FUTURE DEVELOPMENT OF THE EDUCATION LEVEL OF THE POPULATION OF CZECH REGIONS

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Abstract

The classical population projection gives no information about the "quality" of the population. A possible measure of professional qualification of a person is education attained. The paper contains the population projection of the Czech Republic and its regions not only by sex and age but also by education level.

The computation is based on the classical component method of population projections. Only four basic education levels: primary education, lower secondary education, upper secondary education and tertiary education are distinguished. The surviving probabilities are supposed to depend not only on the sex and age but also on the education level of the person. Increase of education level is regarded as an (internal) "migration" from one subpopulation to another.

The projection has been computed for the population of the Czech Republic and its regions since 2001 until 2051. It shows that the proportion of tertiary educated people will increase rapidly and the gap between the education level of males and females will diminish.

Key words: population projection, component method, education level, Czech Republic, Czech regions.

JEL Code: J11, I25.

Introduction

Classic population projections usually provide only the expected future development of the sex and age structure of the population in each year of the projected period. They give no information about the qualitative side of the population, e.g. about the skills, professional qualification and other productive abilities of the people. A very simple (and of course a very rough) measure of the professional qualification of a person can be its education level. Another possible measure is the wage of a person (see, e.g. Bílková 2009, 2012).

This paper describes very briefly the methodology of a population projection not only by sex and age, but also by education level and gives the main results of computation of such projection for the case of the regions of the Czech Republic.

1 Description of Methodology

The computation of the population projection by sex, age and education level of each person is based on the classical component projection method see, e.g., Bogue at al. (1993), Koschin (2005) with simplified model of migration (only immigration at the level of net migration is assumed, emigration is supposed to be zero).

1.1 Classical Population Projection by Age and Sex

Let's denote

$S_{t,x}$ – the number of persons aged x at the beginning of year t,

$I_{t,x}$ – the number of immigrants aged x during year t. In the case of prevailing emigration these values are negative.

$P_{t,x}$ – the survival ratio – the probability that a person aged x will survive year t.

Assuming the independence of survival probabilities in time the probability of surviving part h of year t is equal to the h-th power of the survival ratio, i.e. to $P_{t,x}^{h}$

The formula for computing the projection including immigration is then (see, e.g., Koschin, 2005).

$$S_{t+1,x+1} = S_{t,x} \cdot P_{t,x} + \frac{I_{t,x} \cdot P_{t,x}^{2/3} + I_{t,x+1} \cdot P_{t,x}^{1/3}}{2}. \qquad (1)$$

The age index in the survival ratio is x in both groups of immigrants because it refers to the age at the beginning of the year, not to the age at the moment of immigration.

For computing the population at age 0 of course only immigrants arriving after their birthday are taken into account so the formula is

$$S_{t+1,0} = N_t \cdot P_{t,*} + \frac{I_{t,0} \cdot P_{t,*}^{1/3}}{2}, \qquad (2)$$

where

N_t is the number of live births of the given sex in year t computed using the well-known formula

$$N_t^{(bs)} = \sum_{x=15}^{49} \frac{S_{t,x}^{(f)} + S_{t+1,x}^{(f)}}{2} \cdot f_{t,x}, \quad N_t^{(m)} = (1-\delta) \cdot N_t^{(bs)}, \quad N_t^{(f)} = \delta \cdot N_t^{(bs)}, \qquad (3)$$

$S_{t,x}^{(f)}$ is the number of females at age x at the beginning of year t,

$f_{t,x}$ are the age-specific fertility rates.

$N_t^{(bs)}$, $N_t^{(m)}$, $N_t^{(f)}$ mean the number of live births in year t of both sexes, males and females, respectively,

δ is the proportion of girls in newborns (usually δ=0.485)

and

$P_{t,*}$ is the survival ratio for newborns – the probability that a child born during year t will survive until the end of year t.

1.2 Computation of the population projection by sex, age and education level

Only four groups of education level were distinguished:

A – primary education (including no education or incomplete education); each newborn child is supposed to belong to this group,

B – lower secondary education (without the school leaving exam),

C – upper secondary education (finished with the school leaving exam),

D – tertiary education.

