The Relationship between Economic Indicators and Population Aging in Slovakia

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Abstract

The aim of the paper is to identify the relationships between economic and demographic indicators in the Slovak Republic by NUTS 3 over a 10-year period. The demographic indicators used in the analysis are population, share of seniors, crude migration rate, crude mortality rate, crude fertility rate and economically active population. The economic indicators were GDP per capita, Gini coefficient and poverty risk rate. We used panel data models. It can be concluded that the population, the share of the seniors, the crude migration balance and the crude mortality rate have a positive effect on GDP per capita. Particularly surprising is the result of the analysis concerning the share of seniors, as GDP per capita is expected to grow in the next period as the share of seniors in the population increases. The share of seniors, the crude migration balance and the share of the economically active population have a negative impact on the poverty risk ratio.

INTRODUCTION

Recent decades have witnessed a significant increase in the number of older people, not only in developed countries but also in developing economies. The total world population is projected to reach approximately

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10 billion by 2100, with projections suggesting that by 2050 the number of people aged 65 years and over will double compared to the number of children under 5, indicating significant changes in the context of fertility in recent decades. This demographic shift brings challenges that will need to be addressed to a greater extent, such as the higher costs of caring for the seniors, the need to adapt labour markets and social systems. Migration can also have a negative impact on social systems, in particular the departure of young people from their countries of origin or regions, which reduces the share of young workers contributing through taxes and contributions to the financing of pensions for the seniors. At the same time, the social and health care sector is increasingly burdened by raising number of people aged 50 to 74 in countries. This trend leads to an increasing proportion of older workers qualifying for old-age pensions. The social phenomenon associated with an increase in the proportion of older people in society has significant implications for the development and prosperity of the society. Changes in the age structure of population, migration, mortality and birth rates have a major impact on social and economic development. Their dynamics have an impact on the structure of the labour market, which, in turn, affects economic growth and social stability.

1 LITERATURE REVIEW

Population size, its status and age-sex composition closely correlate with a country's economic growth. The latter is a key factor influencing the lives of people in a society. The economic situation of a country includes important aspects such as GDP development, inflation rate, unemployment rate, state of trade balance, automation rate and other important indicators at local, national and global levels.

Among other things, the automation of production processes has a certain impact on unemployment. This topic was addressed by the authors of Yilmaz and Vardar (2023), who presented results from several studies. Many studies suggest that automation can explain employment and wage stagnation to some extent. Other studies point to a job loss in industries for routine jobs. On the other hand, certain recent research using firm-level data has revealed positive effects of automation on employment in automobile plants in countries such as France, the United States, the United Kingdom, Canada, Denmark and Spain.

According to Kaytaz, Özmucur and Yürükoglu (2023), there has been low or no inflation in the world for almost three decades due to globalization and an increasing independence of central banks. Globalization has led to the integration of more economies, thus injecting more labour resources into the global economy. The availability of cheap labour has thus helped to accelerate economic growth and increase trade.

Some authors are unanimous in arguing that the rise in inflation is partly linked to energy prices, especially the rise in oil prices in 2021 (Blot et al., 2022). Bernoth and Ider (2021) agree with this view and point out that this increase in inflation is the result of recovery of energy prices after their fall and the reversal of VAT cuts in several European countries, also due to the impact of Covid.

Uramova et.al. (2017) conducted an analysis examining which component of GDP has been the most stable over the period 2004–2015. The result of the analysis suggests that the main stable component of GDP in the V4 countries was private household consumption expenditure. More serious problem was the fluctuating private business investment in the countries uncer review. The authors mean that economic policy actors should focus on identifying and removing the barriers that constrain business investment activity. According to the authors, the structure of government spending needs to be evaluated in order to allocate public resources more efficiently, not only in Slovakia, but also in the other V4 countries.

Environmental issues and their impact on our planet are important. Authors Wang et al. (2020) conducted research focusing on the calculation of green GDP in China. Over the past two decades, the Chinese economy has achieved rapid growth. However, with continuous industrialization and urbanization, China is facing major challenges in energy security and environmental issues. In the research, the costs of environmental pollution including CO_2, SO_2, wastewater and waste export were taken into account. The cost of resource consumption, including fossil fuels and water consumption, was also considered.

An examination of the relationship between demographic phenomena, primarily fertility, which is associated with the postponement of childbearing, the increase in fertility at later age and the decline in total fertility, and economic processes is addressed in Beaujouan's (2023) article, acknowledging also the influence of factors such as economic crises, pandemics, etc.

