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English - Or. English

INEQUALITIES IN LONGEVITY BY EDUCATION IN OECD COUNTRIES: INSIGHTS FROM NEW OECD ESTIMATES[1]

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The release of this working paper has been authorised by Martine Durand, OECD Chief Statistician and Director of the OECD Statistics Directorate.

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ABSTRACT / RÉSUMÉ

This paper assesses inequality in longevity across education and gender groups in 23 OECD countries around 2011. Data on mortality rates by age, gender, and educational attainment, as well as cause of death for 17 countries, were collected from national sources with similar treatment applied to all countries in order to derive comparable measure of longevity at age 25 and 65 by gender and education. These estimates show that, on average, the gap in life expectancy between highly educated and poorly educated people is 8 years for men and 5 years for women at age 25, and 3.5 years for men and 2.5 years for women at age 65. Other measures of inequalities in longevity by education (such as country averages of age-standardised mortality rates and the slope index of inequality) do not significantly change the inequality ranking of countries relative to one based on life expectancy measures. While significant, differences in longevity between groups with low and high educational attainment account, on average, for around 10% of overall differences in ages of death. Cardiovascular diseases are the first cause of death for all gender and education groups after age 65, and the first cause of mortality inequality between highly educated and poorly educated elderly people.

Keywords: health, life expectancy, inequality, socioeconomic gradient, cause of death
JEL Classification: I14, I18

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Ce document estime les inégalités de longévité par genre et niveaux d'éducation pour 23 pays de l'OCDE aux alentours de 2011. Des données de taux de mortalité par âge, sexe, éducation et, pour 17 pays, par cause de mortalité, ont été collectées à partir de sources statistiques nationales. Un traitement identique a été appliqué à toutes ces données afin d'obtenir des mesures comparables de longévité à 25 et 65 ans par sexe et niveau d'éducation. Ces estimations montrent que, en moyenne, les différences d'espérance de vie à 25 ans entre les personnes à haut et faible niveaux d'éducation sont de 8 ans pour les hommes et de 5 ans pour les femmes, alors que ces différences sont de 3.5 ans pour les hommes et de 2.5 ans pour les femmes à l'âge de 65 ans. D'autres mesures d'inégalité de longévité par niveau d'éducation (tels que les taux moyens de mortalité standardisés ou les indices de pente d'inégalité) fournissent globalement le même classement de pays en termes d'inégalité, par rapport aux indices basés sur l'espérance de vie. Toutefois les différences de longévité entre haut et faible niveaux d'éducation expliquent seulement 10% des differences d'âge à la mort parmi les personnes. Les maladies cardio-vasculaires sont la première cause de mortalité pour tous les groupes d'éducation et de genre après 65 ans, et la première cause d'inégalité de mortalité entre les seniors à haut et faible niveaux d'éducation.

Mots-clés : santé, espérance de vie, inégalité, gradient socio-économique, cause de mort
Classification JEL : I14, I18

TABLE OF CONTENTS

Tables

Figures

1. Introduction

1. Together with income and employment, health is a key determinant of people's living standards and well-being, as recognised by the OECD Better Life Initiative and the OECD Inclusive Growth project. While cross-country differences in average health outcomes have been analysed in detail, inequalities in longevity *within countries* are less well-understood as their analysis requires more comprehensive data and complex data treatments.

2. This paper aims to fill this gap. It describes results from a new data collection undertaken by the OECD Statistics Directorate, based on harmonised estimates of mortality rates by age, gender, educational attainment and causes of death. Empirical evidence from these data is summarised in the form of estimates of life expectancy at different ages for people with different levels of educational attainment, and of measures of lifespan variability, which shed new light on inequalities in age at death *within* each educational group. This evidence is supported by an assessment of data quality for the various countries included in the analysis. As such, this paper constitutes an essential element of the OECD Inclusive Growth Initiative and provides an important input to the OECD Ageing Unequally report.