Let us denote:

$S_{E,t,x}$ – the number of persons of the education level E at age x at the beginning of year t.

$I_{E,t,x}$ – the number of immigrants of education level E at age x during year t. In the case of prevailing emigration these values are negative.

${}_{E_1}G_{E_2,t,x}$ – the number of people increasing their education level from E_1 to E_2 at age x during year t.

This projection is a multistate type of projection distinguishing four subpopulations, A, B, C and D, respectively. The increase of education level can be regarded as an (internal) "migration" from one subpopulation to another. Unlike international migration, which is supposed to be uniformly distributed throughout the year, the moment of graduation (i.e. the moment of the increase in education level) is usually concentrated at the middle of the year. For people having increased their education level it is assumed that the time of survival until the end of the year is approximately half a year both for those graduating before and after their birthday.

The projection formulas are as follows:

$$S_{A,t+1,x+1} = S_{A,t,x} \cdot P_{A,t,x} + \frac{I_{A,t,x} \cdot P_{A,t,x}^{2/3} + I_{A,t,x+1} \cdot P_{A,t,x}^{1/3}}{2} - \frac{{}_AG_{B,t,x} + {}_AG_{B,t,x+1}}{2} \cdot P_{A,t,x}^{1/2} - \frac{{}_AG_{C,t,x} + {}_AG_{C,t,x+1}}{2} \cdot P_{A,t,x}^{1/2}, \qquad (4)$$

$$S_{B,t+1,x+1} = S_{B,t,x} \cdot P_{B,t,x} + \frac{I_{B,t,x} \cdot P_{B,t,x}^{2/3} + I_{B,t,x+1} \cdot P_{B,t,x}^{1/3}}{2} + \frac{{}_AG_{B,t,x} + {}_AG_{B,t,x+1}}{2} \cdot P_{B,t,x}^{1/2} - \frac{{}_BG_{C,t,x} + {}_BG_{C,t,x+1}}{2} \cdot P_{B,t,x}^{1/2}, \quad (5)$$

$$S_{C,t+1,x+1} = S_{C,t,x} \cdot P_{C,t,x} + \frac{I_{C,t,x} \cdot P_{C,t,x}^{2/3} + I_{C,t,x+1} \cdot P_{C,t,x}^{1/3}}{2} + \frac{{}_AG_{C,t,x} + {}_AG_{C,t,x+1}}{2} \cdot P_{C,t,x}^{1/2} + \frac{{}_BG_{C,t,x} + {}_BG_{C,t,x+1}}{2} \cdot P_{C,t,x}^{1/2} - \frac{{}_CG_{D,t,x} + {}_CG_{D,t,x+1}}{2} \cdot P_{C,t,x}^{1/2}, \quad (6)$$

$$S_{D,t+1,x+1} = S_{D,t,x} \cdot P_{D,t,x} + \frac{I_{D,t,x} \cdot P_{D,t,x}^{2/3} + I_{D,t,x+1} \cdot P_{D,t,x}^{1/3}}{2} + \frac{{}_CG_{D,t,x} + {}_CG_{D,t,x+1}}{2} \cdot P_{D,t,x}^{1/2}, \quad (7)$$

where

$P_{E,t,x}$ is the survival ratio – the probability that a person of education level E at age x will survive year t.

Because all newborns belong to education group A, we have (for each sex separately)

$$S_{A,t+1,0} == S_{t+1,0} = N_t \cdot P_{t,*} + \frac{I_{t,0} \cdot P_{t,*}^{1/3}}{2} \quad (8)$$

and, of course, $S_{B,t+1,0} = S_{C,t+1,0} = S_{D,t+1,0} = 0$, where

N_t is the number of newborn boys (or girls respectively) in the whole population and

$P_{t,*}$ is the so called survival ratio for newborns – the probability that a child born during year t will survive until the end of year t.

A more detailed description of the projection methodology can be found, e.g., in Fiala, Langhamrová and Průša (2011).

2 Scenarios of the population projection

2.1 Classical Population Projection of the Czech Republic

Initial demographic structure for the projection has been so that of 1st January 2011 and the projection has then been computed until 1st January 2051. Two variants of the future development of mortality, fertility and migration have been taken into account.

