**Convergence and divergence tendencies among European countries: possibilities of study and position of the Czech Republic according to recent mortality development**

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Study of convergence and divergence tendencies could be taken as an almost separate field of research in demography (see e.g. Coleman, 2002; Meslé, Vallin, 2002; Wilson, 2001). Moreover, it can play almost a crucial role in calculation of population forecasts. In uncertain situations where the population forecast is needed for a population where the available data time series is not long enough often the results of the analysis of convergence are used. In such a situation the estimated development for any studied country is assumed to converge to some other country (or countries) where time series are sufficient to develop to some extend reliable forecast. There could be more methods of implementing the convergence tendencies into the demographic forecast. However, always the first step consists of finding a country for which convergence can be expected in a reasonably short time horizon.

In this paper, the term "convergence" is not used strictly in a mathematical point of view. The main goal of the paper is to find and apply any simple method of measuring and analyzing the convergence tendencies of the selected population to several other countries. We focused on mortality process where necessary data are available in a unique structure for most of the European countries (we used the Human Mortality Database as a data source).[4] The presented method is based on the study of convergence tendencies of one studied country to several other countries. As a studied country the Czech Republic was selected, as a representative of rapidly developing post-socialist countries. In the paper, the convergence tendencies in mortality are quantified and visualized. As the base for the analysis the life expectancies in selected ages and their linear trend (which was verified using the available data) were used.

One of possible measures of convergence of any two different populations (countries) briefly outlined also by Vallin and Meslé (2004) could be defined as expected year of equalization of their two regression functions $f$ (where those regression functions represent the trend of development of the selected indicator). This time duration ($t_x^{1,2}$) could be calculated as a solution of equation $f_1(x,t_x^{1,2}) = f_2(x, t_x^{1,2})$ where $x$ is a given age for which the indicator (life expectancy) is calculated and $f_j$ is the regression function of the life expectancy of the $j$-th population. Then the time duration to the year of equalization could be simply calculated as $p_x^{1,2} = t_x^{1,2} – 2009$ (where the year 2009 is the initial year of the analysis). It seems reasonable to prefer the target populations with relatively short duration till equalization as assuming convergence (e.g. not in several hundreds of years). When more indicators are used for the evaluation of convergence (e.g. life expectancies calculated for more ages than one), in general when $k$ indicators are used, then the time duration is calculated separately for any of them, however the assessment of convergence have to be done for all of them, i.e. in $k$-dimensional perspective.

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In this paper we used for simplicity only two indicators ($k = 2$) – the life expectancy at the age of 35 and 65 years. The analysis was prepared for males and females separately. When looking for any suitable regression function, it was confirmed that a simple linear regression (calculated for the period 1990–2009) could be used (see Table 1).

***Table 1: Coefficient of determination of linear regression function calculated from the values of life expectancies at the period 1990–2009, males, females, ages 35, 65 years***

| State | Males | | Females | |
|---|---|---|---|---|
| | 35 years | 65 years | 35 years | 65 years |
| Austria | 0,99 | 0,98 | 0,99 | 0,99 |
| Belgium | 0,97 | 0,98 | 0,98 | 0,97 |
| Czech Republic | 0,99 | 0,99 | 0,99 | 0,99 |
| Denmark | 0,97 | 0,95 | 0,93 | 0,85 |
| Finland | 0,99 | 0,98 | 0,99 | 0,98 |
| France | 0,98 | 0,96 | 0,97 | 0,96 |
| Germany | 0,99 | 0,99 | 0,99 | 0,99 |
| Iceland | 0,88 | 0,85 | 0,83 | 0,64 |
| Ireland | 0,95 | 0,94 | 0,95 | 0,93 |
| Italy | 0,99 | 0,98 | 0,98 | 0,98 |
| Luxembourg | 0,94 | 0,91 | 0,92 | 0,89 |
| Netherlands | 0,95 | 0,93 | 0,80 | 0,81 |
| Norway | 0,99 | 0,97 | 0,97 | 0,96 |
| Poland | 0,97 | 0,98 | 0,98 | 0,98 |
| Portugal | 0,97 | 0,97 | 0,97 | 0,96 |
| Slovenia | 0,95 | 0,92 | 0,98 | 0,98 |
| Spain | 0,97 | 0,95 | 0,98 | 0,97 |
| Sweden | 1,00 | 0,99 | 0,98 | 0,95 |
| Switzerland | 1,00 | 0,99 | 0,98 | 0,98 |
| United Kingdom | 0,99 | 0,98 | 0,98 | 0,95 |

For the analysis only those countries were used, where the initial value (in 2009) of life expectancy at both ages (35 and 65 years) was higher than in the studied country, the Czech Republic. Then, based on the parameter estimation of the regression trend, the time duration needed for equalization of the regression functions was calculated (see Figure 1). It is necessary to mention that the extrapolation of the trend is not assumed to be realistic in a long perspective (the linear trend cannot be assumed to last forever). However, the duration till equalization is taken as a measure to evaluate the convergence tendencies and it combines both, the initial distance of the countries in life expectancies as well as the speed of their convergence (difference in trends).

