

Age structure and the burden carried by the productive population of the Czech Republic

Věková struktura a zatížení produktivní populace v České republice

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Abstract: The study evaluates the age structure of the Czech population with the emphasis on the burden born by the productive population due to the pre-productive and post-productive population. The extent of the burden born by the productive population is measured by the age structure coefficients. The situation is best described by the youth and old age dependency coefficients, the overall dependency coefficient, and the ageing index. The dynamic aspects can be best analyzed on the basis of the inflow and outflow coefficients. During the last century, the demographic development was seriously disrupted by a series of events that caused the birth rate fluctuation. The repercussions of these fluctuations are perceptible even today. This study focuses on the period ranging from 1993, when the Czech Republic became an independent state, to the beginning of 2004. The prevailing demographic feature of this time is the decreasing population and the negative development of the age structure. This is marked by a decreasing pre-productive population of children aged under 14, and an increasing post-productive population of old people above 64 years of age. The process of ageing of the Czech population is becoming evident. According to the published forecasts, these negative tendencies are not likely to dwindle in the future. The proportion of young people who were born towards the end of the twentieth century and who will in a few years become a part of the productive population will be considerably smaller than the number of the baby boom representatives who will have retired.

Key words: demographic development, age structure, burden of the productive population, Czech Republic

Abstrakt: Práce se zabývá hodnocením věkové struktury obyvatelstva České republiky se zaměřením na zatížení produktivní populace obyvatelstva předproduktivní a poproduktivní složkou. Míra zatížení produktivní populace je měřena prostřednictvím koeficientů věkové struktury, z nichž nejlépe vystihují situaci koeficienty závislosti mladých, starých a závislosti celkové, index stárí a z dynamického hlediska koeficienty přílivu a odlivu. Velké zásahy do demografického vývoje způsobené mnoha událostmi během minulého století zapříčinily výkyvy porodnosti, které se promítají až do současnosti. Ve sledovaném období od osamostatnění České republiky v roce 1993 do počátku roku 2004 je pro Českou republiku typickým rysem úbytek počtu obyvatel a současně i nepříznivý vývoj věkové struktury s klesajícím podílem dětské předproduktivní složky do 14 let a rostoucím podílem poproduktivní složky starších lidí nad 64 let. Začíná se projevovat proces stárnutí populace. Podle zveřejněných prognóz budoucího vývoje má započatý nepříznivý trend nadále pokračovat. Už v blízkých letech se projeví vstup jen malého počtu mladých lidí narozených koncem 20. století do produktivní populace oproti odchodu silných populačních ročníků do důchodového věku.

Klíčová slova: demografický vývoj, věková struktura, zatížení produktivní populace, Česká republika

Today, the question of the demographic development and ageing population are two increasingly debated issues that are taken more and more seriously both at the global and regional level. Tomšík and Lišková (2004) stress that the age structure study

is important in the business sphere. In the 1990s, the demographic situation in the Czech Republic was developing in such a way that it became soon similar to the situation in the Western European countries. Today, we can say that its demographic

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indices are comparable to those of the developed countries. The low birth rate and the prolongation of the human life span are gradually leading to the ageing of our population. The transformation into market economy that brought new opportunities for young generations contributed to some substantial changes in the population development. This situation caused changes in people's reproduction behaviour and their attitude to lifestyle. More emphasis started to be placed on carrier, exploitation of opportunities to work abroad, various pastimes, etc.

The demographic history is dealt with by Pavlík (1995). He analyses the character of the demographic revolution marked by the declining mortality and birth rate and the increasing life expectancy. According to Pavlík, the gist of the problem consists in the revolutionary change in the demographic behaviour. Růžková and Aleš (1994) assessed the demographic situation in the Czech Republic during the economic and social transformation and identified certain changing trends in the population development. These trends were based on the dissociation from the East European standards and manifested themselves clearly by the enormous decline in marriage and birth rates. Kučera and Šimek (2000) substantiate the changes in the number of the population within the individual age-classes by demographic waves. Whereas the initially stagnant number of new born children has gone down recently, in the case of the older age groups the five years of stagnation are followed with a rapid increase. Aleš (1996), too, regards the stagnation manifested by the decreasing proportion of children as one of the effects the process of ageing has on our population. Koschin (2003) found evidence for the thesis that it was not until the early 1990s when the stationary population turned into a distinctly regressive population component. He maintains that for the time being, there is no imminent danger of a dramatic increase in the number of pensioners. He thinks that such a change will take place in ten or twenty years' time when, however, the number will be skyrocketing to the heights we have never seen before. Kretschmerová (2004) suggests that the age-class distribution in the last decade was affected by the decline and later stagnation in the amount of new born children, and not more than a moderate increase in the number of productive and post-productive population. According to her, these trends temporarily reduced the burden born by the economically active population. She notes, however, that this situation is bound to change in the not too distant future. The burden will grow as the proportion of the dependent inhabitants in their post-productive years will continue to surge. Koschin (2000), Srb (2000),

