DISCUSSION PAPER SERIES

DP13184
(v. 2)

INEQUALITY IN LIFE EXPECTANCIES ACROSS EUROPE

Radim Bohacek, Jesus Bueren, Laura Crespo, Pedro Mira and Josep Pijoan-Mas

LABOUR ECONOMICS AND PUBLIC ECONOMICS

ISSN 0265-8003

INEQUALITY IN LIFE EXPECTANCIES ACROSS EUROPE

Radim Bohacek, Jesus Bueren, Laura Crespo, Pedro Mira and Josep Pijoan-Mas

Discussion Paper DP13184
First Published 17 September 2018
This Revision 08 November 2018

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

This Discussion Paper is issued under the auspices of the Centre's research programme in **LABOUR ECONOMICS AND PUBLIC ECONOMICS**. Any opinions expressed here are those of the author(s) and not those of the Centre for Economic Policy Research. Research disseminated by CEPR may include views on policy, but the Centre itself takes no institutional policy positions.

The Centre for Economic Policy Research was established in 1983 as an educational charity, to promote independent analysis and public discussion of open economies and the relations among them. It is pluralist and non-partisan, bringing economic research to bear on the analysis of medium- and long-run policy questions.

These Discussion Papers often represent preliminary or incomplete work, circulated to encourage discussion and comment. Citation and use of such a paper should take account of its provisional character.

Copyright: Radim Bohacek, Jesus Bueren, Laura Crespo, Pedro Mira and Josep Pijoan-Mas

INEQUALITY IN LIFE EXPECTANCIES ACROSS EUROPE

Abstract

We use harmonized household panel data from 10 European countries (SHARE), the US (HRS), and England (ELSA) to provide novel and comparable measurements of education and gender differences in life expectancy, years in disability, and the underlying multi-state life tables. Common across countries we find substantial interactions between socio-economic status and gender: (a) the education advantage in life expectancy is larger for males, while the education advantage in disability years is larger for females; and relatedly (b) the female advantage in life expectancy and the female disadvantage in disability years are both greatly reduced with education. These interactions happen because the education advantage is relatively more important in health transitions than in conditional survival among females, whereas the converse is true among males. Looking at the differences across countries, inequalities are largest in Eastern Europe and lowest in Scandinavia, while the US stands out as the most unequal across education groups in terms of health transitions and disability-free life expectancy. Finally, we find that countries with higher public health spending have smaller education advantage in conditional survival, the same advantage in health transitions, and smaller gradients in life expectancy.

JEL Classification: I14, I24, J14, J16

Keywords: Life Expectancy, healthy life expectancy, education gradient, Gender Gap

Radim Bohacek - radim.bohacek@cerge-ei.cz
CERGE

Jesus Bueren - jesus.bueren@eui.eu
European University Institute

Laura Crespo - laura.crespo@bde.es
Bank of Spain

Pedro Mira - mira@cemfi.es
Cemfi

Josep Pijoan-Mas - pijoan@cemfi.es
Cemfi and CEPR

Acknowledgements
We thank comments by Axel Borsch-Supan, Eileen Crimmins, Michael Dworski, Nezih Guner, Mathias Kredler, Pierre-Carl Michaud, Victor Rios-Rull and by attendants to seminars held at RAND (Santa Monica) and SAEe (Girona). Radim Bohacek

acknowledges funding from the Ministry of Education, Youth, and Sports of the Czech Republic, grant LM2015052 and the SHARE-CZ+ project; Pedro Mira acknowledges support from grant ECO2014-57768-P from the Spanish Ministerio de Economia y Competitividad; Josep Pijoan-Mas acknowledges funding from from the Spanish Ministerio de Educacion through the 2017 Salvador de Madariaga Mobility Grant and the hospitality of UCL Economics Department. The developers and funders of ELSA, HRS, and SHARE do not bear any responsibility for the analyses or interpretations presented here.

Inequality in Life Expectancies across Europe*

Radim Boháček
CERGE-EI

Jesús Bueren
EUI

Laura Crespo
Banco de España

Pedro Mira
CEMFI

Josep Pijoan-Mas
CEMFI and *CEPR*

November 8, 2018

Abstract

We use harmonized household panel data from 10 European countries (SHARE), the US (HRS), and England (ELSA) to provide novel and comparable measurements of education and gender differences in life expectancy, years in disability, and the underlying multi-state life tables. Common across countries we find substantial interactions between socio-economic status and gender: (a) the education advantage in life expectancy is larger for males, while the education advantage in disability years is larger for females; and relatedly (b) the female advantage in life expectancy and the female disadvantage in disability years are both greatly reduced with education. These interactions happen because the education advantage is relatively more important in health transitions than in conditional survival among females, whereas the converse is true among males. Looking at the differences across countries, inequalities are largest in Eastern Europe and lowest in Scandinavia, while the US stands out as the most unequal across education groups in terms of health transitions and disability-free life expectancy. Finally, we find that countries with higher public health spending have smaller education advantage in conditional survival, the same advantage in health transitions, and smaller gradients in life expectancy.

JEL classification: I14, I24, J14, J16
Keywords: life expectancy, healthy life expectancy, education gradient, gender gap

*We thank comments by Axel Börsch-Supan, Eileen Crimmins, Michael Dworski, Nezih Guner, Mathias Kredler, Pierre-Carl Michaud, Víctor Ríos-Rull and by attendants to seminars held at RAND (Santa Monica) and SAEe (Girona). Radim Boháček acknowledges funding from the Ministry of Education, Youth, and Sports of the Czech Republic, grant LM2015052 and the SHARE-CZ+ project; Pedro Mira acknowledges support from grant ECO2014-57768-P from the Spanish *Ministerio de Economía y Competitividad*; Josep Pijoan-Mas acknowledges funding from from the Spanish *Ministerio de Educación* through the 2017 *Salvador de Madariaga* Mobility Grant and the hospitality of UCL Economics Department. The developers and funders of ELSA, HRS, and SHARE do not bear any responsibility for the analyses or interpretations presented here.

1 Introduction

The study of economic inequality has attracted a great deal of attention in the last decades. New data and methods have been developed and thanks to them we have today a fairly good picture of both the patterns and the differences in income and wealth inequality across countries, see for instance Krueger et al. (2010) or the recent report by Alvaredo et al. (2018). However, less is known about the range of inequalities in health outcomes and mortality across countries. This is unfortunate as health inequality might be more important in terms of welfare, it is likely to become more relevant in the coming years with the aging of population, and it certainly has first order implications for public policy. Furthermore, efforts to understand the origins of health inequality can benefit from both the similarities and the differences to be found across countries.

This paper aims to fill this gap by comparing the inequality in life expectancy and healthy life expectancy between education and gender groups across 10 European countries, the US and England. To do so, we put together harmonized and comparable household panel data from the Survey of Health, Ageing and Retirement (SHARE) for Continental Europe, the Health and Retirement Study (HRS) for the US, and the English Longitudinal Study of Ageing (ELSA) for England to compute multi-state life tables by gender and education starting at age 50 and comprising the period from 2002 to 2015. This delivers the associated gender and education differences in age-50 life expectancy and healthy life expectancy across countries, as well as other statistics of interest. We focus on education as a measure of socio-economic status because it is a good approximation to lifetime income and because of its small measurement error. We focus on gender because it is an important dimension of inequality across individuals that has been somewhat overlooked by the literature on health inequalities. In addition, because neither education nor gender change over the life cycle, these choices simplify the methods used to obtain the multi-state life tables and minimize issues related to reverse causality. We focus on age 50 because most health differences emerge after that age. Our measure of health is the absence of conditions limiting the activities of daily living (ADL), and hence we use the terms healthy life expectancy and disability-free life expectancy interchangeably. This definition of health is of high economic relevance because it is related both to the ability to work and to the need of long-term care.

We uncover three common patterns across countries, all of them underscoring an important interaction between socio-economic status and gender. First, the education gradient in life expectancy (the difference in life expectancy between college and non-college individuals) tends to be larger for males than for females, while the gender gap

in life expectancy (the difference in life expectancy between females and males) tends to be larger among the low educated than among the high educated. Note that these two statements are equivalent due to the double differentiation, so they reflect a unique pattern. More precisely: in our sample of 12 countries the average education gradient is 3.4 years for males and 2.2 year for females, while the average gender gap is 3.9 years among the low-educated and 2.7 years among the high-educated. Looking at the multi-state life tables, we find that the education gradient in life expectancy arises because there is an education advantage in both health transitions and survival conditional on health —with the latter being relatively more important— while the gender gap is almost exclusively driven by the female advantage in conditional survival. The interaction between gender and education appears because the educational advantage in conditional survival rates is larger among males, which is equivalent to saying that the female advantage in survival is larger among the low-educated.

Second, in almost all countries the education gradient in disability-free life expectancy is larger than in total life expectancy, which implies that more educated individuals spend less time in disability despite living longer. Our novel result is that this pattern is clearly stronger among females than among males. In particular, high-educated males spend on average 0.6 fewer years in disability than low-educated ones, while this difference is 1.7 years for females. This result connects with the literature on the compression of morbidity, which conjectures that as life expectancy increases over time there is a parallel decline in morbidity, see Fries (1980). Our cross-country variation across education groups implies that an extra year of life for males (females) is associated with almost 2 (almost 6) fewer months in disability. Looking at the multi-state life tables, we find that the education advantage in disability years arises because of better health transitions and despite the lower conditional mortality by the more educated. Indeed, if the only difference between education groups was in the mortality rates conditional on health, the more educated would suffer more years in disability due to their higher survival. The higher compression of morbidity among females appears because the education advantage in health transitions is relatively larger for women.

And third, we see that in every country the gender gap in disability-free life expectancy is smaller than in life expectancy, or in other words, women live longer and spend more years in disability. This apparent puzzle, which represents a "failure of compression" of sorts, had been observed before and was first described as "women get sicker but men die quicker" by Lorber and Moore (2002). Our novel result is that this pattern applies primarily to the low educated population. In particular, low educated females (high educated) spend on average 1.4 (0.3) more years in disability than low-educated (high

educated) males. This implies that, among the low-educated (high-educated) every extra year of life expectancy enjoyed by females relative to males is associated with 4 (1.5) extra months in disability. Our decomposition results show that this pattern appears because men, especially the low-educated, experience worse survival rates than women once in disability (confirming the "men die quicker") but female health transitions are no worse than those of males (so women "stay" rather than "get" sicker).

To sum up, we note that all the interactions between gender and education appear because of two underlying differences between men and women: the education advantage in conditional survival is relatively more important for men and the education advantage in health transitions is relatively more important for women.

In addition to the common characteristics across countries discussed above, we also find that our data display a large amount of heterogeneity across countries. We can summarize our findings as follows. First, the education gradients are maximal in several Eastern and Western European countries and in the US. Looking at males, the largest education gradients in total life expectancy are in Poland (5.4 years), Estonia (4.6), France (3.9), Austria (3.8), and the US (3.6), while the smallest gradients are in Denmark (2 years) and Sweden and Italy (2.5 years each). For females the largest education gradients in total life expectancy are in Czechia (5.9 years), the US (3.2), and Slovenia (3.0), while the smallest ones are in Spain (0.0), Poland (1.0), England (1.2), Austria (1.7), and France (1.8). The gender differences in the education gradients in life expectancy are largest in Poland (4.4) and Spain (3.5) and virtually non-existent in Denmark, Sweden, Italy, and Slovenia. Finally, with a few exceptions, the gradients in healthy life expectancy do not change much the ranking of countries.

Second, looking at how the education gradients relate to country variables, we find that countries whose governments spend more in health care display smaller education gradients in total life expectancy, no difference in disability-free life expectancy, and larger (negative) gradients in disability years. This suggests that public health care helps reduce mortality in bad health for low educated individuals but does not improve their health transitions. We also find that this pattern is sharper for males than for females, which is consistent with our finding that the education gradient in conditional survival matters more for men than for women.

Third, the gender gaps in life expectancy are largest in Eastern Europe (around 5.5 years for both low and high educated individuals) and lowest in Scandinavia (less than 2 years for both low and high educated individuals), and the same is true for the gradients in healthy life expectancy. The female disadvantage in disability years among the low-educated, the group for which it is more clear, is largest in the Mediterranean (2.4 years

in Italy and 2.1 in Spain) and smallest in Scandinavia (0.4 years in Denmark and 0.7 in Sweden).

Finally, the US stands out relative to Europe in two ways. The first one is that, while some European countries have gradients in male life expectancies that are as large as in the US, the US has the largest gradient in disability-free life expectancy and the largest (negative) gradient in disability years. That is to say, the detrimental effect of low education for the life expectancy gradient is actually amplified more in the US than anywhere else when we consider its "disability-free" and "in-disability" components. The second difference, very much related to the first one, is that differences in health transitions across education groups are more important in the US than anywhere else.

Methodologically, we face the challenge that the SHARE data is not straightforward to use for survival analysis because, for several reasons, it is quite an irregular panel. In this sense, our contribution is to write a three-state continuous time duration model tailored to match micro data obtained in discrete time at irregular intervals. We estimate the model with Bayesian techniques and produce the multi-state life tables that are the basis for the life expectancy calculations and decompositions. We validate the use of SHARE data for survival analysis by comparing our estimated life tables by gender to the ones from population data. We show that the SHARE tables match the population tables reasonably well in many countries and we select for our analysis the 10 best-fitting countries (out of 16). The value of this methodology goes beyond this paper as it can be easily applied to other surveys of similar design and it represents an alternative to the so-called Sullivan method. The Sullivan method is less demanding in terms of data because it only requires population survival rates and cross-sectional data on the health distribution.[1] However, it has a few drawbacks. First, because it does not provide transitions, its scope is more limited. For instance, it cannot be used to analyze the persistence of health states or to decompose the observed gradients into differences in mortality versus differences in transitions. Second, in order to compute education gradients in life expectancies and healthy life expectancies the Sullivan method requires population life-tables by education, and these are not available for all countries. And third, it is based on somewhat more restrictive assumptions, namely that mortality rates be independent from the health state and that the expected number of good-to-bad health transitions equals the expected number of bad-to-good health transitions.

[1]The Sullivan method was developed in the 60's, see Sanders (1964), Sullivan (1966), and Sullivan (1971). See discussion in Laditka and Hayward (2003).

1.1 Related literature

The size of the education gradients of life expectancy and healthy life expectancy —and the shape of the underlying multi-state life tables— are consequential for many economic questions. First, because gradients are big, forecasts of future gains in life expectancy and healthy life expectancy need to keep track of the changes in education attainment of the underlying population. For instance, according to Case and Deaton (2017), the growth in college attainment explains approximately 48 percent of the reduction in age-adjusted mortality in the US between 1910 and 2000. Second, the redistributive power of retirement pensions may be partly eroded by the longer life expectancies of richer individuals, see for instance Brown (2002) or Fuster et al. (2003). Third, the increase in the dependency ratio has led many countries to delay retirement age in order to balance their pay-as-you-go retirement systems. Many papers show that health is an important determinant of labor supply at old age, see Blundell et al. (2016) for a recent survey. In this context, the gradient in healthy life expectancy is important for both the effectiveness and the welfare impact of such policies, see for instance Wen (2017). And fourth, the unhealthy life expectancy (the difference between life expectancy and healthy life expectancy) is critical to predict expenses in long-term care needs and medical assistance. Hence, its gradient matters to understand the redistributive power of public policies that finance these programs, see for instance De Nardi et al. (2016) or Bueren (2017).

There are relatively good measures of the education gradient in life expectancy in the US using both data from death registers —see for instance Meara et al. (2008)— and data from household surveys —see Pijoan-Mas and Ríos-Rull (2014). However, this is not so in Europe. First, death registers are less useful in Europe because they do not record data on education. Some recent papers, however, have linked the death registers with census data to obtain education and sex-specific death rates of individuals up to 79 years of age. A limitation is that country samples are not always nationally representative and the resulting data are not homogenized across countries, which makes cross-country comparisons problematic.[2] And second, regarding survey data only the European Community Household Panel (ECHP) –which covers the period between 1994 and 2000– has been used, see Majer et al. (2010). A limitation of the ECHP is that the survey design is far from ideal for survival analysis because of the small number of old individuals and because of the lack of exit interviews to distinguish attrition from death events. In addition, the range of countries available in the ECHP is also limited as it does not include

[2]See for instance Avendano et al. (2011) or Mackenbach et al. (2008) for results on socioeconomic inequalities in mortality across European countries by use of this register-based mortality data set.

countries of the former communist bloc. Our paper is the first one to use SHARE data for this purpose, for which in principle it is very well suited. Furthermore, due to the similar sample design and questionnaires of SHARE, ELSA, and HRS, we can provide clean comparisons of Continental European countries with England and the US.[3] Regarding healthy life expectancy, there is even less available information. For Europe there are only two studies: Maki et al. (2013) applying the Sullivan method to census-linked mortality data and Majer et al. (2010) estimating multistate life tables with the ECHP survey data.

