Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Statistics

Diploma Thesis

Comparative Assessment of Demographic Trends in the European Union

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DIPLOMA THESIS ASSIGNMENT

Bc. Helena Rýparová

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Thesis title

Comparative Assessment of Demographic Trends in the European Union

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Objectives of thesis

The aim of the diploma thesis is the assortment and assessment of development of demographic indicators of the European Union member states with regard to the pandemic and its consequences.

Methodology

The assessment and comparison of member states in relation to the demographic indicators will be done using statistical analysis. There will be used methods such as time series and cluster analysis, which will classify countries into groups based on similar development.

The proposed extent of the thesis

60 – 80 pages

Keywords

Demographic indicator, cluster analysis, population, pandemic, European Union, Czech Republic

Recommended information sources

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Declaration

I hereby declare that I have worked on this thesis „Comparative Assessment of Demographic Trends in the European Union" by myself under the guidance of the supervisor of this diploma thesis and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague, 31st of March 2022 _____

Comparative Assessment of Demographic Trends in the European Union

Summary

This diploma thesis is dealing with the assessment and assortment of the development of demographic indicators in the member states of the European Union. Higher emphasis is put on the demographic development of the Czech Republic. Chosen demographic indicators for comparison are connected to a phenomenon called demographic ageing. The diploma thesis is divided into theoretical and practical part.

Theoretical part is dealing with the science of demography, key drivers of the population changes, and demographic revolutions. Afterwards, member states as well as the Czech Republic are described based on the development of changes, structure, and migration of the populations. This part also introduces the phenomenon demographic ageing.

The second part consists of cluster analysis, that creates six clusters of states based on their similarities in chosen indicators. For further description, one state from each cluster is chosen to be introduced with regard to the population changes as well as demographic ageing. At last, the topic of ageing is presented as a current problem of developed countries and requires governments of individuals member states to take actions as soon as possible.

Key words: Demographic indicator, cluster analysis, population, pandemic, European Union, Czech Republic

Komparativní zhodnocení demografických trendů v Evropské Unii

Abstrakt

Tato diplomová práce pojednává o zhodnocení směru vývoje demografických ukazatelů ve členských státech Evropské Unie. Větší důraz je kladen na demografický vývoj České republiky. Vybrané indikátory pro porovnání demografického vývoje jsou spojeny s fenoménem demografického stárnutí. Diplomová práce je rozdělena na teoretickou a praktickou část.

Teoretická část se zabývá demografií jako vědou. Dále také hlavními vlivy, které ovlivňují změny v populacích a demografickými revolucemi. Poté jsou státy popsány na základě změn ve struktuře a migraci populací. Tato část představuje také fenomén demografického stárnutí.

Druhá část se zabývá clusterovou analýzou. Pomocí této analýzy bylo vytvořeno šest clusterů na základě podobnosti vybraných ukazatelů. Následně byl vybrán jeden stát z každého clusteru pro podrobnější popis v souvislosti s vývojem populace daného státu a s přihlédnutím na demografické stárnutí. V závěru je téma demografického stárnutí prezentováno jako současný problém a je nastíněno opatření ze strany vlád jednotlivých států.

Klíčová slova: demografický ukazatel, clusterova analýza, populace, pandemie, Evropská Unie, Česká republika

Contents

1 Introduction

Economic analyses that compare the development of member states of the European Union are commonly published in scientific magazines as well as in the news. However, it is necessary to point out, that most of the observed indicators such as gross domestic product, unemployment rate, and average salary is affected by the demographical composition and the behavior of individual populations of individual member states of the European Union.

Ageing is becoming a significant characteristic of the population of the European Union. Proportional differences between the productive and the elderly parts of the population are becoming consequential. Costs for pension and social security scheme are increasing as well as there is a reduction of labor force. One of the possible solutions is to set measures in order to increase the birth rate. However, the elevation of the birth rate to a certain level would not put a stop to ageing, but only avert the decline of the population. It seems that the process of ageing is in inevitable. It is only possible to prevent the population decline. The member states of the European Union are conscious about the issue and are trying to support the population through a positive approach towards the potential of elderly age groups.

Demography plays an important role in the process, where it provides necessary data about the current structure of the population and also the potential future structure due to forecasting. Negative impact of forecasting in demography is the warning of what alternatively happen, if the pessimistic scenarios for birth rates, death rates and migration rates are fulfilled.

In the last decade of the previous century, Czech Republic has gone through significant changes whose consequences lead to changes in the demographic indicators. Opening of the borders lead to changes regarding migration and also the changing of society as a whole. According to the pattern of the European Union, the age of a woman's first baby has prolonged, which reduces the chances of becoming pregnant. The growing ratio of elderly citizens brings the responsibility to pay out the pensions in higher and higher amounts, which is not fulfilled by the decreasing number of labor force. Overall, based on the projections and forecasts of Eurostat, the population of EU is likely to decline after the year 2026.

2 Aims and Methodology

2.1 Aims

The goal of the diploma thesis is the evaluation of trends and similarities in the development of demographic indicators in the European Union. Higher emphasis is put at the development of demographic indicators in the Czech Republic. Member states are selected based on the outcome of cluster analysis. Their development will be subsequently analyzed.

2.2 Methodology

The practical part of the thesis focuses on the cluster analysis, a method used to identify groups of objects with similar values and distances. This thesis is dealing with 27 member states; therefore, the clusters will be in form of groups of member states. Firstly, exploratory data analysis is processed, which gives basic information such as mean, lowest and highest values etc. of the collected data. Next step is to standardize collected data, in order to have the same units. After standardization of data is done, it is possible to proceed with the cluster analysis.

2.2.1 Elementary characteristics

Elementary characteristics are a method of time series analysis, that indicates the trend of the function and shows the changes compared to selected year. Statistical indicators used are 1st difference and chain base index. First difference examines the changes from one period to the next, where on the other hand, the chain base index sets one year as a base and computes the changes.

1st difference formula:

$$\Delta_t^1 = y_t - y_{t-1} \text{ where } t = 2,3, \dots, n \qquad (1)$$

Chain base index formula:

$$k_t = \frac{y_t}{y_{t-1}} \qquad (2)$$

(Hindls et al, 2006)

11

2.2.2 Exploratory data analysis

Martinez claims: *"John W. Tukey (1977) was one of the first statisticians to provide a detailed description of exploratory data analysis (EDA). He defined it as "detective work – numerical detective work – or counting detective work – or graphical detective work". It is mostly a philosophy of data analysis where the researcher examines the data without any pre-conceived ideas in order to discover what the data can tell him of her about the phenomena being studied"* (Martinez, 2017). Chosen indicators for the purpose of EDA were selected – mean, median, lowest, and highest values, variation, range, standard deviation, and variation coefficient.

Mean or so-called arithmetical average belong to basic components of descriptive statistics. It is defined as the sum of all number divided by the number of observations.

Mean formula:

$$\bar{y} = \frac{\sum y_t}{n} \tag{3}$$

Standard deviation, as one of the components of Exploratory Data Analysis explains the deviation among variable within the average value.

Standard deviation formula:

$$s_y = \sqrt{s_y^2} = \sqrt{\frac{\sum (y_t - \bar{y})^2}{(n-1)}} \tag{4}$$

Coefficient of variation is a statistical measure that is defined as a percentage of relative variation to its mean.

Coefficient of variation formula:

$$CV = \frac{s_y}{\bar{y}} * 100 \tag{5}$$

(Bindu, 2019)

Visual representation of data using box blots is necessary for cluster analysis because it reveals outliers and extreme values, that could cause a formation of clusters with just one object. Outliers are points that are located far from the data set, speaking of the distance, outliers are located more than 1.5 times below or above of the interquartile range.

2.2.3 Standardization of data

Standardization of data is necessary to proceed in case the standard deviation of variables is different, one variable would dominate in the analysis. This method will prevent data from having distorted results, which would be dependent of variables with highest range. The method of standardization used is called *z-score* and it is applied across all observations. The new values will have 0 mean and variance of 1.

Sample *z-score* formula:

$$z = \frac{(y - \bar{y})}{s} \qquad (6)$$

Where

y= original observed value

$\bar{y}$ = sample mean

s= sample standard deviation

(Martinez, 2017)

2.2.4 Cluster analysis

Cluster analysis is a method used to analyze multidimensional object, therefore objects that measure a bigger number of variables. It includes several types of methods, that classify object into groups – clusters. Cluster analysis is tool to simplify and inspect data. Maharaj et al claim: *"The respect to observed variables, and the cluster themselves stand apart from one another. In other words, the goal is to divide the units into homogenous and distinct (well separated aim of cluster analysis is to assign units (objects) to clusters so that units within each cluster are similar to one another with the) clusters."* (Maharaj, 2019) In general, there are two types of clustering – hierarchical and non-hierarchical.

Hierarchical clustering

"Hierarchical clustering groups data with a sequence of nested partitions, either from singleton clusters to a cluster including all individual and vice versa. The former is known as agglomerative clustering, and the latter is called divise clustering" (Maharaj, 2019). Hierarchical method does not need to have set the specific number of clusters as compared to the non-hierarchical method. It is necessary to decide on the clustering procedure and also the method used, which measures the distances (dissimilarities). Agglomerative approach takes the position, that each object represents one cluster. Distance matrix is computed, and the closest objects are merged into the first cluster. Then the distance matrix is processed again and again, until all objects are in one big cluster. Divise approach is the opposite. All objects are formed into one cluster, which is separated until the point where each object is a part of one cluster. This thesis is dealing only with agglomerative clustering. The result of the clustering is represented visually through so called dendogram. It is simple to distinguish its interpretation. Clusters and distances are easy to observe. The merging of a pair of clusters or the formation of a new cluster is dependent on the definition of the distance function between two clusters. The most used method for measuring distances is called the Euclidean dissimilarity measure. Other used methods are called Squared Euclidean measure, City-block measure, Chebychev method or Minkowski method (Maharaj, 2019).

Euclidean measure formula:

$$D_E(x_i, x_j) = \sqrt{\sum_{l=1}^{m} (x_{il} - x_{jl})^2} \qquad (7)$$

(Maharaj, 2019)

Agglomerative hierarchical clustering uses methods:
- Nearest neighbor method (single linkage method) – *the distance between a pair of clusters is determined by the two closest units to the different clusters*
- Farthest neighbor method (complete linkage method) – *this method uses the farthest distance of a pair of subjects to define inter-cluster distance*
- Ward's method (minimum variance method) – *the aim of this method is to minimize the increase of the so-called within-class sum of squares*

- Centroid linkage method – *two clusters are merged based on the distance of their centroids (means)*
- Weighted average linkage method – *average linkage is also used to calculate the distance between the newly formed cluster and the rest are weighted based on the number of data points in each cluster*
- Group average linkage method – *the distance between two clusters is defined as the average of the distances between all pairs of data points, each of which comes from a different cluster*

Each method gives out different results, although the important aspects of the classification remain the same. Comparison of the results within the methods is based on the similar features useful for its classification. The number of clusters is defined in the dendogram processed for each of the mentioned methods. However, the optimum number of clusters may be determined by a set of tests and indices (Maharaj, 2019).

Non-hierarchical clustering divides data into a specific number of clusters without hierarchical structure (Maharaj, 2019).

3 Theoretical Basis

3.1 The term Demography

The word demography was first introduced by a Belgian, Achille Guillard, in his book *Elements of human statistics or comparative demography* in 1855. Shryock claims: „*He defined it as the natural and social history of the human species or the mathematical knowledge of populations, of their general changes, and of their physical, civil, intellectual, and moral condition.*" Nevertheless, it is the science that inspects the human population from broad and narrow perspectives. Size, distribution, structure, and change describe the narrow viewpoint. Changes in number of inhabitants, age, and gender groups, spread of the population are all components of demography (Shryock, 1976).

Several different fields explore the human population from many different angles. Demography inspects reproduction, and thus the renewal of population by giving births and dying out. The fundamental topic of demography is the changes in number of inhabitants and increase in population. Changes in population are caused not only by the natural renewal of population but also the result of spatial mobility (migration). Demography cooperates with geography of the population, which is concerned by the layout and the movement of the population.

3.2 Demographic data

The quantity of data sources for the purpose of demographic research is very extended. Most of them fulfill each other. Two types of data are classified. The first one represents size of the population in the sense of number of inhabitants and its structure concerning age and gender. The second one is connected to the movement of people that reflect the change in population such as births, deaths, marriages, migration. The data are published within a specific time frame, most often 1 year. The most common data sources are censuses, registers, and sample surveys. Registers may be very general and inquire only about natality, mortality, marriage, and divorce connected to the individual. Or on the other hand listing may be specific and wonder whether a woman has given birth in the last year (Shryock, 1976). Registers have a long history and were used by ancient Egyptians and Romans, which used the term census, and it is common until today.

Although, the UNITED NATIONS state: *"Population and housing censuses are a primary means of collecting basic population and housing statistics as part of an integrated program of data collection and compilation aimed at providing a comprehensive source of statistical information for economic and social development planning, for administrative purposes, for assessing conditions in human settlements, for research and for commercial and other uses"* (SWANSON, 2004).

Census is a major event, that takes a long time to prepare but provides a lot of data about the population. The carrying out is very time consuming and therefore the executions happen most often once in 10 years. In the Czech Republic, it is required to answer questions connected to the household, family, and nationality. The census in the Czech Republic acquired a special name "Census of people, apartments and houses". The last one was planned for 2021. The questionnaire was available partially online and very user friendly as it is an obligation to Czech citizens and foreigners with residence permits. Czechs living abroad but with permanent residence also participate. The results are processed by the Czech Statistical Office (CSO) (E15, 2021). Further on, that data is used as foundation for pension reform. Czech Republic differs from other European countries, that collect data from mostly from municipalities and registers. Such system is set up for instance in Sweden, Denmark, Netherlands, and Austria.

Demographic structure is a quantitative description of the analyzed population. Demography focuses on the reproduction of the population, characteristics that the demographic structure defines are closely related. Basic approaches of the structure are age and gender.

Age and gender are considered as main characteristics that define the events connected to the reproduction of the population. Fertility rates, marriage rates, divorce rates, mortality rates are directly related to age and also by gender distinguishing. For instance, mortality rates at specific ages differ for men and women. In demography, other types of structure are utilized as well, such as economic structure, geographical structure, spread and density of the population and social characteristics such as education, nationality, gender etc. Demographic structure is influenced by demographic processes (such as demographic revolutions) ongoing in the last decades and predetermines the upcoming development. For representation of the structure, age pyramid or so-called double histograms are used.

Age is found on the x axis and number of individuals in each age category is found on the y axis. The graph has a section for men on the right and women on the left (Fiala, 2013).

Fiala & Langhamrová claim that population is divided into three groups based on their ability of reproduction:

- *Pre reproductive (child); 0-14 years of age - I. biological generation*
- *Reproductive (parent); 15-49 years of age - II. biological generation*
- *Post reproduction (grandparent); 50+ years of age - III. biological generation*

(Fiala, 2013)

The border line between the second and third generation is stated differently in practice. Eurostat and most of the statistical offices use age between 64-65 years of age, retirement age in most cases. Second biological generation takes up usually around 50% of the population. Based on this fact, population is divided into three types.

