

Population Ageing Processes, Case Study (on) Czech and Slovak Republics

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Abstract: *The process of population ageing is a complex and difficult issue. The intensity of the effort to recognize these processes is reflected in the number of the methods and techniques used in this effort. The analysis of the population age structure and its ageing with the help of the sophisticated knowledge instruments is the crucial work of our contribution. The object of our study is the population of the Czech Republic (CR) and Slovak Republic (SR), and the changes in their age structure in the years 1920-2011. We used some indicators of traditional ageing measures (hexagonal diagram, ageing index, age index, Billeter index) and some new measure tools based on the selected generation groups also. The comparison shows a high degree of similarity. In the development of the ageing processes are also certain differences between the CR and SR. The ageing of the population in the CR started earlier than in Slovakia, and the process is more intense. A number of social problems are associated with the processes of population ageing. The first group are the issues of economic nature (income-pensions of non-working persons, the reduction of productive age category, the opportunities for utilization of the elderly population). The second group involves the issues of social and health services (geriatric facilities, physicians and health care professionals, psychological facilities, special housing requirements, retirement houses of various types, etc.).*

Keywords: age structure; population ageing; social support index; hexagonal diagram; dynamic index of reproductive ageing.

Cuvinte-cheie: structură de vârstă; îmbătrânirea populației; indicele de ajutor social; diagramă hexagonală; indicele dinamic al îmbătrânirii reproductive.

Introduction

The age structure is one of the most important basic demographic characteristics of each population, which is multi-causally related to almost all population processes and structures. On one hand, the

age structure is the result of processes such as fertility, mortality, immigration, emigration. At the same time, it substantially affects a number of phenomena and processes such as marriage, divorce, mortality, fertility, migration, potential labor resources and others. Certain relationships

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can be observed also between the age structure and other population characteristics, such as ethnic, educational, sexual, economic or religious structure.

Like nearly all the population phenomena the age structure is also an extremely dynamic phenomenon, which results from the multiple relationships with above mentioned dynamic processes. In the 20th century, ageing, as a crucial factor in the population age structure, won an extraordinary scientific, but also social attention.

The objects of our interest are the research methods and techniques presentation which can be used for the ageing population study. Some of these methods were used in age structures research in the Czech Republic and Slovak Republic. The aim was to identify the process of population ageing in Slovakia and the Czech Republic. The time period for the temporal analysis was selected (focused) based on the availability and comparability of data from 1920-2011. Both populations under observation were part of a single common state for an extended time period (except for the period 1939-1945 and the period after 1993). The population of these countries was thus affected by a uniform population and family policy. Despite the common approach of both countries, certain differences in their population development can be observed. During the entire period of development, the population of the Czech Republic responded to external reproduction stimuli (economic, psychological, etc.) faster than the population of Slovakia (Andrle and Srb, 1983). Our analysis will demonstrate the degree to which this difference was reflected in the population ageing processes.

Two different approaches are often applied to the study of ageing. In the first case, the efforts focus on the comparison of several regional population structures (inter-regional analysis), with emphasis on the differences in the population age structures and the achieved level of ageing. In the second case, the attention focuses mainly on the changes of the age structure

of a single regional population over the course of time (inter-temporal analysis). However, it appears that it is beneficial to combine both approaches, and that there are benefits in geographical analyses.

Several traditional instruments (are) used to analyse age structure and population ageing: share of selected age categories, ageing index, dependency indices, Billeter index, median age, mean age. Graphic methods represent particular instruments for age structure evaluation (population pyramid, triangular graph, hexagonal diagram). The new methods for the analysis of the population ageing are represented by the indicators based on substitution and comparison of the selected population age groups (index of potential social support, index of potential economic support, coefficient of inflow, outflow and exchange, dynamic reproduction ageing index, dynamic index of economic ageing).

