THE CONCEPT OF REPLACEMENT MIGRATION AND ITS APPLICATION IN THE CZECH REPUBLIC*)

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Abstract: The article deals with the concept of replacement migration and its practical application to data for the Czech Republic. The first part contains a discussion of the concept of replacement migration and the reactions produced by its application in selected countries and regions presented in the UN in 2000. The second part presents the results of model calculations based on current expectation regarding natural change in the population of the Czech Republic.

Keywords: replacement migration, ageing, population, cohort component model, projection, Czech Republic

Numerous analyses and studies exist that deal with the current demographic situation in Europe. In one (*Grant et al*., 2004) the situation is described as follows: "Nearly all European nations are experiencing long-term downtrends in fertility, and consequently, ageing of their populations. Fertility rates are now below replacement level (2.1 children per couple) in nearly all countries. As a result, natural population growth rates are entering periods of declining growth or outright decrease. At the same time, the proportion of elderly dependants continues to grow while the working-age population declines as a share of the overall population. Moreover, net immigration, which potentially could offset declines in working-age population, remains generally low in most European countries. Taken as a whole, these demographic trends could have potentially damaging consequences for European economies." (*Grant et al*., 2004, p. xiii).

At the end of the 1990s and the start of the new century many advanced European states are beginning to become increasingly aware of the key links between demographic and, in the wide sense, economic and social development. In addition, they are beginning to discuss this issue more and also beginning to take political and then executive action. In this regard we can mention, for example, the reform of the pension system reform that has already been or is yet to be implemented, changes to tax model parameters, and changes to migration policy. International migration often becomes one of the most discussed but also sometimes even applied (e.g. recruitment programmes targeting selected foreign workforces) alternative solutions to the problem situation that has arisen. Part of the reason for this is that current pro-natal policies is thwarted by the current second demographic transition, which does not favour fertility (e.g. *van de Kaa*, 1997; *Lesthaeghe*, 2000), and thus the resulting expectations are not very optimistic. Naturally this provokes discussions of how desirable and how "necessary" a state's population growth actually is. The answers to the questions in this discussion are not

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simple and in practice they vary between states. Various opinions are put forth and defended at the level of national policy and in the science and research community (see *Burcin*, *Drbohlav and Kučera*, 2007).

The concept of "replacement migration", developed by the United Nations in 2000[1] (*Replacement,* 2000, 2001), works out an alternative solution to expected demographic losses, by determining the volume of migration necessary to offset losses caused by a decline in the size of the population and by a decrease in the percentage of the population of economically active age. What this involves is a structured search for a remedy to the entire process of demographic ageing in advanced countries through international migration. In such a light the UN study formulates several questions and certain related hypothetical scenarios of development to the year 2065.

The UN study[2] essentially attempts to answer the question of how many migrants (measured as the net number of migrants) would be required in individual countries in order to:
– prevent a decrease in total population;
– maintain a constant number of people of productive age in the population;
– keep the ratio of the number of people of productive age (15–64) to the number of people aged 65 and over (the Potential Support Ratio) from falling below 3.0) and
– maintain the conversely defined Old-Age (Elderly) Dependency Ratio (the number of people of post-productive age to the number of people of productive age) at a constant level.

The study reached a number of important conclusions, a selection of which is presented here:
– During the first half of the 21st century most advanced countries will experience a decrease in population size and an ageing of the population as a result of long-term low total fertility rates well below replacement level combined with rising life expectancy;
– In the absence of international migration population losses will be even grater and population ageing even faster;
– Fro France, the UK, the US, and the EU the number of migrants necessary to offset population decline will be smaller than or comparable to the number of international migrants to the given country in the recent past. For Italy, Japan, Korea and Europe the number necessary to replace the expected population losses must be much greater than the size of the migration streams to these countries in the past;
– The number of migrants required to halt the decline in the working age population is much higher than the number required prevent a decrease in the size of the population as a whole.
– The number of migrants required to prevent demographic ageing, in the sense of preserving the Potential Support Ratio, is extremely high and in each case would involve significantly larger migration flows than previously observed in the given countries;
– Preserving the current Old-age Dependency Ratio at current levels by means of immigration seems unrealistic given the extremely high number of immigrants that would be required to eliminate this manifestation of the ageing process;
– The new challenges ushered in by the reality of a declining and ageing population will require an objective, profound, and complex re-evaluation of many established economic, social and political programmes and policies.

