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RESEARCH ARTICLE

Population aging in the context of education. Comparison of selected EU countries

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Abstract

The arrival of the fourth industrial revolution hasfundamentally affected the economy of the developed countries. New and developing fields will need workers with quality education corresponding to the needs and demands of technological development. Thus, the share of tertiary educated population significantly affects the economic level of every country. As a result of the projected population ageing in the developed countries, a major problem with the share of the economically active people can be expected across Europe. The increased share of tertiary educated people in economy can positively influence this problem. Therefore, the article deals with the projection of the share of tertiary educated people. On the basis of information on the education structure of individual EU countries, a hierarchical cluster analysis was created, which was used for selecting countries. For the two most significant clusters, the country with values of all selected indicators most similar to the cluster average values has been selected. A population projection was created for these countries, on the basis of which the total dependency ratio, child-dependency ratio and old-age dependency ratio were calculated. In conclusion, it can be stated that even if the population ageing continues, the number of tertiary-educated persons may remain unchanged.

Keywords

cluster analysis, demographic projection, logistic model, population ageing, tertiary education

JEL codes: H52, I25

Introduction

The developed countries are currently experiencing population ageing. At the same time, most countries have experienced the natural population decrease in recent years; the total population in European countries has stagnated or increased only slightly in recent years due to external immigration to these countries. According to the OECD, a total fertility

rate of more than 2.1 children per woman is needed to maintain a stable population. The last time that the EU average exceeded this threshold, according to the OECD, was in 1976, when the average number of children born per woman equalled to 2.14. However, the fertility rate has been declining since then, and in 2018 was only 1.58 live births per woman over her entire reproductive lifetime in the EU. Due to lower fertility rates and a decline in younger ages, a decline in school enrolment and consequently a decline in the overall workforce may be expected in the future. According to Eurostat projections, the share of people of working age may be expected to fall by 13% over the next 50 years. Conversely, the share of people of retirement age will continue to rise. The demands of the population continue to increase, with society consuming more resources and using more technology to sustain itself. For this reason, an increase in the volume of consumption may be expected, but this will have to be provided by fewer people in the labour market. At the same time, due to the ageing of the population, it is possible to expect an increase in the demand for labour in the health or social services sectors, as the post-productive population will grow.

Due to the decline in the workforce, there will be an increased need to focus on technologies that will partially replace this workforce. Specific skills for research and development of these technologies will be required even more than now. According to Ortiqueira and Santos (1997), the integration of technology into the production of goods and services leads to efficiency gains that have the same impact on the final product as increases in the number of workers. By being efficient, a worker who possesses the necessary technology is able to produce a larger quantity of the product, thereby aiding economic growth. Already today, we can observe the impact of changes on the labour market, the training of potential and existing employees, as well as on production processes. As a result of changes in technology, digitalisation and environment, the EU Council believes that education has an important role to play. The changes coming to the market require a more educated population to apply new processes, as they are more easily applicable to a society with a higher proportion of tertiary educated people than to a society with less qualified people. Indeed, an individual's education does not only bring positive externalities in the form of higher wages to them, but also to society in general. As stated by Gennaioli et al. (2013), an educated workforce contributes to the establishment of firms, which in turn demand labour and thereby help to reduce unemployment in the region. As stated by Migala-Warchol and Pasternak-Malicka (2018), investing in education, skills, and human capital in general is the cheapest way through which a country's competitiveness may be increased, and its economic development accelerated. The authors point out that better educated people often have both better-paid jobs and better health and more social contacts.

Aim of the work

The aim of the work is to create demographic projections for the selected countries and to predict future labour market developments with a focus on the graduates of tertiary education.

The following two hypotheses and a research question were made to achieve this purpose:

- Verify whether the countries under study will experience a decline in the active population and population ageing and how significant the decline will be.
- An increase in the share of tertiary educated persons may be expected between now and 2070. This year was chosen in order for the entire next generation to enter the post-productive age.

- However, the total number of tertiary educated persons will stagnate due to population decline.

Theoretical background

The industrial revolution and the associated development of technology led to an accelerated population growth in Europe and other developed regions of the world in the 19th and 20th centuries. According to Šprocha (2018), intensive urbanisation occurred as a result of innovation and industrial development. During this time, compulsory schooling was gradually introduced. The development of education brought about a reduction in fertility rates. it has been shown that people with higher education have fewer children on average. These families often limit the number of children in order to provide them with a higher education and social status that entails a higher standard of living (Šprocha 2018). The increase in the standard of living of the population has contributed to the improved medical care and has resulted in the increased life expectancy.

All regions of the world have seen significant increases in life expectancy over the last hundred years. While in 1950, according to the United Nations (UN 2022), the world's population was 2.5 billion, in 2019 it was already 7.7 billion and in 2022 it is already more than 8 billion people. This change, according to Ritchie and Roser (2019), shows that populations are becoming healthier. Hence, the life expectancy has been increasing over the years, resulting in an increasing proportion of people over 65 years of age. According to the United Nations (UN 2022), in 1950, 5% of the world's population was over 65 years old, while in 2020 this proportion will rise to 9%. In Europe, which, together with North America, is the most affected by population ageing, the proportion of people over 65 years old increased from 8% in 1950 to 19% in 2020. Demographic projections for 2050 even speak of 25% of people over 65 years old.

At the same time, changes in fertility rates are also having a major impact on the population ageing. While in 1950, according to Statista (2021), the total fertility rate in Europe was 2.66 children per woman over her reproductive lifetime, in 2020 it was only 1.61 children per woman over her reproductive lifetime. This means that, on average, one less child will be born to each woman than 70 years ago. This is causing a significant decline in the population in general and, in particular, in the proportion of people of pre-productive age, which in Europe fell from 17% to 11% between 1950 and 2020, according to the United Nations (UN 2022).