and Kučera (2000) consider the possible solutions of the adverse population development in the Czech Republic, discussing the problem especially in terms of the birth rate and immigration trends.

The generally recognised assumption that the progressive ageing of population will become the predominant feature of the future population development in the Czech Republic is adopted by Burcin and Kučera (2002). Their theory is further supported by the evidence from the developed countries where the same demographic process is taking place as a result of the drop in birth rate and prolongation of the life expectancy. Šimek (1994) forecasts the development of the population in the Czech Republic till 2020, analyzing both the development of the population as such and the development of its pre-productive, productive and post-productive components. His underlying prediction, which does not take into consideration the impact of migration, suggests that the birth rate and death rate will remain steadily low even in the next decade. The prediction of trends within the population of the Czech Republic till 2020 elaborated by Aleš and Šimek (1996) is based on the demographic development in the Western European countries. The forecast is focused on the development of the individual age groups including their connections to the economic and social development. The prognosis on the development of the number and age structure of the Czech population till 2050 was produced in three variant solutions by the Czech Statistical Office. It should be noted that none of the three versions, not even the most optimistic one, implies a positive demographic development, which means that the new situation will bring a series of problems in the socio-economic development.

The goal of this study is to help to describe and analyse the development of the age structure of the Czech population. Its major objective, however, is to contribute to the analysis of the burden that the productive population needs to face and to examine the dynamism of the changes that have taken place over the period of the Czech national independence, i.e. from 1. 1. 1993 up to now.

MATERIAL AND METHODOLOGY

The majority of source data used for this study were taken from the surveys published by the Czech Statistical Office on its website or from its annual reports and other publications dealing with the population of the Czech Republic. The number of the population in the individual age groups is shown in Table 1.

Table 1. Population numbers in the Czech Republic between 1993 and 2004 (as by 1st January)

Year	Total population	Population in the specified age groups				
		0–14	0–19	15–64	20–64	65 +
1993	10 325 697	2 064 545	2 975 205	6 932 894	6 022 234	1 328 258
1994	10 334 013	2 009 752	2 918 362	6 981 337	6 072 727	1 342 924
1995	10 333 161	1 948 024	2 836 074	7 028 905	6 140 855	1 356 232
1996	10 321 344	1 893 259	2 744 924	7 055 805	6 204 140	1 372 280
1997	10 309 137	1 842 679	2 653 537	7 078 210	6 267 352	1 388 248
1998	10 299 125	1 795 032	2 567 529	7 102 231	6 329 734	1 401 862
1999	10 289 621	1 751 471	2 484 719	7 126 712	6 393 464	1 411 438
2000	10 278 098	1 707 205	2 406 737	7 152 815	6 453 283	1 418 078
2001	10 266 546	1 664 434	2 346 767	7 179 109	6 496 776	1 423 003
2002	10 206 436	1 621 862	2 296 320	7 170 017	6 495 559	1 414 557
2003	10 203 269	1 589 766	2 255 048	7 195 541	6 530 259	1 417 962
2004	10 211 455	1 554 475	2 218 516	7 233 788	6 569 747	1 423 192

The methodological guidelines for the calculation of the demographic indices specifying the age structure, as well as the various approaches to the calculations, are presented by Kovář and Říhánek (1995). Into the class of the basic indices, there fall the proportions of the individual age groups and the comprehensive indicators of the average age and the age median. Given the asymmetrical distribution of the population by age, the given mean values are not sufficiently responsive to the changes in the age structure. It is therefore characterised by the dependency coefficients, the ageing index and inflow and outflow indices that serve as dynamic indicators.