Taken on the whole, despite some of the potential offered by migration, based on the exam-

[1] It is, however, possible to trace the philosophy behind this approach to an earlier data – for example, in Cole (1972), Raomaniuc (1984), Ryder (1997) – according to Beaujot (2003) and Lesthaeghe (2000).
[2] The study worked with data for France, Germany, Italy, Japan, Korea, Russia, Great Britain, the USA, and also for Europe and the European Union.

ple of given countries it was clearly demonstrated the immigrations is not a very suitable or effective tool for solving the overall problem of demographic ageing (see also, e.g., *Grant et al*., 2004; *Coleman*, 2003; *Lutz and Scherbov*, 2002, 2003; *Lesthaeghe*, 2000; *Beaujot*, 2003; *Tapinos*, 2000; *Martin*, 2004). Let us look, therefore, at some of the most important critical assessments made of/raised against the concept of replacement migration (for more see *Burcin, Drbohlav and Kučera*, 2007). The UN study criticised mainly on the following points:

1) Some claims in the original study are inaccurately or insufficiently formulated and thus are the cause of incorrect interpretations by journalists, the media, and even, for example, politicians (e.g. *Coleman*, 2000; *Tietelbaum*, 2004). Moreover, only some of the many findings are presented and are done so intentionally and out of context;
2) Some reviewers criticised the very concept of replacement migration for neglecting to take into account a number of aspects (e.g. the role of the majority's relationship to minorities, the qualitative characteristics of immigrants, the role of re-emigration, temporary/short-term migration or illegal migration flows),or that many statements were thus too general, that there was no substantiation for some of the axioms adopted, and no substantiation or justification given for some statements and proposed scenarios. None but demographic solutions are considered, and therefore the entire pleiade of such important provisions connected with the possible mobilisation of internal resources was overlooked.
3) Criticism also touched on the method used to calculate the models in the study. Attention was drawn to the frequent use of different input parameters, which oftentimes differ from the ones used in national statistics. Another target of criticism was the fact that, for example, the definitions of age categories corresponded more to developing rather than the most developed parts of the world. For example, there was no mention of the speculative nature of the projections, which are calculated for a period of more than fifty years.

Despite the criticism, however, the concept of replacement migration must be assessed as well-founded and as a very interesting analytic-synthetic construct, the results of which must, more than anything else, be understood as a kind of "warning message".

The studied at hand draws on the UN study and in a similar vein analyses the situation in the Czech Republic. Its novelty lies in the fact that 1) it is one of just a few studies that examine the issue in the region of Central and Eastern Europe (except for the large study by *Bijak et al*., 2005 and *Vishnevsky*, 2000), and 2) it works with some modified categories and scenarios and tries to answer questions that are beginning to be raised even in the applied sphere.

Methodological aspects of the concept of replacement migration and its application in specific conditions

As suggested above, replacement migration means migration of such volume and structure that is capable of compensating for the change in selected parameters of the size or demographic structure resulting from population processes. In this regard, before operationalising replacement migration it is first necessary to formulate projected estimates of future fertility and mortality trends, and to do so in a structure that corresponds to the planning model that is used.

From a formal perspective, it does not matter whether we are working with realistic or purely modelled estimates, but in practice we are trying to approximate the most likely development of both components of natural population growth. In our case we chose this approach. For our projected estimates we used the classic cohort component projection model, incorporating migration into the model through age– and sex-specific distribution of so-called "net migrants" or in other words the overall net migration.

In comparison with the classic use of projected estimates for forecasting or modelling pro-

jected estimates in the case of replacement migration we encountered one additional problem with their use. We did not know the number of immigrants or the value of some other characteristic that would allow us to estimate that number. On the contrary, it was our task to determine these numbers, while the criterion that the value of the selected population parameter remains constant throughout the entire projection period. Therefore, we first had to determine the appropriate model and model of estimation. The actual estimation methods used in publications focusing on replacement migration are not usually revealed to the reader and anyone interested in the use of this concept is left in practice to rely on his/her own methodological skills or his/her ability to construct a methodology on the basis of a general outline of the substance of the problem and put it into action or operationalise it. "Consequently, when formulating our methodology and estimating the parameters of our model, we had to do so as though we were dealing with a question that had not been previously addressed. After some adjustments, we managed to formulate a general model for estimating the required size/amount of replacement migration under practically any regime/pattern of natural reproduction." The core of this model is the cohort component projection model, the basic application principles of which can be summed up in several individual steps.

