

# EXPERTS IN THE FIELD OF EDUCATION AND OTHER POTENTIAL KNOWLEDGE MAKERS IN 2051

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## **ABSTRACT**

The aim of this paper is to estimate the age-and-sex structure of economically active specialists in the fields of education, science and technology and information and communication technologies (ICT) in the year 2051. Used data come from the final results of the Census 2011 by Czech Statistical Office (CZSO). Using the component method and population projection by CZSO – medium variant we calculate how will look the age-and-sex structures of persons who are the main creator of education and intelligence in our population. Especially these three groups have a key influence on education in schools, universities and other institutions. Results, unfortunately, are not quite positive. The number of these specialists will change and age-and-sex structure upsizes in the top and the average age increases. Will be the distribution of those persons in 2051 sufficient to keep the current level of education quality, knowledge, and science in our population?

## **KEYWORDS**

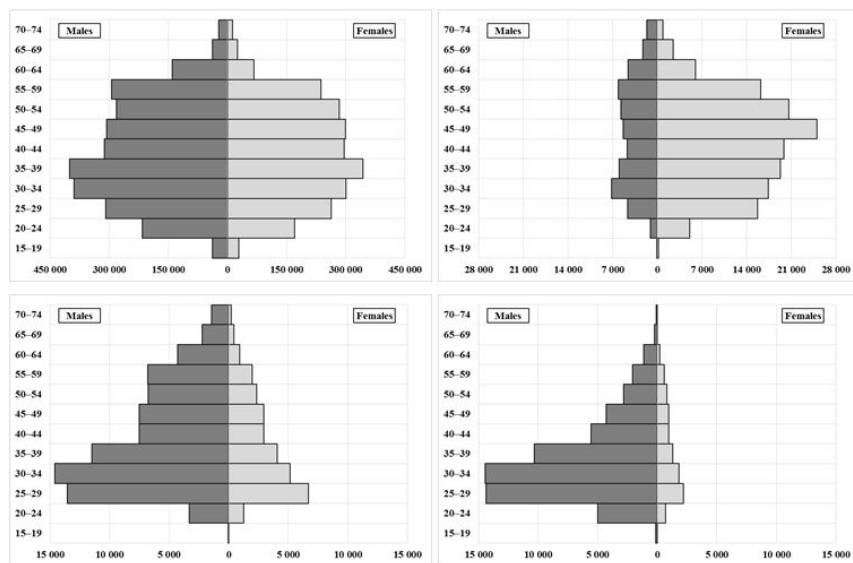
Education, information and communication technologies, science and technology, specialists

## **INTRODUCTION**

Specialists in the field of education work both at primary or secondary schools and universities. Specialists in the field of science and technology work the most frequently in the research and development centres, institutes and universities, and specialists in the field of information and communication technologies (ICT) work in all of these organizations as well. All workers of these groups are the essential building blocks for education, knowledge, training and scientific-technological progress in our society (Pechrová, 2014). So if they truly should fulfil their mission, they must be classified as economically active persons from socio-economic point of view (Fiala, Langhamrová, and Průša, 2011). Given the final results of the Census 2011 by the Czech Statistical Office (CZSO, 2012), we know how the age-and-sex structures of the economically active specialists in these fields looked in 2011. Final results of the Census 2011 are currently the most accurate information channel. The results are complemented every year by the selection of information from the mini censuses, which mostly come from the Labour Force Survey. However, until the next Census in 2021, these values are mere estimates with only partial reliability.

The aim of our paper is to calculate the estimates of age-and-sex structures of specialists in the field of education, science and technology and ICT by more sophisticated way, and especially with the impact on the entire population of the Czech Republic. Given that the specialists from CZSO construct a fairly accurate population projection in three different scenarios (CZSO, 2013), we calculate on the basis of component method (Keyfitz, 1964) the estimates of the age-and-sex structures of these groups of economically active persons

