STRUCTURAL DEMOGRAPHIC CHANGES AS A DETERMINANT OF LABOR FORCE DYNAMICS IN THE FEDERATION OF BOSNIA AND HERZEGOVINA

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Abstract

Relevant demographic indicators and available projections suggest a continued deterioration in the age structure of the population, accompanied by persistent depopulation trends in Bosnia and Herzegovina. These changes have multiple implications for labor force dynamics, as well as for the overall economic and demographic development of the country. They lead to a reduction in the potential labor force, a worsening ratio between the active and dependent segments of the population, and as such, increase pressure on the pension, healthcare and education systems. In light of the above, the primary objective of the research is to determine the relationship between demographic structures and labor force dynamics in the Federation of Bosnia and Herzegovina. The empirical part of the study is based on official documents and statistical data published by the Institute for Statistics of the Federation of Bosnia and Herzegovina and the Federal Institute for Development Programming. The research covers ten cantons and the time period from 2013 to 2024. Using panel regression analysis, the study establishes a significant link between demographic structures and the economic activity of the population in the Federation of Bosnia and Herzegovina.

Keywords: demographic statistics, demographic structures, labor force, quantitative analysis, Federation of Bosnia and Herzegovina

JEL: J10, J21

1. Introduction

For both the present and future economic and demographic development of a given area, changes related to the total population size are of great importance as well as various structural characteristics of the population. The very term structure or composition of the population refers to different characteristics of units that make up the total population, which means that each individual attribute of a person influences the population structure according to a given characteristic (such as sex, age, marital status, occupation, *etc*.). The main goal of studying demographic structures is to understand the complexity of demographic development, in which demographic processes are causally linked with population structures.

In the context of the Federation of Bosnia and Herzegovina, where regional differences are highly pronounced, the analysis of age and sex structures by canton is of great importance for shaping effective economic and demographic policies.

When it comes to the sex structure of the population, it represents a significant factor in determining the overall size of the labor force and the economically active population. To a considerable extent, it also determines the level of burden placed on the economically active segment of the population by dependents. Spatial movement of the population, *i.e.,* migration, significantly affects the gender structure. Traditionally, due to economic opportunities and employment, migration has been more closely associated with the male population. However, contemporary migration trends increasingly point to a process of the feminization of migration, with a growing participation of women in both international and internal migration. These processes can lead to changes in the ratio between male and female population in both the areas of origin and the areas of destination.

On the other hand, the age structure of the population represents the demographic framework from which the necessary labor potential is recruited. Changes in this structure have a direct impact on the size of the working-

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age population, labor productivity, the strain on pension and healthcare systems, as well as the needs of the education sector (Di Matteo & Di Matteo, 1998). Regarding the changes in the age structure of the Federation of Bosnia and Herzegovina over the past decade, two parallel trends can be observed: an increase in the share of the population aged 65 and over (from 12.9% in 2013 to 18.5% in 2024) and a decrease in the share of the population under the age of 15 (from 16.1% in 2013 to 13.2% in 2024). In the context of labor force dynamics, it is important to note that during the same period there was also a decline in the share of the working-age population (from 70,1% in 2013 to 68,2% in 2024).

Although a considerable number of studies have examined individual aspects of demographic development, this paper seeks, for the first time, to establish the interrelationship between key demographic structures (age and sex) and changes in labor force dynamics, using panel data. In this regard, the primary objective of the research is to investigate the correlation between demographic structures and labor force dynamics.

The study covers the territory of the Federation of Bosnia and Herzegovina through its constituent cantons: Una-Sana, Posavina, Tuzla, Zenica-Doboj, Bosnian-Podrinje, Central Bosnia, Herzegovina-Neretva, West Herzegovina, Sarajevo Canton and Canton 10. The temporal scope of the research spans the period from 2013 to 2024.

The main research method applied was desk research, conducted through the analysis of available scientific papers and strategic documents. For the initial analysis of the collected data, descriptive statistics was employed, using official statistical data compiled and published by the Federal Institute for Statistics of the Federation of Bosnia and Herzegovina and the Federal Institute for Development Programming. To examine the relationship between demographic trends and labor force dynamics, a multiple panel regression analysis was applied.

2. Theoretical Framework and Literature Review

2.1 Theoretical Framework

The population, as the subject of demographic study, is composed of individuals and their personal characteristics such as sex, age, education, marital status, occupation, and others. In this regard, demography examines numerous population structures, including sex, age, educational, and economic structures. The study of these structures involves identifying changes in their characteristics, which are examined on the basis of population censuses. By analyzing multiple successive censuses, it is possible to identify changes within them, which provides the foundation for predicting future developments. In conducting such analyses, it is essential to ensure that the definitions of individual population characteristics are comparable across all censuses. The fundamental and most important demographic structures that serve as the starting point for any population analysis are the age and sex structures.

