The Impact of Population Development on the Sustainability of the Rural Regions

Ondřej Šimpach[1], Marie Pechrová [2]

[1]Department of Demography, Department of Statistics and Probability, Faculty of Informatics and Statistics, University of Economics in Prague, W. Churchill sq. 4, 130 67 Prague 3, Czech Republic
ondrej.simpach@vse.cz

[2]Department of Economics, Faculty of Economics and Management, Czech University of Life Sciences Prague, Kamýcká 129, 196 21 Prague 6, Czech Republic
pechrova@pef.czu.cz

Annotation: The aim of the paper is to assess the impact of population development on the sustainability of the rural regions. There are 6 predominantly rural NUTS III regions in the Czech Republic: Plzeňský, Jihočeský, Vysočina, Pardubický, Zlínský and Olomoucký region. The rural regions often suffer by unfavourable demographic development. Our paper examines the development of the population in the rural regions based on two scenarios: a simple baseline scenario (SC1), where no changes are made to the fertility and mortality rates and probable scenario (SC2) when the fertility rate is getting closer to the level of fertility of Prague today and the mortality decreases. Using the projections we calculate the future average age and selected comparative indices based on biological and economic generations: the Sauvy age index and economic dependence index. These relations would get worse in the future. The longevity and ageing of the population will increase the economic dependence of the people. This affects the sustainability of the regions' development. This calls not only for the social policy reform, but also for the action on a regional level and solidarity among generations. We suggest taking important decisions without delay.

Key words: rural regions, population development, mortality, fertility, population projection

JEL classification: C83, J11

1 Introduction

Rural regions often suffer by unfavourable demographic development. As noted by Klijn et al. (2005) "we can witness phenomena like stagnation in population growth or even a decline, ageing and ongoing migration to cities draining rural areas." For the development of the regions, not only the number of population but also its structure is extremely important – especially in the light of Community-led local development promoted by the EU. According to this concept local actors have a better knowledge of local challenges that need to be addressed and the resource and opportunities available. The local actors draw up a strategy of the region, analyse the development needs and potential of the area, and identify the main themes of the development process. There are various drivers of the development of rural regions and various indicators of its sustainability. Amcoff and Westholm (2007) argue that the demographic change is a key determinant for explaining social change. Therefore, local actors should know the population trends to prepare the strategy for combating the resulting challenges. "Population changes are fairly predictable and the age transition can explain a wide range of social economic changes" (Amcoff and Westholm, 2007; Botos, Herdon, 2013). The population size and structure is "determined by three fundamental demographic processes: fertility, mortality and migration" (Klijn et al., 2005). Therefore we predict their development.

Regional demographic projections are important for predicting the future age and sex structure of specific population. Unfortunately, the construction of regional projection is particularly difficult because of a small population and insufficiently detailed data. Luckily it is not the case of Czech Republic's NUTS III regions. There are 6 predominantly rural regions in the Czech Republic: Plzeňský (PLZ), Jihočeský (JIČ), Vysočina (VYS), Pardubický (PAR), Zlínský (ZLN) and Olomoucký region (OLM) for which we project the population. The projections consequently serve for estimation of the characteristics of particular demographic structures in the future and as a tool for a discussion of rural development policy options (Pechrová and Šimpach, 2013a).

2 Methods and Data

The paper examines the development of the population in the rural regions based on two scenarios: a simple **baseline scenario** (SC1), where no changes are made to the fertility and mortality rates (the same trend as today) and **probable scenario** (SC2) when the fertility rate is getting closer to the level of fertility of Prague today and the mortality decreases (see e.g. Šimpach and Langhamrová, 2014). The projections are based on the component method without migration (see e.g. Šimpach and Dotlačilová, 2013b). We consider zero migration balance in the near future (the sum of immigrants to the region equals to the sum of emigrants from the region) (Šimpach and Dotlačilová, 2013a) and period from 1st January 2013 (current population structure) to 1st January 2043. In probable scenario SC2 the future population structure is estimated by own projection.