According to Šprocha (2018), in Western and Northern European countries, the pre-productive component of the population does not reach the post-productive component. At the same time, this fact may also be increasingly observed in the age pyramids of Central European countries. It follows that most European countries are characterised by a regressive type of age pyramid, which confirms the ageing of the population that is currently taking place. Population ageing is one of the greatest challenges in the 21st century. As Lundquist et al. (2015) state, by 2050, for the first time ever in human history, there will be more seniors than children in the world. Especially in the developed countries, where the age pyramid has changed from a progressive to a regressive type over the last half century, population ageing implies the need for a significant transformation of society, according to the United Nations (UN 2022). This transformation will affect all sectors, including the labour market and economic policy. It may be assumed that countries where social and fiscal policies will

not change in the near future due to the increasing number of people of post-working age will face the challenges associated with population ageing.

Therefore, demographic change does not only affect people of post-working age. The countries' labour market and policies are currently affected mainly by people of working age and, in the future, also by people of pre-working age, who are still in the process of preparing for their participation in the labour market. The number of students enrolling in education is declining due to a reduction in the crude birth rate. However, this phenomenon is not observed in the case of tertiary education. Nevertheless, according to Koucký et al. (2010), the number of students in tertiary education in Europe has increased dramatically in recent decades. There are now many more applicants for higher education than in the past. The relationship between the reduction in the number of people in younger age groups and the number of people enrolled in tertiary education is complex. According to Vincent-Lancrin (2008), the number of people enrolling in tertiary education is determined by both financial and non-financial factors. Applicants for tertiary education are often motivated to pursue tertiary education by the vision of higher financial reward in future careers but also by family.

The increase in interest in tertiary education is also associated with a longer duration of study and later entry into employment than in the past. There is a need for new indicators to better assess the current situation. According to the Institute of Informatics and Statistics of the Slovak Republic, these new trends need to be taken into account for indicators assessing population ageing. Changes in the age structure of the population have a significant impact on economic growth, which, according to INFOSTAT (Šprocha 2019), is influenced by a high level of labour productivity. Under the assumption of stable unemployment, it can be expected that as the working age population is ~~also~~ increasing, the labour force is also growing. Therefore, focusing on investment in human capital and technology may significantly affect the economic situation of a country. In recent years, the number of people of post-working age has also been increasing, which will result in an increase in the old-age dependency ratio.

Due to demographic changes, according to Šprocha (2019), there are changes in the field of education. The gradual increase in the importance of the knowledge economy and the increasing need for labour, together with the different levels of remuneration for workers achieving different levels of highest educational attainment (ISCED 5-8) influence changes in the attitude to the value of education. Currently, according to Majo and Šprocha (2016), education is one of the main economic factors in society. This has resulted in a growing interest in higher levels of education, especially tertiary education.

According to the Industry 4.0 initiative released by the Ministry of Industry and Trade of the Czech Republic in 2015, a well-functioning education system is a key factor for success in the implementation of new technologies in the national economy. The initiative speaks about the need to focus on the pre-productive group of people, which will become the future driver of economic growth. This will be determined by the increasing need to use new technologies. This is supported by a Communication from the European Commission (2022), stating that education is challenged by the mismatch between the skills Europe needs and the skills it currently has. This Communication states that, particularly within STEM (**S**cience, **T**echnology, **E**ngineering, **M**athematics) professions, the EU is facing a shortage of skilled labour. The European Commission (2022) states that skills such as critical thinking and problem-solving must be possessed by all graduates after the graduation, regardless of their field of study. Schools should encourage pupils to take an interest in science and

mathematics so that more future university students choose this field of study. In addition, universities should focus in particular on the relevance of the subject matter covered and on offering study programmes that flexibly respond to the current needs in society. The report also points out that many university teachers have either minimal pedagogical training or no pedagogical background at all. Universities should focus not only on their academic development but also on their pedagogical development so that they are able to deliver information to university students even better.

The issue of education and in particular the knowledge economy was discussed by Sukharev (2021), who tried to identify the size of the knowledge economy in the European Union in general, and Russia, Germany, and Spain in particular. Sukharev started with the idea that the knowledge economy has its own characteristics in each country and contributes to the pace of economic development depending on the main sectors of the economies. He claimed that knowledge has been a competitive advantage for a long time. Information represents relevant data obtained by scientific methods that are ready to be reused to build new knowledge and improve the old one. In his article, the author presented an alternative methodology for assessing the knowledge economy. The Eurostat methodology looks not only at industries that have a direct impact on the knowledge economy (industry, IT, pharmaceutical production, etc.) but also at other "supporting" industries (creative, artistic, and entertainment activities, libraries, archives, museums, and other cultural activities). According to Sukharev it is most appropriate to monitor activities involving research and development, education, and scientific and technical activities.