The age structure of the population is among the most important demographic structures. It represents the demographic framework from which the necessary labor potential is recruited, and changes in this structure have a direct impact on development policies in various areas of socio-economic and urban life. The number and capacity of preschools required in a given area, the extent of educational facilities, the number of new jobs in economic and non-economic sectors, as well as the scope and type of expenditures for healthcare, social protection, and other services, all of these are directly dependent on the age structure of the population. The main factors influencing the formation of this structure are: (1) fertility, (2) mortality, (3) migration, and (4) irregular factors.

The sex structure of the population reflects the numerical ratio of male and female populations within the total population. Together with the age structure, it belongs to the group of biological population structures. In general, it represents a highly significant factor in determining the size of the labor force and the economically active population. To a large

extent, the level of burden placed on the economically active segment of the population by dependents depends on this structure. The numerical ratio of male to female population tends to move toward a balanced state over a long period, while it is necessary to take into account that natural sex ratio at birth is slightly biased in favor of boys (about 5% more male infants are born than female), which represents a biological constant. However, greater or lesser deviations from this natural balance may occur, depending on the influence of: (1) the sex ratio at birth, (2) the sex ratio of deaths, (3) migration flows, and (4) external factors such as war, epidemics, and others (Radivojević, 2018).

The most important dynamic component of a country's economic development is the labor force, which serves as the primary driver of the production process. It is often equated with the economically active population, consisting of both employed and unemployed individuals, as well as all persons who are capable of and willing to perform work tasks. In terms of labor market participation, each individual may hold one of three statuses: employed, unemployed, or inactive. According to the definition of the International Labor Organization, an employed person is the one who works for an employer, is self-employed, or participates in a family business without direct compensation. On the other hand, an unemployed person is defined as someone without employment, who is capable of working, actively seeking a job, and ready to accept one under the prevailing labor market conditions (Arandarenko, 2017). In line with the above, the three basic indicators used in labor force analysis are: the activity rate, the employment rate, and the unemployment rate.

The activity rate (a) represents the percentage share of the active population within the total adult population or the working-age population, and it is calculated using the following formula:

$$a = \frac{A}{N} x100 = \frac{E+U}{N} x100$$

Where A represents the total number of active population or the labor force, E represents the number of employed persons, U is the number of unemployed persons, and N is the total population.

The employment rate (e) represents the percentage share of the employed population within the total population.

$$e = \frac{E}{N} x100$$

The unemployment rate (u) represents the percentage share of the unemployed within the active population, *i.e.*, the labor force.

$$u = \frac{U}{A} x100 = \frac{U}{E+U} x100$$

The unemployment rate is very often misinterpreted, as it is commonly assumed that the total number of unemployed persons is compared with the total population, as in the case of the employment rate, rather than with the active population.

In analyzing the labor force, it is necessary to consider both its quantity and quality. The quantity of the labor force is primarily determined by demographic factors, that is, by the size and movement of the population aged 15–65, while the quality of the labor force, or human capital, refers to knowledge, skills, competence, and other attributes relevant to economic activities (Baćović, 2006).

2.1 Literature Review

Due to numerous demographic challenges faced by the entire planet, research on demographic changes is highly relevant. In the following section, the results of some of the most significant studies will be presented.

Demographers Emirhafizović and Zolić (2017) outline the main characteristics of the contemporary demographic profile of Bosnia and Herzegovina, which are primarily: (1) declining birth rates, (2) rapid population aging, (3) emigration of the population in optimal working and reproductive age, and (4) an increase in the mortality rate. The authors emphasize that population aging represents one of the greatest challenges for the society of Bosnia and Herzegovina.

In this regard, two trends are evident in the age structure of the population of Bosnia and Herzegovina: an increase in the share of those aged 65 and over, and a decrease in the share of the young population (0–15 years). Analyzing the 1991 population census data, the authors conclude that at the beginning of the 1990s, the population of Bosnia and Herzegovina was on the threshold of demographic aging. The war accelerated depopulation, so that by 2013 the number of young people was twice as small compared to 1991, while the share of persons aged 65 and older had more than doubled.

The demographic dynamics and its characteristics in Bosnia and Herzegovina were also researched by Dugandžić (2017). Regarding demographic development, the author emphasizes that changes in the number, structure, and distribution of the population of Bosnia and Herzegovina are of great importance for the country's economic development, particularly in the sphere of employment and job creation. The demographic development of Bosnia and Herzegovina is characterized by processes of total and natural depopulation, demographic aging, and spatial polarization of settlement as a regional expression of the country's damaged demographic picture. The author highlights the decline in the child population as a particularly worrying piece of data, which directly reflects on the demographic future of the country. Thus, the total fertility rate in Bosnia and Herzegovina was approximately 1.30 and is one of the lowest among the surrounding countries.