Figure 1 Different types of population pyramids
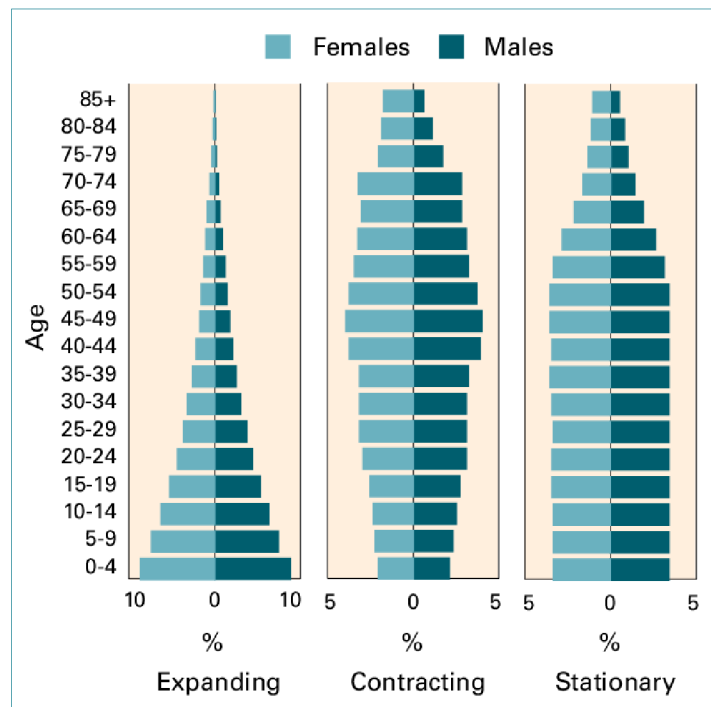
Source: Staetsky, 2016

The first type of the pyramid is called expanding, or progressive in other literature. Young population with the predisposition for population growth is exceeding. Expanding type can be found in developing countries. In the spectrum of the European Union, Luxembourg has a very similar population pyramid. The young generation is dominating because of the inflow of immigration. Second type of the population pyramid is called contracting, in other sources may called as regressive. This type can be found in most of the European countries. The population has a higher number of elderly and small portion of the younger population. The number of children being born is lower than the number of deceased. The last type of population is called stationary. The groups of youngster and elderly are even, the population growth is stagnating.

3.3 Demographic indicators

Speaking of demographic indicators, one of the most talked about phenomenon, that they influence is the population ageing. It affects all social spheres of the social sector and not only, but also the public sectors and government finance. To collect data about ageing, statisticians are focusing on mortality rates, fertility rates and migration. Every nation has a different approach, different lifestyle, different history, therefore the data varies in the whole world. Median age is also considered as an important factor that defines demographic ageing. Lastly, dependency ratios are useful demographic indicators, although because of the latter, they may be often misleading (UNITED NATIONS, 2016).

Old-age-dependency ratio
Old-age-dependency ratio is one of the characteristics of the age structure of the population, which provides information about ageing. It shows the level of support the working part of the population is able to give to the older generations. Throughout time, the old-age-dependency ration is increasing. Around 10 years ago the ratio was 4:1, last few years it is around 3:1 (Eurostat, 2018).

Old – age – dependency ratio:

$$\frac{\text{number of persons aged 65 and over}}{\text{the number of persons aged between 15 and 64}} \tag{8}$$

Median Age

Swanson defines the term as: "*The median age of an age distribution may be defined as the age that divides the population into two groups of equal-size, one of which is younger and the other of which is older than the median. It corresponds to the 50-percentile mark in the distribution*". Arithmetic average is not used as a measurement of central tendency, as age distributions are often provided in intervals (such as 65+ years etc.) (SWANSON, 2004).

Crude birth rate

Eurostat defines crude birth rate as: "*The crude birth rate is the ratio of the number of live births during the year to the average population in that year. The value is expressed per 1 000 persons.*" (Eurostat, 2021).

Crude death rate

Eurostat provides the definition as: "*The crude death rate is the ratio of the number of deaths during the year to the average population in that year. The value is expressed per 1 000 persons.*" (Eurostat, 2021).

Life expectancy

Life expectancy is one of the demographic indicators, that measures the longevity of life. It is determined by many factors such as lifestyle of citizens, level of healthcare in a country, proneness to diseases etc. It is conducted for men and women, as they have different ways of lives. As Swanson claims: "*Life expectancy is the expected number of years to be lived, on the average, by a particular population at a particular time.*" Eurostat, a statistical office of the European Union, gives the definition of life expectancy more clarity: "*the mean number of years that a person can expect to live at birth if subjected to current mortality conditions throughout the rest of their life*" (Eurostat, 2021).

Crude rate of natural change

Definition provided by Eurostat: "*The crude rate of natural change is the ratio of the natural change during the year (live births minus deaths) to the average population in that year. The value is expressed per 1 000 persons*" (Eurostat, 2021).

3.4 World population development

The process of estimating the development of population is not simple at all considering that fact, as there are no records of the population older than a few centuries. Mathematical methods are used to construct the potential models, which already expect a certain variation. Nathan Keyfitz, a Harvard professor of sociology and demography, assessed that there would be 69 billion of inhabitants by the year 1999 (Keyfitz, 1972). In the year 2002, The Population Reference Bureau estimated this number at 106 billion inhabitants, this would mean that 6% of all currently living individuals were already born by the year 2002. Another institution dealing with the topic of world population is UNITED NATIONS. Trends, projections, estimates, analysis can be found in a publication World Population Prospects, which has been updated in the year 2019 (UNITED NATIONS, 2020).

Another source of population projections is processed by the American Statistical Office. The oldest estimates are dated to the year 10 000 B.C., where Ralph Thomlinson set the world population between one to ten million inhabitants. The first population growth was seen around the year 1000 B.C. with the Neolithic revolution. The population at the time consisted of 50 million inhabitants (Roser, 2019). According to the Population Reference Bureau, in the year 0 there were 300 million people, in the year 1000 it was around 310 million inhabitants, which did not show any major growth. In the year 1500, the population reached 500 million and in the year 1800 it grew to 980 million. During the next 100 years the population reached 1.6 billion and in the year 1950 there were 2.6 billion citizens. This rapid increase caused the population to grow to 6.1 billion people. Several projections estimated that in the half of the 21st century, there would be over 10 billion people. Now, it is clear that the growth does not reach the rate it has in the half of the previous century. The difference between the years of reaching another billion is not decreasing but increasing. The period unevenness of growth and layout of the population is very visible.

3.4.1 Neolithic revolution

Two milestones are distinguished speaking the development of the world population. The first one is the Neolithic Revolution which has begun around 10 000 B.C. It is characterized by a change of behavior from a travelling society of hunters and gatherers to a settled down society, which focuses on agriculture. The humans took over the control of raw material and the society was developing independently on migration of animals. This change resulted in

population growth, more specialized professions, and expansion of trade with excess goods (Blakemore, 2019). Another turning point is the industrial revolution which led to a European population expansion in the 18th and 19th century (Hudson, 2009). This era can also be characterized by demographic revolutions.

3.4.2 First demographic revolution

The theory of a demographic transition is often connected to a French demographer Adolf Landry, who was focusing on this topic since the beginning of the 20th century (Landry, 1987). However, the term "first demographic revolution" was first used by an American demographer Frank W. Notestein in his work "*Population – The Long View*". The book was published in the year 1945 (Diggs, 2008).

The process of demographic revolution is acquired in different forms in various societies. The course of demographic revolution is characterized by a decrease in crude death rate (from up to 30 ‰ to less than 15 ‰) and decrease in crude fertility rate (from 45 ‰ to less than 20 ‰). The main reason is believed to be the process of modernization, where the industrial production is experiencing its bloom. People were moving to cities, health care was evolving, hygienic condition were improving that lead to a decline of occurrence of terminal illness. The levels of infant mortality are rapidly declining, where on the other hand the life expectancy nearly doubles. The beginning of the demographic transformation was first seen at the end of 18th century in France, afterwards in England and then further on in the whole world. The changes in the demographic reproduction are described in two phases, that are do not have the same length in all parts of the world, have not even finished in some countries.

3.4.3 Second demographic revolution

Second demographic transition has been visible since the 1960s. A Dutch demographer Dirk van de Kaa has been the first one to use this term in the year 1986, where he described the situation since half of the previous century (Zaidi, 2017). The second demographic transition is having experienced a decline in fertility under the level of low reproduction (where this level is around 2.1 in developed countries with low mortality). The changes are not only caused by the external conditions of people as in was in the first demographic revolution.

Bigger emphasis is put on individualism, attitude, and values. Different models of partner life emerge than just a family of a traditional sense.

Dirk van de Kaa stated that the main reasons of a demographic transition were the change of role of contraception (now it solves a purpose of planning a family, not just prevention of conception), change of position of infants (children are equal members of the family), change of role of marriage and change in family in general from smaller to bigger (Zaidi, 2017). He also elaborated on the course of the second demographic transition in decades:

- 1960s were described as overcoming difficulties which resulted from world wars. It was an era of relative prosperity. Contraception started to fulfill a new function of planning a family, not just a limitation to the number of children.
- In the 1970s, many countries started to enforce abortion laws, which lead to decline of unwanted children.
- In the 1980s, marriage was considered as an essential condition to a long-term partner and family life. Although, the number of divorces is increasing, the number of so-called nonofficial bonds, the fertility rates are stabilized which notes that the second demographic transition is coming to an end.

3.4.4 Demographic ageing

Demographic ageing is a process of changes in the age structure, which leads to an increase in the portion of elderly part of the population. It results in the population getting older even though the number of elderlies is decreasing, on the precondition, that population of youngsters is decreasing more rapidly. The population has never been so old as it is at this very moment. This carries out demographic and socioeconomic consequences. Health care costs and pensions will increase, and the source of its financing will concern all of us. Speaking of the countries with not so generous social security systems, they will have to come up with solutions for this financing this phenomenon as it will become unbearable without interventions and strategies (Légaré, 2015). This process is very closely connected to the demographic revolutions during which led to a significant decrease in fertility. At the end of the second demographic transition, the fertility rates slowly start to stabilize. However, the life expectancy has started to progress. Fertility was put into a suspension as the society focuses on their children to achieve higher education.

UNITED NATIONS are trying to point out the phenomenon of demographic ageing by the concept of active ageing. This incident is changing the age pyramid into a tree-shaped form (UNITED NATIONS, 2020). The United Nations Economic Commission for Europe (UNECE) represents nearly a quarter of the whole worldwide population. Member states of UNECE are countries of Europe, Canada and United States, Central Asia, and Western Asia. The member states represent a diverse portfolio as they represent the world's richer countries as well as developing countries (UNECE, n.d.).

Figure 2:Population pyramids of the UNECE region, 2000, 2015, 2030 (in % of the total population)
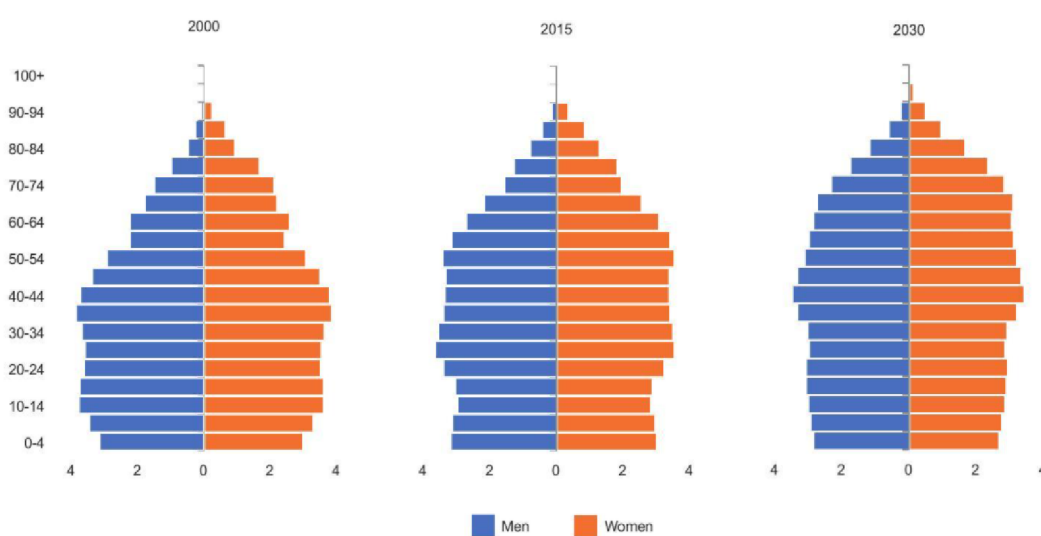
Source: UNITED NATIONS, 2020

Overall, the increase of life expectancy is the most positive result of demographic ageing. Negative consequences such as decreasing ratio of labor force and increasing costs for social security and health care follow. The systems in charge are beginning to be unsustainable as the ratio of givers and takers is becoming more and more uneven. We are present in the era of countries increasing their retirement age, looking for alternative ways to finance the pensions etc. The lowering ratio labor force is expected to be moderated by the support of economic activity of women and elderly (UNITED NATIONS, 2020). It is expected that younger seniors will be in a good condition and will take part in the social life. Problems may arise in the increase of population of the oldest ones as they are more prone to diseases and are more reliable on the help and caring of others. This results in pressure towards the family, social systems, and health care in general.

3.5 Key components of population change

Changes in population may be expressed by several indicators. Firstly, the life expectancy is a driver speaking of population change. It reflects how long the person will live, most often it is reflected at birth. Life expectancy is followed by fertility rates, which guide in how many children are born within one year. Lastly, migration is a factor that influences the number of inhabitants living in one place.

Demographic changes in Europe have a direct influence on the economies and societies. It has been apparent that in the last two years, the economy has gone through a stagnation phase and restrictions connected to the physical contact have had power over our mental health and daily lives. This results in consequences in our social and healthcare security, budgets, needs in housing and infrastructure. Cities and urban areas will potentially become more crowded, and suburbs may face challenges. The professional lives of all the individuals will keep on changing and will try to adapt to current conditions in order to keep the economy going with less people in their productive age.

3.5.1 Life expectancy

Ever since the transition from the 20th century to the 21st century, developed countries are experiencing a major increase in life expectancy. The level of health care in developed countries is higher than ever, the number of educated children is getting higher and higher and lifestyle changes attribute to this fact (OECD/European Union 2018). Governments are preparing scenarios for possible options, if the trend is likely to continue or the opposite.

Overall, the raise of life expectancy for women increased from 72.4 years (period 1960-1965) to 82.6 (2015 - 2020). In general, women have a higher life expectancy than men, worldwide. The reasons behind it are biological, social and life conditions, tobacco consumption and worse way of lifestyle. Men are more likely to pass away in an accident (Kiss, 2020).

Figure 3 Average female and male life expectancy at birth between 1965 – 2020 (stated in years of age)
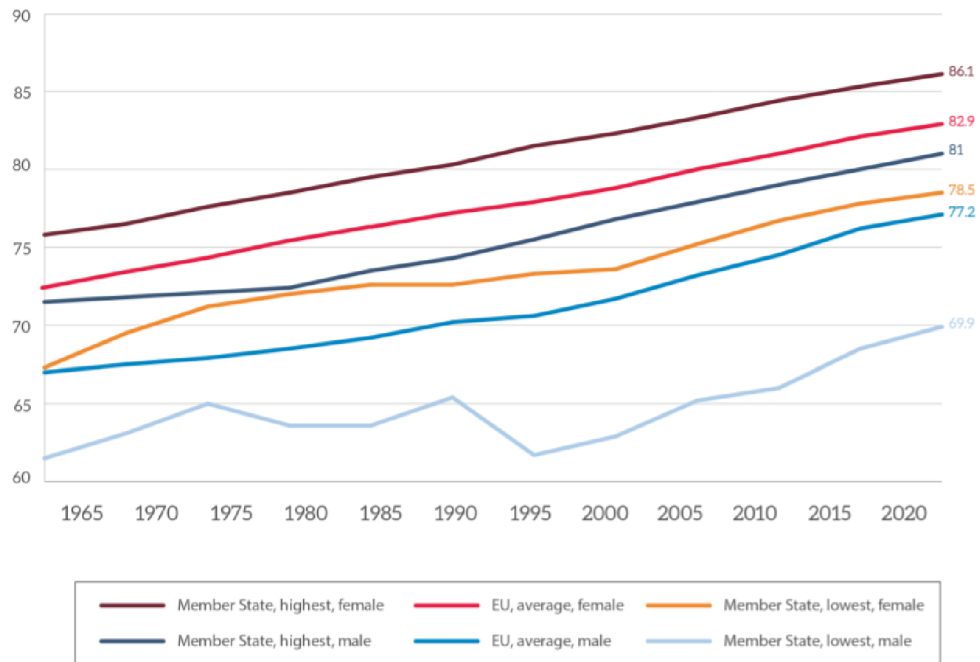
Source: Kiss, 2020

Presently, there are gaps in the development throughout the European Union (Kiss, 2020). Spain and Italy show the highest life expectancy reaching 83 years in 2018. The countries with lowest life expectancy are Bulgaria, Romania, and Latvia. However, life expectancy was rising quickly among the EU countries, but several years even before the COVID-19 pandemic, it started to stagnate. Major flu seasons, decreasing of deaths rates from circulatory diseases have been factors influencing the slowdown. Further stagnation is expected as a results of the first year of the COVID-19 pandemic (OECD/European Union, 2020).