Firstly we calculated the shortened life tables for males / females (5 year intervals) based on the Czech Statistical Office's (CZSO) data for 2013: age-specific number of deaths $M_{t,x}$ and number of mid-year population $\overline{S}_{t,x}$ (where t is time and x is age). For the algorithm of life tables' calculations see e.g. CZSO (2014). The shortened range of life tables is 0, 1–4, 5–9, 10–14, …, 100+ of completed years of life, 0-year-old persons are considered separately. The population projections are constructed for 30 years. The important output from life tables is age-and-sex specific table – the number of living persons l_x. Let for each year t be the table number of 0-year-old living set on (1), where $t = 2013$.

$$l_{t,0} = l_{t+5,0} = l_{t+10,0} = \ldots = 100000, \tag{1}$$

Using the decreasing coefficient of probability of death q_x for a year t the number of living is

$$l_{t,x} = l_{t,x-h} \times \left(1 - k \times \frac{l_{t-5,x-h} - l_{t-5,x}}{l_{t-5,x-h}}\right), \tag{2}$$

where k is the decreasing coefficient of probability of death and h is width of the age interval (5 years). SC1 considers the same trend in mortality as today and the SC2 the probability of death q_x decreasing in the future. Hence, the decreasing coefficient of probability of death is set on 1.00 for males and females in the first case and on 0.93 for males and 0.94 for females in the second case. The coefficients are set according to Šimpach et al. (2014). Because the table number of living persons l_x is in shortened range of life tables for the years t = 2013, 2018, ..., 2043, we recalculate the table number of living persons to the centres of the time intervals $t–h$ = 2013–2017, 2018–2022, ..., 2038–2042 by linear interpolation as

$$l_{t,x} = \frac{4 \times l_{t-1,x} + l_{t+4,x}}{5}. \tag{3}$$

Using the recalculated table number of living persons we estimate the life expectancy at birth. The relation mentioned e.g. by Keyfitz (1991). We use a simple formula (4)

$$e_{t,0}^{0} = h \times \frac{\sum_{x=1-4}^{100-104} l_{t,x} - \frac{l_{t,1-4}}{2}}{l_{t,1-4}}. \tag{4}$$

In the next step the projection coefficients are calculated separately for: live-born persons, 0–4 year old persons, 5–9 year old persons, and older. (The constant (SC1) or lower level (SC2) probability of death is incorporated into the earlier calculated table.) The projection coefficients include this trend for particular time intervals. They have for live-born persons (*) and the time interval t the form used by Koschin (1993) modified for shortened life tables as

$$P_{t,*} = \frac{(1-\alpha)\times l_{t,0} + (2+\alpha)\times l_{t,1-4} + 2\times l_{t,5-9}}{5\times l_{t,0}}. \tag{5}$$

Projection coefficient for 0–4 year old persons and the time t for the shortened projection is

$$P_{t,0-4} = \frac{2{,}5\times(l_{t,5-9} + l_{t,10-14})}{(1-\alpha)\times l_{t,0} + (2+\alpha)\times l_{t,1-4} + 2\times l_{t,5-9}}. \tag{6}$$

Finally, the projection coefficients for persons 5–9 year old and older using Koshin's (1993) formula and modified for shortened life tables is

$$P_{t,x-(x+h-1)} = \frac{l_{t,(x+5)-(x+5+h-1)} + l_{t,(x+10)-(x+10+h-1)}}{l_{t,x-(x+h-1)} + l_{t,(x+5)-(x+5+h-1)}} \text{ for } x \geq 5-9. \tag{7}$$

The prior assumptions for the projection of live-born persons are needed. SC1 presume any changes in total fertility rates, while SC2 assume that the total fertility rates of regions are getting closer to the level of Prague today. They are linearly approximated to the reference region – Prague, where the total fertility rate is one of the lowest in the country (1.36 children per female in average for 2008–2012). Age-specific fertility rates for Prague in 2008–2012 are calculated as

$$f_{2008-2012,x}^{PRG} = \frac{N_{2008-2012,x}^{(v),PRG}}{5\times S_{2010,x}^{(F),PRG}}, \tag{8}$$

where $N_{2008-2012,x}^{(v),PRG}$ stay for the number of live-born persons of x-year-old mothers (x = 15, ..., 49 completed years of life) in Prague during 2008–2012 and $S_{2010,x}^{(F),PRG}$ are the number of females x-year-old, (where x = 15 to 49 completed years of life) in Prague in 2010. Total fertility rate is the summation of the all age-specific fertility rates (age interval h = 5 years):

$$tfr_{2008-2012}^{PRG} = h\times \sum_{x=15-19}^{45-49} f_{2008-2012,x}^{PRG}. \tag{9}$$