Finally, a recent literature has provided important findings about the widening gap of the education gradients of life expectancy in the US, see for instance Meara et al. (2008) or Montez et al. (2011), about the increase in mortality rates of low-educated white males, see Case and Deaton (2017), or about the larger decline in mortality in richer counties for the 50+ population, see Currie and Schwandt (2016). The increase in the education gradient of mortality has also been documented in several European countries, see for instance Mackenbach et al. (2015b) or de Gelder et al. (2017). Our work does not have much to say about this phenomenon as the time span of our underlying data is relatively short. However, our methods can be used to look at time changes when these surveys become larger (and can be already applied to the long HRS panel in the US).

The remainder of the paper is organized as follows. In Section 2 we explain the methodological problems in using SHARE for survival analysis. In Section 3 we explain the duration model we use to estimate multi-state life tables and how we build our measures of life expectancy from them. In Section 4 we describe the data choices we make and in Section 5 we present the main results. Finally, Section 6 looks at the results with more detail by presenting some cross-country regressions, and Section 7 concludes. The online Appendix provides a detailed comparison of country life tables by gender obtained with our SHARE data and the ones coming from population data.

2 Survival analysis with SHARE data

The Survey of Health, Ageing and Retirement in Europe (SHARE) is an important source of data that has been so far underutilized for survival analysis. SHARE is particularly useful for three reasons. First, it is based on nationally representative country samples of the non-institutionalized civilian population aged 50 and older, and individuals are kept in the survey if they move into a nursing home. This allows to compare gradients across

[3]Delavande and Rohwedder (2011) also use data from HRS, ELSA, and SHARE to compare socio-economic gradients of mortality. However, their approach is very different as they use a single cross-section for each country and exploit data on subjective survival probabilities.

countries using a harmonized dataset. Furthermore, the survey design and questionnaires are based on the ones used by the Health and Retirement Study (HRS) in the US, which in turn is the model for the English Longitudinal Study of Ageing (ELSA) in England, and similar surveys in many other countries.[4] This increases the scope of comparability of results. Second, it explicitly attempts to obtain end-of-life interviews so it is arguably less likely to under-report deaths than other survey data. And third, its longitudinal dimension allows us to use a multistate model to improve on the Sullivan method to compute healthy life expectancies.

At the same time, there is a number of potential problems with the use of SHARE data for survival analysis. First, there is the possibility of biases in sample design, response rates at baseline, or sample retention inherent in survey data. The sample retention problem is important for survival analysis if attrition is larger for deceased individuals. However, in the online Appendix we argue that this potential problem should not prevent the use of SHARE for survival analysis, at least for many of its country samples. In particular, we show that for several countries the survival functions compare well to the corresponding population life tables. In addition, we show that the probability of attrition is unrelated to variables that predict survival.

Second, in practical terms, the SHARE panel is not straightforward to use for longitudinal analysis because it is not a perfectly regular panel. First, the time between surveys differs substantially across waves and across countries; second, wave 3 only contains retrospective data, so no information on health states or any time-changing socio-economic information is available; third, a few countries could not guarantee funding for all years and do not provide data for all waves; and fourth, a fraction of individuals in each country were lost for one or two waves and recovered afterwards. To bypass these problems we use a multi-state continuous time survival model with health as a dynamic latent variable. The model allows for flexible interactions of duration and regressors in a tractable way and is estimated with data on the particular observation windows for each individual. Then, we use the estimated model to compute multi-state life tables at annual frequency for each country-gender-education sample, which in turn are used to obtain life expectancies and healthy life expectancies.

And the third problem with SHARE is the small sample sizes for every country. This problem becomes more severe as one breaks down the data by gender, age, education, and

[4]The other countries using the HRS design and questionnaires to collect data on ageing are Brazil, Canada, China, Costa Rica, India, Indonesia, Ireland, Japan, Mexico, New Zealand, North Ireland, Scotland, South Korea, and South Africa. See `https://g2aging.org/` for details. As of now, surveys for these countries still have few waves, if any at all.

health, and is hence of first order importance for the study of socio-economic gradients of health outcomes. To deal with this problem we do three things. First, we pool together individuals of different cohorts to estimate our duration model. In practice, this means that we ignore possible time changes in survival rates and health transitions, but given the relatively short time span of the data we expect this not to be major problem. Second, we use Bayesian techniques to estimate our statistical model of survival and impose a set of "regularity" priors that constrain the model parameters to preserve the age decline of health and survival. This set of priors changes neither point estimates nor their precision for most countries but helps narrowing the posterior distribution of the parameters on those country samples with fewer data. And third, we provide complementary estimates pooling together individuals of similar countries, which allows to reduce the standard errors of our life expectancies without changing the main results.

Perhaps because of these problems, previous work with SHARE for survival analysis is scarce: the only papers we are aware of are Boháček et al. (2015), Nakajima and Telyukova (2015), and Solé-Auró et al. (2015). Boháček et al. (2015), which reports on the first stages of this project, computes non-parametric survival functions for high and low educated individuals for several countries by use of the Kaplan-Meier estimator, which naturally deals with the irregularity of the panel. Nakajima and Telyukova (2015) estimate multi-state health and survival age-dependent markovian matrices between waves 1 and 2 for Sweden only, so they do not need to deal with the irregularity of the panel. Solé-Auró et al. (2015) estimates survival models for several deseases in order to compare prevalence, incidence, and mortality in Europe and the US. These authors deal with the irregularity of the panel and the small country samples by pooling the data of 5 SHARE countries together and by estimating proportional hazard models of mortality and of the onset of disease between waves 1 and 2.

3 Methodology

As discussed in Section 2, the time span between the two consecutive observations that form an individual transition differs across countries, waves, and individuals. This makes unfeasible to simply estimate wave to wave transitions and survival rates as it is typically done with HRS data. For this reason, in Section 3.1 we set up a duration model with three states which is tailored to match microdata obtained in discrete time at irregular intervals; in Section 3.2 we discuss the estimation methods, and in Section 3.3 we discuss how we build the life expectancy measures from the estimated parameters.

3.1 Statistical model

We define 3 states: 0 (dead), 1 (alive-unhealthy), 2 (alive-healthy). A typical measurement at wave w is (a_w, h_w, x_w) where a_w is age, h_w is health state, and x_w are socio-economic variables. Every individual in our sample is observed in at least two (not necessarily consecutive) waves, so our empirical model is based on the transition probabilities $P(h_{w+1}|a_{w+1}, a_w, h_w, x_w)$, where $w+1$ is the next wave of observation for each individual, which is at an arbitrary distance $a_{w+1} - a_w$ from wave w.

We interpret the transitions between states as the outcome of independent competing risks in continuous time, but we assume that the underlying hazard rates are constant between birthdays and that at most one transition occurs between any 2 birthdays and between an observation (wave) and the nearest birthday. This leads to fairly simple expressions. To obtain the likelihood contribution for $P(h_{w+1}|a_{w+1}, a_w, h_w, x_w)$, we need to combine probability contributions for: (i) complete 1-year intervals between birthdays, (ii) incomplete intervals between $\left[a_w, \text{int}(a_w) + 1\right]$ and $\left[\text{int}(a_{w+1}), a_{w+1}\right]$, where $\text{int}(a)$ is a function that returns the integer part of any age a. For instance, an individual who is observed in two waves separated by two and a half years will provide one or two contributions of type (i) and two contributions of type (ii). Furthermore, we need to integrate over all possible trajectories between (a_w, h_w) and (a_{w+1}, h_{w+1}) because health is allowed to change every year but it is unobserved between interviews.

For contributions of type (i) we specify two multinomial logits for the transition probabilities from each state $i = 1, 2$ at birthday a to state $j = 0, 1, 2$ at birthday $a + 1$. The covariates are age a itself and potentially variables for socio-economic status x. To ease notation, let's abstract from x. Define $a \in \{50, 51, ..., \bar{a}\}$, where $\bar{a}$ is the maximum age, and $f_{ij}(a) = \beta_{ij0} + \beta_{ij1} a$. The probability $p_{ij}(a)$ that an individual with health $i \in \{1, 2\}$ at birthday a transits into health $j \in \{0, 1, 2\}$ within a year is given by:

$$\begin{aligned} p_{ii}(a) &= \frac{1}{1 + e^{f_{ik}(a)} + e^{f_{i0}(a)}} \\ p_{ik}(a) &= \frac{e^{f_{ik}(a)}}{1 + e^{f_{ik}(a)} + e^{f_{i0}(a)}} \\ p_{i0}(a) &= \frac{e^{f_{i0}(a)}}{1 + e^{f_{ik}(a)} + e^{f_{i0}(a)}} \end{aligned}$$

where $k \neq i, 0$.

For contributions of type (ii) define $\tilde{p}_{ij}(a, d)$ as the probability that and individual with health $i \in \{1, 2\}$ and age a transits into health $j \in \{0, 1, 2\}$ within a fraction d of a year (before reaching birthday $a + 1$). Computing $\tilde{p}_{ij}(a, d)$ involves two steps.

1. Recovering the hazard rates $\lambda_{ij}(a)$,

$$\begin{aligned} 1 - p_{ik}(a) - p_{i0}(a) &= e^{-(\lambda_{ik}(a)+\lambda_{i0}(a))} \\ p_{ik}(a) &= \frac{\lambda_{ik}(a)}{\lambda_{ik}(a)+\lambda_{i0}(a)}[1 - e^{-(\lambda_{ik}(a)+\lambda_{i0}(a))}] \end{aligned}$$

2. Computing the probabilities as

$$\begin{aligned} \tilde{p}_{ii}(a,d) &= e^{-(\lambda_{ik}(a)+\lambda_{i0}(a))d} \\ \tilde{p}_{ik}(a,d) &= \frac{\lambda_{ik}(a)}{\lambda_{ik}(a)+\lambda_{i0}(a)}\left[1 - e^{-(\lambda_{ik}(a)+\lambda_{i0}(a))d}\right] \\ \tilde{p}_{i0}(a,d) &= \frac{\lambda_{i0}(a)}{\lambda_{ik}(a)+\lambda_{i0}(a)}\left[1 - e^{-(\lambda_{ik}(a)+\lambda_{i0}(a))d}\right] \end{aligned}$$

where $k \neq i, 0$.

Given the objects $p_{ij}(a)$ and $\tilde{p}_{ij}(a,d)$ just defined, we can write the likelihood $P(h_{w+1}|a_{w+1}, a_w, h_w)$ of any given individual transition as,

$$\begin{aligned} P(h_{w+1}|a_{w+1}, a_w, h_w) &= \begin{bmatrix} \mathbb{1}_{h_w=1} & \mathbb{1}_{h_w=2} \end{bmatrix} \begin{bmatrix} \tilde{p}_{11}(int(a_w), d_1) & \tilde{p}_{12}(int(a_w), d_1) \\ \tilde{p}_{21}(int(a_w), d_1) & \tilde{p}_{22}(int(a_w), d_1) \end{bmatrix} \\ &\quad \prod_{a=int(a_w)+1}^{int(a_{w+1})} \begin{bmatrix} p_{11}(a) & p_{12}(a) \\ p_{21}(a) & p_{22}(a) \end{bmatrix} \\ &\quad \begin{bmatrix} \tilde{p}_{11}(int(a_{w+1}), d_2) & \tilde{p}_{12}(int(a_{w+1}), d_2) & \tilde{p}_{10}(int(a_{w+1}), d_2) \\ \tilde{p}_{21}(int(a_{w+1}), d_2) & \tilde{p}_{22}(int(a_{w+1}), d_2) & \tilde{p}_{20}(int(a_{w+1}), d_2) \end{bmatrix} \begin{bmatrix} \mathbb{1}_{h_{w+1}=1} \\ \mathbb{1}_{h_{w+1}=2} \\ \mathbb{1}_{h_{w+1}=0} \end{bmatrix} \end{aligned}$$

where $\mathbb{1}$ is an indicator function and

$$\begin{aligned} d_1 &= int(a_w) + 1 - a_w \\ d_2 &= a_{w+1} - int(a_{w+1}) \end{aligned}$$

Similar expressions for the likelihood contribution of a given individual transition can be derived when the information on health h_w or/and h_{w+1} is incomplete (the survival status is known but not whether the individual is healthy or unhealthy).

Finally, in the data we observe N of such individual transitions. Because, we consider

those N transitions independent, the full likelihood is given by:

$$p(H|\boldsymbol{\beta}) = \prod_{n=1}^{N} P(h_{w+1}^n | a_{w+1}^n, a_w^n, h_w^n), \tag{1}$$

where H represents all the health transitions in the sample and $\boldsymbol{\beta}$ is the vector of β_{ijl} parameters.

3.2 Estimation

In order to reduce the uncertainty of estimated parameters from our small country samples, we rely on Bayesian techniques by constraining the space of possible $\boldsymbol{\beta}$ to satisfy a set of five regularity conditions $r_1(\boldsymbol{\beta}|a)$ to $r_5(\boldsymbol{\beta}|a)$ that we re-write as a prior for $\boldsymbol{\beta}$ with pdf:

$$p(\beta) = \prod_{a=50}^{\bar{a}} r_1(\boldsymbol{\beta}|a) \cdot r_2(\boldsymbol{\beta}|a) \cdot r_3(\boldsymbol{\beta}|a) \cdot r_4(\boldsymbol{\beta}|a) \cdot r_5(\boldsymbol{\beta}|a) \tag{2}$$

These five regularity conditions are:

$$r_1(\boldsymbol{\beta}|a) = \begin{cases} 1 & \text{if } \dfrac{p_{22}(a)}{1-p_{20}(a)} \geq \dfrac{p_{22}(a+1)}{1-p_{20}(a+1)}, \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

$$r_2(\boldsymbol{\beta}|a) = \begin{cases} 1 & \text{if } \dfrac{p_{12}(a)}{1-p_{10}(a)} \geq \dfrac{p_{12}(a+1)}{1-p_{10}(a+1)}, \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

$$r_3(\boldsymbol{\beta}|a) = \begin{cases} 1 & \text{if } p_{20}(a+1) \geq p_{20}(a), \\ 0 & \text{otherwise} \end{cases} \tag{5}$$

$$r_4(\boldsymbol{\beta}|a) = \begin{cases} 1 & \text{if } p_{10}(a+1) \geq p_{10}(a), \\ 0 & \text{otherwise} \end{cases} \tag{6}$$

$$r_5(\boldsymbol{\beta}|a) = \begin{cases} 1 & \text{if } p_{10}(a) \geq p_{20}(a), \\ 0 & \text{otherwise} \end{cases} \tag{7}$$

and allow us to restrict the parameter space such that: conditional on surviving, the probability of remaining in good health decreases with age, equation (3); conditional on surviving, the probability of moving from bad to good health decreases with age, equation (4); the probability of surviving (conditional on both good and bad health) decreases with age, equations (5) and (6); and the probability of dying is larger when in bad health than in good health, equation (7).

The posterior distribution of $\boldsymbol{\beta}$ is given by:

$$p(\boldsymbol{\beta}|H) \propto p(H|\boldsymbol{\beta}) \cdot p(\boldsymbol{\beta}), \tag{8}$$

In order to sample from the posterior distribution, we use Markov Chain Monte-Carlo (MCMC) methods with a standard Metropolis algorithm:

1. Initialize at $\boldsymbol{\beta}^{t=0}$
2. Propose candidate $\boldsymbol{\beta}^c = \boldsymbol{\beta}^t + \epsilon$, where $\epsilon \sim N(0, \sigma_\epsilon^2)$
3. Accept $\boldsymbol{\beta}^c$ with probability:

$$\alpha(\boldsymbol{\beta}^c|\boldsymbol{\beta}^t) = \min\left\{1, \frac{p(\boldsymbol{\beta}^c|H)}{p(\boldsymbol{\beta}^t|H)}\right\}$$

4. If candidate is accepted $\boldsymbol{\beta}^{t+1} = \boldsymbol{\beta}^c$, otherwise $\boldsymbol{\beta}^{t+1} = \boldsymbol{\beta}^t$.
5. Set t=t+1 and go back to 2 until convergence in the posterior distribution.

The empirical results in the next sections are based on 500,000 draws for each sample. The first 40,000 draws are disregarded as burn-in and the remaining 460,000 provide a posterior distribution of the vector of parameters $\boldsymbol{\beta}$ for each country-gender-education sample. We adjust the variance σ_ε^2 of the proposal for every country-gender-education sample to ensure acceptance rates are around 30%.

3.3 Computing life expectancies

We use the posterior distribution of parameter estimates to obtain a distribution of transition probabilities or multi-state life tables $p_{ij}(a)$ for each country-gender-education sample, which in turn we use to compute a distribution of life expectancies (LE), healthy life expectancies (HLE), and unhealthy life expectancies (ULE) using standard formulas (see Appendix A). LE is understood as the average number of years that a 50-year old person will live if the health transitions $p_{ij}(a)$ were to remain constant at the estimated values. Likewise, healthy (unhealthy) life expectancy HLE (ULE) is understood as the average number of years that a 50-year old person will spend in the good (bad) health state if the health transitions $p_{ij}(a)$ were to remain constant at the estimated values. Note that it has to be the case that LE=HLE+ULE.

