DEMOGRAPHIC AGEING IN THE REGIONS OF SLOVAKIA AND THE CZECH REPUBLIC IN 2011–2015

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ABSTRACT

The aim of this paper is to analyse demographic ageing in the regions of Slovakia and the Czech Republic using the ageing index and to compare the convergence of demographic ageing in both countries. The convergence of demographic ageing in the two populations was analysed using the beta convergence method.

Keywords: demographic ageing, ageing index, convergence, regions, Czech Republic, Slovak Republic

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INTRODUCTION

Population ageing is characterised by an increase of the proportion of older individuals and a by decrease in the proportion of young individuals (*Amado – Säo José – Santos*, 2016). It is not short-term trend but rather involves changes that occur over a long period of time. We consider demographic ageing the process of transition from a progressive type of population to a stationary type of population, or from a stationary type of population to a regressive type of population (*Klufová – Poláková*, 2010). It is caused by the extension of the life expectancy, also called population ageing from the top, and by the decreasing birth rate, also called population ageing from the bottom. The state of demographic development of the population is a result of previous economic and social development of the society (*Krajňáková – Vojtovič*, 2017). The intensity of population ageing is significantly influenced by demographic processes, especially the birth rate, mortality rate, and migration. These processes can cause unequal changes in the age structure. An uneven age structure in the population influences the intensity of population ageing. However, as *Klapková, Šídlo* and *Šprocha* (2016) note, demographic ageing is a complex process. It is often presented in a negative way, especially in regard to the expected impact on the economic, social and health systems. However, population ageing is closely linked to progress.

Demographic ageing is monitored by several indicators. These indicators allow us to compare changes in the population structure. According to *Koprlová* and *Koprla* (2010), population ageing is significantly reflected in the following indicators: life expectancy at birth, the ageing index, and the economic burden index. International comparisons of active ageing use a more complex index – the Active Ageing Index. The ageing index is the most widely used measure of demographic ageing at the regional level.

The ageing index reflects the proportion of people of post-productive age (65 and over) per 100 people of pre-productive age (0–14). Its value is therefore mainly influenced by the demographic processes of population natality and mortality. The indicator values are also monitored in a time series by statistical authorities at the NUTS 3 regional level.

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Active ageing and successful ageing are ubiquitous concepts in contemporary societies (*Säo José et al.*, 2017). As population ageing leads to great changes in the population structure, it is necessary for society to respond to this trend in several areas of social life. In addition to adjusting the pension system, it is important to implement changes in services, health care, labour markets, technologies, transport, culture, entrepreneurial activities, etc. These changes should be conceptual and should lead to active ageing, which is a key paradigm for policymaking (*Vidovićová – Kafková Petrová*, 2016).

A policy to prepare for population ageing needs to respond to two key challenges: integrating older people into economic and social development and creating an age-inclusive society. It is important to adapt the employment policy, pension policy, and other policies and services that are impacted by social and demographic changes. The main principles of such a policy include an emphasis on human rights, a lifelong approach to ageing and health, emphasis on family and intergenerational relationships, and the creation of research-based measures (*Ministry of Labour and Social Affairs of the Czech Republic*).

Regional demographic analysis and a subsequent population prognosis are necessary prerequisites for shaping any concepts of regional development (*Šprocha – Vaňo – Bleha*, 2014). Reducing disparities promotes the economic and social development of individual regions, so the prerequisite for this is to achieve sustainable development across the whole country (*Habánik – Koišová*, 2011). The existing differences in population development and the associated differences in the number and especially the structure of regional populations are not only a consequence, but also one of the main factors of the formation of disparities in socio-economic development (*Šprocha – Vaňo – Bleha*, 2014).

In the Slovak Republic (SR) and the Czech Republic (CR) the concept of demographic ageing has been worked into the national programmes. In Slovakia there is the National Active Ageing Programme for the years 2014–2020, in which Slovakia addresses to the issue of active ageing as a political priority in its entire complexity (*Ministry of Labour, Social Affairs and Family of the Slovak Republic,* 2013). In the CR there is the National Action Plan Supporting Positive Ageing for the period 2013–2017 (*Ministry of Labour and Social Affairs of the Czech Republic, 2014*), which has been in effect since 2012.

