

RESEARCH ARTICLE

Gender gap in life expectancy at birth and the role of socioeconomic indicators in South and East Europe, 1991 – 2020: Evidence from a dynamic panel model

Goran Miladinov*

Independent Researcher, Macedonia

Abstract

The purpose of this paper is to explain the role of socioeconomic development, economic, employment, and demographic factors on gender gap in life expectancy at birth (LEAB) in 24 South and East European countries. Aggregated yearly time series mainly from the UN and World Bank database for the period 1991 – 2020 were used. The generalized method of moments/dynamic panel data (GMM/DPD) model, a dynamic panel model, was used to explore the role of socioeconomic development, economic, employment, and demographic factors on sex differences in LEAB. The study shows that in these countries, a narrowed gender gap in LEAB is associated with a higher percentage of urban population in total population. There was found a significant impact of GDP *per capita* with a 2-year lag and Gini index with a 2-year lag as well as to LEAB on the gender gap in LEAB. There was not found a significant relationship between employment and education variables on gender gap in LEAB. However, the findings are important for policy discussions in terms of population health, labor policy, etc. The results are supported by the number of studies which show the relationship between socioeconomic development, economic, and demographic indicators and employment issues with gender gap in LEAB.

Keywords: Gender gap; Life expectancy at birth; Generalized method of moments/dynamic panel data; South-East Europe; Panel data

***Corresponding author:**
Goran Miladinov
(miladinovg@aol.com)

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1. Introduction

For long time, it has been known that the spatial distribution of the population reflects the social and political contextual link with the place of residence and has been considered an important factor influencing a person's exposures to health-associated risks, gain access to health services, as well as with educational and economic set of circumstances over an individual's life course (Graetz & Elo, 2021). Bloom and Canning (2006) pointed out the biggest demographic upheaval in history from the 1950s to 1960s, an upheaval that is still ongoing. In a few developed societies, the sharp post-war rise in fertility was followed by an equally sharp decline. As a result of the shifts in fertility, age structures were transformed with the formation of a "baby boom" generation. Furthermore, the aging of this generation and continued declines in fertility and old-age mortality have led to a shift in the population age structure in developed societies

from the young to the old. Thus, the proportion of old-age population has been increasing rapidly and the process of population aging (Bloom & Canning, 2006). Meanwhile, the developing world experienced a population boom, as a result of improved nutrition and public medical infrastructure as well as health care (Bloom & Canning, 2006). In parallel, the levels of fertility and mortality in many developing countries have also witnessed substantive declines in the same period, and thus, population aging has been taking place in both developed and developing countries, although it was faster in the developed world (United Nations, 2022). However, it should be noticed that these demographic changes were followed as a result of the economic and social development. Accordingly, understanding of future demographic trends (e.g., changes in lifespan) is extremely important for the development of good policies.

Mortality risks across age range fell dramatically during the 20th century, leading to an unprecedented increase in life expectancy at birth (LEAB) (and life expectancies at all ages) for both males and females in most countries in the world (Wilmoth, 2005; Aburto & van Raalte, 2018). Efforts to explain the observed gender differences in mortality are not new and efforts to explain these differences are evident in the empirical and theoretical reports and reviews in various scientific disciplines as demography, anthropology, epidemiology, economics, and evolutionary biology as well as in actuarial studies and reports (Cullen *et al.*, 2015).

International publications and researchers nowadays regularly make use of LEAB in the analysis and the description of the level of mortality. To describe mortality, LEAB (e_0) is generally considered as the most used indicator (Horiuchi *et al.*, 2013; Luy *et al.*, 2020), and it is also an excellent indicator for comparing the mortality of two or more populations (e.g., Kouaouci *et al.*, 2005; SORS, 1997; WHO, 2014), because it is age standardized and is easy to interpret. Thus, LEAB is based on the fixed age-specific death rates, which is calculated by dividing the number of people who die in a given year and age group by the number of people on average living in that year and age group (Luy *et al.*, 2020). When investigating changes and differences in LEAB between two populations or more, it is helpful at times to estimate what mortality differences in a specific age group contribute to the total difference in LEAB (Preston *et al.*, 2001). Thus, one of the estimation methods is decomposing a difference in LEAB.

Using available datasets and UN estimates and models, Attané and Barbiéri (2009) pointed out that accurately measuring gender differences in mortality or longevity were difficult, although in most countries, they noted gender differences. Among the several causes of death, it

is difficult to understand whether gender differences act as a biological discriminant or determine different lifestyles and hence different exposure to risk of death. Höhn *et al.* (2018) demonstrated that females have a mortality advantage over all ages and all causes of death, and that beginning with the age of 50, there is an increasing number of diseases and disabilities among people, as well as the incidence of most unfavorable health conditions increases.

This paper aims to explore how development and employment factors affect the gender gap in LEAB (females' LEAB – males' LEAB) in South and East Europe. It is well known that on average, females live longer than males, and that the gender gap in LEAB varies across countries and changes over time. The objective of this research is to explore to what degree these distinctions and changes are explained by development and employment issues? Therefore, an important research question is whether the economic inequity between the sexes plays a role in differentiating gender-specific LEAB? There is no doubt that these matters are important for policy purposes, like the circumstances in the domain of health and labor issues.

Why these countries? These 24 countries under study are economically and culturally heterogeneous and, for this reason, one would expect to find differences in the influence of factors of economic development on the gender gap in LEAB, cross-sectionally. In addition, although many of the countries within our research come from the European Union and share common goals and values and function in a common economic environment, severe inequalities in LEAB exist (Pinho-Gomes *et al.*, 2022). In addition, the region of South and East Europe was chosen because it is interesting, that is, this region shows unusual periods of sudden change of mortality and considerable LEAB changes, and because the age pattern of mortality change is different from that observed in other Western countries (Aburto & van Raalte, 2018). To assign the countries to specific groupings, the M49 standard of the Statistics Division of the United Nations was used (UNSD, 2021). Thus, according to this classification, South European countries include Albania, Bosnia and Herzegovina, Croatia, Greece, Italy, Macedonia, Malta, Montenegro, Portugal, Serbia, Slovenia, and Spain. East European countries include Bulgaria, Czechia, Hungary, Poland, Romania, Slovakia, Russian Federation, Ukraine, Belarus, and Moldova. In the opinion of the author, Türkiye and Cyprus are additionally included in the group of countries as the closest Mediterranean Southeast European neighbors, even though according to the United Nations Statistics Division (2021), they are classified as Western Asian countries. This research concerns a political entity known as the Republic of Macedonia, which declared independence in 1991, and is

consequently one of the successor states after the breakup of the Yugoslav Federation. Türkiye is a transcontinental country. Only a small portion of Türkiye is located within Balkans in Southeast Europe. In addition, Türkiye has the status of candidate country for EU membership since 1989 and is among the oldest member states of the Council of Europe (since 1950). Cyprus has been an EU country since May 1, 2004.

The paper is structured as follows: Section 1.1 provides a broad theoretical background on the research topic. Section 1.2 presents the research context of the explanatory variables. Section 2 shows data and methods with 2.1 about data sources and measurements and 2.2 about methods used. Section 3 presents results; Section 3.1 describes the trends of the gender gap in LEAB within South and East European countries. In Section 3.2, the application of the generalized method of moments/dynamic panel data (GMM/DPD) method and main findings are presented. Section 4 discusses the results and Section 5 provides major conclusions.

1.1. Theoretical background

LEAB is a well-acknowledged indicator of the general population's health. It is impossible to disentangle LEAB with working and living conditions, exposure to pollution, access to education, health care, income, as well as the social support (Pinho-Gomes *et al.*, 2022). The gender gap in LEAB continues to be a reality across the whole world. Females on average have 5 – 7 years higher LEAB than males (Kavanagh *et al.*, 2017). Females' LEAB exceeds males' LEAB in almost every country throughout the world (United Nations, 2022). The decline in mortality worldwide has always occurred with a change in the gender gap. Attané and Barbiéri (2009, pp.68-69) indicate that: "A situation of broadly equal male and female life spans, gradually gives way to one in which females have a clear advantage over men, albeit varying in size between cultures and regions and the excess female mortality, common at younger ages and in the childbearing years, gradually diminishes and eventually disappears altogether."