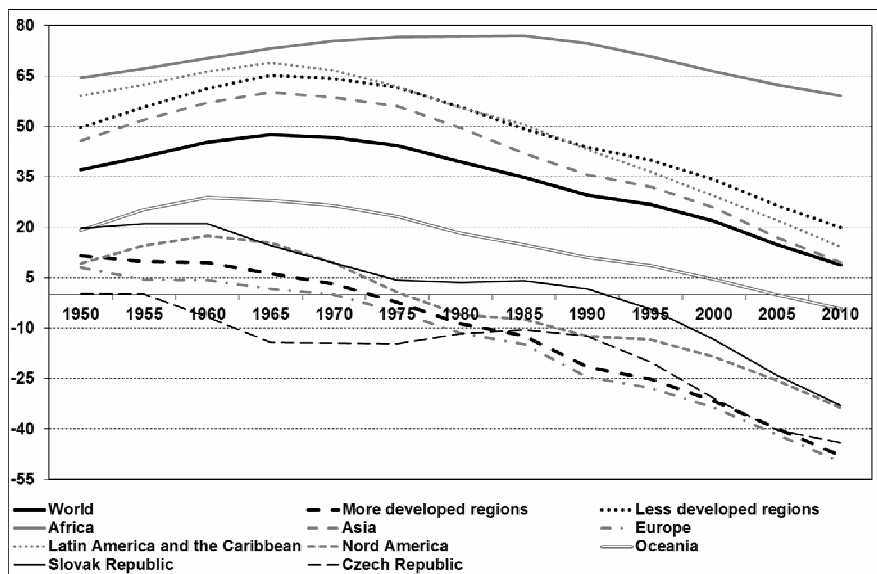
Some methodological remarks

From a demographic point of view, ageing evokes those changes in the population which increase the number, respectively, proportion of the higher age categories (ageing from the top), and relate to the reduction of the number and the proportion of children's category (ageing from the bottom). Seemingly, the simple assessment of young and old age groups of the population becomes complex due to their interconnection.

The population ageing, particularly at a global scale, shows significant regional differences. It reflects the overall social maturity of countries and large regions. If the Billeter index¹ is used as an indicator of ageing, then there are differences between developed and developing regions. Less developed regions, in 2010, have reached the positive value of this index, it means that the number of pre-reproductive (child) population categories was larger than the

number of post-reproductive population categories (50+). At the level of continents, only Africa, Asia and Latin America still reach these index values (Figure 1). The index of developed regions fell into negative values. An high level of

ageing has been achieved primarily in Europe and North America, followed by Oceania. Population of the Czech and Slovak Republics shows also high levels of population ageing.

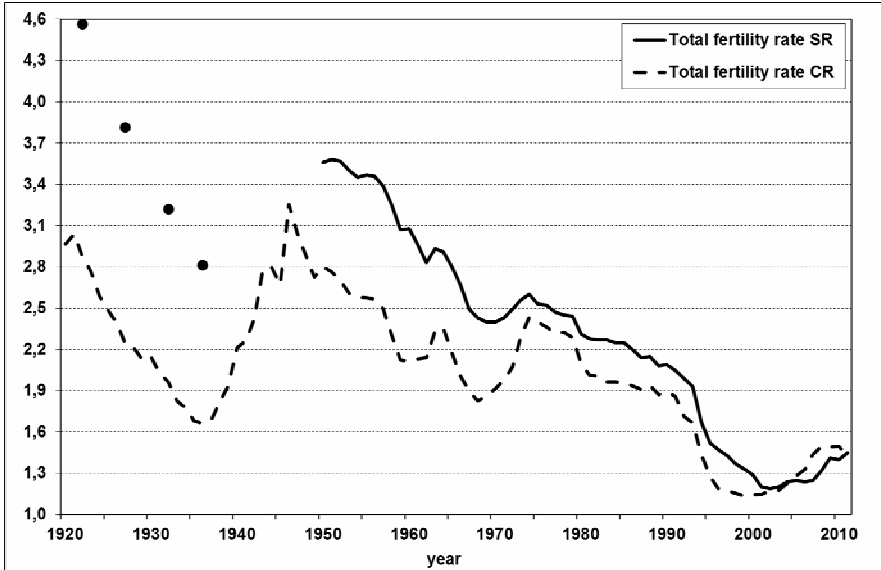


Source: United Nations Population 2011, ČSÚ 2011, ČSÚ 2012a, ŠÚ SR 1946-2006, ŠÚ SR 1997-2012

Figure 1: Billeter index in the World 1950-2010

In the early stages of population ageing, the impact of fertility decline applies in particular, and continuing throughout the whole ageing process. In many demographic analyses, the fertility decline is considered to be the primary determinant of ageing. It confirms also the total fertility

rate development in the Czech and Slovak Republics with the values in the '50s reaching from 3 to 3.5 children per woman, and gradually decreasing to the level of 1.2 to 1.4, today (Figure 2).