3. Health inequalities, and more specifically inequality in mortality and longevity, are very important public policy issues at the crossroad of health, social and economic policies. They are also an important determinant of individual well-being, labour force participation and economic growth (OECD, 2012). In particular, these inequalities have potentially significant policy implications:

- Premature and avoidable mortality implies a significant economic cost to individuals and a loss in social welfare. Premature mortality, as measured by "potential years of life lost" (PYLL), was on average 3 700 years per 100 000 inhabitants aged 0-69 in 2009 (*OECD Health Database*)[2]. The social cost of premature mortality is large: even a conservative valuation of USD 100 000 per life-year would yield an equivalent cost of USD 3 700 per person aged 0-69 (Murphy and Topel, 2005). The wide dispersion in ages at death across individuals (including after age 70) generates large differences in welfare within countries. For instance, Mackenbach, Meerding and Kunst (2011) estimated that there are more than 700 000 avoidable deaths and 33 million preventable cases of ill-health in the European Union every year. The estimated economic losses due to these premature deaths may amount to 1.4% of GDP (or EUR 141 billion); this is equivalent to 15% of the costs of social security systems and 20% of the costs of health-care systems in these countries (Mackenbach, Meerding and Kunst, 2011).

- Inequalities in mortality and life expectancy are stratified along socio-economic lines. In most OECD countries, there is evidence of large differences in longevity across socio-economic groups, as the less educated people live shorter lives than those having attained higher education. This implies that longevity and income inequalities reinforce each other and potentially yield a very high level of inequality in *"full income"* across educational groups (Diaz and Murtin, 2016a,b).

4. Designing policies to deal with inequalities in longevity by education requires broader and better evidence, as well as judgments on whether these inequalities are "unjust" differences that call for policy actions. In the field of measuring inequality of opportunities in income, this task is typically conducted by disentangling personal efforts and various circumstances that are beyond individual responsibility, such as

[2] Potential years of life lost (PYLL) is a measure of the average years a person would have lived if he or she had not died prematurely; the threshold used to measure premature mortality is usually set at 70 years of age. Avoidable mortality is obtained by assuming that all educational groups maintain the same mortality as in the high education group.

parental socio-economic background or place of birth (e.g. Roemer, 1998). However, conducting such an analysis on health is more difficult and is still in its infancy. Regarding the measurement of health inequalities, several OECD and non-OECD publications have shed light on various aspects, but in an incomplete way:

- The 2007 edition of *Society at a Glance* (OECD, 2007) presented estimates of dispersions in ages of death (above the age of 10) for OECD and selected non-member countries. These estimates, however, were not available by socio-economic groups (e.g. educational attainment) or cause of death, hence they do not inform about the proximate causes explaining why some people die earlier than others.

- Eurostat (2015) provides estimates of life expectancy at age 30 and age 65 by educational attainment. These estimates are however available for only fourteen European OECD countries; while the number of deaths by education is drawn from death registers, information on the number of people by age and education is drawn from labour force surveys, thus missing older people and people living institutions.

- The OECD report *Health at a Glance* (OECD, 2015) includes measures of life expectancy at age 30 by education for the 14 European countries covered by Eurostat (2015), as well as for Israel, Mexico and the Netherlands, based on national estimates provided through the annual OECD Health Data questionnaire. Similarly, the 2012 edition of OECD *Education at a Glance* (OECD, 2012) includes estimates of life expectancy by educational attainment at age 30 for 13 European countries, sourced from Eurostat, as well as estimates for Canada and the United States, sourced from national studies. Finally, a chapter on the *OECD Business and Financial Outlook 2016* relies on national estimates of life expectancy at age 65 for 19 OECD countries (four of which non-European) to describe recent changes in inequalities in longevity[3]. All of these publications do not discuss inequality *within* educational groups and on the causes of death that may drive these inequalities in longevity.

- Estimates of ages at death and longevity by gender, education and sometimes causes of death based the same (record linking) methodology are described in van Raalte et al. (2011, 2012) and Mackenbach et al. (2008, 2011), but they are only available for 12 European OECD countries.

5. While existing data on socio-economic mortality differentials show evidence of significant ‘social gradients’, these estimates are affected by differences in population coverage (entire populations, regions or samples), type of underlying data (register-based, census-linked, or cross-sectional unlinked data), socio-economic classifications of the deceased (income, occupation, education), summary indicator of health conditions used, and more.

6. This paper aims to remedy this situation by providing detailed mortality estimates by educational attainment, gender and cause of death. These estimates are calculated based on the same method and for more countries than those covered by other studies on this topic. The paper also discusses some important data quality issues which affect the comparability of existing measures, and provides suggestions for further improvements in the quality of data on inequalities in longevity. In the process, the paper opens the “black box” of longevity calculations, reviews methodological and data issues, and compares estimates

[3] In the case of the United States these measures of life expectancy refer to quartiles of people ranked by different levels of education, rather than discrete educational categories (e.g. ‘low’, ‘medium’ and high’), with different numbers of people in each category. Even when education is used as ‘conditioning variable’, one problem with using estimates from national studies is that these studies may use non-comparable classifications of educational systems, or may use different ways of grouping people by education.

from this data-collection to those drawn from Eurostat. Based on the data collected for the purpose of this paper, complemented by Eurostat data for one country, estimates of longevity by gender and education are presented for 23 countries, of which 17 broken down by cause of death[4].