However, Suhkarev also states that knowledge development is not necessarily a positive factor for economic growth. He gives an example of education in the legal sector. In the view of the author, the activity of lawyers increases transaction costs and at the same time increases the number of lawsuits between firms. This in turn reduces profits and hinders investment and economic growth. On the other hand, more educated lawyers can better coordinate activities in the firm. Some disputes may not happen at all, because with more knowledge they can help prevent problems. At the same time, due to the development of some administrative sectors, the system is becoming over-bureaucratised with increased timeframes, which may slow down economic development or undermine efficiency of the industry. The future of economic development in the context of education and research and development was discussed by Fernald and Jones (2014). According to the results of their research, the growth trend of national economies, which was observed in the last years, will slow down. To restart this trend, according to the authors, more capital needs to be invested in human capital at the expense of physical capital. In particular, there is a need to concentrate investment on research and development, the development of new technologies with a focus on artificial intelligence. It is the artificial intelligence that may in future replace some of the workers that countries will lose as a result of population ageing. Improving education brings greater knowledge among workers and thus also expanding opportunities to use new technology. With the use of technology, the number of workers can be reduced in part of the industries and thereby reducing the negative consequence of the reduction in the number of people of working age. Robotization will make it possible to employ people in the post-productive age in some industries. Currently, the number of students in tertiary education is increasing not only among the young generation, but also among the elderly. It is therefore necessary to consider the concept of lifelong learning as an opportunity to develop skills. Jung (2020) dealt with the fourth industrial revolution and the associated need for knowledge economy in South Korean conditions. It was based on the idea that knowledge is

the main driving force of economic growth in all world economies, and at the same time it is becoming a new comparative advantage. The strengths that create the right environment for a knowledge-based economy are found to be a skilled workforce with a university degree.

Data and methodology

The data for this work were collected with a strong emphasis on relevance and timeliness. For this reason, data were taken exclusively from the databases of official organisations such as Eurostat, Word Bank, and OECD. For all the indicators, it was important that the used data were recent, which is why most of the datasets are for 2019.

Cluster analysis

In order to show the relevance of the comparison of the V4 countries (Czech Republic, Slovakia, Poland and Hungary) with Scandinavian countries, a cluster analysis was first performed on the basis of several variables for the EU countries and Norway. A hierarchical cluster analysis was used to classify the European countries based on the economy and education indicators (see table 1). Objects are divided into clusters based on the values of the considered parameters that characterise these objects. Due to the different dimension of the considered parameters, the values of these parameters had to be standardised first. Therefore, a standardised Euclidean metric was used to evaluate the distance measure between objects. Ward's criterion was used for quality assessment. Similarly, cluster analysis was also used in the work of Varvařovská & Staňková (2021) and Kubicová & Blašková (2021).

The variable used to reflect the economic situation in the country was GDP per capita in the year 2019. The other variables were strictly related to education and, in particular, to the knowledge economy as reported by Sukharev (2021) and the European Commission (2022).

Table 1. Selection of variables for cluster analysis

Variable	Indicator	Units
GDP per capita	GDP_pc	[EUR]
Unemployment rate of tertiary educated aged 15-64	Un_ter	[%]
Share of secondary educated persons aged 15-64	SEC	[%]
Share of tertiary educated persons aged 15-64	TER	[%]
Share of those educated in STEM fields among all aged 20-29	STEM	[‰]
Share of tertiary graduates in category 5 (business, administration)	Grad_05	[%]
Share of tertiary graduates in category 6 (natural sciences)	Grad_06	[%]
Share of tertiary graduates in category 7 (IT technology)	Grad_07	[%]
Share of tertiary graduates in category 8 (production and construction)	Grad_08	[%]
Share of tertiary graduates in category 10 (health care and welfare)	Grad_10	[%]

Source: compiled by the authors

Population structure by age

Over the last 20 years, according to Eurostat (2021), life expectancy at birth in countries has risen by an average of 4.9 years and in 2019 it was, for example 77.8 years in Slovakia, and even 79.3 years in the Czech Republic. According to the projection made by Eurostat, European countries will see a sharp increase in the median age of the population in each country over the next 50 years. Between 2020 and 2070, the median age is expected to increase by 11.3 years even in Poland.

The increase in the median age is associated with an ageing population. Most developed countries are facing population ageing. The population aged 25-64 will decline in all European countries. These people make up the largest part of the working population. Due to the increasing number of young people attending higher education, the 15-24 age group is mainly made up of students, who are included in the productive population, but due to the dominant economic activity of students, they are rather economically inactive. This suggests that the countries will face a decline in the labour force. While in 2000 there were more than 3 persons aged 25-64 for every 1 person of post-working age, by 2100 this gap is projected to decrease rapidly. On average, we may expect less than 1.5 persons aged 25-64 for every person aged 65+ in 2100. Scandinavian countries have the highest life expectancy in Europe. The average life expectancy at birth here is 82.5 years. The highest one is in Sweden, where it is 83.2 years. As in most developed countries, Scandinavian countries are experiencing a population ageing. However, thanks to the relatively high birth rate, the problem is not so great. According to the projection made by Eurostat, between 2020 and 2070 the median age is expected to increase by 4.6 years in Sweden (median age was 45 in 2020).

Demographic projections of population structure

Demographic projections were used in this work to assess the future development of the population with tertiary education over the next 50 years. The basis for this chapter was the cohort-component method (see (Rowland 2003)), but this has been modified as this work does not consider migration.

The projection threshold (t) or base period of the projection was 2019. Demographic projections were made for 2030 and 2070, separately for women and men according to their age. For the base period, the average population was first calculated based on the assumption of a linear population trend, which became the baseline values that were adjusted throughout the projection. The projection used two basic components affecting population trends, birth and death rates. The projected number of live births in the projection year was always calculated as the product of the number of women and the fertility rate for women in this age. The total projected number of live births was then calculated as the sum of the number of children born to women of a given age. In addition, a fertility change indicator was added to the calculation to make the values more reflective of dynamic changes in women's reproductive behaviour. This coefficient was calculated based on the change in fertility over the last 10 years. The mortality rate was calculated from life tables, which were used to estimate the probability of surviving to the desired age based on the number of persons living at that age. However, as the life tables contained values for persons up to 75 years of age, other survival probabilities for older ages had to be approximated by predicting the future values of the appropriate model. The age structure of the population in the projected years was then calculated based on birth and death rates.