The aging of the population has an extremely negative impact on the demographic and economic development of Croatia, according to the conclusion reached by Mečev and Vudrag (2012) in their research. From a demographic standpoint, the process of population aging negatively affects the population structure, while in an economic sense, population aging influences the increase and decrease in the number of the working-age population and the activity rate of the total population.

Depopulation and significant changes in the age structure of the population, which lead to a reduction in the labor force, represent a major challenge for the labor market in Poland. In recent years, Poland has recorded a labor demand that exceeds its supply of labor. This labor shortage was partially compensated by workers who arrived in Poland after the Russian invasion on Ukraine, when Poland accepted hundreds of thousands of refugees. In this way, the situation on the Polish labor market was significantly improved (Sobolewska-Poniedzialek, 2024).

Chawla, Kawiorska, and Chelleraj (1998), using multivariate analysis of healthcare expenditures on data for Poland from 1960 to 1995, concluded that there is a weak positive correlation between the population aged 65 and over and increased healthcare spending. Conversely, Di Matteo and Di Matteo (1998), using regression analysis, found that the growth in the percentage of the elderly population increases the annual real per capita healthcare expenditures by an average of 1.3%.

Akrap, Strmota and Krešimir (2018) researched the specific economic activity rates of the population aged 55 to 64 in Croatia, which represents the demographic reserve of the labor force. The results indicate a significant difference between the European Union (EU) average and Croatia in the observed group. Namely, Croatia has a significantly lower rate of economic activity, both compared to newer and older EU members. This low economic activity in the 55-64 age group has a negative impact on economic well-being at both micro and macro levels. The authors point out that the economic activity of the population aged between 55 and 64 grew in all EU countries by an average of 13.6% in the period from 2007 to 2017. According to this indicator, Croatia outperformed only Romania. When it comes to economic activity by gender, it is lower for women than for men in the observed age group. This holds true for all analyzed EU countries, except Finland and Estonia. The largest gender disparities in economic activity were in Malta (39%), Greece (25%), Cyprus and Italy (23%), and Romania (22%).

In comparison to middle-aged workers (35-54), younger workers (16-34) more often transition from employment status to unemployment status and vice versa. This is the result of research conducted by Flek, Hála

and Mysíková (2018) in selected EU countries (Austria, France, Poland, and Spain) during the financial crisis (2008-2012). In this context, socioeconomic factors leading to such movements were analyzed. The authors conclude that policy formulation should focus on reducing the differences in unemployment risk between young and middle-aged workers. This is important both for improving the position of marginalized young people in the labor market and for achieving a more balanced unemployment rate between young and middle-aged workers. An interesting finding is the trend observed in all analyzed countries where young people's chances of employment decrease as the duration of unemployment increases. After 10 months of unemployment, young people's chances of finding a job significantly diminish.

Analyzing the movement of the total population of Croatia, authors Obadić and Smolić (2007) determined an intensified rate of population decline in Croatia. The share of the 0-15 age group decreased by 40% between 1953 and 2001, while the share of the 65+ age group more than doubled in the same period. Demographic trends within the EU and the deterioration of the population's age structure indicate a long-term decrease in the working contingent and labor force. Research results confirm population aging in all observed EU countries. In comparison with other members, Croatia, following Poland and Bulgaria, had the lowest employment rate (for both women and men).

Changes in the demographic structure of the labor force were also the subject of research at the EU level. Specifically, Dvořáková (2013) highlights that these changes are caused primarily by the decline in the birth rate, population aging, and increased immigration flows. The results indicate an inevitable decrease in the share of the working-age population and an increase in the number of people over 60 by approximately two million annually. The ultimate effect of these negative trends is a burden on public finances, which necessitates the need to adjust economic policy to new conditions to preserve global competitiveness.

3. Methodology

The statistical analysis in this paper is based on secondary data, collected from official statistical sources, primarily the data from the Institute for Statistics of the Federation of Bosnia and Herzegovina and the Federal Institute for Development Programming. Data on the age and sex structure were taken from the regular statistical publication entitled “Federation of Bosnia and Herzegovina in figures” published by the Federal Office of Statistics, while data on the economic activity of the population were sourced from the publication entitled "Macroeconomic Indicators by Cantons of the Federation of Bosnia and Herzegovina" issued by the Federal Office for Development Planning. Data for ten cantons of the Federation of Bosnia and Herzegovina over the time period from 2013 to 2024 were observed.

Standard methods of statistical and demographic analysis used in the study of demographic trends were employed in this paper. Descriptive analysis was used for the graphical and tabular presentation of the calculated mean values. Given that a larger number of periods and multiple observation units were covered to determine the correlation between demographic structures and labor force dynamics, panel data analysis was also used in the paper. With this type of data, we observe the same cross-sectional unit over time, meaning they encompass both a spatial and a temporal component.

