CONTRIBUTION OF POPULATION PROCESSES TO POPULATION AGEING: A COMPARISON OF THE CZECH AND SLOVAK REPUBLICS

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Abstract
The population ageing processes become a topical issue in contemporary stage of the population development. In terms of demographic research, the problem of socio-economic implications of this process seems to be as important as the theoretical background of its formation. The main goal of this article is to point out population ageing development trends and the mechanism of the main demographic processes effect. From the variety of methods and techniques, we have chosen those which permit identification of the contribution, accession of fertility, mortality, in-migration and out-migration on age structure changes. These processes represent inputs and outputs of the population and this way influence its age structure (ageing or rejuvenation). We attempted to identify the ageing processes in the Czech Republic and in the Slovak Republic in the last 30 years.

Key words: population ageing, age structure, comparative projections, population processes, Czech Republic, Slovak Republic.

INTRODUCTION

Social development makes population ageing an increasingly more frequent talking point among the general public and professionals alike. Characteristic features of the second demographic transition include a decrease in total fertility rate, changes of family behaviour and improved mortality patterns. Population ageing, as one of the consequences, has thus become the most distinct trait of population development in the late 20th and early 21st centuries, particularly in more developed countries.

On a global scale, ageing is a phenomenon of profound effect on reproduction of population, generally associated with the quality of life or with certain environmental issues. While the population ageing process itself is not a subject of concern and may be, in a way, viewed as an "achievement of the life modernisation", it does translate into a number of problems related to family life and to the social or economic aspects of society. Even though the process is irreversible with regard to individuals or specific populations, it can be altered in a limited degree and in a shorter time span. The extent of such changeability is becoming an important aspect in research in population ageing with respect to the society.

The article examines the population ageing processes, especially from the demographic point of view, and is aimed to highlight the ageing development trends as well as the mechanism of action of the main population processes – fertility, mortality and migration. Selected methods were used to identify such mechanisms determining the population ageing in the Czech Republic (CR) and Slovak Republic (SR).

SIGNIFICANCE OF POPULATION PROCESSES IN POPULATION AGEING – OVERVIEW OF STUDIES

It is widely agreed that birth rate, mortality and migration are processes of major significance in the population age structure formation. However, the effects of these processes are time-specific and space-specific. Such a clear-cut assumption is supported, among other authors, by Pavlík et al. (1986), Mašková (1991), Dittgen (1989), Weeks (1996), Rabušic (1995), and Tomeš (2005).

As observed by Sorokin (1989), the relative significance of fertility and mortality for the age structure development varies according to demographic situation and is subject to major changes in demographic transition. In the demographic transition theory it is the mutual relation between natality and mortality processes that has a key role in the growth of population or its decrease. Koschin (2007), on the other hand, highlights the role of migration in demographic reproduction and builds on the findings of van de Kaa (1999) who points out that, as a rule, migration is reflected in the long-term demographic development or the development of natural population changes, and has a balancing role – the net migration is negative where natality exceeds mortality, and positive in the opposite case.

Van de Kaa (1987) identifies population ageing as a feature of the second demographic transition, and also draws attention to depopulation that is closely linked to demographic changes characterised by the second demographic transition model. The issue of depopulation has been examined by Bucher and Mai (2005) who regard it as a consequence of population ageing. Two types of depopulation are identified by the two authors: whereas the "old" type results mainly from emigration, the "new" pattern is determined by natural shrinkage of population.

The above studies have confirmed the mutual links among the birth rate, mortality and migration in the demographic development of every existing population, although their impact on population ageing process in individual development stages may vary.

Impact of fertility

"Fertility (the births in a population) is, together with mortality, the most crucial process of demographic reproduction" (Kalibová et al. 1998). At the same time, fertility may be considered a decisive population process involved in the age structure formation. To put it plainly, the decreasing annual number of births results in the bottom-up ageing and, simultaneously, in relative the top-down ageing (with the percentage of elderly population growing). High number of births, on the other hand, is a sign of population rejuvenation.

The decisive influence of fertility on population ageing has been presented by a number of authors. Mašková (1991) sees the downward natality trend, resulting particularly from lower fertility, as a dominant factor of ageing of populations in the Czech and Slovak Republics (as well as in most advanced countries) in the post-war period (1950–1985). Bartoňová (2001) presents an identical opinion on the Czech population ageing in the 1990s, emphasising the ageing from the population pyramid base in the same period.

Similar results are presented by Pastor (2000) in his study of linear correlation between the crude birth rate and the age structure indicator in the period 1990–1996 at the level of districts in Slovakia. The age structure is characterised by the percentage of post-productive population. The entire subject period attests to negative correlations between the live birth rate and the percentage of population in the post-productive age. In every single year of the subject period the correlation coefficient varies from -0.5 to -0.7, which indicates a substantial correlation with a significance level of $\alpha = 0.05$.

Using France as an example, Dittgen (1989) demonstrates the influence of birth rate on the age structure, identifying the birth rate changes as the main indicator of the ageing process and attributing the difference in ageing between the north (young) and the south (old) to the regional variability of fertility.

Jackson (2001) presents the change of total fertility rate[1] and the completed fertility rate[2] on the example of Australia. As she points out, the higher age of mothers at childbirth results in decreasing tendency of total birth rate whereas the younger age of mothers makes the total birth rate grow. She also observes that population ageing slows down with the earlier timing of births due to the shorter time span between the generation cycles, which contributes to formation of a younger age structure.

Impact of mortality

Like in the case of birth rate, mortality too can influence the age structure in two ways: by population rejuvenation or by its ageing. While a decrease in juvenile mortality (infant, neonatal and child mortality) results in rejuvenation of population, a decrease in older-age mortality causes ageing of population.