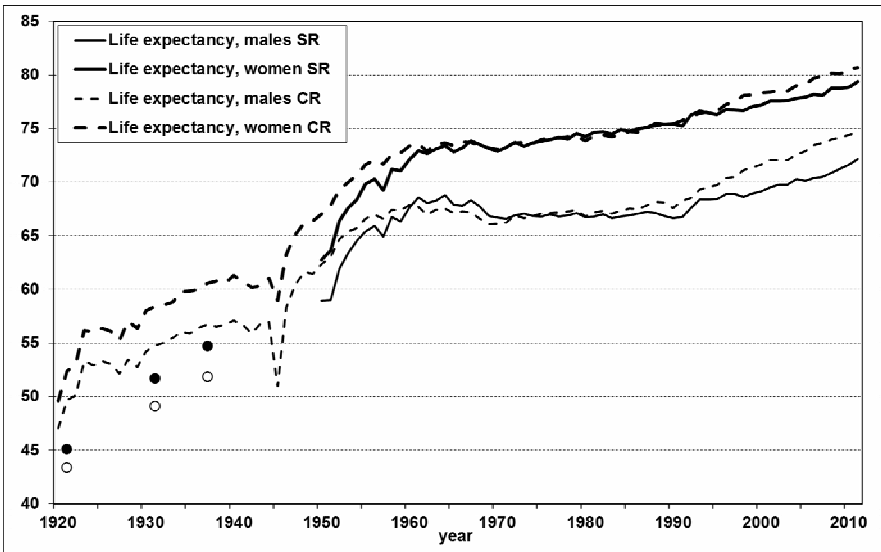


Source: ČSÚ 2011, ČSÚ 2012b, ŠÚ SR 1970-2001, Slovak Popin 2012

Figure 2: Fertility development in Czech and Slovak Republics (1920-2011)

The decline of population mortality, especially in infant and older age were the results of the overall social development. It is

expressed as an increase in the proportion of older categories and the growth of the surrogate indicator – life expectancy (Figure 3).



Source: ČSÚ 2011, ČSÚ 2012b, ŠÚ SR 1970-2001, Slovak Popin 2012

Figure 3: Life expectancy development in Czech and Slovak Republics (1920-2011)

Considering the changes in the age structure, there are both optimistic (positive) and pessimistic (negative) views on the ageing processes. The positive evaluation of population ageing is based on the steady growth of the quality of life, expressed, in particular, in an increased life expectancy. In Slovakia, in 1950, the life expectancy at birth reached 59 years for men and 63 years for women. In the Czech Republic, it was 62 years for men and 67 years for women (Figure 3). By 2011, these indicators increased in Slovakia to 72.2 years for men (or 74.7, in the Czech Republic) and 79.4 years for women (or 80.7, in the Czech Republic). Also during the 20th century, the population 65 and over, in Slovakia, increased 4.3 times (while the total population increased only 1.8 times), and its share increased from 5.3% to 12.8%. In the Czech Republic, the total population increased 1.1 times and the population older than 65 years increased 2.7 times, while the share of the aged 65 nad over population increased from 6.2% to 15.9% between 1920 and 2011. These indicators reflect the economic development, (better) public health care, better nutrition, and the educational and cultural progress of the society.

The pessimistic perception considers population ageing as a major threat to the economic and social future development, related to the economic issues (ageing workforce), health care costs, and particularly the financial sustainability of the pension system. The very specific needs of the older population – enormous needs on medical support, requirements on size and technical equipment of the housing, special dietary requirements, demands for cultural activities and sport and others – are often coupled with increased needs for their financial security. The most common solution to these problems is the increase of the retirement age, which can enrich the economic resources and reduce spending on old-age pensions.

The complexity and importance of the population age structure and the processes of change are reflected in a relatively extensive set of methods and techniques used to assess it. The set can be divided into several groups, in order to get better insight (Káčerová and Mládek, 2012).

The first group is represented by simple one-component indices (Pavliková and Mládek, 1999; Univerzita Komenského, 2006). They characterize only one typical population age category, such as indices of absolute and relative frequency of age categories, like population in a post-productive age and post-reproductive age in selected age categories.

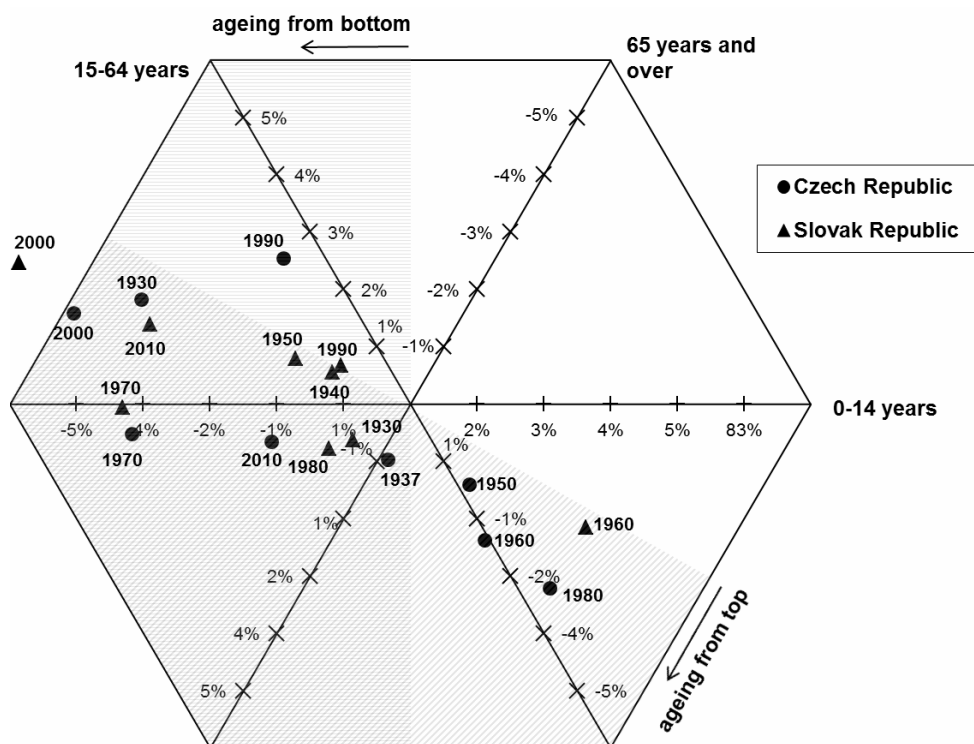
The second group consists of more complicated rates of population ageing. These are a statistical rates in the construction of which several characteristic population age categories are taken into account or all age categories are considered (Mládek and Káčerová, 2008; Mládek et al., 2006; Verešík, 1984; Michálek, 1995). Age index, ageing index, dependency indices, *Billeter* index, median age and mean age should be included in this group of indices. The ability to characterize the population age structure is also characteristic of some mean values, for example, the mean age and median age.

