LITTERA SCRIPTA

VŠTE

Littera Scripta

(Economics, Management, Corporate Finance, Finance and Valuation)

Content

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Abstract

The aim of this study was to evaluate the trends in population ageing and assess its impact on unemployment in the Czech Republic from 2014 to 2023. Another objective was to determine whether there is a correlation between the ageing index and the unemployment rate and to analyze how generational ageing affected unemployment in selected age groups in the Czech Republic. Data collection was conducted using content analysis, and the obtained values were presented in graphs using graphical methods. It was found that, despite the gradual ageing of the population, the unemployment rate declined over the same period. Consequently, a correlation analysis was performed using Pearson's correlation coefficient, preceded by data normalization using the Min-Max method. The result was a negative correlation coefficient, indicating a strong to very strong correlation. It was also observed that younger age groups had fewer registered job seekers compared to older age groups in the records of the Labor Office. A limitation of this study is the impact of the Covid-19 pandemic and the war in Ukraine, which necessitate interpreting certain findings with caution.

Keywords: Population ageing, unemployment, trends, correlation, age groups, ageing index, data normalization

Introduction

Population ageing is currently one of the most significant demographic phenomena, affecting the whole world, including the Czech Republic. Long-term predictions do not bode well either (Šídlo et al., 2020). The number of people over 59 dramatically increases, while the percentage of adolescents under 16 drastically plummets. Birth rates also witness a marked decline, while people live to see a more advanced age. This rare occurrence currently poses a radical demographic challenge to the developed countries, housing the largest number of the global pensioners (Xue et al., 2022).

This accelerating trend provokes massive social and economic upheavals, calling for the attention of experts and politicians (Chen et al., 2022). The transformation of the population age distribution deeply influences macroeconomic indicators, including GNP,

inflation, fiscal equilibrium, labour market and unemployment (Goh et al., 2020). Population ageing also affects the workforce, labour demand and job opportunities. Unemployment rates are a key indicator reflecting the economic stability and performance, governing the decisions of the government, enterprises and individuals (Monušová, 2020). Although the issue is vital on a global scale, domestic labour markets and national economies will face a massive increase of the older generation, indicating a chance smaller by 25% to find a job (Flek et al., 2020).

This demographic phenomenon boosts a demand for effective solutions in the employment policy, compelling the government and employers to ensure a steady and thriving labour market despite a marked decline in working population (Chu et al., 2021). Our research outcomes may clarify the relationship between population ageing and changes in unemployment rates, suggesting practical measures that will stimulate the labour market and economic stability.

As global population has considerably aged, expert communities try to map this worldwide phenomenon and assess its impact on the key indicators of economic performance, including unemployment, and offset, or at least mitigate, its negative effect on society. Many articles, studies, methods or pieces of research from the whole world have contributed to this problem.

Impacts of population ageing

Population ageing sways many economic and social indicators, including pension, healthcare and social security expenses (Stahmeyer et al., 2021). This demographic trend shakes the labour market structure, slashing the workforce and causing an economic slow-down. Population ageing also burdens younger generations with increased taxes to fund pension systems. Wang et al. (2022) explored the impacts of this phenomenon on Chinese society between 1990 and 2020 using Autoregressive Distributed Lag. Their results indicate a strong negative effect of the ageing population growth on human welfare. Ranking No. 1 problem in China, tackling this issue should improve the health of local population. Liu et Zhao (2023) analysed the impact of population ageing on Chinese financial sustainability between 2010 and 2019 using two-way fixed-effect models, showing inverse proportion between population ageing and fiscal sustainability. The suggested measures involve increasing the birth rate, protect fiscal expenses and efficiently using funds for healthcare and social security. Li et al. (2022) devised an OLG (Overlapping Generations) model and CGE (Computable General Equilibrium) model to apply two-child and postponed retirement policies and to cushion the adverse impacts of rapidly ageing Chinese population.

Balachandran et al. (2020) compared population ageing in Europe and Asia using time consistency and comparative methods, revealing faster population ageing in Asian countries than in the EU. This confirms the findings of the previous authors.

Consistent population ageing profoundly affects national economic growth, energy consumption, CO_2 emissions and sustainable development. Pais-Magalhaes et al. (2022)

confirmed this theory by analysing the impact of accelerated population ageing on households in 28 EU countries between 2005 and 2018 using econometric methods.