Correlation analysis was used to determine the relationship between demographic structures and labor force dynamics, within the framework of testing the assumptions for applying the panel regression model that relates to multicollinearity.

The influence of demographic structures on population activity was verified using panel regression analysis, by applying fixed and stochastic effects models and testing their assumptions. After formulating the model and identifying the dependent and independent variables, the basic assumptions for using the regression model were checked. These assumptions relate to heteroscedasticity, multicollinearity, autocorrelation, and stationarity.

The tests for heteroscedasticity and multicollinearity were performed based on the pooled OLS model, using the White test to check for heteroscedasticity, and the VIF indicator and Pearson correlation coefficients to check for multicollinearity.

The statistical processing and analysis of the collected data were carried out using Microsoft Excel, and the statistical data processing software STATA, which allows for work with panel data.

4. Results and Discussions

Starting from the stated research objective, which relates to examining the connection between demographic structures and labor force dynamics in the Federation of Bosnia and Herzegovina, the results of the conducted empirical analysis are presented below.

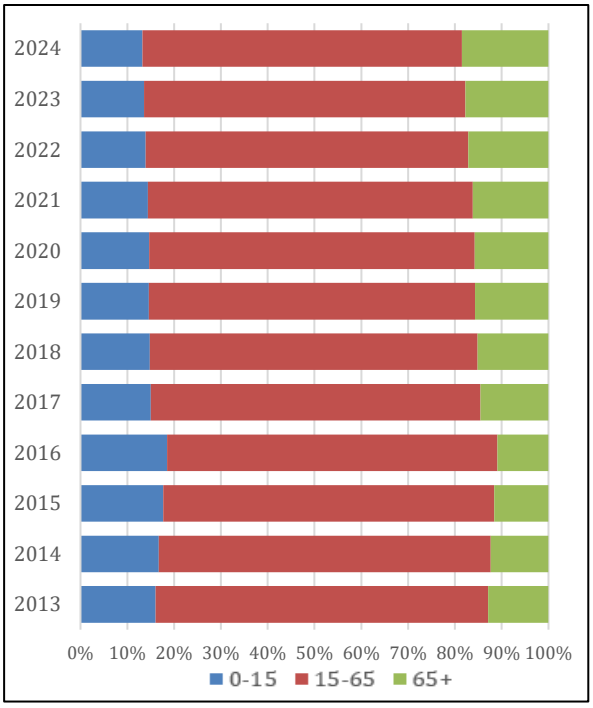

Figure 1. The changes in the age structure of the population of the Federation of Bosnia and Herzegovina in the period from 2013 to 2024

Source: Authors' own visualization based on data from the Institute for statistics of the Federation of Bosnia and Herzegovina (2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025).

Regarding the age structure of the population, the results of the conducted research indicate that significant demographic changes occurred in the period from 2013 to 2024 (Figure 1). This primarily relates to demographic aging and a decrease in the share of the young population. In connection with the above, a drop in the share of the young population was recorded in the period from 2016 to 2024, specifically from 18.5% in 2016 to 13.2% in 2024. This may indicate a reduced birth rate and a long-term decrease in the potential labor force. The share of the working-age population also gradually decreased, from 71.0% in 2013 to 68.2% in 2024. Although it is a relatively mild decline, it is consistent over the observed period and reflects a reduction in the share of the population aged 15 to 65. The most pronounced change was recorded among the population older than 65, where the share increased from 12.9% in 2013 to 18.5% in 2024. The previously mentioned trends clearly indicate the process of demographic aging in the Federation of Bosnia and Herzegovina.

Figure 2. Trends in the number of male and female population in the Federation of Bosnia and Herzegovina in the period from 2013 to 2024

Source: Authors' own visualization based on data from the Institute for statistics of the Federation of Bosnia and Herzegovina (2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025).

In the 2013-2024 period, there was a decrease in the total number of inhabitants in the Federation of Bosnia and Herzegovina (from 2,219,131 in 2013 to 2,144,748 in 2024), with similar trends noticeable for both male and female segments of the population. The number of male inhabitants decreased from 1,087,882 in 2013 to 1,052,946 in 2024, which represents an absolute reduction of 34,936 or a percentage decrease of 3.21%. In the same period, the total number of the female population decreased by 39,447 or 3.49% (from 1,131,249 in 2013 to 1,091,802 in 2024). Despite the fact that the number of inhabitants constantly decreased during the observed period, the sex structure remained stable (men account for approximately 49% and women for 51% of the total population) (Figure 2).

Regarding labor force dynamics, changes in the employment rate, unemployment rate, and activity rate were analyzed (Figure 3).