These general observations are proved by Rabušic (1995) through comparison of specific mortality rate curves. "At the beginning of demographic ageing the mortality rate influences the age structure much less than fertility, and, in addition, in an opposite way" (Coale 1964, in Rabušic 1995). This is explained by the fact that "a decrease in mortality rate is first evident in infant or juvenile ages rather than in older age groups" (Rabušic 1995). The author also adds that in the countries where demographic transition began back in the 19th century, the effect of mortality patterns increases as it influences the top of the age pyramid. As the younger-age mortality is almost zero, any decrease in mortality rate must occur in older age groups which would, in turn, contribute to population ageing.

Mašková (1991) examined also the mortality influence on the age structure of the Czech and Slovak populations in the post-war period. As her findings show, the mortality influence was lower and in general it slightly rejuvenated the age structure (especially in Slovakia) as an intensive drop in mortality was most prominent in younger age groups.

Because mortality rate is, in its essence, more stable, its development is viewed by Bartoňová (2001) as less dramatic, too. She adds that the low mortality rate (mainly in younger groups) appeared to have just a subtle influence on the changes of age structure in European populations. According to the author, however, the continuing population ageing will make the mortality rate issue more prominent.

"The impact of mortality decline is more variable than that of fertility, and depends on whether the decline in mortality operates mainly at younger or at older ages. The first stages of mortality decline have usually particularly benefited infants and children, making population younger. However, changes in mortality may assume a greater importance for population ageing later in the demographic transition. In countries where mortality rates at young ages are already low, further declines have tended to affect mainly the adult and older ages, and have contributed to population ageing" (Mirkin and Weinberger 2000:3).

Chovancová (1999) analysed the nature and intensity of ties between the age structure and mortality in the districts of Slovakia in 1996. Using correlation and regression analysis method she detected a significant direct linear relation between the crude death rate and the share of the 50+ age groups, with the correlation coefficient value of $r = 0.831$. On the other hand, she also points to a significant (though indirect) relation between the mortality and the share of the child population, where the correlation coefficient was $r = -0.525$.

The best death rate assessment indicator is life expectancy at birth[3] as a synthetic indicator resulting from the use of particular age-specific

[1] *Total fertility rate* – the average number of live-born children per woman over her reproductive period with the unchanged fertility rate throughout the subject year and with a zero-level mortality.

[2] *Completed fertility rate* – the average number of live-born children per woman for a given cohort of women by the end of their reproductive years, with a zero-level mortality of the women throughout the reproduction period.

[3] An indicator identifying the average age of death in a hypothetical group of children born in the same year and exposed to the mortality pattern in a particular year.

mortality rates. This indicator was adopted by Kinsella and Velkoff (2001) in an analysis of mortality rate development in various countries of the world (between 1900 and 1990): "In developed countries the life expectancy at birth grew, in average, by 66% in males and by 71% in females."

It could be plainly said that a favourable development of death rate or the specific rates of mortality at middle or older ages has an influence on the increase of elderly population. Fialová (1998) reports that besides rapid innovations in treatment of cardiovascular diseases and certain types of tumors the current improvement of mortality patterns is mainly associated with a change in lifestyle of a continuously growing number of people. According to the author, a constant growth in the number of people reaching higher age may thus be expected.

Impact of migration

Migration is identified as a third factor influencing the age structure. "In general, migration reflects the territorial differences in social and economic conditions of people's lives" (Pavlík, Kučera et al. 1999). Migration does not necessarily influence the age structure and it does not inevitably cause the population ageing either. What matters is the age of migrants, with people in productive age migrating most often. In out-migration the declining proportion of this age group thus results in ageing of the population, while in in-migration the growing share of the productive age group leads to rejuvenation of the population.

Jackson (2001) emphasises that the emerging reality of the decline in natural increase of population will accentuate the compensatory function of migration. In near future the compensatory migration will be subject to three demands:

- preservation of the overall size of population,
- preservation of the size of population in active working age,
- preservation of the proportion of people in active working age and old people.

With regard to the impact of fertility and migration on the population of Australia, Young (1990) assumes that "maintaining fertility near a level that would allow replacement of generations is a more efficient way of slowing the population ageing than raising the migration level". The same conclusion was made by McDonald and Kippen (1999) in an analysis of Australian population with "measurement" of efficiency of reduction of population groups aged 65 and over by migration gains and fertility impact. Australia had a relatively young age structure, which was due to two reasons. Firstly, there was a massive baby-boom in the 1950s and 1960s, and in-migration had helped to keep Australia younger in the past. Although population ageing reduction was one of the in-migration programme principles, the two authors observe that migration in 1945–2000 failed to keep Australia's population young. Instead, in 2000 the age structure was totally determined by oscillations in the annual number of births over the past 80 years. Decrease in mortality rate has a low impact.

Studying the consequences of low fertility, Grant et al. (2004) think that in-migration offers no acceptable solution to the population ageing problem. They believe that allowing entry of productive-age migrants by the EU Member States would present just a short-term deceleration of population ageing and a simplistic putting off of the problem.

An identical opinion on migration (or in-migration) as a way of addressing the issue of lower population increase was expressed by Rabušic (1995). He supports his view by finding in-migration problematic as concentration of in-migrants in a certain age group may, after time, set the age structure off its balance. Besides that, in-migrants may not necessarily have higher fertility than the domestic population; as research shows, in this respect in-migrants actually conform very fast to the low fertility standard. It should also be taken into account that in-migrants come from countries with different cultural or racial characteristics which may make them second-class citizens in economic, social or political terms.

According to Pavlík et al. (1986), external migration has a more pronounced impact on states only in certain historically specific periods. A good example may be the territory of the present-day Slovakia, where the massive scale of out-migration in the early 20th century resulted in disproportions in the productive elements of the population (Svetoň 1958).

Tziafetas and Tzougas (1989) similarly identify the out-migration flows from Greece to the Western Europe in the post-war period as the most crucial demographic component of the age structure changes.