Population ageing was assessed based on population structure indicators such as ageing index (proportion of people of post- and pre-productive age), old-age dependency ratio (ratio of persons aged 65+ and persons aged 15-64), and total dependency ratio (ratio of persons aged 0-14 and 65+ and persons aged 15-64). For more details on these indicators, see Preston et al. (2000).

Prediction of tertiary education

Based on the age structure of the population obtained from the projections, the population aged 15-64 years, those who are of working age, was identified. A logistic model for the period 2004-2020 was developed to assess the future evolution of the share of tertiary educated. A time series of the share of tertiary educated of working age was then used to predict future values up to 2100. As EU countries follow the same economic and political strategies, it is possible to assume that the national values of most of the Member States' indicators will converge to the same value. A threshold of 60% has been set as the maximum saturation point that European countries may reach by 2100 in terms of the share of tertiary-educated working-age people. This threshold is based on the projections for 2100 in terms of educational attainment for European countries produced by the Wittgenstein Centre for Demography and Human Capital (Dataexplorer 2018).

Results

A cluster analysis was performed to divide the European countries into four clusters. The clusters are shown in Figure 1 in different colours.

The most numerous, green, cluster consists of the countries of Central and Eastern Europe. The second most numerous, red, cluster includes the countries of Northern and Western Europe. The purple cluster represents the countries of Southern Europe, and the blue cluster represents small EU countries.

As may be seen from Table 2, the group of Central and Eastern European countries including all V4 countries is characterised by the lowest GDP per capita. At the same time, it is possible to observe the highest share of people with secondary education, which, however, occurs at the expense of a low share of people with tertiary education. Nevertheless, due to the high demand for tertiary-educated workers and the relatively low number of such educated persons, the countries of Central and Eastern Europe are characterised by the lowest unemployment rate among tertiary-educated persons. The share of tertiary graduates in STEM fields is low and may be compared with Southern European countries. Compared to other groups, Central and Eastern European countries have the highest proportion of tertiary graduates in engineering, manufacturing, and construction. The share of graduates expected to participate in knowledge economy by field of study (categories 5–8 and 10) is 63%, the second lowest among the groups studied.

The Scandinavian countries are in the cluster that includes also Western European countries. These countries are characterised by more than twice as much as GDP per capita of Central and Eastern European countries. These countries have the highest proportion of tertiary educated people of any group. However, there is also a high proportion of people with secondary education. Despite the high share of tertiary educated persons, these countries are characterised by low average unemployment of tertiary educated persons. The

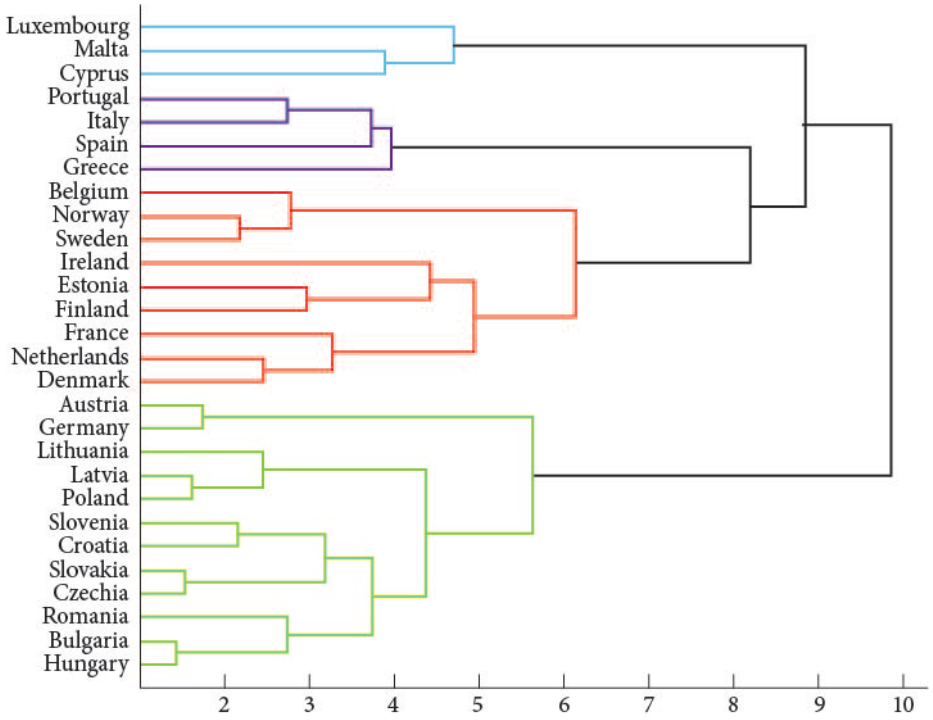

Figure 1. Dendrogram of the distribution into groups according to educational structure. *Source*: authors' estimations

group of Northern and Western European countries is also ranked first in terms of the share of graduates in STEM subjects. The share of graduates in knowledge economy (categories 5–8 and 10) is high, adding up to 66%. Compared to Central and Eastern European countries, Northern and Western European countries have a higher share of graduates in science, mathematics, statistics, ICT, health, and welfare.

As shown in Table 2, the cluster of Northern and Western European countries has the best average values for most of the indicators. The average size of GDP per capita in these countries was 43,013 EUR in 2019. Only small European countries achieved higher GDP per capita values. However, the value is somewhat overestimated for this group, as it includes Luxembourg, whose GDP per capita size is more than 3 times higher than the average of all other European countries. In the case of the tertiary education share, Northern and Western European countries have the highest share. This 36.58% share is only slightly higher than the share of tertiary education in small European countries. However, since the share of STEM graduates is 2.5 times higher in Northern and Western European countries than in small European countries, it is evident that in terms of tertiary education Northern and Western countries, lead among the other groups.