First variant is a slightly modified medium variant of the population projection computed by the Czech Statistical Office in 2009 (*variant CZSO*). See ČSÚ (2009). The second variant assumes that the fertility of the Czech females will (with several years "delay") follow the fertility of the Netherlands' females (*variant NL*). Netherlands' females fertility is very often used as a pattern of future fertility of Czech females because in this country the transition of the fertility to higher age of females has been finished and the fertility seems to be relatively stable.

The trends of population development are assumed to be the same in both variants but the rate of growths differs (see Tab. 1). In the variant NL higher increase in fertility, more

rapid growth of the life expectancy and higher annual net migration have been assumed than in the variant CZSO. The common mortality scenario has been then differentiated according to education level. See, e.g., Mazouch and Fischer (2007). We expect (in both variants) that the Czech Republic will remain to be the country of prevailing immigration but the annual net migration is expected to be much lower than in 2008.

Tab. 1. Scenario of the fertility, mortality and migration

Characteristic	Variant	2010	2015	2020	2025	2030	2035	2040	2045	2050
Total fertility rate	CZSO	1.492	1.529	1.565	1.585	1.605	1.613	1.620	1.628	1.635
	NL	1.492	1.535	1.600	1.650	1.700	1.750	1.800	1.825	1.850
Life expectancy at birth – males	CZSO	74.4	75.7	76.9	78.2	79.4	80.4	81.4	82.4	83.4
	NL	74.4	75.9	77.3	78.8	80.3	81.8	83.3	84.7	86.2
Life expectancy at birth – females	CZSO	80.6	81.7	82.8	84.0	85.1	85.9	86.7	87.6	88.4
	NL	80.6	81.9	83.1	84.4	85.7	86.9	88.2	89.4	90.7
Net migration	CZSO	15 648	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
	NL	15 648	25 000	30 000	35 000	35 000	35 000	35 000	35 000	35 000

Source: Authors' assumptions

Scenario of the demographic projection for the regions of the Czech Republic

The demographic projection for the individual regions was also calculated in two variants derived from the above-mentioned scenarios for the Czech Republic. The structure of fertility and mortality according to age is assumed to be the same in all the regions as in the Czech Republic (but the total fertility rates and life expectancies at birth can be different). Similarly it is assumed that the sex and age structure of net external migration will be the same in all the regions as in the Czech Republic as a whole.

For each region there was a separate assumption of internal migration (i.e. migration between the given region and the other regions of the Czech Republic). For the sake of simplicity it was always only the net migration that was considered – the difference between the number of immigrants and emigrants – and of course that value can be negative if the number of emigrants is higher than the number of immigrants. Both variants assumed a subsequent reduction in internal net migration during the projection period.

2.2 Population projection by sex, age and education level

The initial demographic structure according to education level (i.e. the latest available data of the Czech population by sex, age and education level) come from the population census in 2001. See ČSÚ (2003). Initial demographic structure for the projection has been so that of 1st January 2001 and the projection has then been computed until 1st January 2051.

The estimate of numbers of persons increasing their education level has been based on the numbers of school graduates. Their numbers in 2002–2010 were available in the statistic yearbooks on education. The expected numbers of graduates in the few years following 2011 were estimated from the corresponding numbers of admitted students in previous years and from the expected proportion of graduates estimated according to shares in previous years. The estimated numbers of graduates in later years were based on the assumption that the proportion of graduates out of the total population of a given age will remain constant or will be growing very slightly. For more details see, e.g. Hulík and Tesárková (2009).

For the inclusion of external immigrants in the individual educational groups, it is assumed that the structure of immigrants of a given age according to education level is the same as the structure of the population of the Czech Republic.

This projection is described in more details e.g. in Langhamrová at al. (2011) and in Fiala and Langhamrová (2009), the assumptions concerning immigration are based on Kačerová (2010). More common information concerning the methodology of population projections can be found e.g. in Bogue at al. (1993).