Then we calculate the age-specific fertility rates for each rural region in 2008–2012 and the total fertility rate in this region. Firstly, we calculate the age-specific fertility rates at the end of the projection (years 2038–2042) (equation 10), and then we focus on age-specific fertility rates in the middle of the projection period (years from 2013–2017 to 2033–2037), which are calculated by linear interpolation (equation 11).

$$f_{2038-2042,x}^{region} = \frac{tfr_{2038-2042}^{region,ex.}}{tfr_{2008-2012}^{PRG}} \times f_{2008-2012,x}^{PRG}, \tag{10}$$

where $tfr_{2038-2042}^{region,ex}$ is the expected level of total fertility rate in the region during 2038–2042.

$$f_{t,x}^{region} = f_{2008-2012,x}^{region} + \frac{\left(f_{2038-2042,x}^{region} - f_{2008-2012,x}^{region}\right)}{(2038-2008)\times(t-2008)}, \quad (11)$$

where t are the beginnings of the time periods 2013–2017, 2018–2022, …, 2038–2042. We consider zero migration balance in the near future (see Šimpach and Dotlačilová, 2013a).

The population projection has a threshold of 1st Jan. 2013. We use the approach presented by Koschin (1993), which we modified for males (M) and females (F) and the region as

$$S_{t,x}^{(M),region} = N_{t-h}^{(v),(B),region} \times P_{t-h,*}^{(M),region} \text{ and } S_{t,x}^{(F),region} = N_{t-h}^{(v),(G),region} \times P_{t-h,*}^{(F),region} \text{ for } x = 0-4. \quad (12)$$

The number of older people, males and females in each region is calculated as

$$S_{t,x}^{(M),region} = S_{t-h,x-h}^{(M),region} \times P_{t-h,x-h}^{(M),region} \text{ and } S_{t,x}^{(F),region} = S_{t-h,x-h}^{(F),region} \times P_{t-h,x-h}^{(F),region} \text{ for } x \geq 5-9. \quad (13)$$

We estimate the number of live-born persons for the time period t = 2013–2017, 2018–2022, ..., 2038–2042 to x-year old mothers for analysed region using the equation

$$N_{t,x}^{(v),region} = 5\times\left(\frac{\left(S_{t,x}^{(F),region} + S_{t+h,x}^{(F),region}\right)}{2}\right)\times f_{t,x}^{region} \text{ for } x = (15-19)-(45-49). \quad (14)$$

The total number of live-born boys (B) and live-born girls (G) is calculated as

$$N_t^{(v),(B),region} = \sum_{x=15-19}^{45-49} N_{t,x}^{(v),region} \times 0{,}515 \text{ and } N_t^{(v),(G),region} = \sum_{x=15-19}^{45-49} N_{t,x}^{(v),region} \times 0{,}485 \quad (15)$$

where constants 0,515 and 0,485 are the long term proportions of boys and girls at birth. Two types of generations are recognized: biological and economical (see e.g. Tinker, 2002 or Fiala et al. 2011). Considering biologic generations (the age intervals: 0–14 years (I), 15–49 years (II) and ≥ 50 years (III) the Sauvy age indices are calculated. They express how many grandparents per one child are there in the region's population.

$$ix_t^{Sauvy} = \frac{III_{t,bg}}{I_{t,bg}} \quad (16)$$

Using economical generations (the age intervals: 0–19 years (I), 20–64 years (II) and ≥ 65 years (III), the economic dependence indices are calculated. They express how many persons unable to work (pre/postproductive) are depended on productive and economic active persons.