In the first step, a calculation is made of all the projections based on an estimate of the detailed parameters of fertility and mortality. The results of these calculations are drawn on to calculate the observed (reference) characteristic and determine the difference between its starting and end values in the given projection step. In the third step, with the sex and age structure of the net migration fixed, it is necessary to estimate the aggregate effect of one average "net migrant" (including the effect of the forces of natural reproduction) on the development/trend of the given reference characteristic. When we have established the aggregate effect of the unit net migration, in the first approximation we can determine the necessary extent of replacement migration and test it with the use of the above-described modification of the cohort component model. If the testing shows a significant difference between the start and end values of the reference parameter we repeat, cyclically, the above-described steps three through five until the difference is zero or at least sufficiently small. In each cycle we work only with the residual difference and not with the total original difference. By means of these iterations we arrive at the necessary volume of net migration, while, in the final calculation, within the given projection step, the sum effect of replacement migration to its fully estimated extent is specified. At the same time it is necessary to determine the sex and age structure of the given population and with it the size that is the starting structure for the next projection step and which can be further specified with estimates of the number of individual events and other characteristics of reproduction behind the emergence of the new starting structure.

The iterative procedure described above forms the basis of the entire estimate and is applied in each of the projection steps continuously covering the entire defined period.

In the estimates that we made for the population of the Czech Republic as a whole the applied concept of replacement migration was based on specific internal and external model assumptions.

The internal assumptions of the model are:

1) All the events are equally distributed in each of the defined time fields under observation, where the mean population is always equal to the arithmetic average of utmost states of population and the numbers of events in the equally large parts of each field of observation are identical.
2) The parameters of the projection model can only change with the transition from one projection step to another, and never within a single step.
3) Migrants wholly adopt the demographic behaviour of the destination population.
4) The volume of replacement migration is estimated for both sexes together by means of the

total net migration and its sex and age structure, which means that full/complete replacements for men and women separately need not and usually are not achieved. The fulfilment of this requirement would lead to a different task that is not complementary to our original assignment. Specifically this means that ensuring/securing replacement at the level of each sex need not mean, with the exception of the total population, that the replacement of the population as a whole is secured, as the ratio of men to women in the population necessarily changes over time.

The external assumptions are:

1) The initial population size and the sex and age structure correspond to the parameters of the population of the Czech Republic on 1 January 2005 as presented by the Czech Statistical Office.
2) The value of fertility and mortality characteristics (Tab. 1) corresponds to the actual working revision of our last published forecast of population development in the Czech Republic (*Burcin – Kučera – Drbohlav*, 2003), which we prepared over the course of 2006 and which covers the entire period between 2005 and 2006.
3) The gender ratio at birth is constant at 485 girls and 515 boys out of every one thousand live-born children.
4) The relative age structure of net migration by gender (Fig. 1) is constant throughout the forecast period and is represented by the adjusted current age structure of the net migration of the Czech Republic, that is, foreign migration recorded in official statistics for the years 2002 to 2004.

We limited ourselves in the calculations to just the medium, mostly likely variant of the forecast of the natural change, but we also applied the concept of replacement migration to the utmost variants – low and high. In each of them we also examined the necessary extent of replacement migration from the perspective of each of the four following parameters: the total population size, the average age of the population, the percentage of people of productive age, and the values of the Dependency Ratio I (the number of people of post-productive age to the number of people of productive age), in other words, characteristics generally discussed in the context of the population of the Czech Republic in recent years. Also, we defined the basic age groups of the population in an innovative way, proposing a narrower productive age span (between the ages of 20 and 60 instead of the customary 15 and 65). By respecting the real rather than the nominal ages at which people enter and exit the labour market, this age span provides a better approximation of the economically active population.

Main findings

The size of the net migration necessary to compensate for changes caused by expected natural population change in the Czech Republic is generally determined by two factors: the ex-

Table 1 Fertility and mortality trends (low, medium and high forecast variants), 2005–2065

Year	Total fertility rate			Life expectancy at birth					
				Men			Women		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
2005*		1.29			72.9			79.1	
2010	1.36	1.42	1.45	73.4	74.1	74.9	79.7	80.3	81.0
2020	1.35	1.58	1.71	75.4	76.5	77.6	81.3	82.4	83.4
2030	1.41	1.66	1.79	77.0	78.7	80.0	82.6	84.0	85.2
2040	1.45	1.70	1.84	78.4	80.4	81.8	83.6	85.4	86.7
2050	1.47	1.73	1.87	79.7	82.0	83.4	84.6	86.7	88.0
2065	1.50	1.77	1.92	81.3	84.0	85.7	85.8	88.3	89.8

Note: *Empirical values.