For Slovakia and the Czech Republic it is characteristic that the current development of the demographic behaviour is manifested especially by ageing of population and ongoing problems characterised by the drop in reproduction behaviour (*Ladzianska,* 2009). The share of older people is growing at the expense of the declining proportion of productive population (*Šimková – Sixta*, 2015). Moreover, for both countries, it applies that the period of retirement is gradually extending, but it also leads to increase of life expectancy and time lived without significant health restrictions. The problems of ageing will probably first appear in countries with a high proportion of industry and construction in the GDP. Economies with a high proportion of services will be affected to a lesser degree (*Arltová et al.*, 2016). Both the Czech Republic and Slovakia are countries with a large share of industry.

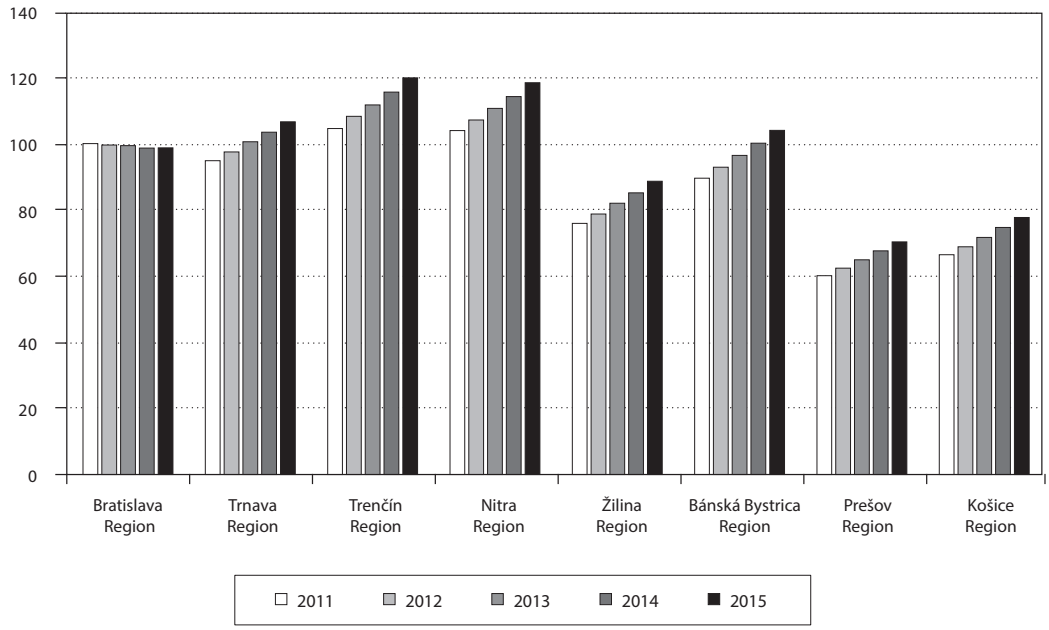
DEMOGRAPHIC AGEING IN THE SLOVAK REPUBLIC

At the beginning of our analysis we compared the index of ageing in the regions of the SR. Then we compared the index of ageing in the regions of the Czech Republic.

According to the data in the Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016) the arithmetic mean of the ageing index based on regional values in 2011–2015 in the SR has been increasing. Its variation, expressed by the standard deviation, has been increasing too. However, there are significant differences in the values of the ageing index between regions. The highest value of the ageing index throughout the period analysed was observed in the Trenčín Region. The second-highest value was in the Nitra Region (2012–2015). The Prešov Region had the lowest ageing index value. The second-lowest value was in the Košice Region. The Bratislava Region had an above-average ageing index value, and it was also the only region in which the ageing index was decreasing. Figure 1 shows the ageing index in the regions of the Slovak Republic.

As demographic ageing is influenced by the rise in life expectancy and by the birth rate, their dynamics

Figure 1 The ageing index in the regions of Slovakia, 2011–2015 (%)



Source: Author's analysis based on data from the Statistical Yearbook of Slovak Regions, 2016.