Graphic methods represent the third group of the instruments intended for age structures evaluation and presentation (Sonis, 1981; Podolák, 2001; Mládek et al., 2006; Káčerová, 2005). The most frequently used method, especially for its illustrative character, is perhaps the population pyramid. The triangular graph (*Ossan's triangle*) is suitable for the analysis and interpretation of population's age structure. Its basis consists of an equilateral triangle in which the observed population structures (communes, districts, and States) are represented by means of three coordinates (Univerzita Komenského, 2006). Other possibility is the population observation in various time periods.

A complex view on changes in age structures of both the countries offers the hexagonal diagram. Its substance consists in the characteristics of regions (States) by means of the relative representation of three significant population age categories (0-14 years old, 15-64 years old and 65 and more years old), and their changes in the course of one or several periods (1920 to 2011). It concerns the comparison of age structures in time. The ageing process is characterized by changes of age categories. This comparison results in a vector $(\Delta p, \Delta q, \Delta r)^2$ characterized by the set of three values giving information on the relative population ageing. If $(\Delta p < 0)$, it is ageing of the population at the bottom, if $(\Delta r > 0)$ it is ageing of the population from top).

After the evaluation of the age structure changes (in a period of 10 years) through hexagonal diagram (Figure 4), we can conclude that, already at the beginning of the following period both republics' population aged from the top and the bottom of the age pyramid. However, the ageing of the age pyramid base took place much intensive in the Czech population, as a result of preference for one child model family. Ageing from the top was carried out following the improvement in mortality which during the war years achieved very high values (direct loss, poor population nutrition, epidemics). By 1937 (CR), respectively 1940 (SR), ageing intensity slightly decreased, however, (it) continued the ageing at the base as well as the top of the age pyramid. Differentiated development occurs in the postwar years, when the Slovak Republic records continue ageing, while the Czech population is getting young from the bottom. At the beginning of the World War II, namely and paradoxically in the Czech Republic, the birth rates began to rise, even though the weak women generation of World War I is involved in the reproduction process. Increases of birth rate took place under the

influence of a number of factors, which may include closing of universities, abolition of military services and the fact that pregnant wife and her early motherhood was a kind of defense against the total deployment in Germany (Fialová, 1991). Mothers of young children are also protected from being put into work, and, finally, young families had also better food-supply (Srb, 2004). In the '50s, both Republics rejuvenate in the base of the age pyramid, following the post-war *baby-boom*. This process is more intensive in the Slovak Republic concerning the proportion of the pre-reproductive age group, at the beginning of the period. Contrariwise, declining birth rate in the '60s caused a sharp ageing from the bottom until 1970, with continued ageing from the top. This period can be described as one of the most dynamic period of ageing in the Czech and Slovak Republics. Following the natality measures, this trend manage to reverse during the '70s, and in this period there was a slight rejuvenation of the Czech population, in (to/from) the base of the age pyramid. Slovak population reacted to these measures slow, and continues the ageing at the base of the age pyramid. In the '80s, there is only one period when rejuvenation took place in the Czech Republic at the top of the age pyramid, and the Slovak Republic stagnantes. The reason was the entry of weaker generation of the World War I in the post-productive age category and stagnant mortality circumstances. In the period 1990-2000, the bottom-ageing has intensified, following the declining of the birth rates. Due to the fact that, once again, there were also top ageing, there has been another very significant ageing period of the studied population. In the past 10 years, population ageing intensity decreased slightly, particularly in the Czech Republic.