One of the standard methods to draw up the age structure of a given population is to classify the age groups in correlation with their economic activity. In this way, we can speak of pre-productive, productive and post-productive population.

Problems arise when the age limits are to be set for the transition from and to the productive years. There are various approaches to the question how the upper and lower age limits for the economically active generation should be set. The internationally recognised lower limit set for the transition to the productive years is 15 years but in the Czech environment the real limit is more likely to be 20 as most young people tend to get at least some secondary education before they launch their carriers. Given the increasing popularity of the education programmes at the bachelor level, it is reasonable to expect that for a considerable part of the young people this limit will be further extended by another three years. The

limit for the transition to the post-productive years should logically coincide with the limit set for retirement. This means that the corresponding legislation must be respected. The limits in this country are being shifted and, what is more, there are differences between the age limits for the retirement of men and women. From the international point of view and according to the World Health Organisation, the age limit for the post-productive years is set at 65 years, which corresponds with the retirement age in the European Union. The quoted limit is also appropriate with regard to the future development.

The redefinition of the age limits for the productive years can cause substantial differences in calculations of the productive population's burden. The age limits for the transition to the productive age used for the calculations of burden coefficients in this study are therefore 15 and 20 years, considering the biological and economic limit respectively. Such calculations are bound to produce a better analysis of the demographic situation in the whole of the Western and Central Europe. The age limit for the transition to the post-productive years used in all calculations is 65, both for men and women.

Age structure coefficients:

– *Youth dependency coefficient* expresses the burden of the productive population imposed on it by the pre-productive generation:

biological limit:

$$C_{D(y-b)} = \frac{P_{(0-14)}}{P_{(15-64)}} \times 100$$

economic limit:

$$C_{D(y-ec)} = \frac{P_{(0-19)}}{P_{(20-64)}} \times 100$$

– *Old age dependency coefficient* indicates the proportion of the post-productive and productive population:

$$C_{D(old)} = \frac{P_{(65+)}}{P_{(15-64)}} \times 100$$

– *Overall dependency coefficient* defines the burden of the productive population imposed on it by the pre-productive and post-productive population:

biological limit:

$$C_{D(ov-b)} = \frac{P_{(0-14)} + P_{(65+)}}{P_{(15-64)}} \times 100$$

economic limit:

$$C_{D(ov-ec)} = \frac{P_{(0-19)} + P_{(65+)}}{P_{(20-64)}} \times 100$$

– *Ageing index* specifies the proportion of the post-productive and pre-productive population:

biological limit:

$$I_{AGE(b)} = \frac{P_{(65+)}}{P_{(0-14)}} \times 100$$

economic limit:

$$I_{AGE(ec)} = \frac{P_{(65+)}}{P_{(0-19)}} \times 100$$

– *Inflow coefficient:*

$$C_{in} = \frac{P_{(15-19)}}{P_{(15-64)}} \times 100$$

– *Outflow coefficient:*

$$C_{out} = \frac{P_{(60-64)}}{P_{(15-64)}} \times 100$$

The analysis also employs statistical measures producing a comprehensive picture of the dynamism of changes within time series of demographic indicators:

– *Average absolute growth (decrease):*

$$\bar{\Delta} = \frac{1}{n-1} \sum_{i=2}^n \Delta_i = \frac{y_n - y_1}{n-1}$$

– *Average growth coefficient:*

$$\bar{k} = {}^{n-1}\sqrt{\prod_{i=2}^n k_i} = {}^{n-1}\sqrt{\frac{y_n}{y_1}}$$

FINDINGS AND DISCUSSION

The development of age structure of the population is affected by the long-term development of the birth rate and death rate, whereas the impact of migration has only a marginal significance. In the twentieth century, the birth rate development in the Czech Republic was rather uneven, which

Table 2. Age structure of the population of the Czech Republic (as by 1st January)