3.5.2   Low fertility rates

Europe is experiencing a decline in fertility rates since 1960s. Until 1970s, it has maintained a level of around 2.1 children per woman in Europe, where it is bearable for the generation replaces itself by the new one. When the level decreases, which means less children are born as well as the elderly part of the population is increasing and causing the ageing of the European population. This is still the case in Europe (Kiss, 2020).

Figure 4 Total fertility rate development in EU 2019
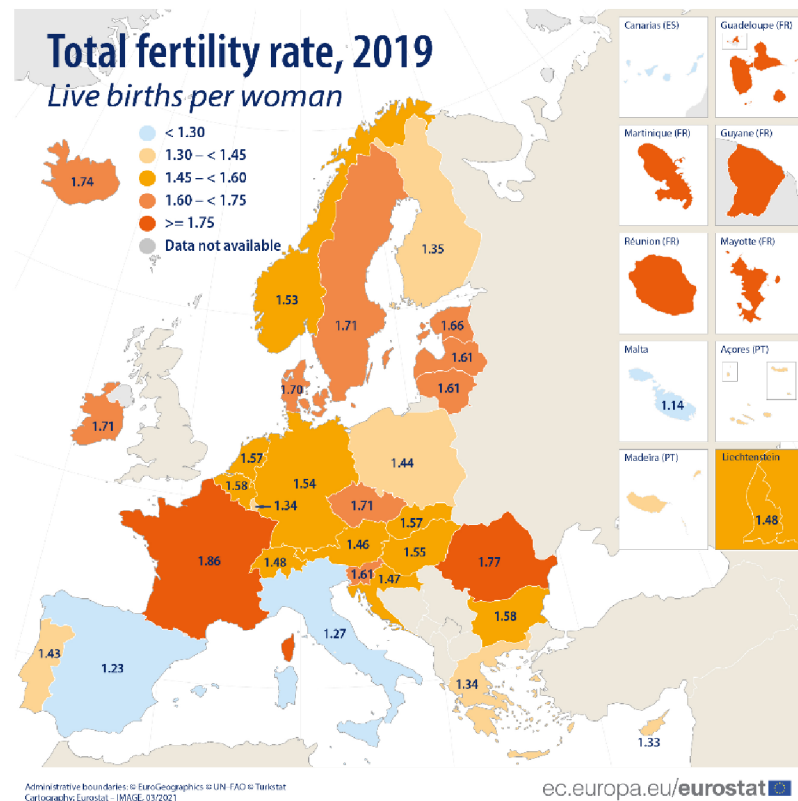
Source: Eurostat

Worldwide, the trend is similar as in Europe. Although the starting point of around five births per woman is incomparable. As the number of children being born is constantly decreasing, the effect of migration has gained its importance in keeping the population steady. Replacement fertility rate plays an important role while examining the fertility rates. It represents 2.1 of children per woman in order to maintain the stability of the population with no consideration of migration and mortality rates (OECD, 2016).

Figure 5 Total fertility rates (live births per woman)
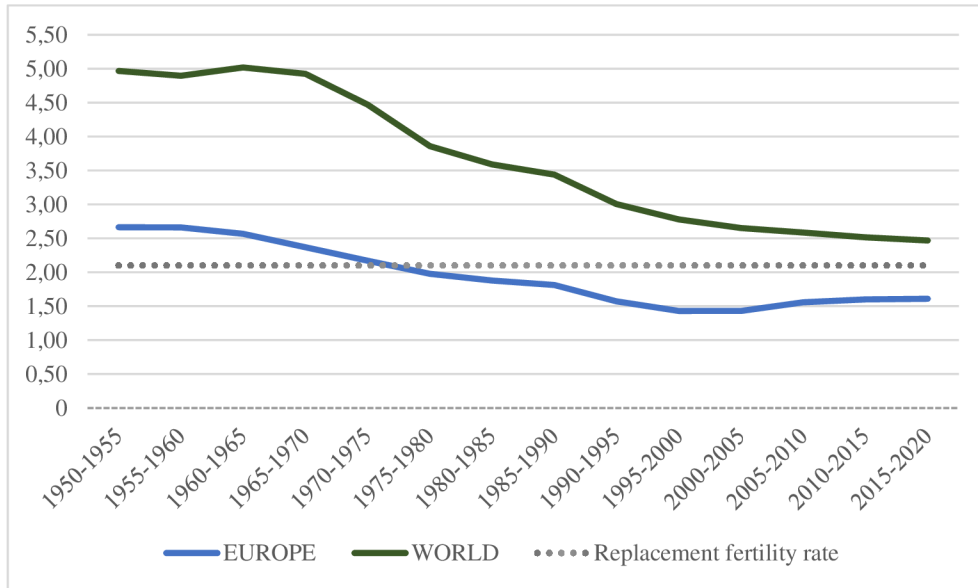
Source: World Bank, 2021

3.5.3   Cities and peripheries

Demographic trends differ throughout all the member states. It is possible to observe some similarities based on the historical development or the geographical location. Europe is having to deal with descending number of inhabitants. One of the influences benefiting this cause is the inflow of immigrants mainly from outside of the European Union. The first countries that issued residence permit were Poland, Germany, United Kingdom and France (Kiss, 2020). The labor market within the EU is very favorable as it is easy for apply for a job in another member state. Germany was the number one country, followed by the United Kingdom. Most affected areas are often the outskirts on the states level. Outstanding increase in the number of inhabitants experienced Ireland, the Netherlands, the United Kingdom and Belgium. In general, the population tends to increase in the capital cities, Paris, and London for instance.

Based on the projections, big cities will be home to almost a half of the European population. Rural areas are not attractive for society because of lack of job opportunities, economic prospects, availability of health care and possibly increasing poverty. In the long run, these specific geographic locations may experience drops in economic growth and lower level of business activities. However, suburban, and rural areal close to the metropolitan cities can be a change for inflow of citizens and seasonal workers (Kiss, 2020).

3.6 European population development

Europe has played an important role not only in the economic field in the modern history. The world population has been directly or indirectly influenced by the European population. Demographic evolution has been put through many challenges that lead to an increase, decrease or stagnation in the population. During the era of prosperity and peace the population slightly increased. The growth has been negligible, because of the high level of mortality, that absorbed the higher level of fertility rates. These periods were interspersed with wars, epidemics, poverty, and famine. The effects of disasters came hand in hand as they occurred in the same time period.

Undoubtedly the most significant influence the structure of the European population was the plague outbreak in the middle of 14th century. The losses were counted up to 25% of the population. In some parts of the Europe, it has been almost half of the population. The decrease has been also influenced by a shortage of food, caused by a long-term crop failure.

3.7 Development of EU member states based on demographic indicators

3.7.1 Changes in the population

The population of the European Union has reached nearly 450 million inhabitants on January 1st, 2020. The EU experienced a drop compared to the year before mainly due to stepping down of Great Britain and the COVID-19 pandemic. Nearly 1 million was a positive change due to migration. Altogether the natural change has gone through a shift in the year 2012, since then there are more deaths than births in the European Union (Eurostat, 2020).

Considering the 27 member states, Germany has the largest population followed by France, Italy, Spain, and Poland. The countries that experienced quite major growth of population are Malta, Luxembourg, Cyprus, and Ireland. On the other hand, Bulgaria, Latvia, and Croatia experienced population decreases (Eurostat, 2020).

Table 1 Member states population as of 1.1. of 2000, 2010 and 2020 and its changes

Member states	Population (in thousands)			Growth index		Chain base index (2000)	
	2000	2010	2020	2010	2020	2010	2020
EU 27	428 929	440 660	447 319	2.73	1.51	2.73	4.29
Austria	8 012	8 352	8 901	4.24	6.57	4.24	11.10
Belgium	10 251	10 839	11 522	5.74	6.30	5.74	12.40
Bulgaria	8 170	7 422	6 951	-9.16	-6.35	-9.16	-14.92
Croatia	4 468	4 303	4 058	-3.69	-5.69	-3.69	-9.18
Cyprus	694	819	888	18.01	8.42	18.01	27.95
Czechia	10 255	10 462	10 694	2.02	2.22	2.02	4.28
Denmark	5 340	5 535	5 823	3.65	5.20	3.65	9.04
Estonia	1 397	1 333	1 329	-4.58	-0.30	-4.58	-4.87
Finland	5 176	5 351	5 525	3.38	3.25	3.38	6.74
France	60 762	64 659	67 320	6.41	4.12	6.41	10.79
Germany	82 212	81 802	83 167	-0.50	1.67	-0.50	1.16
Greece	10 806	11 119	10 719	2.90	-3.60	2.90	-0.81
Hungary	10 211	10 014	9 770	-1.93	-2.44	-1.93	-4.32
Ireland	3 805	4 549	4 964	19.55	9.12	19.55	30.46
Italy	56 942	59 190	59 641	3.95	0.76	3.95	4.74
Latvia	2 368	2 121	1 908	-10.43	-10.04	-10.43	-19.43
Lithuania	3 500	3 142	2 794	-10.23	-11.08	-10.23	-20.17
Luxembourg	436	502	626	15.14	24.70	15.14	43.58
Malta	390	414	514	6.15	24.15	6.15	31.79
Netherlands	15 926	16 575	17 408	4.08	5.03	4.08	9.31
Poland	38 259	38 023	37 958	-0.62	-0.17	-0.62	-0.79
Portugal	10 290	10 573	10 295	2.75	-2.63	2.75	0.05
Romania	22 443	20 295	19 329	-9.57	-4.76	-9.57	-13.88
Slovakia	5 389	5 390	5 458	0.02	1.26	0.02	1.28
Slovenia	1 989	2 047	2 096	2.92	2.39	2.92	5.38
Spain	40 567	46 487	47 333	14.59	1.82	14.59	16.68
Sweden	8 872	9 341	10 328	5.29	10.57	5.29	16.41

Source: Eurostat, own processing

Table 1 shows that Luxembourg (43.58%) and Malta (31.79%) have the most significant increase in population compared to the year 2000. Island countries Malta and Cyprus also reached the level of 20% increase in population between the years 2000-2020. Although, the growth in many of the countries is not consistent. For instance, Portugal experienced only a slight population growth by 0.05%, but the drop compared to the previous decade was negative 2.63%.

Eastern Europe has experienced a decline in the number of inhabitants between the years 2000-2020. Baltic states Lithuania (-20.17%) and Latvia (-19.43%) represent biggest declines in the whole European Union. It has been already addressed by International Monetary Fund to face the problems. One of the possible solutions could be attracting foreigners for labor purposes. However, Baltic states present a high level of nationalism and protectionism towards their culture. Based on the projections executed by UNITED NATIONS, Lithuania and Latvia will love 15% of their population by the year 2050 (Hernandez, 2018).

When the COVID-19 pandemic started, the expectations of the society were, that there will be a baby boom due to lockdown and restrictions. It is very early to predict, as we have available data for the first year of the pandemic. Family life took a turn and is more likely to suffer (Kreyenfeld, 2020).

3.7.2   Structure of the population

The population of the European Union is ageing. In order to observe the age distribution, median age is used as one of the methods of central tendency measurement (SWANSON, 2004). Median age, which represents half of the population older than the median, where on the other hand the second half is younger than the median age.

Figure 6 Median age of EU member states in 2010 and 2020
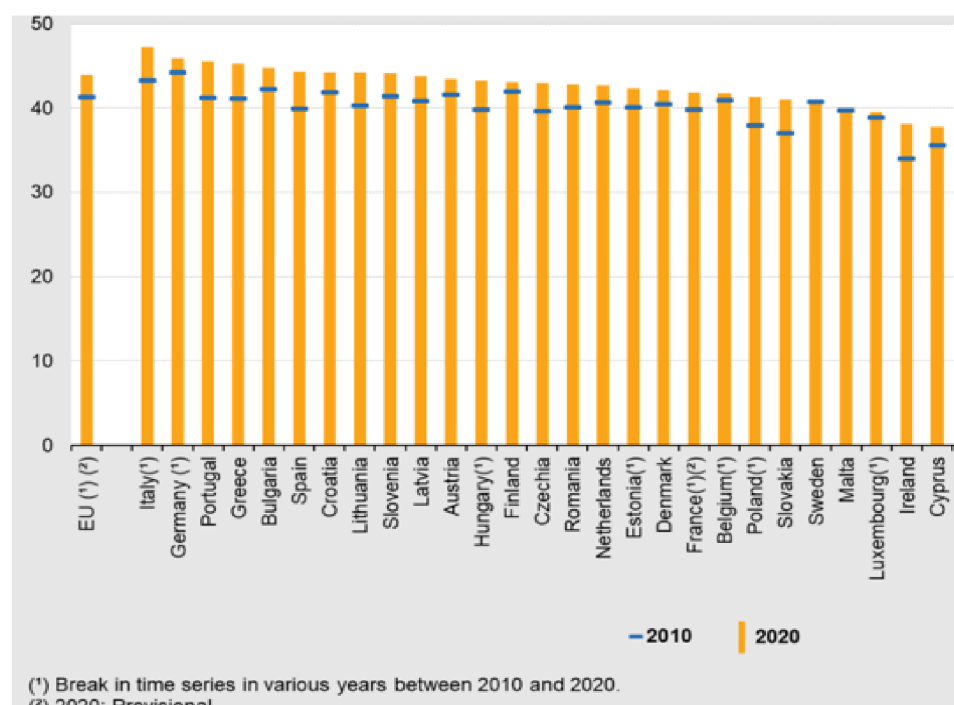
Source: Eurostat, 2021

Median age of the European population has been increasing several years in a row and it is expected to rise in the next decades. By the year 2070, the median age may get up to 49 years of age, 5 more years than it is at the moment. With increasing median age, the ratio of elderly part of the population is increasing as well.

The median age has increased to 43.9 years of age in the European Union in 2020. It is increasing by average of 0.3 years per year. In Sweden the median age decreased, whilst in Spain, Portugal, Greece, Ireland median age increased (Eurostat, 2021).

In order to see the process of ageing throughout the European Union and on the international level, the old-age dependency ratio is used for comparison. It is the ratio of people above the age of 65 expressed per 100 persons. Considering this ratio, Italy (38.6%) and Finland (38.4%) have the oldest populations. Based on the forecasts, Slovakia is expected to increase by 2.2 times by the year 2050. The projections expect that the old-age dependency ratio will reach over 55% by the year 2050, which means there will be less than 2 people in an economically productive age for each older person (Eurostat, 2021).