Figure 1 The expected distribution of net migration by sex and age

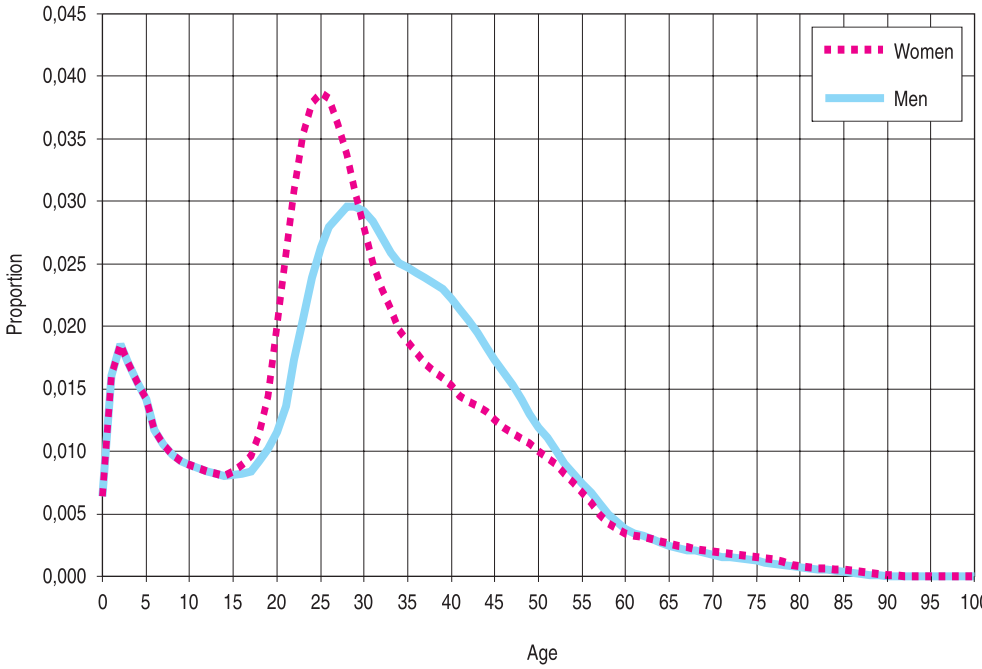
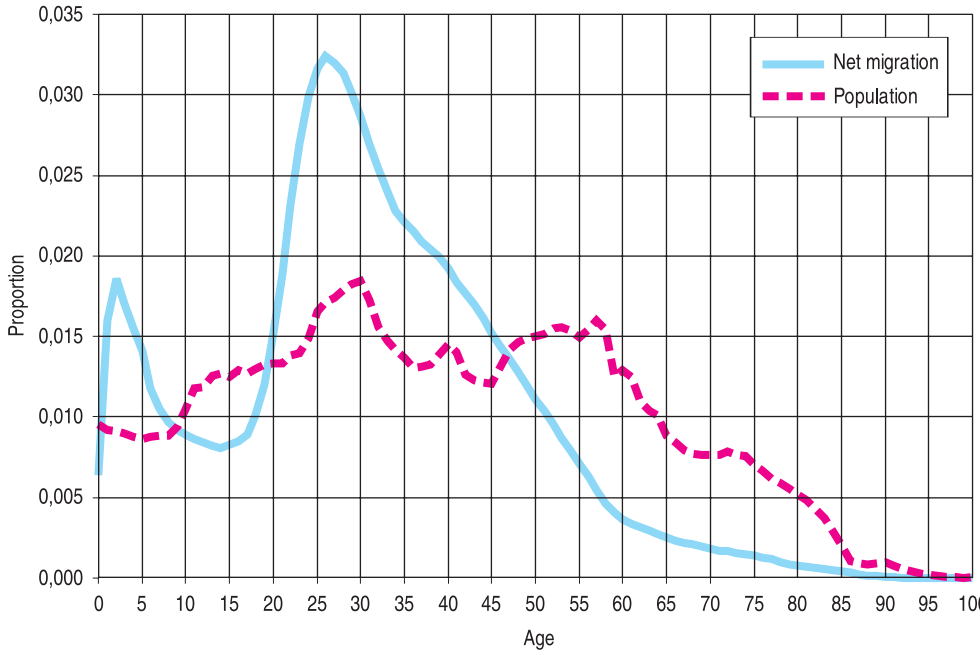