In most developed countries, females are expected to live about 4 – 5 years longer than males. The roots of the gender gap in LEAB seem to appear in biological differences among males and females and as well as modified by social-based norms and roles, obstacles, lifestyles, and epidemiological conditions that allow behavioral patterns and differences in the environmental surroundings to have an effect on health (Zarulli *et al.*, 2021). When looking at the variations in the gender gap between different countries, Medalia and Chang (2011) suggested that the biological component is likely to be directly conditional by social factors. Existing evidence shows that regardless of better

health, males experience a shorter longevity than females, because of both biological and environmental differences that involve behavioral, cultural, and social factors (Alberts *et al.*, 2014). This gender health survival paradox was well documented at the end of the last century within high-income countries in Europe, Japan, and the United States. The reasons why females have greater longevity but with poorer conditions of health than males are compound and are in general ascribed to differences in socioeconomic position, genetic and acquired risks, responses of the immune system, function of hormones, prevention and the type of disease, change in health, and health behavior (Gu *et al.*, 2009; Oksuzyan *et al.*, 2008). In addition, according to these scholars, studies confirmed that it is more probable for males to pass away immediately and that it is more likely to be the case for females to be exposed to a slow process of physical deterioration. Thus, Cambois *et al.* (2001) explained this to a certain extent by gender-related differences in the type of widespread diseases: Males had a greater prevalence of fatal diseases and females had suffered more from disabling diseases. Furthermore, research on populations regarding the health survival paradox suggests the female disadvantages in health and functioning and that males are physically stronger, report a small number of diseases, and have not many constraints in the daily living activities at older ages than females.

No matter how, the question of gender differences in morbidity has been considered as more complicated than the scheme in daily living activities and physical performances. This is so because of variation in the acuteness of diseases and the measure of severity, diagnostic procedures, as well as the age-related change in incidence and prevalence of many diseases (Alberts *et al.*, 2014). As an example, these scholars mentioned the incidence of coronary heart disease that starts to rise earlier for males than for females, but the gender differences in heart disease are small at the oldest ages.

Glei and Horiuchi (2007) demonstrated that the differences in LEAB between males and females could broaden even when the differences in age-specific death rates lessen. This is possible if the level of mortality dispersion is dissimilar between males and females, because the relation between the gain in LEAB and mortality change depends on mortality dispersion. Glei and Horiuchi (2007) disclosed that the increase in LEAB as a consequence from mortality decline has a tendency to be slighter if adult mortality rises more sharply with age. Thus, for a given rate of mortality decline, the gain in LEAB is greater if the age pattern of mortality is more dispersed. In other words, if the level of mortality dispersion differs between the males and females, the same age-specific rates of mortality decline for both sexes could change the gender differences in LEAB.

The research of Luy (2004) on Bavarian communities in Germany estimated that around 80% of the sex difference in LEAB in general population was indeed a gender difference, with earlier mortality for males. In 2003, a mortality analysis for the period 1890 to 1995 was carried out by Marc Luy to address the question to which degree biological factors provide explanation to the existence of the extensive differences in LEAB by sex. Luy (2004) made a comparison of the data on mortality of more than 11.000 Catholic nuns and monks in Bavarian communities which have had very similar living situations in terms of their behavior and surrounding with the life table data of the German's general population. Therefore, as stated by Luy (2004), the higher differences noted in the general population in Germany could not be ascribed to biological factors but to some other explanations, such as the risk gained by the social roles, environmental conditions, and behavior. In addition, variations in the gender gap in longevity across time and countries may be the first indication that the same ones cannot be explained as a purely biological phenomenon (Schünemann *et al.*, 2016). The widening gap in LEAB by gender was occurring with the considerable rises in the sex ratio of age-specific death rates (Glei & Horiuchi, 2007). Accordingly, these rises are generally associated with gender differences in trends of behavioral and social risk factors such as smoking, abundant drinking, violence, and occupational dangers (Glei & Horiuchi, 2007).

The gender gap, which implies that females are in a more favorable position than males when it comes to LEAB, was first noticed in developed countries in the 20th century, but during the 21st century, it was basically a universal phenomenon (Barford *et al.*, 2006; United Nations, 2022a). This outstanding achievement that females in all places of the world can likely to happen to have longer lives than males became certain.

In human history, all over Europe, females' LEAB has been always greater than males' LEAB from recorded data available, for example, Sweden since 1751, Denmark since 1835, and England and Wales since 1841 (Barford *et al.*, 2006; Luy, 2004). It is also important to emphasize that in West Europe and North America, the LEAB gaps between females and males have begun to narrow since the 1980s (Glei & Horiuchi, 2007). Throughout the last century, both males' and females' LEABs were with a stable growth with exceptions for World War II, but the gender difference in LEAB has widened considerably in favor of females in most of the second half of the century. Similar to many other countries of the world, the gender gap in LEAB continued to persist among East European countries during the 1970s and the late 1980s with a lesser scale among South European countries and Ireland (Glei & Horiuchi, 2007).

The study by Trovato and Heyen (2006) found a narrowing gender gap in LEAB in the late 1990s for the populations of six countries that belong to the G7 group countries: Italy, France, Canada, Germany, United Kingdom, and the United States. Accordingly, the continuation of this trend was considered a prominent characteristic of the epidemiological shape of the countries with high income. The basic measure for this analysis was the central age-specific death rate. The analyses of this research show the role of age pattern of change in the contribution of five large age groups to the change LEAB in the late 1990s as well as in the period when the gender gap reached the highest levels. In addition, the study found that the contribution of age groups under 35 was negligible.

In the early and mid-2000s, the gender differences in LEAB begun to decline in West Europe and flattened off among several countries in South Europe and the United States, even though it continues to rise in Japan (Crimmins *et al.*, 2016; Glei & Horiuchi, 2007). As stated by Glei and Horiuchi (2007), both causes of death, behavioral and medical factors contributed to the narrowing of the gender gap in mortality rates and as a result of that the narrowing of the gender differences in LEAB. These factors include increased smoking among females and decreased prevalence among males and the progress in medical treatments for cardiovascular disease that may have greater benefit for males than females (Crimmins *et al.*, 2016; Glei & Horiuchi, 2007). There was considerable debate about whether gender is best viewed as an instrument for behavioral and lifestyle issues, or as a proxy for an unobserved acquired survival advantage (Sickles & Taubman, 1997). The US and international empirical data strongly suggest that human LEAB varies by gender. In the United States, the disparity in LEAB between males and females remained fairly constant over the last several decades of the 20th century in spite of the conventional view that the male survival disadvantage is associated with behavioral patterns modified through public education and even with the considerable boost in female labor force participation rates, as well as female adoption of dominantly male lifestyle behaviors such as smoking (Crimmins *et al.*, 2016; Crimmins *et al.*, 2019; Sickles & Taubman, 1997).

Research has pointed out that health improvements are not omnipresent and that the changed patterns, to some extent, are regarded as being caused by the phase of the epidemiologic transition in a specific country (Gu *et al.*, 2009; Mercer, 2018; Omran, 2005). In terms of a concept, epidemiological transition theory focuses on the compound change in patterns of health and disease as well as the interactions between these patterns and their demographic, economic, and societal factors and

outcomes (Omran, 2005). As claimed by Omran (2005), the epidemiological transition is in line with demographic and technological transitions in the developed countries and it is still in progress in less developed countries. According to the epidemiological transition or health transition theory, deaths from cerebrovascular and cardiovascular diseases, cancers, and other non-communicable diseases increasingly become leading causes for death since mortality due to infectious diseases reaches a low level (GBD 2017 Causes of death Collaborators, 2018; Gu *et al.*, 2013; Mercer, 2018).