Figure 7 Old-age dependency ratio in EU member states in 2010 and 2020
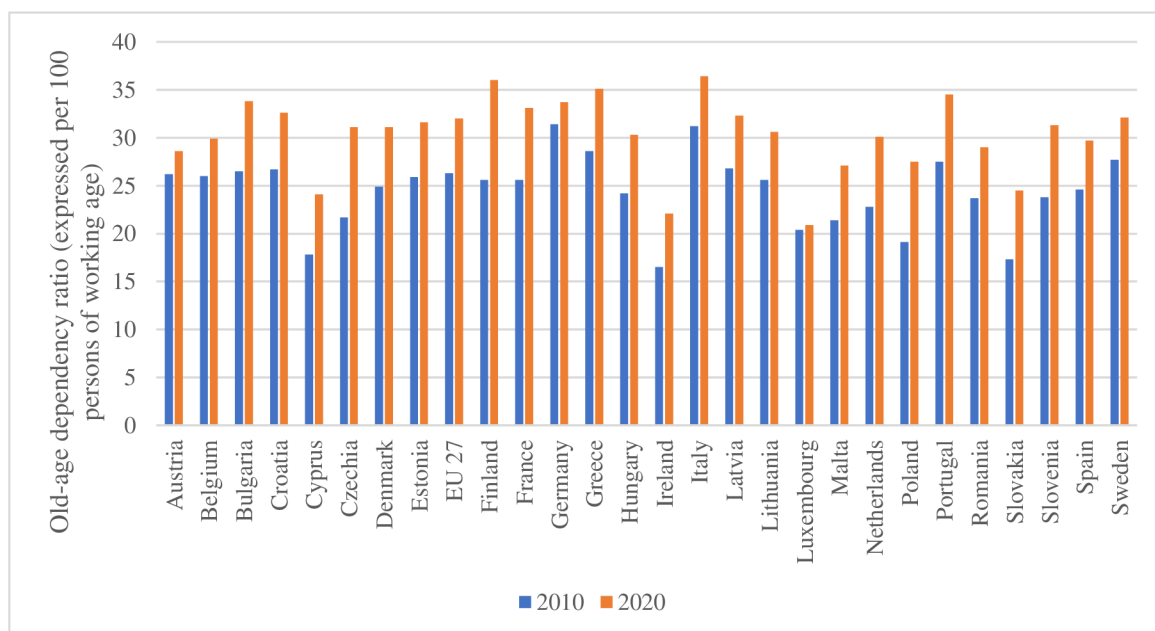
Source: Eurostat, own processing

Life expectancy has been on the rise in the last decade in the whole European Union. The COVID-19 pandemic put a stop to such a steady growth and caused stagnation throughout Europe with exceptions of Denmark and Finland.

Although, the life expectancy in EU has reached 81 years of age in 2018. Southern Europe showed the best results, Spain, and Italy. Women tend to have higher life expectancy (OECD/European Union, 2020). The reasons various, starting from diets, alcohol consumption, higher probability of heart diseases and also deaths. Differences in life expectancy are not only among men and women, but also based on the socio-economic status (Raleighi, 2019).

Marriage rates differ in the whole European Union, but in general, the number of marriages per 1000 persons (crude marriage rate) is decreasing in the past decades. On the other hand, number of divorces is increasing (Eurostat, 2021). The lowest marriage rates (less than 3.5 marriages per 1000 persons) are found in Italy, Portugal, and Slovenia. On the contrary, twice as high marriage rates are found in Hungary, Latvia, and Lithuania with close to 7 marriages per 1000 persons. In addition to the drop concerning marriage rates, the average age of men and women who are getting married is increasing. In the 1990s, the average age was around 22 – 30 years. By the year 2019, the average age increased to 27 – 33 years for women and 29 – 35 years for men. The Nordic countries, especially Sweden, are specific for their high age of men and women in their first marriage. For women in Sweden, it is 34.1 years and for men 36.7 years. It is given by of different paths, lifestyle, the fact the long-term partnership and cohabitation is preferred (OECD, 2019).

Decreasing rates of marriage are going hand in hand with increasing divorce rates in the modern society of the 21st century. Data from 2019 show us the crude divorce rates are lowest in Ireland as 0.7 divorces per 1000 persons. Conversely the highest rates are found in Latvia, Luxembourg, and Lithuania as high as 3 divorces per 1000 persons. In the last 50 years, the divorce rates have doubled in most of the European countries. Even though, the divorce rates are increasing steadily, the number of people getting married for the first time is very high. Throughout the OECD countries, four in five people have not been married. Only one in five people have been divorced. But these differences vary among countries (OECD, 2019).

3.7.3 Migration and foreigners

Throughout the year, European countries development diverse approaches when it comes to managing international migration. The reasons behind it were different social conditions, distinction of migration waves but also political traditions and culture. In the 1980s, migration and asylum were parallelly the subject of conversation with regard to the integration attempts from the European Union. During the past decades, European Union is trying hard to achieve better management regarding work migration, problem solving when it comes to irregular migrants and better cooperation with third world countries with the purpose of strengthening connections and development.

One of the pillars of the European Union is the free movement of goods, capitals, services, and labor. There are many Eurosceptics, that have a problem with the last part. Free movement of people have been affected my two eastern enlargements in 2004 and in 2007, economic crisis and debt crisis. Unemployment was rising, and the pressure on borders due to refugees running from their home countries because of war conflicts (Vrbová, 2015).

Most of the economic analyses show that migration has a positive effect on the European Union and should not be restricted. Rather than reducing migration, the states should focus more on their social and retirement politics.

Figure 8 Nationalities with most first residence permits in EU in 2019 and 2020
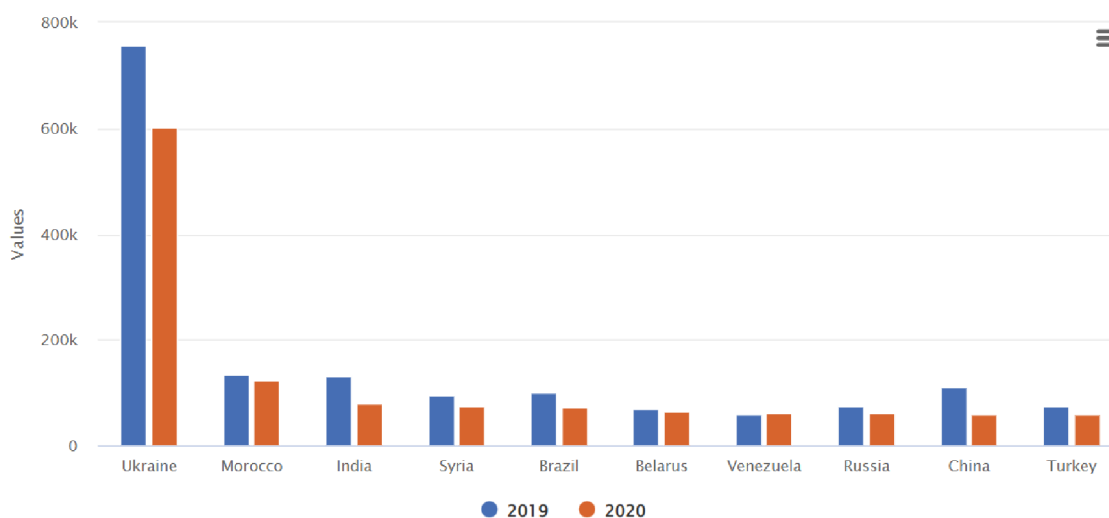
Source: Eurostat, 2021

One of the main reasons of difficulties, when it comes to refugees, is that they move into a country and ask for a social security, where they were not contributing all this time. The society seems to take this without any kind of pleasure. Although, migration in Europe for work purposes also is a massive benefit of the European citizenship, established by the Lisbon Treaty (Vrbová, 2015). Europe is an attractive location for all the non-EU inhabitants mostly for residence permits mostly for family, work, asylum reasons. There were nearly 5% of the total number of non-EU immigrants, that were employed in the EU labor market. Nations that are coming to Europe in high numbers are from Ukraine, Morocco, India and also Syria. The rest can be observed on Figure 8 (Eurostat, 2021).

Europe is a target of a lot of immigrants. Although, illegal immigrants and people smuggling has been a big topic of the European agencies. Until this day it represents a regional humanitarian and security problem. Migration and asylum policies are one of the topics that member states of the EU are able to agree on (Plevák, 2021).

The first year of pandemic had a negative impact of education and study permits due to COVID-19 restrictions. Nearly 3 million people immigrated to the EU and a little over 1 million emigrated from the EU (European Commission, 2021).

3.8 Demographic development in the Czech Republic

Czech Republic is situated in the heart of Europe with area of 78 866 km^2. Number of inhabitants has been 10 682 029 inhabitants as of 30.9.2021. The country may be characterized by numerous small villages and relatively evenly distributed population density. The capital city Prague belongs to the most populous regions with the Central Bohemian region in the Czech Republic. Prague has recorded 1 341 370 inhabitants in the first quarter of 2021, a slight increase compared to the previous quarter. The difference is caused by moving. Due to natural demographic processes the number of inhabitants dropped by around 500 (European Commission, 2021).

The demographic evolution in the post war era was very unregular and uneven. The reasons behind this fact were governmental intervention in order to raise the number of inhabitants such as preferential treatment for families with children when assigning apartments, prolonging of mother leave, and provision of bargain just married loans.

3.8.1 Changes in the population

Czech Republic is experiencing an increase in population in the last decade. Census, which is executed every 10 years, enables the Czech Statistical Office to track the situation in the country. The last census took place in 2021 in the Czech Republic. It is quite unusual for a country to have a census, as in many other different states, demographic data is taken from the register and questioning is only for a sample of the population. It is an obligation for Czech citizens to participate. According to the statisticians, there is a slight increase in the population. The census also showed, that only in the year 1930, there have been more inhabitants in the area of Czech Republic compared to the year 2020 (ČTK, 2022).

Population development has been highly influenced by the COVID-19 pandemic. All the restrictions and the epidemic itself reflected in most of the observed demographic processes. The increase in the number of inhabitants between the first and last day of the year 2020 represented the smallest increase in the last decade. Long term trends were disrupted, minimal and maximal values in the last decade had to be rewritten (Czech Statistical Office, 2020).

Figure 9 Population development in the Czech Republic 2000 - 2020
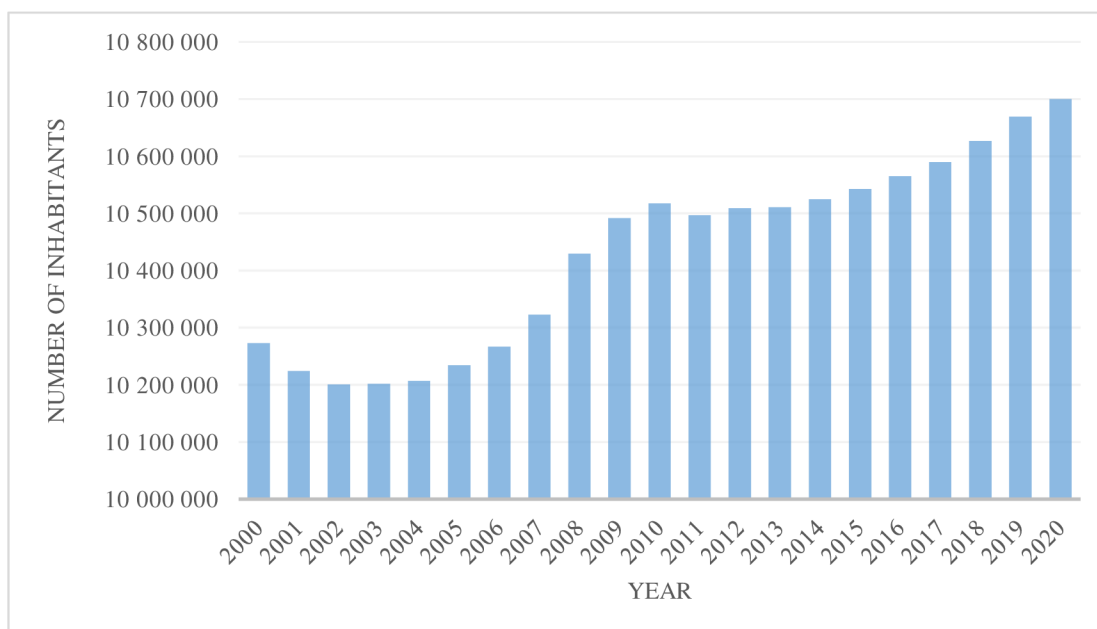
Source: Eurostat, own processing

36

3.8.2   Structure of the population

Structure of the population according to the age is fully dependent on the previous demographic development. On the Figure 9 we can see how the structure changed in the last 20 years. The first graph shows us the situation just 3 years after the establishment of the Czech Republic. The first state shows grooves, which are still consequences of a decline in natality after the First World War. The Second World War has had softer consequences. After the end of these sequence of events, the natality experienced so called post-war baby boom. These distortions work in a cyclical movement and are transferred from generation to generation and bring other deviations. The last irregular effect is the large number of children born in the 1970s. The reason is the post-war boom which increased the fertility rates and also the support from the state such as irretrievable loans and other forms of support for families.

Figure 10 Age structure in 2000 and 2020 in the Czech Republic
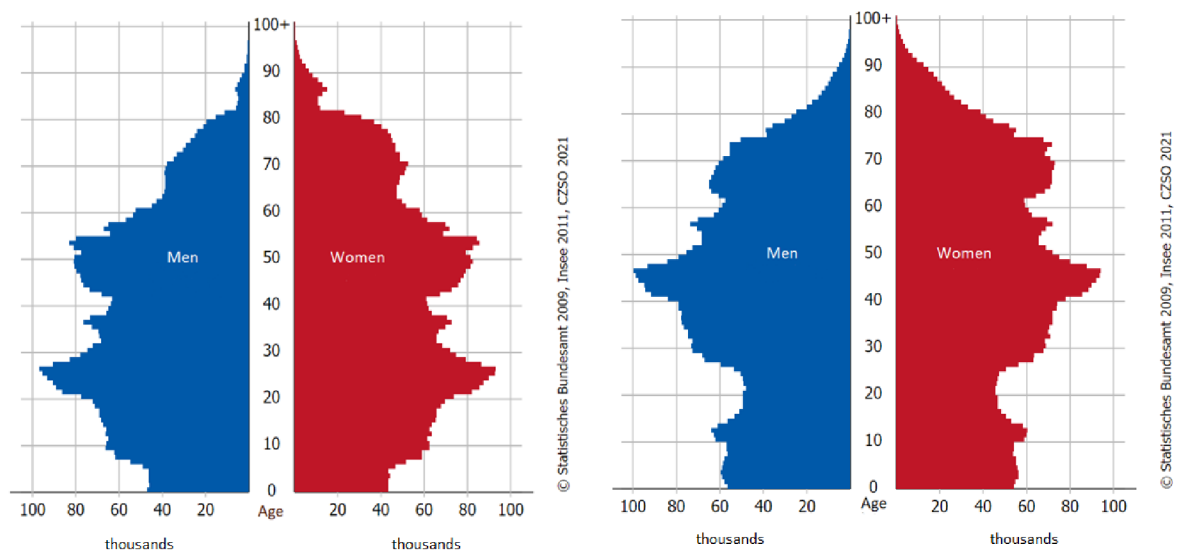
Source: CSO, 2021

The graph from the year 2020, shows the consequences of the transition between centuries. The post-war generation is at the top of the pyramid and is now in the retirement age. After the transition to the independent state, the natality was in decline until the year 2002. This proves the sequence and some kind of periodicity of demographic development.
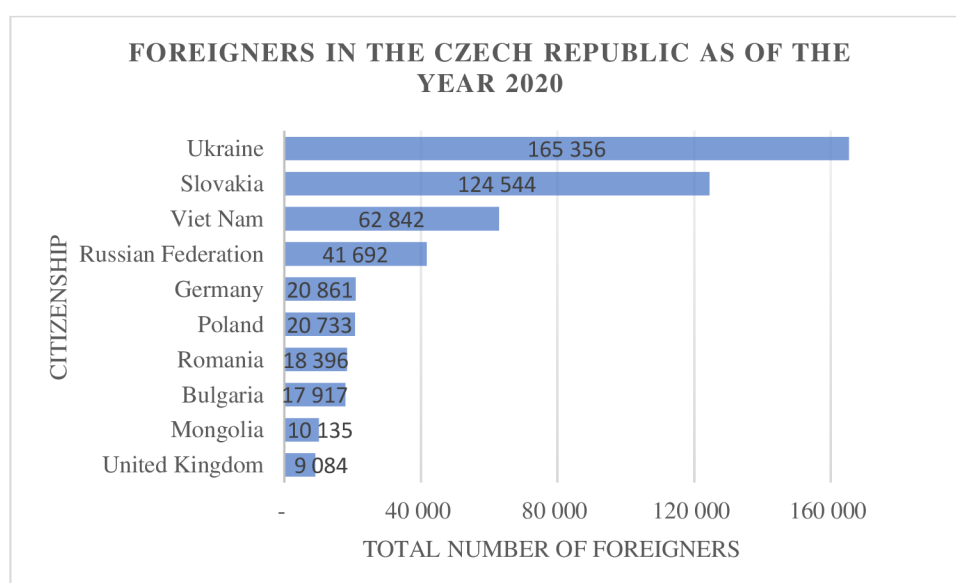
Life expectancy

The Czech Statistical Office conducts and publishes mortality information ever since the year 1920. Without considering both World Wars, there has not been such a significant

decline in life expectancy as in the year 2020. In the last twenty years, life expectancy in the Czech Republic has an increasing trend, in average by 0.2 year per annum. A drop in mortality during the pandemic has caused a return to the life expectancy rates from the year 2013 (Morávek, 2021). Life expectancy reached 81.4 years for women, which represents a 0.7-year interannual decline, and 75.3 years for men, which represents 1-year interannual decline (Czech Statistical Office, 2020).