Figure 2 The distribution of the population of the Czech Republic on 1 January 2005 and net migration by age



pected size of the change in the age structure of the population as a result of the effect of fertility and mortality, the difference between the relative age structures of the population and the net migration. The starting differences in the age structures are presented for illustration in

The only exception to the cited conditionality is replacement migration compensating the change in population size, as in this case the difference in the age structures of the population and the net migration logically does not play a role.

The inherent or internal reproductive potential of the population of the Czech Republic, which is determined by historically established irregularities in the age structure and by current and expected fertility and mortality rates, is not especially great. Future development based just on natural change would almost certainly in the long term lead to a clear and relatively sharp decline in the total number of inhabitants and very dynamic ageing of the population (Tab. 2).

Table 2 Population size and age structure of the population over time by natural change (low, medium and high forecast variants) 2005–2065

Year	Population (thousand): 1 January			Mean age of the population: 1 January		
	Low	Medium	High	Low	Medium	High
2005*		10 221			39.77	
2010	10 171	10 205	10 230	40.91	40.93	41.00
2020	9 908	10 105	10 236	43.56	43.37	43.43
2030	9 426	9 819	10 066	46.37	45.92	45.92
2040	8 791	9 392	9 753	48.40	47.76	47.69
2050	8 081	8 922	9 403	49.92	48.83	48.52
2065	6 894	8 104	8 782	51.48	49.90	49.34

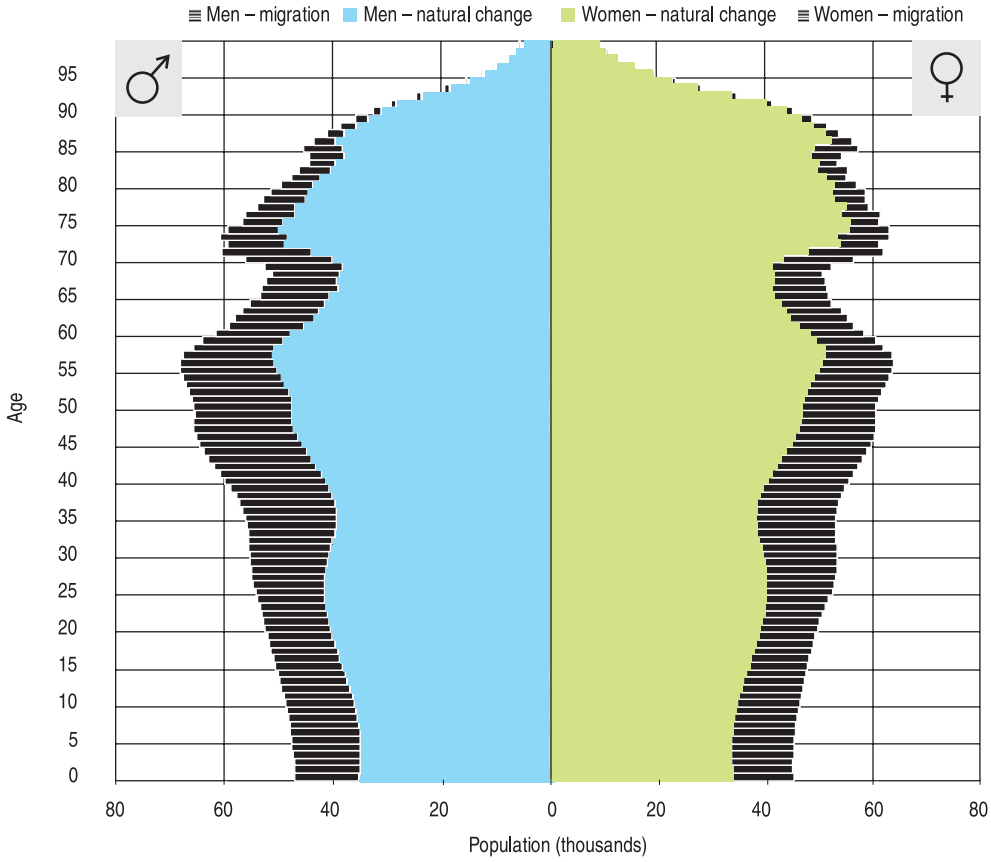
Note: *Empirical values.