The impact of mortality, while questioning the significant impact of low fertility on population aging, has been addressed by De Santis and Salinari (2023), who in their study examined the importance of mortality in shaping the age structure of the population in the long run and pointed out that changes in the age structure of countries could be explained mainly by changes in survival, with fertility and migration not being as important as assumed. Their study uses time series data (in some cases going back to 1820) from several populations in Europe, North America or Oceania. As a result of the analyses, it was found that it was possible to predict satisfactorily the evolution of the age structure on the basis of mortality rates alone.

The impact of migration, especially of young people leaving for work, on population aging is undeniable. The proportion of young people in the labour force is declining, causing a reduction in the ratio of workers to non-workers, which can lead to economic problems with social welfare. In Poland, this issue has been addressed by White (2010). The article focuses on young people from poorer towns and villages with a high incidence of migration.

The increasing proportion of seniors may have a negative impact on economic growth in the sense that health care costs are rising. Authors Páleník and Musilová (2020) argue: If the aging trend in the Slovak health care system is not slowed down or prevented, we may face a total collapse of the Slovak health care system.

Williams et al. (2022) have produced a study that discusses a proposal to address population aging in Mongolia. By 2060, Mongolia's senior population is expected to grow rapidly, with the proportion of people over 65 years of age estimated to increase more than threefold.

A study on how to mitigate the effects of population aging by promoting education has been undertaken by Kelin et.al. (2022). They used data from 15 European countries: Belgium, Czechia, Estonia, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Romania, Spain and Slovakia. The study shows that people with higher education are more likely to be employed and able to support the dependent population longer and more effectively than those with lower education. Investing in education can be beneficial for economic sustainability at a time when the population is getting older and can help mitigate the negative effects of aging on public finances and the economies of European countries. These findings are reminiscent of the concept of successful aging proposed by Rowe and Kahn (1997). In their publication, they describe how people can achieve a high quality of life even at an advanced age.

The main objective of the paper is to find out the correlations between the selected, below mentioned, economic and demographic indicators. Panel data models will be used. Ullah (2001) in his econometrics handbook describes developments in panel data econometrics. He gives an overview of linear panel data models with predetermined variables, discussing the implications of assuming that the explanatory variables are predetermined, as opposed to strictly exogenous in dynamic structural equations with unobserved heterogeneity.

2 METHODS

The data base of the analyses consisted of data drawn from the public database DATAcube of the Slovak Statistical Office[5] and from the EU SILC publications – Indicators of Poverty and Social Exclusion.

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[5] *<https://datacube.statistics.sk/#!/view/sk/vbd_dem/om7011rr/v_om7011rr_00_00_00_sk>*.

From the methodological point of view, panel data models are used, since from the spatial point of view the analysis is focused on the NUTS3 regions of Slovakia and the time horizon is 10 years (2014–2023). The analyses were carried out using Gretl, EViews, Phyton – Spyder software.

The demographic indicators used were population size, mean population size processed by the balance method as of 1 July of a given year (SR Statistical Office, 2023), share of seniors in the population, crude migration rate, crude mortality rate, crude birth rate and economically active population:
  – Economic indicators: GDP per capita, Gini coefficient, poverty risk rate.
The following abbreviations are used:
  – Population – popul (in thousands),
  – Seniors (relative representation of seniors in the total population),
  – Crude rate of net migration – CRM (net migration per 1 000 inhabitants),
  – Crude death rate – CDR (the number of deaths per year per 1 000 inhabitants),
  – Crude birth rate – CBR (the number of birth per year per 1 000 inhabitants),
  – Share of economically active population – EAP (relative representation of EAP in the total population),
  – GDP per capita – GDP (euro per capita),
  – GINI coefficient – GINI (%),
  – At-risk-of-poverty rate – RPR (%).

2.1 Regional abbreviations

Slovakia is often divided into three basic regions: Western, Central and Eastern Slovakia. This regional classification is not officially established by law, but is used in various statistical, geographical or administrative contexts.

BA – Bratislava Region, TT – Trnava Region, TN – Trenčín Region, NR – Nitra Region – western Slovakia, ZA – Žilina Region, BB – Banská Bystrica Region – central Slovakia, PO – Prešov Region, KE – Košice Region – eastern Slovakia.