7. While the main focus of the paper is on differences in longevity by level of education, different proxies of socio-economic status (henceforth SES) have been considered by other epidemiological studies. For instance, Banks et al. (2006) for the United Kingdom, and Blanpain (2016) for France rely on measures of life expectancy by occupation; and Chetty et al. (2016) analyse life expectancy by income percentiles of the US. The concept of SES is multi-dimensional and different breakdowns by income, occupation or education, may provide different pictures. One reason of selecting education as the most relevant 'conditioning' variable is that the risk of ‘reverse causality’ is weaker when looking at the relationship between adult health and education[5], compared to the two-way relationship between health and income for instance[6]. However, relationships between education and longevity are complex and are also

[4] The OECD data and estimates discussed in this paper pertain to 22 countries, namely Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, France, Finland, Hungary, Israel, Italy, Latvia, Mexico, Norway, New Zealand, Poland, Slovenia, Sweden, Turkey, the United Kingdom (limited to England and Wales) and the United States. In addition to these data, provided by national correspondents, data on the number of deaths and population by age, gender and educational attainment for 6 European countries (Denmark, Finland, Norway, the Slovak Republic, Slovenia and Sweden) were also collected from Eurostat website, and the same calculations have been applied to these data. Overall, estimates based on a consistent methodology are shown in this paper for 23 countries, based on detailed data-files either collected by the OECD (22 countries) or drawn from the Eurostat website (1 country, i.e. the Slovak Republic). For comparison purposes, Sections 3.1 and 3.2 also include estimates of life expectancy at age 25 and 65 published by Eurostat for 13 European countries, namely the Czech Republic, Denmark, Estonia, Finland, Hungary, Italy, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Sweden and Turkey.

[5] A causal long-term relationship between education and longevity has been established by looking at exogenous changes in school laws in Lleras-Muney (2001), or at very long lags between changes in education (i.e. education of the grandparents and great-grandparents generation) and changes in longevity in Murtin (2013), with both authors finding large effects. Likewise, James et al. (2015) consider a large number of proximate determinants of longevity across a panel of OECD countries between 1990 and 2013, concluding that education brings about the largest effects, followed by air pollution and health spending. This evidence suggests that education has a direct impact upon longevity, in addition to any indirect impact channelled through the reduction in tobacco, alcohol or calories consumption. In that respect, Marmot and Wilkinson (2006) highlight that a socio-economic gradient of mortality is also evident among UK civil servants who never smoked, suggesting that healthier behaviours cannot entirely explain inequality in longevity across groups. Among the effects of education on people's health status are the higher propensity of more educated people to behave in a more forward-looking way (Farrell and Fuchs, 1982), to be better informed and more capable of navigating through the health system (Deaton, 2013). However, as emphasised by Deaton (2013), health may also have a causal effect on longevity, due to the possibility that worse health conditions during childhood may negatively affect educational attainment and health status in adulthood.

[6] Other socio-economic factors such as income or occupation contribute to longevity inequality, but the two-way relationship between health status and these socio-economic variables makes causation difficult to establish. The correlation between longevity and people's income or occupation is very strong and well documented (Marmot and Wilkinson, 2006) but the direction of causality between the two variables is contentious (Deaton, 2013). On the one hand, low income, income declines and poverty may lead to lower consumption of health services and to worse health conditions (Deaton, 2003, McInerney et al., 2013); similarly, people having manual occupations are more exposed to physical strain and fatalities (Banks et al., 2006), while unemployment worsens mental and physical health (Bassanini and Caroli, 2014). On the other hand, disability and poor health conditions may lead to withdrawal from the labour force and hence lower income; for example, Case and Deaton (2003) report that most – although not all - of the correlation between income and self-reported health is removed when those not in the labour force are excluded from the analysis.

related to the skills gained at early stages of life. These skills not only largely predetermine occupation, income, and other socio-economic characteristics at later stages of life, but also contribute to individual health-related life styles, disease risk profiles, and psychosocial characteristics.