Compensation for population losses

Methodologically the simplest estimate of replacement migration is connected with establishing the total size of the population. As already noted, the volume of replacement migration is equal to the momentary surplus or deficit in the natural change. In our model calculations we assumed that the natural change deficit increases gradually throughout the entire period the model applies to. The only possible exception could be the next several years, when, based on the medium and high variants of the forecast, we can expect the population size to stagnate or slightly increase by natural change. As a result then in the next ten to fifteen years the Czech Republic could make do with a foreign net migration at a level of just several hundred or thousand people in order for the population size to be preserved. It is very likely that at least until the year 2030 it will not be a serious problem to maintain the population size, as only after that year should the volume of necessary replacement migration begin to exceed the current foreign net migration.

In order to avoid depopulation, for the next roughly sixty years the Czech Republic would need to obtain from abroad in sum between 1.2 and 3.0 million new inhabitants, while based on the medium and the most likely variants around 1.8 million should suffice. In this case, and under the hypothetical assumption that throughout the entire period no one would ever move out of the country, the number of inhabitants born outside the state could represent roughly 15% of the population by the year 2065. Figure 3 shows their age distribution. The percentage of people born outside the Czech Republic could realistically reach as much as one-quarter of the population, while a somewhat smaller but negligible percentage could be made up of children of first-generation immigrants. However, as indicated by the data in Table 3, replacement migration compensating the population losses from natural change would have only a small effect on reducing population ageing expressed by the indicator of the average age of the population.

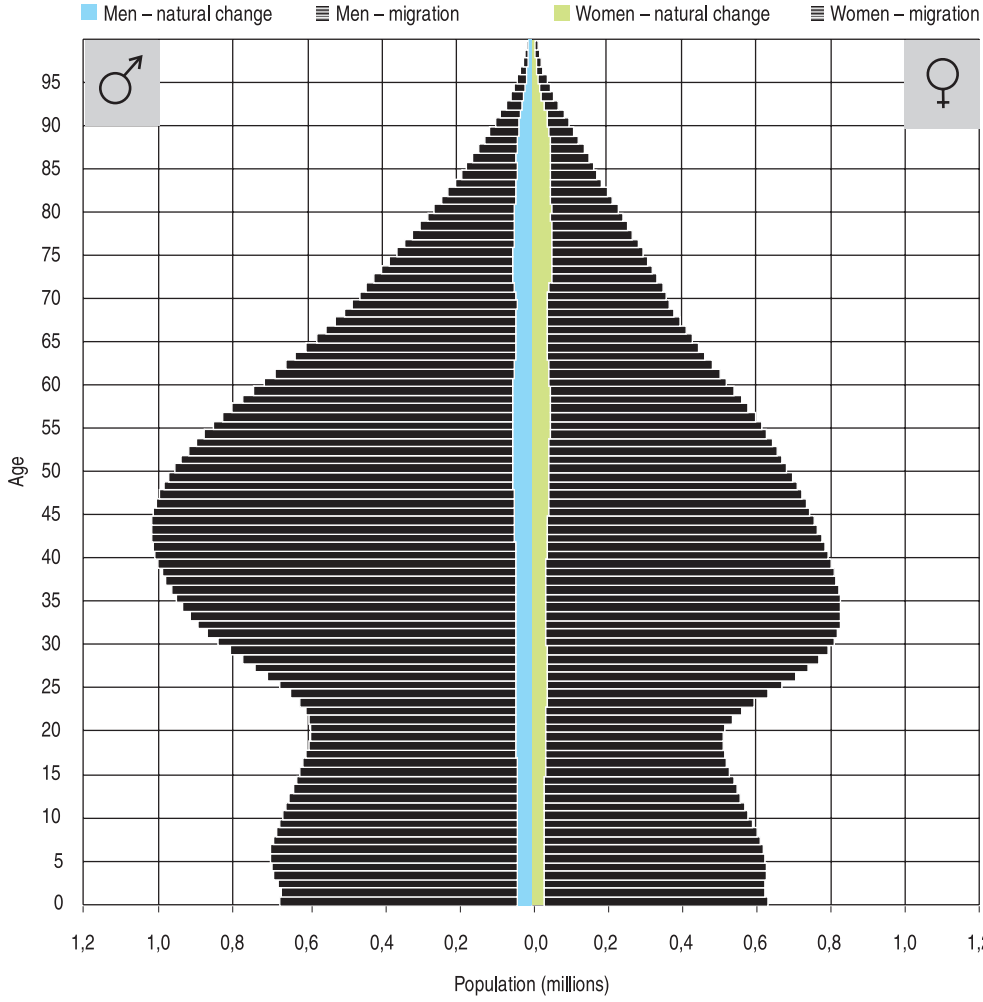
Figure 3 Model of the sex and age structure of the population of the Czech Republic on 1 January 2065, medium forecast variant, constant number of inhabitants