with great precision. The conditions of our calculations are as follows: (I) *selected scenario of the population projection by CZSO is medium variant*. This is because the low and high variant is rather referred to as lower and upper bound – the confidence interval. The most likely scenario that occurs according to CZSO is the medium variant. Our calculation (II) *assume the same decline in mortality over time, which is expected by CZSO* (i.e. the increase in life expectancy at birth of males (females) from 74.70 (80.82) years in 2011 to 83.07 (88.04) years in 2051 and linear increase in the total fertility rate from the value of 1.43 in 2011 to 1.56 in 2051. Finally, it is important to note that (III) *our expectations cannot calculate with a dramatic change in the behaviour of immigration and emigration*. If there is for example a conflict in our society between the Ministry of Education, Youth and Sports and the trade unions negotiating the salaries of teachers and experts in public science and research and these workers would have decided to emigrate, e.g. to some of the neighbouring western countries, where the salaries are higher, our model would not take it into account. Census 2011 was processed by the CZSO's methodology (CZSO, 2012), (results of the economically active persons used in this paper can be seen in Fig. 1), and the population projections of the Czech Republic are also calculated by the CZSO's methodology (see CZSO, 2013). Because the beginning of our analysis is the year 2011 and the Census takes place every 10 years, our results are published for the years 2021, 2031, 2041 and 2051.



**Fig. 1: Empirical data of economically active persons in total (top left), economically active specialists in the field of education (top right), economically active specialists in the field of science and technology (bottom left) and economically active specialists in the field of ICT (bottom right) by Census 2011. Data source: CZSO (2012), author's illustrations.**

Estimation of age-and-sex structures of specific (and smaller) populations is not quite simple (see e.g. study by Fiala, Langhamrová, and Průša, 2011, who predicted the Czech population by the highest level of education attained). In this paper we follow the study by Fiala, Langhamrová (2011), who calculated projections of ICT experts in various economic fields and Šimpach, Pechrová (2014), who analysed the predominantly rural

populations of the Czech Republic. The results of this paper are worrying because they show a future increase in the number of specialists in the highest age groups – slimming of the base of the population pyramids (due to low level of Czech fertility) and also increasing of the average age of the economically active specialists. The lower number of specialists in the field of education may mean in the future (with conditions to keep the same number of total population as today) worsening conditions in the education of our descendants and lower quality of Czech schools and universities. The higher number of elderly specialists in the fields of science and technologies and ICT may mean lack of competitiveness. Czech Republic's population according to the CZSO's projection should not diminish in the future (see on-line results of medium variant by CZSO, 2013 and study by Kincl, Novák, and Štrach, 2013). Our population should take into account potentially lower number of specialists in the field of education right now and take the appropriate steps, such as motivational programs for young people to study in the university programs, which are applicable in the field of education and science (see e.g. Jindrová, Vostrá Vydrová, and Dömeová, 2013).

## MATERIALS AND METHODS

From the results of Census 2011 we know the total number of persons in the population ( $S$ ) in 5-year age groups ( $x-x+h-1$ ) at time  $t = 2011$  by sex ( $M$  - male or  $F$  - female), the number of economically active persons in total ( $EA\_TOT$ ), the number of economically active specialists in the field of education ( $EA\_EDU$ ), in the field of science and technology ( $EA\_SCI$ ) and in the field of ICT ( $EA\_ICT$ ), also in 5-year age groups ( $x-x+h-1$ ) at time  $t = 2011$  by sex, where  $x$  is completed age and  $h$  is the width of age interval 5 years. All the numbers of economically active persons are considered in the age interval from 15–19 to 70+ years. Census 2011 has obviously higher intervals for the total number of persons in the population ( $S$ ), i.e. 70–74, 75–79 ... 100+, but because the number of economically active persons in the highest age group is relatively small, we consider interval 70+ from the groups of ( $EA$ ) as comparable with the interval 70–74 from ( $S$ ) group. This measure is commonly used in similar analyses and as previously stated Fiala, Langhamrová (2011) or Šimpach, Langhamrová (2014), a significant distortion of the results will not happen. Component method of population projection stands on the assumption that the person at the exact age of  $x$  will be next year with a certain probability exactly 1 year older (Keyfitz, 1964, Bogue et al., 1993). The exceptional situations are when a person dies, emigrates, or in addition someone else immigrates. Tab. 1 shows initial assumptions for our projection for males' and Tab. 2 for females' experts.