4 Data

We use all available waves of SHARE data plus waves 6 to 11 of HRS and 1 to 6 of ELSA in order to have data for the US and England for a comparable time frame.[5,6]

We create a sample where every individual-wave observation refers to a transition between the given wave and the next available (not necessarily consecutive) one. This observation keeps track of the date of interview and health in the next available wave or the date of death if the individual did not survive, as well as gender, education, age and health of the current wave. After recording this information, the last wave of every individual is dropped because it cannot provide any further transition. Of course, we drop individuals with only one observation because they cannot provide any transition. We keep those individuals with age at their first interview above 49 and below 91. Individuals

[5]We use data from SHARE Waves 1, 2, 3 (SHARELIFE), 4, 5 and 6 (DOIs: 10.6103/SHARE.w1.610, 10.6103/SHARE.w2.610, 10.6103/SHARE.w3.610, 10.6103/SHARE.w4.610, 10.6103/SHARE.w5.610, 10.6103/SHARE.w6.610), see Börsch-Supan et al. (2013) for methodological details. The SHARE data collection has been primarily funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812) and FP7 (SHARE-PREP: N211909, SHARE-LEAP: N227822, SHARE M4: N261982). Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

[6]ELSA data were made available through the UK Data Archive. ELSA was developed by a team of researchers based at the NatCen Social Research, University College London and the Institute for Fiscal Studies. The data were collected by NatCen Social Research. The funding is provided by the National Institute of Aging in the United States, and a consortium of UK government departments co-ordinated by the Office for National Statistics.

with missing information on health but known survival status are kept as they also provide valuable likelihood contributions (this is the case for instance for all individuals in Wave 3 of SHARE). Except in ELSA, the age variable is continuous because we use year and month of birth and year and month of interview.

High education is defined in all countries as completing a degree at a tertiary educational institution (college or university) corresponding to ISCED 1997 codes 5 and 6, whereas low education correspond to all the remaining categories, that is ISCED 1997 codes 0, 1, 2, 3, or 4.[7]

A person in a healthy state is defined as having no limitations with activities of daily living (ADL). That is, he or she has no limitations with any of the following six activities: dressing (including putting on shoes and socks), walking across a room, bathing or showering, eating, getting in and out of bed, and using the toilet.[8] There is a well-known educational gradient in the incidence of difficulties in ADLs, see Cutler and Lleras-Muney (2010).

In Table 1 we report for every country the number of waves for which the survey was run, the interval of years for which the survey was conducted, and the number of individuals. Clearly, the HRS and ELSA samples, with around 30,000 and 15,000 individuals are much larger than any country sample in SHARE, which range between very small samples in Greece, Israel, Netherlands, Poland, Slovenia, and Switzerland (all below 3,500 individuals) and larger ones in Belgium, Czech Republic, France, Estonia, and Spain (all over 6,000). Countries also differ in the number of waves. A higher number of waves allows to extract more transitions from the same number of individuals. HRS and ELSA provide 6 waves each, and then most SHARE countries provide 6 but Netherlands, Greece, Israel, Czech Republic, Poland, Slovenia, and Estonia provide fewer than 5 waves either because they dropped from SHARE or because they entered later than other countries.

Finally, as discussed in Section 2 there are potential problems in the use of SHARE data for survival analysis. For this reason, in the Online Appendix we perform a validation exercise by comparing the survival functions computed with our survey data for each country to the ones in the population life tables for the same range of years. Our results indicate that most SHARE samples, plus the ELSA and HRS samples, aggregate

[7]See Table B.1 in Appendix B for a comparison of the education distribution in our country samples with the one from the population from Eurostat and OECD for the relevant age groups.

[8]Counts of ADL were first proposed by Katz et al. (1963) to measure the degree of independence of old people. Limitations in ADL have been widely used as health variables to understand economic decisions of the old like labor supply (e.g. Dwyera and Mitchell, 1999), savings (e.g. Ameriks et al., 2015), or the purchase of long-term care insurance (e.g. Braun et al., 2017). In terms of international comparability, Chan et al. (2012) find good equivalence for the ADL items between the HRS and SHARE, but less so with ELSA.

TABLE 1: Sample statistics

	Waves	First year	Last year	Individuals
Austria*	6	2004	2015	5139
Belgium	6	2004	2015	6557
Czechia*	5	2006	2015	6441
Denmark*	6	2004	2015	4453
Estonia*	3	2010	2015	6322
France*	6	2004	2015	5964
Germany	6	2004	2015	5723
Greece	4	2004	2015	3394
Israel	4	2005	2015	3041
Italy*	6	2004	2015	5248
Netherlands	5	2004	2013	3474
Poland*	4	2006	2015	2175
Slovenia*	3	2011	2015	3035
Spain*	6	2004	2015	6927
Sweden*	6	2004	2015	5242
Switzerland	6	2004	2015	3557
England*	6	2002	2013	14242
US*	6	2002	2013	27198

Notes: "First year" and "Last year" refer to year of interview or death in our sample. An * mark indicates that the country sample has been selected for the main exercises of the paper, see the Online Appendix for details.

reasonably well to the population life tables, and that attrition from the sample is not related to variables that predict survival. However, a few SHARE countries do not do as well. Hence, we choose to keep the data only for those countries for which the validation exercise is best; these countries are indicated with an asterisk symbol in Table 1.

5 Results

In this Section we present for our 12 countries our results on life expectancy (LE), healthy life expectancy (HLE), and unhealthy life expectancy (ULE) for four demographic groups: males and females with and without college education, and we focus on the differences between these groups.[9] When analyzing the interaction between gender and education, note that the gender differences in the education gradients and the education differences in the gender gaps are linked by an identity due to the double differenciation. That is to say, the difference in the college premium of any life expectancy between men and women

[9]The actual levels of the life expectancy for each of the four demographic groups in each country are reported in Table B.2 and B.3 of Appendix B, while the ones for males and females without distinguishing education level are reported in Table B.4. The corresponding life tables for each group and country are available online at the authors' web pages.

is equal to the difference in the gender gap between the non college and college groups.[10]

In order to organize the information and obtain more precise estimates with larger samples, we also group the 10 Continental European countries into 4 regions and estimate again our duration model with the pooled data of each region in order to compute the region *average* multi-state life tables and associated LE, HLE, and ULE. The four regions we consider are Western Europe (Austria and France), Eastern Europe (Czechia, Estonia, Poland and Slovenia), Mediterranean (Italy and Spain), and Scandinavia (Denmark and Sweden).

5.1 Education gradients in life expectancy

We start by examining our findings for education. In Table 2 we report the gradients in LE separately for men (Panel A, column 1) and women (Panel B, column 1), as well as for the difference among the two genders (Panel C, column 1). As it is well-known, more educated individuals have larger LE in all countries for both males and females. More importantly, we find that inequality tends to be larger among males than among females: the average of the education gradient across the 12 countries is 3.4 years for males and 2.2 years for females. Our results, however, show a large amount of heterogeneity across countries. First, looking at males, the gradient is largest in Eastern and Western Europe (around 4 years), while it is lowest but still important in Scandinavia (2.1). The Mediterranean (3) stands in the middle. In Eastern and Western Europe the gradients are indeed larger than in England (3.4) and the US (3.6). There is substantial heterogeneity within Eastern Europe: while the largest gradient across all countries is in Poland (5.4), Slovenia (2.5) presents a gradient among the smallest of our sample. Second, the pattern for females is different. The gradient is still largest in Eastern Europe (3.9) but it is smallest in the Mediterranean (0.7), with Scandinavia (2.3) and Western Europe (1.7) in the middle. For females, only Eastern Europe shows a gradient larger than the US (3.2). And third, the interaction between education and gender also varies across countries. In particular, there is virtually no gender difference in the education gradient of LE in Scandinavia, Italy, or Slovenia. Instead, Poland (with 4.4 years of difference in the gradient between males and females), Spain (3.5), and Austria, France, and England (2.2) show large gender differences in the education gradient. Czechia (with -2.3 years) is the only country where there is significantly more inequality among females.

Our international comparison of life expectancy gradients of education are qualita-

[10]Formally, let m denote males, f females, nc non-college and c college. Then, it is the case that $(\text{LE}_{m,c} - \text{LE}_{m,nc}) - (\text{LE}_{f,c} - \text{LE}_{f,nc}) = (\text{LE}_{f,nc} - \text{LE}_{m,nc}) - (\text{LE}_{f,c} - \text{LE}_{m,c})$ and of course the same is true for HLE and ULE.

TABLE 2: Education gradients

	A. Males			B. Females			C. Difference		
	LE	HLE	ULE	LE	HLE	ULE	LE	HLE	ULE
Western Europe	3.9	4.6	-0.8	1.7	3.0	-1.3	2.2	1.6	0.6
	(0.7)	(0.7)	(0.4)	(0.6)	(0.7)	(0.4)	(1.0)	(1.0)	(0.6)
Austria	3.8	4.1	-0.3	1.7	2.7	-1.0	2.2	1.4	0.8
	(1.1)	(1.0)	(0.5)	(1.1)	(1.0)	(0.5)	(1.5)	(1.4)	(0.7)
France	3.9	5.0	-1.1	1.8	3.2	-1.5	2.2	1.8	0.4
	(1.0)	(1.0)	(0.5)	(0.8)	(0.9)	(0.7)	(1.3)	(1.4)	(0.9)
Eastern Europe	4.0	4.3	-0.3	3.9	5.1	-1.2	0.1	-0.8	0.9
	(0.8)	(0.7)	(0.3)	(0.6)	(0.6)	(0.4)	(1.0)	(0.9)	(0.5)
Czechia	3.5	4.0	-0.5	5.9	5.7	0.1	-2.3	-1.6	-0.7
	(1.3)	(1.2)	(0.5)	(1.0)	(1.1)	(0.8)	(1.7)	(1.7)	(0.9)
Estonia	4.6	4.6	-0.0	2.5	4.5	-2.0	2.1	0.1	2.0
	(1.3)	(1.2)	(0.5)	(0.8)	(0.8)	(0.5)	(1.5)	(1.4)	(0.7)
Poland	5.4	4.5	0.8	1.0	1.3	-0.6	4.4	3.2	1.3
	(2.0)	(1.9)	(1.1)	(2.6)	(2.6)	(1.7)	(3.2)	(3.2)	(2.0)
Slovenia	2.5	3.7	-1.3	3.0	5.3	-2.5	-0.5	-1.6	1.2
	(1.7)	(1.6)	(0.8)	(1.5)	(1.7)	(1.0)	(2.3)	(2.4)	(1.2)
Mediterranean	3.0	3.4	-0.4	0.7	4.1	-3.5	2.3	-0.7	3.1
	(1.0)	(1.0)	(0.5)	(1.1)	(1.1)	(0.4)	(1.5)	(1.5)	(0.7)
Italy	2.5	2.1	0.3	2.5	5.9	-3.6	0.1	-3.8	3.9
	(1.3)	(1.4)	(0.8)	(1.6)	(1.8)	(0.8)	(2.1)	(2.3)	(1.2)
Spain	3.4	4.3	-0.9	-0.0	3.0	-3.1	3.5	1.3	2.2
	(1.4)	(1.4)	(0.5)	(1.4)	(1.5)	(0.6)	(2.0)	(2.0)	(0.8)
Scandinavia	2.1	2.9	-0.8	2.3	3.7	-1.4	-0.1	-0.8	0.7
	(0.7)	(0.7)	(0.3)	(0.6)	(0.6)	(0.3)	(0.9)	(0.9)	(0.4)
Denmark	2.0	3.0	-1.0	2.1	4.0	-1.9	-0.1	-1.0	0.9
	(1.0)	(1.0)	(0.4)	(1.0)	(1.0)	(0.4)	(1.4)	(1.4)	(0.6)
Sweden	2.5	2.9	-0.5	2.8	3.6	-0.8	-0.3	-0.7	0.3
	(0.8)	(0.9)	(0.5)	(0.8)	(0.8)	(0.5)	(1.1)	(1.2)	(0.7)
England	3.4	4.7	-1.3	1.2	3.0	-1.8	2.2	1.7	0.5
	(0.6)	(0.6)	(0.3)	(0.6)	(0.6)	(0.4)	(0.8)	(0.8)	(0.5)
US	3.6	5.3	-1.7	3.2	5.1	-2.0	0.4	0.1	0.3
	(0.4)	(0.4)	(0.2)	(0.4)	(0.4)	(0.2)	(0.6)	(0.6)	(0.3)
Average	3.4	4.0	-0.6	2.2	3.9	-1.7	1.2	0.1	1.1
	(0.4)	(0.3)	(0.2)	(0.4)	(0.4)	(0.2)	(0.5)	(0.5)	(0.3)

Notes: LE stands for life expectancy, HLE for healthy life expectancy, and ULE for unhealthy life expectancy, all at age 50. The education gradient is the difference in the corresponding life expectancy between college and non-college individuals. Panel A refers to males, Panel B to females, and Panel C is the difference between the male and female gradients. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

tively in line with findings in mortality gradients of other studies, although there are some important differences. In particular, using census-based mortality studies, papers like Mackenbach et al. (2008), Mackenbach et al. (2015a) and Avendano et al. (2011) document that mortality differences among 30-79 year-olds are largest in Eastern Europe (but less so in Slovenia), intermediate in Nordic countries, and smallest in Mediterranean. Mackenbach (2017), refers to these results as the "Eastern Disaster", the "Nordic Paradox", and the "Southern Miracle". The term "Nordic Paradox" highlights that one would expect the lowest inequality in mortality to arise in countries with low income inequality and strong welfare states, while the term "Southern Miracle" underscores the low inequality in mortality in countries where the welfare state is not so strong. Our results confirm the "Eastern Disaster" —as inequalities are large in former communist countries— but not the "Nordic Paradox" —as inequalities in Denmark and Sweden are indeed among the lowest in our sample— nor the "Southern Miracle" —as inequalities in Italy and Spain are not the smallest in our sample. There are several possible reasons for the discrepancy between our results and the ones obtained in the census-based mortality studies quoted above. First, the age range of the underlying populations are different: 50+ in SHARE, HRS, and ELSA, and 30-79 in the census-based mortality studies. Second, the sampling methods are different. For instance, in the census-based mortality studies Italy is represented only by Turin and Spain by Barcelona, Madrid and the Basque Country. And third, in the census-based mortality studies, Finland and Norway are the Scandinavian countries that create the "Nordic Paradox", while Denmark and Sweden have inequalities among the lowest, as it happens in our sample.

5.2 Education gradients in healthy and unhealthy life expectancy

In Table 2 we also report the education gradients in HLE (second column in each panel) and ULE (third column in each panel). We find that the gradient in HLE is typically larger than the gradient in LE, and more so among females. In particular, the average education gradients of HLE and LE over the 12 countries are 4.0 and 3.4 years for males and 3.9 and 2.2 years for females. There are two comments to make regarding these results. First, because of the identity linking LE, HLE, and ULE, the gradient of ULE is negative —more educated individuals spend fewer years in disability despite enjoying longer lives— and larger for females (-1.7) than for males (-0.6). Second, the higher inequality among males measured in the education gradient of LE (3.4 years for males, 2.2 for females) disappears when looking at the education gradient of HLE (4.0 years for males, 3.9 for females).

Looking at the numbers for males by regions, we see that the gradient in ULE is largest

in the US (-1.7) and England (-1.3) and it is smallest in Eastern Europe (-0.3) and the Mediterranean (-0.3), see the third column in Panel A. Country by country, however, there are a few exceptions to this pattern: in Italy and Poland it is the more educated who spend more time in disability, although the differences are small and not significant. Looking at the numbers for females we see that the gradient in ULE is largest in the Mediterranean (-3.5) and smallest in Eastern Europe (-1.2), Western Europe (-1.3) and Scandinavia (-1.4), see the third column in Panel B. England (-1.8) and the US (-2.0) are in between these two blocks. In terms of country data, we find that Czechia is an exception as high educated females spend more time in disability than the low educated ones although again the number is very small (0.1). Finally, looking together at the results for males and females, it is clear that the difference in the ULE gradient between females and males is particularly large in the Mediterranean. In this region, high educated females spend 3.5 fewer years in disability than less educated ones while high educated males only spend 0.4 years less in disability, so that the gender difference in the ULE gradient is 3.1 years. For the rest of regions, the US, and England this difference is positive but small, less than 1 year.

Our results are qualitatively in line with some previous findings. Crimmins and Cambois (2003), in a review of single-country studies, document that the socio-economic gradient tends to be larger in HLE than in LE for several definitions of health and socio-economic status. Majer et al. (2010), using survey data from the ECHP for several European countries, also find that gradients in HLE are larger than in LE and that the gradient is larger among men than among women for LE, but less so in HLE. However, they do not have data on Eastern Europe nor on England and US. Maki et al. (2013) apply the Sullivan method to census-linked mortality data and calculate gender-specific educational differences in disability-free life expectancy between the ages of 30 and 79 years. They find that the educational differences are much greater in HLE than in LE in all countries. The smallest differences in HLE among men appear to be in the Mediterranean (4 years in Turin-Tuscany, 4.6 in Madrid-Barcelona), while the largest ones are in Lithuania (10.2) and Austria (7.8).