Poulain (1989) tried to find interaction between the population ageing and internal migration. The author observes that where the differences in fertility and mortality between individual regions are not big, the variations in regional population ageing are caused by internal migration.

Impact of age structures

A factor of major influence on the actual manifestation of the three above-mentioned population processes shaping the age structure, or on the ageing processes, is the initial age structure itself. This is also confirmed by Weeks (1996) who maintains that "the current speed of population growth is determined by a combination of fertility, mortality and migration, while the intensity of changes in each of the processes is influenced by age structure."

The population's age structure and the processes of its formation can be regarded as rather complex demographic phenomena. Unlike the large group of phenomena and events that are only related to a certain part of population (marriage and divorce rate, fertility, education, etc.), the age structure formation and its changes affect the entire population. The population's age structure complexity is also reflected in the multi-causal relations with a number of population and social phenomena. The age structure mirrors the development of fundamental population processes such as fertility, mortality and migration mobility. On the other hand, the age structure of every population may significantly influence the development of many population phenomena and processes (in addition to those mentioned above it includes marriage, labour force potential, etc.).

As the presented information suggests, the initial age structure contains predispositions for a number of development characteristics of the population (destructive war and crisis stages, post-war compensation stages, pro-natality policy effects, etc.). These will be involved in shaping the future development and will also jointly determine the extent of influence of the basic demographic processes on the population ageing.

RESEARCH IN THE IMPACT OF DEMOGRAPHIC PROCESSES ON THE POPULATION AGEING

Population ageing has become an extensively discussed issue in recent years, as is also reflected by the broad range of methods and techniques used to assess its intensity or speed (Mládek 2006; Mládek and Káčerová 2008; Ondačková 2011; Káčerová and Mládek 2012). The methods examining the contribution of individual demographic processes to population ageing appear to be somewhat less numerous.

Over a long period of time, the present-day Czech Republic and Slovak Republic had co-existed in one state. Both territories have thus shared the influence of social events with the resulting emergence of very similar demographic behaviour patterns. Nevertheless, certain specific features may be observed in the two populations, especially in their fertility. As Slovakia had a higher birth rate, the Czech population ageing processes were faster. Even after splitting into two separate states, both countries have been experiencing a similar development and their populations are nowadays ageing rapidly. Our attention was therefore focused on examining the similarities and differences of the impact of individual demographic processes determining the population ageing in the Czech and Slovak Republics in 1980–2009 (in five-year periods), using the method applied by Preston et al. (1989), as well as the method of comparative projections.

Impact of fertility, mortality and migration

Influences of demographic processes on population ageing has been analysed by Preston et al. (1989) who, besides presenting theoretical and statistical reasoning, also studied these effects on the example of Japan, USA and the Netherlands. Population ageing was identified through the use of the mean age that strongly correlates with other age structure indicators and responses sensitively to changes in demographic processes. The method is based on the fact that every individual grows older by a year in one year's time. Therefore, if there were no births, deaths or migration, the mean age of the population would correspondingly grow by one year.

Analysed was the development of populations in the Czech Republic and Slovak Republic over 30 years. If ageing was defined in the same way (i.e. discounting the births, deaths and migration) the resulting theoretical model of both populations would display a mean age growth by 30 years. It is the modification of such a theoretical model that is significantly influenced by real demographic processes. With regard to this, the "rejuvenation" process may be interpreted as the decrease in the theoretical growth of the mean age of a population.

Fertility increases the population with an increment of zero-year-olds and thus always leads to a lower mean age. Its effect depends on the birth rate intensity and the population's mean age – the older the population, the bigger the difference between the mean age of the population and the newborns, and the more the population is made younger by fertility. Mortality, as one of the agents causing population decrease, may influence the population's mean age in two ways. Where the mean age at death does not exceed the mean age of the population, mortality operates as a factor increasing the mean age (population ageing). Where the mean age at death is higher than the mean age of the population, mortality-induced rejuvenation occurs. The impact of out-migration may be defined in a similar way while in-migration, causing increment in the subject population, has the inverse effect on the mean age. The tendencies can be expressed by the following equation:[4]

$$\frac{\mathrm{d}MA}{\mathrm{d}t} = 1 - CBR \times MA - CDR \times (MA_D - MA) - CIR \times (MA - MA_I) - COR \times (MA_O - MA) \quad [1]$$

where $\mathrm{d}MA/\mathrm{d}t$ is the change (derivate) of the mean age over a unit of time, MA is the mean age of population, MA_D is the mean age at death, MA_I is the mean age of in-migrants, MA_O is the mean age of out-migrants, CBR is the crude birth rate, CDR is the crude death rate, CIR is the crude in-migration rate, COR is the crude out-migration rate. The result of the equation is thus a predicted change of the mean age, which is then compared with the observed real change of the mean age.[5] Calculation of the effect of individual demographic processes followed, where the effect of birth rate on the mean age of the population is represented by the variable $CBR \times MA$, the mortality effect was expressed as $CDR \times (MA_D - MA)$ and the migration effect was $CIR \times (MA - MA_I) - COR \times (MA - MA_O)$.

The growth of the mean age of population was higher in Slovakia (by 6.0 years) than in the Czech Republic (5.2 years). The latter one, however, had had a three-year-older age structure of its population ever since 1980 (Table 1). While in the first decade both countries experienced a similar growth of the mean age, in Slovakia the rejuvenation resulted primarily from the fertility (63.9% in 1980–1984 and 60.6% in 1985–1989), and in the Czech Republic the difference between the effects of fertility and mortality was less distinct (52.2% and 50.8%). The reason lies in a higher crude birth rate in Slovakia as well as in the higher crude mortality rate in the Czech Republic (Figure 1, Figure 2), with an identical difference between the mean age at death and the mean age of the population. In the 1990s the Czech Republic's ageing was faster mainly due to an accelerated decrease in the birth rate; although

[4] For detailed grounds of the calculation see Preston et al. (1989).