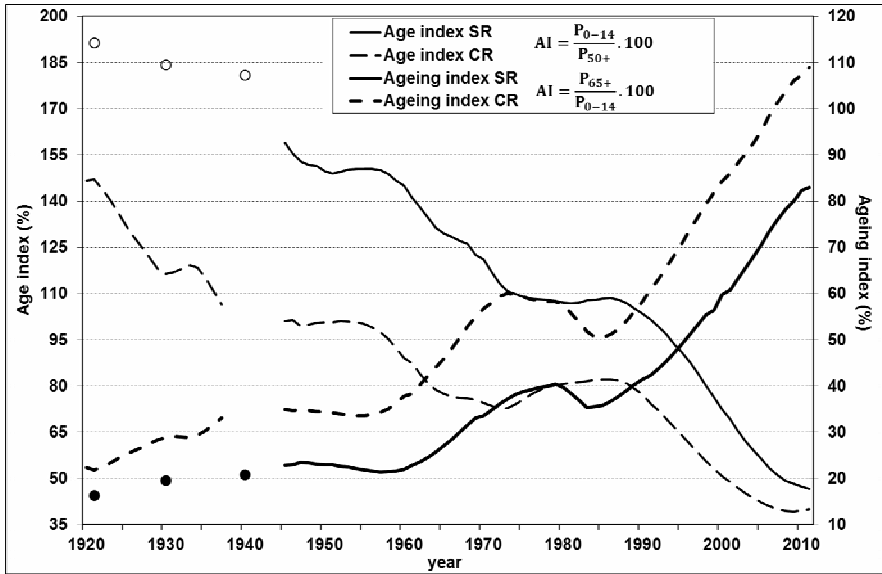


Source: ČSÚ 2011, ČSÚ 2012a, ŠÚ SR 1946-2006, ŠÚ SR 1997-2012, ŠÚ SR 1990-2001

Figure 4: Hexagonal diagram of age population structure changes of Slovak and Czech Republics (1920-2011)

The application of very frequently used indicators of ageing – the ageing index and age index – enables a preliminary assessment of ageing in both populations, over the course of the century (Figure 5). In particular, characteristic features appear such as the similarity between the population ageing process in the Czech Republic and the Slovak Republic (almost parallel curves). Along with the obvious similarity, there is also the advance of the Czech Republic in the development of the indicator that was accentuated in the 1930s. Until the beginning of World War II, the Czech Republic was closer to the western type of family behaviour (the *Hajnal* line) (Rabušic, 2001), while the Slovak Republic was closer to the

eastern model. Since the age of marriage in the western type of family behaviour was very high and sexual intercourse before marriage was inadmissible, the age at first birth was also high, as a consequence. In the Czech society this led to the preference for only one child between the wars (Roubiček, 1997), while in Slovakia, a family model with two or more children was preferred. Substantial is the fact that the ageing index and age index lines of the CR and SR have equal courses. The difference between ageing indexes of populations enlarge, and the difference among age indexes reduces. The reasons are favourable mortality circumstances of the senior age group in CR.



Source: ČSÚ 2011, ČSÚ 2012a, ŠÚ SR 1946-2006, ŠÚ SR 1997-2012, ŠÚ SR 1990-2001

Figure 5: Development of population ageing indexes in CR and SR (1920-2011)

New methods of population ageing studies and comparisons: Czech and Slovak Republics

The analysis of the population age structure and its ageing using the sophisticated knowledge instruments is the crucial work of our contribution. The indicators are based on the comparison or substitution of the selected population groups, most often, generation groups – generations associated with certain major demographic, economic and social processes and functions. These may be generations with major reproduction function, generations of economically active population, generations with the function of edu-

cation and social support (Długosz and Kurek, 2009; Hrubý, 1996; Lutz, 2006; Qiao, 1988).

Very often, the emphasis is put on the substitution of certain important social age groups. Długosz and Kurek (2009) consider the 85+ age category to be one of such important social groups. Usually, this age category is associated with the need of special care, social or family support. With respect to certain demographic trends and the achieved population parameters of the population in Slovakia and Czech (life expectancy) we have reduced this age limit to 80 years. Upon such modification, the indexes of potential social support (parents) looks as follows:

$$I_{ss1} = \frac{P_{80+}}{P_{50-64}} * c$$

$$I_{ss2} = \frac{P_{85+}}{P_{50-64}} * c$$

Index (Iss1) represents the number of individuals in the 80+ age group per 100 50-64 old individuals. This ratio can be viewed as the relationship between the