5.3 Decomposition of education gradients

The estimation of multi-state life tables by education and gender allows us to measure to which extent the observed education gradients arise because of differences across education groups in health already present at age 50, differences across education groups in health transitions after age 50, and differences across education groups in mortality. In particular,

following Pijoan-Mas and Ríos-Rull (2014) we compute the counterfactual LE, HLE, and ULE in which education types only differ in (a) their health distribution at age 50, (b) their health transitions conditional on survival, and (c) their mortality conditional on health.[11] Tables 3, 4, and 5 report the decomposition for the LE, HLE, and ULE gradients respectively.[12]

First, we find that higher educated individuals tend to live longer because of both an advantage in health transitions and an advantage in conditional survival rates. Differences in health across education groups at age 50 are inconsequential as most individuals in their fifties are healthy. Among males, the advantage in survival is clearly more important: mortality differentials explain on average 2.7 years of the observed gradients in LE (and most of its cross-country variation), while education differences in health transitions explain 0.8 years. Hence, morality differences account for about 3/4 of the gradient and health transitions only for 1/4. An important exception is the US, where the male gradient in LE driven exclusively by differences in health transitions is the greatest among all countries with 1.4 years and representing almost 1/2 of the whole gradient.[13] In contrast, differences in mortality rates across education groups are relatively less important for females: mortality differentials explain on average 1.3 years of the observed gradients in LE, while education differences in health transitions explain 0.8 years as for males. Hence, morality differences account for about 3/5 of the gradient and health transitions for 2/5. Looking at the interaction of gender and education, note that the average gender difference in the education gradient of LE is entirely driven by the gender difference in the mortality gradient and that the education gradient of health transitions is similar across genders. This is indeed true for most countries and regions, with the exception of the Mediterranean where the education advantage in health transitions turns out to be substantially larger among females.

Second, the decomposition of the HLE gradients shows a larger importance of the educational differences in health transitions. Looking at the average across countries, we see that the educational advantage of health transitions is as large as the education advantage

[11] This decomposition is also similar to what Solé-Auró et al. (2015) do in order to assess whether the larger prevalence of desease among old Americans (as compared to Europeans) is due to larger prevalence at age 50, larger incidence after age 50, or higher survival.

[12] To compute these counterfactual LE, HLE, and ULE we combine the initial health distribution and multi-state life tables for the whole population (without distinguish between education groups) with the education-specific ones used in Section 5.1 and 5.2.

[13] This result differs from Pijoan-Mas and Ríos-Rull (2014), who find that the gradient in LE in the US is almost exclusively explained by the different transitions across education groups. The reason for this difference is likely to be found on the definition of health: Pijoan-Mas and Ríos-Rull (2014) use self-rated health, which is a very good predictor of mortality.

TABLE 3: Decomposition of LE education gradients

	A. Males				B. Females			
	LE	LE_a	LE_b	LE_c	LE	LE_a	LE_b	LE_c
Western Europe	3.9	0.0	0.8	3.2	1.7	0.0	0.6	1.1
	(0.7)	(0.0)	(0.2)	(0.7)	(0.6)	(0.0)	(0.2)	(0.7)
Austria	3.8	0.1	0.8	3.3	1.7	0.0	0.5	1.2
	(1.1)	(0.0)	(0.3)	(1.1)	(1.1)	(0.0)	(0.2)	(1.1)
France	3.9	0.0	0.9	3.0	1.8	0.0	0.7	1.1
	(1.0)	(0.0)	(0.3)	(1.0)	(0.8)	(0.0)	(0.2)	(0.9)
Eastern Europe	4.0	0.1	0.7	3.3	3.9	0.0	0.8	3.0
	(0.8)	(0.0)	(0.2)	(0.8)	(0.6)	(0.0)	(0.2)	(0.6)
Czechia	3.5	0.1	1.2	2.6	5.9	0.0	1.0	5.0
	(1.3)	(0.0)	(0.4)	(1.4)	(1.0)	(0.0)	(0.4)	(1.2)
Estonia	4.6	0.0	0.4	4.1	2.5	0.0	0.7	1.6
	(1.3)	(0.0)	(0.2)	(1.3)	(0.8)	(0.0)	(0.2)	(0.8)
Poland	5.4	0.1	0.1	5.2	1.0	0.0	0.1	0.9
	(2.0)	(0.1)	(0.4)	(2.0)	(2.6)	(0.0)	(0.5)	(2.4)
Slovenia	2.5	0.0	0.8	1.2	3.0	0.1	0.8	1.7
	(1.7)	(0.0)	(0.5)	(1.9)	(1.5)	(0.0)	(0.4)	(1.9)
Mediterranean	3.0	0.0	0.7	2.6	0.7	0.0	1.4	-1.6
	(1.0)	(0.0)	(0.3)	(1.0)	(1.1)	(0.0)	(0.3)	(1.2)
Italy	2.5	0.0	0.1	2.4	2.6	0.0	1.8	0.1
	(1.3)	(0.0)	(0.4)	(1.3)	(1.6)	(0.0)	(0.5)	(2.1)
Spain	3.4	0.0	1.2	2.5	-0.0	0.0	1.0	-2.1
	(1.4)	(0.0)	(0.4)	(1.4)	(1.4)	(0.0)	(0.3)	(1.4)
Scandinavia	2.1	0.0	0.7	1.6	2.3	0.0	0.8	1.5
	(0.7)	(0.0)	(0.2)	(0.7)	(0.6)	(0.0)	(0.2)	(0.7)
Denmark	2.0	0.0	0.7	1.3	2.1	0.1	1.0	0.8
	(1.0)	(0.0)	(0.2)	(1.0)	(1.0)	(0.0)	(0.3)	(1.0)
Sweden	2.5	0.0	0.6	2.1	2.8	0.0	0.5	2.3
	(0.8)	(0.0)	(0.3)	(0.9)	(0.8)	(0.0)	(0.2)	(0.8)
England	3.4	0.1	1.1	2.5	1.2	0.0	0.5	0.6
	(0.6)	(0.0)	(0.2)	(0.6)	(0.6)	(0.0)	(0.1)	(0.6)
US	3.6	0.1	1.4	1.9	3.2	0.1	1.3	2.0
	(0.4)	(0.0)	(0.1)	(0.5)	(0.4)	(0.0)	(0.1)	(0.4)
Average	3.4	0.1	0.8	2.7	2.2	0.0	0.8	1.3
	(0.4)	(0.0)	(0.1)	(0.4)	(0.4)	(0.0)	(0.1)	(0.4)

Notes: LE stands for the education gradient in life expectancy at age 50. LE_a, LE_b, and LE_c correspond to the counterfactual education gradient in life expectancies when education types differ only in the health distribution at age 50, only in the health transition conditional on survival, and only in probability of survival respectively. Panel A refers to males, Panel B to females. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

TABLE 4: Decomposition of HLE education gradients

	A. Males				B. Females			
	HLE	HLE_a	HLE_b	HLE_c	HLE	HLE_a	HLE_b	HLE_c
Western Europe	4.6	0.1	2.1	2.5	3.0	0.1	2.2	0.7
	(0.7)	(0.0)	(0.5)	(0.6)	(0.7)	(0.0)	(0.5)	(0.5)
Austria	4.1	0.1	1.6	2.6	2.7	0.1	1.7	0.8
	(1.0)	(0.0)	(0.7)	(0.8)	(1.0)	(0.0)	(0.6)	(0.8)
France	5.0	0.1	2.4	2.4	3.3	0.1	2.5	0.7
	(1.0)	(0.0)	(0.7)	(0.7)	(0.9)	(0.0)	(0.8)	(0.6)
Eastern Europe	4.3	0.2	1.7	2.5	5.1	0.1	2.7	2.1
	(0.7)	(0.0)	(0.4)	(0.6)	(0.6)	(0.0)	(0.4)	(0.4)
Czechia	4.0	0.1	2.4	1.8	5.7	0.0	2.5	3.0
	(1.2)	(0.0)	(0.6)	(1.0)	(1.1)	(0.0)	(0.8)	(0.7)
Estonia	4.6	0.1	1.2	3.2	4.5	0.1	2.8	1.3
	(1.2)	(0.0)	(0.6)	(1.0)	(0.8)	(0.0)	(0.6)	(0.6)
Poland	4.5	0.3	0.3	3.9	1.3	0.2	0.5	1.2
	(1.9)	(0.1)	(1.1)	(1.4)	(2.5)	(0.0)	(1.8)	(1.4)
Slovenia	3.7	0.1	2.0	1.2	5.4	0.2	3.4	1.3
	(1.6)	(0.0)	(1.0)	(1.4)	(1.7)	(0.0)	(1.1)	(1.3)
Mediterranean	3.4	0.0	1.6	1.8	4.1	0.0	4.6	-0.7
	(1.0)	(0.0)	(0.6)	(0.7)	(1.1)	(0.0)	(0.7)	(0.7)
Italy	2.1	-0.0	0.4	1.8	6.0	0.0	5.4	0.2
	(1.4)	(0.0)	(1.0)	(1.0)	(1.8)	(0.0)	(1.1)	(1.1)
Spain	4.3	0.1	2.5	1.8	3.0	0.0	3.6	-0.9
	(1.4)	(0.0)	(0.7)	(1.1)	(1.4)	(0.0)	(1.1)	(1.0)
Scandinavia	2.9	0.1	1.8	1.1	3.7	0.1	2.4	1.1
	(0.7)	(0.0)	(0.4)	(0.6)	(0.7)	(0.0)	(0.4)	(0.5)
Denmark	3.0	0.1	2.0	0.9	4.0	0.2	2.9	0.8
	(1.0)	(0.0)	(0.6)	(0.8)	(1.0)	(0.0)	(0.6)	(0.8)
Sweden	2.9	0.1	1.5	1.4	3.6	0.1	1.9	1.6
	(0.9)	(0.0)	(0.6)	(0.7)	(0.8)	(0.0)	(0.6)	(0.6)
England	4.7	0.3	2.9	1.6	3.0	0.2	2.4	0.3
	(0.6)	(0.0)	(0.4)	(0.4)	(0.6)	(0.0)	(0.4)	(0.4)
US	5.3	0.3	3.2	1.5	5.1	0.4	3.5	1.3
	(0.4)	(0.0)	(0.3)	(0.4)	(0.4)	(0.0)	(0.3)	(0.3)
Average	4.0	0.2	1.9	2.0	3.9	0.1	2.8	1.0
	(0.3)	(0.0)	(0.2)	(0.3)	(0.4)	(0.0)	(0.3)	(0.2)

Notes: HLE stands for the education gradient in healthy life expectancy at age 50. HLE_a, HLE_b, and HLE_c correspond to the counterfactual education gradient in healthy life expectancies when education types differ only in the health distribution at age 50, only in the health transition conditional on survival, and only in probability of survival respectively. Panel A refers to males, Panel B to females. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

TABLE 5: Decomposition of ULE education gradients

	A. Males				B. Females			
	ULE	ULE_a	ULE_b	ULE_c	ULE	ULE_a	ULE_b	ULE_c
Western Europe	-0.8	-0.1	-1.3	0.7	-1.3	-0.1	-1.6	0.4
	(0.4)	(0.0)	(0.3)	(0.2)	(0.4)	(0.0)	(0.4)	(0.3)
Austria	-0.3	-0.1	-0.7	0.7	-1.0	-0.1	-1.2	0.4
	(0.5)	(0.0)	(0.4)	(0.3)	(0.5)	(0.0)	(0.4)	(0.4)
France	-1.1	-0.1	-1.5	0.6	-1.5	-0.0	-1.8	0.5
	(0.5)	(0.0)	(0.4)	(0.4)	(0.7)	(0.0)	(0.6)	(0.4)
Eastern Europe	-0.3	-0.1	-1.0	0.9	-1.2	-0.1	-1.8	0.9
	(0.3)	(0.0)	(0.2)	(0.2)	(0.4)	(0.0)	(0.3)	(0.3)
Czechia	-0.5	-0.1	-1.2	0.9	0.1	-0.0	-1.5	2.0
	(0.5)	(0.0)	(0.3)	(0.4)	(0.8)	(0.0)	(0.4)	(0.6)
Estonia	-0.0	-0.1	-0.8	0.9	-2.0	-0.1	-2.2	0.3
	(0.5)	(0.0)	(0.4)	(0.3)	(0.5)	(0.0)	(0.4)	(0.3)
Poland	0.8	-0.2	-0.2	1.2	-0.5	-0.2	-0.4	-0.3
	(1.1)	(0.0)	(0.7)	(0.7)	(1.7)	(0.0)	(1.4)	(1.2)
Slovenia	-1.2	-0.1	-1.2	0.0	-2.5	-0.1	-2.6	0.4
	(0.8)	(0.0)	(0.6)	(0.6)	(1.0)	(0.0)	(0.9)	(0.7)
Mediterranean	-0.4	-0.0	-0.9	0.7	-3.5	-0.0	-3.2	-0.9
	(0.5)	(0.0)	(0.3)	(0.3)	(0.4)	(0.0)	(0.5)	(0.5)
Italy	0.3	0.0	-0.3	0.6	-3.6	-0.0	-3.5	-0.1
	(0.8)	(0.0)	(0.6)	(0.4)	(0.8)	(0.0)	(0.8)	(1.1)
Spain	-0.9	-0.0	-1.3	0.7	-3.1	-0.0	-2.5	-1.2
	(0.5)	(0.0)	(0.4)	(0.4)	(0.6)	(0.0)	(0.7)	(0.5)
Scandinavia	-0.8	-0.1	-1.1	0.5	-1.4	-0.1	-1.6	0.4
	(0.3)	(0.0)	(0.3)	(0.2)	(0.3)	(0.0)	(0.3)	(0.2)
Denmark	-1.0	-0.1	-1.3	0.4	-1.9	-0.1	-1.8	-0.0
	(0.4)	(0.0)	(0.4)	(0.3)	(0.4)	(0.0)	(0.4)	(0.3)
Sweden	-0.5	-0.1	-0.9	0.6	-0.8	-0.1	-1.4	0.7
	(0.5)	(0.0)	(0.4)	(0.2)	(0.5)	(0.0)	(0.4)	(0.3)
England	-1.3	-0.2	-1.8	0.8	-1.8	-0.2	-1.9	0.3
	(0.3)	(0.0)	(0.3)	(0.3)	(0.4)	(0.0)	(0.3)	(0.3)
US	-1.7	-0.2	-1.8	0.4	-2.0	-0.3	-2.2	0.7
	(0.2)	(0.0)	(0.1)	(0.1)	(0.2)	(0.0)	(0.2)	(0.2)
Average	-0.6	-0.1	-1.1	0.7	-1.7	-0.1	-1.9	0.3
	(0.2)	(0.0)	(0.1)	(0.1)	(0.2)	(0.0)	(0.2)	(0.2)

Notes: ULE stands for the education gradient in unhealthy life expectancy at age 50. ULE_a, ULE_b, and ULE_c correspond to the counterfactual education gradient in unhealthy life expectancies when education types differ only in the health distribution at age 50, only in the health transition conditional on survival, and only in probability of survival respectively. Panel A refers to males, Panel B to females. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

of survival for males (1.9 and 2.0 years respectively) and much larger for females (2.8 and 1.0). Indeed, the larger contribution of the education advantage in health transitions is true for females in all regions and for males in the US, England, and Scandinavia. Instead, for males in several countries in Western and Eastern Europe and in the Mediterranean differences in mortality across education groups are more important than differences in health transitions. This is especially so among Polish and Estonian males, whose HLE_b are small, 0.3 and 1.2 respectively but whose HLE_c are very large, 3.9 and 3.2 respectively. Indeed, these two countries have exceptionally large gradients in HLE, and what this decomposition shows is that they are mainly driven by the fact that less educated males face substantially higher mortality rates conditional on health than more educated ones.

And third, we find that more educated individuals spend fewer years in disability because of their better health transitions and despite their better survival functions. When looking at the decomposition of the negative education gradient in ULE in Table 5, we see that for most countries and genders the gradient due to mortality differences is positive while the gradient due to health transitions is negative and larger in absolute value than the whole gradient in ULE. In particular, the average gradient in ULE_c across all countries is 0.7 and 0.3 years for males and females respectively, while the average gradient in ULE_b is -1.1 and -1.9 years for males and females respectively. In other words: absent the differences in health transitions the more educated would display larger (not smaller) ULE due to to their better survival rates in disability. Finally, note that the education advantage in disability years being larger among females (the fact that the gradient in ULE is -1.7 years for females and -0.6 for males) is mainly due to and education advantage of health transitions that is larger among females (the gradient in ULE_b is -1.9 years for females and -0.1 for males) .

5.4 Gender gaps in life expectancy

We now turn to examining our result for inequality between men and women. In particular, we define the difference between the average life expectancy of women and men as the gender gap in life exepectancy. In Table 6 we report the gender gaps in LE separately for low and high educated individuals (first column in Panels A and B respectively), as well as the difference of the gender gaps across the two education groups (first column in Panel C). As in population life tables, we find that LE is larger for females than for males. But more importantly, we also find a significant socio-economic component of the gender gap: life expectancy differences between females and males are larger among low-educated

individuals. In particular, looking at the average across the 12 countries, low educated women live 3.9 more years than men while high educated women live only 2.7 more years than men.

