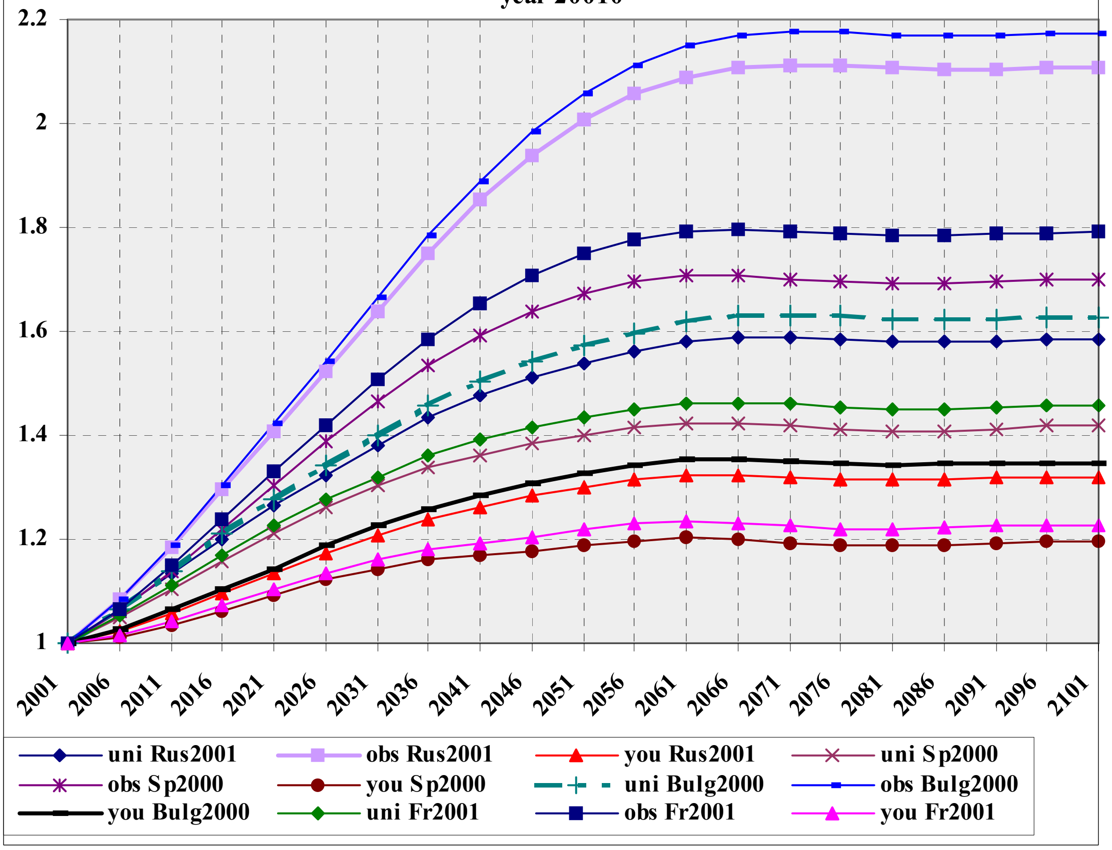


Fig.4. Dynamics of the population size for selected scenarios: age profile of migration - Russia 2001; TFR=1.243 (Russia 2001), age distributions of the TFR correspond to Russia, France, Spain and Bulgaria (relative to the initial year 20010



References

1. Hansen P.E. Leslie Matrix Models / Mathematical Population Studies – Vol. 2 (1), 1989, - pp.37-67.
2. Il'in E., Kosolapenko N., Safarova G. Otsenka zameschayuschei migratsii.//Ekonomiko-matematicheskie issledovaniya i informatsionnye tehnologii. IV. –St.-Petersburg: Nauka, 2005, v.1. – P.186-200
3. Keyfitz N. Introduction to the Mathematics of Population. – Reading, Mass.: Addison-Wesley, 1968.
4. Leslie P. *H.* On the use of matrices in certain population mathematics // Biometrica. – 1945. – vol.33. – P. 183-212
5. Pirozhkov S., Safarova G. Migration impact on population size and structure for countries in transition (the case of Russia and Ukraine) / Book of Abstracts of the 1999 European Population Conference.- The Hague, The Netherlands, 1999.- p.246-247.
6. Replacement Migration. Is it a Solution to Declining and Ageing Populations? – UN, 2000.