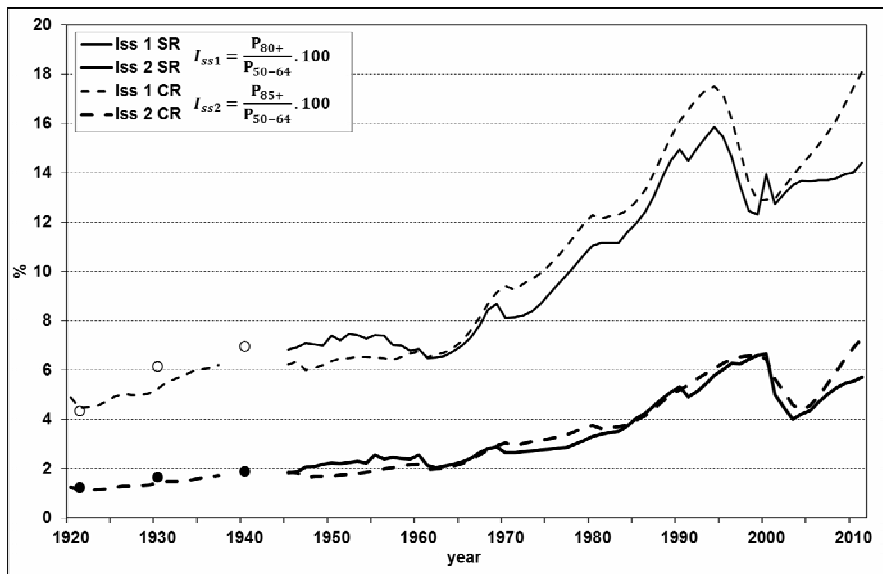
generation of parents and their children, and as a potential possibility of direct inter-generation assistance. Kinsella and Velkoff (2001) define this index also separate for

women. Because it gets more values, looks like parent support of total population, concerning feminisation of old age.

Developments in the ratio of the generation of “parents” (80+) to the generation of their “children” (50-64 years) confirms the ageing of the population in Slovakia and the Czech Republic through the social support index. At the beginning of the subject period, these indicators were at the level of 4-5 with a slight upward trend, and, thus, in the 1950s for 100 individuals in the generation of children there were only seven parents. By 1980, the index had risen to 11, and in 1993 it was 17-18 (Figure 6). The most significant factor was reduced mortality associated with so-called premature deaths (at the age of 0-64 years),

which was disproportionately high in the Czech Republic, in comparison with developed countries (Dzúrová, 2001). The reduction of the social support index since 1994 (to the level of 12-13) is associated with the transition of less numerous generations born during WWI into the 80+ age category. In the recent years, the value of this index has increased to 14% in SR, and 18% in ČR.

The increase of life expectancy don't give only higher number of seniors, but also higher number of seniors which suffer from terminal visceral or mental afflicts. In such instance, the caring family isn't always sufficient, and raise the pressure on social services for senior with health afflict.



Source: ČSÚ 2011, ČSÚ 2012a, ŠÚ SR 1946-2006, ŠÚ SR 1997-2012, ŠÚ SR 1990-2001

Figure 6: Indexes of potential social support in CR and SR (1920-2011)

The category of productive population is generally considered very important, in the socio-economic sense. That is why we need to assess its changes, as the younger generations enter the category of productive population and older generations

leave it (Hrubý, 1996; Káčerová, 2009). However, we need to say that in the population 15-64 year old there are specific persons groups which aren't economically active (students).

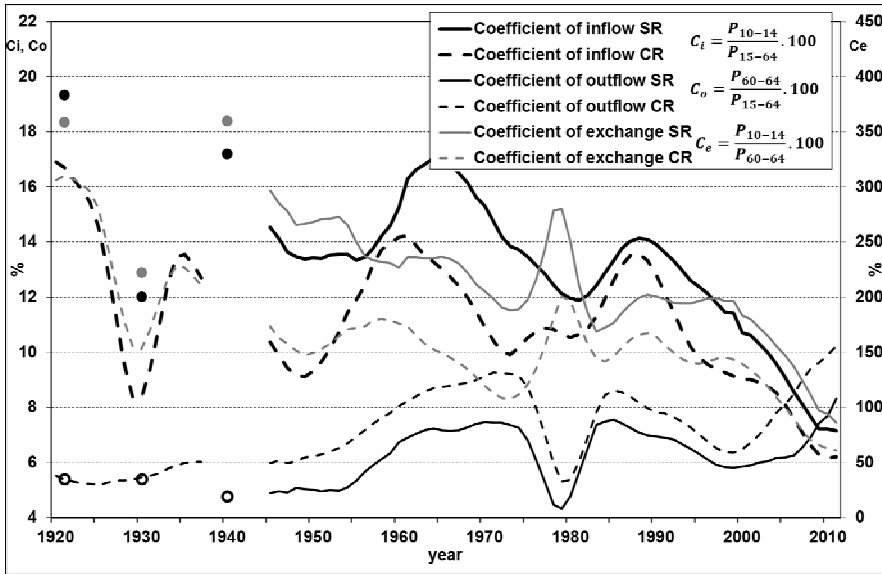
$$C_i = \frac{P_{10-14}}{P_{15-64}} * c \quad C_o = \frac{P_{60-64}}{P_{15-64}} * c \quad C_e = \frac{P_{10-14}}{P_{60-64}} * c$$