Looking at variation across countries, the gender gap in LE among the low educated is largest in Eastern Europe (5.6 years) and lowest in Scandinavia (1.8 years), while Western Europe, the Mediterranean, England and the US present similar values (between 3.7 and 3.3 years). Among the high-educated, the gender gap is still largest in Eastern Europe (5.5 years), although the region shows large heterogeneity with gender gaps ranging from 0.9 years in Poland to 7.3 years in Czechia. Instead, Western Europe, the Mediterranean, England and Scandinavia have all small gender gradients (at values between 1.3 and 1.9). The socio-economic dimension of the gender gap is particularly clear in the Mediterranean (where the gender gap is 2.3 years larger among the low educated than among the high educated) and in Western Europe and England (2.2 years), while there is no substantial difference in the gender gap across education groups in Scandinavia and Eastern Europe, and there is a very small one in the US.

5.5 Gender gaps in healthy and unhealthy life expectancy

In Table 6 we also report the gender gaps in HLE (second column in each panel) and ULE (third column in each panel). We find that the female advantage in LE diminishes when looking at HLE, that is, the gender gradients are smaller in HLE than in LE. By construction, the flip side of this result is that the gender gap in ULE is generally positive, that is to say, females tend to spend longer time in disability than males. Indeed, it is well known that females tend to report a higher incidence of disability.[14] Our results show that (a) there is a socio-economic dimension in this pattern as the gender gap in ULE is larger among low educated than among high educated, and (b) there is also substantial variation across countries. In particular, the average gradient in ULE is 1.4 years among the low educated, while it is only 0.4 years on average and non-existent for a few countries among the high educated. Looking at data across countries, we see that in Western Europe the gender gap in ULE is 1 year among the low educated and 1/2 of a year among the high educated, a pattern which is similar in Eastern Europe or England. In the Mediterranean and in Scandinavia, while low-educated females have ULE larger than males, high-educated females tend to spend similar or less time in disability than males. Instead, for the high educated only Czechia and the US present substantial gender gaps in ULE (1.8 and 1.4 years respectively).

[14]See for instance Crimmins et al. (2011) who also use data from HRS, SHARE and ELSA.

TABLE 6: Gender gaps

	A. Low educated			B. High educated			C. Difference		
	LE	HLE	ULE	LE	HLE	ULE	LE	HLE	ULE
Western Europe	3.7	2.6	1.0	1.5	1.0	0.5	2.2	1.6	0.6
	(0.6)	(0.5)	(0.2)	(0.8)	(0.8)	(0.5)	(1.0)	(1.0)	(0.6)
Austria	3.0	2.2	0.8	0.8	0.8	0.0	2.2	1.4	0.8
	(0.9)	(0.8)	(0.4)	(1.2)	(1.2)	(0.7)	(1.5)	(1.4)	(0.7)
France	4.2	2.9	1.3	2.0	1.1	0.9	2.2	1.8	0.4
	(0.7)	(0.6)	(0.3)	(1.1)	(1.2)	(0.8)	(1.3)	(1.4)	(0.9)
Eastern Europe	5.6	4.1	1.6	5.5	4.9	0.6	0.1	-0.8	0.9
	(0.4)	(0.4)	(0.2)	(0.9)	(0.8)	(0.4)	(1.0)	(0.9)	(0.5)
Czechia	4.9	3.8	1.1	7.3	5.5	1.8	-2.3	-1.6	-0.7
	(0.7)	(0.7)	(0.3)	(1.5)	(1.5)	(0.9)	(1.7)	(1.7)	(0.9)
Estonia	7.3	4.9	2.4	5.1	4.8	0.4	2.1	0.1	2.0
	(0.8)	(0.7)	(0.3)	(1.3)	(1.2)	(0.6)	(1.5)	(1.4)	(0.7)
Poland	5.3	3.8	1.5	0.9	0.6	0.1	4.4	3.2	1.3
	(1.0)	(0.9)	(0.5)	(3.1)	(3.0)	(2.0)	(3.2)	(3.2)	(2.0)
Slovenia	4.4	3.5	0.8	4.8	5.2	-0.4	-0.5	-1.6	1.2
	(1.2)	(1.1)	(0.5)	(2.0)	(2.1)	(1.1)	(2.3)	(2.4)	(1.2)
Mediterranean	3.7	1.4	2.3	1.3	2.1	-0.8	2.3	-0.7	3.1
	(0.4)	(0.4)	(0.2)	(1.4)	(1.5)	(0.6)	(1.5)	(1.5)	(0.7)
Italy	2.8	0.4	2.4	2.7	4.2	-1.5	0.1	-3.8	3.9
	(0.6)	(0.5)	(0.3)	(2.0)	(2.2)	(1.1)	(2.1)	(2.3)	(1.2)
Spain	4.4	2.3	2.1	0.9	1.0	-0.1	3.5	1.3	2.2
	(0.6)	(0.6)	(0.3)	(1.9)	(1.9)	(0.7)	(2.0)	(2.0)	(0.8)
Scandinavia	1.8	1.2	0.6	1.9	2.0	-0.1	-0.1	-0.8	0.7
	(0.5)	(0.5)	(0.3)	(0.7)	(0.8)	(0.4)	(0.9)	(0.9)	(0.4)
Denmark	1.3	0.9	0.4	1.4	2.0	-0.5	-0.1	-1.0	0.9
	(0.9)	(0.9)	(0.4)	(1.1)	(1.1)	(0.4)	(1.4)	(1.4)	(0.6)
Sweden	2.1	1.4	0.7	2.4	2.0	0.4	-0.3	-0.7	0.3
	(0.7)	(0.7)	(0.3)	(0.9)	(1.0)	(0.6)	(1.1)	(1.2)	(0.7)
England	3.5	2.0	1.5	1.3	0.3	0.9	2.2	1.7	0.5
	(0.3)	(0.3)	(0.2)	(0.7)	(0.7)	(0.5)	(0.8)	(0.8)	(0.5)
US	3.3	1.6	1.6	2.9	1.5	1.4	0.4	0.1	0.3
	(0.3)	(0.3)	(0.1)	(0.5)	(0.5)	(0.2)	(0.6)	(0.6)	(0.3)
Average	3.9	2.5	1.4	2.7	2.4	0.3	1.2	0.1	1.1
	(0.2)	(0.2)	(0.1)	(0.5)	(0.5)	(0.3)	(0.5)	(0.5)	(0.3)

Notes: LE stands for life expectancy, HLE for healthy life expectancy, and ULE for unhealthy life expectancy, all at age 50. The gender gap is the difference in the corresponding life expectancy between females and males. Panel A refers to individuals without college, Panel B to individuals with a college degree, and Panel C is the difference between the non-college and the college gender gaps. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

5.6 Decomposition of gender gaps

As we did with the education gradients in Section 5.3, we decompose the gender gaps for low and high educated individuals in LE, HLE, and ULE into (a) gender differences in the health distribution at age 50, (b) gender differences in the transition conditional on survival, and (c) gender differences in mortality conditional on health. Tables 7, 8, and 9 report the decompositions of LE, HLE, and ULE respectively for low (Panel A) and high educated (Panel B) individuals.

In all three life expectancies we find that initial differences in health at age 50 are irrelevant. When looking at the decomposition of the gender gap in LE (see Table 7), we find that virtually all the LE advantage for females comes from gender differences in survival conditional on health, captured by LE_c in the fourth column of each Panel, and that differences in health transitions across genders, captured by LE_b in the third column of each Panel, are inconsequential for LE differences. The only exception is the low educated in the Mediterranean, where health deteriorates faster for females and hence health transitions contribute to narrow down the gender gap in survival. The pattern is similar for the decomposition of the gradients in HLE (see Table 8).

It may seem odd that gender differences in health transitions turn out to be inconsequential for gender differences in LE given that females —especially low-educated— spend longer time in disability than males. The answer to this apparent puzzle is that the reason why females have longer ULE than males is not that they are more prone to disability but that their mortality conditional on disability is lower, which mechanically extends the duration of the disability state. This is shown in the decomposition of the gender gap in ULE (see Table 7). In particular, for the low-educated the gender gap in ULE comes entirely from the gender gap in mortality conditional on health, with the exception of the Mediterranean (where almost 1/2 comes from the worse health transitions of females) and the US (1/3).

5.7 Overall inequality

In order to complement the results on the differences of life expectancies across education and gender groups, we also compute the differences in LE, HLE, and ULE between females with a college degree and males without, which are the longest and shortest lived groups. The results are reported in Table B.5 in the Appendix. As one may expect from the results in the previous sections, these differences are large and again heterogeneous across countries. On average, the difference between high educated females and low educated males is 6.2 years for LE and 6.4 for HLE. Looking at variation across countries in terms

Table 7: Decomposition of LE gender gaps

	A. Low educated				B. High educated			
	LE	LE_a	LE_b	LE_c	LE	LE_a	LE_b	LE_c
Western Europe	3.7	0.0	0.0	3.7	1.5	0.0	0.0	1.5
	(0.6)	(0.0)	(0.1)	(0.6)	(0.8)	(0.0)	(0.1)	(0.8)
Austria	3.0	0.0	0.1	2.7	0.8	0.0	0.1	0.7
	(0.9)	(0.0)	(0.2)	(0.9)	(1.2)	(0.0)	(0.2)	(1.2)
France	4.2	0.0	-0.0	4.2	2.0	-0.0	-0.0	2.0
	(0.7)	(0.0)	(0.1)	(0.7)	(1.1)	(0.0)	(0.3)	(1.1)
Eastern Europe	5.6	-0.0	-0.0	5.7	5.5	-0.0	0.2	5.3
	(0.4)	(0.0)	(0.1)	(0.4)	(0.9)	(0.0)	(0.2)	(0.9)
Czechia	4.9	-0.0	0.2	4.7	7.3	-0.0	0.1	7.2
	(0.7)	(0.0)	(0.2)	(0.7)	(1.5)	(0.0)	(0.3)	(1.5)
Estonia	7.3	-0.0	-0.2	7.4	5.1	-0.0	0.3	4.8
	(0.8)	(0.0)	(0.1)	(0.8)	(1.3)	(0.0)	(0.3)	(1.3)
Poland	5.3	0.0	-0.0	5.3	0.9	-0.0	-0.1	1.1
	(1.0)	(0.0)	(0.2)	(1.0)	(3.1)	(0.0)	(1.0)	(2.9)
Slovenia	4.4	-0.0	0.2	4.1	4.8	-0.0	0.7	4.1
	(1.2)	(0.0)	(0.2)	(1.2)	(2.0)	(0.0)	(0.7)	(2.0)
Mediterranean	3.7	0.0	-0.6	4.3	1.3	0.0	0.3	1.0
	(0.4)	(0.0)	(0.1)	(0.4)	(1.4)	(0.0)	(0.3)	(1.4)
Italy	2.8	-0.0	-0.8	3.7	2.8	0.0	0.5	1.9
	(0.6)	(0.0)	(0.2)	(0.6)	(2.0)	(0.0)	(0.5)	(2.0)
Spain	4.4	0.0	-0.4	4.8	0.9	-0.0	-0.1	1.2
	(0.6)	(0.0)	(0.1)	(0.6)	(1.9)	(0.0)	(0.5)	(1.9)
Scandinavia	1.8	-0.0	-0.0	1.8	1.9	-0.0	0.1	1.8
	(0.5)	(0.0)	(0.1)	(0.5)	(0.8)	(0.0)	(0.1)	(0.7)
Denmark	1.3	-0.0	0.1	1.3	1.5	-0.0	0.3	1.2
	(0.9)	(0.0)	(0.2)	(0.9)	(1.1)	(0.0)	(0.2)	(1.1)
Sweden	2.1	0.0	-0.1	2.2	2.4	-0.0	0.0	2.4
	(0.7)	(0.0)	(0.2)	(0.7)	(0.9)	(0.0)	(0.1)	(0.9)
England	3.5	0.0	-0.0	3.5	1.3	0.0	-0.1	1.4
	(0.3)	(0.0)	(0.1)	(0.3)	(0.7)	(0.0)	(0.1)	(0.7)
US	3.3	-0.0	-0.3	3.7	2.9	-0.0	-0.3	3.2
	(0.3)	(0.0)	(0.1)	(0.3)	(0.5)	(0.0)	(0.1)	(0.5)
Average	3.9	-0.0	-0.1	4.0	2.7	-0.0	0.1	2.6
	(0.2)	(0.0)	(0.0)	(0.2)	(0.5)	(0.0)	(0.1)	(0.5)

Notes: LE stands for the gender gap in life expectancy at age 50. LE_a, LE_b, and LE_c correspond to the counterfactual gender gaps in life expectancies when genders differ only in the health distribution at age 50, only in the health transition conditional on survival, and only in probability of survival respectively. Panel A refers to non-college individuals, Panel B to individuals with a college degree. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

TABLE 8: Decomposition of HLE gender gaps

	A. Low educated				B. High educated			
	HLE	HLE_a	HLE_b	HLE_c	HLE	HLE_a	HLE_b	HLE_c
Western Europe	2.6	0.0	0.0	2.6	1.0	0.0	0.0	1.0
	(0.5)	(0.0)	(0.3)	(0.4)	(0.8)	(0.0)	(0.6)	(0.6)
Austria	2.2	0.0	0.1	2.0	0.8	0.0	0.4	0.3
	(0.8)	(0.0)	(0.5)	(0.7)	(1.2)	(0.0)	(0.7)	(0.9)
France	2.9	0.0	-0.1	3.0	1.0	-0.0	-0.3	1.3
	(0.6)	(0.0)	(0.4)	(0.5)	(1.2)	(0.0)	(1.0)	(0.8)
Eastern Europe	4.1	-0.0	0.0	4.1	4.9	-0.0	0.8	4.2
	(0.4)	(0.0)	(0.2)	(0.3)	(0.8)	(0.0)	(0.5)	(0.7)
Czechia	3.9	-0.0	0.4	3.4	5.5	-0.0	0.2	5.4
	(0.7)	(0.0)	(0.4)	(0.5)	(1.5)	(0.0)	(0.9)	(1.2)
Estonia	4.9	-0.0	-0.5	5.4	4.8	-0.0	0.9	3.9
	(0.7)	(0.0)	(0.4)	(0.6)	(1.2)	(0.0)	(0.8)	(1.0)
Poland	3.8	0.1	-0.1	3.7	0.6	-0.0	-0.2	1.1
	(0.9)	(0.0)	(0.6)	(0.8)	(3.0)	(0.0)	(2.5)	(2.0)
Slovenia	3.6	-0.1	0.7	2.9	5.2	-0.0	2.2	2.8
	(1.1)	(0.0)	(0.6)	(0.9)	(2.1)	(0.0)	(1.5)	(1.5)
Mediterranean	1.4	0.0	-1.6	3.0	2.1	0.0	0.9	1.2
	(0.4)	(0.0)	(0.2)	(0.3)	(1.5)	(0.0)	(0.9)	(1.3)
Italy	0.4	-0.0	-2.2	2.6	4.2	0.0	2.2	1.8
	(0.5)	(0.0)	(0.4)	(0.4)	(2.3)	(0.0)	(1.5)	(1.7)
Spain	2.3	0.0	-1.1	3.3	1.0	-0.0	-0.2	1.3
	(0.6)	(0.0)	(0.3)	(0.5)	(1.9)	(0.0)	(1.2)	(1.7)
Scandinavia	1.2	-0.1	-0.1	1.3	2.0	-0.0	0.4	1.6
	(0.5)	(0.0)	(0.4)	(0.4)	(0.8)	(0.0)	(0.5)	(0.6)
Denmark	1.0	-0.1	0.3	0.8	2.0	-0.0	0.8	1.1
	(0.9)	(0.0)	(0.6)	(0.7)	(1.1)	(0.0)	(0.6)	(1.0)
Sweden	1.4	0.0	-0.3	1.7	2.0	-0.0	0.2	1.9
	(0.7)	(0.0)	(0.5)	(0.5)	(1.0)	(0.0)	(0.7)	(0.7)
England	2.0	0.0	-0.2	2.2	0.3	0.0	-0.5	0.8
	(0.3)	(0.0)	(0.3)	(0.2)	(0.7)	(0.0)	(0.5)	(0.5)
US	1.6	-0.1	-0.8	2.6	1.5	-0.0	-0.9	2.5
	(0.3)	(0.0)	(0.2)	(0.2)	(0.5)	(0.0)	(0.3)	(0.4)
Average	2.5	-0.0	-0.3	2.8	2.4	-0.0	0.4	2.0
	(0.2)	(0.0)	(0.1)	(0.2)	(0.5)	(0.0)	(0.3)	(0.4)

Notes: HLE stands for the gender gap in healthy life expectancy at age 50. HLE_a, HLE_b, and HLE_c correspond to the counterfactual gender gaps in healthy life expectancies when genders differ only in the health distribution at age 50, only in the health transition conditional on survival, and only in probability of survival respectively. Panel A refers to non-college individuals, Panel B to individuals with a college degree. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