Year	Proportional representation of the age group in %				
	0–14	0–19	15–64	20–64	64 +
1993	19.99	28.81	67.15	58.33	12.86
1994	19.45	28.24	67.55	58.76	13.00
1995	18.85	27.45	68.02	59.42	13.13
1996	18.34	26.59	68.36	60.11	13.30
1997	17.87	25.74	68.66	60.79	13.47
1998	17.43	24.93	68.96	61.46	13.61
1999	17.02	24.15	69.26	62.13	13.72
2000	16.61	23.42	69.59	62.78	13.80
2001	16.21	22.86	69.93	63.28	13.86
2002	15.89	22.50	70.25	63.64	13.86
2003	15.58	22.10	70.52	64.00	13.90
2004	15.22	21.73	70.84	64.33	13.94
$\bar{\Delta}$	-0.4336	-0.6436	0.3355	0.5455	0.0982
\bar{k}	0.9755	0.9747	1.0049	1.0089	1.0074

resulted in the uneven age structure of the current living population. Another significant factor was the declining mortality and prolonged life expectancy, which is now reflected in a steady growth in the proportion of inhabitants reaching a very advanced age. In the analysed period, the migration factor did not practically affect the age structure at all, since the increasing number of foreigners immigrating to our country has not so far achieved any proportionally significant level.

After the revolutionary change of the political system, Czech population, like other populations in other post-communist countries, underwent certain changes related to the reproduction and family behaviour. The new social system and its rules are gradually gaining ground, which has been approximately since 1993, when the independent Czech Republic came into being, distinctly manifested by the change of the demographic indicators.

The number of the population as by 1st January 1993 was 10 325 697. Over the following two years, the number of the population went slightly up but then it dropped down again to dive to its record lows of 10 203 269 in 2003. Kučera and Šimek (2000) inform us that since the annual number of new born children levelled off at 90 thousand, the curve has been dropping steadily, namely by some 4 per cent since 1991.

Apart from the drop in the absolute number of the population, there is enough evidence of other changes taking place in the age structure, especially in terms of a significant decrease in the proportion of children aged under 14. On the other hand, the baby boom generation of the 1970s had already become economically active, which led to an increase in the productive component of the population. The number of university graduates and secondary school leavers in particular was then so high that the amount of job openings proved to be insufficient. As far as the people in the post-productive years are concerned, the 1990s did not see any dramatic change in their population. Their number was growing very slowly since only the people born in the 1930s, when children were enormously scarce, reached the corresponding upper age limit. The proportion of people above 80, who were born after the WWI, went up.

The development of the proportional representation of the individual age groups is documented by Table 2. Here we can observe the rising proportion of the old population in contrast with the declining proportion of young people both under the biological limit of 14 and under the economic limit of 19 years of age. Aleš (1996) observes that in 1995 the proportion of under fourteens did not even achieve 19% and Kretschmerová (2004) confirms that the proportion of children in 2003 went as low as to 15.2%. The average absolute

Table 3. Dependency coefficients between 1993 and 2004

Year	Youth dependence by		Old age dependency $C_{D(old)}$	Overall dependence by	
	biological standards $C_{D(y-b)}$	economic standards $C_{D(y-ec)}$		biological standards $C_{D(ov-b)}$	economic standards $C_{D(ov-ec)}$
1993	29.78	49.40	19.16	48.94	71.46
1994	28.79	48.06	19.24	48.02	70.17
1995	27.71	46.18	19.30	47.01	68.27
1996	26.83	44.24	19.45	46.28	66.36
1997	26.03	42.34	19.61	45.65	64.49
1998	25.27	40.56	19.74	45.01	62.71
1999	24.58	38.86	19.80	44.38	60.94
2000	23.87	37.29	19.83	43.69	59.27
2001	23.18	36.12	19.82	43.01	58.03
2002	22.62	35.35	19.73	42.35	57.13
2003	22.09	34.53	19.71	41.80	56.25
2004	21.49	33.77	19.67	41.16	55.43
$\bar{\Delta}$	-0.7536	-1.4209	0.0464	-0.7073	-1.4573
\bar{k}	0.9708	0.9660	1.0024	0.9844	0.9772

decrease in the age group between 0 to 14 and 0 to 19 in the examined period reached the level of 0.42 and 0.64 per cent respectively. The average coefficients of growth in both age groups were almost identical, amounting to 0.9755 and 0.9747, respectively. It means that in relative terms the proportion of young people analysed within both groups was on average falling each year by 2.5% at the given absolute level. An absolute growth was identified in the productive as well as the post-productive population, although the group of the old population did not grow more than by 0.1 per cent (the relative proportion was rising by 0.74%).