1.2. Research contexts of the explanatory variables

The economic and social development, economic related and employment variables, as well as demographic indicators are one of the major determinants for the gender gap in LEAB but they have not been studied sufficiently in the literature. If the gender gaps in longevity are analyzed at the level of cross-country differences, socioeconomic factors should play a decisive role (Fedotenkov & Derkachev, 2020). As pointed out by Fedotenkov and Derkachev (2020), some studies based on a large group of countries found that higher inequality in the income as well as a higher degree of economic development quantified by GDP *per capita* widens the gender gap in longevity (Fedotenkov & Derkachev, 2020). Fedotenkov and Derkachev (2020) themselves found that in developed countries, a higher economic development level in terms of GDP *per capita* has a negative effect on the sex gap in longevity. This means that if income rises, there is an increase in their health investment, for both males and females, but as their study showed, the impact on males is more pronounced. Therefore, higher incomes lead to a narrowing gender gap in longevity. In addition, Schünemann *et al.* (2016) pointed out that in developed countries, the gender gap in LEAB appears to be strongly and negatively correlated with GDP *per capita*. Nevertheless, some studies have also shown that economic development is more beneficial to females because the absolute as well as relative increases of LEAB occur with increases in income (Bai *et al.*, 2018; Borah, 2021).

The enormous inequality and harsh environmental conditions in cities are an important feature of urban areas, leading to high heterogeneity in socioeconomic circumstances and resources (Santana *et al.*, 2015). This means that the consequences of urbanization are not the same for everyone. Several studies that focus on urbanization and mortality come to some conclusions about their associations, such as higher urbanization is associated with ischemic heart disease, infectious disease, chronic liver disease, and cirrhosis, and that the lower levels of urbanization are associated with suicide, stomach cancer, diabetes, and dementia (Santana *et al.*, 2015, p.2). In

addition, it was also found that a higher level of urbanization and better environmental conditions are associated with a smaller gender gap in longevity (Fedotenkov & Derkachev, 2020). The dominant conventional literature on urbanization and urban poverty increasingly discusses gender issues (e.g., Borrell *et al.*, 2014; Masika *et al.*, 1997; Margaras, 2019; Veneri & Ruiz, 2013). Therefore, Masika *et al.* (1997) emphasized that urbanization tends to affect gender roles, relations, and inequalities (although with differences in the intensity). Urban growth can be driven by factors such as growth in total income, technological advances, and declining travel costs (Veneri & Ruiz, 2013). However, urbanization is a double-edged sword and can have undesirable consequences. Due to the high aggregation of the population, many urban areas are exposed to a range of environmental issues that can have an effect on their sustainability and the quality of life of those who live and work in them (Margaras, 2019). Thus, the agglomeration of population in certain urban areas led to undesirable side effects, for example, overcrowding, rising housing prices, pollution, and deterioration of the quality of life. In addition, air pollution in many European cities still remains a health risk and a lot of the cities do not comply with EU air quality directives. Hence, Borrell *et al.* (2014, p. 246) highlight the special characteristics of cities: Cities have high population density, typically higher within the central part of city, and national, cultural, and religious diversity; cities have a lot of human resources, cities provide services to the population such as medical care, education, or social services that are usually absolutely accessible; and socioeconomic inequalities in health tend to be greater in urban areas, with poor groups of people in disadvantaged circumstances concentrated in marginalized neighborhoods, typically on the periphery of the city or in the very center of the city.

Other indicators related to social development are very important, therefore, in that regard, there will be examined the link between the gender gap in LEAB and the indicators related with social development. The gender gap in mortality attracted researchers from the natural and social sciences. Clearly, the related health economics literature provides relatively little theory-based discussion of the gender gap in mortality. One of the reasons for this was certainly that the health capital model dominated the literature for several decades (Schünemann *et al.*, 2016). Because health capital is a latent variable, which is exclusively used by economists; hence, it was reasonable why it was alien and problematic to use by the medical and biological sciences (Schünemann *et al.*, 2016). Appropriately, Schünemann *et al.* (2016) found that health and health investment preferences can contribute about 70% to the gender gap. When these scholars extended the model with gender-

specific preferences for unhealthy consumption, their experiments suggested that up to 88% of the gender gap could be due to gender-specific preferences. According to Fedotenkov and Derkachev (2020), the education factor, for example, female enrollment in secondary school has less important effect on the gender gap in longevity in developed countries, since all girls there have the right to secondary education.

The prior research also focuses on other economic-related indicators. The positive correlation between LEAB and income is one of the most primary relationships in the areas of population health and development (Bloom & Canning, 2006). Bloom and Canning (2006) mentioned a strong positive relationship between levels of national income and LEAB in poorer countries, although the relationship is non-linear in wealthier countries as the levels of LEAB are less responsive to variations in average income. However, these scholars also observed that LEAB is increasing over time at all income levels. No matter how, when the economy grows, the difference between males' and females' incomes decline, lessening the differences in time and health goods allocations between the genders (Fedotenkov & Derkachev, 2020) and this leads to a narrowing gender gap in LEAB. Furthermore, Fedotenkov and Derkachev (2020) also emphasize that income inequality is one of the factors affecting LEAB. Thus, the relative-income hypothesis posits that the gender gap in LEAB may also depend on income distribution. Fedotenkov and Derkachev (2020) tested this hypothesis and confirmed that higher income inequality increases the gender gap in LEAB at the national level.

Differential health behaviors from involvement in dangerous occupational and vocational activities are the obvious explanations for at least some of the gender differences in mortality now and historically (Cullen *et al.*, 2015; Schumacher & Vilpert, 2011). The increase in mortality among working-age males was first detected in Hungary, but it quickly became clear that it was a more general trend shared by many countries of the former Soviet Union and some other countries in Central and East Europe (Botev, 2012). In the opinion of Botev (2012), this is probably the first case of a sustained and significant increase in mortality in the history of the world population that is not associated with a serious epidemic or war. According to Fedotenkov and Derkachev (2020), it is also widely accepted that the most dangerous and demanding work is usually performed by males, which means that males are at greater risk of environmental- and pollution-related hazards than females. Moreover, these scholars emphasized that males are more often faced with unhealthy working conditions than females. Other studies also suggested that the different social roles of the two sexes influence their respective

mortality rates, emphasizing that males tend to engage in more dangerous, harmful, stressful, or difficult occupations than females (Gjonça *et al.*, 1999). These attitudes based on socioeconomic differences and socio-occupational factors may explain some of the variation in LEAB between the two sexes. While some of these studies have shown that females' participation in the workforce positively affects their health and mortality, some other studies have found that work-family antagonism can lead to increase stress and mortality (Medalia & Chang, 2011). Finally, Fedotenkov and Derkachev (2020) revealed that the greater difference between female and male aggregate unemployment rates increases the female advantage in LEAB.

The gender gap may differ in different demographic transition stages. As mentioned earlier, females' more favorable position LEAB was first observed in developed countries in the history, but it has been a universal phenomenon since the 21st century (Barford *et al.*, 2006; Schünemann *et al.*, 2016; United Nations, 2022a). The rapid improvement of LEAB in the developed world was accompanied by a widening of the gap between male and female survival and this widening of sex difference was mainly due to the higher rate of improvement for females rather than to a decrease in LEAB for males (Gjonça *et al.*, 1999). All these likely suggest that gender gap may vary in different demographic transition stages.

2. Data and methods

2.1. Data sources and measurements

Data were used from the following sources: World Bank Development Indicators (World Bank, 2022), National System Accounts from the United Nations Statistics Division (UN, 2022b), the World Population Prospects (WPP) 2022 from the United Nations, Population Division (UN, 2022a), World Health Organization (WHO, 2022a; 2022b), and from Our World in Data platform (OWiD, 2022). The focus of this research was on South and East European countries. The period examined is 1991 – 2020 (inclusive); and the data represent an unbalanced panel.