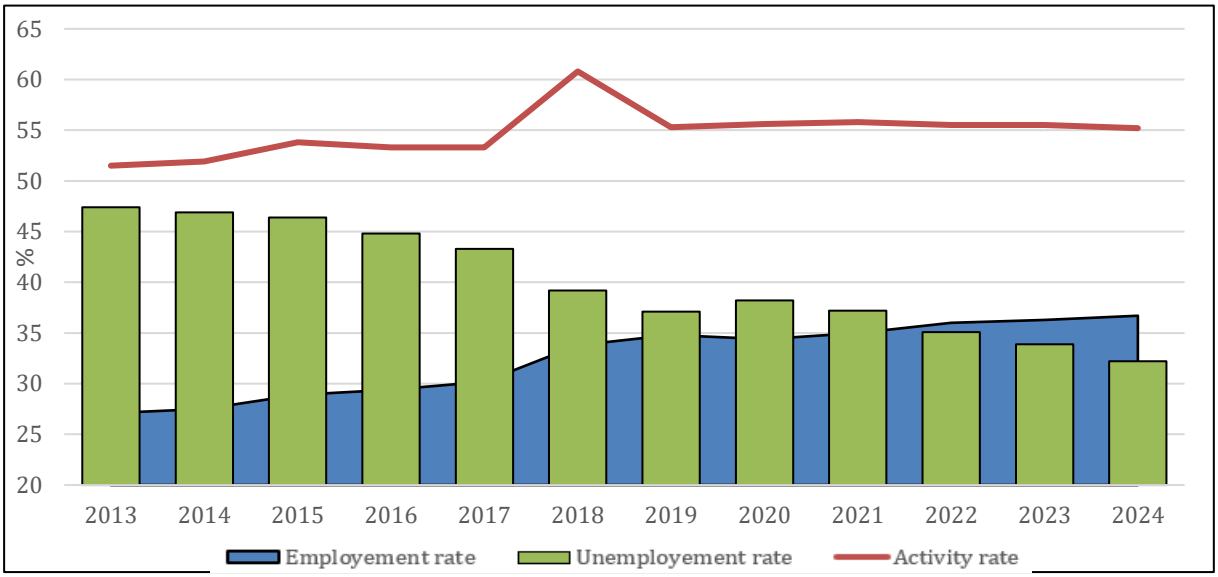

Figure 3. Dynamics of the employment, unemployment, and activity rates in the Federation of Bosnia and Herzegovina in the period from 2013 to 2024

Source: Authors' own visualization based on data from the Federal Institute for Development Programming (2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025)

The results of the empirical research showed that the employment rate had a slightly increasing trend during the observed period (an increase from 27.1% in 2013 to 36.7% in 2024). On the other hand, the unemployment rate was enormously high in 2013 (47.4%), but it recorded a constant decline over the following years. By 2024, it decreased to 32.2%, which still represents a high level but is significantly lower compared to the beginning of the observed period.

After analyzing the key indicators of labor force dynamics at the level of the Federation of BiH, their structure by cantons is considered below. Table 1 shows the average values of the key indicators of labor force dynamics for the observed period, as well as the corresponding ranks.

Based on the calculated average values presented in the previous table, the following conclusions can be drawn:

- The highest employment rate in the period from 2013 to 2024 was recorded in Sarajevo Canton (46.2%) and Bosnian-Podrinje Canton (42.8%), while the lowest was in Canton 10 (18.9%) and Una-Sana Canton (18.5%);
- The lowest unemployment rate was also recorded in Sarajevo Canton (30.7%) and Bosnian-Podrinje Canton (32.5%), with the highest in Una-Sana Canton (53.2%);
- In terms of the average activity rate, Sarajevo Canton (71.9%) and Bosnian-Podrinje Canton (63.1%) were ranked highest, while Una-Sana Canton (34.9%) and Canton 10 (32.7%) were ranked lowest.

Table 1. Ranking of cantons in the Federation of Bosnia and Herzegovina according to key indicators of the labor force dynamics

Canton	Employment rate		Unemployment rate		Activity rate	
	%*	Rank	%*	Rank	%*	Rank
Una-Sana Canton	18.5	10	53.2	10	34.9	9
Posavina Canton	21.3	8	42.4	6	37.1	8
Tuzla Canton	29.7	6	46.5	9	50.2	5
Zenica-Doboj Canton	30.8	5	43.2	8	54.3	4
Bosnian-Podrinje Canton	42.8	2	32.5	2	63.1	2
Central Bosnia Canton	26.6	7	43.2	7	47.1	7
Herzegovina-Neretva Canton	35.2	3	37.1	4	56.0	3
West Herzegovina Canton	30.9	4	36.3	3	48.5	6
Sarajevo Canton	46.2	1	30.7	1	71.9	1
Canton 10	18.9	9	42.3	5	32.7	10
Federation of Bosnia and Herzegovina	32.5		40.1		54.8	

*/ Average values were calculated for the period from 2013 to 2024.
Source: Authors' own calculation based on data from the Federal Institute for Development Programming (2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025)

A comparative analysis of the age structure of the population by cantons of the Federation of Bosnia and Herzegovina, for 2013 and 2024, makes it possible to recognize the basic demographic trends and differences between the cantons (Table 2).