[5] *Predicted change* – an estimated change of the mean age on the basis of a theoretical model. *Observed change* – a real change of the mean age on the basis of real statistical data.

Table 1 Demographic indicators development in the Czech and Slovak Republics in 1980–2009. Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980–2010), own calculation.

Indicators		**1980–1984**	**1985–1989**	**1990–1994**	**1995–1999**	**2000–2004**	**2005–2009**
Mean age at the beginning of period	CR	35.41	35.67	36.17	37.03	38.46	39.78
	SR	32.49	32.84	33.42	34.28	35.68	37.13
Mean age at the end of period	CR	35.67	36.17	37.03	38.46	39.78	40.64
	SR	32.84	33.42	34.28	35.68	37.13	38.49
Mean age at death	CR	69.95	70.67	70.85	71.69	72.33	73.06
	SR	66.91	68.02	68.63	69.74	70.50	71.29
Mean age of in-migrant	CR	23.89	24.01	32.53	33.76	31.40	30.95
	SR	26.09	25.37	28.02	34.56	35.62	34.44
Mean age of out-migrant	CR	27.01	26.51	28.56	31.57	33.72	33.99
	SR	23.73	23.91	26.83	31.90	30.00	31.65
Crude birth rates	CR	0.0139	0.0128	0.0118	0.0089	0.0091	0.0109
	SR	0.0184	0.0163	0.0140	0.0110	0.0098	0.0104
Crude death rates	CR	0.0129	0.0125	0.0118	0.0109	0.0106	0.0103
	SR	0.0101	0.0101	0.0100	0.0097	0.0097	0.0099
Crude in-migration rates	CR	0.0011	0.0010	0.0013	0.0011	0.0035	0.0068
	SR	0.0013	0.0012	0.0015	0.0004	0.0005	0.0013
Crude out-migration rates	CR	0.0009	0.0007	0.0007	0.0001	0.0024	0.0019
	SR	0.0021	0.0019	0.0015	0.0001	0.0002	0.0003

the country's crude mortality rate was falling, it was still higher than in Slovakia (Figure 3). In 1995–1999 mortality even made the age structure in the Czech Republic younger to a greater degree (by 1.9 years) than the birth rate did (by 1.6 years). Slovakia witnessed a decrease in the crude birth rate with a stable development of mortality; its age structure was consequently rejuvenated by the birth rate by 2.3 or 1.9 years and by mortality by 1.8 or 1.7 years (Table 2). In 2000–2004 the Czech Republic experienced a birth rate growth and the effects of fertility and mortality on its age structure were equalised again (by 1.7 years). In Slovakia the birth rate decline continued and, like in the Czech Republic, a balanced effect of fertility and mortality was observed (by 1.7 years). Perhaps the most distinct difference between the two populations may be found in the most recent period when the mean age in Slovakia grew by 1.4 years whereas in the Czech Republic it only increased by 0.9 years. In both countries the birth rate resumed an upward trend, which in the initially older Czech population led to a comparatively more pronounced rejuvenation. Besides that, in 2005–2009 the Czech population began to be more influenced also by migration (decreasing the mean age by 0.2 years), which until then had been reaching just insignificant values (Figure 4, Figure 5).

In general it may be said that in the 30-year period covered by research the migration influenced the Slovak population mostly as a process contributing to population ageing (0.095 years), while in the Czech Republic it had a slight rejuvenation effect on the age structure (0.4 years). In Slovakia the mortality generally made the population younger by 10.4 years, while in the Czech Republic it contributed to population rejuvenation by 11.8 years. In both

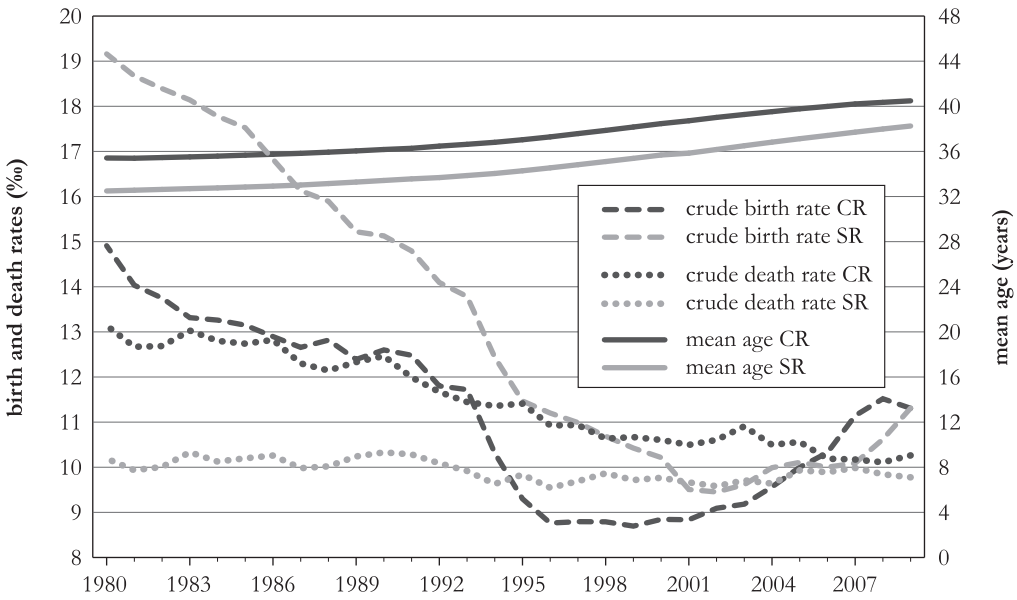

Figure 1 Development of fertility and mortality in the Czech and Slovak Republics in 1980–2009. Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980–2010), own calculation.