Population ageing radically affects many countries, including the Czech Republic. Štěpánek (2022) analysed macroeconomic and sectoral impacts of rapid population ageing and migration on the demography of the Czech Republic. He applied content analysis and an OLG-CGE model to various age groups with varied education and occupation and revealed that national economy will face restricted labour supply and changes in the aggregate and sectoral demand, leading to a slow-down in the economic growth (GNP reduced by 4.4% by 2050), increased labour costs (wages raised by 5.2%) and weakened competitiveness of the economy. Gawthrope (2022) used content analysis and simulation methods to assess the effectiveness of fiscal policy measures for mitigating the impact of ageing on the income and welfare, recommending an extended version of the Czech model regulated by the Ministry of Finance. The model involves adopting postponed retirement policies, increasing pensions and reducing social security payments while raising GNP rates and other transfers to overcome the deficit. Pension schemes endorsing postponed retirement are more sustainable thanks to reduced pension costs, reinvigorating depressed national economy and sluggish labour market. Krpán et al. (2020) confirm this theory, analysing the differences between pension schemes of selected EU countries using Ward's clustering method.

Population ageing and unemployment

The impact of population ageing on unemployment has recently been subject to many scholarly studies and articles, exploring how demographic changes (accelerated population ageing) affect the labour market. Although many experts dread the adverse effects of this phenomenon like declining workforce and mounting pressure on younger generations, other scholars emphasize advantages, including job security for seniors and their deeper involvement in the working process. What also varies are opinions to which extent population ageing influences unemployment rates.

Ochsen (2021) argues that accelerated active population ageing cuts the unemployment rate by 1%, using a panel data model on the US districts between 2000 and 2014.

Rozen-Bakher (2020) measured the influence of postponed retirement on unemployment according to age groups in 30developed countries, comparing the unemployment rates between young people and pensioners. Using comparative correlation analysis, the author revealed that although postponed retirement leads to a lack of job openings for younger generations (including adults) in an already-crowded labour market, it reduces senior unemployment rates. The study recommends offsetting the labour shortage with postponed retirement to expand the workforce and resolve pension scheme issues. Lee et al. (2021) analysed a similar problem in Korea, where people feared that postponed retirement would result in exorbitant unemployment rates in younger generations. By processing the data from a Korean panel study on jobs and incomes from 1998-2017 and Korean census from 2000, 2005, 2010 and 2015 and applying a logit model, the authors revealed no correlation between postponed retirement and job vacancies for young

people. They also recommend opening new jobs for older generations to alleviate poverty and strengthen economic security. Apello (2024) examined whether postponed retirement will leave young people unemployed, i.e. if the older workforce will replace young workers by analysing job openings in Latin America. Rather than proved, their correlation analysis rejected this hypothesis, revealing a positive correlation between the employment rates of older and younger generations. The results also show a direct relationship between the wages of older and younger workers. These findings suggest that employing older people stimulates economic growth and increases the labour demand of young candidates.

Katagiri (2021) explored how population ageing influences unemployment in Japan using a multisector New Keynesian model to analyse job cuts and openings. They revealed that population ageing curbed inflation by 0.3%, increased unemployment rates by 0.3% - 0.4% and reduced GNP by 1.8% from 1990s to 2000, indicating a profound impact on local economy.

We use content analysis for the data collection, using correlation analysis to process our findings. We also apply data normalization using Min-max method and graphical analysis to answer the research questions.

The study aims to explore the population ageing trend and assess its influence on unemployment in the Czech Republic in 2014-2023.

The research questions are as follows:

RQ1: What was the population ageing trend and unemployment rates in the Czech Republic in 2014-2023?

We explore the relationship between population ageing trends and unemployment rates in 2014-2023, showing possible correlations between population ageing indicators and unemployment.

RQ2: Is there a correlation between the ageing index and unemployment rates?

We examine whether a correlation between the ageing index and unemployment rate exists in the Czech Republic between 2014 and 2023 and, if so, what its nature is.

RQ3: How did population ageing influence unemployment rates in selected age groups in the Czech Republic between 2014 and 2023?