Compensating for the rise in the average age of the population

In the past fifteen years the relatively substantial and over time stable dynamics in the rise in the average age of the population of the Czech Republic has been caused by significant changes at both ends of the age pyramid as a result of the fall in fertility and the rapidly improving mortality conditions, especially among the very elderly, and also by the shift in the more significant irregularities in the age structure to a later age levels. Were reproduction to occur only by change, it can be realistically expected that in the next 25 and 30 years the current annual dynamics of the rise in average age, which is 0.20-0.25 years, would be maintained. Without a "youthening" effect of migration it is very likely that in the next sixty years the average age of the population would increase by 10 to 11 years and theoretically could exceed the limit of 50 years of age. To fully compensate for the increase in the average age it would be necessary that already today the foreign net migration would have to be approximatelly 300 000 people annually, which is probably around a ten times higher than the level indicated in recent years in official statistics. The necessary extent of replacement migration would also continue to dynamically increase into the future, and would so owing to the fact that the newcomers would with their age structure compensate not just for the ageing of the

Figure 4 Model of the sex and age structure of the population of the Czech Republic on 1 January 2065, medium forecast variant, constant average age of inhabitants



original population but also for the ageing of the immigrants who came before them and their children. Our calculations indicate that in 2065 the annual price for sixty years of population average age stability would be, according to the median variant, 4.2 million foreign immigrants in their current age structure; this is of course assuming that during this period no one would move out of the Czech Republic. The total "price" would then be the very hard to imagine 90 million immigrants. Under these conditions by 2065 the country would have around 110 million inhabitants, of which around 80 million would be citizens who were born outside the country and 20 million would be their children. The resulting age distribution of the population is presented in Figure 4. These findings are well outside any real or realistic notions, and they can only be interpreted as a clear illustration of the extremely limited opportunities to regulate the ageing of the population by means of immigration from abroad.

Table 3 Expected volume of replacement migration and selected effects (by criteria and low, medium and high variant of the natural increase forecast), 2005–2065