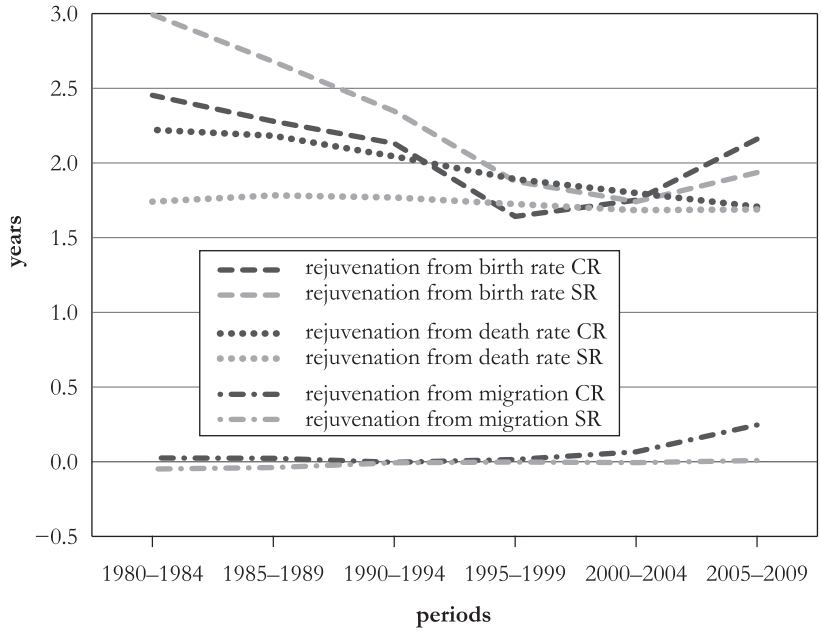

Figure 2 Contributions to population rejuvenation – 5-year periods between 1980 and 2009. Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980-2010), own calculation.

Table 2 Development of the population rejuvenation indicators in the Czech and Slovak Republics in 1980–2009.
Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980–2010), own calculation.

Indicators		1980–1984		1985–1989		1990–1994		1995–1999		2000–2004		2005–2009		1980–2009	
		years	share (%)	years	share (%)	years	share (%)	years	share (%)	years	share (%)	years	share (%)	∑ years	share (%)
Efect of fertility in years	CR	2.453	52.2	2.279	50.8	2.131	51.1	1.642	46.3	1.751	48.4	2.160	52.5	12.417	50.4
	SR	2.993	63.9	2.679	60.6	2.347	57.1	1.877	52.1	1.741	50.9	1.936	53.3	13.753	56.9
Effect of mortality in years	CR	2.222	47.3	2.182	48.7	2.044	49.0	1.892	53.3	1.799	49.8	1.707	41.5	11.845	48.1
	SR	1.741	37.2	1.783	40.3	1.769	43.1	1.725	47.9	1.684	49.3	1.689	46.5	10.391	43.5
Effect of migration in years	CR	0.025	0.5	0.023	0.5	−0.004	−0.1	0.015	0.4	0.066	1.8	0.246	6.0	0.371	1.5
	SR	−0.049	−1.1	−0.039	−0.9	−0.007	−0.2	−0.002	0.0	−0.006	−0.2	0.008	0.2	−0.095	−0.4
Total effect	CR	4.700	100.0	4.484	100.0	4.171	100.0	3.549	100.0	3.615	100.0	4.114	100.0	24.633	100.0
	SR	4.685	100.0	4.423	100.0	4.109	100.0	3.601	100.0	3.418	100.0	3.632	100.0	23.868	100.0
Projected change of mean age	CR	0.30		0.52		0.83		1.45		1.38		0.89			
	SR	0.31		0.58		0.89		1.40		1.58		1.37			
Observed change of mean age	CR	0.25		0.50		0.86		1.43		1.31		0.86			
	SR	0.35		0.58		0.86		1.40		1.44		1.37			
Difference between projected and observed value	CR	−0.05		−0.01		0.04		−0.02		−0.07		−0.02			
	SR	0.03		0.01		−0.03		0.00		−0.14		0.00			

Note: ∑ – sum of effects in years

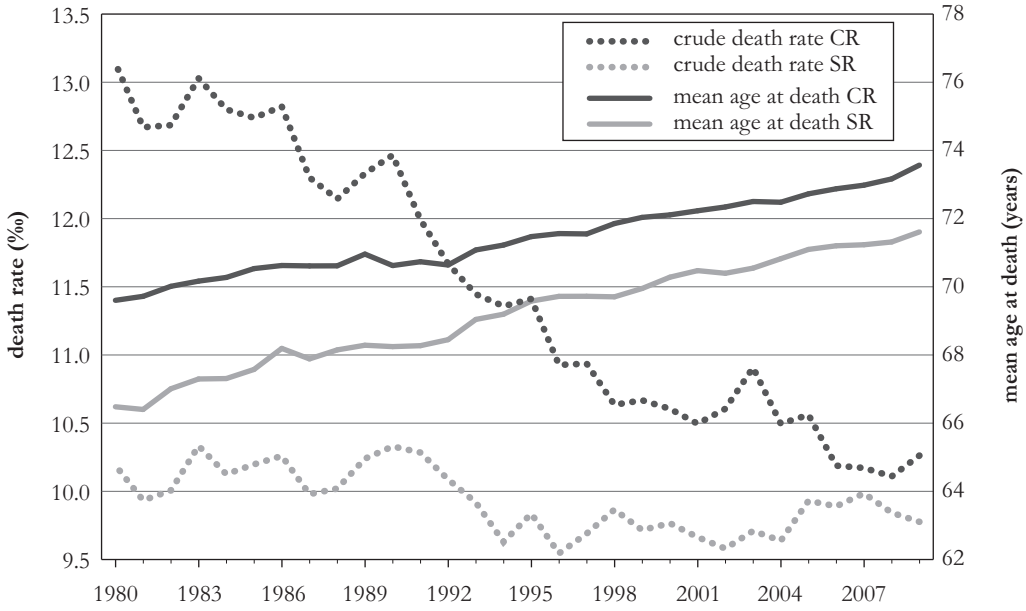

Figure 3 Development of mortality and mean age at death in the Czech and Slovak Republics in 1980–2009. Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980–2010), own calculation.