According to Fiala, Langhamrová (2011) methodology, in our projection we supposed that each population (and profession as well) has its own saturation point in particular age group which achieves and which also will not exceed in the future. These saturation points, calculated as the proportion of economically active persons (and experts in the particular field) to the total population by age group are highlighted in the Tab. 1 for males and in Tab. 2 for females. At the same time we are assuming that every expert works in his / her profession until he / she dies or until he / she reaches the retirement age. (Retirement was generally set at the value of 64 years both for males and for females, the sum of emigration and immigration of experts in the particular field is considered equal to zero). Because of this assumption the proportion of economically active male experts in each cohort after the saturation point will remain at the level of 1,68 % (EDU), 3,50 % (SCI) and 3,71 % (ICT) until he reaches the retirement age and at the level of 7,30 % (EDU), 1,86 % (SCI) and 0,62 % (ICT) until she reaches the retirement age. The average

age of the population is calculated as a weighted average (Coale, Kisker, 1986), where the weights are the number of inhabitants

$$\bar{x} = \frac{\sum_{15-19}^{70-74} (x + \frac{1}{2}) \times EA\_TOT_{x,t}^{M/F}}{\sum_{15-19}^{70-74} EA\_TOT_{x,t}^{M/F}} \quad (1)$$

$x$  is in our case  $(x-x+h-1)$ , and we have to consider the means of the age intervals. Average ages for the population  $EA\_EDU$ ,  $EA\_SCI$  and  $EA\_ICT$  are calculated in the same way.

Age	S	EA_TOT	EA_EDU	EA_SCI	EA ICT	EA_TOT (%)	EA_EDU (%)	EA_SCI (%)	EA ICT (%)
15-19	297 860	38 032	33	49	135	12,77	0,01	0,02	0,05
20-24	354 381	215 405	1 053	3 320	4 993	60,78	0,30	0,94	1,41
25-29	387 292	308 904	4 674	13 549	14 361	79,76	1,21	3,50	3,71
30-34	463 655	388 980	7 139	14 593	14 467	83,89	1,54	3,15	3,12
35-39	459 293	400 142	6 008	11 484	10 310	87,12	1,31	2,50	2,24
40-44	364 367	312 658	4 694	7 516	5 575	85,81	1,29	2,06	1,53
45-49	356 929	306 054	5 380	7 510	4 274	85,75	1,51	2,10	1,20
50-54	338 051	282 131	5 668	6 754	2 840	83,46	1,68	2,00	0,84
55-59	369 091	293 794	6 142	6 793	2 080	79,60	1,66	1,84	0,56
60-64	353 635	140 317	4 608	4 284	1 155	39,68	1,30	1,21	0,33
65-69	250 635	38 356	2 253	2 232	260	15,30	0,90	0,89	0,10
70-74	163 771	21 674	1 651	1 457	93	13,23	1,01	0,89	0,06
TOTAL	4 158 960	2 746 447	49 303	79 541	60 543	66,04	1,19	1,91	1,46

**Tab. 1: Males' economically active experts in the particular field in the Czech population.**  
Source: data CZSO (2012), authors' calculations

Age	S	EA_TOT	EA_EDU	EA_SCI	EA ICT	EA_TOT (%)	EA_EDU (%)	EA_SCI (%)	EA ICT (%)
15-19	282 322	28 799	209	23	12	10,20	0,07	0,01	0,00
20-24	333 971	170 755	5 069	1 240	686	51,13	1,52	0,37	0,21
25-29	359 138	262 753	15 714	6 683	2 212	73,16	4,38	1,86	0,62
30-34	435 335	300 272	17 390	5 169	1 821	68,97	3,99	1,19	0,42
35-39	432 522	343 664	19 266	4 054	1 301	79,46	4,45	0,94	0,30
40-44	343 645	295 954	19 837	2 947	973	86,12	5,77	0,86	0,28
45-49	342 704	300 081	25 017	2 955	949	87,56	7,30	0,86	0,28
50-54	336 610	283 511	20 624	2 331	803	84,23	6,13	0,69	0,24
55-59	386 841	237 045	16 215	1 984	593	61,28	4,19	0,51	0,15
60-64	391 152	67 031	5 997	913	219	17,14	1,53	0,23	0,06
65-69	302 702	25 711	2 507	430	39	8,49	0,83	0,14	0,01
70-74	220 356	12 787	890	196	5	5,80	0,40	0,09	0,00
TOTAL	4 167 298	2 328 363	148 735	28 925	9 613	55,87	3,57	0,69	0,23