The most substantial effect of the pandemic was observed between the age groups 75-79 and 80-84, where the number of deceased increased by 1/5. The number of deceased increased up to nearly 130 thousand people in 2020, the highest number since the year 1987. The largest increase was at the end of the year 2020, where the autumn wave of the COVID-19 epidemic struck (Czech Statistical Office, 2022).

In comparison to the European Union member states, Czech Republic is one of the countries with a small ratio of foreigners towards the whole population. During the year 2019, the ratio of foreigners towards to whole population was 5,2% where the average ratio in the member states was 9,3%. Czech Republic cannot be compared to countries such as Luxembourg. Although, from the Eastern part of Europe, Czech Republic is above the eastern average. The most represented are citizens of Ukraine, Slovakia, and Vietnam. Immigrants from these countries represent over 55% of foreigners in the Czech Republic.

Figure 11 Foreigners based on nationality in the Czech Republic in 2020

Source: CSO, own processing

Natality, fertility

After the change of the regime in the Czech Republic in the year 1989, the demographic processes started to look similar as in western Europe. Life expectancy prolonged, natality decreased, age of first marriage increased as well as age of a woman having her first child. Women were given more access speaking of contradiction methods. Total fertility rate, which is number of children that would be born to a woman during her lifetime, dropped to 1.2 in 1996. Whereas in the year 1990 the value reached 1.89. In the year 2004, the border line has been crossed by over 100 thousand children were born and total fertility rate was up to 1.2 per woman. This increase is explained through the populous generation born in the 1970s started to have children. During the years 2008-2010 the total fertility rate remained stable around 1.5 rate per woman. Since then, fertility rate is slightly increasing, over 110 thousand children were born in the yeah 2019 in the Czech Republic. The average age of a woman having her first child is increasing over the years, it reached 28.5 in the year 2019. Life expectancy has a growing trend, in average women reach 82.1 and men 76.3 years of age (European Commission, 2021).

Figure 12 Total fertility rate development in the Czech Republic 2000 - 2020
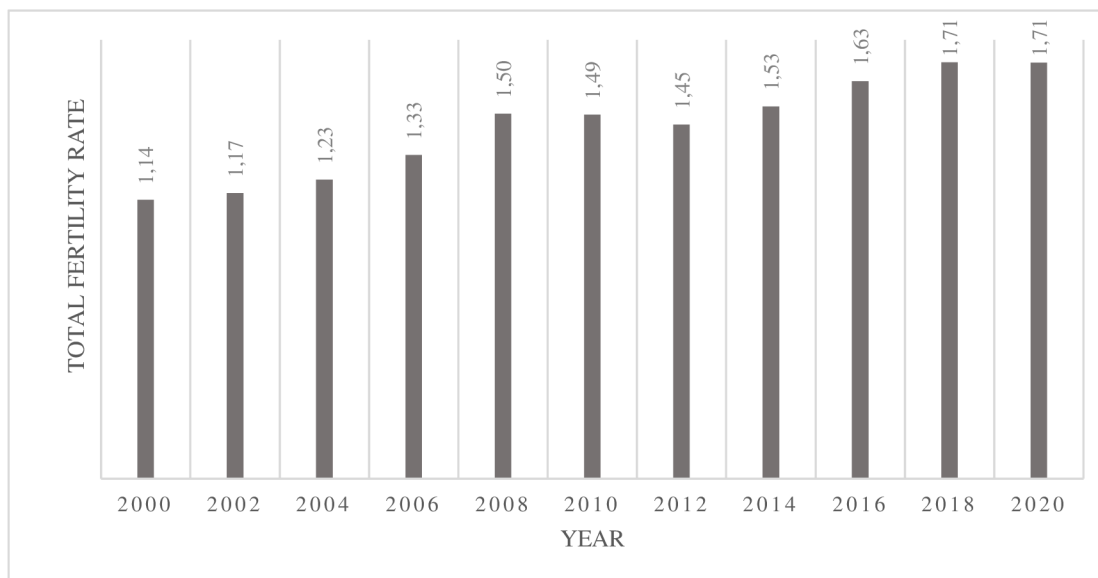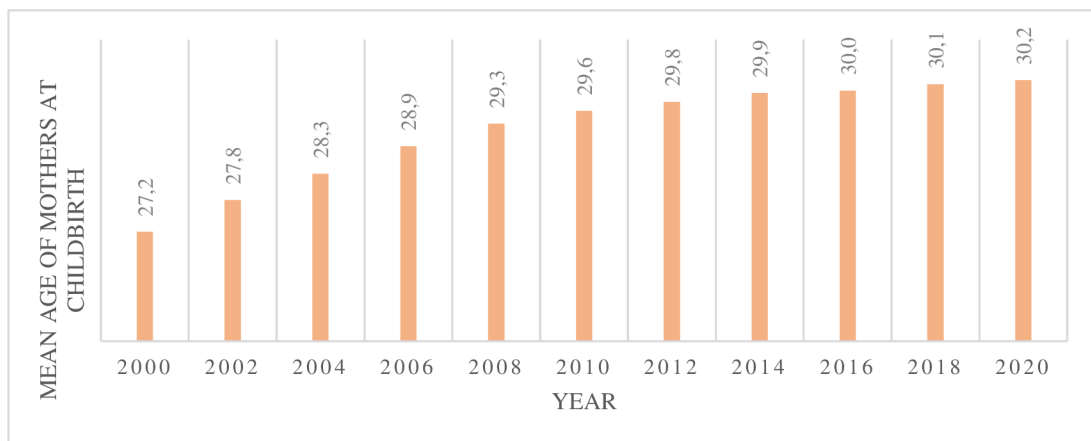

Source: CSO, own processing

Czech Republic welcomed 110.2 thousand newborns in the year 2020. The trend is decreasing 3 years in a row. It is caused by the change of the structure of women in their reproductive period, however the level of fertility rate remained stable in the years 2018 – 2020 with the value of 1.71 children per woman. The last time we had such level of fertility rate was in 1992 (Czech Statistical Office, 2022).

Since the year 2000, the fertility rate had a slow growing trend, only interrupted by the first and second decade of the 21st century caused by the economic crisis (Czech Statistical Office, 2022). The year 2002 was a breaking point and since then the fertility rates begun to rise and it was considered as a new population wave. The expected reasoning was that the children were being born to the strong generation of 1970s, but it happened to be yet another population wave. In the year 2008, the level of 1.3 children per woman has been accomplished which shows a dangerous border line for the upcoming generations (Křesťanová, 2016). In the last decade between the years 2011 – 2018 the fertility increased from 1.43 children to the current 1.71 children (Czech Statistical Office, 2022).

Figure 13 Mean age of mothers at childbirth in the Czech Republic 2000 - 2020

Source: CSO, own processing

The age structure of women giving birth markedly changed in the last two decades. The reasons behind it are the wide range of women in different age groups (change of strong population year), changes in the timing connected to fertility (family planning shifted towards older age). Whereas the largest number children born fell on the age group of women between 25 – 29 years, since the year 2008 the age group of women with the most children born is between 30 – 34 years (Czech Statistical Office, 2022). The average age of women when giving birth increased from 27.2 to 30.2 years within two decades.

Marriages, divorces

Indicators regarding marriage and divorce complement the whole outlook on the transformation of demographic formulas. Due to the COVID-19 restrictions (ability and number of participants), marriage rate dropped by 17.2% compared to the year 2019. Until then, the number of marriages was constantly growing. The least number of marriages was

in March 2020, which was the lowest number in the whole statistics of marriages in the Czech Republic.

According to the Ministry of Justice of the Czech Republic, the number of divorces decreased by 10% compared to the year 2019. It represents the lowest number of divorces since the beginning of the century. The pandemic also took its own, considering the governmental restrictions which limited the functions of the courts.

3.8.3   Migration and foreigners

Czech Republic has gone through many changes with regards to migration and foreigners. After the Velvet Revolution, the country served as a transition country, but after the change of the century, migrants kept on choosing it as a final destination country.

Regularly, migration contributes to the total of the population of the Czech Republic. Overall, results have always been positive, in observed 20-year time frame, except two declines in the years 2001 and 2013. The largest growth was observed in the year 2007 and 2008, just around the era of the economic crisis (Marešová, 2021). Yet in 2019, the balance reached its peak. In 2020, the balance dropped by 39%, however the compared to the year 2011-2016 it was still beneficial. The decline was also influenced by the COVID-19 restrictions connected to the free movement of people but also because of the amendment to the law regarding residence of foreigners in the Czech Republic.

Figure 14 Migration development in the Czech Republic 2000 - 2020

Source: CSO, own processing

41
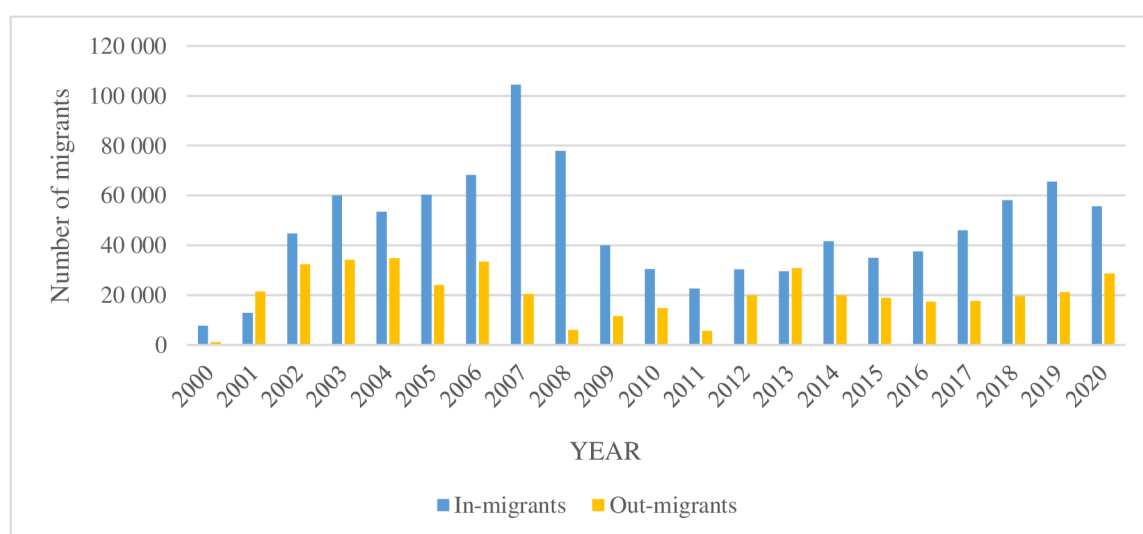
Migration is generally dominated by men in their productive age between 20 – 34 years as the reason behind migration is occupation or entrepreneurship. The dominating countries of migration are Ukraine and Slovakia (Czech Statistical Office, 2022).

4 Cluster Analysis

Cluster analysis has the purpose to classify and divide individual member states of the European Union into clusters based on their similarities regarding demographic indicators. Indicators, that were selected correspond with demographic ageing, one of the most popular phenomena in Europe. The result will identify states, that are more or less comparable and affected by demographic ageing and will be commented in the next chapter. The objects that are examined are 27 member states of the European Union. The selected variables intended for cluster analysis are median age, life expectancy, crude live births, crude death rate, old-age dependency ratio, crude rate of natural change of population. The analysis is processed with data from the year 2020, the most current data provided by Eurostat.

4.1 Exploratory data analysis

Exploratory data analysis in Table 1 is processed in order to have an investigative view, discover patterns, and detect extreme values.

Table 2 Exploratory data analysis for cluster variables

Variable	Mean	Median	Min. value	Max. value	Variance	Range	Standard deviation	Var. coefficient
Median age	44.4	44.9	38.2	48.6	7.4	7.2	2.7	0.06
Life expectancy	79.7	81.1	73.6	82.6	8.3	8.0	2.8	0.04
Crude birth rate	9.3	9.3	6.8	11.2	1.4	1.3	1.1	0.12
Old-age dependency ratio	30.4	31.1	20.9	36.4	16.9	16.2	4.0	0.13
Crude death rate	11.5	11.5	6.4	18.0	6.8	6.5	2.6	0.22
Crude rate of nat. change of population	-2.1	-2.3	-9.5	4.9	10.8	10.3	3.2	-1.54

Source: Eurostat, own processing, values of EU-27

The segments of the exploratory data analysis include mean, median, minimal value, maximum value, variance, range, standard deviation, and variation coefficient. Box plots for each variable have also been processed through SAS Studio and can be found in Appendix 2. Box plots are used for visual representation of data, which show median, lower, and upper quartiles. With regards to the exploratory data analysis, box plots also show important characteristics of observed data – outliers and extreme values. Outliers are specific because they are located more than 1.5 times out of the interquartile range.

The process of box plots creation shows, that only two of the selected variables show extreme values, so called outliers – old-age dependency ratio and crude death rate. Luxembourg and Ireland tend to have a low number of elderlies compared to the productive part of the population. The range of the ratio is high, as there are countries whose old-age dependency ratio is nearly double, such as Italy or Finland. The second box plot that showed extreme values was crude death rate. The country with a high degree of deaths per 1000 persons was Bulgaria. Compared to Ireland, it is nearly three times higher.

4.2 Clustering and data interpretation

Cluster analysis groups data into based on similar development and distances. In order to start proceeding with the cluster analysis, standardization of data should be done to not have heterogenous units. The method used for standardization of data is called *Z-score*, the mean is subtracted from the values and therefore divided by standard deviation. Afterwards, all variables have standard deviation equal to 1, and average is 0. Clustering has been processed using available methods in statistical program SAS Studio. The chosen method of dissimilarity was Euclidean.

All dendograms are listed in Annex 3 and due do different clustering methods, they show diverse results. Most of the methods tend to separate Luxembourg from most clusters, as well as Italy in some cases. Due to Exploratory Data Analysis, these countries have extreme values in selected variables. *Ireland – Cyprus* and *Poland – Slovakia* are stable clusters in most computed methods. Similarities are also found among *Portugal – Greece, Latvia – Lithuania, Belgium – Austria*, and *Czechia – Estonia – Slovenia*. Several methods such as the farthest neighbor method, centroid linkage method, average linkage method show very similar results.

For the basis of this thesis, dendogram of the method of the farthest neighbor (complete linkage) is used. In order to get a comparable number of clusters, dendogram is cut at the distance 1 on the x-axis. This was determined due to the fact that results will be compared afterwards, and smaller number of clusters would lead to diverse groups. Higher number of clusters would lead to difficulties in comparing member states.