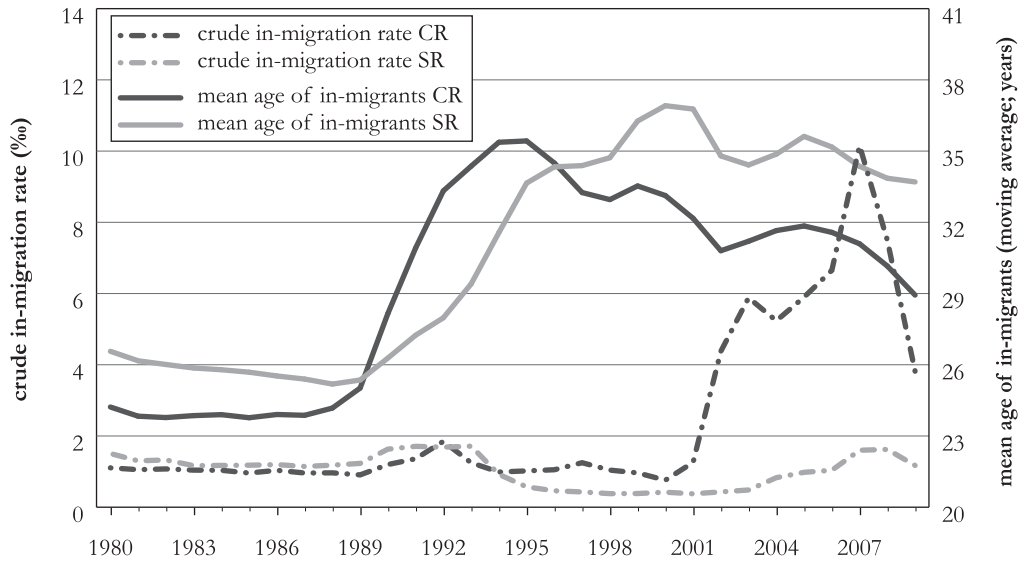

Figure 4 In-migration characteristics of the Czech and Slovak Republics in 1980–2009. Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980–2010), own calculation.

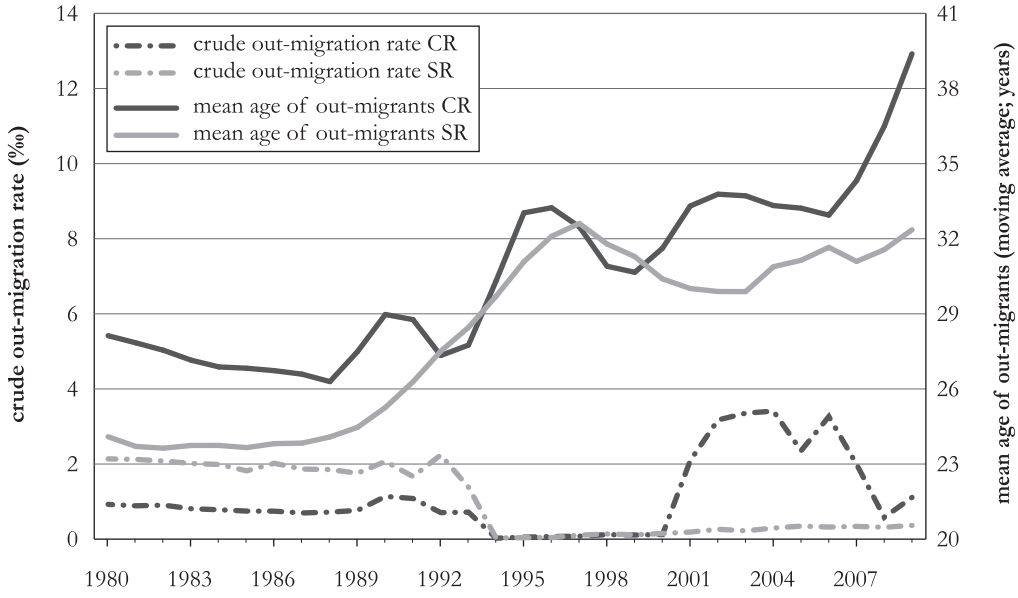

Figure 5 Out-migration characteristics of the Czech and Slovak Republics in 1980–2009. Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980–2010), own calculation.

countries it was the birth rate that had the most prominent rejuvenation effect. In Slovakia it was 13.6 years, which markedly exceeded the effect of mortality. In the Czech Republic the rejuvenation effect reached 12.4 years, which is not much above the mortality effect (Table 2).

Comparative (simulation) projections

The so-called comparative (simulation) projections provide a possibility to identify the effects of individual processes on population ageing. In the former Czechoslovakia this method was applied by Mašková (1991). Her projections were developed in a standard cohort-component model based on the shift of age groups, their shrinkage determined by the survival probability and the replenishment determined by the fertility rates and migration.[6] The method principle is based on four projections of the studied population:

1 – the projection in which the birth rate is constant on the level seen at the beginning of the subject period while mortality and migration evolve as real observed values;
2 – the projection in which mortality is constant on the level seen at the beginning of the subject period while birth rate and migration evolve as real observed values;
3 – the projection in which birth rate and mortality evolve as real observed values while migration is zero;
4 – the projection in which birth rate and mortality are constant on the level seen at the beginning of the subject period while migration is zero.

