Recent trends in subnational life expectancy in Austria, Czechia, and Slovakia

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Abstract

Trends and spatial patterns in mortality have long been of interest to demographers. Previously, researchers have mainly focused on cross-country comparisons or examined spatial mortality patterns in national populations. Combining both perspectives, i.e. the subnational perspective across countries with shared borders, could provide a more comprehensive picture of recent mortality trends. Therefore, we estimate trends and spatial patterns in sex-specific life expectancy in 272 regions, located in three neighboring countries (Austria, Czechia, and Slovakia) from 2003 – 2019. This time period is particularly interesting because Czechia and Slovakia were among ten countries who became members of the European Union in May 2004 while Austria had previously been a member. A methodological challenge arises due to small population numbers and resulting erratic death counts. We utilize two approaches: First, we estimate life expectancy from the raw data. Second, we use Bayesian small-area estimation methods to produce stable estimates of life expectancy.

1 Motivation & Objectives

Mortality estimates at the subnational level are increasingly interesting to both researchers and policymakers. These estimates are often used to learn about population health and mortality inequalities at fine spatial granularity. However, with few exceptions (e.g. Mühlichen et al. (2023) and Wilson et al. (2020)) studies usually focus on one country at a time (e.g. Hrzic et al. (2023),

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Rashid et al. (2021), and Rau and Schmertmann (2020)). In this paper, we aim to estimate trends in life expectancy at the subnational level in 272 LAU regions in Austria, Czechia, and Slovakia from 2003 − 2019.

On 1 May 2004 Czechia and Slovakia were among ten countries that became members of the European Union. Both countries have a direct border with EU-member state Austria, making it an interesting case to study mortality patterns over time. Previous research at the subnational level focused on Austria (Gächter and Theurl, 2011), Czechia (Kašpar et al., 2017), Slovakia (Michálek and Podolák, 2007) or a subset of new EU-member states at the NUTS 2 level (Hrzic et al., 2021). However, due to different time frames and methodologies, comparisons across studies and – consequently – regions are hardly possible. Furthermore, none of these studies used small-area estimation methods to estimate life expectancy.

A methodological challenge arises due to erratic death counts in small populations. Scherbov and Ediev (2011) show that this has consequences for estimating life expectancy as well as the corresponding standard errors in (very) small populations. Furthermore, as a general guideline, they recommend a case-by-case analysis for assuming normality of the standard errors – which is often used to calculate confidence intervals – for populations between 5 000 and 50 000. To help alleviate these problems small-area estimation methods have been developed (Alexander et al., 2017; Denecke et al., 2023; Dharamshi et al., 2023; Rashid et al., 2021; Rau and Schmertmann, 2020; Schmertmann and Gonzaga, 2018).

Substantively, we aim to study sex-specific patterns of mortality over time. In particular, (i) how sex-specific life expectancy at birth developed over time, (ii) whether males and females experienced the same trajectories, (iii) whether there are any outlying regions with comparatively small or large changes, and whether (iv) these developments were similar across the three countries.

2 Data & Methods

We use death and population counts by age and sex for 272 subnational regions in Austria, Czechia, and Slovakia covering the time period from 2003 − 2019. The subnational regions cover 116 Austrian districts including the districts of Vienna, 77 okresy of Czechia, and 79 okresy of Slovakia. The smallest district had a population of less than 2 000 in 2019 (Rust, Austria) while the largest had more than 1.3 million inhabitants (Prague, Czechia). Finally, more than 66% of all districts had less than 50 000 male person-years-lived in 2019. For females, this share was larger than 63%.

In order to obtain stable estimates of life expectancy, we use a novel Bayesian model (Dharamshi et al., 2023). A feature of this model is that multiple subgroups, such as males and females, are modeled simultaneously (Dharamshi et al., 2023). It is assumed that death counts in age group a, region r, year t, and sex s, $D_{a,r,t,s}$ are Poisson distributed with the respective mortality rate $m_{a,r,t,s}$ and population $P_{a,r,t,s}$, i.e. $D_{a,r,t,s} \sim \text{Poisson}\left(m_{a,r,t,s} P_{a,r,t,s}\right)$. The log mortality is then equal to a linear combination of right singular vectors obtained by decomposing a matrix of representative log mortality rates over time and an error term:

$$\log m_{a,r,t,s} = \sum_{p=1}^{P} \beta_{i,r,t,s} \cdot Y_{i,a} + u_{a,r,t,s}.$$