8. The main results of the paper are as follows:

- On average, across the countries covered in the analysis, the gap in life expectancy at age 25 years between high and low-educational groups is 8 years for men and 5 years for women. At the age of 65, these gaps are 3.5 years for men and 2.5 years for women, implying that *relative* inequalities in longevity increase with age. Gaps in life expectancy by education are especially large in Latvia and Poland, while they are comparatively low in Italy[7].

- Other measures of inequalities in longevity by education (such as country averages of age-standardised mortality rates and the slope index of inequality) do not significantly change the assessment relative to one based on life expectancy measures.

- Differences in longevity between groups with low and high educational attainment account, on average, for around 10% of overall inequalities in ages of death; this implies that eliminating average differences in longevity across groups with different education does not imply eliminating *all* differences in mortality across people. Also, within-group inequality in ages at death is larger among low-education people than among highly educated people, mainly reflecting higher premature mortality. Because of this pattern, reducing premature mortality, especially among men with low educational attainment, hold the promise of raising both overall longevity and reducing inequality in ages at death.

- Cardio-vascular diseases are the first cause of death for all gender and education groups after age 65 years, and the first cause of mortality inequality between the high and low-education elderly.

9. In terms of data quality, there is also evidence that countries relying on a “linked approach”, whereby individual death records are linked to data from a recent population census or administrative file, display higher quality data. The data used in this paper for countries such as Belgium or the Czech Republic, which rely on an “unlinked procedure”, feature a large pool of people with an unstated level of education in death registers, implying that estimates of longevity inequality by education are particularly subject to measurement errors. These patterns conform to those reported by Mackenbach et al. (2015).

10. The paper is structured as follows. Section 2 describes the data, Section 3 presents estimates of longevity inequalities *between* educational groups, while Section 4 describes inequalities *within* groups. Section 5 explains between-group inequality in mortality by looking at specific causes of death, while Section 6 describes time trends and last Section concludes.

[7] The gap in longevity at age 65 between the highest and lowest education groups is estimated to be twice as large as the one reported by Eurostat; most of this difference is explained by the fact that Eurostat does not take into account mortality differentials after the age of 75 years.

2. Data Construction

11. This section highlights data's general characteristics and describes their treatment in details.

2.1. Data characteristics

12. Data files on mortality and population by gender, age (25 years old and over), educational attainment (5 levels, based on the ISCED 1997 classification) and causes of death (4 causes) were collected for 22 countries and several years around 2011, based on a detailed questionnaire sent to national contact-points in OECD National Statistical Offices and other public agencies that routinely collect these types of data. This involves a very large number of mortality observations, namely more than 450 000 data points.

13. The data collected from national contact-points were complemented with detailed data from Eurostat website for 6 European countries (5 of these European countries are also covered by the data collection undertaken for this paper)[8]. As these files differ from those collected for this paper, comparison of estimates between the two sources allows checking the robustness of the estimates with respect to the underlying data. Estimates based on the data collection undertaken for this paper are also compared with Eurostat published figures, which enables to gauge the influence of the data treatment and key underlying assumptions. In total, the estimates presented in this paper refer to 23 countries, with two sets of estimates of longevity inequality by education for some (European) countries[9];

- Those based on the data and calculations undertaken by the authors for this paper (22 countries).
- Those derived by applying the methodology and calculations used in this paper to the Eurostat detailed data (i.e. downloaded directly from Eurostat website); this applies to 6 European countries (5 of them being countries also covered by the data collection undertaken for this paper, plus the Slovak Republic).

14. The data needed to compute estimates of inequality in longevity are compiled in different ways in different countries. Two main approaches (study design) can be distinguished:

- ***'cross-sectional'(unlinked) design***, where information on the socio-economic characteristic of the deceased is drawn directly from death certificates, as reported by relatives or public officials; data on the number of deaths by educational attainment are then related to population numbers (for the same population categories) as found in the most recent population census.
- ***'linked design'***, where socio-economic information on the deceased is retrieved by individual data linkage to the most recent population census or administrative register records.

15. Among the 22 OECD countries that provided detailed data based on the specifications provided by the authors, 14 are based on linked methodologies (Austria, Denmark, Finland, Israel, Latvia, Norway, New Zealand, Slovenia and Sweden) and 8 are based on an unlinked procedure[10]. In the past, most data collection on socio-economic differences in mortality rates were based on information on the occupation or educational attainment of the deceased as recorded on death certificates: data on the number of deaths by

[8] http://ec.europa.eu/eurostat/data/database

[9] Sections 3.1 and 3.2 also report estimates published by Eurostat, which cover two additional countries (Estonia and Portugal).