Table 2. Age structure of the population by cantons: comparative overview for 2013 and 2024

Canton	0-15		15-65		65+	
	2013.	2024.	2013.	2024.	2013.	2024.
Una-Sana Canton	17.4	11.4	71.8	72.2	10.9	16.3
Posavina Canton	13.8	7.6	71.0	72.4	15.2	20.0
Tuzla Canton	15.7	13.2	72.2	68.1	12.1	18.7
Zenica-Doboj Canton	16.6	14.5	71.9	68.2	11.5	17.3
Bosnian-Podrinje Canton	13.6	14.2	69.9	63.5	16.5	22.2
Central Bosnia Canton	17.0	12.6	71.6	70.1	11.4	17.3
Herzegovina-Neretva Canton	15.2	12.4	69.2	66.8	15.6	20.8
West Herzegovina Canton	17.6	13.3	67.0	67.8	15.5	18.9
Sarajevo Canton	15.0	15.4	70.8	65.7	14.2	18.9
Canton 10	14.0	8.7	68.2	67.4	17.9	23.9
Federation of Bosnia and Herzegovina	16.1	13.2	71.0	68.2	12.9	18.5

Source: Authors' own calculation based on data from Institute for statistics of the Federation of Bosnia and Herzegovina (2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025)

The results show that the share of the population under 15 decreased in almost all cantons. This is particularly pronounced in Posavina Canton (from 13.8% in 2013 to 7.6% in 2024) and Canton 10 (from 14.0% to 8.7%). On the other hand, an increase in the share of the young population occurred in only two cantons: Sarajevo Canton (from 15.0% to 15.4%) and Bosnian-Podrinje Canton (from 13.6% to 14.2%).

Regarding the population aged between 15 and 65, a decrease in its share was recorded in most cantons, which is consistent with the federal trend (from 71.0% to 68.2%). The largest drops were recorded in Bosnian-Podrinje

Canton (from 69.9% to 63.5%) and Sarajevo Canton (from 70.8% to 65.7%), while a slight increase was recorded in Posavina Canton (from 71.0% to 72.4%), West Herzegovina Canton (from 67.0% to 67.8%), and Una-Sana Canton (from 71.8% to 72.2%). The most significant changes occurred in the category of the population older than 65, whose share increased in all cantons. The largest relative growth was recorded in Tuzla Canton (from 12.1% to 18.7%), Central Bosnia Canton (from 11.4% to 17.3%), and Zenica-Doboj Canton (from 11.5% to 17.3%). These data confirm the process of demographic aging, which is evident throughout the entire Federation of Bosnia and Herzegovina, but with varying intensity among the cantons.

To determine the eventual correlation between demographic structures and labor force dynamics, panel regression analysis was used. The analysis included variables related to the age and sex structure of the population. Within the age structure, the population under 15, the population aged between 15 and 65, and the population older than 65 were observed. Within the sex structure, the female and male population were analyzed. To avoid the potential problem of multicollinearity, the variable "male population" was excluded from the analysis, given that it is entirely determined by the variable "female population." For the same reason, one of the three variables related to the age structure of the population also had to be omitted. Bearing in mind that the younger population does not directly participate in the labor market but represents the potential labor force, the variable "population under 15" was excluded from the analysis.

The indicators used to measure these variables were: the activity rate, the share of the population aged between 15 and 65, the share of the population older than 65, and the share of the female population.

Taking the above into account, the following panel regression model was formulated:

$$y_{it} = \alpha + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \beta_3 x_{3,it} + u_{it}$$

where: y – population activity rate, x_1 – share of the population aged between 15 and 65, x_2 – share of the population older than 65, x_3 – share of the female population.

Before testing the hypothesis regarding the relationship between demographic structures and labor force dynamics, a descriptive statistical analysis was conducted, which is of great importance for understanding the variables that would be included in the model. The main goal of this analysis was to identify certain patterns among the variables, detect extreme values (outliers), and uncover any potential errors in the data. The verification was performed using a Box–Plot (B–P) diagram, and the results indicated that the dataset contains no outliers that could affect further analysis. Table 3 presents basic information about the variables included in the model.