According to these results, Northern and Western European countries are rightly regarded as a role model in the field of education, and it makes sense to compare the countries with them.

Table 2. Average values of the observed indicators for each group in EUR

Variable	Central and Eastern Europe	Northern and Western Europe	Southern Europe	Small European countries
GDP_pc	17,540	43,013	22,215	44,377
SEC	56.77	41.32	35.78	35.00
TER	26.15	36.58	26.03	36.00
Un_ter	3.76	4.03	13.53	4.63
STEM	17.93	21.06	18.85	8.37
Grad_05	24.07	23.17	19.31	37.78
Grad_06	4.95	5.75	6.91	3.89
Grad_07	4.46	5.03	2.79	4.65
Grad_08	16.62	13.03	15.74	8.02
Grad_10	12.75	18.86	14.97	10.20

Source: Elaborated by the authors

Note: see Table 1 for description of variables

Population projection for selected countries

Based on the collected data, population projections were made for Slovakia and Sweden. These countries were chosen for the projections because they are the territorial units whose characteristics, examined in the cluster analysis, are the closest to the average values of the clusters they belong to. In order to compare the similarity between the countries studied and the average clusters, the average relative deviation was considered. The projections focus on natural population change due to fertility and mortality.

Projections for Slovakia

While the average population in Slovakia was 5,457,147 in 2019, it is projected to decline to 5,333,050 in 2030. This decline is expected to be mainly due to low total fertility, which in Slovakia averaged only 1.57 children born per woman during her entire reproductive period in 2019. At the same time, there has been a 0.7% annual decline in the total number of live births in Slovakia over the past decade, which will result in a decline in the number of persons of pre-productive age. Specifically, Slovakia may expect a 12% decline in the pre-productive group, a 6% decline in the productive group, and a 26% increase in the post-productive group between 2019 and 2030.

The above-mentioned changes in the pre-productive, productive, and post-productive groups of the population are reflected in the population structure indicators shown in Table 3. This table shows that there will be a gradual increase in the old-age dependency ratio. According to the projection, the total dependency ratio will also show an increasing trend. Between 2019 and 2070, the projection expects an increase of more than 20 persons of non-productive age for every 100 persons of productive age.

In 2019, the child dependence ratio took on a value of 23.24 persons of pre-productive age for every 100 persons of productive age. By 2030, it is possible to assume that there will be a decrease in this indicator. The decline will be due to a large decrease in persons

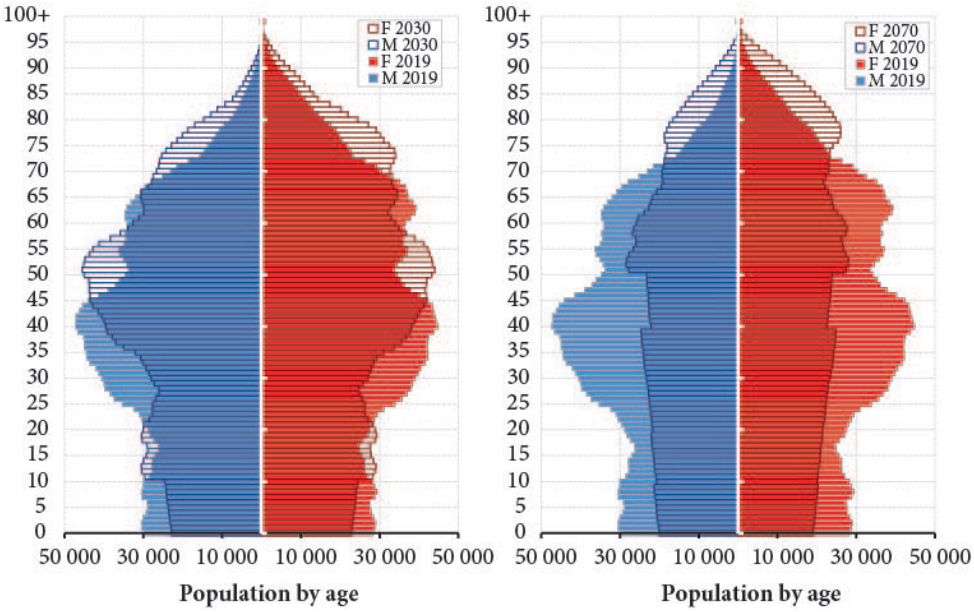

Figure 2. Population pyramid for Slovakia in 2019 and projections for 2030 (left) and 2070 (right)

of pre-productive age and a relatively small decrease in persons of productive age. In 2070, however, the indicator should be higher than in previous periods. The number of people in the pre-productive age group is projected to fall sharply as a result of a steadily declining birth rate. While the child dependency ratio is expected to fluctuate, the old-age dependency ratio will continue to increase. Between 2019 and 2070, the ratio of people aged 65+ to those aged 15-64 is projected to almost double. Based on the ageing index we see a problem with the ageing population (in 2019 the 103 post-productive age people per 100 pre-productive age people, in 2070 is estimated to be 168.25 post-productive age people)

As Table 3 shows, even greater changes in the population structure may be expected in the 2070 projection. The age pyramid of the projection for this year is shown in Figure 2. Over the next 50 years, the future population is projected to decrease by almost 1.5 million inhabitants in Slovakia (to a projected population of 4,024,354 in 2070). The decline will be caused mainly by a steadily decreasing birth rate. In relative terms, a 29% decline in the pre-productive group may be expected by 2070. Within the productive group, there will be

Table 3. Population structure indicators for Slovakia in 2019 and projections for 2030 and 2070

	2019	2030	2070
Ageing index	103.35	149.03	168.25
Total dependency ratio (0-14 and 65+ per 15-64)	47.27	54.51	68.69
Child dependency ratio (0-14 per 15-64)	23.24	21.89	25.60
Old-age dependency ratio (65+ per 15-64)	24.02	32.62	43.08

Source: authors' calculations

a more significant decline in the population, by more than 35% compared to 2019. Population growth may only be expected in the post-productive group, which is expected to increase by 15% by 2070.