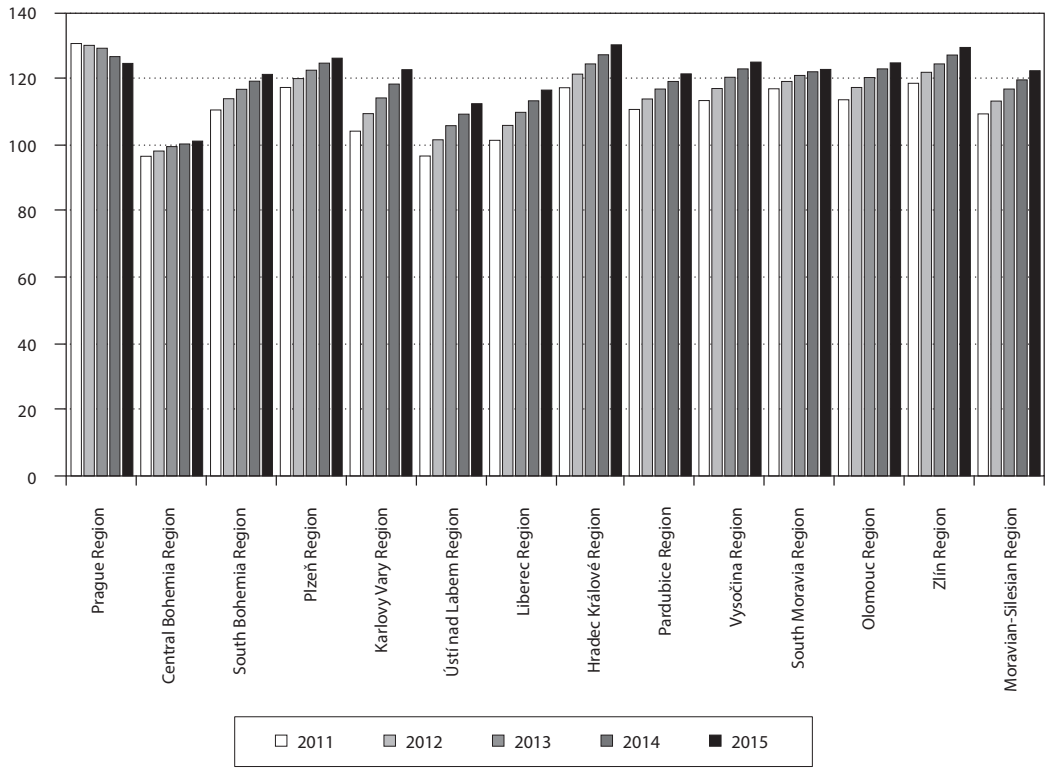
has an influence on the dynamics of the ageing index. There are significant differences in life expectancy at birth across the SR. According to the data in Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016) the highest life expectancy at birth for both men and women in the period analysed was in the Bratislava Region. This region is characterised by the strongest economic performance. Regional GDP per capita in this region significantly exceeds GDPs in other regions. According to the data in the Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016), the second-highest value for men and women was in the Trenčín Region. Conversely, the lowest value of this indicator at the beginning of the period for men and throughout the period for women was in the Košice Region. The Prešov Region had a higher life expectancy at birth throughout the period analysed than the Košice Region. At the end of the period analysed, the lowest life expectancy at birth was in the Banská Bystrica Region. In all the regions of the SR life expectancy at birth was increasing over time.

There were regional differences also in the number of live-born children. According to the data in the Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016), the largest number of births per 1,000 inhabitants was in the Bratislava Region. This is the region with the largest number of job opportunities and, in terms of internal migration, it is also the region to which the largest number of people of reproductive age move. This region was followed by regions in eastern Slovakia: the Prešov and Košice Regions. According to the data in the DATA cube (*Statistical Office of the Slovak Republic,* 2016), these are the regions with the largest number of Roma inhabitants. The Nitra Region had the smallest number of births per 1,000 inhabitants. It was followed by the Trenčín Region.

DEMOGRAPHIC AGEING IN THE CZECH REPUBLIC

Several conclusions can be drawn from the analysis of the ageing index in the CR. The arithmetic mean

Figure 2 The ageing index in the regions of the Czech Republic, 2011–2015 (%)



Source: Author's analysis based on data from 'A Comparison of Regions in the Czech Republic' 2015, 'A Comparison of Regions in the Czech Republic' 2016, and the Demographic Yearbook of Regions 2005–2014.