$$ix_t^{dependence} = \frac{I_{t,eg} + III_{t,eg}}{II_{t,eg}} \quad (17)$$

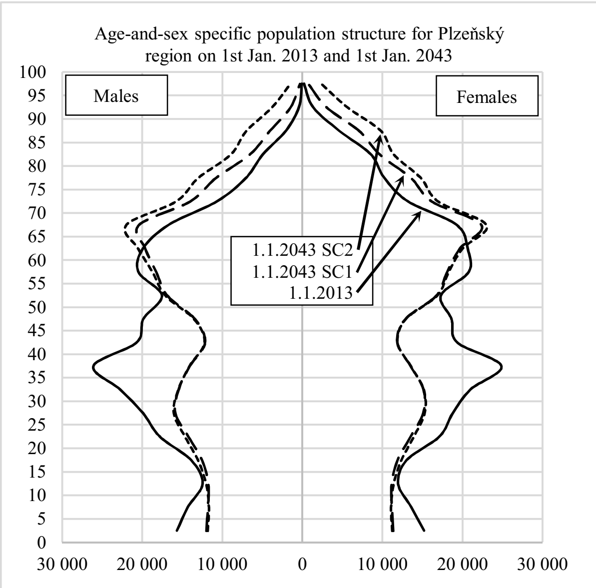
3 Results and Discussion

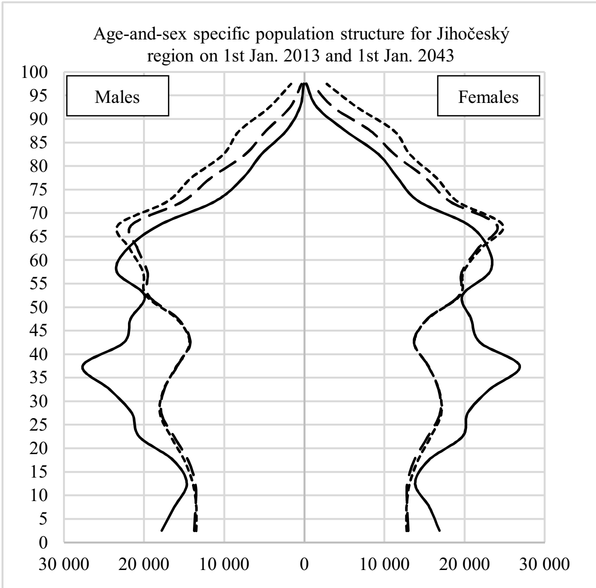
Age-and-sex population structures for rural regions are shown in Fig. 1. Full lines mark current demographic structures, dotted lines show modelled scenarios (SC1 and SC2). The shape of the population pyramid becomes regressive at the top in the future. The increase of number of persons in the highest ages indicates longevity. The population will get older in all regions. Ageing will be difficult issue for local actors in all analysed rural regions and it is the right time now to take important decisions and actions to deal with it.

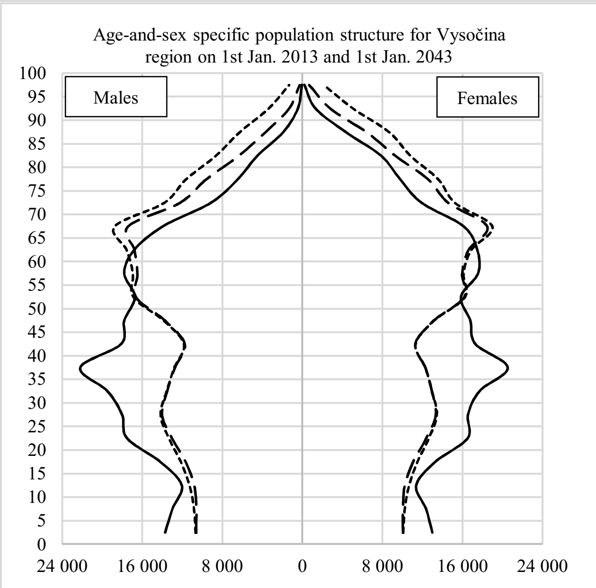
Besides the age-and-sex population structure the Sauvy age indices and economic dependence indices are important (see Table 1). Longevity of the population causes that there will be around 2.5–3.0 grandparents per one child in 2043. There were less than 2.0 grandparents in