Projections for Sweden

Sweden is projected to experience similar to Slovakia changes, yet not so significant. Similar to Slovakia, there will be a gradual smoothing of the age pyramid and an increase in the number of elderly people. However, unlike Slovakia, Sweden has shown annual increases in births of 0.01% over the last decade.

According to the projection, Sweden's population is expected to increase slightly by 2030. The projected population pyramid for 2030 is shown in Figure 3. In 2019, the total population was 10,278,887 and is projected to increase to 10,414,348 by 2030. Despite the increasing trend in fertility observed in recent years, the total fertility rate was only 1.71 children. Therefore, an 11% decline in the pre-productive population is projected over the next decade. The productive group is more likely to stagnate, with an expected decline of only 0.5%. In contrast, the post-productive group will experience an 18% increase by 2030. Therefore, by 2030, there will be relatively significant changes in the age structure indicators shown in Table 4.

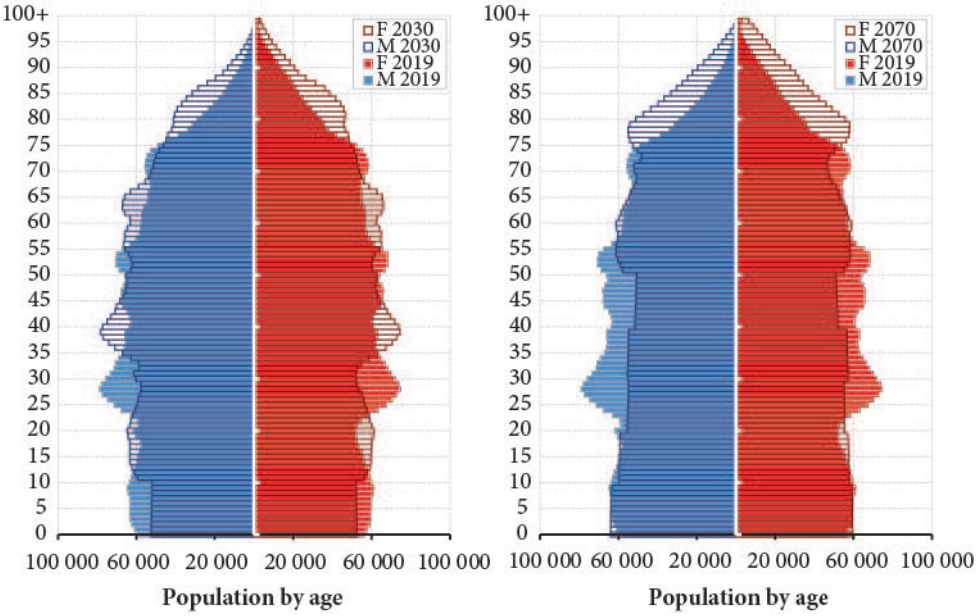

Figure 3. Population pyramid for Sweden in 2019 and projections for 2030 (left) and 2070 (right)

Table 4. Population structure indicators for Sweden in 2019 and projections for 2030 and 2070

	2019	2030	2070
Ageing index	112.22	148.57	142.43
Total dependency ration (0-14 and 65+ per 15-64)	60.58	63.62	78.98
Child dependency ratio (0-14 per 15-64)	28.55	25.59	32.58
Old-age dependency ratio (65+ per 15-64)	32.03	38.03	46.40

The value of the ageing index will increase significantly between 2019 and 2030. While in 2019 there were 112.22 post-productive age persons per 100 persons of pre-productive age, in 2030 there will be 148.57 post-productive age persons. However, due to the projected increase in fertility rate, there should be a subsequent slight decline in the old-age dependency ratio by 2070. In fact, during the period between 2030 and 2070, a higher increase in the pre-productive component of the population is projected rather than in the post-productive component. As there will be projected increases in both non-productive groups and a simultaneous decrease in the productive component, this will have a negative impact on the dependency ratio. The child dependency ratio and the old-age dependency ratio will also increase over the period under consideration. From 2019, when the child dependency ratio was 28.55 persons aged 0-14 years per every 100 persons aged 15-64 years, this ratio will rise to 32.58 persons aged 0-14 years per every 100 persons aged 15-64 years.

Even larger changes are projected for the old-age dependency ratio. As may also be seen in the age pyramid projected for 2070, shown in Figure 3, by 2070 there is expected to be a large increase in the number of people, especially in the post-productive group. This will result in a change in the old-age dependency ratio, which will rise from 32.03 to 46.40.

Projections for the year 2070 for Sweden assume that there should be significant changes in the population of almost all groups in the age pyramid. Despite rising fertility rates, the population in the pre-productive group will decline by only 0.5% compared to 2019. This is due to the small size of the productive age group to which these children are born. It is the changes in the working age population that are the most significant changes that may be expected. In particular, the 20-55 age groups are projected to experience a significant decline. In total, the working-age population is expected to decline by almost 13% by 2070 compared to 2019.On the other hand, significant population increases may be expected especially in the age groups over 75 years. The number of such people in Sweden in 2070 is expected to be 26% higher than in 2019. Overall, Sweden's population is expected to decline by 300 thousand people over the next 50 years.