Aggregate annual data about the LEAB by sex have been obtained from the country-specific life tables in WPP 2022. The annual aggregate data on GDP *per capita* in constant prices – 2015 US Dollars and for annual GDP growth rate have been acquired from the United Nations Statistics Division. In addition, the yearly aggregate data about employment rate in total population 15+ by sex, unemployment rate by sex as percentage of total labor force, the percentage of urban population in total population, as well as percentage share of the completion of the secondary education by females among school-age population aged 15 – 18 were retrieved from the World Bank Open database

(<http://data.worldbank.org/indicator>). Furthermore, data about the Gini index have been obtained from the Our World in Data platform whose data are based on the World Bank Poverty and Inequality Platform. Finally, data about the health expenditure as percentage of GDP have been retrieved from World Health Organisation databases and additionally from other WHO data link.

Conceptually, these nine indicators should be differentiated into at least three groups. In reality, they were classified into four groups: GDP *per capita* and the percentage of the urban population are preferably categorized under economic development and as indicators related to social development are included secondary education (% females) and health expenditure as percentage share of GDP). Two of our explanatory variables – difference in employment rate in total population 15+ and the difference in unemployment rate by sex as percentage of total labor force – are related to the issue of employment. These two employment variables have been defined as a simple difference between sexes of employment rate in total population 15+ and as a difference between sexes in unemployment rate, separately for each of the countries and for each year. In addition, as economic-related indicators within this study are included GDP growth rate and Gini index as a proxy measure of income inequality. Mortality gender gap as the dependent variable was calculated by the author as a difference of the LEAB between females and males (i.e., females' LEAB – males' LEAB) from the UN database, from 1991 to 2020, separately for each of the countries and for each year.

2.2. Methods

This research uses the GMM/DPD, an estimation technique commonly used in econometrics (Arellano & Bond, 1991; Baltagi, 2005; Wooldridge, 2001a), to analyze related factors associated with the gender gap in LEAB. GMM panel estimators are based on moments of the general form in Eqs. 1 and 2:

$$g(\beta) = \sum_{i=1}^M g_i(\beta) = \sum_{i=1}^M Z_i' \epsilon_i(\beta) \quad (1)$$

Where, Z_i is a $T_i \times p$ matrix of instruments (i.e., exogenous explanatory variables) for cross-section country i ($i=1, 2, \dots, M$); g_i is $T_i \times k$ derivative matrix of β coefficients estimator; T refers to the total number of time periods; k refers to the number of regressors; $\sum_{i=1}^M$ represents total sample moments; and $\epsilon_i(\beta)$ represents a vector of errors of coefficients for cross-section i , and

$$\epsilon_i(\beta) = (Y_{it} - f(X_{i,t}, \beta)), \quad (2)$$

Where, $f(X_{i,t}, \beta)$ is the function of k -vector of regressors and its coefficients for cross-section i , at period t ; and Y_{it} is the dependent variable for cross-section i at period t . The fundamentals of GMM estimation include a clear identification of the instruments Z and a selection of the weighting matrix H and determining an estimator for coefficient covariance Λ (Baltagi, 2005; Wooldridge, 2002).

The linear dynamic panel data specification can be considered as given by Eq. (3):

$$Y_{it} = \sum_{j=1}^p \rho_j Y_{it-j} + X_{it}' \beta + \delta_i + \gamma_t + \epsilon_{it} \quad (3)$$

Where, Y_{it} is the dependent variable for cross-section i at time t ; Y_{ij-j} is the dependent variable at lag j for cross-section i and time t ; p is the total number of instruments; ρ_j is the average of the j -th order auto-covariance; X_{it} is the k -vector of regressors for cross-section i at time t ; β represents the coefficients that vary across cross-sections and periods; δ_i and γ_t represent cross-section and period-specific effects (fixed or random), respectively, and ϵ_{it} is the error term for cross-section i at panel period t . First, differencing of the specification in Eq. (3) removes the individual effect and generates an expression of the form shown in Eq. (4), where denotes the difference operator:

$$Y_{it} = \sum_{j=1}^p \rho_j Y_{it-j} + X_{it}' \beta + \epsilon_{it}, \quad (4)$$

which can be estimated using GMM techniques (Wooldridge, 2002). An efficient GMM estimation of this type of equation should commonly use a different number of instruments for each period, with the period-specific instruments corresponding to the different number of lagged dependent and pre-specified variables accessible in a given period. Therefore, despite all strictly exogenous variables, one should use period-specific instrument sets that correspond to the lagged values of the dependent and other predetermined variables. Given estimates of the residuals from the one-step Arellano-Bond estimator, where it is assumed that ϵ_{it} are not autocorrelated, the optimal GMM H^d weighting matrix for the differenced specification may be given as in Eq. (5):

$$H^d = \left(M^{-1} \sum_{i=1}^M Z_i' \Xi Z_i \right)^{-1} \quad (5)$$

Where, Ξ is the matrix and Z_i contains a mix of strictly exogenous and predetermined instruments (Wooldridge, 2002). It is noteworthy to observe that this weighting matrix is the one employed in the one-step Arellano-Bond estimator. The weighting matrix is a major component for an efficient GMM analysis. The weighting matrix can be

acquired by inversion of the consistent estimator of the variance-covariance matrix of the moment conditions. As further stated by Wooldridge (2001a), if there are $m > k + 1$ total moment conditions, where, k represents the number of covariates in the model, the weighting matrix would have $m \times m$ dimensions. In addition, if concerns are existed about heteroskedasticity, there are methods for calculating standard errors and testing statistics that are robust to heteroskedasticity of not known form. The usual approach when facing heteroskedasticity of unknown form is to use the GMM (Baum *et al.*, 2003). The GMM estimator using weighting matrix places no restrictions on either the unconditional or conditional (on Z_i) variance matrix of u_i , that is, the asymptotically efficient estimator can be obtained without making additional assumptions (Wooldridge, 2001b). First, differencing is applied to remove the unobserved effect, and thereafter, lags are utilized as instrumental variables for the differenced lagged dependent variable. Wooldridge (2001a) added further that since the original time-varying errors are supposed to be serially uncorrelated, the differenced errors must have serial correlation. GMM is well fitted for securing efficient estimators that consider for the serial correlation (e.g., Arellano and Bond (1991). As specified by Lucas *et al.* (1997), the approach of Arellano and Bond (1991) supports consistent estimates under very weak distributional assumptions. Developed by Arellano and Bond (1991), GMM techniques can control for both unobserved country-specific effects and first difference non-stationary variables, and further to overcome the problem with endogeneity of the explanatory variables using instruments and test for the presence of autocorrelation (Adusei, 2013). For dynamic model estimation using yearly data, it is found that GMM with additional moment conditions can provide more accurate estimates than two-stage least squares (Wooldridge, 2001a).

For models estimated by GMM, the first- and second-order serial correlation statistics initiated by Arellano and Bond (1991) were used as a method to test for serial correlation. The test has in effect two different statistics, one for first-order correlation and the other for second-order correlation. If the innovations are *i.i.d.*, it is expected the first-order statistic to be significant (with a negative autocorrelation coefficient), and the second-order statistic to be not significant (Arellano & Bond, 1991). The test statistics proposed by Arellano and Bond is calculated as shown in Eqs. (6-8):

$$m_j = \frac{\rho_j}{\sqrt{\text{VAR}(\rho_j)}} \quad (6)$$

$$\rho_j = \frac{1}{T-3-j} \sum_{t=4+j}^T \rho_{ij} \quad (7)$$

$$\rho_{ij} = \rho_{ij} = E(\epsilon_{i,t}, \epsilon_{i,t-j}) \quad (8)$$

Where, m_j is the test statistics of j -th order of serial correlation and ρ_j is the average j -th order auto-covariance.