The fertility effect is calculated as the difference between the real observed values and Projection 1 values, the mortality effect as the difference between the real observed values and Projection 2 values, the migration effect as the difference between the real observed values and Projection 3 values, and the initial age structure effect as the difference between Projection 4 values and the initial age structure values.

[6] Methodology of calculation by the cohort-component method is referred to e.g. by Kučera (1998, in Burcin et al. 2008).

Table 3 Influence of selected factors on age structure changes in the Czech and Slovak Republics between 1980 and 2009. Source: Popin Czech Republic (1999–2002), Czech Statistical Office (2001–2010), Slovak Popin (1980–2010), own calculation.

Factors and effects	Change in age categories				Change in mean age	
	share of 0–14 years old		share of 65+ years old			
	pp	%	pp	%	years	%
Czech Republic						
Fertility	−5.7	62.45	1.5	90.54	2.6	49.55
Mortality	−0.4	4.36	2.7	169.41	1.4	26.51
Migration	0.0	0.33	−0.3	−17.55	−0.3	−4.92
Original age structure	−2.5	27.52	−1.8	−109.47	1.6	31.34
Data, model	−0.5	5.34	−0.5	−32.93	−0.1	−2.49
Total	−9.1	100.00	1.6	100.00	5.2	100.00
Slovak Republic						
Fertility	−8.3	76.82	1.6	91.65	3.5	58.29
Mortality	−0.1	1.25	1.0	59.25	0.5	7.93
Migration	0.0	0.33	0.2	12.88	0.1	1.18
Original age structure	−2.2	20.22	−0.7	−41.03	2.0	33.50
Data, model	−0.2	1.38	−0.4	−22.75	−0.1	−0.91
Total	−10.8	100.00	1.7	100.00	6.0	100.00

Note: pp – percentage points

Application of comparative projections facilitates the assessment of demographic processes' impact on population ageing not only through the mean age, but also allows to examine their influence on the bottom-up ageing (changes in the age group 0–14) and on the top-down ageing (changes in the age group 65 and over).

The dominant reason of ageing in both countries is the slump in the proportion of child population which in the past 30 years has decreased by 10.8 percentage points in Slovakia and by 9.1 percentage points in the Czech Republic (Table 3). Logically, the most distinct effect in this case was a decline in the birth rate, which explains the decrease of child population by as much as 77% in the Slovak Republic and by 62% in the Czech Republic. The second most significant reason in both countries was the initial age structure which made this age group fall by two more percentage points. It was mainly due to the fact that less numerous groups of people born in the 1960s reached their fertility age during the studied period. In the Czech Republic significance may also be attributed to the decrease caused by improvement of mortality patterns (by 0.4 percentage points) with reduction of infant as well as child mortality. The effect of migration on the child population was zero in both countries.

Comparison of changes in the old-age population presents a different picture. While in Slovakia the growth of the senior population was mainly due to the birth rate decrease, in the Czech Republic the main reason of top-down ageing was the lower mortality rate. That is also confirmed by the analysis of contribution of individual age categories to the life expectancy at birth when the age group of 65 and over contributed to the increase by more than two years. In both countries, the senior populations became lower due to the initial age structure when the less numerous age groups of people born during the First World War, the Great

Depression and the Second World War entered their senior age. Owing to the more prominent decrease in the birth rate during the 1930s in the Czech territory, the rejuvenation of the old population groups resulting from the age structure was more obvious in the Czech population (by 1.8 percentage points) than in the Slovak population (by 0.7 percentage points). A different situation unfolds from the migration impact assessment. While in Slovakia migration contributed to the top-down ageing (by 0.2 percentage points), in the Czech Republic it operated as a rejuvenating factor (by 0.3 percentage points).

Assessment by the mean age corresponds with the method applied by Preston et al. (1989). In both countries the birth rate reduction effect accounts for half of the growth (58.3% in Slovak Republic and 49.6% in the Czech Republic). Also, in both populations the initial age structure was the second most significant factor of population ageing (Table 3). However, in the Czech Republic an equally substantial role may be attributed to the mortality effect (a proportion of 26.5%). While the impact of migration was not significant, some differences may be observed again – in Slovak Republic migration operated as a factor of population ageing, whereas in the Czech Republic it contributed to population rejuvenation.

CONCLUSION

During the studied period of 30 years the age structures of populations in both countries experienced rather substantial changes with a dominant ageing trend. If the mean age of the population is considered as the decisive indicator of these changes, in the Czech Republic the mean age grew by five and in Slovak Republic by six years. Due to uneven intensity of ageing processes the difference between the two populations' mean ages shrank from 2.9 (1980) to 2.2 (2009) and the gap between the two age structures became narrower. Thus, the ageing of the Slovak population was faster.

Methods and techniques that allow identification of the contribution of individual demographic processes to the age structure changes were selected from the broad range of population ageing research instruments. These included, in particular, the fertility, mortality, in-migration and out-migration as the factors causing either increase or decrease of a population and consequently influencing its age structure (ageing or rejuvenation). The varied intensity of these processes had different contributions to the age structure changes.

The subject period showed a pronounced influence of fertility and mortality. While the contribution of the two factors to population ageing varied in the individual five-year intervals, the fertility impact was slightly more dominant. It was especially the case in the Slovak population which displayed a higher effect of the fertility (reaching its peak of 64% in 1980–1984). A less distinct contribution of fertility was observed in the Czech Republic where there was actually a period in which the effect of mortality prevailed (1995–1999, 53%). With regard to their extent, the migration effects were only minimal.

Characteristic feature of the age structures is their regional differentiation. Impact of evaluated processes on population ageing is in this special case as analysed and showed on national scale. But in the case of geographically differentiated units (districts or some others, e.g.) impact of the values might be quite different. The smaller the unit – the higher differentiation of impact not only of migration, but in some cases fertility and mortality as well, and in both directions, positive and negative. Impact of some other processes – changes in ethnic structure, shifts in social structures in connection with suburbanization movements etc. – may show, in smaller territorial units, increasing nature.