[10] Some countries such as Belgium have supplied unlinked data to the OECD Secretariat; linked data are however already available, or will soon be so in the near future.

occupation and education were then related to population numbers (by occupation or education) as found in the most recent population census. An obvious drawback of this so-called "cross-sectional" or "unlinked" design, which is still employed by most countries reviewed in this paper, is that it can only be implemented when death certificates include information on the occupation and education of the deceased. A second drawback is that, even when this information is included in death certificates, it is typically affected by (large) recording errors (Sorlie and Johnson, 1996; Kunst et al., 1998; Shkolnikov et al., 2007; Jasilionis et al., 2007, 2011, 2012; Rey et al., 2013). As noted by Gordis (1982), information about socio-economic status in death records suffers from a reporting bias, as proxy informants tend to provide imprecise information about the deceased (e.g. the "promoting the dead" phenomenon). Such misreporting may lead to substantial biases in the cross-sectional mortality estimates by socio-economic group, with estimates even failing to report the true direction of inequality (Kunst et al., 1998; Jasilionis et al., 2012).

16. The "unlinked" cross-sectional approach has been increasingly replaced by estimates based on longitudinal design. The longitudinal design relies on "census links", in which socio-economic information on the characteristics of the deceased is retrieved by individual data linkage to the population census or administrative records. In turn, individual linkage of the deceased person is performed either on the basis of personal identification numbers (e.g. as in several Nordic countries) or on the basis of a combination of individual characteristics like birth date, gender and postcode of residence (probabilistic record linkage).

17. While data quality varies with the type of design used, the linked design allows generating estimates of socio-economic inequalities in lifespans even for countries where death registers do not contain the information required to implement the cross-sectional design. Further, this approach also provides higher quality estimates than those based on the unlinked approach, providing that the degree of "matching" is high (i.e. when only few of the deceased could not be linked to a census record, due to migration or other factors)[11].

18. Table 1 describes the meta-characteristics of the data used in this paper. With the exception of Chile, whose data relate to the 2002-2006 period, the data used in this paper relate to a period centred around 2011[12]. Death and population data are classified by single year of age of the deceased, with the only exceptions of Australia, the United Kingdom, New Zealand and the United States, whose data are classified by 5-year age groups. To increase robustness and comparability with these countries, single-year data have been aggregated into 5-year age groups for all countries. Finally, data on causes of death are available for 17 countries.

19. The distribution of the adult population (i.e. those above 25 years of age) by educational attainment (i.e. the highest level of education completed) varies significantly across countries as well as across gender and age groups. Table 2 reports these characteristics for two broad age groups (25-64 years and 65-89 years), separately for men and women, as used in this study. For the purpose of computing summary statistics on longevity inequality, the category "No Schooling" was merged with that for "primary and lower secondary" to form the category "Low level of education". The "Middle" level of education category is composed of the "upper-secondary" and "post-secondary non-tertiary" education reported by country contact-points in the detailed data transmitted to the OECD, while the "High" level category is composed of people with tertiary education. The group of population with "Missing" level of education is also reported in Table 2. Several features can be highlighted from this table:

- Educational attainment is substantially higher for the younger cohort (25-64 years), especially for women. For instance, the share of women with high education varies from about 13% in the older

[11] Most estimates of life expectancy by education produced by Eurostat are based on data produced with an unlinked design. In contrast, many of the results by Mackenbach and co-authors rely on a linked design.

[12] Across all countries, the average year of analysis is exactly 2011 when excluding Chile.

cohort to 31% in the younger cohort; the corresponding values for men are 19% and 25%. These gender differences reflect the fact that women lead in terms of higher educational attainment among younger generations, while the opposite is true among the older generation. This shift in educational attainment across generations raises comparability issues across time and space that are discussed later in this paper.

- The percentage of population with missing information on education is large in Belgium, the Czech Republic, Norway and Poland for prime-age men; and in Norway, New Zealand and Turkey for older people. Most of these countries rely on an unlinked design for their data, which results in larger measurement errors. However, high proportions of people with 'missing information' are also reported for Norway and New Zealand, whose data rely on a linked design.