2.2 Panel data models

The impact of demographic characteristics on the evolution of economic indicators was investigated through econometric models using panel data. Fixed effects, random effects and pooled regression model estimates were used through the least squares method. The shape of each model is given by Formulas (1), (2) and (3). The suitability of the models was assessed using the Hausman test.

$$GDP_{it} = \beta_0 + \beta_1 popul + \beta_2 seniors_{it} + \beta_3 CRM_{it} + \beta_4 CDR_{it} + \beta_5 CBR_{it} + \beta_6 EAP_{it} + u_{it} \text{,} \tag{1}$$

where:
i – sectional dimension $i = 1, 2, ...N$,
t – time dimension $t = 1, 2, ...T$,
u – random term of the model,
βk – estimated regression coefficient,
k – index of exogenous variables, $k = 1, 2, ...6$).

$$GINI_{it} = \beta_0 + \beta_1 popul + \beta_2 seniors_{it} + \beta_3 CRM_{it} + \beta_4 CDR_{it} + \beta_5 CBR_{it} + \beta_6 EAP_{it} + u_{it} \text{,} \tag{2}$$

$$RPR_{it} = \beta_0 + \beta_1 popul + \beta_2 seniors_{it} + \beta_3 CRM_{it} + \beta_4 CDR_{it} + \beta_5 CBR_{it} + \beta_6 EAP_{it} + u_{it} \text{.} \tag{3}$$

3 RESULTS

3.1 Comparison of regions

In the first part of the paper, a comparison of the regions of the Slovak Republic in terms of selected demographic (population, share of seniors, crude migration balance, crude mortality rate, crude live birth rate, share of economically active population) and economic (GDP per capita, GINI coefficient, at-risk-of-poverty rate) indicators was carried out with the help of box plot charts (e.g. see Figures 1–9).

Figure 1 Population (in number)
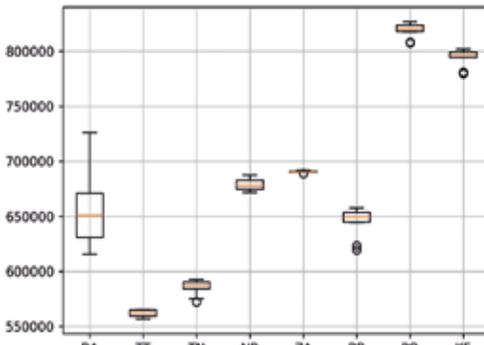
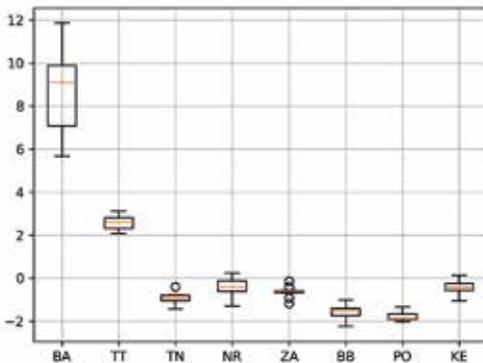**Source:** Own processing in Spyder software

Figure 2 Seniors (relative representation of seniors in the total population)
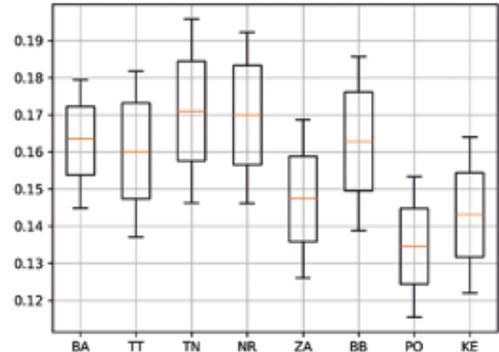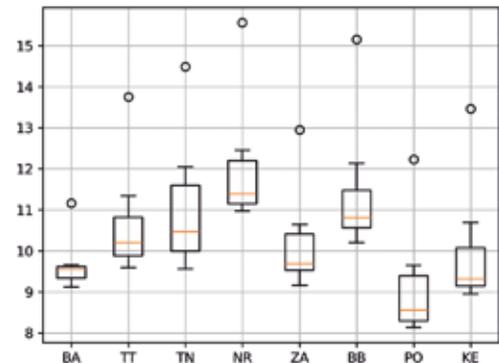

Source: Own processing in Spyder software

The greatest variability in the number of inhabitants over ten years is in the BA region, i.e. during the period under study the number of inhabitants measured by the mean population has changed the most compared to other regions of Slovakia (e.g. see Figure 1). In Figure 2 (e.g. see Figure 2) – share of seniors it can be seen that all boxplots are relatively symmetrical. The highest Share of seniors was recorded in the TN and NR region in the period under study, the youngest population was in PO region.