3. Results

3.1. Trends of the gender gap in LEAB in South and East European countries

Solid evidence has shown that a spectacular rise in LEAB for South and East European countries that started since 1965 has continued to progress and some of South European countries (e.g., Spain, Italy, Malta, Portugal, and Cyprus) are now the leaders of LEAB in Europe (Caselli *et al.*, 2014; Eurostat, 2021; United Nations, 2022a).

Figure 1A and 1B presents LEAB levels and the gender gaps in LEAB for 24 countries in the study region. The figures show that the group of South and East European countries is heterogeneous in different levels of LEAB. In general, LEAB for both sexes is lower for Russia, Ukraine, Belarus, Moldova, Türkiye, Bulgaria, Romania, Montenegro, Bosnia and Herzegovina, Macedonia, Serbia, and Hungary, whereas it is higher in Italy, Portugal, Spain, Malta, Cyprus, Greece, and Slovenia. The group of countries as Albania, Croatia, Czechia, Slovakia, and Poland is more or less in an intermediate position. In South Europe, not only the gains in LEAB in the period 1991 – 2020 vary greatly but geographical inequalities are more pronounced than elsewhere. During the period of our research study (1991 – 2020), Türkiye, Croatia, and Malta are the three countries where the expected LEAB increased the most (by 9.5, 8.1, and 7.8 years, respectively), unlike Montenegro and Bulgaria, where the increase was only 0.5 years and 3.7 years, respectively.

One characteristics of mortality in the study period 1991 – 2020 are the stagnation of LEAB in 1991 – 1995 due to the increase in probability of dying at almost all age groups that were resulted from impacts of collapse of previous socioeconomic systems in these countries. During the beginning of the 1990s, many East European countries even underwent decrease in LEAB, while other parts of Europe witnessed an increase (SORS, 1997). The considerable increase of LEAB in the mid- or late-1990s is probably the response of that earlier stagnation in mortality trends that are generally attributed to an end of health crises of the transitional period. As Avdeev *et al.* (2011) stated, across Europe, females have a longer life than males, but the range of the gap in LEAB between the two sexes varies extensively, as does the development in the region throughout the time. Thus, South Europe follows the same trend of East Europe but with greater

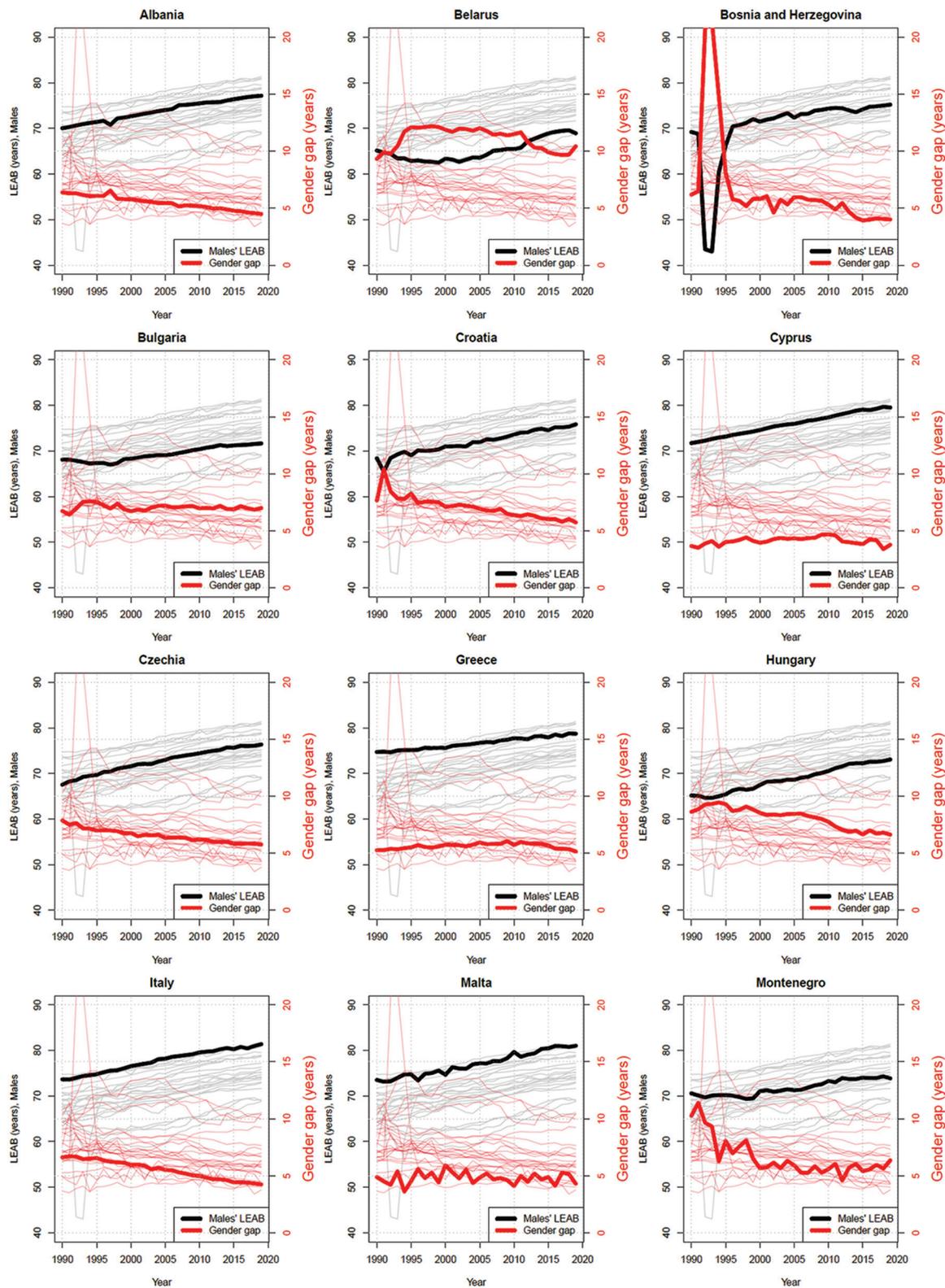


Figure 1A. Males' LEAB and the gender gap in LEAB in South and East European countries, 1990 – 2019

Source: World Population Prospects 2022 (United Nations, 2022a).

Note: The names of the countries/areas are directly taken from WPP 2022.