Table 1 Descriptive statistics of the ageing index in the regions of Slovakia and the Czech Republic, 2011–2015

	N	Arithmetic mean (%)	Min. (%)	Max. (%)	St. deviation
SR 2011	8	86.71	59.94	104.31	17.3037
SR 2012	8	89.19	62.19	108.03	17.3750
SR 2013	8	91.94	64.47	111.41	17.4066
SR 2014	8	94.71	67.47	115.30	17.5286
SR 2015	8	97.78	70.12	119.55	17.9721
CR 2011	14	110.49	95.93	129.70	9.2392
CR 2012	14	113.72	97.44	129.20	8.4963
CR 2013	14	116.50	98.78	128.30	7.8941
CR 2014	14	118.68	99.56	126.38	7.5014
CR 2015	14	120.67	100.48	129.31	7.3736

Source: Author's analysis.

of the ageing index based on regional values increased in the 2011–2015 period, like in the SR. However, in contrast to the SR, the variation of the indicator, expressed by the standard deviation, was decreasing. In the period between 2011 and 2013, the highest ageing index was in the Prague Region. Throughout the period analysed the ageing index declined only in the Prague Region. Figure 2 shows the ageing index in the regions of the CR.

According to the *Czech Statistical Office* (2014, 2015a), the dynamics of the ageing index influenced the dynamics of life expectancy at birth and the dynamics of the number of births. Life expectancy at birth increased in all the regions of the CR. Life expectancy at birth was the highest for both men and women in the Prague Region. This region also has the strongest economic performance. GDP in this region significantly exceeds GDP levels in the other regions. According to the *Czech Statistical Office* (2014, 2015b, 2016), the largest number of births per 1,000 inhabitants was in the Prague Region. This region also has the largest number of job opportunities and is the region to which the largest numbers of people of reproductive age move in terms of both internal and external migration. The regions with the smallest number of births per 1,000 inhabitants included the Zlín Region and the Moravian-Silesian Region.

A COMPARISON OF THE AGEING INDEX IN SLOVAKIA AND THE CZECH REPUBLIC

In 2011–2015 the ageing index was higher in the CR than in the SR. From the above analysis it can be concluded that the process of demographic ageing was more dynamic in the CR than in the SR. In 2015, all regions in the CR had an ageing index higher than 100%. In the SR, only 4 regions had ageing index values higher than 100%. The arithmetic mean of the ageing index based on regional values in the SR was under 100% throughout the period; in the CR it was over 100%.

The same trend can be identified in the capital cities of both states: both capitals have the highest mean life expectancy and the largest number of live-born children per 1,000 inhabitants. At the same time, these were the only regions in which the ageing index declined. The difference is the fact that in the SR there were no changes in the regions with the maximum and minimum ageing index values. In the CR, these regions changed during the period analysed. While in the Slovak Republic there was a slight increase in the variation of the ageing index, expressed by the standard deviation, in the Czech Republic there was a significant decline. The decreasing standard deviation in the CR may indicate that the regions have similar ageing index values. Table 1 presents the descriptive statistics of the ageing index in the SR and the CR.

AIM, DATA AND RESEARCH METHODOLOGY

Demographic ageing is a process that concerns all the regions in the SR and the CR. The effects vary according to the dynamics of the process. The different dynamics could result in the regions becoming more or less alike over the period analysed. The aim of this paper is to analyse and compare the convergence of ageing in the regions of the SR and the CR. The analysis focuses on the period between 2011 and 2015. Data for the regions in the CR were obtained from the following publications: 'A Comparison of Regions in the Czech Republic 2015', 'A Comparison of Regions in the Czech Republic 2016', 'The Demographic Yearbook of Regions 2005–2014', and 'The Demographic Yearbook of Regions 2006–2015'. Data for the regions in the SR were obtained from 'The Statistical Yearbook of the Slovak Regions 2016'. The beta convergence method was used in the analysis.

Demographic ageing was analysed using the ageing index (AI), expressed as follows:

$$AI(\%) = \frac{S(65+)}{S(0-14)}\,100, \qquad (1)$$

S(65+) is the number of people in the population aged 65 and over,
S(0–14) is the number of people in the population aged 0 to 14 years.

BETA CONVERGENCE

The convergence of regions is understood as the convergence of regions over a specific period of time at the value of a certain indicator. There are several

methods that can be used to analyse regional convergence. The two basic methods are based on two concepts: sigma convergence and beta convergence. Sigma convergence is based on the assumption that when the regions converge, the variation in the logarithm of values expressed by their standard deviation decreases. On the other hand, when the regions diverge, the variation of the logarithm of values expressed by their standard deviation increases. Beta convergence is based on the assumption that regions converge over a specific period of time if the regions that had low values at the beginning of the period show faster growth than regions that had higher values at the beginning of the time interval. And regions diverge when the regions that had low levels at the beginning of the period show slower growth than regions that had higher values at the beginning of the time interval.

