Declining Life Expectancy Gains in Western Europe: Trends and Differences across 410 Regions (2002–2019)

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Abstract

Decreasing gains in life expectancy (e_0) observed in several high-income countries before the COVID-19 pandemic raised concerns about the future prospects for human longevity. We aim at (i) assessing the trends of e_0 at the sub-national level for 11 countries in Western Europe from 2002 to 2019, (ii) locating hot spots where e_0 gains were almost null in recent years, (iii) providing insights about the factors influencing overall e_0 improvements by breaking down this analysis by age groups. We leverage an extensive dataset of mortality data sourced from reliable records for 410 European regions. We smooth this dataset using a non-parametric approach to obtain reliable estimates of mortality rates ensuring that our analysis reflects real changes in population health rather than random deviations inherent to small populations. Our results reveal that the average pace of life expectancy gains across European regions rapidly decelerated between 2002 and 2015. However, such a dramatic deceleration took no longer between 2015 and 2019. Nevertheless, this recent positive trend is accompanied by large increases in regional disparities and the number of regions with null e_0 gains. These regions are mainly situated in Germany and France.

Keywords: Life expectancy gains · European regions.

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1 Introduction

Life expectancy at birth (e_0) is a key indicator of public health and societal well-being, providing insights into the overall quality of life within a population. While Western countries have generally benefited from a life expectancy increase over past decades, the gains in recent years have been more modest in some high-income countries. Notably, the United States, the United Kingdom, and Germany experienced only marginal improvements, or even stagnations and declines in e_0, contrasting with the sustained progress observed in previous years (Jasilionis et al., 2023; Leon et al., 2019). This raises important questions about the drivers of public health progress and whether other countries will reach similar challenges in extending e_0.

At the same time, studying the pace of life expectancy gains at a fine geographic level, as opposed to the national level, is of paramount importance, as national averages can obscure significant regional variations. For example, some areas have made substantial progress while others have struggled to keep pace within Germany (Mühlichen et al., 2023; Sauerberg et al., 2024). A regional approach could help identify hot spots as well as demographic factors, healthcare resource distribution, and public health interventions that mainly drive the e_0 gains in recent years.

Moreover, analyzing the evolution of age-specific death rates is equally crucial, as improvements in healthcare, lifestyle, or social conditions may affect specific age groups or cohorts more significantly. By examining them, we can provide insights into the factors influencing overall e_0 improvements.

In this paper, we propose to examine the evolution of e_0 gains in regions of Western Europe between 2002 and 2019. This period presents an ideal window for analysis, as it captures a relatively stable era before the global COVID-19 pandemic, which had a profound impact on e_0 trends worldwide, especially in European regions (Bonnet et al., 2024). By comparing trends and identifying regional patterns, this study aims to uncover the determinants that contribute to disparities and progress in e_0, providing insights that can inform future health and social policies. Understanding these trends is not only crucial for improving health outcomes in the region but also for addressing inequalities that may hinder further progress in increasing e_0.

To achieve this goal, we leverage an extensive dataset comprising time series of mortality data, stratified by age and sex, across 410 regions covering 11 Western European countries. In analyzing temporal changes within small sample sizes, raw data frequently exhibit irregular patterns that can hinder the extraction of clear conclusions. To address this issue, we applied a smoothing approach to the original dataset, effectively reducing the statistical noise commonly associated with highly granular data, while still preserving important underlying patterns. The pace of longevity progress is subsequently assessed by computing regional values of both e_0 and death rates for specific age groups.

2 Data and Methods

To examine the regional gains in e_0 over the past two decades, we collect and employ data spanning from 2002 to 2019 coming from reliable records of national statistical institutes. Our analysis involves death and population counts categorized by age groups; while these age groups may vary between countries, they remain consistent over time. We use the NUTS system, i.e. European nomenclature of territorial units: NUTS-3 for Denmark, France, Italy, Luxembourg, Spain, Sweden, and Switzerland (the finest level of the NUTS classification), and NUTS-2 for Austria, Belgium, Netherlands, and Portugal. For Germany, we use a national classification ('Raumordnungsregionen').

From a methodological standpoint, our study faces two key challenges. First, mortality rates in small regions often exhibit random fluctuations due to the low number of events, which can lead to misleading conclusions when analyzing raw data. To address this, we apply P-splines as a smoothing technique. Particularly suitable for mortality data, this method enables us to capture smooth trends across age and time without imposing a predefined model structure. Given that our data encompasses age 0, we have customized P-splines as in Camarda (2019). Moreover, we adjust the smoothness degree for each region by independently minimizing the Bayesian Information

Criterion for each spatial unit. These adjustments provide more reliable mortality estimates than those coming from raw data, by ensuring that our analysis accurately reflects genuine changes in population health rather than being skewed by random short-term variations.