3 Preliminary Results

We present preliminary results from the Bayesian model for Austria. Figure 1 allows for a number of observations. First, life expectancy for both males and females increased over time. Second, male and female life expectancy has begun to converge. While there was a significant gap between the lowest performing female region and the highest performing male region in 2003, this is no longer the case. Third, within each sex, life expectancy gaps between worst and best performing regions are increasing over time, suggesting higher inequalities across subnational regions.

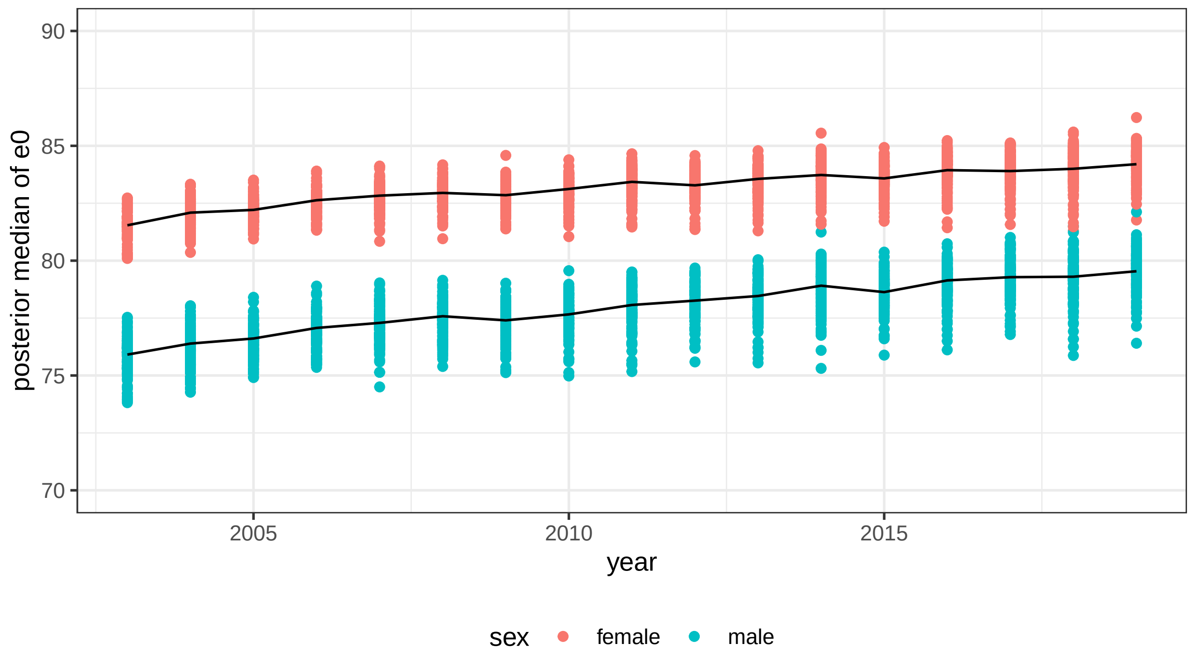

Figure 1: Posterior medians of life expectancy at birth over time. The black lines are the national life expectancies as extracted from the Human Mortality Database (Human Mortality Database, 2022). The idea of this figure comes from Rashid et al. (2021, Fig.1B).

Figure 2 shows the posterior medians of life expectancy with 90% credible intervals for all regions. The regions are displayed by decreasing order of life expectancy. The figure reveals that while uncertainty prohibits to precisely order the districts in the middle, it is possible to differentiate between best and lowest performing regions. In particular, the gap has been widening over time and it seems that a number of districts in Vienna are responsible for this widening gap. Life expectancy in the worst performing region in 2019 is at the 2003 level of the best performing regions.