To measure the beta convergence, we collected data on values of the variable at the beginning of the time interval (initial value) and at the end of the time interval (*Minařík – Borůvková – Vystrčil*, 2013). In beta convergence, point estimates of linear regression parameters are determined by the method of least squares, where the dependent variable is the logarithm of the average growth coefficients and the independent variable is the logarithm of the initial values. The average growth coefficient is expressed as the geometric mean of the growth coefficients. From the time series of growth coefficient k_t for $t = 2, 3,...,T$, which were determined from the values of the time series y_t for $t = 1, 2,...,T$, the average growth coefficient will be calculated as (2)

$$\overline{k} = \sqrt[T-1]{k_2 k_3 \dots k_T} = \sqrt[T-1]{\frac{y_2}{y_1}\frac{y_3}{y_2} \dots \frac{y_T}{y_{T-1}}} = \sqrt[T-1]{\frac{y_T}{y_1}} \qquad (2)$$

If the estimated linear regression function is declining, we can talk about a predominant trend towards convergence. If the estimated linear regression function is increasing, we can talk about a predominant trend towards divergence. In addition to estimating the linear regression parameters, it is important to express also the determination coefficient of the model. The determination coefficient expresses how great a percentage of the total variation is explained by the model. When the values of the determination coefficient are high, we can talk about highly proven convergence or divergence. If the tendency towards convergence or divergence is not highly proven, the analysis should be supplemented with a correlation diagram. The correlation diagram is a point figure with values, like in the regression analysis. The points in the figure are separated by lines. One goes through the mean of the logarithm of the initial values. The second goes through the mean of the logarithm of the average-growth factor. Thus, all the points (in our case representing the regions) are divided into four groups with a below-average or above-average value of the logarithm of initial values and with a below-average or above-average value of the logarithm of the average-growth coefficient (*Minařík – Borůvková – Vystrčil*, 2013).

In this analysis, I decided to use beta convergence because if beta convergence is met, sigma convergence is met as well. However, if there is sigma convergence, there need not necessarily be beta convergence.

RESEARCH RESULTS AND DISCUSSION THE CONVERGENCE OF REGIONS IN SLOVAKIA

For the purpose of this analysis the logarithm of the initial values and the logarithm of the average-growth coefficient of the ageing index in the regions of the SR in the period analysed were calculated and the parameters of linear regression were estimated using the Statistica program. The estimated regression coefficient indicates that the regression coefficient is almost 0, so there is neither convergence nor divergence. The determination coefficient is only 22.36%. Thus, only 22.36% of the total variation is explained by the model. Table 2 presents the estimated parameters of the linear regression function.

In the next step, a correlation diagram (Figure 3) was constructed to divide the regions into groups. The groups of regions are shown in Table 3. The values in the brackets indicate the region's designation in Figure 3. The first group consists of the following regions: Trenčín, Nitra and Banská Bystrica. They have above-average initial values and an above average growth coefficient. These regions decrease the evidence of convergence. These regions show a tendency to diverge from the other regions. The second group consists of regions with below-average initial values and above-average values of the average growth

Table 2 Estimated parameters of the linear regression function (regions in Slovakia)