Figure 3 Crude rate of net migration (migration per 1 000 inhabitants)

Source: Own processing in Spyder software

Figure 4 Crude death rate (number of deaths per year per 1 000 inhabitants)
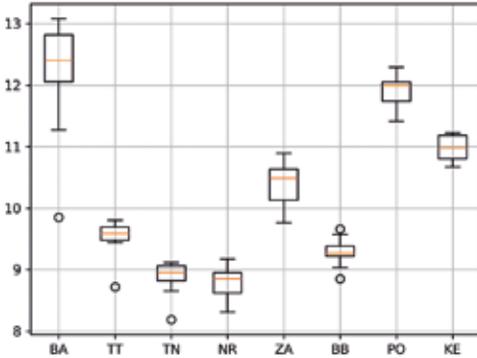

Source: Own processing in Spyder software

The Crude rate of net migration indicator shows the highest positive migration balance, which is significantly different during the whole period in the BA region, the least attracted people are

in the PO and BB regions (e.g. see Figure 3). Crude death rates between 2014 and 2023 reached the highest level in the NR and TN regions, and lowest in the PO region (e.g. see Figure 4). In all regions of the Slovak Republic there were found outlying years, these are years of high mortality rates in the whole area – the Covid period.

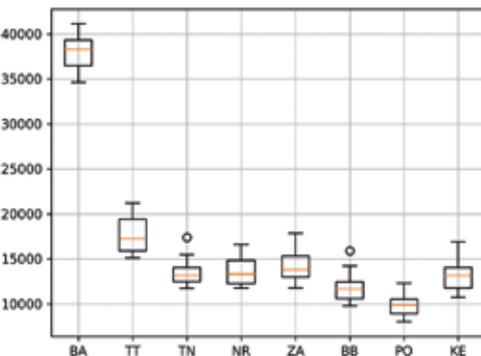| **Figure 5** Crude birth rate (number of birth per year per 1000 inhabitants)	**Figure 6** Share of economically active (relative representation of EAP in the total population)

Source: Own processing in Spyder software
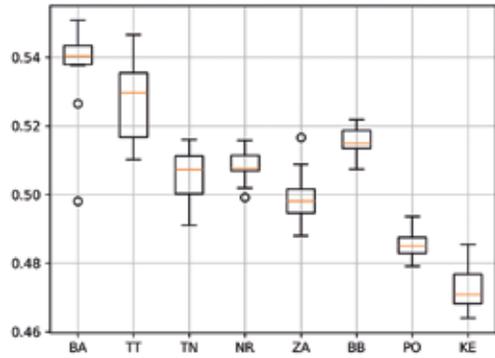
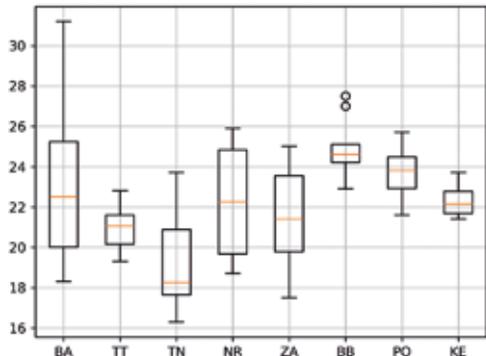**Source:** Own processing in Spyder software

The average Crude birth rate during the period under study is approximately 10.24‰. This trend is associated with several factors, including economic or educational conditions, as well as social preferences regarding family and career. The highest Crude Birth Rate is in the BA region. It is followed by the PO and KE regions (e.g. see Figure 5); the situation in the eastern regions can be explained by a higher concentration of minority Roma population. The largest share of economically active population according to the LFS (the Labour Force Sample Survey) was in the BA region in the period under study (e.g. see Figure 6). As with most demographic indicators, the lowest share of economically active population is in the eastern regions of Slovakia. The significant differences between the BA region and the eastern Slovak regions are largely due to the different development of these areas, with employment opportunities also playing a non-negligible role.

| **Figure 7** GDP (euro per capita)	**Figure 8** GINI coefficient (%)

Source: Own processing in Spyder software

Source: Own processing in Spyder software

The BA region has a significant lead in the GDP per capita indicator. It is followed by the TT region, although with a significant difference in the values of descriptive statistics. The other regions were at approximately the same level – around 13 000 € per capita (e.g. see Figure 7). The medians of the BA, TT, NR, ZA and KE regions in the GINI coefficient indicator are in the interval from about 21% to about 23%, which means that the level of income inequality in the territory of the Slovak Republic is relatively low. Nevertheless, there are not negligible differences between the richest and the poorest regions of Slovakia (e.g. see Figure 8).

The BA region can be considered as the region with the lowest at-risk-of-poverty rate, which is related to the greater availability of job opportunities typical for larger cities and more economically developed areas. On the contrary, the highest at-risk-of-poverty rate is shown by the PO region, where the median rate is 17.6% e.g. see (e.g. see Figure 9).