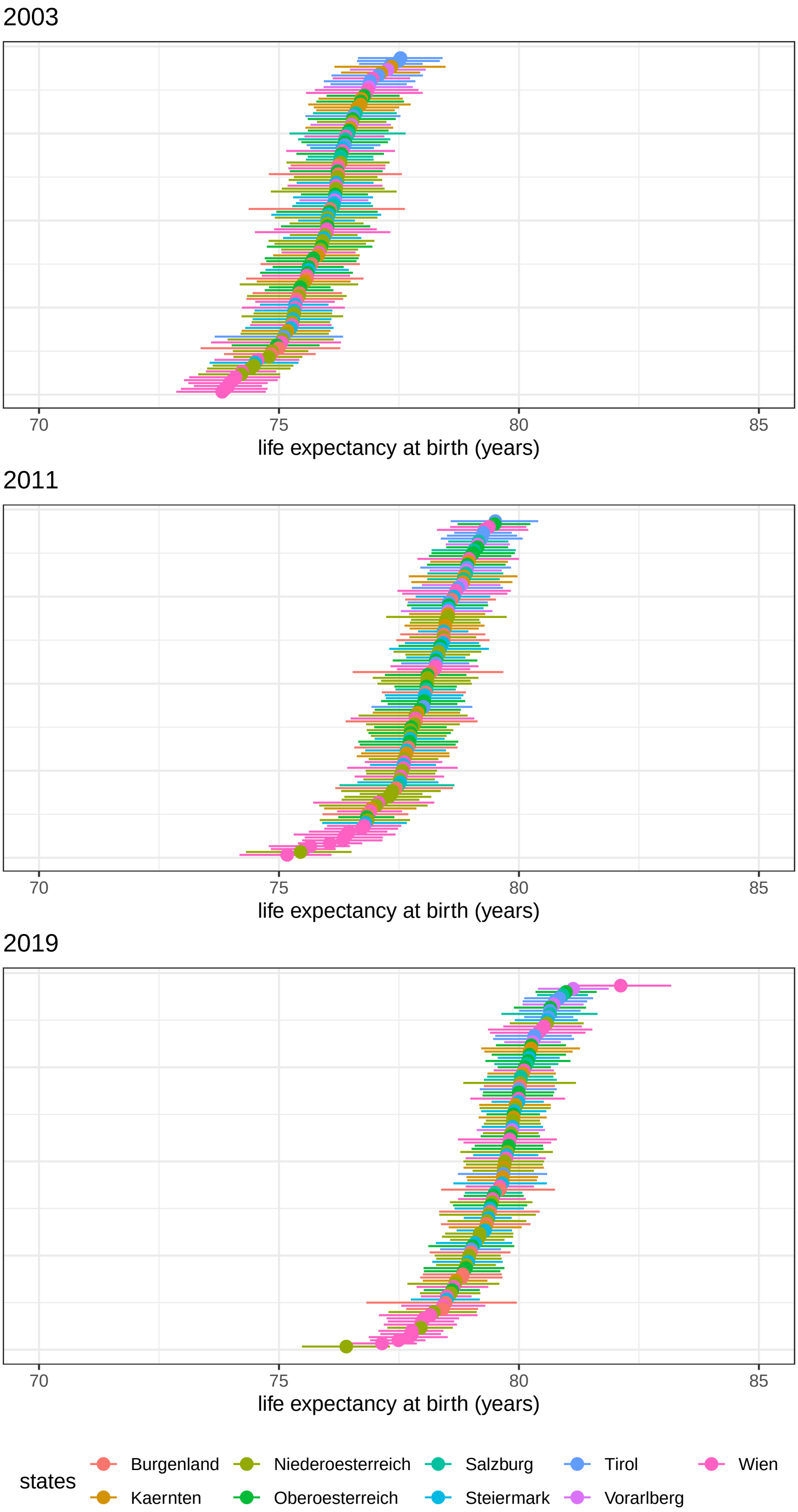

Figure 2: Posterior medians with 90% credible intervals of male life expectancy at birth for each district in 2003, 2011, and 2019. The districts are ordered by decreasing life expectancy. The idea of this figure comes from Rau and Schmertmann (2020, Fig.1).

4 Next Steps

We are planning several next steps in our analysis:

- Validate the Bayesian model and perform sensitivity checks.
- Compare the results to those obtained from the raw data.
- Apply the same model to the Czech and Slovakian data.

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