Table 3: Descriptive Statistics of Variables Included in the Panel Regression Model

Variable		Mean	Std. dev.	Min	Max
Activity rate (in %)	overall	49.86	12.3214	26.90	76.60
	between		12.1678	32.66	71.93
	within		4.1768	31.74	56.74
Population aged 15-65 (%)	overall	69.55	2.0708	63.53	72.74
	between		1.7849	67.24	72.05
	within		1.1820	65.84	72.23
Population aged 65+ (%)	overall	15.90	3.2074	9.06	23.86
	between		2.2482	12.73	19.86
	within		2.3875	10.99	19.90
Female population (%)	overall	50.54	0.9083	49.29	52.83
	between		0.9480	49.42	52.79
	within		0.0975	50.22	51.05

Source: Authors' own calculation

According to the presented data, the average activity rate in the cantons of the Federation of Bosnia and Herzegovina during the period from 2013 to 2024 was 49.86%, with relatively high overall variability (σ = 12.3214). The range of variation (from 26.9% to 76.60%) indicates pronounced differences among the cantons. The share of the population aged 15 to 65 ranged from 63.53% to 72.74%, with relatively low absolute variability (σ = 2.0708). Slightly higher variability was recorded in the share of the population over 65 years of age, where the standard deviation value was 3.2074, while the share of the female population showed the lowest absolute variation (σ = 0.9083). Overall, the descriptive indicators suggest that the greatest differences are expressed in the activity rate and the share of the elderly population.

The influence of independent variables on the dependent variable was assessed using fixed effects and random effects models. Before testing these models, the basic assumptions for using a panel regression model were verified.

The results of the balance check of the analyzed dataset showed that the dataset is strictly balanced, meaning that for each year there is a complete time series, *i.e.*, no missing data. The multicollinearity check in the model refers to the procedure of determining whether the independent variables are significantly correlated. To assess multicollinearity in the model, correlation coefficients shown in Table 4 and the VIF indicator were used.

Table 4: Correlation Matrix

	Active population	Population aged 15-65	Population aged 65+	Female population
Active population	1			
Population aged 15-65	-0.5223*	1		
Population aged 65+	0.0495	-0.6210*	1	
Female population	0.7189*	-0.1849*	-0.1538	1

Source: Authors' own calculation

Based on the results of the correlation analysis, it can be concluded that the highest degree of correlation existed between economic activity and the share of the female population (r=0.72, p=0.00). This means that a larger share of women in the total population was accompanied by a higher level of economic activity. A statistically significant correlation was also found between economic activity and the population aged between 15 and 65 (r=−0.52, p=0.00), and between the population aged between 15 and 65 and the population older than 65 (r=−0.62, p=0.00). Calculating the values of the VIF coefficient confirmed the absence of multicollinearity in the model (all calculated coefficients are less than 10, specifically 1.87, 1.85, and 1.18, respectively).

The White test was applied to check for heteroscedasticity of errors in the regression model, yielding the following results: χ^2 =6.95 with p=0.6419. This means that heteroscedasticity was not present in the model. The results of the Wooldridge test indicate the presence of first-order autocorrelation (F=829.7, p=0.0), which is why the model was estimated with robust standard errors.

After testing for multicollinearity, heteroscedasticity, and autocorrelation, the stationarity of the variables was also checked using the: LLC, IPS, Breitung, and Fisher tests (ADF and PP). The calculated p-values for these tests are shown below:: LLC (activity rate =0,00, share of population aged 15-65=0,86, share of population over 65=0,60, share of female population =0,01), IPS (p=0,04; 1,0; 1,0 and 0,52, respectively), Breitung (p=0,52; 1,00; 0,95 and 0,97, respectively), Fisher ADF (p=0,12; 0,98; 0,99 and 0,50, respectively), and PP test (p=0,12; 0,98; 0,99 i 0,50, respectively). Taking the aforementioned results into account, it can be concluded that the observed variables were not stationary at the level, so stationarity of the first differenced series was checked. The results confirmed stationarity in the first differenced series (p<0.05), which was

a prerequisite for applying the Pedroni test to determine the cointegration of the variables. Based on the calculated values of the Modified Phillips-Perron (t=2.46, p=0.00), Phillips-Perron (t=−4.67, p=0.00), and Augmented Dickey-Fuller statistics (t=−7.73, p=0.00), it was concluded that cointegration existed among the analyzed variables. After checking the basic assumptions for applying panel regression analysis, the fixed effects model was tested, with the results shown in Table 5.

Table 5: Fixed Effects Model

Activity rate	Coefficient	Std. err.	t	p	95% conf. interval	
Population aged 15-65	-1.8110	0.4104	-4.41	0.000	-2.6246	-0.9975
Population aged 65+	-0.5240	0.2074	-2.53	0.013	-0.9351	-0.1129
Female population	-16.1687	4.6361	-3.49	0.001	-25.3594	-6.9783
Constant	1001.0570	230.1594	4.35	0.000	544.7932	1457.3210
R-squared		0.3831				
F test		15.52				
p>F		0.000				

Source: Authors' own calculation

The testing results of this model indicate a statistically significant influence of demographic structures on the economic activity of the population in the Federation of Bosnia and Herzegovina. The value of the coefficient of determination (r^2=0,3831) shows that the model explains 38.31% of the variations in the population activity rate.