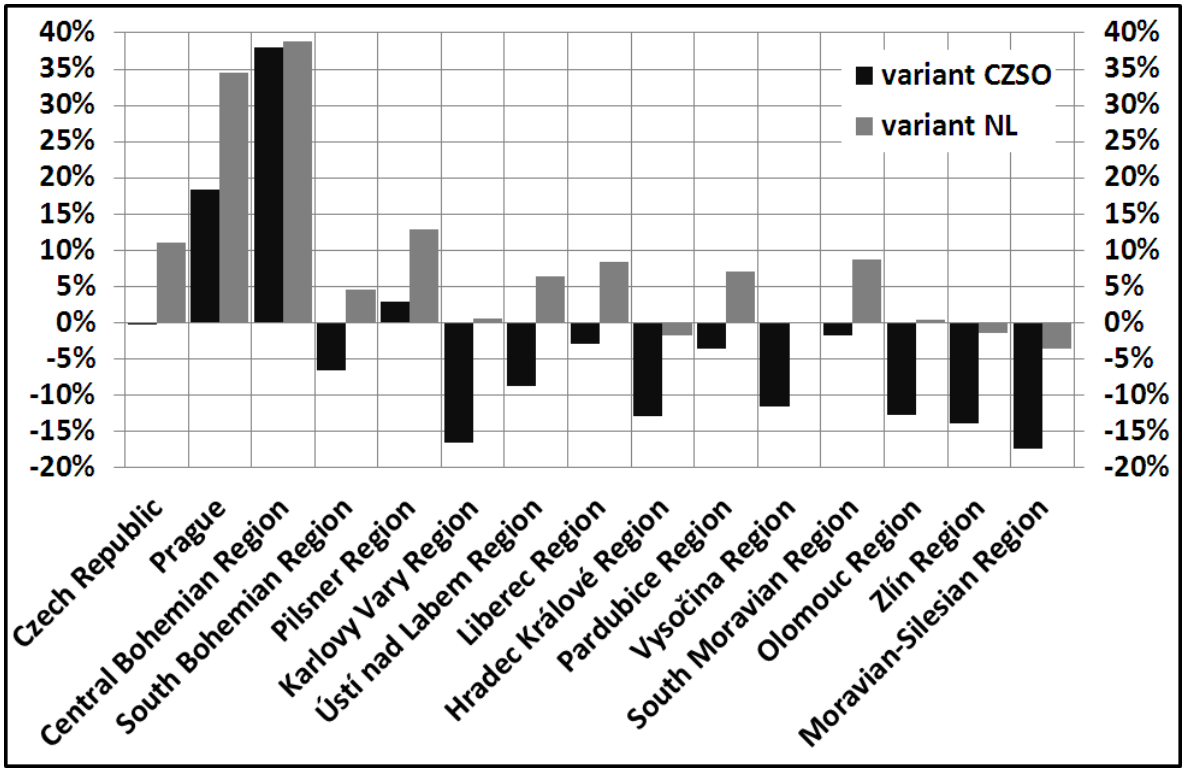
3 Main results of the projection

Because of the limited scope of this article we present only selected results at the regional level. Specific results for the regions have been published in Langhamrová et al. (2011).

According to the CZSO variant the population size of the Czech Republic in 2050 will be approximately the same like at present. But there will be considerable regional changes. The population in Prague will grow by almost 20 %, the population in Central Bohemia Region even by almost 40 %. Most other regions will have population decline. (see Fig. 1). The NL variant on the other hand would result in population increase in most of Czech regions.