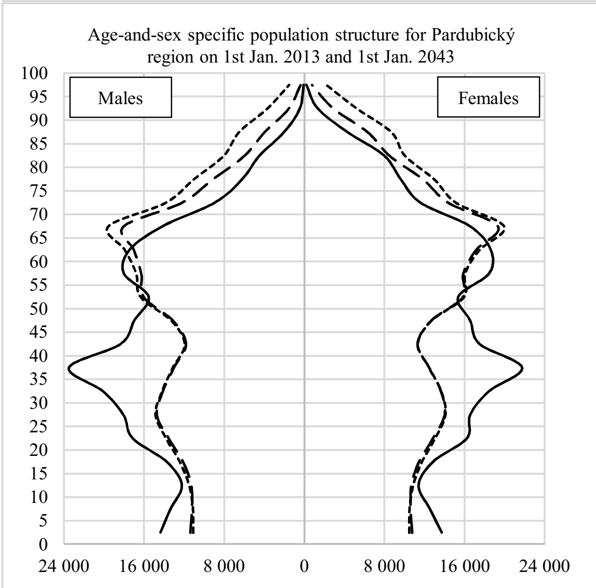
2013. From social point of view it is desirable that the children will have grandparents to later ages than before. However, from economic perspective there will be costs related with taking care of seniors. This is a challenge for the improvement of the social policy which should promote the home care. Economic dependence index was between 0.6–0.7 dependent person per one productive person in particular region in 2013. However, its value will strongly increase in majority of the predominantly rural regions. It will reach almost 1.0 in 2043. In other words, one productive person will have to support almost one person that is unable to secure financial means for living.

Solidarity among generations and social cohesion in the region is needed. The social system in the CR in current setting is probably not able to accommodate the population development.









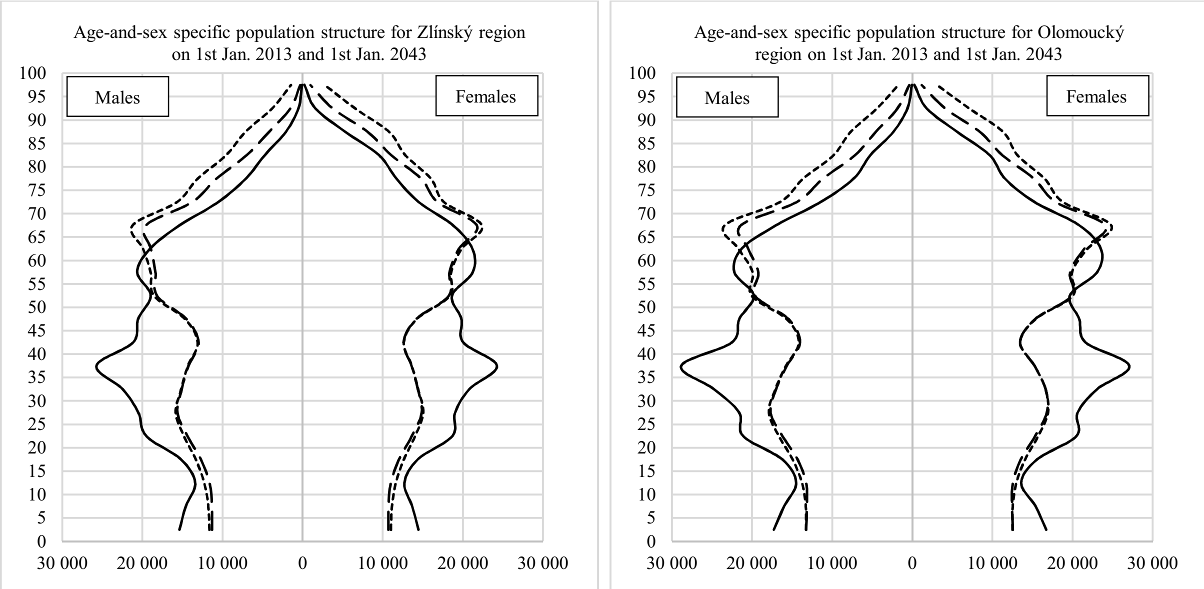


Fig. 1. Age-and-sex specific demographic structures of predominantly rural regions, population on 1st Jan. 2013 and on 1st Jan. 2043 by scenarios SC1, SC2; Source: own calculations and illustrations based on data from CZSO

Predominantly rural regions are specific. They were relatively "young" (i.e. the average age was lower in the past), but had become ageing.