From the results it is clear, that the nearest geographical neighbors of the Czech Republic, like Germany and Austria, could be equalized (according to the life expectancy) after more than one century (under the assumption of constant trend of development). In the case of males at the age of 65, there are not any convergence tendencies with these two countries at all – the negative values of the time duration represent rather divergent tendencies. When looking for any achievable (for the Czech Republic) values of life expectancy in Europe, it could be seen in the maps, that those could be found in countries like Denmark, Netherlands or Spain and Portugal. More detailed description could be done also using the scatter plots. There the “nearest” neighbors could be found easily as the points lying closest to the origin of the coordinate system (see Figure 2 for males and Figure 3 for females).

*Figure 1: Estimated time duration (p) from the year 2009 to the equalization of the life expectancies at age 35 (upper graphs) and 65 (lower graphs) years assuming a linear trend of development, males (left), females (right)*

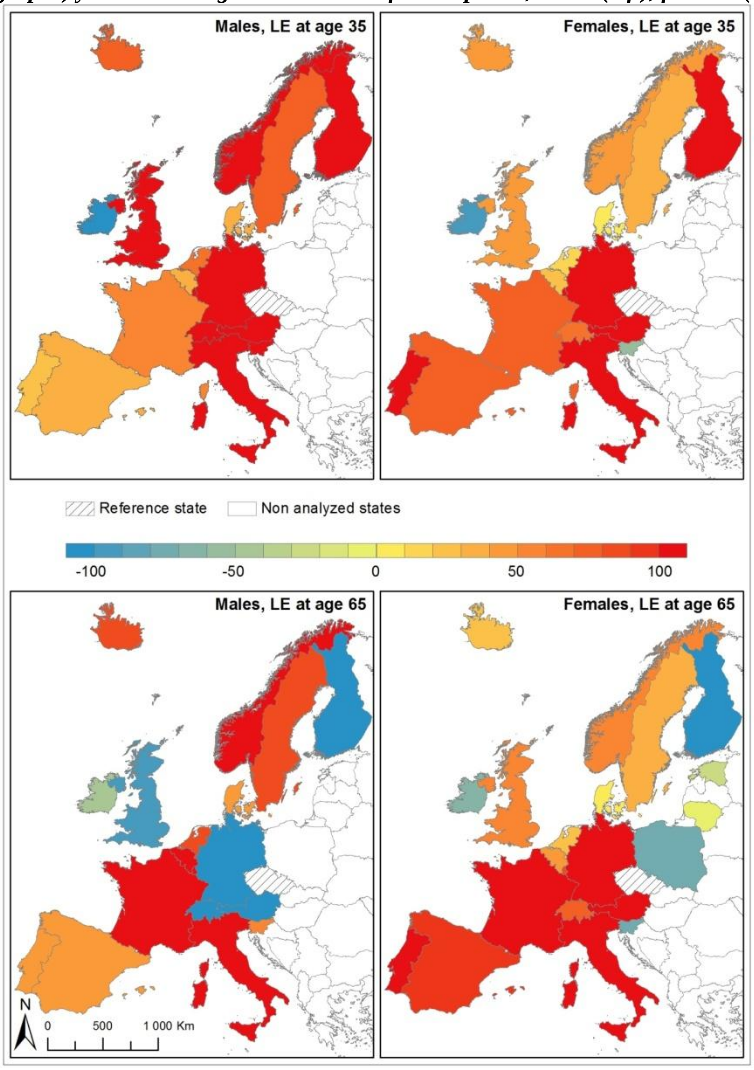



*Figure 2: Expected time duration to the equalization of the life expectancies at ages 35 and 65 for the Czech Republic and other European countries (with higher value of life expectancies in both the ages in 2009), males*