Figure 9 At-risk-of-poverty rate (%)
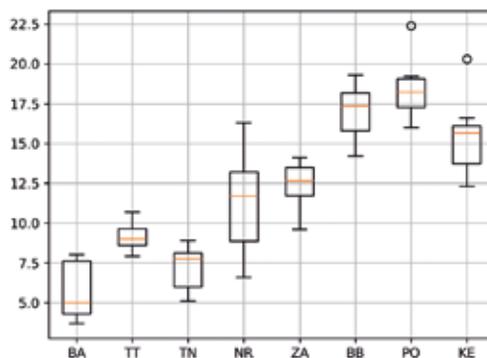
Source: Own processing in Spyder software

3.1.1 Regional differences in socio-economic development of Slovakia

Slovakia has long been characterised by significant regional disparities, which are most pronounced between the BA region and the regions of eastern Slovakia, especially the PO and KE regions. These disparities are the result of a combination of historical, economic, geographical and institutional factors that affect the quality of life of the population and the level of regional development.

The BA region is the most developed region of the Slovak Republic in terms of socio-economic indicators. It is characterised by the highest crude domestic product (GDP) per capita, which in the long term exceeds not only the Slovak, but also the European average. The region benefits from a concentration of state institutions, international corporations, research centres and a highly skilled workforce. In addition, thanks to its favourable location close to the borders with Austria and Hungary, Bratislava as the capital city has direct access to advanced Western European markets. A well-developed transport infrastructure, including motorway connections, a railway network and an international airport, significantly increases the attractiveness of the region for both domestic and foreign investors. On the contrary, eastern Slovakia has long lagged behind in the main indicators of economic and social development. Unemployment rates in the PO and KE regions are among the highest in the republic, while the economic activity of the population is significantly lower than in the western part of the country. This situation is partly a consequence of historical marginalisation of the region, which was reflected in the lower rate of industrialisation in the past, as well as the insufficient development of transport and innovation infrastructure. In addition, eastern Slovakia is also facing a population outflow, especially of young and educated people, which further weakens its development potential.

Available statistical data, such as the Labour Force Sample Survey (LFS) and poverty and social exclusion indicators from the EU SILC survey, show that the BA region has the lowest risk of poverty and the highest employment rate, while the eastern regions are the most vulnerable in terms of social exclusion. These facts point to the need for a targeted regional policy that would contribute to levelling out disparities and ensure more balanced development of all parts of the country.

3.2 Exploring the relationship between selected demographic and economic indicators

In this section, we focus on the analysis of the relationships and dependencies between selected economic and demographic indicators. For this purpose, we use panel data models, fixed effects models and random effects models. In each model, we include all demographic indicators as exogenous variables, which we then analyse in the context of one particular economic indicator as an endogenous variable.

3.2.1 Impact of demographic characteristics on GDP per capita

In this section of the paper, we have included GDP per capita in place of the explanatory variable. Based on the test results reported in Table 1 (e.g. see Table 1), we compare the goodness of fit of the models. The results of testing for the presence of group effects in the fixed effects model (F-test) indicate the appropriateness of using this model. To compare the appropriateness of using the pooled regression model and the random effects model, we used the Breusch-Pagan test, which indicates the presence of individual effects, thus it is more appropriate to choose the random effects model. The crucial test for choosing between the fixed effects model and the random effects model is the Hausman test. Based on a p-value of less than 0.05, we used the fixed effects model. We report the results of the three models (e.g. see Table 2).

Table 1 Tests of panel models for the endogenous variable GDP

Statistic	Value	P-value
F-test	10.4971	2.44E-06
Breusch-Pagan test	22.5463	2.05E-06
Hausman test	155.348	5.72E-31

Source: Own processing based on outputs from the Gretl program

In the fixed effects model, four parameters were found to be statistically significant at different significance levels (e.g. see Table 2). At the 1% level, the Share of seniors lagged by one time period was significant, at the 5% level the Crude mortality rate lagged by one time period, and at the 10% level the Population and the Crude migration balance rate were significant. The positive regression coefficient for the Share of Seniors lagged by one time period suggests that a higher share of seniors in the population is associated with higher GDP per capita, which we consider an unexpected result. As the share of seniors in the population increases (e.g., in the previous year), GDP per capita is expected to increase in the next period. This relationship may signal a variety of factors, for example, that a higher share of seniors may be associated with greater consumption or investment in pensions, health care or infrastructure, which could boost the economy. To explain this phenomenon more thoroughly, it would be necessary to investigate the mechanisms that lead to such an outcome. Similarly, the positive regression coefficient on the Crude Mortality Rate lagged by one year suggests that a higher mortality rate positively affects GDP per capita. That is, regions with higher mortality rates also had higher GDP per capita values. It is important to note that this relationship is non-standard and can be influenced by a number of specific economic, political and social factors. In real life, higher mortality rates are usually associated with negative impacts on the economy, so it is important to look at this relationship in the context of other variables. Among the statistically significant variables are Crude Migration Balance and Population,

which are closely related. These regressors showed a positive effect on GDP, meaning that an increase in them led to an increase in GDP per capita. Migration could mean the arrival of skilled labour to the region, thereby increasing labour productivity and economic performance. There is also a variable Share of economically active population in the model, which shows a positive effect on GDP per capita, but not statistically significant. Similarly, the parameter Crude Live Birth Rate, which has a negative but insignificant effect on the explanatory variable.