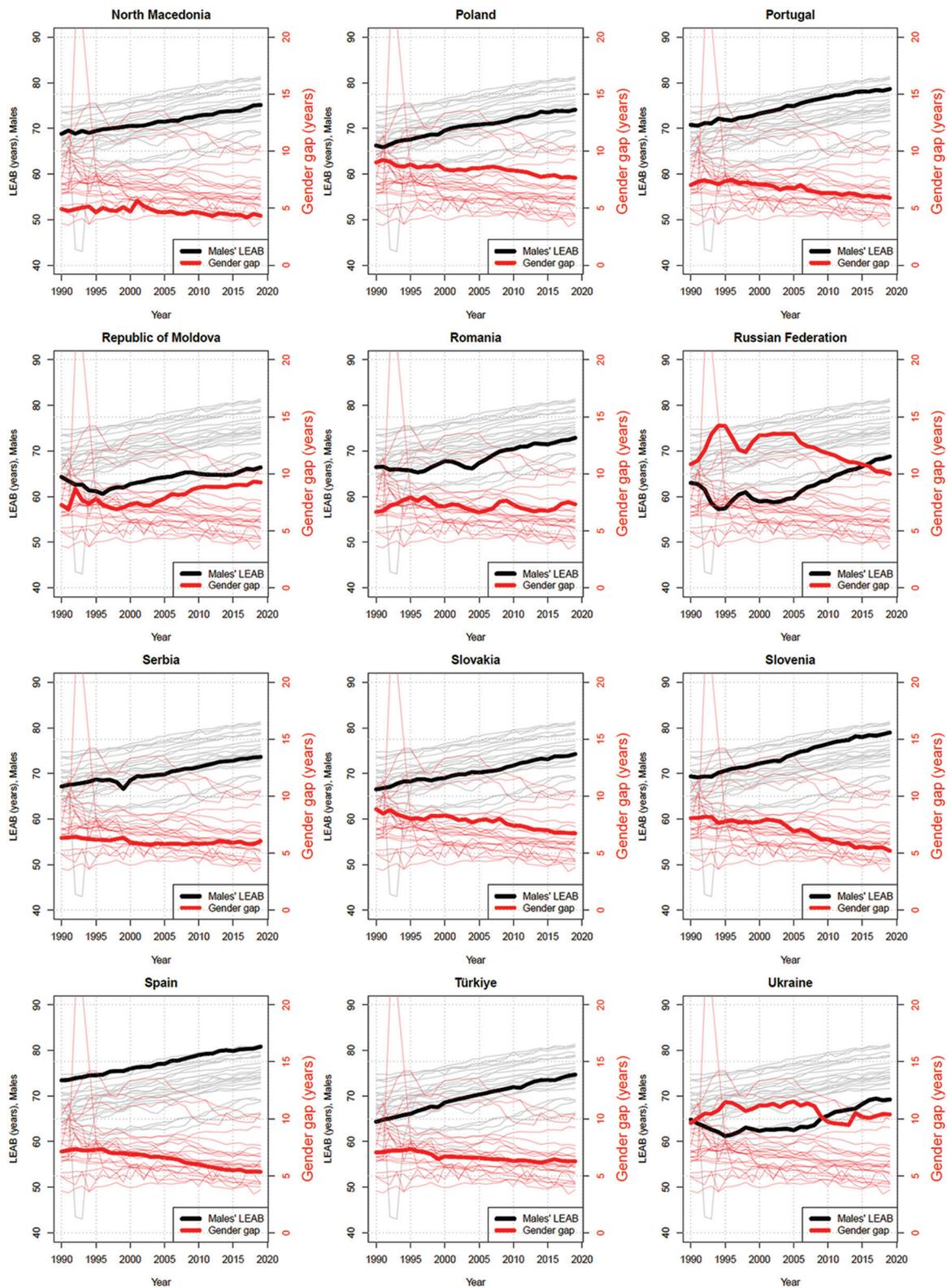


Figure 1B. Males' LEAB and gender gap in LEAB in South and East European countries, 1990 – 2019, continued

Source: World Population Prospects 2022 (United Nations, 2022a).

Note: The names of the countries/areas are directly taken from WPP 2022.

internal dissimilarities: In most of the South European countries, there has been a reduction in male's excess mortality since the mid-1990 except for Portugal where the reduction occurred only after 2000. By contrast, a stabilizing gender gap in life expectancy has been observed in South European countries such as Croatia, Macedonia, and Greece. In Romania, males lost exactly 1 year in LEAB between 1991 and 1996, the deterioration can be related to the economic and social problems with which this country was, and the same can be noticed for Bulgaria as well (1.1 years). The greatest loss among males is observed in Russia and Moldova (2.8 years), Ukraine (2.4 years), and Belarus (1.7 years) for the same period 1991 – 1996. In contrast, Bosnia and Herzegovina and Türkiye gained about 2 years, that is, 2.0 and 2.3 years, respectively, in males' LEAB between 1991 and 1996. In the period 1991 – 2001, LEAB in South and East European countries plus Türkiye improved from year to year, with average 0.32 years for males and 0.36 for females annually.

While the stagnation was found in the early 1990s for most countries in the region, the stagnation was found in the entire decades (1991 – 2001) in several countries with the most noticeable in Bulgaria (0.06 years) annually, followed by Romania (0.13 years), Macedonia (0.13 years), Greece (0.14 years), and Serbia (0.15 years). In the period 1991 – 2001, four East European countries saw an annual decrease in LEAB, and an annual average of 0.23 years for Russia, 0.07 years in Ukraine, 0.05 years in Belarus, and about 0.01 year in Moldova. Montenegro even experienced a sharp decline of 3 years in LEAB in 1991 – 2001 for both sexes. The largest annual decline among males for this period (1991 – 2001) was observed in Russia (0.33 years) followed by annual decline of 0.14 years in Belarus and 0.11 years for Ukraine. The largest annual decline in females' LEAB was recorded in Russia (0.14 years). The largest annual gains in LEAB during this period from 1991 to 2001 were recorded by Türkiye (0.36 years), Croatia (0.35 years), Poland (0.31 years), and Bosnia and Herzegovina (0.31 years). Males gained more than females. The largest annual gain in male's LEAB in the period was found in Croatia (0.50 years), followed by Türkiye (0.38 years), Poland (0.34 years), and Bosnia and Herzegovina (0.34 years). The largest increases in females' LEAB were witnessed by Bosnia and Herzegovina (0.30 years), Poland (0.28 years), Italy (0.26 years), Portugal (0.26 years), Malta (0.26 years), and Hungary (0.26 years).

By the end of the decade 1991 – 2001, the highest LEAB was found in females in Spain (83.2 years), Italy (82.8 years), and Greece (81.8 years). LEAB for both sexes exceeded 78 years in Spain and Italy in 1995 and in Greece in 1997. If LEAB for both sexes in Italy, Spain and Greece during the period 1995–1997 were compared with those in Romania, Türkiye, Hungary, Bulgaria, Ukraine, and Belarus for the

same period, differences were over 7 years. If these levels of LEAB in Italy and Spain from 1995 to 1997 are compared with the levels of LEAB in Russia and Moldova from 1995 to 1997, then, the differences are higher for more than 12 years. In this period, a high gender difference in LEAB was recorded in some countries. For instance, sex difference in LEAB was over 20 years in 1992 – 1993 in Bosnia and Herzegovina, over 12 years for Russia during 1992 – 2001, over 10 years in 1991 for Croatia and Montenegro, in Ukraine (1991 – 2001), Belarus (1993 – 2001), and over 9 years in 1992 – 1993 in Hungary and Poland.

The gender gap in LEAB during the period 2002 – 2020 (with the exception of 2020 because of the COVID-19 pandemic) was somewhat different from the previous periods. The highest LEAB in our study group was found in the southern countries. Italy had the highest males' LEAB in 2019 (81.4 years) followed by Malta (81.0 years) and Spain (80.8 years). The level of males' LEAB was comparable to that of some West and/or North European countries, such as Norway and Sweden and Switzerland (United Nations, 2022a). In addition, females' LEAB in 2019 in Slovenia and Greece (84.2 and 83.9 years, respectively) was the same as that in Austria, and also females' LEAB in Italy (85.6 years) was exactly the same as that of France in 2019 (United Nations, 2022a). However, within the group of South and East European countries, disparity in LEAB is large. For example, LEAB for both sexes combined, Bulgaria and Romania were about 8 and 7 years lower from that for Italy and Spain, which were (83.5 years for both countries) in 2019. When Italy's LEAB for both sexes in 2019 is compared with the LEAB in Russia, Belarus, and Ukraine, it is higher for more than 9 years and even for 12 years higher than Moldova's LEAB. Further, a child born in 2019 in Bulgaria as an EU country is “deprived” of more than 6 years of life if compared to a child born in Slovenia and Greece. The difference was even larger (10 years) between Bulgaria and Italy.

Within the 30-year period of analysis, the gender difference in LEAB had a substantial reduction in some countries: More than 4 years in Montenegro, 2.5 years in Italy, 2.4 years in Bosnia and Herzegovina, 2.3 years in Croatia, and about of 2 years in Russia. By contrast, the gender gap in LEAB in Moldova, Bulgaria, and Romania was increased by 1.7 years, 0.6 years, and 0.5 years, respectively. For the remaining countries, the gender gap in LEAB for the whole period was more or less constant. Several authors related the narrowing gender gap in LEAB observed in UK, Denmark, the Netherlands, Norway, and Sweden to the significant changes in the lifestyle, education, family roles, and employment of females (Spijker *et al.*, 2007). Over the study period (i.e., 1991 – 2019), LEAB was prolonged for all study countries not with the same length.