The changing proportional representation of the individual age groups within the age structure affects the extent of the burden born by the productive population. The relevant changes are quantified by means of the youth and old age dependency coefficients and by the overall dependency coefficient, see Table 3.

Youth dependency coefficient based on the biological limits fell by 7.16 per cent between the years 1993 and 2004. In 2002, some 22 “biologically” young people were dependent on 100 members of the productive population. The calculations of the youth dependency coefficient based on the economic rather than biological factors also reveals a decreasing tendency, but the values are logically higher than those resulting from the latter (decline by as much as 14.05 per cent). This trend is connected with the fact that in the early 1990s, nearly the whole baby boom generation of the 1970s became productive. But if only a limited part of a baby boom generation (aged above 20) moved into the productive sphere, the dependency coefficient would be affected accordingly.

Old age dependency coefficient in the analysed period grows steadily, advancing to its record high in 2000 to fall slightly back again towards the end of the examined period (the men and women born during the economic crisis are beginning to reach the retirement age). Nearly 20 people above 65 years of age are dependent on 100 economically active inhabitants.

Overall dependency coefficient is equally going down until 2004 when 100 members of the productive population carry the burden imposed on them by 41 biologically young or old people. Judging by economic standards, more than 55 young or old people are dependent on 100 economically active inhabitants.

The average absolute and relative changes of dependency coefficients reflect the average absolute growth (decrease) and average growth coefficients listed in Table 3. Both indicators of the old age dependency coefficients pose certain problems, as the initial growth changed over the time into a decline. Until 2000, the average absolute growth at the average growth coefficient of 1.0049 amounted to 0.0957, whereas after 2000 these indicators fell to 0.9980 and 0.0400 respectively.

The graphic representation (Figure 1) shows clearly that the old age dependency coefficient remains more or less stable while the other coefficients are gradually falling. This is caused by a considerably reduced number of children and a slightly increasing number of the post-productive population. Nevertheless, it is clear that the burden of the productive population is created more by the agency of the pre-productive element rather than by the people older than 65. The old age dependency and youth dependency

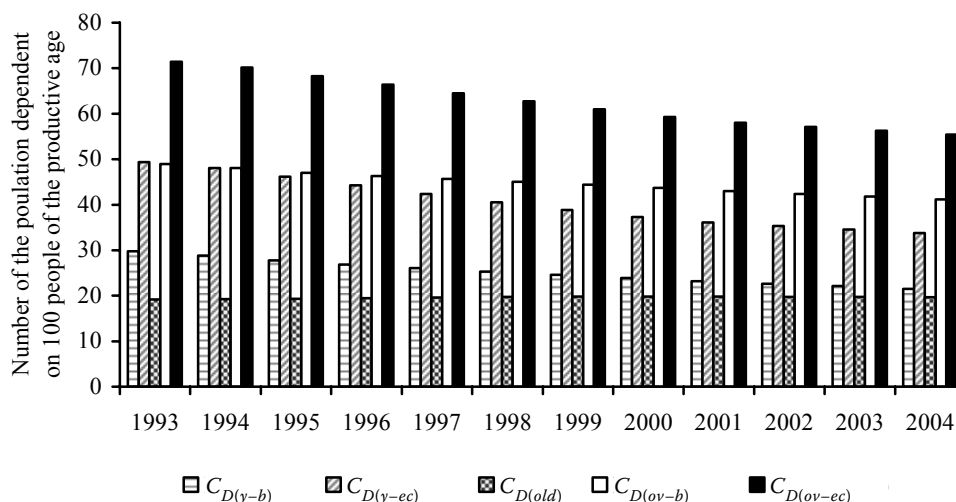


Figure1. Dependency coefficients in the population of the Czech Republic between 1993 and 2004

Table 4. Ageing index and inflow and outflow coefficients between 1993 and 2004

Year	Ageing index by		Coefficient	
	biological standards $I_{AGE(b)}$	economic standards $I_{AGE(ec)}$	inflow C_{in}	outflow C_{out}
1993	64.34	44.64	13.14	7.59
1994	66.82	46.02	13.01	7.38
1995	69.62	47.82	12.63	7.16
1996	72.48	49.99	12.07	6.87
1997	75.34	52.32	11.46	6.62
1998	78.10	54.60	10.88	6.42
1999	80.59	56.80	10.29	6.35
2000	83.06	58.92	9.78	6.36
2001	85.49	60.64	9.50	6.57
2002	87.22	61.60	9.41	6.86
2003	89.19	62.88	9.25	7.14
2004	91.55	64.15	9.18	7.58
$\bar{\Delta}$	2.4736	1.7736	-0.3600	-0.0009
\bar{k}	1.0326	1.0335	0.9679	0.9999

coefficient analysed in biological terms are showing gradual convergence.