We inspect how population ageing influenced unemployment rates in selected age groups in the Czech Republic between 2014 and 2023.

Methods and Data

The methodology involves three main parts, including data collection, used methods and results containing answers for the research questions.

Data

We used content analysis to collect secondary data for the first research question, analysing the statistics from a public database and of official websites of the Czech Statistical Office (CSO, 2024). We process data about population and its age distribution, birth rates, death rates, active ageing index and unemployment rates in the Czech Republic from 2014 to 2023. We summarize the data to the end of the year, i.e. 31st December, compiling a graphical table in MS Excel.

The second research question also involves data from a public database and official websites of the Czech Statistical Office (CSO, 2024), emphasizing the figures relating to active ageing indices and unemployment rates over the same monitored period.

The third research question includes secondary data gathered by content analysis from the official websites of the Ministry of Labour and Social Affairs (MLSA, 2024), analysing the data about the numbers of job applicants registered in the Unemployment Office according to the age. The monitored period and data observation remain the same as in the previous cases.

Methods

The first research question includes content and graphic analysis, mapping and assessing the selected indicators of population ageing and unemployment rates in the Czech Republic over the monitored period.

The second research question involves correlation analysis, whose prerequisite is data normalization due to their various nature and magnitude. We use Min-max method for data normalization, converted into the interval from 0 to 1.

This data normalization method is as follows (Shantal et al., 2023):

$$x' = \frac{x - \min(x)}{\max(x) - \min(x)} \qquad (1)$$

where:
x = original value to normalize
x_{min} = minimum variable value in the whole dataset
x_{max} = maximum variable value in the whole dataset
x´ = normalized value

We use correlation analysis and Pearson's correlation coefficient to explore the relationship between population ageing and unemployment, defined as follows (Eldomiaty et al., 2020):

$$r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}} \qquad (2)$$

where:
x = ageing index value
$\bar{x}$ = average ageing index value

y = unemployment rate [%]
ȳ = average unemployment rate [%]
α = significance level [%]

The significance level α is set to 5%.

We use MS Excel to calculate r correlation coefficient, classifying the results into five categories:

Very strong	r > = 0.8
Strong	r = 0.6 – 0.8
Medium	r = 0.4 – 0.6
Weak	r = 0.2 – 0.4
Very weak	r = 0 – 0.2

The zero-coefficient r does not indicate any relationship between the ageing index and unemployment rate, whereas the coefficient close to 1 or -1 shows a very strong correlation. Positive values imply a direct proportion between the ageing index ad unemployment rate, while negative numbers indicate the inverse relationship between the measured variables.

We formulated a zero hypothesis H0 to validate data normality. Depending on the rejection or confirmation of the former, we also constructed an alternative hypothesis H1.

H0: There is a correlation between the ageing index and unemployment rates.

H1: There is no correlation between the ageing index and unemployment rates.

The third research question also involves content analysis.

The adopted methodology allows us to fulfil our research aim and answer the research questions.

Results

This chapter presents our findings based on the collected data using the methodology from the previous part. The chapter suggests a chronological overview including three parts that respectively answer our hypotheses, allowing a practical and systematic assessment of the relationship between demographic population ageing and unemployment rates.

Population ageing and unemployment trends in the Czech Republic
The evaluation of the population ageing trend in the Czech Republic within 2014 – 2023 is shown on the selected indicators.

Graph 1: Total population trend in the Czech Republic
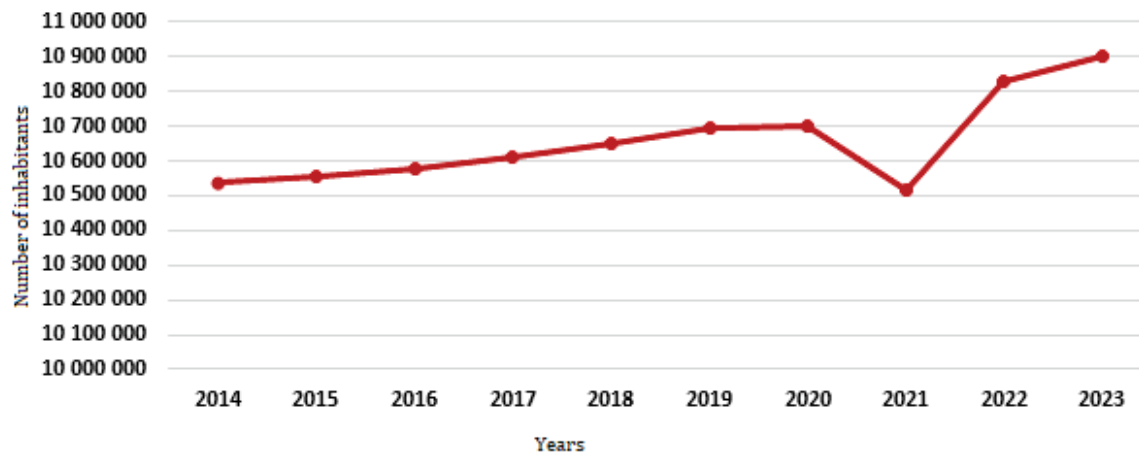
Source: Author from CSO data (2024).