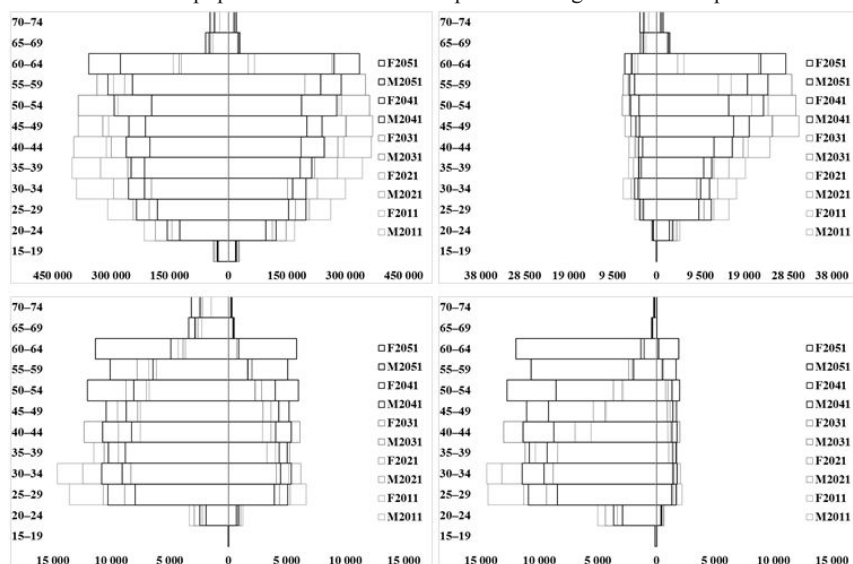
**Tab. 2: Females' economically active experts in the particular field in the Czech population.**  
Source: data CZSO (2012), authors' calculations.

## RESULTS AND DISCUSSION

Using the above methodology we calculate the estimates of the economically active population in total, the number of economically active specialists in the fields of education,

science and technology and ICT at 1<sup>st</sup> January 2021, 2031, 2041 and 2051. We use the multi-tree charts, i.e. the population pyramid, where time is represented by the shadow changes, for the presentation of results. The lightest shade represents presence, the darkest far future. Males are according to the conventions always displayed on the chart on the left side of zero central axes, females on the right. The results of population projection present Fig. 2.

We can see that in almost all young age groups the number of the economically active specialists decline in the future and in almost all older age groups the number of these specialists increase. Mentioned declines are mainly caused due to the fact that the Czech population is aging in general and the age-and-sex structure begins to have a regressive shape such as the population of the Western European type. An increase in the number of economically active specialists in the highest age groups indicates longevity of the Czech population and the need to remain economically active to the later ages due to the later retirement (more e.g. in Potužáková, 2009 or Kubanová, Linda, 2013. Our simplified assumption was that we set the retirement age on the value of 64 years both for males and females. According to current negotiating of pension reform, the retirement age could exceed 70 years in the future). Low level of the total fertility rate, which is (and will be) below the natural level of the population reproduction (below 2.08 children per 1 female during her reproductive period), is not enough to restore the population. To maintain the current state of the population in the Czech Republic immigration can help.



**Fig. 2: Projection of economically active persons in total (top left), economically active specialists in the field of education (top right), science and technology (bottom left) and ICT (bottom right) for years 2021, 2031, 2041 and 2051. Males are on the left side, females on the right side. (Source: author's calculations and illustrations)**

The empirical data from the year 2011 and projected results up to the year 2051 provide an interesting view on the population of economically active experts in the field of education and ICT. While in education field always dominated (and will dominate) females, in ICT it is opposite. Given that females work as teachers in primary and secondary schools to a

greater extent than males, this result is logical. The number of female teachers begins to equal the number of male teachers only at the universities. In the case of ICT it is clear that the profession which requires working with computers always was and will be the domain of males rather than females. The base of the male ICT pyramid is very young – progressive, because the greatest knowledge potential and economic efficiency have young people in this area. The shape of this population pyramid will be dramatically changed in the future, because if today people working as ICT experts remain in their profession and grow old here, the population pyramid gets significantly regressive form at the (left) males' side. In order to comprehensively summarize these results, we look at the Fig. 3, in which is shown the expected future development of economically active persons in total and economically active population by particular field.