Year	Population, total			Mean age			Proportion of persons of working age (P_{20-59}/P_{total})			Age dependence rate I (P_{60+}/P_{20-59})		
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Net migration of replacement migration (thousands)												
2005	7	7	7	292	292	292	31	31	31	194	194	194
2010	13	3	–4	331	329	346	229	276	308	351	377	404
2020	34	16	5	634	548	531	296	479	603	318	364	406
2030	53	35	25	1 071	913	888	368	671	908	658	742	820
2040	58	37	27	1 699	1 357	1 277	1 032	1 530	1 948	1 330	1 477	1 611
2050	64	39	29	2 844	2 175	1 995	1 622	2 796	3 755	1 941	2 231	2 468
2065	72	44	30	5 854	4 208	3 790	2 494	5 340	8 043	3 775	4 439	5 002
Accrued net migration of replacement migration (thousands)												
2005	7	7	7	292	292	292	31	31	31	194	194	194
2010	61	18	–14	1 796	1 813	1 919	1 244	1 421	1 537	2 008	2 120	2 242
2020	328	124	–8	6 721	6 213	6 269	4 487	5 861	6 777	5 670	6 138	6 608
2030	781	399	171	15 401	13 696	13 568	7 653	11 562	14 325	10 662	11 796	12 877
2040	1 342	764	439	29 220	25 050	24 414	15 938	23 663	29 605	21 870	24 130	26 255
2050	1 961	1 146	721	52 054	42 785	40 828	29 594	45 584	58 340	38 375	42 835	46 851
2065	3 008	1 797	1 188	116 167	90 146	83 892	57 286	103 286	142 602	78 156	89 586	99 432
Population (thousands): 1 January												
2005*		10 221			10 221			10 221			10 221	
2010	10 221	10 221	10 221	11 684	11 741	11 857	11 216	11 384	11 496	11 880	12 006	12 129
2020	10 221	10 221	10 221	16 431	16 265	16 526	14 405	15 930	16 950	15 690	16 422	17 065
2030	10 221	10 221	10 221	25 082	24 112	24 423	17 481	22 077	25 297	20 428	22 258	23 793
2040	10 221	10 221	10 221	39 271	36 474	36 651	25 208	34 525	41 610	31 432	35 109	38 168
2050	10 221	10 221	10 221	62 991	56 051	55 431	39 192	58 158	73 215	48 695	55 864	61 662
2065	10 221	10 221	10 221	130 699	109 318	105 563	68 628	123 061	169 375	90 391	108 271	122 385
Mean age of the population: 1 January												
2005*		39.77			39.77			39.77			39.77	
2010	40.87	40.92	41.01	39.77	39.77	39.77	40.08	40.00	40.00	39.64	39.59	39.59
2020	43.25	43.25	43.44	39.77	39.77	39.77	40.58	39.78	39.45	40.20	39.80	39.64
2030	45.52	45.47	45.70	39.77	39.77	39.77	41.98	40.25	39.50	41.22	40.49	40.17
2040	46.89	46.81	47.05	39.77	39.77	39.77	41.32	39.74	39.01	40.50	39.80	39.49
2050	47.76	47.49	47.56	39.77	39.77	39.77	40.47	39.04	38.37	40.23	39.46	39.11
2065	48.43	48.05	48.00	39.77	39.77	39.77	40.99	39.08	38.29	40.53	39.70	39.32

Note: *Empirical values.

Compensating for the change in values of selected demo-economic characteristics

The extent of migration needs worked out in the scenario of compensation for the average age of the population logically is comparable to that worked out in estimating replacement migration in the case of scenarios where the values of two other observed indicators are fixed: the percentage of people of productive age and the Dependency Ratio I, as defined above. However, differences nonetheless exist between the scenarios of compensation for the rise in average age, the decline in the percentage of people of productive age, and the rise in the values of the Dependency Ratio I. In the first case the biggest migration need corresponds to the lowest variant of development, characterised by lower probability of surviving to an older age but also and especially by fewer children born. It is child births that have a strong "youthening effect". In our current circumstances the effect of the birth of one child in a year of obser-

vation on compensating for the rise in average age is around four times greater than that of an immigrant, who on average is aged 31 years. Therefore, higher fertility leads generally to lower necessary volumes of replacement migration. In the case of Dependency Ratio I, the situation is the reverse: the larger number of children and people of post-productive age under the higher variant of development by natural change logically means that a larger number of people of productive age and therefore migrants is required in order to keep the index value on an unchanging level.

Given the culmination of the percentage of people of productive age in the population at the start of this decade the total number of migrants in the sense of a cumulated volume of the net migration between the years 2005 and 2065 to compensate for the decrease in the percentage of the productive component of the population in the medium variant of development would be 103 million migrants with a final range of variants between 143 and 57 million immigrants. To stabilise the Dependency Ratio I "just" 90 million migrants would be necessary, in a somewhat narrower interval of 99 and 78 million immigrants according to the utmost variants of developments.

Conclusion

Our interest in the concept of replacement migration as presented in this article was not primarily theoretical or methodological but rather practical. For some time demographic ageing has been the subject of political discussion in the Czech Republic, and in it regulated migration from abroad has been presented as an important if not the main tool for solving the entire problem. Although a certain sense for reality prevents us from sharing that opinion or investing it with even the slightest hope, in this regard the numbers speak for themselves. In the Czech Republic, like in the majority of advanced countries, the figures are intelligible and clear: if our aim is just to maintain the current size of the population in the Czech Republic, under current or comparable conditions foreign migration could relatively easily help us and could do so in the long term. However, in the case of other parameters, the battle to maintain current levels of selected and many other similar indicators is lost before we start. Therefore, it will be enough compensation for the expended effort if our findings contribute to the abandonment of useless discussions and empty hopes and turn the attention of the relevant individuals towards a genuinely active and systematic preparation of society for population ageing, which is essentially an irreversible process.

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