Ci - coefficient of inflow, Co - coefficient of outflow, Ce - coefficient of exchange

The coefficient of inflow represents the number of individuals in the age category 10-14 entering the productive age. Overall, the inflow coefficient in both populations is declining, which means a decrease in the inflow of young population in the productive age category (Figure 7). At the beginning of the period, there were 17-19 persons aged 10-14 years per 100 of the working population. By 2011, the inflow coefficient was reduced to 6-7 (of 10-14-year old per 100 of the working population). At the same time, we can observe the convergence of the observed populations resulting from low fertility in

both countries, in the 1990s, which resulted in very low values of this indicator by the end of this period. Throughout the entire reporting period, the inflow coefficient was higher in Slovakia – reflecting the higher birth rate of the Slovak population.

The coefficient of outflow represents the efflux of 60-64-year olds from the productive age category to the post-productive population. The curves demonstrate the growing trend in both populations (Figure 7). The higher value of the coefficient for the Czech population demonstrates the faster ageing of the Czech population in the period immediately after WW2.



Source: ČSÚ 2011, ČSÚ 2012a, ŠÚ SR 1946-2006, ŠÚ SR 1997-2012, ŠÚ SR 1990-2001

Figure 7: *Coefficient of inflow, outflow and exchange in CR and SR (1920-2011)*

The coefficient of exchange expresses the changes in the proportion of “incoming” and “leaving” to and from the productive population. During the period of

interest, the situation changed dramatically. At the beginning of the century, the exchange coefficient reached 300 to 359%. At present, the inflow of the young

population groups does not compensate for the outflow (94% for the Slovak and 65% for the Czech population) (Figure 7).

Dynamic population ageing metrics attempt to compare the size of the age groups that enter or leave the important age categories of the population, at a certain time. This is used to compare the entering

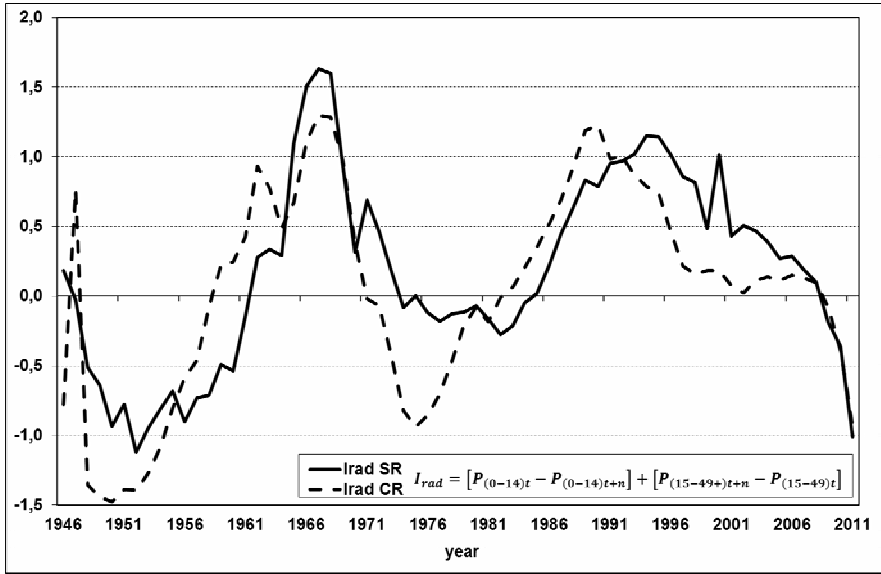
and leaving population, with respect to the category of productive population (Długosz and Kurek, 2009). In order to assess the changes of the population age structure with respect to the reproduction, we should use the modified indicator – dynamic reproduction ageing index

$$I_{rad} = \left[P_{(0-14)t} - P_{(0-14)t+n} \right] + \left[P_{(15-49)t+n} - P_{(15-49)t} \right]$$

Irad – dynamic reproduction ageing index: $P_{(0-14)t}$ – share of population aged 0-14 at the beginning of the study period, $P_{(0-14)t+n}$ – share of population aged 0-14 at the end of the study period, $P_{(15-49)t+n}$ – share of population aged 15-49 at the end of the study period, $P_{(15-49)t}$ – share of population aged 15-49 at the beginning of the study period.