	Estimated parameters
Constant	0.07452
Regression coefficient	–0.0316

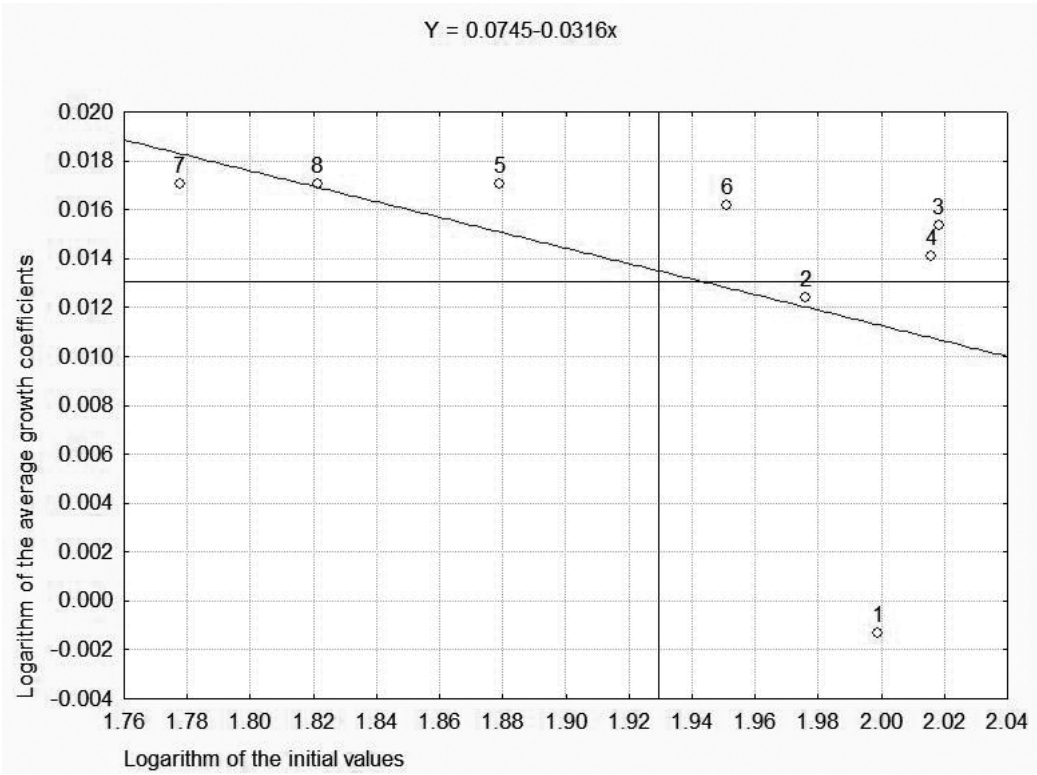
Source: Author's analysis using Statistica.

Table 3 Regions by group (in Slovakia)

1.	2.	3.	4.
Trenčín Region (3)	Žilina Region (5)		Bratislava Region (1)
Nitra Region (4)	Prešov Region (7)		Trnava Region (2)
Banská Bystrica Region (6)	Košice Region (8)		

Source: Author's analysis.
Notes: The first group contains regions with above-average initial values and an above-average growth coefficient. The second group comprises the regions with below-average initial values and an above-average growth coefficient. In the fourth group are the regions with above-average initial values and a below-average growth coefficient.

Figure 3 A correlation diagram of regions in Slovakia



Source: Author's analysis using Statistica.

coefficient. They show a tendency to move increasingly towards the first group, i.e., into the group of regions that show a trend towards moving away from the other regions. This group includes both regions in Eastern Slovakia and the Žilina Region. In the fourth group are regions with above-average initial values and a below-average growth coefficient. These regions are the ones closest to the capital of Slovakia – the Bratislava Region and the Trnava Region. The trend in these regions is towards increasing convergence with the third group, i.e., the group of regions that tend to lag behind the others.

THE CONVERGENCE OF REGIONS IN THE CZECH REPUBLIC

For the purpose of this analysis the logarithm of the initial values and the logarithm of the average growth coefficient of the ageing index in the CR during the period analysed were calculated and then the parameters of the linear regression expressing the dependence of the logarithm of initial values and the logarithm of the average growth coefficient were estimated using the Statistica program.

The estimated regression coefficient indicates that the linear regression function is decreasing. The determination coefficient is 41.37%. This demonstrates that there is a trend towards regional convergence in the CR. Estimated parameters of the linear regression function are in Table 4.

In the next step, a correlation diagram (Figure 4) was constructed in order to divide the regions into groups. Table 5 presents the groups of regions in the CR. The values in the brackets represent the designation of the regions in Figure 4.

The first group contains the regions with above-average initial values and an above-average growth coefficient. There are Hradec Králové Region, Vysočina Region and Olomouc Region. This region reduces the evidence of convergence. The second group comprises the regions with below-average initial values and an above-average growth coefficient. This group includes the Ústí nad Labem, Liberec, Karlovy Vary, South Bohemia, Pardubice and Moravian-Silesian Region. They show a tendency to move increasingly towards the first group, i.e., the group of regions that are increasingly diverging from the other regions. There is only one region in the third group – Central Bohemia Region. This region shows below-average initial values and a below-average growth coefficient. The Central Bohemia Region tends to lag behind the other regions. In the fourth group are regions with above-average initial values and a below-average growth coefficient. These include the regions of Prague, Plzeň, South Moravian and Zlín. They show a tendency towards increasing convergence with the third group, i.e., the group of regions that tend to lag behind the others. It should be noted, however, that in this group the Zlín Region is on the border between the first and the fourth group.