LEAB gained the most in Türkiye (10 years for males and 9 years for females) and least in Bulgaria (3.5 years for males and 3 years for females) and Montenegro (4 years for males). The largest gender gap in LEAB was found in Russia, Ukraine, and Belarus with mostly 10 – 12 years, then in Croatia, Hungary, Poland, Slovakia, Moldova, and Romania with mostly between 7 and 9 years, whereas the smallest gap was found in Cyprus, Macedonia, Malta, and Greece, with mostly between 4 and 6 years. Due to the wars and military actions in Bosnia and Herzegovina in 1992 – 1994 and in Croatia in 1991 in the study period, these couple of years were not taken into account these years in comparisons and analyses about LEAB.

The COVID-19 pandemic outbreak from January 2020 onward has apparently altered mortality rates a lot and consequently LEAB for both sexes across the whole world. Our study countries have not been any exception from this pandemic. Because of this shock to mortality rates and LEAB in 2020, this mentioned year was excluded from the GMM/DPD analyses. In that direction, the data in 2020 about the LEAB show that there was a drastic decrease in LEAB for almost all countries. Countries with the largest decreases in LEAB between 2019 and 2020 were Russia (2.5 years), Macedonia (2.1 years), Albania (2 years), and Türkiye and Ukraine (1.9 years). Malta was the only country that registered an increase of the total LEAB of 0.2 years, and Cyprus has stayed at the same level between these 2 years, without any changes in the total LEAB. If we observe the reductions by gender compared for these 2 years (2019 and 2020), the greatest reduction in LEAB was observed among males in Albania (2.6 years) and Russia (2.6 years), Macedonia (2.2 years), Türkiye (1.9 years), Ukraine (1.6 years), Belarus (1.6 years), Bulgaria (1.5 years), Italy (1.4 years), Serbia (1.4 years), Slovenia (1.4 years), and Romania (1.4 years). On the other side, the greatest losses in LEAB in 2020 were observed among females in Russia (2.4 years), Ukraine (2.2 years), Macedonia (2 years), Albania (1.9 years), Türkiye (1.9 years), and Belarus (1.5 years). As quite the opposite, for females in Malta and Cyprus, an increase in LEAB was observed for the period by 0.9 and 0.1 years, respectively (United Nations, 2022a).

3.2. Applications of dynamic panel model using GMM: Main findings

GMM/DPD model was applied to find out the relationship between gender gap in LEAB and explanatory variables for 24 South and East European countries from 1991 to 2019. The estimation was based on the unbalanced 339 observations panel of country level data. The analysis fits the gender gap in LEAB (MGG, measured by females' LEAB – males' LEAB) to the difference in employment

rate by sex in total population 15+ with a 1-year lag, as females – males DIFFEMPL(-1), the difference in unemployment rate by sex as percentage of total labor force, as females – males (DIFFUNEMPL), Gini index with a 2-year lag Gini(-2), the urban population as a percentage of total population (URBANPOP), GDP *per capita* – constant 2015 US\$ with a 2-year lag GDPPC(-2), health expenditure as percentage of GDP (HEGDP), GDP growth rate (GDPGR), life expectancy at birth with a 1-year lag LEAB(-1) and the percentage share of the completion of the secondary education by females among the school-aging population aged 15 – 18 with a 1-year lag SEDUF(-1). Since the model was assumed to be dynamic, the Dynamic Panel Wizard tool for estimating GMM/DPD was applied. Our dependent variable was MGG (gender gap in LEAB), and the first lag of MGG (i.e., MGG (-1)) was an explanatory variable. Furthermore, to remove the cross-section fixed effects of the dynamic panel model, the first difference transformation was specified. In addition, period-specific (predetermined) instruments (i.e., MGG with one lag and the remaining exogenous instruments) were specified as well. Finally, the weighting and coefficient covariance calculation was specified. Therefore, 1-step GMM iteration was selected for *i.i.d* innovations to calculate the Arellano-Bond 1-step estimator. In this case, fixed weights standard errors from estimation were computed. The coefficient estimates and summary statistics of the output of the GMM/DPD model are provided in Table 1. The standard errors presented in Table 1 are the standard errors of the 1-step Arellano-Bond estimator. In the literature, there is proof that the standard errors for the 1-step estimator are most reliable.

The results of the GMM estimation presented in Table 1 indicate that the estimated coefficients of Gini index up to 2-year lag and GDP *per capita* with 2-year lag have a positive and significant effect on gender gap in LEAB at $p < 0.01$ and $p < 0.05$, respectively. Nevertheless, the coefficient of GDP growth rate also remains positive, and the corresponding p value is close to the 10 percent significance level. The coefficients of URBANPOP and LEAB (-1) both have a negative impact on gender gap in LEAB at $p < 0.05\%$ and $p < 0.01$, respectively. The employment variables, education variable, and health expenditure as percentage of GDP have all statistically insignificant coefficients. However, within the model specification, the difference in unemployment rate by sex and the health expenditure as percentage of GDP has both negative sign and therefore insignificant negative impact on the gender gap in LEAB. On the contrary, positive sign but with insignificant impact on gender gap in LEAB was found for the coefficient of the difference in employment rate by sex with a 1-year lag and for the female share of the completion of secondary

Table 1. Estimation output of the GMM/DPD model^{abc}

Variable	Coefficient	Standard error	t-statistic	p
Gender gap in LEAB (MGG, -1)	-0.1107	0.0626	-1.7681	0.0780
Difference in employment rate by sex (-1)	0.0061	0.0142	0.4266	0.6699
Difference in unemployment by sex	-0.0155	0.0212	-0.7311	0.4652
Gini index (-2)	0.2621	0.0989	2.6509	0.0084
Percent of urban population in total population	-0.0506	0.0250	-2.0253	0.0436
GDP per capita (-2)	0.6038	0.3032	1.9913	0.0473
Health expenditure as percentage of GDP	-0.0074	0.0277	-0.2671	0.7895
GDP growth rate	0.0066	0.0043	1.5349	0.1258
LEAB (-1)	-0.2479	0.0663	-3.7347	0.0002
Percent of females completed secondary education (-1)	0.0222	0.0349	0.6371	0.5245
Instrument specification:				
Gender gap in LEAB (MGG,-1)				
Difference in employment by sex (-1)				
Difference in unemployment by sex				
GDP per capita (-2)				
Gini index (-2)				
Percent of urban population in total population				
Health expenditure as % of GDP				
GDP growth rate				
LEAB (-2)				
Percent of females completed secondary education (-1)				
Constant added to Instrument list				
Cross-section fixed (first differences)				
Mean dependend var	-0.0377			
S.E.of regression	0.2736			
J-statistic	2.4129			
S.D. dependend var	0.1634			
Sum squared resid	24.621			
Instrument rank	10			

Note: The coefficients were obtained from GMM/DPD with gender gap in LEAB (MGG) as the dependent variable and the first differences as transformation from the 339 unbalanced panel observations among 24 countries in South and East Europe in 1995 – 2019. A Negative values in the parentheses refers to the number of lag of the given variable. ^aFixed weights standard errors from estimation. ^bTransformation: First differences. ^cDifference specification instrument weighting matrix.

education with the 1-year lag. Furthermore, the lagged variable of the dependent variable MGG is significant and negative at $p < 0.10$.

Table 2 displays the results for a serial correlation test of both the first- and second-order serial correlation. The tests results show that the first-order statistic is statistically significant at $p < 0.05$ and with a negative auto-correlation coefficient which is what is expected if the model error terms are serial uncorrelated in levels. In our case, the second-order statistic is statistically not significant at $p < 0.1$. These results are expected if the error terms of the model are serial uncorrelated in levels (Arellano & Bond, 1991).