The dynamic reproduction ageing indexes of the Slovak and Czech population reflect the characteristic changes in both age categories (0-14 year old, 65 and older), and alternating periods of population ageing and rejuvenation (Figure 8). Periods of population rejuvenation can be observed in the 1950s and 1970s, when the main factor was mainly the increased fertility. Accelerated population ageing was observed in the 1960s and from the end of the 1980s. In the recent period, the ageing process has been affected especially by reduced fertility (bottom-up ageing), resulting from a strong individualism and the

mass spread of (hormonal) contraception. Moreover, the situation was intensified by social insecurity, growing unemployment and unfavourable economic situation, particularly in the area of independent housing (Mládek et al., 2006). In 1980 in Slovakia, the proportion of 0-14 age category was 26.1% (in the Czech Republic, 23.3%), and the proportion of 65+ age category was 10.4% (CR 13.5%). By 2011 the proportion of children category in Slovakia was reduced to 15.4% (14.6% in the CR), and the proportion of elderly increased to 12.8% (15.9% in the CR). The positive values of *Irad* indicate the faster reproductive ageing of the population. There is a decline in the proportion of children categories (potential for reproductive category) and in the reproductive age category. In the case of negative *Irad* values, the reproductive rejuvenation of the population occurs.



Source: ČSÚ 2011, ČSÚ 2012a, ŠÚ SR 1946-2006, ŠÚ SR 1997-2012

Figure 8: *Dynamic reproduction ageing index in CR and SR (1946-2011)*

The development of reproductive ageing in both countries is of a cyclical nature (Figure 8), reflecting the development cycles of fertility, and the subsequent rising or falling of the proportions of the reproductive category. The first is the period of the 1950s with the rejuvenation of the populations mainly due to high fertility after WW2. In the 1960s, it was replaced by the ageing of the population, resulting from declining fertility as a consequence of the global economic crisis and the passing of a more liberal abortion law. During this period, the Czech Republic has even seen a decline in total fertility, crude and net reproduction rates (falling) under the sustainability level. Another period of rejuvenation was observed in the 1970s and first half of the 1980s: reflecting the increase in fertility (due to numerous pro-natality arrangements, which reacted very quickly especially the population of the Czech Republic), and (to) the influx of numerous generations from the 1950s into the reproductive age category). The new ageing

period is observed in the late 1980s and the 1990s, mainly due to a sharp decline in fertility. Remarkable is the reduction of the rate of ageing in recent years, even a hint of rejuvenation in both populations. Apart from a slight recovery in fertility, these changes have to be attributed to numerous generations born in the 1970s, representing increased reproductive potential. The reduction of this indicator is also strongly affected by the transfer of post-war baby-boomers to the post-reproductive age group.

Conclusion

The analysis of the age structure and population ageing confirmed very significant changes during the last ninety years. Original knowledge was obtained using the whole set of statistical methods. The new ones include those that attempt to compare the frequency and representation of major age generations.

Both populations have progressed in aging from the bottom and from the top of their age pyramids during the period observed. The share of 0-14 age category dropped by 17.3 percentage points in the Slovak and by 13.2 percentage points in the Czech population. The share of 65+ age category increased by 7.5 percentage points in the Slovak and by 9.7 percentage points in the Czech population. The flow of aging from the top was smooth. The opposite, rejuvenation from the top was only observed in the Czech population during the 1980s when the First World War generation entered senior age and mortality stagnated. Aging from the bottom was more prominent some time before, during the 1960s, and once again during the 1990s, accelerating the change of age pyramid shape.

The ageing processes give rise to the need to address a whole series of social problems that currently are a burden especially for the developed countries. The first group of problems are the issues of economic nature – especially the issue of economic conditions development that would enable the satisfaction of the justified and specific needs of non-working pensioners. With the growing proportion of this population, it will be constantly more difficult to generate their income (pensions). In addition, the productive age category reduces its share from bottom and from top, too. At the same time, it will be necessary to generate the opportunities for further utili-

zation of the capabilities and knowledge of the elderly population – active ageing.

The second group of problems involves the issues of social and health services. The increase of life expectancy doesn't give only a higher number of seniors, but also higher number of seniors which suffer from terminal visceral or mental afflicts. In such an instance, the caring family isn't always sufficient, and raise the pressure on social services for senior with health afflict.

The extended health care services should address the qualitative, as well as the quantitative aspects. It is essential to provide an extended network of specialized facilities for the treatment of elderly people and chronically ill patients – more geriatric facilities, more trained physicians and health care professionals to treat this population group, including psychological facilities and more extensive preventive activities. The reduction of the income of this population should not result in the radical limitation of their needs. This is very important in the area of nutrition, personal services. There are also the special housing requirements, transport, etc. of the elderly population. Czech Republic plans to codify housing accessibility standards and to ensure their implementation in all new buildings. Alternative solutions need to be considered – retirement houses of various types, conditions for the existence of multi-generation families, provision of nursing care services.

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Notes

¹ Billeter index $B_i = ((\text{Population}_{0-14} - \text{Population}_{50+}) / \text{Population}_{15-49}) * 100$.

² $\Delta p = {}_t \text{Population}_{0-14} - {}_{t-1} \text{Population}_{0-14}$

$\Delta q = {}_t \text{Population}_{15-64} - {}_{t-1} \text{Population}_{15-64}$

$\Delta r = {}_t \text{Population}_{65+} - {}_{t-1} \text{Population}_{65+}$

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