Table 2 Estimates of the impact of selected demographic indicators on GDP per capita

	Pooled OLS	FEM	REM
Const.	−31 117.1 (0.0557)*	−11 446.0 (0.1920)	−14 972.7 (0.1742)
Popul.	0.0181 (0.0834)*	0.0149 (0.0965)*	0.0188 (0.0651)*
$Seniors_1$	131 999 (0.0010)***	98 609.5 (6.41E-06)***	102 934 (2.16E-18)***
CRM	2 228.1 (1.35E-06)***	246.348 (0.0793)*	758.851 (0.0201)**
CDR_1	87.3379 (0.7991)	339.875 (0.0153)**	306.667 (0.1104)
CBR	298.443 (0.6341)	−210.018 (0.4380)	−402.120 (0.3868)
EAP	1 926.4 (0.4469)	−2 765.56 (0.7763)	7 025.39 (0.7395)
R-squared	0.9373	0.9970	
P-value	5.36E-07		
Akaike criterion	1 322.496	1 116.6160	1 475.4850

Notes: *, **, *** statistical significance of estimated parameters at the 10%, 5%, 1% level, p-value of parameters is in parentheses.
Source: Own processing based on outputs from the Gretl program

3.2.2 Impact of demographic characteristics on the GINI coefficient

In the following analysis, the GINI coefficient takes the place of the endogenous variable. Considering the test results presented in Table 3 (e.g. see Table 3), we conclude that the best fitting model is the fixed effects model. The F-test comparing the predictive ability of the fixed effects model and the pooled regression model with one locus constant for all cross-sectional units showed a p-value less than 0.05 (0.0066). Hence, the fixed effects model is more appropriate. Based on the Breusch-Pagan test (p-value = 0.0002), we preferred to use the random effects model over the pooled regression model. Due to the low p-value of the Hausman test (0.91E-17), the fixed effects model was preferred to the random effects model.

Table 3 Tests of panel models for the endogenous variable GINI

Statistic	Value	P-value
F-test	3.663	6.60E-03
Breusch-Pagan test	14.157	2.00E-04
Hausman test	87.6969	9.11E-17

Source: Own processing based on outputs from the Gretl program

We report the results of the model estimates for the endogenous variable GINI coefficient in Table 4 (e.g. see Table 4). The fixed effects model achieves a higher percentage of explained variability (coefficient of determination = 0.751). In the fixed-effects model, four parameters are found to be significant: Population, Proportion of seniors lagged by one time period, Crude Migration Balance Rate and Crude Live Birth Rate lagged by one time period (significance level 0.1), all of which have a negative regression coefficient. The parameter Population had a negative effect on the GINI coefficient. The negative regression coefficient of the variable Share of seniors indicates that a higher share of seniors in the population is associated with a lower value of the GINI coefficient, which implies greater income equality. The crude migration balance contributes by its increase to income equality. This indicator helps to achieve income equality in a similar way to the Population indicator. Based on the impact of the Crude Live Birth Rate lagged by one time period, we can argue that areas that are characterized by higher live birth rates are associated with lower GINI coefficients or greater income equality. The indicator of income inequality or equality is negatively affected by the Percentage of economically active population and positively affected by the Crude Mortality Rate lagged by one time period, but statistically insignificant.

Table 4 Estimates of the impact of selected demographic indicators on the GINI coefficient

	Pooled OLS	FEM	REM
Const.	−8.2377 (0.7111)	112.111 (0.0006)***	51.0865 (0.0027)***
Popul.	1.7662E-05 (0.0411)**	−7.5264E-05 (0.0002)***	−1.8640E-05 (0.1139)
Seniors$_1$	−106.9320 (0.0512)*	−100.857 (0.0139)**	−128.986 (0.0006)***
CRM	0.05997 (0.8366)	−0.5322 (0.0710)*	−0.1495 (0.5843)
CDR$_1$	0.2714 (0.3849)	0.0121 (0.9614)	0.3060 (0.1717)
CBR$_1$	−0.6544 (0.2243)	−1.6916 (0.0553)*	0.0066 (0.9921)
EAP	77.3754 (0.0670)*	−10.2030 (0.7834)	2.0071 (0.9548)
R-squared	0.405427	0.7512	
P-value	1.03E-03		
Akaike criterion	327.689	278.9769	361.1145