Secondly, we require a framework to accommodate country-specific age-group structures in our mortality data and estimate comparable mortality rates. In this study, we integrate our smoothing approach within a Composite Link Model (CLM) framework. While CLM has previously been used for modeling mortality with coarsely grouped data (Rizzi et al., 2018), we extend this method to handle country-specific age-group structures in a two-dimensional context.

In the end, we obtained estimates of e_0 and age-specific death rates broken down by year, region, and sex. Due to space constraints, we only present results about e_0 in this extended abstract.

3 Selected results

Figure 1 illustrates the evolution of the average and standard deviation of e_0 gains for the 410 regions in our panel, for women (in blue) and men (in red). Values are expressed in days. Between 2002 and 2015, the average e_0 gains decreased threefold for women (from 90 to 30 days) and twofold for men (from 120 to 60 days). Concurrently, the regional differences in e_0 gains decreased by 40% for women and 25% for men, even though with temporary fluctuations. This trend reversed since 2015: the decrease in average e_0 gains has largely stalled for both sexes while the regional disparities have shown a marked upward trend.

Figure 2 maps sex-specific e_0 gains across the analyzed European regions between 2002 and 2003, 2010 and 2011, and 2018 and 2019. Again, the values are expressed in days. Regions where e_0 gains are close to zero are shown in white, while those where e_0 decreases by more than 15 days are shown in blue. These maps highlight previously observed trends: (i) e_0 gains are higher for men than for women, and (ii) overall, e_0 gains have significantly declined over the period. Several distinct hotspots emerge on the maps. For men, large areas covering Portugal, the Netherlands, eastern Germany, and northern Italy/eastern France exhibited very high e_0 gains in 2002-2003; in 2018-2019, large areas in France and Germany show gains close to zero. The same is true for a few areas in Spain and Italy. For women, Germany presents extensive areas where e_0 stagnated in 2018-2019. Although this trend has already been noted in national studies, we can now see that it also applies to large areas in France and certain regions in Spain and Italy.

4 Outlook

During the next months, we plan to extend our analyses in several ways. First, we will conduct a more detailed analysis of these trends by examining the evolution of death rates across different age groups to identify those that have contributed most to the significant decline in e_0 gains. Second, we will explore whether these e_0 gains are linked to a convergence process, where the lagging regions experience the largest gains; or conversely, whether they are associated with a divergence process within Western Europe, where the lagging regions remain in regional development traps, a concept widely used in other dimensions of human progress (Diemer et al., 2022). Finally, we intend to extend our analyses by adding the most recent data available. This will enable us to assess whether e_0 gains have returned to their pre-COVID-19 pandemic pace or have fallen further.

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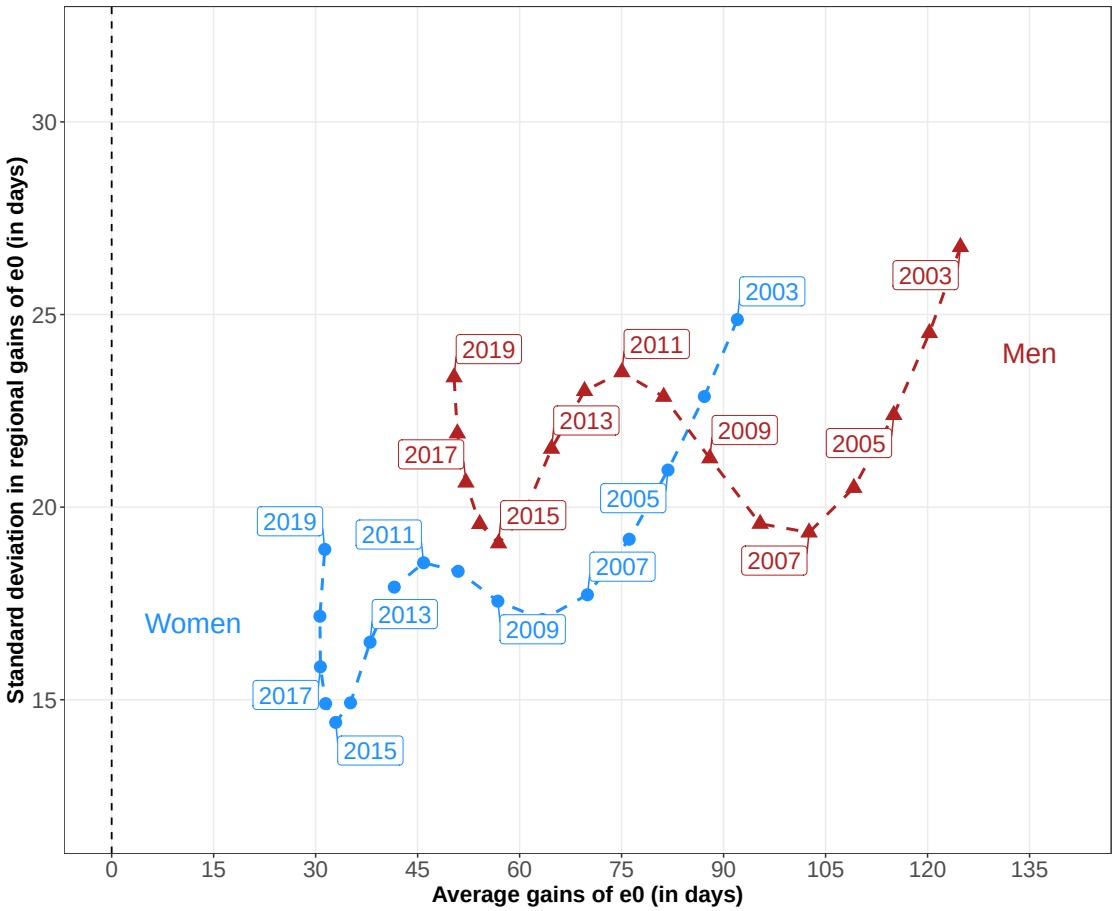