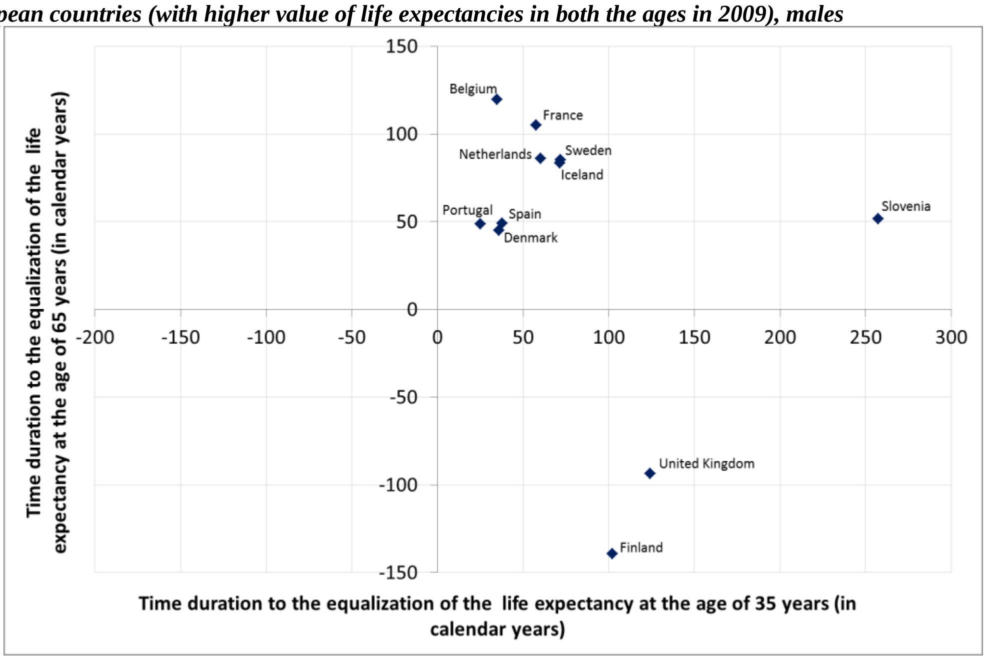
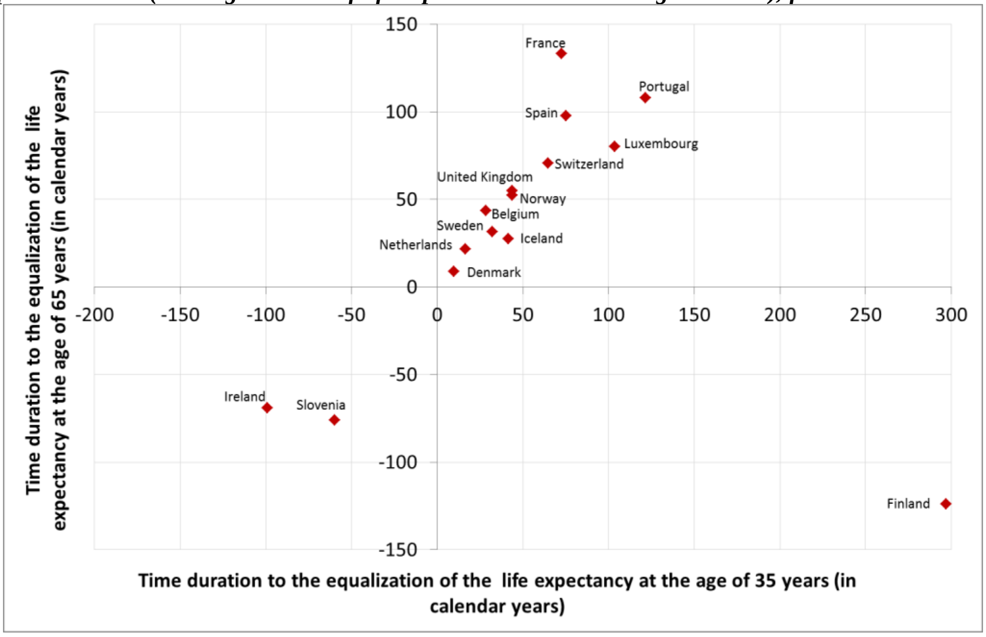


*Figure3: Expected time duration to the equalization of the life expectancies at ages 35 and 65 for the Czech Republic and other European countries (with higher value of life expectancies in both the ages in 2009), females*




Based on the results we showed that the introduced simple method of convergence evaluation is usable in practice. In the paper we applied the method on the example of the Czech Republic, as an example of a post-communist country with rapid positive mortality development after the 1990s. It showed that the “demographic nearest neighbor” in a mortality point of view for the Czech Republic is Denmark – for males as well as for females. Easily such an approach could be applied to any other county.

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