Projection of the share of tertiary educated

Based on the forecasts of the logistic model, the future development of the share of tertiary educated was evaluated. The logistic model was only used to estimate the share of tertiary educated people in the population. The cohort-component method estimated the number of persons in a given age. The number of tertiary educated was then calculated on the basis of linking the estimated number of persons with the logistic regression parameters. As the values in Table 5 show, there will be a sharp increase in the share of tertiary educated persons in both countries over the next fifty years. In Slovakia, because of the lower initial value, a more pronounced overall increase in the share of tertiary educated is expected. Specifically, it will be more than 140% in Slovakia and only 58% in Sweden.

Table 5. Expected share of tertiary-educated 15–64-year-old between 2019 and 2070

	Slovakia	Sweden
2019	23.43%	36.98%
2030	34.83%	45.97%
2070	57.71%	58.51%

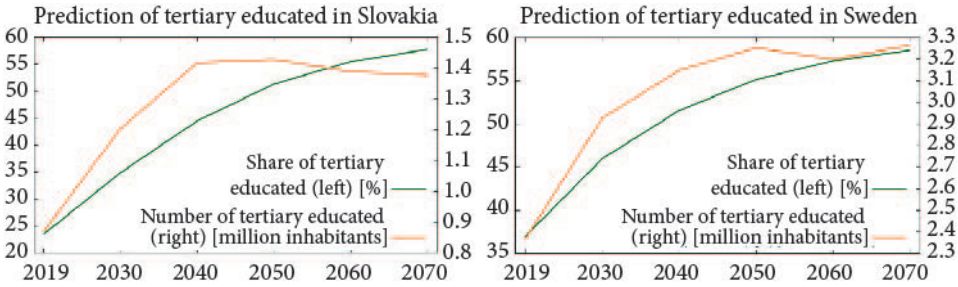

Figure 4. Number of tertiary educated persons and their share in the productive population in Slovakia (left) and Sweden (right) for the period between 2019 and 2070

As there will be changes in the population structure, at the same time, the increases in the share of tertiary educated persons will not be as marked in the total number of such educated persons. Figure 4 shows the predicted evolution of the share and number of tertiary educated persons in both countries over the next 50 years.

In Slovakia, a rapid increase in the share of tertiary educated persons is expected until 2040, accompanied by an increase in the total number of such persons. In 2040, 3.2 million people are projected to be tertiary educated, which should represent 45% of the productive population. Consequently, despite the expected increase in the share of tertiary educated persons by almost 6 percentage points (pp), the number of tertiary educated persons should stagnate between 2040 and 2050. This will be caused by a decline of 0.4 million in the working population. The decline in the productive population will continue to have a negative impact on the total number of tertiary educated persons, despite the expected increase in the share of tertiary educated persons. In 2070, it is projected that the share of tertiary educated persons aged 15-64 will reach almost 58%. However, their absolute number will be the lowest in the last 20 years. On the other hand, the highest absolute number of tertiary educated persons in Slovakia is expected in 2050, when the number of tertiary educated persons is predicted to be 1,427786. In Sweden, whose trend in the share of tertiary educated persons is shown in Table 5 and together with the total number of tertiary educated persons in Figure 4, it is possible to observe a similar development as in Slovakia.

Discussion

Based on the cohort-component method of demographic projections, it has been verified that Slovakia and Sweden will experience population ageing. According to Šprocha (2018), the total fertility rate decreases as the educational level in society increases. This results in a change in the population structure, which in the developed countries increasingly resembles a regressive type. Population projections were made for Slovakia (as a representative of the V4 countries) and Sweden (as a representative of the Scandinavian countries). In the case of Slovakia, where the number of births has been declining for a long time, it is possible to assume that the age pyramid will indeed be of a highly regressive type in 2070. In the case of Sweden, however, there has been a gradual increase in the total number of live births over the last decade, which has been reflected in the population projections. Compared to Slovakia, the projections suggest that the age pyramid for Sweden in 2070 will have a rather stationary shape.

The group that is most affected by the labour market is always the group that is currently productive. By 2030, it is projected that there will be a 6% decline in the productive group in Slovakia, but only a 0.5% decline in Sweden. By 2070, a decline of more than 35% of the productive population is projected in Slovakia compared to 2019, while in Sweden the decline will be 13%. Very similar values are projected for Slovakia in the UN projection (UN 2022). In the case of Sweden, this projection expects an increase in the productive population. This difference is due to the inclusion, or exclusion of migration in the projections. While the UN projection (UN 2022) includes migration, which is very high to Sweden in the long term, the projections in this paper were estimated only for natural increase and decrease, i.e., without including migration. According to the UN projection (UN 2022), it is assumed that the influx of migrants to Sweden will continue, which will result in a reversal of the population decline in the productive group that is expected to occur as part of a natural change.

In contrast, the projection developed in this paper and the UN projection (UN 2022) for Slovakia assume very similar developments. This is mainly due to the lower rate of migration to Slovakia compared to Sweden. Even though in 2019 the migration intensity was positive in both countries, it was ten times higher in Sweden.

The possibility of eliminating population ageing through migration

The expected declines in the productive population will need to be replaced in some way. One possibility is the arrival of migrants to participate in the labour market. Since the projections did not take migration into account, it is possible that the population decline in the two countries under consideration will not actually be as severe. The projection was deliberately created without migration. Projections assume invariable external conditions, and this is not the case in the current political situation. Therefore, the inclusion of migration could bias the projections. The goal of the research was to make a projection that would be as stable as possible from the point of view of changes in the external environment of the analyzed countries.

Both countries have had positive migration in recent years, meaning that more people are moving in than out. However, in 2019, Sweden's migration intensity was ten times higher than Slovakia's. There was an increase of 6.62 persons per 1,000 inhabitants in Sweden due to migration. In Slovakia, it was only 0.67 persons.