Figure 1. Pathways of average gains in e_0 and regional inequalities of gains in e_0 across 410 European regions (2002-2019).

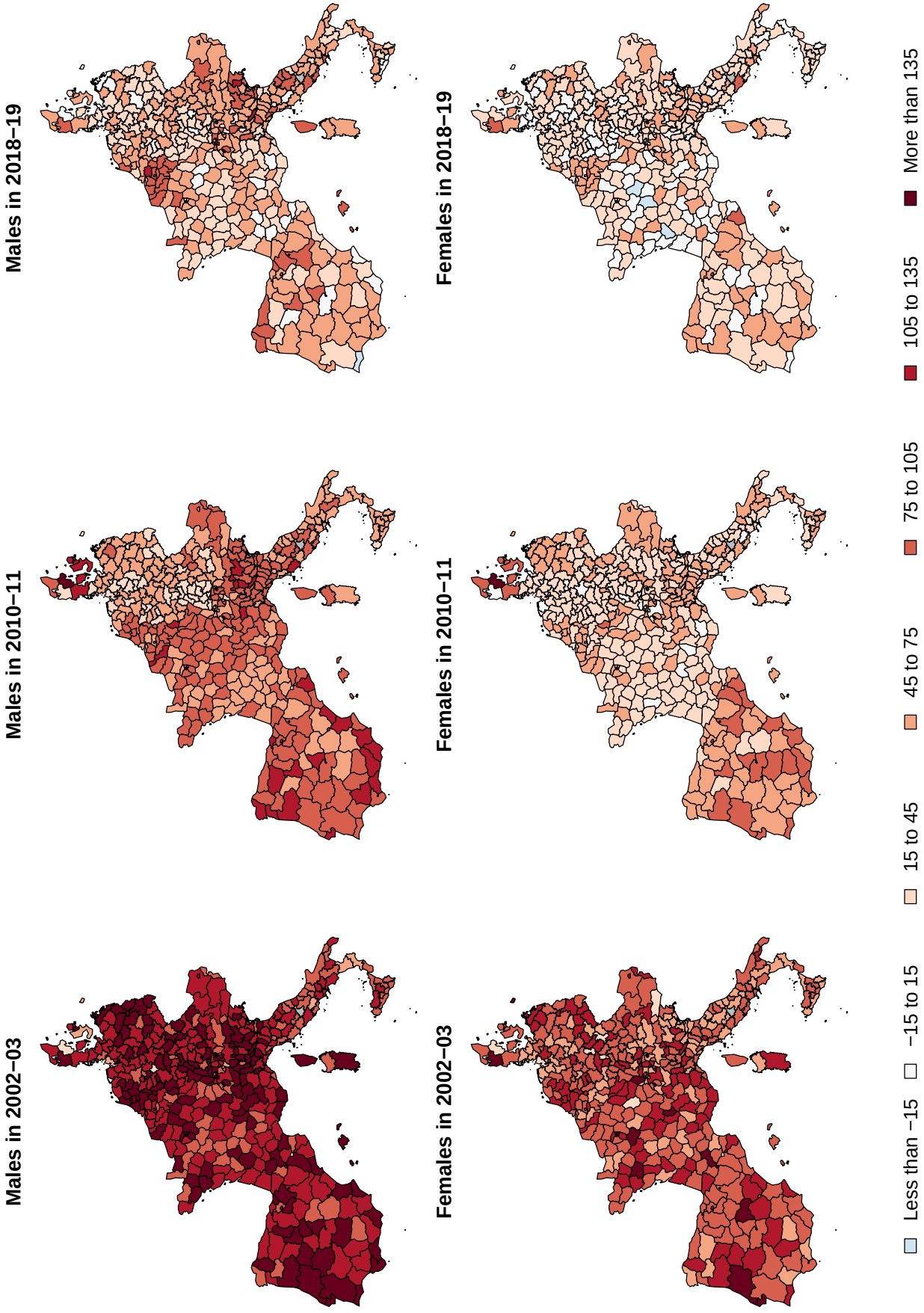

Figure 2. Maps of regional gains in e_0 for three periods.