The total population trend in the Czech Republic is a key factor for assessing its ageing trend, depicted in Graph 1 over 10 years from 2014 to 2023. The data were gathered from the public database of the Czech Statistical Office to 31st December of each year. The graph depicts a continuous increasing population trend, indicating the strongest year-to-year rise in history in 2022 when the Czech population grew by 310.8 people. However, the CSO (2024a) suggests that this population explosion reflected mass immigration caused by the armed conflict in Ukraine. The Office further states that the growing trend indicates a predominantly positive balance of the massive migration wave; otherwise, birth and death rates in the Czech Republic decline as of 2019, as illustrated in Graph 2.

Graph 2: Birth and death rate trends
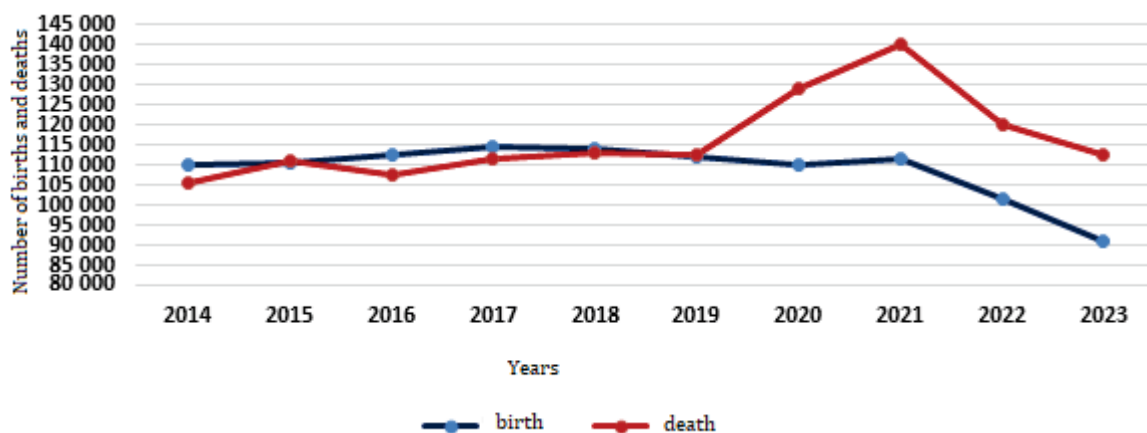
Source: Author from CSO data (2024b).

Graph 2 depicts birth and death rate trends in the Czech Republic over the monitored period from CSO data to 31st December, suggesting a steady decline in the birth rates. In 2014, 109,860 babies were born, seeing a downturn to 91,149 newborns in 2023. Death

rates witness a constant or a slightly increasing trend, supposing we rule out Covid-19 pandemic death tolls from 2020, 2021 and 2022.