TABLE 9: Decomposition of ULE gender gaps

	A. Low educated				B. High educated			
	ULE	ULE_a	ULE_b	ULE_c	ULE	ULE_a	ULE_b	ULE_c
Western Europe	1.0	-0.0	0.0	1.1	0.5	-0.0	-0.0	0.5
	(0.3)	(0.0)	(0.2)	(0.2)	(0.5)	(0.0)	(0.5)	(0.2)
Austria	0.8	-0.0	0.0	0.8	-0.0	-0.0	-0.3	0.4
	(0.4)	(0.0)	(0.3)	(0.2)	(0.7)	(0.0)	(0.6)	(0.4)
France	1.3	-0.0	0.1	1.3	0.9	0.0	0.2	0.6
	(0.3)	(0.0)	(0.3)	(0.2)	(0.8)	(0.0)	(0.7)	(0.3)
Eastern Europe	1.6	0.0	-0.0	1.6	0.6	0.0	-0.5	1.1
	(0.2)	(0.0)	(0.2)	(0.1)	(0.4)	(0.0)	(0.4)	(0.2)
Czechia	1.1	0.0	-0.2	1.3	1.8	0.0	-0.1	1.7
	(0.3)	(0.0)	(0.2)	(0.2)	(0.9)	(0.0)	(0.7)	(0.5)
Estonia	2.4	0.0	0.3	2.0	0.4	0.0	-0.7	0.9
	(0.3)	(0.0)	(0.3)	(0.2)	(0.6)	(0.0)	(0.5)	(0.3)
Poland	1.5	-0.1	0.0	1.5	0.1	0.0	0.1	-0.0
	(0.5)	(0.0)	(0.4)	(0.3)	(2.0)	(0.0)	(1.6)	(1.2)
Slovenia	0.8	0.0	-0.4	1.2	-0.4	0.0	-1.4	1.2
	(0.5)	(0.0)	(0.4)	(0.3)	(1.1)	(0.0)	(0.9)	(0.8)
Mediterranean	2.3	-0.0	1.0	1.3	-0.8	-0.0	-0.7	-0.2
	(0.2)	(0.0)	(0.2)	(0.1)	(0.6)	(0.0)	(0.6)	(0.3)
Italy	2.4	0.0	1.3	1.1	-1.5	-0.0	-1.6	0.1
	(0.3)	(0.0)	(0.2)	(0.2)	(1.1)	(0.0)	(1.1)	(0.5)
Spain	2.1	-0.0	0.7	1.5	-0.1	0.0	0.1	-0.2
	(0.3)	(0.0)	(0.2)	(0.2)	(0.7)	(0.0)	(0.7)	(0.3)
Scandinavia	0.6	0.1	0.1	0.5	-0.1	0.0	-0.3	0.2
	(0.3)	(0.0)	(0.2)	(0.1)	(0.4)	(0.0)	(0.3)	(0.2)
Denmark	0.4	0.1	-0.2	0.4	-0.5	0.0	-0.5	0.0
	(0.4)	(0.0)	(0.4)	(0.2)	(0.4)	(0.0)	(0.4)	(0.2)
Sweden	0.7	-0.0	0.2	0.5	0.4	0.0	-0.2	0.5
	(0.3)	(0.0)	(0.3)	(0.2)	(0.6)	(0.0)	(0.6)	(0.3)
England	1.5	-0.0	0.1	1.4	0.9	-0.0	0.4	0.6
	(0.2)	(0.0)	(0.2)	(0.1)	(0.5)	(0.0)	(0.4)	(0.3)
US	1.6	0.1	0.5	1.1	1.4	0.0	0.5	0.8
	(0.1)	(0.0)	(0.1)	(0.1)	(0.2)	(0.0)	(0.2)	(0.1)
Average	1.4	0.0	0.2	1.2	0.3	0.0	-0.3	0.6
	(0.1)	(0.0)	(0.1)	(0.1)	(0.3)	(0.0)	(0.2)	(0.1)

Notes: ULE stands for the gender gap in unhealthy life expectancy at age 50. ULE_a, ULE_b, and ULE_c correspond to the counterfactual gender gaps in unhealthy life expectancies when genders differ only in the health distribution at age 50, only in the health transition conditional on survival, and only in probability of survival respectively. Panel A refers to non-college individuals, Panel B to individuals with a college degree. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

of LE, the highest difference is in Eastern Europe where an educated female can expect to live 9.5 years more than an uneducated male. The differences are also large in all countries in the region, ranging from 6.3 years in Poland to 10.8 in Czechia. Next come the US (6.5 years), Western Europe (5.4), England (4.7), the Mediterranean (4.4) and Scandinavia (4.1). The ranking of countries is preserved when looking at differences in terms of HLE because differences in ULE tend to be small.

6 Discussion

In this Section we put together several of the results in Section 5 to discuss them in more detail.

6.1 Compression of morbidity

The results in Section 5.2 show that for both males and females the gradient in HLE tends to be larger than the gradient in LE in most countries. This means that the high educated individuals not only live longer but also spend fewer years in disability, that is, they have smaller ULE. This result is a cross-sectional version of the recent findings on the compression of morbidity: the conjecture that the increase in LE over the last decades has happened in parallel to a decline in ULE, so that as we live longer we also spend less time in disability.[15]

In order to look at these results in more detail, we regress the ULE against the LE for all countries and education groups, separately for males and females. In particular, let i denote country and e denote education. For each gender we run the following regression:

$$\text{ULE}_{ie} = \alpha + \beta \text{LE}_{ie} + \gamma_i + \delta_e + \varepsilon_{ie} \tag{9}$$

where γ_i and δ_e are country and education fixed effects that we introduce in turns. A negative sign of β would be evidence of compression of morbidity. The results are reported in Table 10. When omitting the country and education fixed effects, we find an estimated negative correlation between ULE and LE for both males and females, which is marginally non-significant (see first column of each Panel). When we allow for country fixed effects

[15] Fries (1980) was the first to note that the delay in mortality in the US may have been associated to an even larger delay in the onset of disease or disability, thereby reducing the average time spent in poor health. This was in contrast to Gruenberg (1977), who argued that delays in mortality are associated to smaller delays in the onset of disease and hence to increases in unhealthy life expectancy. Recent results by Cutler et al. (2013) confirm the compression of morbidity in the US since the 90's. See Fries et al. (2011) for a survey of this literature.

TABLE 10: Compression of morbidity

	A. Males			B. Females		
	(1)	(2)	(3)	(1)	(2)	(3)
β	-0.11	-0.15**	-0.04	-0.28*	-0.46**	-0.02
	(0.07)	(0.06)	(0.09)	(0.14)	(0.17)	(0.16)
Country FE	No	Yes	No	No	Yes	No
Edu FE	No	No	Yes	No	No	Yes
N	24	24	24	24	24	24

Notes: This Table displays the estimated slope parameter (β) of a regression of ULE against LE, see equation (9). Standard errors in parenthesis, statistical significance: * at 10%, ** at 5%, *** at 1%

to isolate the variation coming from education only, the point estimates are still negative, larger, and more precisely estimated, see the second column in each Panel. In particular, an extra year of life is associated with almost 2 fewer months in disability for males and almost 6 fewer months in disability for females. If instead we add education fixed effects to explore cross-country variation only, the estimations show a lack of correlation between ULE and LE, see the third column in each Panel. All in all, there is a clear compression of morbidity across education groups within countries but no compression of morbidity across countries within education groups.

Finally, our decomposition results discussed in Section 5.3 show how the compression of morbidity appears across education groups. Mortality differences across education groups do not generate a negative correlation between ULE and LE but a positive one. This is because the high educated experience lower mortality in the bad health state, which prolongs the duration of this state. Instead, the compression of morbidity is created by education differences in the health transition: because education protects the health evolution after age 50, the high-educated visit disability less often and hence have lower average ULE. Likewise, the larger compression of morbidity among females arises because the educational advantage in health transitions are relatively more important among females.

6.2 Women get sicker but men die quicker

The gender differences in life expectancy are not associated to a compression of morbidity. In particular, in Section 5.5 we showed that females, who live longer, also tend to spend more time in disability: on average across our 12 countries, low educated females live 3.9 more year than men and spend 1.4 more years in disability, whereas high educated females live 2.8 more years than men and spend 0.4 more years in disability. The higher

TABLE 11: Women get sicker but men die quicker

	A. Low educated		B. High educated	
	(1)	(2)	(1)	(2)
β	0.19**	0.34***	0.01	0.12
	(0.08)	(0.04)	(0.10)	(0.07)
Country FE	No	Yes	No	Yes
N	24	24	24	24

Notes: This Table displays the estimated slope parameter (β) of a regression of ULE against LE, see equation (10). Standard errors in parenthesis. Statistical significance: * at 10%, ** at 5%, *** at 1%

morbidity among females is a well-known phenomenon, see Van Oyen et al. (2013) and Case and Paxson (2005) for recent evidence in the EU and the US respectively.

In order to look at these results in more detail, we regress the ULE against the LE for all countries and gender groups, separately for low educated and high educated individuals and allowing for country fixed effects. In particular, let i denote country and g denote gender. For each education group we run the following regression:

$$\text{ULE}_{ig} = \alpha + \beta \text{LE}_{ig} + \gamma_i + \varepsilon_{ig} \tag{10}$$

A positive sign of β would be evidence of the phenomenon "women get sicker but men die quicker", which is the opposite from a compression of morbidity. The results are reported in Table 11, Panel A for the low educated and Panel B for the high educated. The first column in Panel A shows a positive and significant coefficient β equal to 0.19 in the regression for the low-educated without country fixed effects. When adding country fixed effects to isolate gender variation only, the estimated coefficient β for the low-educated increases to 0.34 and it is estimated with more precision, see the second column in Panel A. This means that among the low educated each extra year of LE for females is associated to 4 extra months in disability. Instead, this pattern is much less clear among the high educated. In the first column of Panel B we see that the estimated coefficient β is 0.01 among the high educated, which increases to 0.12 when adding country fixed effects, see column 2. However, in both cases the estimated coefficients are smaller than for the low educated, are estimated with less precision, and are not statistically different from zero. Therefore, the well-known notion that "women get sicker but men die quicker" seems to be absent among high educated individuals.

Finally, the decomposition results in Section 5.6 shows that the "women get sicker but men die quicker" phenomenon is driven by gender differences in mortality not transitions. That is to say, women have health transitions that are no worse than those of men, but

TABLE 12: Cross country regressions: education gradients

	A. Males			B. Females		
	LE	HLE	ULE	LE	HLE	ULE
Health spending	-0.44**	-0.08	-0.35**	-0.12	0.09	-0.18
	(0.19)	(0.23)	(0.14)	(0.35)	(0.34)	(0.25)
Gini income	0.10*	0.10*	0.00	-0.09	-0.04	-0.05
	(0.05)	(0.05)	(0.05)	(0.09)	(0.09)	(0.07)
Edu gradient ever smoked, (m,f)	-1.13	-3.41	2.09	-8.55	-2.90	-6.09
	(5.02)	(4.80)	(3.72)	(6.00)	(6.30)	(4.39)

Notes: Each entry reports the regression coefficient of the corresponding life expectancy on the health spending over GDP (first row), the gini index of income (second row), and the education gradient in smoking for males or females (third row). Standard errors in parenthesis. Statistical significance: * at 10%, ** at 5%, *** at 1%

when in bad health they survive more than men, which extends their duration in disability. This phenomenon is especially important in the low-educated population because the gender differences in mortality are particularly large for this group. Hence, the statement "women get sicker but men die quicker" should perhaps be replaced by "women stay sicker while men die quicker".

6.3 Country regressions

In Section 5 we have organized our results by geographical region. Alternatively, one can relate the heterogeneity of life expectancies across countries to other country-specific economic outcomes. This is useful in order to shed light on possible determinants of the observed gradients. In particular, we collect country-specific variables from different sources. First, we use data on the share of public health spending over GDP in the year 2010 from OECD (2018); second, we use data on the Gini index of income for the year 2004 from the World Development Indicators; and third, we collect data on smoking behavior for males and females of different education levels from Eurostat for the year 2014. In Table 12 we present the results of regressing the LE, HLE, and ULE gradients for males and females in each country against these variables (a different regression for each variable).

We find a negative and strong correlation between public spending on health and the gradient in LE for males. The estimated regression coefficient is -0.44, which indicates that the education gradient in LE for males is 1.8 years smaller when the health spending goes from 4.6% of GDP (the lowest in the sample, Poland) to 8.8% (the highest in the sample, Denmark). These 1.8 years represent 53% of the average LE gradient for males.

We can further explore the relationship between health spending and the gradients of HLE and ULE separately.[16] Table 12 shows that all the effect goes to the ULE gradient: countries with more public health spending tend to have smaller education gradients in LE, the same gradient in HLE, and larger (in absolute value) gradients in ULE. One way to interpret this result is that public health spending allows less privileged individuals to live longer but in worse health, which would be consistent with public health spending improving the survival of less educated individuals in bad health but not improving their health transitions. Consistent with this interpretation, we find that the negative effect of public health spending on the counterfactual gradients of Section 5.3 is apparent in LE_c and ULE_c but not in LE_b and ULE_b.[17] For females, public spending on health is also negatively related to the education gradient in LE with a point estimate of -0.12, which is smaller and less precisely estimated than for males. This result is to be expected: public health spending seems to diminish the education gradients in LE by reducing the education advantage in survival and, as discussed in Section 5.3, survival differences across education groups matter less for females.

Looking at income inequality, we find a positive but weak correlation between the gini and the education gradient in LE for males. The regression coefficient is 0.10, which indicates that the education gradient in LE is 1.6 years larger when the gini index goes from 24.9% (the lowest in the sample, Slovenia) to 40.5% (the highest in the sample, US). When looking at the relationship between inequality and the male gradients in HLE and ULE, we see that all the effect goes to the HLE gradient: more unequal countries tend to have larger education gradients in LE and the extra years are all spent in good health. However, the effects for females are less clear. In particular, more income inequality is associated to lower not bigger education gradients in LE, although the less precise point estimate is far from any notion of statistical significance.

These patterns relate to the literature on the determinants of the education gradient of health outcomes, and to the question whether the gradient is the result of the income channel (the fact that more educated individuals are richer). Lleras-Muney (2005) shows how changes in compulsory education laws from 1915 to 1939 in the US led to large falls in mortality, thereby implying a causal effect of education on health.[18] Buckles et al.

[16]Because of the identity LE=HLE+ULE and the linearity of the covariance operator, the regression coefficients for the gradients of HLE and ULE add up to the regression coefficient for the gradient of LE, which allows for a clean decomposition. In practice, however, this sum is not exact in Table 12 because we use the median and not the mean of the posterior distribution of the gradients in LE, HLE and ULE.

[17]The regressions of the counterfactual gradients can be found in Table B.6 of Appendix B.

[18]However, evidence for other countries is less clear. For instance, using the same type of variation as Lleras-Muney (2005), Clark and Royer (2013) and Meghir et al. (2013) report no effect of an additional year of schooling on adult mortality in Britain and Sweden, respectively.

(2016), using the draft-avoidance behavior during the Vietnam War, show that college completion reduces cumulative mortality by 30 percent for males. But support for the income channel is weak. For instance, evidence from the quasi-natural experiments of the Rand Health Insurance Experiment and the Oregon Health Insurance Experiment (see Aron-Dine et al. (2013) and Finkelstein et al. (2012) respectively) points to mild or null improvements in health outcomes as a result of giving low income individuals access to public health care. Currie et al. (2018) show that, while income inequality has increased in both France and the US, inequality in mortality has remained low and stable in France and it has increased for older groups (especially women) in the US. Our own evidence is inconclusive: the results for public health spending and the effects of income inequality on the education gradients among males seem to support the income channel, but the effects for income inequality on the education gradients among females paint a more complex picture.

Finally, education gradients in LE may also arise because of different behavior or lifestyle across groups that do not need to be related to income differences. There is evidence that higher socio-economic groups benefit more from newly arising opportunities for lowering mortality, see for instance Mackenbach et al. (2015a) and Mackenbach et al. (2017). Among these opportunities smoking is a clear case as it is a strong predictor of mortality and is today more prevalent among the low educated. Furthermore, differences in smoking among demographic groups have already been related to differences in mortality, see for instance Preston and Wang (2006). For this reason, we regress our education gradients in life expectancies against measures of smoking gradients across countries. We find no significant relationship across countries between the smoking gradients and the life expectancy gradients, see 3rd row in Table 12.

7 Conclusions

The use of harmonized household-level panel data for the elderly, allows to compare morbidity and mortality across countries and in particular, their relationship with a wealth of demographic and socio-economic variables. In this paper we have unlocked the potential of the SHARE data set for the first time to compare life expectancy and healthy life expectancy across countries, with a focus on the interaction between education and gender.