The groups of clusters are the following:

1. Italy – Portugal – Greece – Germany – Finland
2. Romania – Hungary – Lithuania – Latvia – Croatia – Bulgaria
3. Luxembourg – Ireland – Cyprus
4. Slovakia – Poland
5. Malta – Sweden – France – Netherlands – Denmark
6. Estonia – Czechia – Spain – Slovenia – Belgium - Austria

Figure 15 Dendogram using Complete Linkage Method
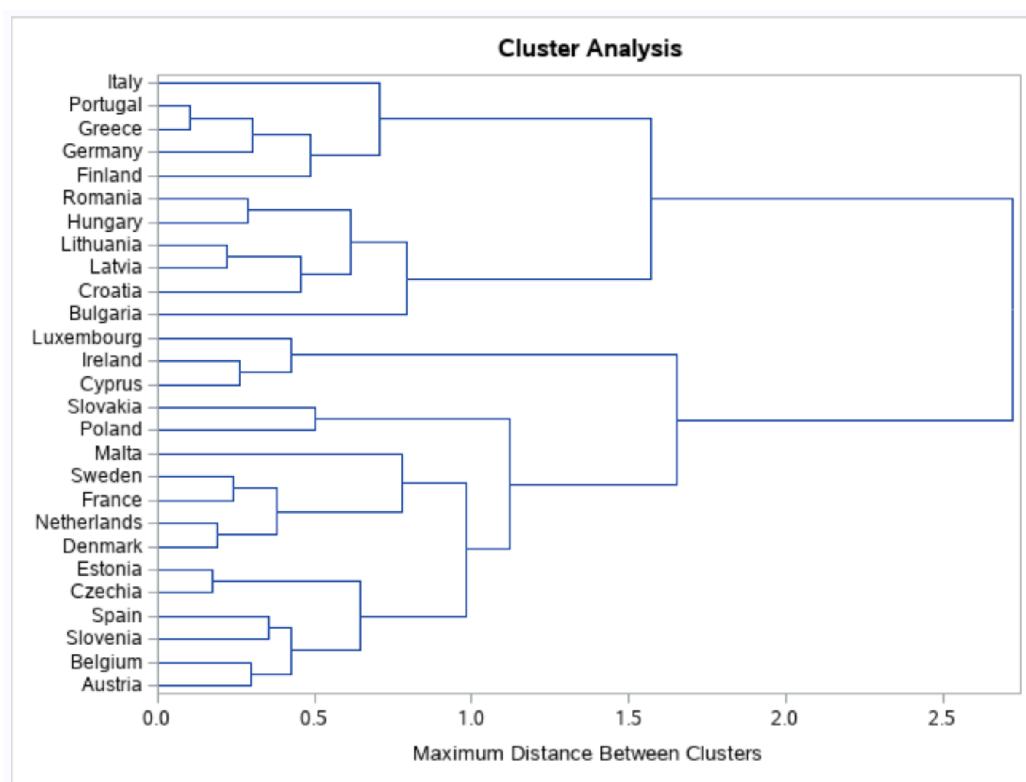
Source: SAS Studio, own processing

First cluster consists of southern European countries as well a northern European country. All of the countries are consistent in high values of the share of persons aged 65 and over in the total population. Within the 20-year period time frame, increase could be observed in all Member States. However, all countries from the first cluster have the highest shares (each country over (20%) in the old-age dependency ratio). It is expected for share of elderly towards to population to even increase by the year 2060 especially for Portugal and Greece. The projections show increase up to nearly 60%, which results in two working individuals per one retired person (Creighton, 2014). All of the mentioned countries are also the

45

countries of Europe with lowest births rates among the 27 Member States. Italy represents the country with highest median age and lowest crude death rate in the EU, it will be described in the next chapter.

Cluster number 2 copies most of the countries from the former Eastern Bloc. The countries are grouped together because of their similar values in crude death rate and also life expectancy. Bulgaria recorded highest crude death rates in the European Union in 2020, 18 deaths per 1 000 persons. The rest of the countries of the cluster followed. There are various reasons behind this fact. As a country of the Eastern Europe, the cause of death is very often a type of cardiovascular sickness. Bulgaria is fighting the prevention of such chronic diseases by employing the *National Program for Prevention of Chronic Non-Communicable Diseases 2014-2020* in order to improve health and mortality rates (Banuelos, 2021). In Bulgaria, compulsory health insurance is still a difficulty and luxury to a part of the population. Rural areas, disabled people and unemployed are all a subject to harder accessibility to insurance.

Bulgaria is also suffering from poverty; government tries to recognize this fact when working on the aspect of compulsory health insurance. Overall, the population of the Eastern Europe is heading toward a negative declining demographic trend. Bulgaria is a specific country when it comes to demographic decline, throughout the 20+ year history, the country declined by nearly 2 million inhabitants. Such loss is unprecedented during a non-war period. Projections predict another loss of 20%. Although, it is not only the high mortality rates, throughout Europe fertility rates are declining. Bulgaria has the highest crude death rate ratio in the whole European Union, this country will be explained in more detail in the following chapter.

Luxembourg, Ireland, and Cyprus belong to the top of the list when it comes to countries with high life expectancy rate. Luxembourg and Ireland have an expensive health care system, for Luxembourg it is the highest expensive health system in the whole Europe. Due to a high level of migration, Luxembourg has the lowest old-age dependency ratio and will be described in more detail in the next chapter. Overall, the population of the European Union has increased by 4%, the largest increases were recorded in Luxembourg, Ireland, and Cyprus, all over 20%. These countries are open to migration, which is a significant factor

when it comes to population growth. In general, the Western Europe is more open to immigrants which throughout the year has led to increases in the populations. On the other hand, Eastern Europe is still not fully open to immigration, the countries are expected to be declining and eventually shrinking. Luxembourg represents the country with the highest ratio of immigrants and therefore will be described in more detail in the next chapter.

All of the countries from the third cluster represent countries with the lowest median age in Europe. Median age is influenced by life expectancy, social and economic development and also fertility rates. All countries have a high level of crude birth rate due to favorable conditions.

Members of the fourth cluster is Poland and Slovakia, countries in the middle of Europe, similar historical background, and both are religious states. Both states have similar demographic development. However, the projections of the Central European countries are expecting declines within demographic indicators. Poland, the most populous central European country, however nowadays it is a combination of demographic declines and low fertility rates. It is expected for Poland and Slovakia to have an increase in their 65+ year population, which leads to potential changes in the pension system and also public healthcare services. Slovakia's population will be more explained in the next chapter, due to similar development with the Czech Republic.

France and Sweden, countries from the fifth cluster, are in the lead when it comes to crude birth rate. This cluster contains countries from western (Netherlands, France) and northern (Sweden, Denmark) Europe, but also Malta an island country made its way in. All countries have shown favorable results in their life expectancy rates, all of them above EU average (80.6 years of age). The increase in life expectancy has been a result of prevention and reduction of cardiovascular diseases, Netherlands has the lowest rates in Europe. Secondly, the cause of the death in these countries also lung cancer, as a result of excessive smoking. Malta has shown the highest increase and population growth, over 20%, therefore the development of this country will be explained further on in the next chapter.

The last cluster consists of countries from all corners of Europe. All countries are not in favorable position when it comes to ageing of the population. Spain and Slovenia can be

characterized by very high age of life expectancy. Spain is in the lead in Europe. Clustered countries have a high level of old-age dependency ratio in their populations. From the last cluster, Czechia will be more discussed in detail in the following chapter.

5 Characteristics of chosen states

This chapter will introduce selected states more into detail with regards to the topic – population ageing and focus also on the population development. Each country is provided with a population pyramid that shows all age groups and their representation in the society.

5.1 Italy

Italy, a country that occupies the territory of Apennine Peninsula in Southern Europe, also having a specific shape that looks like kicking boot. Italy has borders with Austria, France, Vatican City, San Marino, Slovenia, and Switzerland. Sardinia and Sicily, two largest Mediterranean islands are a property of Italy. One of the founding states of EU predecessor (European Coal and Steel Community) happened to be Italy. The official religion is Catholicism. Italy has come a long way from being one of the weaker economies during the 20th century to being comparable to the western European economies. The government managed to bring high inflation down and adopted policies such as privatization. North of Italy is seen as the industrial part of the country, it has even taken over its western European neighbors. The number of people employed in agriculture is often an indicator of how developed the country is – in Italy it is nearly 4% (Palma, 2022).

Overall demography in Italy is fairly consistent with comparison to the rest of the countries in Western Europe. Italy is benefiting mostly from immigration when speaking of the population development. Although, the process of growth rate of the population is slowing down.

Figure 16 Population pyramid Italy 2020
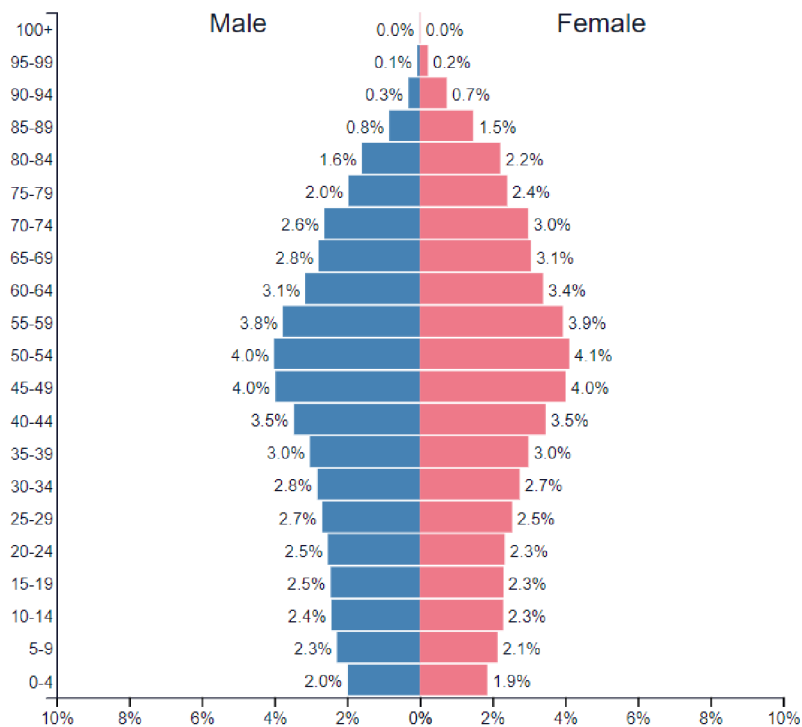
Italy is also specific for its regions, where in the north the fertility rates and family size vastly differ from the south. Mortality rates tend to be higher in the south due to lower level of health care. In general, life expectancy rose during the second half of the 20th century. After Japan and Monaco, Italy has the third oldest population in the world. The median age of an Italian is 48.6 years of age and has been on the rise for the past couple of years. The youngest regions are located in the south of Italy, where on the hand the oldest regions are in the north. Italy belongs to the group of top 5 countries with the highest life expectancy at birth in the world. Low birth rates, another characteristic of ageing population, is also a problem of Italian citizens. Not only is the number of people decreasing and number of elderlies increasing, it also widely affects the economy (Statista Research Department, 2021).

Based on scientific studies, when the population growth stops, the GDP growth also slows down. Governments should be acting fast due to overextended pension and health systems. This will also affect the working population due to possible increases in taxation (Statista Research Department, 2021).
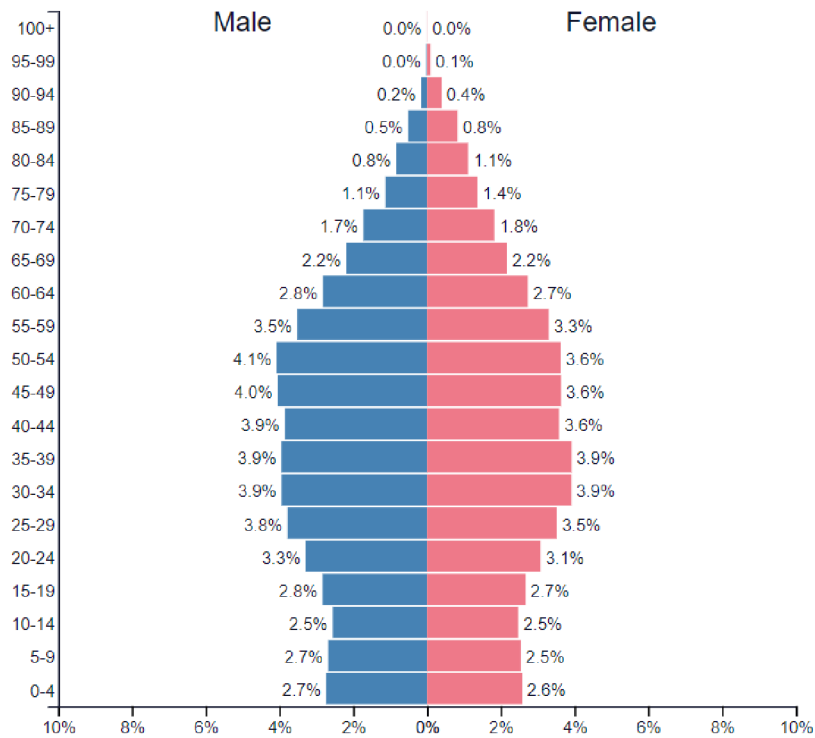
5.2 Luxembourg

Luxembourg, officially the Grand – Dutchy of Luxembourg, is one of the smallest countries in the world. It is bordered by Germany on the north, France on the south, Belgium on the west and north. Luxembourg was one of the founding states of European Economic Community, predecessor of the European Union. The Grand Duchy has been a crossroad for all the nations throughout the historical development. The religion that dominates is Catholicism. Luxembourg as a multicultural country with a high rate of foreigners. The population consists of Belgians, Germans, Italians, French and also Portuguese. The level of birth rate is very low among native Luxembourgers. Most of the foreigners work in international companies such as BNP Paribas, Amazon, international audit companies and many others that are located in the capital. Iron and steel industry is also a important part of the Luxembourg economy. The Grand Duchy has one the highest GDP per capita in the whole European Union.

Luxembourg has one of the lowest number of inhabitants compared to the whole European Union, where on the contrary the population growth rate belongs to the top 5 countries in Europe. The crude rate of natural change was 2.9 per 1000 persons and has been steady for the last decade. The growth is affected mainly because of the positive migratory inflow due to a favorable way of life and job opportunities. In addition, Luxembourg is considered to be one of the safest countries in the world.

In January 2020, population of Luxembourg reached 626 108 inhabitants, of which 47.4% were foreigners. It is expected, as one of the very few countries in Europe, for the population to nearly double by the year 2060. The first year of the pandemic also negatively affected the death rate, in 2020 the death rate increased by 3.7%, according to the statistical office nearly 11% were deaths caused by COVID-19 infection (RTL, 2021). From all the 27 member states, Luxembourg belongs to the one with the lowest old-age dependency ratio. The demographic transition for Luxembourg was very long, it started during the 18th century and finished possibly during the 1950s. For many countries of Europe, the transition is not finished yet.

Figure 17 Population pyramid Luxembourg 2020

Although, the concern of population ageing has not nearly reached the same level as in other countries, Luxembourg is facing the same concerns. Preparation of the retirement system, especially pension funding, health care system, even family policies are the main topics that concern Luxembourg.

5.3 Slovakia

Slovakia, a central European state, which Czech Republic shared most of 20th century with. Poland to the north, Austria to the southwest, Hungary to the south, Ukraine to the east and also Czech Republic from the west are all neighbors of Slovakia. More than four fifths of the population are ethnic Slovaks. There is around 10% of Hungarians living in the south close to the border districts, making it less than one tenth of the population. Another population lives in the eastern part of the country, it is the Roma population. The religion is Slovakia that predominates is Catholicism, which is a relief after decades under the communism control and prescribed atheism (Blazek, 2022).