Graf 3: Population trends for 0-14 years and over 64
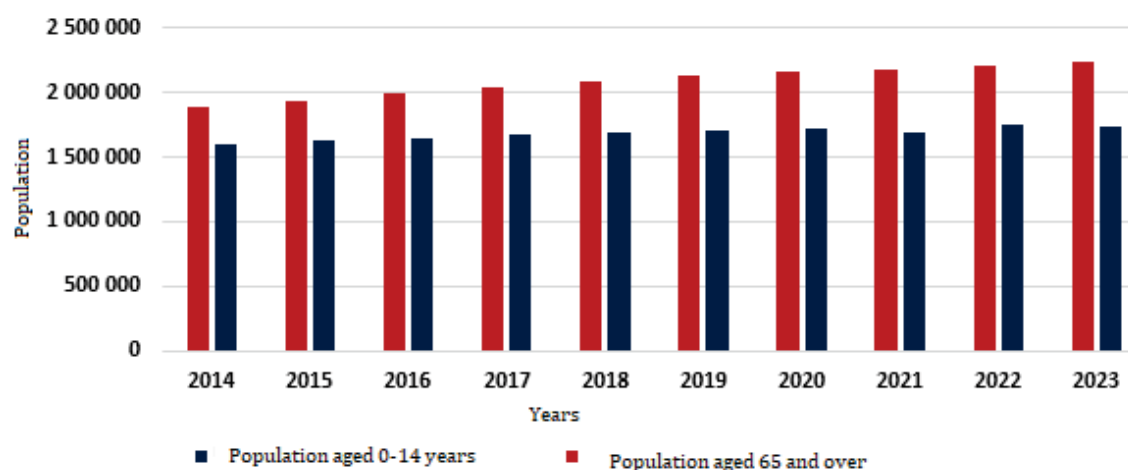
Source: Author from CSO data (2024).

Other indicators showing population ageing trends are population levels within 0-14 and over 64 years, depicted in Graph 3 based on the publicly available of the CSO to 31st December over the same period. The graph illustrates a massive upsurge in population over 64 years, contrasted to an imperceptible increase in young people between 0 and 14 years. A numerical overview suggests that 2014 recorded 1,880,406 people in the pensionable age, while 2023 saw this age group soar to 2,237,322 people, indicating a growth in pensioners by 356,916 inhabitants. According to CSO (2024c) retirees have continuously been outnumbering children up to 15 years in a ratio of 100 children to 130 pensioners to 31st December 2023. This ratio is expected to surpass 200 by 2040.

Graph 4: Ageing index trend
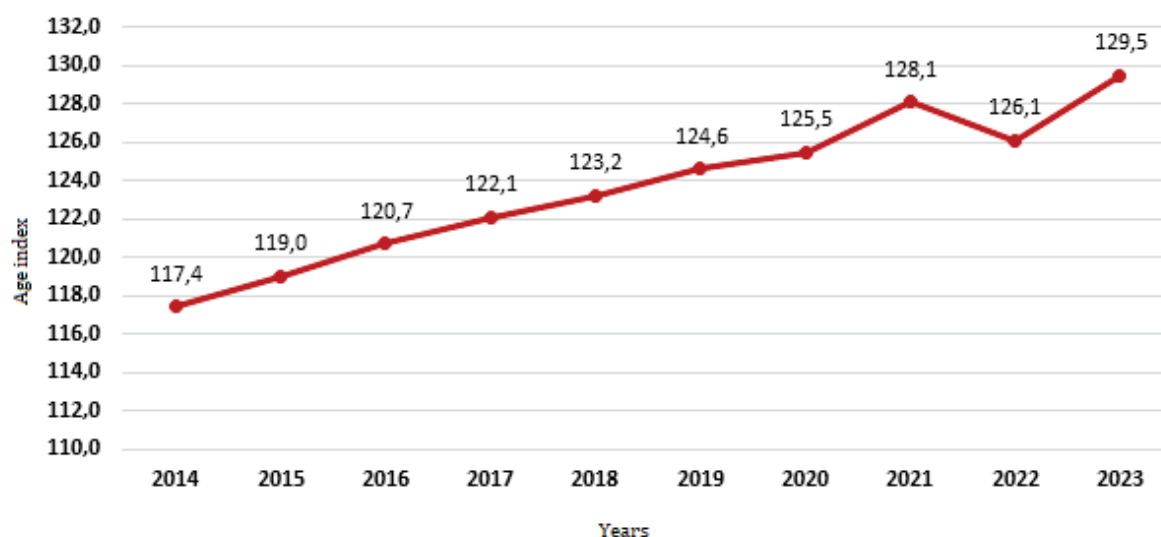
Source: Author from CSO data (2024).