The development of the ageing index as well as the inflow and outflow coefficients that reflect the dynamism of changes in the burden carried by the productive population point to the fact that the population is ageing.

Ageing index changed dramatically over the analysed span of time. Table 4 shows that between 1993 and 2004 the index increased from 64.34% by 27.21 percent, i.e. to 91.55% (by biological standards).

This trend was caused by the plummeting number of children and a moderate growth in the number of the oldest population. In 2004, there were more than 91 inhabitants above 65 years of age per 100 people aged from 0 to 14. It can be expected that in the near future, the two proportions will reach the same level and that the ageing index identified by the biological standards will amount to 100. The ageing index calculated by the economic standards increased between 1993 and 2004 by 20 percent. Both growths are graphically indicated in Figure 2.

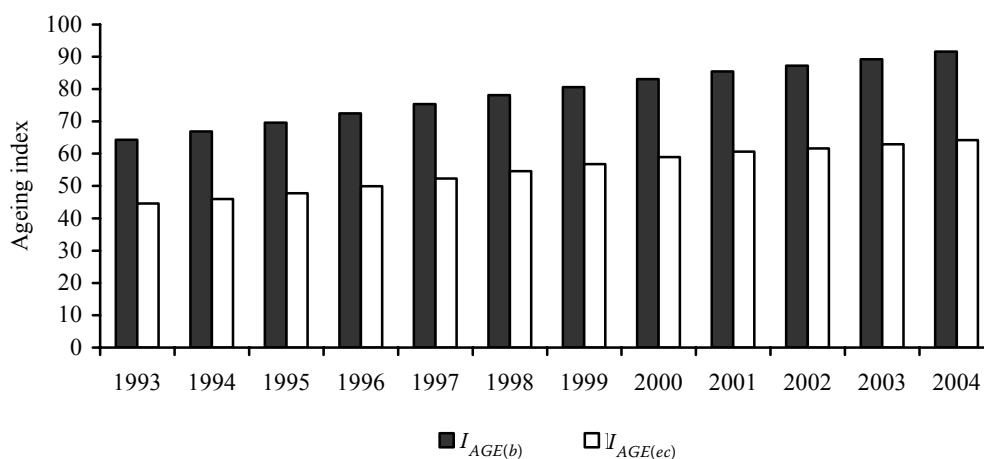


Figure 2. Ageing indices in the population of the Czech Republic between 1993 and 2004

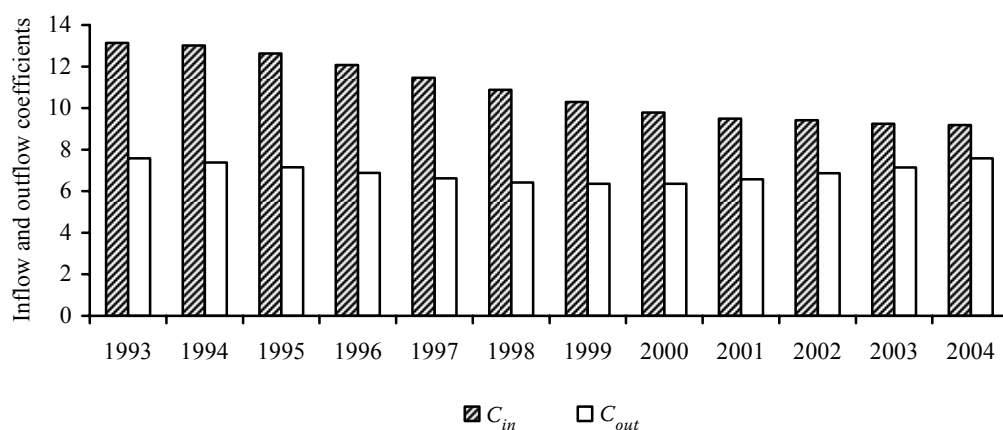


Figure 3. Inflow and outflow coefficients in the population of the Czech Republic between 1993 and 2004