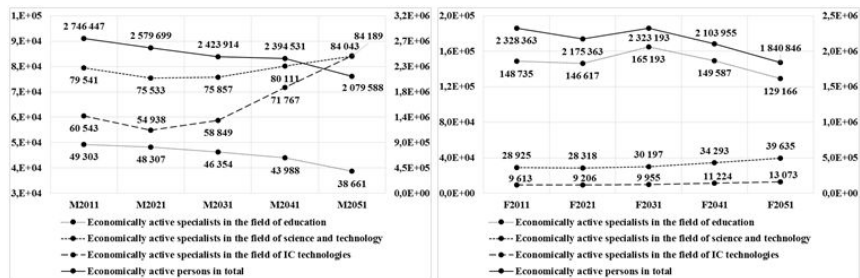


Fig. 3: Calculated total numbers of economically active males (left) and females (right) by various types of their knowledge potential for projected years 2021, 2031, 2041 and 2051.

Economically active persons in total are assigned to the right y-axes. (Source: author's calculations and illustrations)

The average ages calculated according to formula (1) significantly rise until 2031 in the case of economically active females in total and economically active female experts in the field of education, where occurs the peak and these ages again slightly fall in 2041 and 2051 (see Fig. 4). The average age of the economically active males in total and all of the analysed expert populations will grow because males have the stronger bases in these age-and-sex structures. It is mainly caused because males do not stay on maternity and parental leave; (the same claim also stated Krebs, Průša, 2013). This strong base will grow old one day. The most significant increase in the case of male population is 50.20 years of average age at ICT experts. This information should not be overlooked, because our society could have a non-competitive ICT sector one day, because elderly structure of experts is not able to keep up with the times. Given that the year 2031 will occur quite early (within 16 years), it is the right time to motivate young people to study scientific disciplines orientated towards the area of education, science and technology and ICT as well. The average is sensitive to the outliers and therefore it would be sufficient to motivate about several thousand young people who would strengthen the base of these analysed structures in subsequent few years, so the mentioned year 2031 should be the peak or the inflexion point only and significant future aging of the expert population would occur with much less intensity. Very significant increase in the average age has also male and female population of experts in the field of science and technology, which may well mark a significant proportion of professors and associate professors in the population, but innovation and new ideas are often produced by a young and ambitious scientific generations.

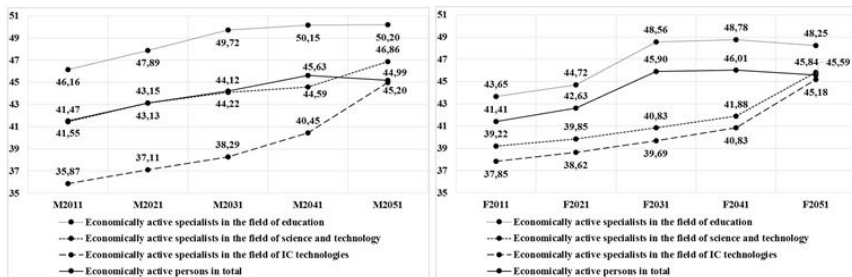


Fig. 4: Calculated weighted average ages of economically active males (left) and females (right) by various types of their knowledge potential for projected years 2021, 2031, 2041 and 2051. (Source: author's calculations and illustrations)

## CONCLUSION

The aim of this paper was to estimate the future shape of the age-and-sex structure of economically active persons in the fields of education, science and technology and ICT up to the year 2051 and point out the possible future adverse development that will mean slimming down the bases of these structures. The highest average age will probably continue to increase in these groups during all analysed period. Our selected groups of people have a key influence on education in primary and secondary schools, universities and other educational institutions. If the ratio of specialists to the population of the appropriate age groups and the appropriate points of interest decreased, it could deteriorate the quality not only in education but also in scientific and technological progress of our society. It is important to note that the results of our projection stand on certain assumptions and that no model can unfortunately take into account the unexpected changes that may occur (such as unexpected changes in people's behaviour, government intervention through legislation and public policy, or the global situation in the world, such as economy, political regimes, wars or diseases).

In the future we will expand our research with similar analysis of the age-and-sex population structures of the economically active specialists in the fields of education, science and technology and ICT based on high and low variants of the population projections by CZSO, which would give us the upper and lower bounds to our analysis. Low variant by CZSO takes into account the relatively strong population decrease (mainly due to the low level of total fertility rate and weak immigration) and high variant works with significant population increase (mainly due to higher level of total fertility rate and stronger immigration). Very interesting modification of this study would occur if we consider the different ages of retirement in our calculations. After the approval of new pension reform, we will be able to recalculate results and use various scenarios of the retirement age.

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