Ageing indices are a key indicator of population ageing depicted in Graph 4. We again collected the data from the CSO database to 31st December of each year over the monitored period. The graph suggests a continuous increasing trend of the ageing index, starting at 117.4 in 2014 and peaking at 129.5 ten years later. The CSO (2024d) states that the ageing index involves the number of people over 64 per 100 people in the age between 0 and 14. The charts also indicate that a growing number of pensioners and declining young population will push the ageing index further up.

Graph 5: Unemployment trends
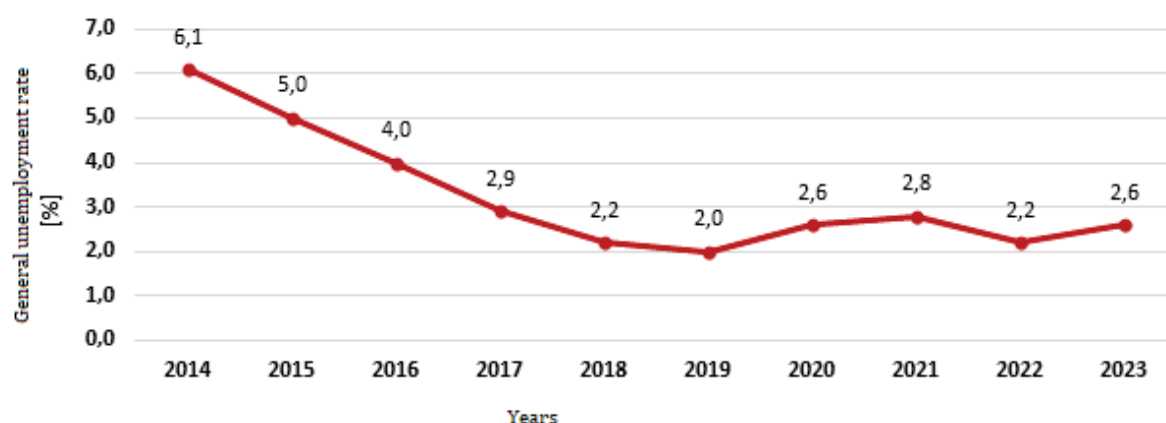
Source: Author from CSO data (2024e).

Graph 5 illustrates unemployment rates to 31st December of each year over the monitored period, indicating a gradual decline from 6.1% in 2014 to 2.6 at the end of 2023. The figures suggest that despite rapid population ageing the unemployment rates in the Czech Republic saw a sharp downturn between 2014 and 2023.

Correlation between the ageing index and unemployment rate

Although the ageing index dramatically increased every year, unemployment rates saw a gradual decline over the monitored period. We conducted correlation analysis to identify whether a correlation between the ageing index and unemployment rates exists.

To do that, we must normalize the data from a publicly available data of the CSO using Min-max normalization methods. The tables and data before and after normalization are attached as annexes.

Tab. 1: Correlation analysis between the ageing index and unemployment rates

	Ageing index	Unemployment rate
Ageing index	1	
Unemployment rate	-0.795041974	1

Source: author from CSO data (2024, 2024e).

Table 1 suggests a negative correlation coefficient of -0.795041974, indicating a disharmony between the ageing index and unemployment rates, i.e., an increasing ageing index means a decreasing unemployment rate and vice versa. The table drawn in Data and Methods illustrates the strength of the correlation, showing a strong or very strong correlation.

Based on our findings, we reject H_1 and confirm H_0, suggesting that a correlation between the ageing index and unemployment rates exists.

Unemployment statistics in selected age groups in the Czech Republic

Our research on how population ageing affected unemployment figures in selected age groups in the Czech Republic between 2014 and 2023 involves three age groups, including the younger generation (20-29 years), middle-aged generation (40-49 years) and older generation (55-64 years). We gathered the data from the websites of the Ministry of Labour and Social Affairs to December of each year.