The common patterns that emerge across countries are interesting and some of them novel. In particular, we document that the interaction between gender and socio-economic status —a dimension that has been largely overlooked— is important. We find that the education gradient in life expectancy tends to be larger for males than for females

and that the gender gap in life expectancy tends to be larger among the low educated than among the high educated. Furthermore, we find that the compression of morbidity across education groups turns out to be larger among females than among males and that the well-known phenomenon that females experience higher morbidity alongside lower mortality, the "women get sicker but men die quicker", is almost absent among the high-educated individuals. It is important to note that, because of the identity in the double differentiation, the first two patterns are equivalent to each other, and the same is true for the last two. Looking at the reasons for these interactions we find that they can basically be explained by the facts that (a) the education advantage in conditional survival is relatively more important for men and (b) the education advantage in health transitions is relatively more important for women.

Of course, there is heterogeneity in these patterns across countries and further research may want to exploit these different experiences to learn something about the underlying causes of health inequality. Our findings show suggestive evidence of a negative correlation between public health spending and life expectancy that is worth investigating further.

Appendix A: Building life expectancies

In this Appendix we explain how we compute the life expectancy, the healthy life expectancy and the unhealthy life expectancy from our estimated multi-state life tables. Given the parameter estimates, we recover $p_{ij}(a)$, the probability that an individual with health $i \in \{1,2\}$ transits into health $j \in \{0,1,2\}$ from age a to age $a+1$. We define Γ_a as the three-state transition matrix containing these probabilities,

$$\Gamma_a = \begin{bmatrix} p_{11}(a) & p_{21}(a) & 0 \\ p_{12}(a) & p_{22}(a) & 0 \\ p_{10}(a) & p_{20}(a) & 1 \end{bmatrix}$$

where each matrix entry is the probability of transiting between any two states at age a (of course, dead is an absorbing state). Now, let's define the 3×1 vector z_a as the vector describing the fraction of individuals in each state $(z_0(a), z_1(a), z_2(a))$. Given an initial health distribution at age $a = 50$ (our initial age) we can compute, $z_{a+1} = \Gamma_a z_a$ for all ages.[19]

To derive the expected duration in each health status, we start by computing the expected years lived in each health status in the interval $(a, a+1)$. The expected years lived in status $i \in \{1,2\}$ is given by:

$$z_i(a)p_{ii}(a) + \frac{1}{2}z_i(a)\Big[p_{ij}(a) + p_{i0}(a)\Big] + \frac{1}{2}z_j(a)p_{ji}(a)$$

where $j \in \{1,2\}$ and $j \neq i$. The first term counts a full year for those individuals who were in health i at age a and remain in health i at age $a+1$, the second term counts half-year for those individuals who were in health i at age a and change state (either to health j or to death) before age $a+1$, and the third term counts half-year for those individuals who were in health j at age a and transit to state i before age $a+1$. Thus the expected duration at age 50 in status i is given by:

$$ED_i = \sum_{a=50}^{\bar{a}} z_i(a)p_{ii}(a) + \frac{1}{2}z_i(a)\Big[p_{ij}(a) + p_{i0}(a)\Big] + \frac{1}{2}z_j(a)p_{ji}(a)$$

where $\bar{a} = 90$. Keeping with our notation, HLE $\equiv ED_2$, ULE $\equiv ED_1$, and LE = HLE+ULE.

[19] To compute the health distribution at age 50 we use the average share of individuals in good health between ages 50 and 54

Appendix B: Extra tables

TABLE B.1: Educational Attainment

	EUROSTAT (Age 55-74)		Sample (Age 55-74)		Sample (Age 50-90)	
	Males	Females	Males	Females	Males	Females
Austria*	19.6	7.9	20.0	14.2	20.3	14.6
Belgium	22.7	17.2	29.1	24.4	29.7	25.6
Czechia*	13.9	7.8	20.6	11.7	20.3	12.1
Denmark*	25.1	23.1	36.5	36.5	37.4	37.7
Estonia*	26.8	31.4	21.4	20.5	21.7	21.2
France*	15.9	13.2	20.5	16.5	20.8	16.9
Germany	30.1	13.8	33.5	20.4	33.6	20.7
Greece	15.3	7.7	18.6	8.8	19.2	9.5
Italy*	8.9	6.3	8.6	5.8	8.9	6.1
Netherlands	29.1	17.0	26.5	16.5	27.2	17.7
Poland*	12.9	10.9	6.4	5.4	6.4	5.3
Slovenia*	17.3	13.1	15.2	10.7	14.9	10.9
Spain*	17.3	9.6	10.8	6.8	11.1	7.9
Sweden*	21.6	26.6	21.8	22.9	21.8	22.9
Switzerland	33.8	12.7	19.3	10.4	19.6	11.3
England*	26.4	23.8	16.4	12.5	16.4	12.6
US*	31.3	24.1	27.7	20.4	27.8	21.1

Notes: An * mark indicates that the country sample has been selected for the main exercises of the paper. Sources: EUROSTAT (Population by educational attainment level, sex and age [edat_lfs_9903]) share of population age 55-74 with ISCED11 tertiary education (levels 5-8), average for years 2004-2012. For the US: OECD (2016) share of population age 55-64 with at least a bachelor's degree. Sample: In continental Europe, share of population with at least 15 years of education. In England, share of population finished full-time education after age 19. In the US, share of population with completed college.

Table B.2: Life expectancies: College

	A. Males			B. Females			C. Difference		
	LE	HLE	ULE	LE	HLE	ULE	LE	HLE	ULE
Western Europe	34.1	30.9	3.2	35.6	31.9	3.7	-1.5	-1.0	-0.5
	(0.6)	(0.6)	(0.3)	(0.6)	(0.6)	(0.4)	(0.8)	(0.8)	(0.5)
Austria	33.5	30.3	3.2	34.3	31.1	3.2	-0.8	-0.8	-0.0
	(0.8)	(0.8)	(0.4)	(0.9)	(0.9)	(0.5)	(1.2)	(1.2)	(0.7)
France	34.7	31.4	3.3	36.7	32.5	4.2	-2.0	-1.1	-0.9
	(0.8)	(0.9)	(0.5)	(0.7)	(0.8)	(0.6)	(1.1)	(1.2)	(0.8)
Eastern Europe	30.2	26.9	3.3	35.7	31.8	3.9	-5.5	-4.9	-0.6
	(0.7)	(0.6)	(0.3)	(0.5)	(0.5)	(0.3)	(0.9)	(0.8)	(0.4)
Czechia	29.6	26.6	2.9	36.9	32.1	4.7	-7.3	-5.5	-1.8
	(1.2)	(1.1)	(0.4)	(0.9)	(1.1)	(0.8)	(1.5)	(1.5)	(0.9)
Estonia	30.1	26.5	3.5	35.2	31.3	3.9	-5.1	-4.8	-0.4
	(1.1)	(1.0)	(0.4)	(0.6)	(0.7)	(0.4)	(1.3)	(1.2)	(0.6)
Poland	30.8	26.1	4.5	31.6	26.7	4.7	-0.9	-0.6	-0.1
	(1.8)	(1.8)	(1.1)	(2.5)	(2.5)	(1.7)	(3.1)	(3.0)	(2.0)
Slovenia	32.1	29.3	2.7	37.0	34.5	2.3	-4.8	-5.2	0.4
	(1.5)	(1.4)	(0.7)	(1.4)	(1.6)	(0.9)	(2.0)	(2.1)	(1.1)
Mediterranean	33.0	30.6	2.4	34.4	32.7	1.6	-1.3	-2.1	0.8
	(0.9)	(0.9)	(0.5)	(1.1)	(1.1)	(0.4)	(1.4)	(1.5)	(0.6)
Italy	33.5	30.3	3.1	36.3	34.5	1.6	-2.7	-4.2	1.5
	(1.3)	(1.4)	(0.8)	(1.6)	(1.8)	(0.8)	(2.0)	(2.2)	(1.1)
Spain	32.5	30.5	1.9	33.4	31.5	1.9	-0.9	-1.0	0.1
	(1.3)	(1.3)	(0.5)	(1.3)	(1.4)	(0.6)	(1.9)	(1.9)	(0.7)
Scandinavia	32.7	30.2	2.5	34.6	32.2	2.4	-1.9	-2.0	0.1
	(0.5)	(0.5)	(0.3)	(0.5)	(0.5)	(0.3)	(0.7)	(0.8)	(0.4)
Denmark	31.6	29.3	2.3	33.1	31.3	1.7	-1.4	-2.0	0.5
	(0.8)	(0.8)	(0.3)	(0.8)	(0.8)	(0.3)	(1.1)	(1.1)	(0.4)
Sweden	33.6	30.8	2.7	36.0	32.9	3.1	-2.4	-2.0	-0.4
	(0.7)	(0.7)	(0.4)	(0.6)	(0.7)	(0.4)	(0.9)	(1.0)	(0.6)
England	32.6	28.2	4.4	33.9	28.5	5.4	-1.3	-0.3	-0.9
	(0.5)	(0.5)	(0.3)	(0.5)	(0.5)	(0.4)	(0.7)	(0.7)	(0.5)
US	31.0	28.2	2.8	33.9	29.8	4.1	-2.9	-1.5	-1.4
	(0.4)	(0.4)	(0.1)	(0.3)	(0.3)	(0.2)	(0.5)	(0.5)	(0.2)

Notes: LE stands for life expectancy, HLE for healthy life expectancy, and ULE for unhealthy life expectancy. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancies that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

Table B.3: Life expectancies: No College

	A. Males			B. Females			C. Difference		
	LE	HLE	ULE	LE	HLE	ULE	LE	HLE	ULE
Western Europe	30.2	26.2	4.0	33.9	28.9	5.0	-3.7	-2.6	-1.0
	(0.5)	(0.4)	(0.2)	(0.3)	(0.3)	(0.2)	(0.6)	(0.5)	(0.2)
Austria	29.6	26.2	3.4	32.6	28.4	4.2	-3.0	-2.2	-0.8
	(0.7)	(0.7)	(0.3)	(0.5)	(0.5)	(0.2)	(0.9)	(0.8)	(0.4)
France	30.7	26.3	4.4	34.9	29.2	5.7	-4.2	-2.9	-1.3
	(0.6)	(0.5)	(0.2)	(0.4)	(0.4)	(0.2)	(0.7)	(0.6)	(0.3)
Eastern Europe	26.2	22.6	3.6	31.8	26.6	5.2	-5.6	-4.1	-1.6
	(0.4)	(0.3)	(0.1)	(0.3)	(0.2)	(0.1)	(0.4)	(0.4)	(0.2)
Czechia	26.0	22.6	3.5	31.0	26.4	4.5	-4.9	-3.8	-1.1
	(0.6)	(0.5)	(0.2)	(0.4)	(0.4)	(0.2)	(0.7)	(0.7)	(0.3)
Estonia	25.5	21.9	3.6	32.7	26.8	5.9	-7.3	-4.9	-2.4
	(0.7)	(0.6)	(0.2)	(0.5)	(0.4)	(0.3)	(0.8)	(0.7)	(0.3)
Poland	25.4	21.6	3.8	30.6	25.4	5.3	-5.3	-3.8	-1.5
	(0.8)	(0.7)	(0.3)	(0.6)	(0.6)	(0.4)	(1.0)	(0.9)	(0.5)
Slovenia	29.6	25.6	3.9	34.0	29.2	4.7	-4.4	-3.5	-0.8
	(0.9)	(0.8)	(0.4)	(0.7)	(0.7)	(0.4)	(1.2)	(1.1)	(0.5)
Mediterranean	30.0	27.2	2.8	33.6	28.6	5.1	-3.7	-1.4	-2.3
	(0.3)	(0.3)	(0.1)	(0.3)	(0.2)	(0.1)	(0.4)	(0.4)	(0.2)
Italy	30.9	28.2	2.7	33.7	28.6	5.1	-2.8	-0.4	-2.4
	(0.4)	(0.4)	(0.2)	(0.3)	(0.3)	(0.2)	(0.6)	(0.5)	(0.3)
Spain	29.0	26.2	2.8	33.4	28.5	5.0	-4.4	-2.3	-2.1
	(0.5)	(0.5)	(0.2)	(0.4)	(0.4)	(0.2)	(0.6)	(0.6)	(0.3)
Scandinavia	30.5	27.3	3.2	32.3	28.5	3.8	-1.8	-1.2	-0.6
	(0.4)	(0.4)	(0.2)	(0.4)	(0.4)	(0.2)	(0.5)	(0.5)	(0.3)
Denmark	29.6	26.3	3.3	31.0	27.3	3.7	-1.3	-0.9	-0.4
	(0.6)	(0.6)	(0.3)	(0.6)	(0.6)	(0.3)	(0.9)	(0.9)	(0.4)
Sweden	31.1	27.9	3.2	33.2	29.3	3.9	-2.1	-1.4	-0.7
	(0.5)	(0.5)	(0.2)	(0.4)	(0.5)	(0.2)	(0.7)	(0.7)	(0.3)
England	29.2	23.5	5.7	32.7	25.5	7.2	-3.5	-2.0	-1.5
	(0.3)	(0.3)	(0.1)	(0.2)	(0.2)	(0.2)	(0.3)	(0.3)	(0.2)
US	27.5	23.0	4.5	30.7	24.6	6.1	-3.3	-1.6	-1.6
	(0.2)	(0.2)	(0.1)	(0.2)	(0.2)	(0.1)	(0.3)	(0.3)	(0.1)

Notes: LE stands for life expectancy, HLE for healthy life expectancy, and ULE for unhealthy life expectancy. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancies that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

TABLE B.4: Life expectancies: Pooled education

	A. Males			B. Females			C. Difference		
	LE	HLE	ULE	LE	HLE	ULE	LE	HLE	ULE
Western Europe	31.3	27.4	3.8	34.3	29.5	4.8	-3.0	-2.0	-1.0
	(0.4)	(0.3)	(0.2)	(0.3)	(0.3)	(0.2)	(0.5)	(0.4)	(0.2)
Austria	30.8	27.5	3.3	32.9	28.9	4.0	-2.1	-1.4	-0.7
	(0.6)	(0.5)	(0.2)	(0.5)	(0.4)	(0.2)	(0.7)	(0.7)	(0.3)
France	31.7	27.4	4.2	35.2	29.8	5.4	-3.5	-2.3	-1.2
	(0.5)	(0.4)	(0.2)	(0.3)	(0.3)	(0.2)	(0.6)	(0.6)	(0.3)
Eastern Europe	26.9	23.3	3.6	32.4	27.4	5.0	-5.5	-4.0	-1.4
	(0.3)	(0.3)	(0.1)	(0.2)	(0.2)	(0.1)	(0.4)	(0.4)	(0.2)
Czechia	26.7	23.3	3.3	31.5	27.0	4.5	-4.8	-3.7	-1.2
	(0.5)	(0.5)	(0.2)	(0.4)	(0.4)	(0.2)	(0.7)	(0.6)	(0.3)
Estonia	26.4	22.9	3.5	33.3	27.9	5.5	-6.9	-5.0	-1.9
	(0.6)	(0.5)	(0.2)	(0.4)	(0.4)	(0.2)	(0.7)	(0.6)	(0.3)
Poland	26.0	22.1	3.8	30.8	25.6	5.2	-4.8	-3.4	-1.4
	(0.7)	(0.7)	(0.3)	(0.6)	(0.6)	(0.4)	(0.9)	(0.9)	(0.5)
Slovenia	30.1	26.4	3.7	34.3	29.8	4.5	-4.2	-3.4	-0.8
	(0.8)	(0.8)	(0.3)	(0.6)	(0.6)	(0.3)	(1.1)	(1.0)	(0.5)
Mediterranean	30.2	27.5	2.8	33.7	28.8	4.9	-3.4	-1.3	-2.1
	(0.3)	(0.3)	(0.1)	(0.2)	(0.2)	(0.1)	(0.4)	(0.4)	(0.2)
Italy	31.2	28.4	2.8	33.8	28.8	5.0	-2.7	-0.4	-2.2
	(0.4)	(0.4)	(0.2)	(0.3)	(0.3)	(0.2)	(0.5)	(0.5)	(0.3)
Spain	29.4	26.6	2.8	33.4	28.6	4.8	-4.1	-2.0	-2.0
	(0.5)	(0.4)	(0.1)	(0.4)	(0.3)	(0.2)	(0.6)	(0.5)	(0.2)
Scandinavia	31.1	28.2	3.0	33.0	29.7	3.3	-1.9	-1.5	-0.3
	(0.3)	(0.3)	(0.1)	(0.3)	(0.3)	(0.1)	(0.4)	(0.4)	(0.2)
Denmark	30.3	27.4	2.9	31.8	28.8	3.0	-1.5	-1.4	-0.1
	(0.5)	(0.5)	(0.2)	(0.5)	(0.5)	(0.2)	(0.7)	(0.7)	(0.3)
Sweden	31.8	28.8	3.0	33.9	30.4	3.5	-2.1	-1.6	-0.5
	(0.4)	(0.4)	(0.2)	(0.3)	(0.4)	(0.2)	(0.5)	(0.6)	(0.3)
England	29.8	24.4	5.4	32.8	26.0	6.9	-3.0	-1.6	-1.5
	(0.2)	(0.2)	(0.1)	(0.2)	(0.2)	(0.1)	(0.3)	(0.3)	(0.2)
US	28.3	24.3	4.1	31.3	25.5	5.8	-3.0	-1.3	-1.7
	(0.2)	(0.2)	(0.1)	(0.2)	(0.2)	(0.1)	(0.3)	(0.2)	(0.1)

Notes: LE stands for life expectancy, HLE for healthy life expectancy, and ULE for unhealthy life expectancy. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancies that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

TABLE B.5: Gender-education gradients

	LE	HLE	ULE
Western Europe	5.4	5.6	-0.3
	(0.7)	(0.7)	(0.4)
Austria	4.6	4.9	-0.2
	(1.2)	(1.1)	(0.5)
France	5.9	6.1	-0.2
	(0.9)	(1.0)	(0.7)
Eastern Europe	9.5	9.2	0.3
	(0.6)	(0.6)	(0.4)
Czechia	10.8	9.5	1.2
	(1.1)	(1.2)	(0.8)
Estonia	9.8	9.4	0.3
	(0.9)	(0.9)	(0.5)
Poland	6.3	5.1	0.9
	(2.6)	(2.6)	(1.7)
Slovenia	7.3	8.9	-1.7
	(1.7)	(1.8)	(1.0)
Mediterranean	4.4	5.5	-1.2
	(1.1)	(1.2)	(0.4)
Italy	5.3	6.3	-1.2
	(1.6)	(1.8)	(0.8)
Spain	4.4	5.3	-1.0
	(1.4)	(1.5)	(0.6)
Scandinavia	4.1	4.9	-0.8
	(0.6)	(0.7)	(0.3)
Denmark	3.4	5.0	-1.6
	(1.0)	(1.0)	(0.4)
Sweden	4.9	5.0	-0.1
	(0.8)	(0.8)	(0.5)
England	4.7	5.0	-0.3
	(0.6)	(0.6)	(0.4)
US	6.5	6.8	-0.3
	(0.4)	(0.4)	(0.2)

Notes: LE stands for life expectancy, HLE for healthy life expectancy, and ULE for unhealthy life expectancy, all at age 50. The Gender-education gradient is the difference in the corresponding life expectancy between college females and non-college males. For each country we report the median (and the standard deviation in parenthesis) of the distribution of the corresponding life expectancy that arises from the posterior distribution of the estimated $\boldsymbol{\beta}$ parameters.