The most significant changes in the ageing index expressed by the logarithm of the average growth coefficient are in the Karlovy Vary Region. The Karlovy Vary Region had relatively low initial ageing index values. In the period analysed, however, the ageing index increased the most (in this region).

A COMPARISON OF THE CONVERGENCE OF REGIONS IN SLOVAKIA AND THE CZECH REPUBLIC

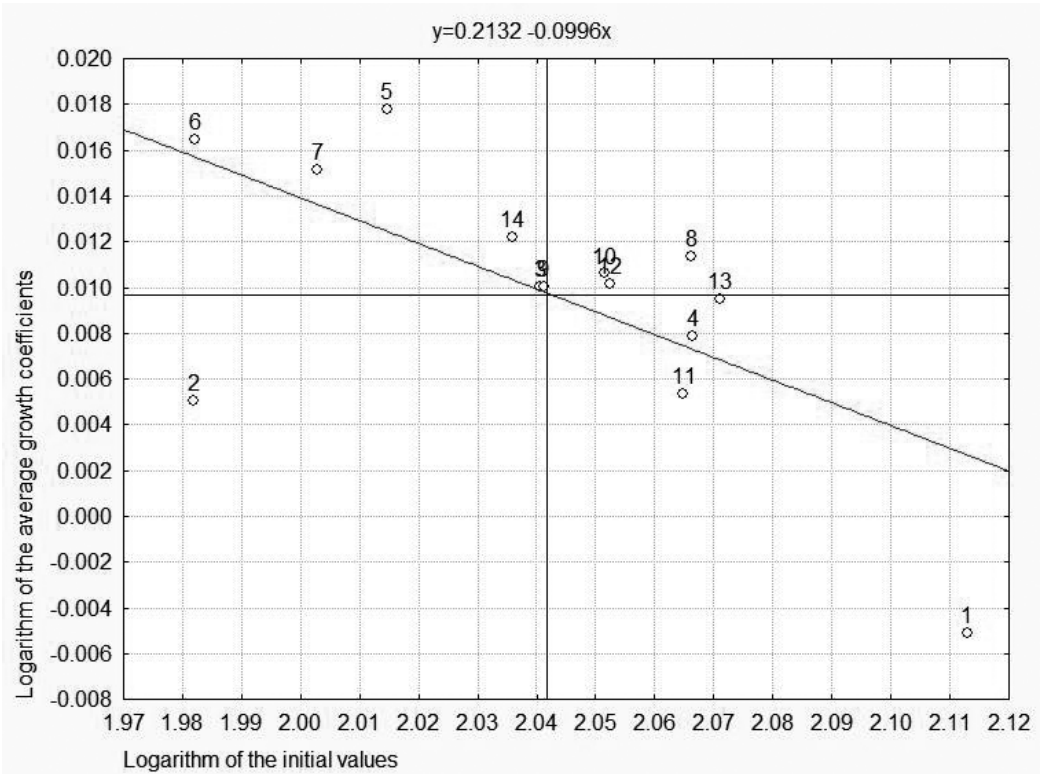
The convergence analysis indicates that there is no evidence of convergence of the ageing index in Slovakia. The trend towards convergence is stronger in CR. There are several factors that, in our opinion, are responsible for the fact that the trend towards convergence in Slovakia wasn´t demonstrated. According to the Statistical Office of the Slovak Republic (2014), the housing and population census in the Slovak Republic

Table 4 Estimated parameters of the linear regression function (regions in the Czech Republic)

	Estimated parameters
Constant	0.2132
Regression coefficient	–0.0996

Source: Author's analysis using Statistica.

Figure 4 A correlation diagram of regions in the Czech Republic



Source: Author's analysis based on data from 'A Comparison of Regions in the Czech Republic' 2015, 'A Comparison of Regions in the Czech Republic' 2016, and the Demographic Yearbook of Regions 2005–2014.