If the individual influence of the independent variables is observed, the calculated p-values indicate that all variables are statistically significant (p<0.01). Taking the coefficient values into account, the following conclusions can be drawn:

- the share of the population aged 15 to 65 has a negative and highly significant influence on the activity rate (β=−1.811, p=0.00). This means that a one percentage point increase in the share of this age category leads to a decrease in the activity rate by 1.8 percentage points, ceteris paribus;
- the share of the population older than 65 also has a negative and significant influence on the activity rate (β=−0.524, p=0.01);
- the share of women in the total population has a strong negative influence on the activity rate (β=−16.169, p=0.00).

Following the fixed effects model, the stochastic effects model was tested, with results presented in Table 6.

Table 6: Random Effects Model

Activity rate	Coefficient	Std. err.	t	p	95% conf. interval	
Population aged 15-65	-2.4049	0.4203	-5.72	0.000	-3.2288	-1.5811
Population aged 65+	-0.3017	0.2173	-1.39	0.165	-0.7276	0.12407
Female population	3.9046	2.3101	1.69	0.091	-0.6232	8.4324
Constant	24.3054	121.0302	0.20	0.841	-212.9093	261.5202
R-squared		0.6523				
Wald χ^2		39.02				
p>F		0.000				

Source: Authors' own calculation

The results of the panel regression analysis showed that the random effects model is statistically significant at the 1% level of significance (Wald χ^2 = 39.02, p = 0.000). The coefficient of determination is 0.6523, which means that the independent variables in the model explain 65.23% of the changes in the dependent variable.

When considering the individual impact of the independent variables, it can be concluded that only the variable "population aged 15 to 65" is statistically significant at the 1% level, while the variable "female population" is statistically significant at the 10% level. The variable "population over 65 years of age" is not statistically significant ($p = 0.165$).

To select the final panel regression model, the Hausman test was used, and the results showed that the fixed effects model is more appropriate for testing the relationship between demographic structures and the labor force ($\chi^2 = 20.88$ with a p-value of 0.001).

In order to verify the reliability and stability of the selected model, and due to previously identified autocorrelation, the model was re-estimated using Driscoll-Kraay standard errors. The results of this subsequent analysis showed that the variables "population aged 15 to 65" ($\beta = -1.5958$, $p = 0.012$) and "female population" ($\beta = -14.9075$, $p = 0.002$) remain statistically significant. On the other hand, the variable "population over 65 years of age" lost its statistical significance ($\beta = -0.3393$, $p = 0.231$).

Although this change suggests that the impact of the share of the elderly population in the total population on labor force activity is not sufficiently robust, this does not necessarily mean that it has no influence at all. The effect of this variable may be indirect (through other variables) or may depend on other population structures, spatial aspects, social policies, and similar factors, which should be determined through further research.

5. Conclusion

The impact of demographic structures on the labor force is a highly relevant topic due to increasingly pronounced global trends related to population aging, declining birth rates, and frequent migration movements. These demographic changes directly affect both the quantity and quality of the labor force. This paper presents the changes in the age and gender structure of the population of the Federation of Bosnia and Herzegovina during the period from 2013 to 2024 and their consequences for economic activity.

The analysis of the age structure of the population shows that, during the observed period, a trend of a decreasing share of the young and working-age population was recorded, while the share of the population older than 65 continuously increased. These trends clearly indicate the process of demographic aging in the Federation of Bosnia and Herzegovina.

A negative trend is also evident in the gender structure of the population of the Federation of Bosnia and Herzegovina. Namely, during the same period, a continuous decline was recorded in both the male and female segments of the population, with women being more numerous throughout the entire observed period. Based on the calculated average values of the key indicators of labor force dynamics, it was concluded that the Federation of Bosnia and Herzegovina is facing a low employment rate, high unemployment, and weak population activity.

Furthermore, significant differences among the cantons are evident. For example, Sarajevo Canton and Bosnian-Podrinje Canton are the best-ranked across all analyzed parameters and show significantly better results compared to the federal average. In contrast, certain cantons are lagging behind (Una-Sana Canton and Canton 10) in terms of employment, unemployment, and the economic activity of the population. The analysis of the age structure by cantons determined that, in the period from 2013 to 2024, a decrease in the share of the young population was recorded, along with a slight decline in the working-age population and a pronounced growth in the share of the older population. The results of the panel regression analysis confirmed a statistically significant influence of the aforementioned demographic structures on the population activity rate.

The limitation of this research relates to the use of only official data on registered employment, unemployment, and activity. Despite the fact that administrative sources provide reliable and continuous series, they do not fully cover all aspects of the labor market (informal employment). Therefore, a recommendation for future research would be to use data from the Labor Force Survey. Furthermore, the

analysis included a limited number of independent variables, and it would be desirable in future studies to include control variables that could further explain the variations in the population activity rate.

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