Figure 18 Population pyramid Slovakia 2020
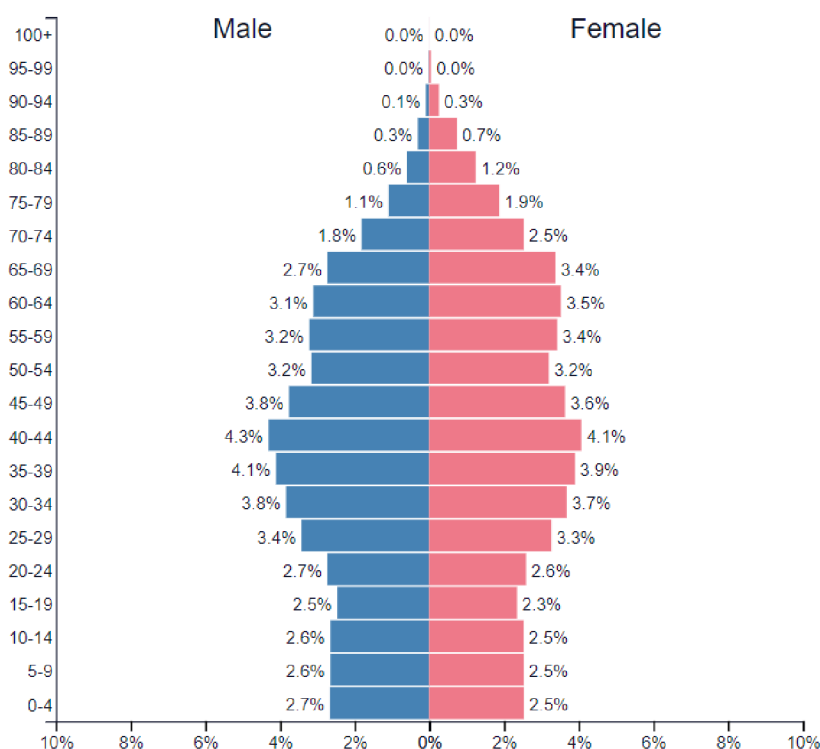
It is important to consider, that Slovakia is a relatively new country. It is challenging to see the demographic development for such a shorter period time compared to the other countries. The growth rate of the population has been 0.1% in 2020, the projections expect just a small increase. The development is very similar to the Czech Republic. However, the development in Slovakia remained stable, COVID–19 pandemic has already shown negative consequences. Significant decline is already visible in life expectancy at birth, due to a very high rate of mortality. Ongoing decline in life expectancy is expected due to the shock in form of a pandemic. The average of 51-54 thousand people passed away each year in Slovakia, during the first year of pandemic the number has risen to 60 thousand. Because of high mortality rates, life expectancy dropped by in 1.8, which is only considering the first year of the pandemic (Gáliková, 2022).

Population ageing, one of the greatest concerns of Slovakia is a result of increasing life expectancy and declining fertility rates. OECD predicts that Slovakia's working age population will drop by 20% in the next 20 years. It is also affecting the public debt, which is expected to rise. OECD suggest focusing more of prolongation of working lives, financial

aids for mothers, and support the Roma community and also help with unemployment of selected groups (Emerging Europe Staff, 2022).

5.4 Bulgaria

Bulgaria, a country located eastern Europe on the Balkan Peninsula, bordered by five countries – Romania, Serbia, North Macedonia, Greece, and Turkey. The ethnicity in Bulgaria consists mainly of Bulgarians, making it four fifths of the total. The largest minority are the Turkish, that comprise one tenth of the population. The history of the religion has the same development as in the countries of the former communist era, since then Bulgarians are followers of the Bulgarian Orthodox Church (Carter, 2022).

After the Second World War, as in many other countries in Europe, the free medical care case has been established. This lead to a drop in death rates, due to accessibility towards health care. During the 1970s, the era of the baby boomers, the death rate started to increase rapidly. In the 21st century, the death rate in Bulgaria is reaching its peaks and still increasing. It has grown until the point, where the birth rate was one third higher than the death rate, which is more than alarming towards the global norms. As in many other countries after the change of the regime at the end of the previous century, countries were experiencing massive outflow of individuals because of better work conditions and tempting economic situations abroad (Carter, 2022).

Figure 19 Population pyramid Bulgaria 2020
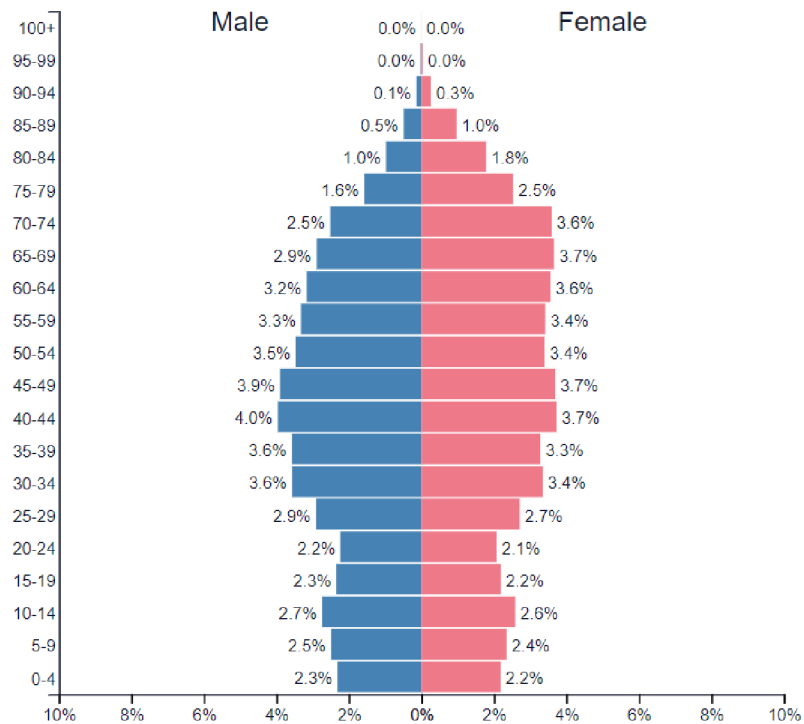
Bulgaria belongs to the top of the list of countries with highest death rates in the world. Among chronic and hereditary diseases, alcohol consumption and high presence of tobacco products on the market are the main causes of death in Bulgaria. The country is also trying to fight demographic ageing, but low fertility rates, very high proportion of adults in the population and emigration are current problems of Bulgaria. Focusing on the Bulgarian healthcare system has two coverages – mandatory and voluntary. As in most of the European countries, citizens are provided with universal healthcare are taken from their monthly salaries (Pitheckoff, 2017). Voluntary Health Insurance (VHI) is offered by private insurance companies. Citizens are not providing with information regarding the voluntary insurance and therefore it is not used in a wide form, also for some it is not affordable. Due to unemployment problems, people living in rural areas the level of healthcare may not be always provided in the highest possible form.

5.5 Malta

Malta, an island country located in the Mediterranean Sea. Malta has a strategic position in the sea, it has been through rocky history as it has been a subject of many potential cultures that were in conflict due to the power over the Mediterranean Sea. Maltese culture is closely connected to Catholicism. Malta's economy is dependent on the foreign trade and tourism. Malta's economy may be considered as prosperous and stable.

Figure 20 Population pyramid Malta 2020
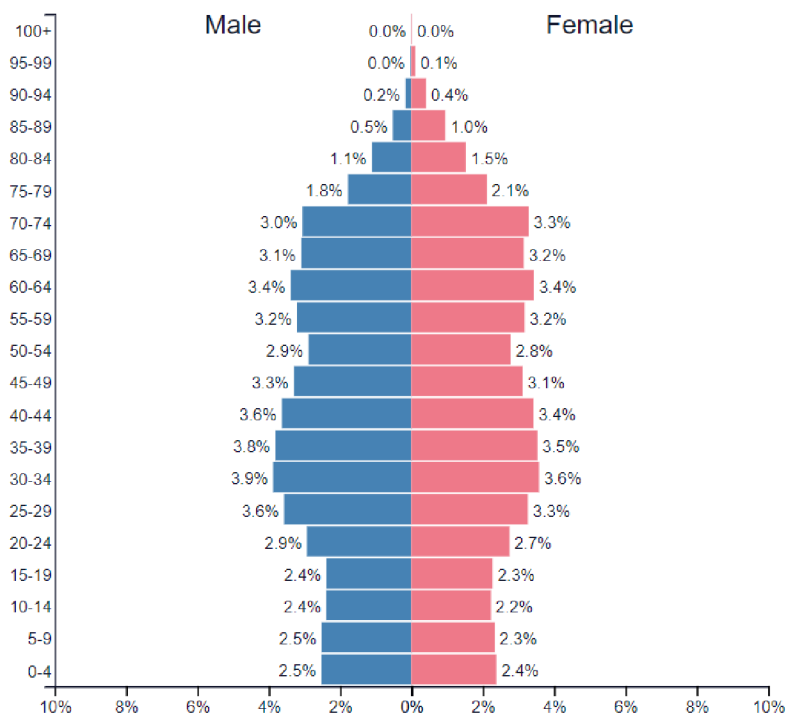
Source: www.populationpyramid.net

Malta belongs to the top 10 countries of steadily growing population. The estimations for the upcoming years do not show decline as Malta is a perspective place for potential immigrants. There are two side to immigration. One is the economic benefits, where the base for taxpayers increases as well as consumer spending. On the other hand, immigration means higher demand for the supply of food, healthcare, and transportation. The island is more restrictive than land countries, they are able to produce 20% of the food supply. Certainly, Malta is dependent on foreign trade. A lot of the population consists of immigrants, coming from the European Union member states (Said, 2021).

55

5.6 Czechia

Czechia, a country situated in the heart of Europe, consisting of three provinces – Bohemia, Moravia, and Silesia. The country adopted a new name in the year 2016, until then the official name was Czech Republic. The ethnicity is the Czech Republic is clear, two thirds are Czechs. The rest are minorities of Slovaks, Polish, Germans and Roma. As all the post-communist states, atheism was the official policy. After the change of the regime, most of the population remained with the belief. Sometimes Czech Republic is labeled as the most atheist country in the European Union.

Population development of the Czech Republic was significantly influenced by the COVID-19 pandemic. The consequences are visible in all demographic processes. The pandemic has shown its first negative impacts in the life expectancy age for men and women. For men and women, the life expectancy decreased by nearly 1 year of age during the years of 2019 and 2020.

Before the pandemic, the trends of life expectancy growth were stable. The impacts on this fact were a large amount of funds were flowing into the healthcare system. Also, another factor influencing the growth, may be ignored, but it is the independent choice of doctor, accessibility towards all kinds of medication, innovation in modern technologies and constant reminders of prevention. Czech Republic also exports of medicine to third world countries. Nowadays, the healthy lifestyle trends are very promoted in the last couple of years in Czechia, we are served and supplied with better quality of products. In the recent years, the fear of losing income and decrease of way of life are also the factors that influence the lust for having a healthy life.

Figure 21 Population pyramid Czechia 2020
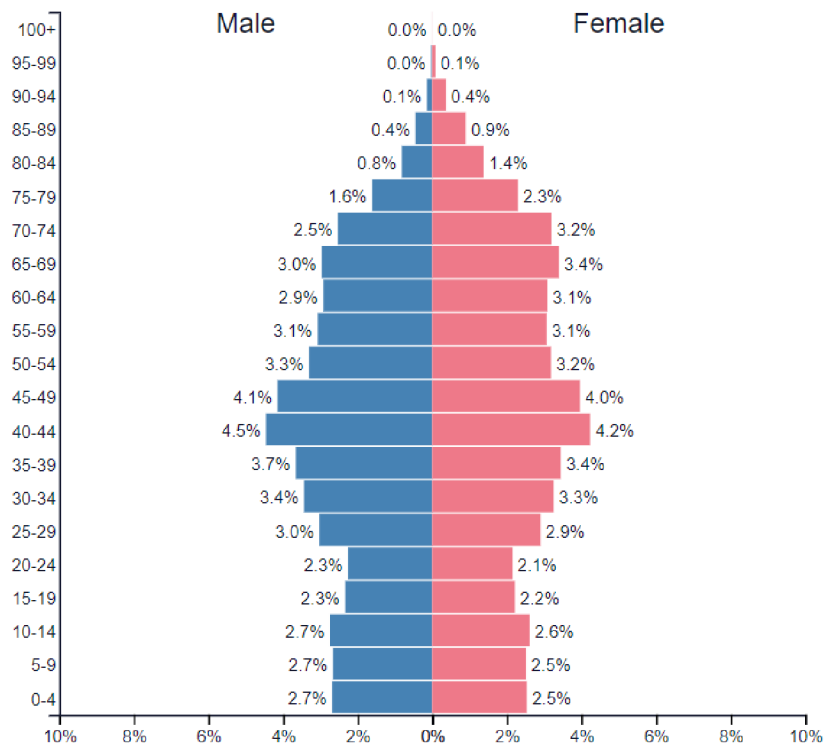
Source: www.populationpyramid.net

The number of individuals in the age groups was progressing in a similar tendency in the year 2020 as it was during the previous years. Children composition of the population is showing growing trends and represented over 16% of the whole population. The senior part of the Czech population has also a growing trend and for the first time in Czech history crossed the border of representing 20% of the whole population. Growth of the elderly population was also caused by the fact that the generation was compounded by a very strong generation born in the 1940s and also increasing life expectancy. Considering the youngsters and also the elderly, the growth rate was the slowest in the year 2020. Citizens in their productive age (15-64 years) happens to have a decreasing trend (Czech Statistical Office, 2021).

Long-term growth of the senior part of the population, its dominance over the children part of the population, and decrease of the productive part of the population lead to continuous ageing. Average age has increase in the last 10 years by nearly two years of age. Median, that divides the population into two groups has increased even more the average age, it grew by 3,5 years (Czech Statistical Office, 2021).

6 Results

The ageing of the population, therefore the increasing of elderly towards the rest of the population, is a process that demographers have been focusing on for decades. In the past, it was one of the causes for increasing life expectancy and significant decreasing of infant mortality. During the last decades of 20th century, the developed countries are experiencing a increase in mortality rates as well as increasing life expectancy not only at birth. In the beginning, the society was taking it as a more of a positive step, than something to be afraid of in the future. The topic of conversation among the citizens of countries was to fulfil the time of the elderly so they do not just "waste time". In the 1990s, the economic consequences kicked in. Increasing social costs and healthcare became a regular topic within governmental meeting as well as pre-election campaigns. The problem of ageing raised suspicion even of the public. Rapidly it became a discussed subject on most of the demographic meetings, and a subject of many scientific books that were being published. Until this day, the situation remains the same, if not worse.

It is necessary to point out, that countries are fighting the ageing thanks to very advanced level of medical care, prevention against the sicknesses that are the main reasons of death. Social and economic factors are also an influence, as well as the changes of lifestyle, accessibility to sports and trainings and nutrition. Individuals are living and longer more healthy life.

Germany, southern European countries (Italy, Portugal, Greece) as well a northern European country (Finland) are members of the first cluster. All these mentioned countries are grouped together because of high level (over 20%) of old-age dependency ratio. Although, increase has been recorded in all member states of the European Union. Countries such as Greece and Portugal are expecting significant increase in their shares of the elderly in the population. Another factor that determined demographic ageing are low birth rates, where all the mentioned countries have the lowest birth rates.

Former Eastern Bloc copies second cluster. These countries share similar values regarding life expectancy and crude death rates. Bulgaria represents an alarming case as it has one of the highest crude death rates in the world. The rest of the countries is not far behind. Most

of the member in the Eastern Europe can be characterized by a high percentage of cardiovascular illnesses due to lack of prevention and lifestyle. Bulgaria shows a very specific occurrence. During the last 20 years, Bulgaria lost nearly 2 million inhabitants. Such a high number has not been registered in any other country during non-war period

Luxembourg, Ireland, and Cyprus, as the members of the third cluster, have the highest life expectancy rate in the whole European Union. This indication may be connected to a high and expensive level of health care system in mentioned countries. These countries are open to migration, which is a significant factor when it comes to population growth. Countries of the western Europe are more open towards immigrants due to career opportunities and also no barriers with regard to language as English is on a high level.