Inflow and outflow coefficients describe the situation when a five-years-old age group of a population is preparing to reach the lower or upper age limit marking the productive life span. The assessment of the relevant findings makes it possible to forecast the short-term development of the situation. Table 4 shows clearly that the inflow coefficient is going down to nearly the low level of 9 people aged 15–19 per 100 inhabitants in the reproductive years. This means that the productive population is gradually shrinking. The outflow coefficient is, too, marked by a steady decrease, but after 1999, it bottoms out and goes on to move in the opposite direction as more and more people are passing over the threshold of

the post-productive years. The situation is illustrated by Figure 3.

Whereas the old age indices show an increasing tendency throughout the entire analysed period, with the average absolute increase of 2.4736 and 1.7736 at the relative growth of over 3%, the inflow coefficient has a decreasing tendency, with the average absolute decrease of -0.3600 at the relative decline of over 3% (however, with a significantly lower absolute level) and the outflow coefficient has practically the same value at both the beginning and the end of the analysed period, so the average absolute increase approximates 0 and the average growth coefficient approximates 1. Over the examined period, the outflow coefficient was, however, not very stable, going down at the first stage and up later on. As the level of inflow is still higher than the level of outflow, the number of young people becoming economically active should remain higher for the time being than the number of people who retire.

From the age structure of the Czech population analysed in this study, it follows that throughout the period in question, i.e. from the declaration of the Czech national independence to 1993, the Czech population is undergoing the process of ageing. The analysis further confirms the gradual increase in the average age as a comprehensive indicator of the age level, see Table 5.

The average age rose between 1993 and 2004 by almost 3 years, i.e. from 36.6 to 39.5. This trend corresponds to the average absolute annual growth of 0.2636, the relative growth represented by the average growth coefficient standing at 1.0070 and the average annual growth at 0.70%. The table also implies certain differences between genders. Women enjoy life expectancy that is by more than 3 years higher and, in addition to that, their population shows a higher absolute and relative growth. The ageing process of our population was quantified by Koschin (2003) on the basis of the age median that rose by 2 years over the decade of 1991–2001.

Table 5. Average age between 1993 and 2004

Year	Average age		
	total	men	women
1993	36.6	34.9	38.3
1994	36.8	35.1	38.4
1995	37.0	35.3	38.6
1996	37.3	35.6	38.9
1997	37.6	35.9	39.2
1998	37.9	36.2	39.4
1999	38.2	36.5	39.7
2000	38.5	36.8	40.0
2001	38.8	37.1	40.3
2002	39.0	37.4	40.5
2003	39.3	37.7	40.8
2004	39.5	37.9	41.0
$\bar{\Delta}$	0.2636	0.2727	0.2454
\bar{k}	1.0070	1.0075	1.0062

CONCLUSION

The disruption of the population development caused by wars, the economic crisis, totalitarian regime and transformation of the Communist State into a democratic system led to such a fluctuation of the birth rate that its implications for the following generations manifest themselves even in the twenty-first century. The generation with the highest representation in the current age structure is formed by the people who were born in the 1970s. After the political, economic and social transformation of the state in 1989, the reproduction and family behaviour of young population underwent certain dramatic changes. The young people started to focus their attention on other ways of spending their leisure time than on marriage and bearing children.

Due to the falling number of children, young people are less dependent on the productive population. This tendency, however, is bound to have a negative impact in the future when the proportion of the productive population will be increasingly outnumbered by other non-productive population components. The overall youth and old age dependency on the productive population went down, which was determined by the fact that the youth dependency decreased whereas the old age dependency stagnated. The development of the ageing index took an alarming course. It is expected to reach 100 in the near future, which means that the proportion of children and the proportion of post-productive population will be balanced, with the prospect of the latter outnumbering the former. The future intensity of the demographic ageing is aptly illustrated by the development of average age.

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and their general and regionally specific manifestations in the standard demographic characteristics of the country environment.

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