Table 1. Sauvy age indices and economic dependence indices in rural regions on 1st Jan. by scenarios SC1, SC2; Source: own calculations

Year	PLZ				VYS				ZLN			
	SC1		SC2		SC1		SC2		SC1		SC2	
	Sauvy	Dep.	Sauvy	Dep.	Sauvy	Dep.	Sauvy	Dep.	Sauvy	Dep.	Sauvy	Dep.
2013	1,887	0,662	1,881	0,663	1,842	0,681	1,839	0,681	1,928	0,662	1,922	0,663
2018	1,904	0,739	1,904	0,747	1,886	0,733	1,891	0,740	1,979	0,725	1,979	0,733
2023	2,019	0,811	2,032	0,831	1,993	0,792	2,011	0,811	2,100	0,790	2,108	0,810
2028	2,303	0,817	2,343	0,852	2,220	0,808	2,256	0,842	2,356	0,806	2,377	0,843
2033	2,536	0,815	2,643	0,865	2,423	0,817	2,502	0,867	2,597	0,817	2,653	0,871
2038	2,628	0,815	2,836	0,879	2,546	0,819	2,701	0,886	2,742	0,819	2,866	0,892
2043	2,593	0,894	2,885	0,978	2,587	0,876	2,824	0,963	2,779	0,880	2,977	0,977
	JIČ				PAR				OLM			
2013	1,834	0,670	1,830	0,671	1,793	0,681	1,790	0,681	1,860	0,666	1,855	0,667
2018	1,862	0,744	1,867	0,751	1,806	0,751	1,815	0,757	1,878	0,740	1,881	0,747
2023	1,973	0,818	1,993	0,837	1,900	0,816	1,928	0,834	1,982	0,809	1,998	0,829
2028	2,223	0,829	2,271	0,862	2,138	0,822	2,198	0,852	2,240	0,819	2,278	0,854
2033	2,428	0,829	2,539	0,877	2,336	0,819	2,460	0,863	2,456	0,820	2,549	0,870
2038	2,509	0,829	2,715	0,892	2,426	0,819	2,644	0,877	2,556	0,818	2,737	0,884
2043	2,497	0,895	2,790	0,977	2,424	0,888	2,733	0,966	2,564	0,886	2,829	0,973

Thanks to better health condition of the population in these regions, developed infrastructure, higher living standards and other related issues (see Thatcher et al., 1998, or Boleslawski and Tabeau, 2001), the population in all regions will live longer (see mainly SC2) and the life expectancy will increase. However, it must be taken into account that increasing living standards of the population bring also the need to keep people more economic active than before (see e.g. Pechrová and Šimpach, 2013b or Šimpach and Langhamrová, 2014). Indexes of economic dependence point on the fact that more people will be economically dependent on the less. The social system in the CR is not yet ready to manage the population change and prepared for absorbing this social burden. Police makers are probably aware of the situation, but do not have certain instruments to solve it. It is difficult to prepare and launch projects such as investments to retirement houses or to change the social policy and aim more financial means to people who would take care of their old parents at home. Also programs for joining the working process (i.e. the benefits for mothers on parental leave) are important.

4 Conclusion

The aim of the paper was to assess the impact of population development on the sustainability of the predominantly rural regions in the Czech Republic. There were two scenarios considered: a baseline (SC1), with no changes in fertility and mortality rates and probable scenario (SC2) when the fertility rate is getting closer to the current Prague‘s level and mortality decreases. The future average age and the Sauvy age index and economic dependence index were calculated. Not surprisingly, the results of our calculated projection show that the population will be continuously ageing in all selected regions. Thanks to better living conditions, improved health care and other related factors, the longevity will be more often observed phenomena. Government in the CR and local actors in rural regions should consider the development and take actions. A reform of the social policy system might be needed – not only on the state level, but also at the regional one. The regions probably should not fully rely on the state help, but the local actors should address these population development issues too. Otherwise, the unfavourable age structure might cause serious problems to the sustainability of their development. Besides, sustainable development requires not only people rooted in the regions, but also active people familiar with local situation, who are able to identify the needs of the region, and are competent to find and implement the solutions. When there are more economically inactive people, it is harder to enhance the development. Rural regions are in unfavourable position, as their population is ageing. Its influence has also a migration, which we did not consider (for simplification and due to shorter time horizon of the prediction). In the future research, the migration should be also examined closer, as the “flight of young” from rural areas is often observed.

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