Poland and Slovakia, states of the central Europe are members of the fourth cluster. These countries share similar historical and demographic development and same values in religion. Central European countries do not show favorable future, as the projections show demographic declines. Slovakia and Poland are also expected to have a higher old-age dependency ratio which will leads changes in the healthcare and pension system.

Fifth cluster consists of developed countries such as France, Sweden, Netherlands, Denmark, and Malta. All countries have shown very favorable results within crude birth rate and also life expectancy rates, all of them above EU average (80.6 years of age). The reason behind this fact, it the attention towards prevention and also therefore reduction of diseases. Malta has shown the highest increase and population growth, over 20%.

The last cluster consists of countries from all corners of Europe – Estonia, Czechia, Spain, Sweden, Slovenia, Belgium, and Austria. Clustered countries have a high level of old-age dependency ratio in their populations. All countries are not in favorable position when it comes to ageing of the population. Spain is in the lead speaking of life expectancy age in the European Union but has very low crude birth rate.

When picturing the population pyramid of countries with population ageing, the percentage of elderly is located on the top of the age pyramid, therefore it can be called as *"top-down ageing"*. On the other hand, aging is also a result of the opposite phenomena called *"bottom-*

up ageing". This may be characterized by the changes of lifestyle and habits of women. More emphasis is put on their work and school schedule rather than on the family part of their lives. During the 21st century, birth control methods are very effective and give women the chance to plan their future in advance. All these facts lead to a downward sloping trend of birth rates as it is unable for the family to attain replacement fertility rate in order for the generation to replace itself.

The population of the European Union has grown by nearly 4% during the last 20 years. The most significant increase was observed in Luxembourg, Ireland, Malta, and Cyprus. Luxembourg is facing a wave of immigration of young individuals seeking job opportunities. Ireland, Malta, and Cyprus are all island states and are highly influenced by religion. Their position towards births and family status is very traditional. The largest drops were seen in Latvia and Lithuania (both over 20%).

Over the 20 years, the population development of the European Union was declining but at a steady rate. The largest increases in live births during this time period were observed in Czechia, Cyprus, and Sweden (all over 20%). The largest fall within the observed time frame and considering live births were observed in Latvia and Lithuania (all below 20%). These Baltic states are expected to have significant declines of population due to very low birth rates and are very careful when it comes to immigration.

COVID-19 pandemic is having a unique impact on the number of the deaths. There was 11% increase of deaths between the years 2020 and 2021. Italy, Spain, and Poland were experiencing the biggest losses, all over 15%. Overall, within the 20-year time frame, Cyprus, Poland, Spain, Italy, Malta had suffered through an increase of deaths by 30%. The main reasons behind this are a high percentage of diagnosed cardiovascular diseases due to lack of prevention, not enough information and also lifestyle.

Considering the ratio of elderly (persons aged 65+ years of age) towards the whole population of the member states, Italy (23%), Greece, Germany, Finland, Bulgaria, and Portugal (all over 22%). On the other hand, as the box plots showed, Luxembourg showed the lowest results (15%). During the 20-year time frame, all member states experienced increase.

Conclusion

The goal of the diploma thesis was to assess and assort the demographic development and demographic indicators of the member states of the European Union. Higher emphasis was put on the Czech Republic. The development of the demographic indicators was taken in regard to a very discussed topic nowadays – demographic ageing. The thesis is divided into a theoretical and practical part.

Theoretical part explains the term and the science of demography, defines the key influences of population change, defines demographic indicators, and briefly comments on the demographic revolutions. Further on, the member states of the European Union are described with regard to their demographic development regarding the changes, structure, and migration of the population. Secondly, the population development of the Czech Republic is introduced more into detail. This part also introduces the topic of demographic ageing, describes its causes and consequences within the social and economic sphere.

Similarities of member states of the European Union with regard to demographic indicators were processed in a cluster analysis. Using dendogram processed by method called complete linkage (farthest neighbor), 6 clusters were identified. All members were assorted one cluster, where Luxembourg and Ireland were observed with outliers but managed to create one cluster with Cyprus. These countries have similar values of median age, crude death rate, life expectancy and crude birth rate. Therefore, demographic ageing tends to have a slower process due to lower mortality rates and higher birth rates than in other member states.

For the comparison of demographic indicators, six countries were chosen for their further description of the population development and their situation towards demographic ageing. The countries are Italy, Bulgaria, Luxembourg, Slovakia, Malta, and Czechia. All of the countries are experiencing ageing. Each case differs by the pace, its causes, and its course. In some countries the trend is directly growing, the age structure varies and also fluctuates. The slowest process can be seen in Luxembourg, which is highly influenced of immigration of young generation.

Demographic ageing, a very discussed topic nowadays, brings severe economic and social consequences, that the society has to deal with. Declining fertility rates, as one of the main factors influencing demographic ageing, are a subject of various factors. Member states have gone through changes regarding the political and social spectrum. For instance, throughout the years adoption became a very popular trend for the young generation. For nearly a half of the member states of the European Union, the countries have gone through political and economic changes such as transition to market economy which led to unemployment, loss of income and increasing inflation rates. All these factors have shown negative impacts towards fertility rates. Overall, the demographic ageing is becoming an unsustainable process, which needs higher attention and more efficient actions from the governments in order to slow down the process.

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8 List of Figures, Table and Appendices

8.1 List of Figures

8.2 List of Tables
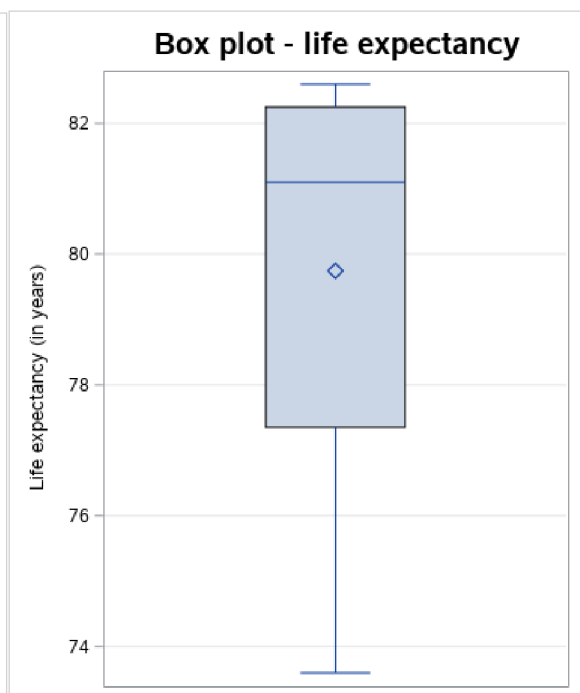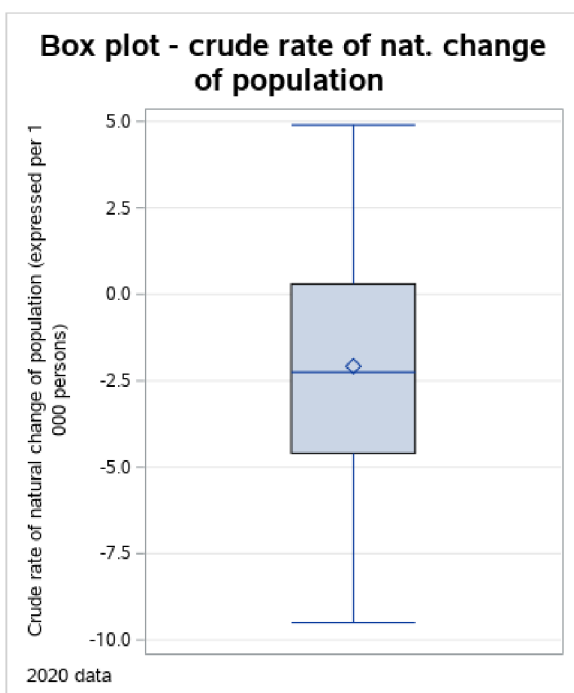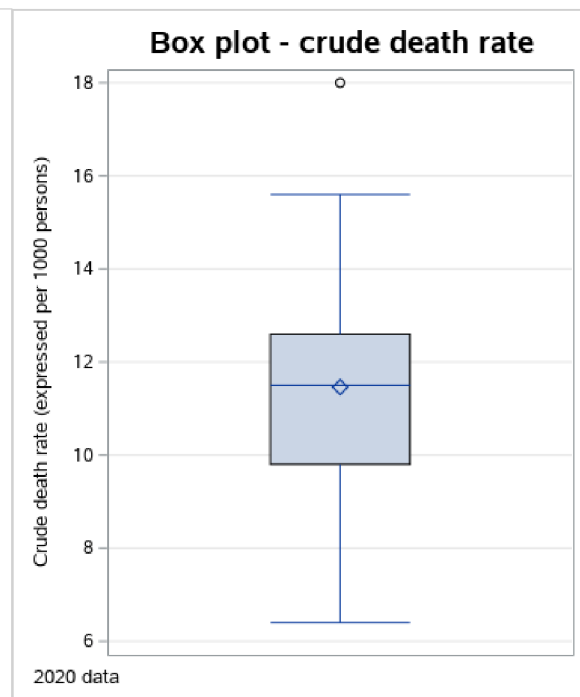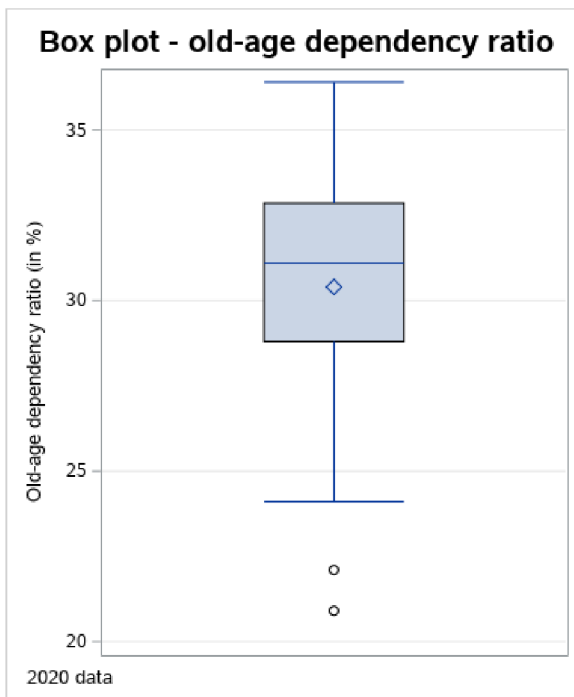
8.3 List of Appendices

9 Appendices

Appendix 1 Entry matrix for cluster analysis (2020 data)

Member states (data from 2020)	Median age	Crude birth rate (expressed per 1000 persons)	Old-age dependency ratio (in %)	Crude death rate (expressed per 1000 persons)	Crude rate of natural change of population (expressed per 1 000 persons)	Life expectancy (in years)
EU 27	45.40	9.1	32.00	11.60	-2.50	80.30
Austria	45.00	9.4	28.60	10.30	-0.90	81.30
Belgium	42.90	8.5	29.90	11.00	-1.10	80.90
Bulgaria	46.80	8.5	33.80	18.00	-9.50	73.60
Croatia	46.40	8.9	32.60	14.10	-5.20	77.80
Cyprus	38.20	11.1	24.10	7.20	3.90	82.30
Czechia	44.20	10.3	31.10	12.10	-1.80	78.30
Denmark	43.10	10.4	31.10	9.40	1.10	81.60
Estonia	45.60	9.9	31.60	11.90	-2.00	78.60
Finland	44.70	8.4	36.00	10.00	-1.60	82.20
France	43.50	10.9	33.10	9.90	1.00	82.30
Germany	47.60	9.3	33.70	11.90	-2.60	81.10
Greece	46.70	7.9	35.10	12.20	-4.30	81.20
Hungary	45.20	9.6	30.30	14.50	-4.90	75.70
Ireland	38.60	11.2	22.10	6.40	4.90	82.35
Italy	48.60	6.8	36.40	12.60	-5.80	82.40
Latvia	47.50	9.2	32.30	15.20	-5.90	75.70
Lithuania	47.90	9.0	30.60	15.60	-6.60	75.10
Luxembourg	40.00	10.2	20.90	7.30	2.90	81.80
Malta	41.00	8.6	27.10	7.90	0.60	82.60
Netherlands	43.60	9.7	30.10	9.70	0.00	81.50
Poland	43.00	9.4	27.50	12.60	-3.20	76.60
Portugal	47.10	8.2	34.50	12.00	-3.80	81.10
Romania	44.50	9.2	29.00	15.40	-6.20	74.20
Slovakia	42.50	10.4	24.50	10.80	-0.40	76.90
Slovenia	45.90	8.9	31.30	11.40	-2.50	80.60
Spain	45.40	7.1	29.70	10.40	-3.20	82.40
Sweden	41.60	10.9	32.10	9.50	1.40	82.40

Appendix 2 Box plots of clustered variables

Box plot - old-age dependency ratio

Box plot - crude death rate

Box plot - crude rate of nat. change of population

Box plot - life expectancy
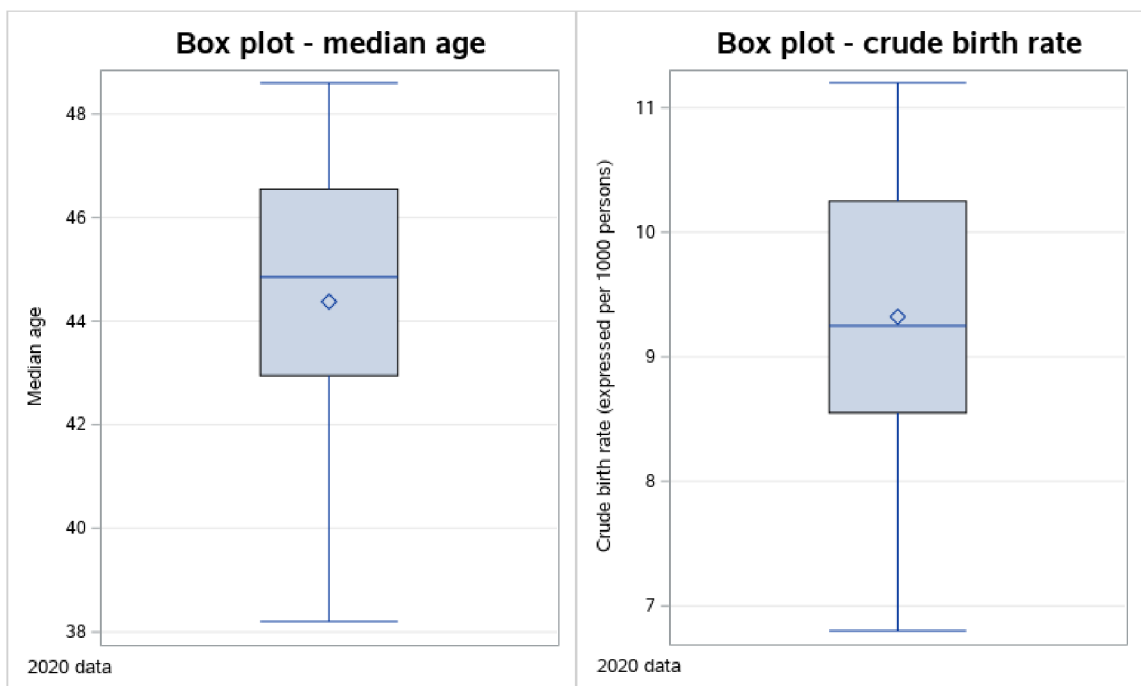
Appendix 3 Dendograms processed by several clustering methods

Cluster Analysis

Cluster Analysis

Cluster Analysis

Cluster Analysis