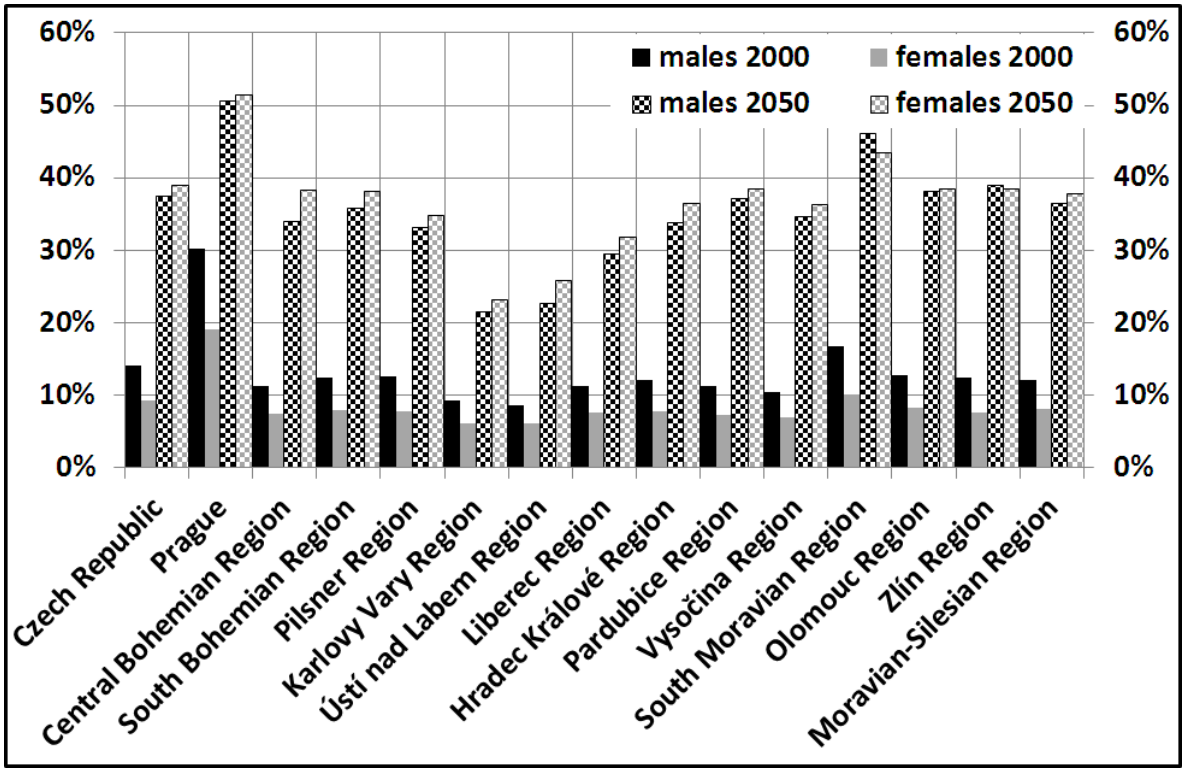
The differences in the population structure by education level between the two projection variants are negligible, we shall present the results for the NL variant only. Because the biggest growth will occur in the proportion of people with tertiary education, we are concentrating only on this level of education at the regional level. Fig. 2 shows the shares of males and females older 25 years with tertiary education in the Czech Republic as a whole and in the individual regions in 2000 and 2050.

Fig. 1. Projected changes in the population size in 2011–2050 (%)



Source: authors' computations and graph

Fig. 2. Proportion of persons older 25 years with tertiary education (%)