Notes: *, **, *** statistical significance of estimated parameters at the 10%, 5%, 1% level, p-value of parameters is in parentheses.
Source: Own processing based on outputs from the Gretl program

3.2.3 Impact of demographic characteristics on the risk of poverty

In the following analysis, at-risk-of-poverty rate is included in place of the endogenous variable. The most appropriate model to describe the relationship is the fixed effects model (e.g. see Table 5). An F-test was used to test for the presence of group effects in the fixed effects model. Because of P-value = 0.0002, we prefer to use the fixed effects model rather than the pooled regression model. We used the Breusch-Pagan test to prove the existence of individual effects in the model, and therefore using

a random effects model would be preferable to using a pooled regression model. The crucial criterion for the choice is the Hausman test, which indicated the appropriateness of using a fixed effects model (P-value= 0.023).

Table 5 Tests of panel models for the endogenous variable Poverty Risk Rate

Statistic	Value	P-value
F-test	6.2792	2.00E-04
Breusch-Pagan test	48.4018	3.47E-12
Hausman test	14.6601	2.31E-02

Source: Own processing based on outputs from the Gretl program

The results of the model estimates for the endogenous variable RPR are reported in Table 6 (e.g. see Table 6). The fixed effects model achieves a higher coefficient of determination (0.893) compared to the pooled regression model and has the lowest value of Akaike's information criterion (295.62) among the three models.

Table 6 Estimates of the impact of selected demographic indicators on the Poverty Risk Rate

	Pooled OLS	FEM	REM
Const.	−43.6041 (0.0264)**	39.220 (0.0683)*	30.1401 (0.0846)*
$Popul._1$	2.4297E-05 (0.0075)***	−7.5462E-05 (0.6257)	−1.5259E-06 (0.9068)
$Seniors_1$	−76.5032 (0.0046)***	−70.203 (0.0002)***	−69.304 (1.13E-19)***
CRM_1	−1.02714 (3.80E-05)***	−0.4293 (0.0753)*	−0.5892 (0.0023)***
CDR_1	0.9024 (0.0031)***	0.8428 (6.66E-05)***	0.8466 (1.11E-14)***
CBR_1	0.9633 (0.0232)**	1.7352 (0.0275)**	1.5719 (0.0217)**
EAP_1	63.9498 (0.0500)**	−74.3393 (0.0257)**	−61.2655 (0.0237)**
R-squared	0.724791	0.8932	
P-value	6.61E-07		
Akaike criterion	349.7751	295.6203	374.3711

Notes: *, **, *** statistical significance of estimated parameters at the 10%, 5%, 1% level, p-value of parameters is in parentheses.
Source: Own processing based on outputs from the Gretl program

In the model estimation there are two parameters statistically significant at the 1% level ($seniors_1$, CDR_1), two parameters statistically significant at the 5% level (CBR_1, EAP_1) and one parameter statistically significant at the 10% level (CRM_1) all shifted by one period. With a higher proportion of seniors,

the risk of poverty decreases, which we find an interesting and unexpected result and more research would be needed to investigate the mechanisms that lead to such a result. One reason for this may be that the older population has had a long period of working life during which they have built up savings or assets that may help to reduce the risk of poverty. These assets (e.g. real estate, investments or savings) can ensure their financial stability even after retirement. Another reason is that seniors often have a lower cost of living compared to younger generations, as they no longer have children to support or educate, and often have lower housing costs (for example, if they own a house or apartment). This factor may also contribute to their lower risk of poverty. The crude migration balance had a negative impact on the poverty risk rate. With a positive migration balance in an area, people have a lower risk of being among those with an equivalent disposable income below the poverty risk threshold, which is 60% of the national median equivalent disposable income. Both the crude death rate and the crude live birth rate had a positive effect on the endogenous variable. When the mortality/live birth rate is higher, the poverty risk of the area also increases. High fertility rates are associated with underdeveloped areas, so there is an expectation that we can also expect to see an increased risk of poverty in these areas. The proportion of the population that is economically active has a negative impact on the poverty risk rate. There is also a parameter popul1 in the model that negatively affects the endogenous variable, but this parameter is not significant due to statistical non-significance.

4 DISCUSSION

Based on the results of the analyses, we assess that GDP per capita is positively affected by population, the share of seniors, the crude migration balance and the crude mortality rate, which is in line with the results of other authors. According to Rayevnyeva et al. (2023), migration has a positive effect on GDP per capita, which means that the inflow of migrants leads to an increase in the economic output of a country. In their study, they proved that migration and GDP per capita have a correlation.