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Résumé

Příspěvek demografických procesů k stárnutí populace: komparace České republiky a Slovenské republiky

V současné fázi populačního vývoje, kdy určující je modernizace reprodukčního chování a zlepšení úmrtnosti podmínek, získaly procesy stárnutí obyvatelstva mimořádnou aktuálnost. Z hlediska demografického poznávání je možné za závažné problémy považovat socioekonomické důsledky tohoto procesu i teoretické pozadí jeho formování. Cílem tohoto příspěvku je poukázat na vývojové trendy populačního stárnutí a mechanismy působení hlavních demografických procesů. Z různých metod a technik jsme vybrali takové, které umožňují identifikaci příspěvků, vkladů jednotlivých demografických procesů na změny věkových struktur. Jsou to především vlivy porodnosti, úmrtnosti, imigrace a emigrace, které představují vstupy a výstupy z populace a tím ovlivňují její věkovou strukturu (stárnutí nebo mládnutí). Pokusili jsme se o identifikaci procesů stárnutí v České republice a Slovenské republice v období posledních 30 letech. Rozdílná intenzita těchto procesů

se odlišným způsobem podílí na změnách věkových struktur.

Vlivy demografických procesů na stárnutí analyzoval Preston et al. (1989), který, kromě prezentace teoretických a statistických úvah, studoval tyto efekty na příkladu Japonska, USA a Nizozemí. Stárnutí populace bylo identifikováno pomocí průměrného věku, který silně koreluje s ostatními ukazateli věkové struktury a citlivě reaguje na změny demografických procesů. Tato metoda je založena na tom, že každý obyvatel v průběhu jednoho roku individuálně stárne o jeden rok. Proto, pokud by v populaci nebyli narození, zemřelí nebo migrující, průměrný věk populace by vzrostl o jeden rok.

Analyzován byl populační vývoj České republiky a Slovenské republiky za období 30 let. Pokud stárnutí bylo definováno stejným způsobem (tj. bez narození, úmrtí a migrace), výsledný teoretický model obou populací by zaznamenal růst průměrného věku o 30 let. A právě na modifikaci tohoto teoretického modelu se podstatnou měrou podílejí reálné demografické procesy. S ohledem na tyto vlivy může být snižování teoretického růstu průměrného věku populace interpretováno jako její „omlazování".

Česká republika a Slovenská republika tvořily během dlouhého období jeden státní útvar, v důsledku čehož obě země ovlivňovaly stejné společenské události, které vedly k utváření podobných vzorců demografického chování jejich obyvatel. Přesto lze pozorovat i určitá specifika v obou populacích, a to zejména ve výši porodnosti. Na Slovensku byla vyšší, v důsledku čehož procesy stárnutí v České republice probíhaly rychleji. I po rozpadu společného státu je populační vývoj obou republik podobný a obě země v současnosti patří mezi rychle stárnoucí populace. Proto se naše pozornost zaměřila na zhodnocení podobností a odlišností vlivu jednotlivých demografických procesů determinujících populační stárnutí v České republice a Slovenské republice v období let 1980–2009 (v pětiletých časových obdobích). Využila se přitom jak metoda Preston et al. (1989), tak i metoda komparativních projekcí.

Během sledovaného období 30 let se věkové struktury populací obou zemí poměrně významně změnily, a to ve směru jejich stárnutí. Pokud za rozhodující indikátor změn považujeme reálný průměrný věk obyvatelstva, pak v České republice vzrostl o 5 let, na Slovensku o 6 let. Rozdíl v intenzitě procesů stárnutí dokazuje i zmenšení rozdílů v průměrném věku obou populací (z 2,92 v roce 1980 na 2,15 v roce 2009), což je důkazem konvergentního vývoje jejich věkových struktur. To také znamená, že stárnutí populace Slovenska bylo rychlejší.

V období pozorování obě populace vykazovaly velmi významný dopad porodnosti a úmrtnosti na jejich stárnutí. Příspěvek každého procesu na stárnutí populace v pěti analyzovaných obdobích byl odlišný, zpravidla mírně dominoval vliv porodnosti. To platí zejména pro slovenskou populaci, která má ve všech obdobích vyšší vliv porodnosti (maximální v letech 1980–1984, 64 %). Méně významný přínos porodnosti se projevuje v české populaci, a dokonce v jednom období byl výraznější vliv úmrtnosti (1995–1999, 53 %). Účinky migrace, pokud jde o jejich velikost, byly nepatrné.

Při aplikaci komparativních projekcí se nám naskýtá možnost vyhodnotit dopad demografických procesů na populační stárnutí nejen prostřednictvím průměrného věku, ale také jejich vliv na stárnutí zdola (změny ve věkové skupině 0–14 let) a na stárnutí shora (změny ve věkové skupině 65- a víceletých).

Dominantní příčinou stárnutí v obou republikách je pokles podílu dětské složky, která v posledních 30 letech zaznamenala pokles o 10,8 procentního bodu na Slovensku a o 9,1 procentního bodu v České republice. Největší efekt zaznamenal v tomto případě logicky pokles porodnosti, který vysvětluje až 77 % poklesu dětské složky na Slovensku a 62 % v Česku. Druhou nejvýznamnější příčinou v obou zemích byla výchozí věková struktura, díky níž zaznamenala tato věková skupina pokles o další dva procentní body. Příčinou byl zejména fakt, že do fertilního věku se ve sledovaném období dostaly početně slabší ročníky

z šedesátých let 20. století. V České republice lze za významný považovat i pokles v důsledku zlepšování úmrtnostních poměrů (o 0,4 procentního bodu). Migrace měla na dětskou složku v obou republikách nulový efekt.

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