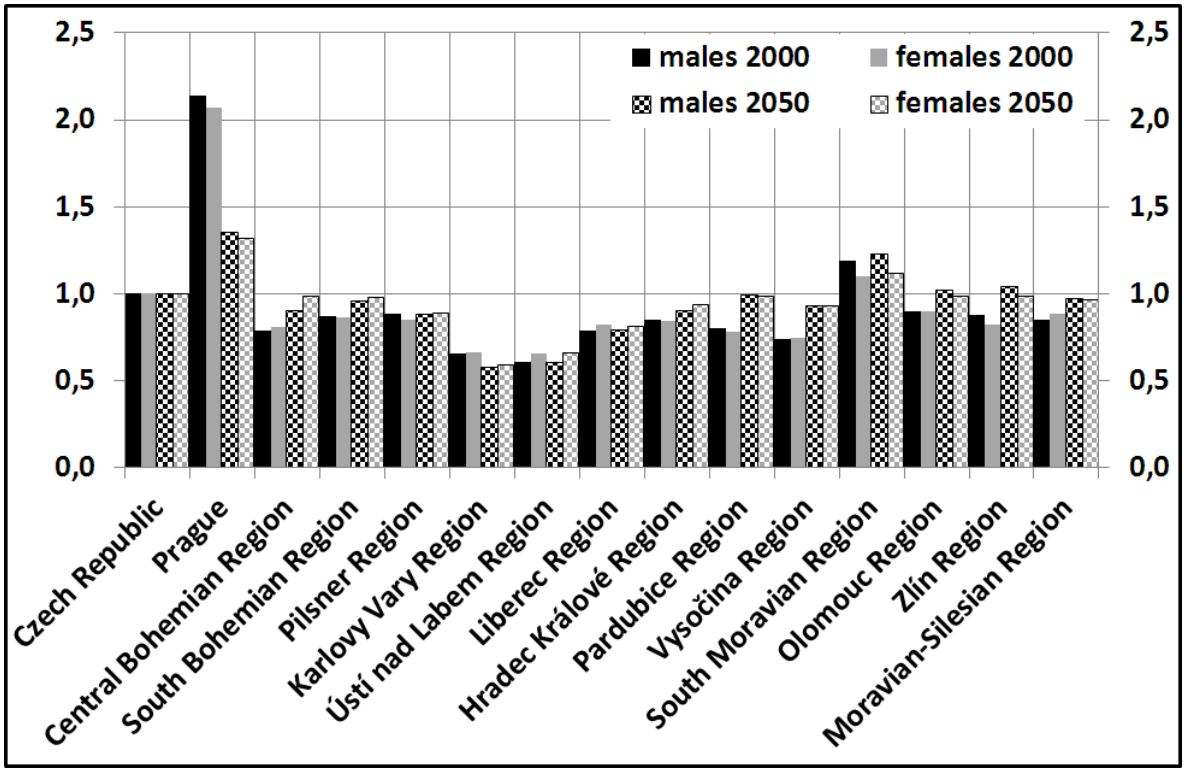


Source: authors' computations and graph

While in 2000 the average share of tertiary educated people has been about 10 % of population only, until 2050 it will grow to almost 40 %. At the same time the gap between the education level of males and females will diminish. Whereas in 2010 there were only about 80 females with tertiary education for every 100 males with this level of education in the Czech Republic, in 2050 there will be a little bit more tertiary educated females than males.

The largest shares of people with tertiary education are, as expected, first of all in Prague and also in the South Moravian Region where the proportion of people with tertiary education is higher than in the Czech Republic as a whole. On the other hand the shares of people with this level of education are in the regions of Ústí nad Labem and Karlovy Vary nearly half in comparison with the level of the Czech Republic. (See Fig. 3). Until 2050 this regional differences will partly decline. The proportion of tertiary educated people in Prague will not more be twice as high as in the Czech Republic but only about by 40 % higher. Many regions (e.g. Central Bohemian, South Bohemian, Pardubice, Olomouc and Zlín) will almost reach the level of the Czech Republic. On the other hand the gap between the republic level and the "less educated" regions will remain (in the Karlovy Vary Region will be even a little bit higher than at present).

Fig. 3. Indices of the proportion of persons older 25 years with tertiary education in Czech regions with respect to the republic level



Source: authors' computations and graph

Conclusion

It can be assumed that there will be further growth in the level of education of the population. The decline of the proportion of people with only primary education will continue, while conversely the proportion of people with tertiary education will increase several-fold. The level of education of females will equal that of males. There are relatively large differences between the education levels of populations in individual regions. The proportion of people with tertiary education in Prague is twice the average level of the Czech Republic. On the other hand, the proportion of tertiary educated people in the regions of South and West Bohemia is three times lower than in Prague.

Despite the differences between males and females, the differences between the education levels in individual regions will not be eliminated during the projected period. But for some regions the differences 2030 2040 2050 will considerably diminish. In 2050 the proportion of people with tertiary education in Prague will be only about 30% higher than that of the whole Czech Republic. On the other hand, the proportion of tertiary educated people in Central Bohemian, South Bohemian, Pardubice, Olomouc, Zlín and Moravian-Silesian regions, which is at present around 80–90% of the average share for the Czech Republic will almost draw even with the level of the average share for the Czech Republic by 2050.

The human capital is utilized only if the people are employed. Especially a long-term unemployment brings means a considerable loss for utilizing the human capital. See, e.g. Löster and Langhamrová (2011).

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