Mihajlović and Miladinov (2024) published a study that aimed to examine the impact of one of the most significant contemporary changes in demographic structure, population aging, on the economic performance of eight emerging economies in Central and Eastern Europe. Using Pooled Mean Group estimation in the ARDL panel model, the study finds that a one percent increase in the senior dependency ratio leads to a 0.52 percent decline in the GDP per capita growth rate. Their findings highlight the importance of implementing active aging programs, building fiscal buffers, promoting lifelong learning and encouraging employment among vulnerable groups to mitigate the adverse effects of population aging on economic growth in emerging economies.

In the analysis, we found that the GINI coefficient was negatively affected by the indicators of population, proportion of senior citizens, crude migration balance or crude live birth rate. Some results of various studies that have examined the relationship between the proportion of seniors in the population and income inequality suggest a positive relationship between the indicators, and thus the larger the proportion of seniors people, the more unequally income is distributed (Wang, Guanghua, Luo and Zhang, 2017). Another study by Gustafsson and Johansson 1999 found that the effect of the proportion of seniors in the population on the GINI coefficient was not significant, or that the proportion of seniors had no significant effect on income inequality. The theory has been confirmed using data from 16 OECD countries. However, there is also some support for the theory that population aging, as expressed by the proportion of seniors in the population, can reduce income inequality (Chu and Jiang, 1997). The proportion of seniors, the crude migration rate, and the proportion of the population that is economically active, all have a negative impact on the poverty risk ratio. The crude death rate and the crude live birth rate show a positive effect. Regarding the impact of the crude mortality rate, according to several studies, there is also a poverty-influenced mortality relationship (Liu et al., 2024). In their work focusing on 12 south-eastern states in the US, they concluded that household income was significantly related to mortality.

During the period of study, they also found that the life expectancy of people in the lowest income group was more than 10 years shorter than those in the highest income group. Interestingly, poor participants of pale skin experienced higher overall mortality than poor participants of dark skin.

In the context of the findings presented in the paper, i.e. that population aging, but also migration flows and other demographic factors, significantly affect GDP per capita, income inequality and the risk of poverty, some measures can be considered, such as active aging policies and the active involvement of older people in the economy and society through the development of lifelong learning programs focusing on digital and soft skills and intergenerational programs aimed at sharing experiences. Other appropriate measures would be to reduce income inequalities in the context of demographic change, e.g. tax reforms that could take into account the age structure of households, regional policies to mitigate economic disparities between areas with different demographic structures, support for families with children in the context of the positive impact of fertility rates on poverty, increasing access to quality healthcare for disadvantaged groups and investment in public health and prevention, especially in low-income regions.

CONCLUSION

The literature shows that the relationship between economic indicators and population aging is complex and interrelated. Population aging can have a negative impact on labour productivity, GDP growth and public spending. In the case of the Slovak Republic, there are large regional disparities that may affect the way these economic factors manifest themselves. Based on existing research, it appears that a comprehensive policy response by policy makers and other professionals will be needed to mitigate the negative impacts of aging, including labour market, social policy and health care reforms.

The results of the analysis in the regions of the Slovak Republic point to a number of important contexts that can serve as a basis for the development of targeted regional policy. On the basis of the findings, a number of recommendations can be formulated that take into account the specificities of individual regions according to their level of development, demographic structure and economic performance. The finding that an increasing share of seniors in the population has a positive impact on GDP per capita points to the potential of active aging. This trend may be particularly beneficial for the more developed regions of western and central Slovakia, where the share of the seniors population is higher. It is appropriate to promote the employment of older people through flexible forms of work, improving qualifications and creating conditions for their active participation in the labour market. The positive impact of the migration balance on GDP and its negative impact on the poverty risk rate point to the importance of population stabilization and support for migration to less developed regions, especially in eastern Slovakia. For the PO, KE and BB regions it is necessary to increase attractiveness for young people and families through affordable housing, quality services and job opportunities. An important part of the strategy should also be to support return migration from abroad and to reduce barriers to entrepreneurship for returnees. It is essential to strengthen policies aimed at activating the labour market, especially in regions with high unemployment rates, to promote retraining. In the longer term, a regionally specific approach to development is needed, taking into account local needs and potential. While the BA region can continue to support innovation and highly productive sectors, the regions of central and eastern Slovakia should emphasize the diversification of the economy, infrastructure development, support for small and medium-sized enterprises and the use of natural and cultural capital, for example in tourism or the green economy.

Demographic change – and in particular the aging of the population – should not only be seen as a challenge, but also as an opportunity for economic growth and social stability. The key is to actively integrate them into strategic planning and public policy-making to ensure sustainable and inclusive development across all regions of the Slovak Republic.

The paper summarizes existing research and highlights key aspects of the relationship between economic indicators and population aging that are relevant to the Slovak Republic. The conclusions provide important insights into how population aging affects the economy, while also showing that the situation in different regions of the country can cause variations in these impacts.

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