TABLE B.6: Cross-country regressions: education gradients and their decompositions

	A. Males			B. Females		
	LE	HLE	ULE	LE	HLE	ULE
Health spending	-0.44**	-0.08	-0.35**	-0.12	0.09	-0.18
	(0.19)	(0.23)	(0.14)	(0.35)	(0.34)	(0.25)
Gini income	0.10*	0.10*	0.00	-0.09	-0.04	-0.05
	(0.05)	(0.05)	(0.05)	(0.09)	(0.09)	(0.07)
Edu gradient ever smoked, (m,f)	-1.13	-3.41	2.09	-8.55	-2.90	-6.09
	(5.02)	(4.80)	(3.72)	(6.00)	(6.30)	(4.39)
	A. Males			B. Females		
	LE_b	HLE_b	ULE_b	LE_b	HLE_b	ULE_b
Gini income	0.01	0.02	-0.01	0.01	0.03	-0.02
	(0.03)	(0.06)	(0.03)	(0.03)	(0.08)	(0.05)
Health spending	0.13	0.34	-0.20*	0.12	0.26	-0.12
	(0.09)	(0.19)	(0.11)	(0.10)	(0.28)	(0.19)
Edu gradient ever smoked, (m,f)	-1.39	-4.00	2.69	0.66	3.60	-2.74
	(2.16)	(4.57)	(2.57)	(1.98)	(5.29)	(3.42)
	A. Males			B. Females		
	LE_c	HLE_c	ULE_c	LE_c	HLE_c	ULE_c
Gini income	0.09	0.07	0.02	-0.10	-0.06	-0.04
	(0.07)	(0.05)	(0.02)	(0.10)	(0.06)	(0.05)
Health spending	-0.55**	-0.41**	-0.13*	-0.23	-0.21	-0.01
	(0.21)	(0.16)	(0.06)	(0.39)	(0.21)	(0.18)
Edu gradient ever smoked, (m,f)	0.55	1.33	-0.80	-12.13*	-6.38	-5.58*
	(5.88)	(4.51)	(1.56)	(6.28)	(3.69)	(2.86)

Notes: Each entry reports the regression coefficient of the corresponding life expectancy gradient on the gini index of income (first row), the health spending over GDP (second row), and the education gradient in smoking for males or females (third row). The top block refers to the actual gradients, the middle block refers to the counterfactual gradients in which education groups only differ in transitions, and the bottom block refers to the counterfactual gradients in which education groups only differ in conditional mortality. Standard errors in parenthesis. Statistical significance: * at 10%, ** at 5%, *** at 1%

References

Alvaredo, F., L. Chancel, T. Piketty, E. Saez, and G. Zucman (2018): *World Inequality Report*, World Inequality Lab.

Ameriks, J., J. S. Briggs, A. Caplin, M. D. Shapiro, and C. Tonetti (2015): "Long-term Care Utility and Late in Life Saving," NBER Working Paper 20973.

Aron-Dine, A., L. Einav, and A. Finkelstein (2013): "The RAND Health Insurance Experiment, Three Decades Later," *Journal of Economic Perspectives*, 27, 197–222.

Avendano, M., R. Kok, M. Glymour, L. Berkman, I. Kawachi, A. Kunst, and J. Mackenbach (2011): "Do Americans Have Higher Mortality Than Europeans at All Levels of the Education Distribution?: A Comparison of the United States and 14 European Countries," in *International Differences in Mortality at Older Ages: Dimensions and Sources*, ed. by E. M. Crimmins, S. H. Preston, and B. Cohen, National Academies Press, chap. 11.

Blundell, R., E. French, and G. Tetlow (2016): "Retirement Incentives and Labor Supply," in *Handbook of the Economics of Population Aging*, ed. by J. Piggott and A. Woodland, Amsterdam: North Holland, chap. 8, 457–566.

Boháček, R., L. Crespo, P. Mira, and J. Pijoan-Mas (2015): "The Educational Gradient in Life Expectancy in Europe: Preliminary Evidence from SHARE," in *Ageing in Europe - Supporting Policies for an Inclusive Society*, ed. by A. Börsch-Supan, T. Kneip, H. Litwin, M. Myck, and G. Weber, Berlin: de Gruyter, chap. 29, 321–330.

Börsch-Supan, A., M. Brandt, C. Hunkler, T. Kneip, J. Korbmacher, F. Malter, B. Schaan, S. Stuck, and S. Zuber (2013): "Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE)," *International Journal of Epidemiology*, 42, 992–1001, dOI: 10.1093/ije/dyt088.

Braun, R. A., K. A. Kopecky, and T. Koreshkova (2017): "Old, Frail, and Uninsured: Accounting for Puzzles in the US Long-Term Care Insurance Market," Federal Reserve Bank of Atlanta, Working Paper 2017-3b.

Brown, J. (2002): "Differential Mortality And The Value Of Individual Account Retirement Annuities," in *The Distributional Aspects of Social Security and Social Security Reform*, ed. by M. Feldstein and J. B. Liebman, University of Chicago Press, chap. 10.

Buckles, K., A. Hagemann, O. Malamud, M. Morrill, and A. Wozniak (2016): "The Effect of College Education on Mortality," *Journal of Health Economics*, 50, 99–114.

Bueren, J. (2017): "Long-Term Care Needs: Implication for Savings, Welfare and Public Policy," Mimeo, Cemfi.

Case, A. and A. Deaton (2017): "Mortality and Morbidity in the 21st Century," *Brooking Papers on Economic Activity*, Spring, 397–443.

Case, A. and C. Paxson (2005): "Sex Differences in Morbidity and Mortality," *Demography*, 42, 189–214.

Chan, K., J. Kasper, J. Brandt, and L. Pezzin (2012): "Measurement Equivalence in ADL and IADL Difficulty Across International Surveys of Aging: Findings from the HRS, SHARE, and ELSA," *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 67, 121–132.

Clark, D. and H. Royer (2013): "The Effect of Education on Adult Mortality and Health: Evidence from Britain," *American Economic Review*, 103, 2087–2120.

Crimmins, E. M. and E. Cambois (2003): "Social Inequalities in Health Expectancy," in *Determining Health Expectancies*, ed. by J.-M. Robine, C. Jagger, C. D. Mathers, E. M. Crimmins, and R. M. Suzman, Chichester, UK: John Wiley & Sons, Ltd, chap. 5, 111–125.

Crimmins, E. M., J. K. Kim, and A. Sole-Auro (2011): "Gender differences in health: Results from SHARE, ELSA and HRS," *European Journal of Public Health*, 21, 81–91.

Currie, J. and H. Schwandt (2016): "Mortality Inequality: The Good News from a County-Level Approach," *Journal of Economic Perspectives*, 20, 29–52.

Currie, J., H. Schwandt, and J. Thuilliez (2018): "Pauvreté, Egalité, Mortalité: Mortality (In)Equality In France And The United States," NBER Working Paper 24623.

Cutler, D. M., K. Ghosh, and M. B. Landrum (2013): "Evidence for Significant Compression of Morbidity in the Elderly U.S. Population," NBER Working Paper 19268.

Cutler, D. M. and A. Lleras-Muney (2010): "Understanding Differences in Health Behaviors by Education," *Journal of Health Economics*, 29, 1–28.

de Gelder, R., G. Menvielle, G. Costa, K. Koávcs, P. Martikainen, and B. H. Strand (2017): "Long-term Trends of Inequalities in Mortality in 6 European Countries," *International Journal of Public Health*, 62, 127–141.

De Nardi, M., E. French, and J. Jones (2016): "Medicaid Insurance in Old Age," *American Economic Review*, 106, 3480–3520.

Delavande, A. and S. Rohwedder (2011): "Differential Survival in Europe and the United States: Estimates Based on Subjective Probabilities of Survival," *Demography*, 48, 1377–1400.

Dwyera, D. S. and O. S. Mitchell (1999): "Health Problems as Determinants of Retirement: Are Self-Rated Measures Endogenous?" *Journal of Health Economics*, 18, 173–193.

Finkelstein, A., S. Taubman, B. Wright, M. Bernstein, J. Gruber, J. P. Newhouse, H. Allen, and K. Baicker (2012): "The Oregon Health Insurance Experiment: Evidence from the First Year," *Quarterly Journal of Economics*, 127, 1057–1106.

Fries, J. F. (1980): "Aging, Natural Death, and the Compression of Morbidity," *The New England Journal of Medicine*, 303, 130–135.

Fries, J. F., B. Bruce, and E. Chakravarty (2011): "Compression of Morbidity 1980-2011: A Focused Review of Paradigms and Progress," *Journal of Aging Research*, 261702.

Fuster, L., A. İmrohoroğlu, and S. İmrohoroğlu (2003): "A Welfare Analysis of Social Security in a Dynastic Framework," *International Economic Review*, 44, 1247–1274.

Gruenberg, E. (1977): "The Failures of Success," *Milbank Memorial Fund Quarterly*, 55, 3–24.

Katz, S., A. B. Ford, R. W. Moskowitz, B. A. Jackson, and M. W. Jaffe (1963): "Studies of Illness in the Aged: the Index of ADL: a Standardized Measure of Biological and Psychosocial Function," *JAMA*, 185, 914–919.

Krueger, D., F. Perri, L. Pistaferri, and G. Violante (2010): "Cross Sectional Facts for Macroeconomists," *Review of Economic Dynamics*, 13, 1–14.

Laditka, S. B. and M. D. Hayward (2003): "The Evolution of Demographic Methods to Calculate Health Expectancies," in *Determining Health Expectancies*, ed. by J.-M. Robine, C. Jagger, C. D. Mathers, E. M. Crimmins, and R. M. Suzman, Chichester, UK: John Wiley & Sons, Ltd, chap. 11.

Lleras-Muney, A. (2005): "The Relationship Between Education and Adult Mortality in the United States," *Review of Economic Studies*, 72, 189–221.

Lorber, J. and L. J. Moore (2002): *Gender and the Social Construction of Illness*, Plymouth, United Kingdom: Altamira Press.

Mackenbach, J. P. (2017): "Nordic Paradox, Southern Miracle, Eastern Disaster: Persistence of Inequalities in Mortality in Europe," *European Journal of Public Health*, 14–17.

Mackenbach, J. P., I. Kulhanova, M. Bopp, P. Deboosere, T. A. Eikemo, R. Hoffmann, M. C. Kulik, M. Leinsalu, P. Martikainen, G. Menvielle,

E. Regidor, B. Wojtyniak, O. Ostergren, and O. Lundberg (2015a): "Variations in the Relation Between Education and Cause-Specific Mortality in 19 European populations: A Test of the 'Fundamental Causes' Theory of Social Inequalities in Health," *Social Science and Medicine*, 127, 51–62.

Mackenbach, J. P., I. Kulhanova, G. Menvielle, M. Bopp, C. Borrell, G. Costa, P. Deboosere, S. Esnaola, R. Kalediene, K. Kovacs, M. Leinsalu, P. Martikainen, E. Regidor, M. Rodriguez-Sanz, B. H. Strand, R. Hoffmann, T. A. Eikemo, O. Östergren, and O. Lundberg (2015b): "Trends in Inequalities in Premature Mortality: a Study of 3.2 Million Deaths in 13 European Countries," *Journal of Epidemiology and Community Health*, 69, 207–217.

Mackenbach, J. P., C. W. Looman, B. Artnik, M. Bopp, P. Deboosere, C. Dibben, R. Kalediene, K. Kovacs, M. Leinsalu, P. Martikainen, E. Regidor, J. Rychtarikova, and R. de Gelder (2017): "'Fundamental Causes' of Inequalities in Mortality: an Empirical Test of the Theory in 20 European Populations," *Sociology of Health and Illness*, 1–17.

Mackenbach, J. P., I. Stirbu, A.-J. R. Roskam, M. M. Schaap, G. Menvielle, M. Leinsalu, and A. E. Kunst (2008): "Socioeconomic Inequalities in Health in 22 European Countries," *The New England Journal of Medicine*, 358, 2468–2481.

Majer, I., W. Nusselder, J. Mackenbach, and A. Kunst (2010): "Socioeconomic Inequalities in Life and Health Expectancies Around Official Retirement Age in 10 Western-European Countries," *Journal of Epidemiology and Community Health*.

Maki, N., P. Martikainen, T. Eikemo, G. Menvielle, O. Lundberg, O. Ostergren, D. Jasilionis, and J. P. Mackenbach (2013): "Educational Differences in Disability-free Life Expectancy: a Comparative Study of long-standing Activity Limitation in Eight European Countries," *Social Science and Medicine*, 94, 1–8.

Meara, E., S. Richards, and D. Cutler (2008): "The Gap Gets Bigger: Changes in Mortality and Life Expectancy by Education, 1981-2000," *Health Affairs*, 27, 350–360.

Meghir, C., M. Palme, and E. Simeonova (2013): "Education, Cognition And Health: Evidence From A Social Experiment," NBER Working Paper 19002.

Montez, J. K., R. A. Hummer, M. D. Hayward, H. Woo, and R. G. Rogers (2011): "Trends in the Educational Gradient of U.S. Adult Mortality from 1986 through 2006 by Race, Gender, and Age Group," *Research on Aging*, 2, 145–171.

Nakajima, M. and I. A. Telyukova (2015): "Medical Expenses and Saving in Retirement: The Case of U.S. and Sweden," Mimeo.

OECD (2018): "Health expenditure indicators: Health expenditure and financing," Doi = http://dx.doi.org/10.1787/data-00349-en.

Pijoan-Mas, J. and J. V. Ríos-Rull (2014): "Heterogeneity in Expected Longevities," *Demography*, 51, 2075–2102.

Preston, S. H. and H. Wang (2006): "Sex Mortality Differences in the United States: The Role of Cohort Smoking Patterns," *Demography*, 43, 197–222.

Sanders, B. S. (1964): "Measuring Community Health Levels," *American Journal of Public Health*, 54, 1063–1070.

Solé-Auró, A., P.-C. Michaud, M. D. Hurd, and E. Crimmins (2015): "Disease Incidence and Mortality Among Older Americans and Europeans," *Demography*, 52, 593–611.

Sullivan, D. F. (1966): "Conceptual Problems in Developing an Index of Health," *Vital and Health Statistics Series 2*, 17.

——— (1971): "A Single Index of Mortality and Morbidity," *HSMHA Health Reports*, 86, 347–354.

Van Oyen, H., W. Nusselder, C. Jagger, P. Kolip, E. Cambois, and J.-M. Robine (2013): "Gender Differences in Healthy Life Years within the EU: an Exploration of the "Health-Survival" Paradox," *International Journal of Public Health*, 58, 143–155.

Wen, J. (2017): "Occupational Retirement and Social Security Reform: the Roles of Physical and Cognitive Health," Mimeo.