Table 1. Countries and data sources included in the analysis

Country	Source	Method	Death registers	Population exposure	Retained period of analysis	Age range	Age frequency	Cause of death available
AUS	OECD	linked	27-09-2012	Census 2011	2011	25-115	5-year	Yes
AUT	OECD	linked	1/11/2011-31/10/2012	Census 31/10/2011-	2011-2012	25-95	annual	No
BEL	OECD	unlinked	2010-2012	Census 1/1/2011	2011	25-120	annual	Yes
CAN	OECD	linked	2006-2011	Census 2006	2009-2011	25-115	annual	Yes
CHL	OECD	unlinked	2002-2006	Census 2002	2002-2006	25-120	annual	Yes
CZE	OECD	unlinked	2010-2014	Census 2011	2010-2014	25-120	annual	Yes
DNK	OECD	linked	2009-2013	2009-2013	2009-2013	25-120	annual	Yes
DNK	Eurostat	unlinked	2007-2013	2007-2013	2009-2013	25-100	annual	No
FIN	OECD	linked	1/1/2006-31/12/2010	Census 31/12/2005-	2008-2010	25-120	annual	Yes
FIN	Eurostat	unlinked	2008-2012	2008-2012	2008-2012	25-100	annual	No
FRA	OECD	linked	2009-2013	2012	2009-2013	25-105	annual	No
GBR	OECD	linked	2002-2013	2002-2013	2009-2013	25-85	5-year	Yes
HUN	OECD	unlinked	2010-2013	Census 2011	2010-2013	25-120	annual	Yes
ISR	OECD	linked	2000-2012	2000-2012	2008-2012	25-120	annual	No
ITA	OECD	linked	2012	Census 2011	2012	25-120	annual	No
LVA	OECD	linked	1/3/2011-31/12/2012	Census 1/3/2011	2011-2012	25-120	annual	Yes
MEX	OECD	unlinked	2010	2010	2010	25-100	annual	Yes
NOR	OECD	linked	1971-2009	1971-2009	2009	25-90	annual	Yes
NOR	Eurostat	unlinked	2007-2014	2007-2013	2009-2013	25-100	annual	No
NZL	OECD	linked	2001-2011	Census 2001-2006	2006-2011	25-95	5-year	Yes
POL	OECD	unlinked	2010-2013	Census 2011	2010-2013	25-120	annual	Yes
SVK	Eurostat	unlinked	2011-2013	2011-2012-2013	2011-2013	25-100	annual	No
SVN	OECD	linked	2011-2013	Census 2011 - 2012-2013	2011-2013	25-100	annual	Yes
SVN	Eurostat	unlinked	2007-2013	2011-2012	2011-2012	25-100	annual	No
SWE	OECD	linked	1/1/2010-31/12/2014	Census 1/1/2010-	2010-2014	25-120	annual	No
SWE	Eurostat	unlinked	2007-2013	2007-2013	2010-2013	25-100	annual	No
TUR	OECD	unlinked	2012-2013	2012-2014	2013	25-100	annual	Yes
USA	OECD	unlinked	2011-2012	2011-2012	2011-2012	25-85	5-year	Yes

Table 2. Distribution of adult population by educational attainment, gender and age