Graph 6: Number of job applicants registered in the Unemployment Office according to the selected age groups
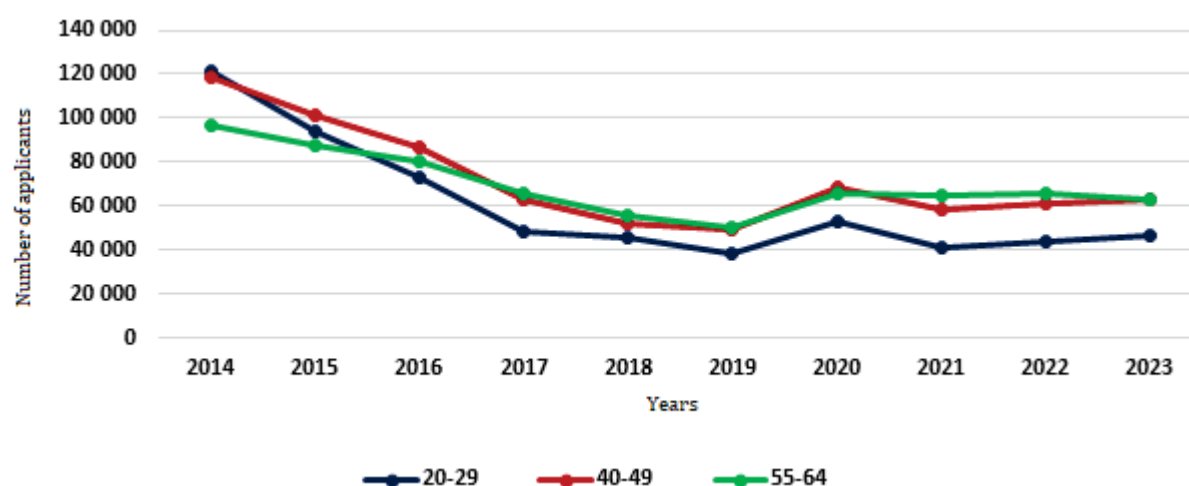
Source: author from MoLaSA (2024).

Graph 6 suggests that the number of job applicants gradually decreases, caused by falling unemployment rates. Despite a marked increase of older applicants, the overall number of job seekers almost remains the same. Younger age groups have fewer job applicants registered at the Unemployment Office than their older counterparts.

Discussion

Based on our findings, we can answer the following research questions.

RQ1: What was the population ageing trend and unemployment rates in the Czech Republic in 2014-2023?

To answer the first question, we used content and graphic analysis, mapping and assessing the selected indicators of population ageing and unemployment rates in the Czech Republic over a 10-year period.
Although national Czech population increases, birth rates get the short end of the stick, as this population explosion reflects mass immigration related to the war in Ukraine and international migration. Birth rates significantly decrease over the monitored period, as confirmed by Xue et al. (2022), but death rates see a steady growth.
Despite the subtly rising number of the cohort in the age between 0 and 14 years, we witness a constantly accelerating trend in the age group of over 64 years, as proved by Xue et al. (2022). We registered 1,880,406 people in the pensionable age in 2014 to see it grow to 2,237,322 to the end of 2023. The elderly population rose by 356,916 people over the monitored 10-year period. According to the CSO (2024c), 100 children fell on 130 pensioners to 31st December 2023, expecting the ratio, the ageing index, will have exceeded 200 by 2040.
The ageing index dramatically soars every year, settling at 117.4 in 2014 and peaking at 129.5 ten years later. The increasing number of retirees and declining young population will push the ageing indices further up.

The unemployment rate topped 6.1% in 2014, witnessing a steady decrease over the monitored period, and settled at 2.6% in 2023. Our findings suggest that despite the

accelerating trend in population ageing, the unemployment rates in the Czech Republic steadily dwindled over the same period, as confirmed by Ochsen (2021).

RQ2: Is there a correlation between the ageing index and unemployment rates?

To answer this question, we used correlation analysis from a publicly available database of the CSO. Before the correlation, the data had to be normalized using Min-max method.

The analysis showed a negative r correlation coefficient of -0.795041974, indicating a marked dissonance between the ageing index and unemployment rates. This scenario suggests that heightened ageing indices alleviate unemployment and vice versa. The table in Data and Methods illustrates a strong or very strong correlation of r correlation coefficient.

We therefore reject the alternative hypothesis H_1 and confirm zero hypothesis H_0, declaring the existence of the correlation between the ageing index and unemployment rates.

I see one reason why the ageing index grows with decreasing unemployment rates in the increasing number of retirees, profoundly depleting labour supply and reducing the unemployment rate. The dwindling quota of the younger generation at the labour market pushes the unemployment rates even lower, as the production of economically active population came to a stall. Ageing population may also boost the demand for healthcare and social services, creating new job opportunities and alleviating unemployment in this sector.