Table 5 Regions by group (in the Czech Republic)

1.	2.	3.	4.
Hradec Králové Region (8)	South Bohemia Region (3)	Central Bohemia Region (2)	Prague Region (1)
Vysočina Region (10)	Karlovy Vary Region (5)		Plzeň Region (4)
Olomouc Region (12)	Ústí nad Labem Region (6)		South Moravian Region (11)
	Liberec Region (7)		Zlín Region (13)
	Pardubice Region (9)		
	Moravian-Silesian Region (14)		

Source: Author's analysis.

Notes: The first group contains the region with above-average initial values and an above-average growth coefficient. The second group comprises the regions with below-average initial values and an above-average growth coefficient. In the third group are the regions with below-average initial values and a below-average growth coefficient. In the fourth group are regions with above-average initial values and a below-average growth coefficient.

in 2011 indicated a large share of the population declare themselves to be religious (only 13.4% do not belong to any particular church/faith) and the majority are Roman Catholics (62%). Religion currently influences the birth rate, but to a lesser extent than it did in the past. There are considerable differences among the regions of the SR in the share of people who claim to be religious. Differences in the population structure by religion can also be a factor behind regional differences in the birth rate. Another important factor is the fact that according to the Statistical Office of the Slovak Republic (2014), the housing and population census in the Slovak Republic indicates that 2% of the total population declared themselves to be members of the Roma population. The majority of Roma live in eastern Slovakia. Their way of life may also be a factor of regional differences in population ageing. Another fact that should not be overlooked is the different economic levels of individual regions. The regions in western Slovakia in particular tend to have a stronger economic performance than the regions in eastern Slovakia.

In Slovakia, the largest number of regions were in the first group, i.e., in the group where the regions tend to move away from the others, and in the second group, where the regions exhibit a tendency towards convergence with the first group. There was no region in the third group. Thus, no region tends to lag behind the others. In the CR, most regions were in the second group. These regions tend to move into the first group.

Understanding regional differences in the state and dynamics of the process of demographic ageing in individual regions of both countries is important in order to meet the goals and implement the measures of an active ageing policy. Such knowledge can be used to determine what specific measures need to be implemented in different regions.

CONCLUSION

As *Káčerová* and *Bleha* note (2007), it is important to question whether the ageing process is irreversible or whether there is some way to influence it. On a global scale, in the coming decades it will definitely be an irreversible process. A simple combination of reduced fertility and high life expectancy will act towards ageing at the base of the age pyramid and at the top.

Based on our research it was possible to draw several crucial conclusions. In both countries, the population structure has been changing, as the ongoing process of ageing shows. In the previous period, demographic ageing was more pronounced in the Czech Republic. This was manifested by the higher ageing index values at the beginning of the period analysed. However, in the period analysed ageing was more dynamic in the SR. This was manifested as a higher average growth coefficient of the ageing index in Slovakia than in the Czech Republic.

In both countries the development and dynamics of the ageing process differ among the regions. The only regions in which the ageing index declined are the regions with the capital cities. These regions have the highest life expectancy and an above-average number of live-born children. In the other regions, the ageing index increased. Of all the regions in Slovakia and in the Czech Republic, the Karlovy Vary Region had the fastest growing ageing index. Large initial values and rapid growth of the ageing index was observed in the Trenčín, Nitra and Banská Bystrica Regions in Slovakia and the Hradec Králové Region, Vysočina Region and Olomouc Region in the CR. When active ageing measures are being implemented in both countries, it will be important to take into account the regional differences. In the regions where the level and dynamics of demographic ageing are highest, the most significant need is to create and implement active ageing measures in different areas of social life.

This analysis confirmed that the trend towards convergence in the process of demographic ageing is stronger in the CR. In the SR, no trend towards convergence or divergence of demographic ageing was confirmed. The factors influencing the fact that there is no convergence of demographic ageing in the SR are probably the regional differences in the population structure in terms of religion, the proportion of Roma in the population (especially in the east of Slovakia), and regional differences in economic performance, etc. These facts have a negative impact on the regions' convergence process.

There are some limitations to this analysis. Population ageing was not addressed in the broader context of changes in life expectancy and birth rates. In further research, it would be advisable to monitor the dynamics of changes, i.e. the dynamics and convergence of the development of the life expectancy and the number of live-born children. Nevertheless, this analysis contributes to the field of study by extending the findings that are not part of statistical surveys.

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