Table 2. Arellano-Bond serial correlation test outputs

Test order	m-Statistic	rho	SE (rho)	p
AR (1)	-2.1669	-1.5263	0.7043	0.0302
AR (2)	0.6763	0.6616	0.9784	0.4989

Note: The test includes 339 unbalanced panel observations for 24 South and East European countries from 1994 to 2019. Pearson's product moment correlation coefficient rho is a measure of the linear relationship and m-statistic denotes the population and sample mean.

4. Discussion

Our findings concerning economic development and demographic factors and their effect on gender gap in LEAB

in 24 South and East European countries are generally consistent with the established literature on the link between economic development and gender gap in LEAB, such as Fedotenkov and Derkachev (2020) and Schünemann *et al.* (2016). There is consistence with the findings of Fedotenkov and Derkachev (2020) that GDP *per capita*-positive affects the sex gap in longevity. To be specific and very simple, our results show that a lower economic development level widens the gender gap in LEAB and that a higher economic development level leads to a narrowing of the gender gap in LEAB in South and East European countries. Therefore, the GMM/DPD model indicates that higher GDP *per capita* considered with a 2-year lag narrows the gender gap in LEAB. Generally speaking, higher GDP *per capita* allows people to build up larger savings over their lifetimes, as well as in public and private pension funds. In turn, higher savings lead to a better quality of life and the ability to afford medical treatment, which can have long-term effects on people's health. Specifically, our empirical results show that the Gini coefficient up to 2-year lag is positively associated with gender gap in LEAB, implying that it has time-related effects on gender gap in LEAB. Greater income inequality within countries is associated with a wider gender gap in LEAB and that a lower level of Gini index, that is, less income inequality within countries leads to a narrowed gender gap in LEAB. Indeed, these empirical results may be explained in a way that the GDP per capita and Gini index may affect male's LEAB more than female's LEAB.

Our empirical results for the other economic development or demographic indicator, that is, the percentage of urban population in total population, revealed a negative statistically significant effect on the gender gap in LEAB. This finding clearly means that a higher percentage of urban population in total population leads to a narrowing of the gender gap in LEAB. In the literature, there are numerous empirical confirmations of such findings such as the studies by Borrell *et al.* (2014); Santana *et al.* (2015); and Veneri and Ruiz (2013). Herewith, it is worth mentioning the opinion of Borrell *et al.* (2014), as argued that when implementing public health policies and investigating the economic, social, political, and health changes occurring in a country, it is important to understand these processes because the majority of Europeans live in cities. In this regard, it is worth highlighting the observation also by Spijker and Van Wissen (2010) that the mortality-increasing effects of urbanization and industrialization succeeded to hide the mortality-reducing effects as a result of a high living standards as well as country-specific factors, for example, dietary habits acted as a confound.

Furthermore, it may be put forward for consideration that the not significant effect for some employment and

education variables may be explained by the presence of some other included economic or demographic factor in the model, such as, for example, the percentage of urban population in the total population. Hence, as a result of gender constraints and opportunities in terms of access to income, resources and services, reduced job creation, and downward pressure on real wages, males and females respond to urban poverty in different ways. For that reason, unemployment and underemployment are a major concern for many urban economies (Nierenberg, 2005). Conventionally, the movement to cities contributed to economic growth and global integration, as more people found homes close to schools, medical clinics, workplaces, and communication networks (Nierenberg, 2005). The persistence of poverty, and social and health inequalities despite the general improvement in all health and social indicators, proceeds from previous social and political conditions that, at different levels, are also present in some metropolitan areas or cities in European countries; mainly in those that have had delayed industrialization and urbanization (Santana *et al.*, 2015).

The difference in employment rate by sex and the difference in unemployment rate by sex have not significant effect on gender gap in LEAB. In general, our results about the impact of gender differential in employment on gender gap in LEAB are consistent with the theoretical concepts in the literature (e.g., Fedotenkov & Derkachev, 2020; Gjonça *et al.*, 1999). For this variable of difference in employment by sex with a 1-year lag, there is a consensus with the findings of Schumacher and Vilpert (2011), Cullen *et al.* (2015), and Botev (2012) that the gender differences in health behaviors and in mortality as a result of hazardous occupational and employment activities have been obvious explanations of the gender gap in LEAB, which is more relevant when historically speaking versus when seen from today's perspective or during recent decades the backward effect of these employment variables is less pronounced. Furthermore, it can be said that our results about the employment variables may be due to less risky jobs in these sectors for both sexes.

In addition, since it is known that employed persons as well as the unemployed belong to working age, that is, up to 65 years old and considering the advanced character of the epidemiological transition in these countries, it is likely to expect that in most part the dynamics regarding gender differences in LEAB started to occur in the 60s and older life (Trovato & Heyen, 2006; Zarulli *et al.*, 2021). In addition, if we accept the belief that most of the unemployed belong to a younger age group, due to further education, job search, or so, then in proving the validity of our results about not significant effect of the difference of unemployment by sex will be mentioned again the findings by Zarulli *et al.*

(2021). Accordingly, since the death cases between the ages of 15 and 40 are insignificantly low, the proportion of male to female mortality rates at that age has a negligible impact on the sex differences in LEAB. In addition, it was also clearly added by Trovato and Heyen (2006) and; Attané and Barbiéri (2009), that the contribution of age groups under 35 on sex differences in LEAB is insignificant.

Finally, the model results clearly show that an increase in LEAB for an increase in LEAB for both sexes is associated with a decline in the gender gap in LEAB. This finding suggests that when LEAB reaches a high level or a plateau such as in South and East European countries (i.e., a later demographic transition stage), the advantage in mortality for females over males tends to reduce. This is interesting. However, to understand and disentangle, some root causes of such phenomenon need a global analysis with a much longer analytical time period.

The study limitations include the lack of focus on different sets of countries separately but only using a large pool to measure gender gap in LEAB. For that reason, some of our results seem to be contradictory, but this is so since these regions within East and South Europe provide different cultural and historical backgrounds as well as various economic challenges, which may have an impact on not only country-specific fixed effects but also to the slopes of the economic development factors. Future research can address these shortcomings and give strength to the conclusions of their research. Therefore, our suggestion is that the future cross-country research in this field includes a focus on different sets of countries: Developed versus less developed countries, Balkan countries versus other countries in these regions, etc.

5. Conclusions

In accordance with the present time trend of worldwide population aging, this research work has provided a new perspective to confirm the relationship between the gender gap in LEAB and socioeconomic development, economic, and demographic indicators. This paper analyses the relation of these indicators and conditions in South and East Europe on the gender gap in LEAB. The results suggest that the difference in employment rate of males and females does not have statistically significant impacts on the differences in LEAB by sex. The not significant effect was found for the difference in unemployment of males and females as well as to social development indicators in relation to the sex gap in LEAB. Therefore, in general, it can be concluded that the economic inequality between the sexes does not play some special role when it comes to the gender gap in LEAB within these countries. The same is with the impact of the social development

indicators. In this regard, urban growth, the economic development through GDP *per capita*, and economic indicators, especially income inequality of population with the Gini index as a proxy measure, have significant impact on gender gap in. Comparing these results for these countries can provide a clearer understanding of the dynamics of the gender gap in LEAB. The findings of this study may be useful to propose some policy recommendations to reduce the economic risks within different economic circumstances as well as in the domain of population health. This research also calls for a more comprehensive study with all countries of the world with longer time periods for more robust findings.

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Conflict of interest

The author has no conflicts of interest to declare.

Author contributions

This is a single-authored paper.

Ethics statement

Not applicable as this study involves the analysis of secondary data collected by the UN and World Bank websites.

Availability of supporting data

Data utilized to this paper are from secondary sources and available to the public. The data can be freely accessed online from the World Bank Indicator database (<http://data.worldbank.org/indicator>), the UN databases (<https://population.un.org/wpp> and <https://unstats.un.org/unsd/snaama/Basic>), and the WHO databases (<https://apps.who.int/nha/database/ViewData/Indicators/en> and <https://gateway.euro.who.int/en/datasets/european-health-for-all-database>).

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