RQ3: How did population ageing influence unemployment rates in selected age groups in the Czech Republic between 2014 and 2023?

To answer the third question, we process secondary data from the official websites of the Ministry of Labour and Social Affairs for the monitored period to December of each year using content analysis. We chose three age groups – the younger generation (20-29 years), middle-aged generation (40-49 years) and older cohort (55-64 years).

We identified a steady decline in job applicants over the monitored 10-year period, caused by reduced unemployment rates and postponed retirement of ageing population, as confirmed by Rozen-Bakher (2020). Despite a marked increase in elderly population, the number of job seekers registered at the Unemployment Office remains unaffected. What may play the role is the government support of the employment of older workers, offering age-related tax allowances and incentives for employers. Low unemployment rates may also compel employers to hire older employees, given a lack of young workforce, as confirmed by Lee et al. (2021). The research also revealed that younger generations have fewer applicants registered at the Unemployment Office than older cohorts, given the employers' burgeoning demand for young people's artifice in using modern technologies. Postponed retirement does not affect the unemployment rates of younger generations, as confirmed by Apello (2024).

Conclusion

Our study aims to evaluate population ageing trends and assess its influence on unemployment rates in the Czech Republic within 2014-2023. The research aim also involves whether a correlation between selected indicators, i.e. ageing indices and unemployment rates, exist, and what is the influence of the ageing generation on unemployment in selected age groups in the Czech Republic over the same monitored period. The research aim was fulfilled and research questions answered with a reference to elaborated results.

As national birth rates witness a dramatic slow-down over the monitored period, overall population growth reflects mass immigration related to war in Ukraine and massive global migration. Compared to a subtle rise in young people between 0 and 14 years, we see a marked increase in the generation over 64 years. The ageing index dramatically soars every year, equalling 117.4 in 2014 and peaking at 129.5 ten years later. The ever-increasing number of pensioners and plummeting quota of the coming cohort will push the ageing index up. Unemployment rates steadily dropped over the monitored period, falling from 6.1% in 2014 to 2.6% in 2023. We argue that despite gradual population ageing, unemployment rates steadily dwindled.

We conducted correlation analysis to prove a correlation between the ageing index and unemployment rates using Min-max method for normalization. The resulting negative r correlation coefficient equalled -0.795041974, indicating an inverse relationship between ageing indices and unemployment rates, i.e. ageing indices grow with slumping unemployment. The r correlation coefficient demonstrates a strong or very strong correlation, confirming a correlation between the ageing index and unemployment rates.

A gradually decreasing number of job applicants over the monitored 10-year period reflects dwindling overall unemployment rates marked population ageing and postponed retirement. Despite a massive upsurge in ageing population, the number of job seekers registered at the Unemployment Office remained untouched. Younger age groups indicated fewer job applicants registered in the Unemployment Office than their older counterparts. Postponed retirement did not affect youth unemployment.

Our study's major limitations involve a possible bias in our results caused by the Covid-19 pandemic and armed conflict in Ukraine.

The study largely contributes to deepening the understanding between population ageing and fluctuating unemployment rates, providing employers and government representatives with valuable data to adopt the measures for improving labour market conditions and ensuring worldwide economic stability.

Further research could focus on predicting the future population ageing trends and their potential impacts on society.

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Appendix

Tab. 1: non-normalized data

Year	Ageing index	Unemployment rates
2014	117.4	6.1
2015	119	5
2016	120.7	4
2017	122.1	2.9
2018	123.2	2,2
2019	124.6	2
2020	125.5	2.6
2021	128.1	2.8
2022	126.1	2.2
2023	129.5	2.6

	Ageing index	Unemployment rates
min. value	117.4	2
max. value	129.5	6.1

Year	Ageing index	Unemployment rates
2014	0	1
2015	0.132231405	0.731707317
2016	0.272727273	0.487804878
2017	0.388429752	0.219512195
2018	0.479338843	0.048780488
2019	0.595041322	0
2020	0.669421488	0.146341463
2021	0.884297521	0.195121951
2022	0.719008264	0.048780488
2023	1	0.146341463