Sweden, as a Nordic welfare state, attracts a large number of migrants from EU and non-EU countries. From non-EU countries, citizens of India, Syria, Pakistan, and other countries in the Near and Middle East in particular come to Sweden. An average of almost 50,000 people a year have applied for asylum in Sweden over the last 10 years. The highest number, over 160,000, was in 2015, when the migration wave from the Middle East peaked. At that time, Sweden became the second most preferred country among these migrants.

Slovakia, by contrast, was hardly affected the 2015 migration wave. The number of asylum applications at this time did not differ from other years. On average, it has been around 300 people per year for the last decade. The situation changed in the spring of 2022, when huge numbers of refugees flowed into Slovakia in connection with the conflict in Ukraine. According to the Slovak Ministry of the Interior, as of 25 March 2022, almost 270 thousand persons arrived in Slovakia, of which more than 92% were Ukrainians. Between 1 and 25 March 2022, more than 52 thousand persons applied for temporary asylum in Slovakia. It is almost impossible to determine the total number of persons from Ukraine residing in Slovakia as of 6 April 2022, as since 2017, a visa-free regime has been in force for citizens

of Ukraine, which, according to the Slovak Ministry of Foreign Affairs, allows them to stay up to 90 days during 6 months in the Schengen area countries. However, in a broader perspective, it is possible to argue that a similar situation that occurred in 2015 in relation to migration in Sweden will be repeated in 2022 in Slovakia and other EU countries.

However, the question remains whether the influx of migrants into the country will be able to reverse the unfavourable demographic situation, which, if no changes are made, will also be reflected in the labour market. The information on unemployment in Sweden provided on the official website of the European Commission (2022) shows the problem of immigrants' participation in the labour market. While in the last quarter of 2021 the unemployment rate for native Swedes was only 3%, the unemployment rate for foreign-born people exceeded 16%. This implies that a person who immigrates to Sweden is more than five times as likely to be unemployed as the native population. This may cause concern for the future as to whether the influx of migrants may really replace a workforce that will decline in the future due to a natural change.

The influx of migrants from Ukraine, which has increased several-fold due to the ongoing conflict, was also registered in the past. Slovakia is an attractive country for Ukrainian citizens to move to, and especially for work. According to the Ministry of the Interior of the Slovak Republic, more than 56 thousand persons of Ukrainian nationality were registered for valid residence in Slovakia in 2021. Ukrainians already accounted for more than 50% of all third-country nationals living in Slovakia. In order to be granted a long-term visa, the purpose of stay, which is most often work or study, must be documented. As a result, it is possible to assume that almost all Ukrainians living in Slovakia are participating in the labour market or are continuously preparing for future entry into the labour market. On the basis of these data, it may be assumed that some of these persons who fled to Slovakia before the conflict will want to stay here after the conflict is over and thereby join the active population in the labour market.

The possibility of eliminating population ageing through education

A second option to avoid the problems that may be associated with population decline in the productive group is to focus on research and development in the field of artificial intelligence, as suggested by Fernald and Jones (2014). They argue that a new start to rapid economic growth will occur mainly with the help of research and development in the field of artificial intelligence. As this paper shows, there will be an ageing population and a decline in the productive population in the future. This will result in the need to replace some workers with this artificial intelligence. The authors argue that the carriers of research and development in this area are tertiary educated people.

As a result of the reduction in the fertility rates, there has been an overall decline in the number of students. Even so, there is a sharp increase in the number of tertiary education students (Koucký et al., 2010). The increase in interest in tertiary education was confirmed based on the projection made in this paper. By 2030, the share of tertiary educated persons in the productive population is projected to increase by more than 10 pp in Slovakia, while in Sweden this increase will be 8 pp. In 2070, the share of tertiary educated persons in both countries is predicted to be close to 60%. As a result of this significant increase in the share of tertiary education, the number of tertiary educated persons in the working population will continue to increase steadily until 2040. From 2040, however, despite the increase in the share of tertiary educated people, the decline in the working population

will lead to stagnation in the number of tertiary educated people. Therefore, the increase in the number of tertiary educated persons will be only short-term. In the long term, the number of such educated persons will rather stagnate. However, despite this, tertiary educated persons may bring new technologies and design innovations to increase the existing labour productivity.

Conclusion

It has been demonstrated that the values reported by the V4 countries within the indicators monitored are similar. The same applies to the Scandinavian countries. At the same time, it has been shown that the cluster of countries in which the Scandinavian countries are located is the one that shows the best values in the factors studied. As a result, it was confirmed that the level of education in Scandinavia is very high.

The European Union needs strategies for increasing the level of education. The Scandinavian countries could then be a kind of a model, for example, for the V4 countries. That is why we see the comparison of these Scandinavian countries and the V4 countries appropriate.

The projection shows that both countries will be affected by population ageing, but within the current population (excluding future migrants), Slovakia is more affected. The hypothesis that the number of tertiary educated people will rather stagnate in the surveyed countries, despite an increase in the share of such people, was only partially confirmed. According to the forecast, the share of tertiary educated persons is expected to increase throughout the period. However, regarding the total number of tertiary educated persons, a relatively large increase is expected between 2019 and 2040. Thereafter, however, there will be a stagnation or even a slight decline in the number of such educated persons due to the overall population decline. In Sweden, tertiary education is projected to increase until 2050. Thereafter, a slight decline in the number of such educated people is projected, which will be caused, as in Slovakia, by a decline in the productive population. Between 2050 and 2070, the number of tertiary educated persons in Sweden is expected to stagnate.

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