Country	Source	Males								Females							
		Age 25-64 years				Age 65-89 years				Age 25-64 years				Age 65-89 years			
		Low	Middle	High	Missing	Low	Middle	High	Missing	Low	Middle	High	Missing	Low	Middle	High	Missing
AUS	OECD	15.6	52.9	31.4	0.0	30.8	43.4	25.9	0.0	18.5	45.0	36.5	0.0	49.3	27.8	23.0	0.0
AUT	OECD	14.8	64.5	20.7	0.0	26.3	57.0	16.7	0.0	23.3	59.2	17.4	0.0	54.0	41.3	4.7	0.0
BEL	OECD	29.7	33.1	27.1	10.1	57.3	16.7	16.1	9.9	27.2	31.1	32.7	9.1	65.4	13.8	9.9	10.9
CAN	OECD	38.6	15.8	45.5	0.0	51.4	17.2	31.4	0.0	38.2	9.0	52.8	0.0	65.3	7.0	27.7	0.0
CHL	OECD	35.4	40.6	24.0	0.0	65.8	23.2	11.0	0.0	37.1	41.0	21.9	0.0	70.1	24.0	5.9	0.0
CZE	OECD	7.4	69.6	16.3	6.7	14.3	69.0	15.8	0.8	12.2	66.6	16.9	4.3	40.9	51.3	6.6	1.1
DNK	OECD	21.8	46.6	27.6	3.9	36.5	40.8	19.8	2.8	21.0	39.8	36.0	3.2	52.1	30.0	15.1	2.8
DNK	Eurostat	21.8	46.4	27.7	4.0	36.5	40.7	20.0	2.8	20.8	39.8	35.9	3.5	52.1	30.0	15.1	2.9
FIN	OECD	23.8	48.5	27.7	0.0	58.8	20.2	21.0	0.0	18.9	43.5	37.6	0.0	64.0	21.6	14.4	0.0
FIN	Eurostat	23.3	46.2	30.5	0.0	57.7	20.8	21.5	0.0	17.7	40.4	41.8	0.0	62.9	22.2	15.0	0.0
FRA	OECD	23.0	46.8	30.2	0.0	51.2	33.5	15.3	0.0	24.9	40.0	35.1	0.0	65.3	24.2	10.6	0.0
GBR	OECD	53.5	28.0	18.5	0.0	70.1	14.2	15.8	0.0	49.2	31.9	18.9	0.0	74.1	13.0	12.9	0.0
HUN	OECD	16.2	65.8	18.0	0.0	50.0	30.7	19.3	0.0	20.9	55.2	23.9	0.0	68.1	23.0	8.9	0.0
ISR	OECD	23.1	46.6	30.3	0.0	42.2	24.1	33.7	0.0	18.2	47.0	34.8	0.0	47.9	22.7	29.3	0.0
LVA	OECD	15.0	63.7	21.3	0.0	34.6	45.2	20.2	0.0	8.7	55.9	35.4	0.0	37.6	46.8	15.6	0.0
MEX	OECD	63.0	16.6	20.4	0.0	87.8	3.8	8.4	0.0	65.7	16.1	18.2	0.0	91.0	4.5	4.5	0.0
NOR	OECD	20.1	44.9	28.4	6.5	32.8	46.4	19.8	1.0	20.0	39.0	35.7	5.4	43.4	43.1	12.5	1.0
NOR	Eurostat	20.0	44.4	29.6	6.0	30.8	47.1	21.2	0.9	19.5	37.8	38.1	4.6	40.7	44.6	13.9	0.9
NZL	OECD	19.0	28.6	47.6	4.8	32.9	21.2	36.4	9.5	16.6	34.2	45.0	4.2	37.8	25.3	23.7	13.2
POL	OECD	11.2	64.7	18.1	6.0	39.1	45.1	13.8	2.1	11.0	57.6	25.3	6.0	56.0	34.3	7.6	2.2
SVK	Eurostat	46.1	34.3	19.5	0.1	59.6	24.9	15.4	0.2	36.5	40.3	23.1	0.1	69.5	23.5	6.9	0.1
SVN	OECD	18.3	63.1	18.6	0.0	29.2	55.2	15.7	0.0	21.0	50.3	28.8	0.0	59.2	33.2	7.6	0.0
SVN	Eurostat	18.9	62.7	18.4	0.0	29.7	54.8	15.5	0.0	21.7	50.2	28.1	0.0	60.3	32.5	7.2	0.0
SWE	OECD	15.7	56.8	26.1	1.4	38.8	40.7	19.3	1.2	11.6	49.8	37.4	1.2	39.4	39.3	19.8	1.5
SWE	Eurostat	16.0	55.3	26.8	1.8	40.8	39.3	18.4	1.5	12.0	48.6	38.0	1.4	42.4	37.6	18.2	1.8
TUR	OECD	54.2	24.2	18.1	3.4	81.4	6.5	7.6	4.5	67.4	16.3	13.6	2.8	89.0	3.3	2.1	5.6
USA	OECD	13.6	50.4	36.0	0.0	17.2	47.0	35.7	0.0	10.8	46.9	42.3	0.0	18.8	54.8	26.4	0.0
Average		25.2	46.7	26.1	2.0	44.6	34.4	19.7	1.4	24.8	41.9	31.5	1.7	56.2	28.7	13.5	1.6

2.2. Data treatment

20. The countries analysed in this paper differ in terms of study design and quality of the underlying data. This difference, in turn, led to a range of measurement challenges relating to:

- ***Overall coverage, completeness, and quality of death registration***: WHO (2016) shows that virtually all countries complete high coverage, with the exception of Turkey and Mexico that should be considered with care.

- ***Treatment of people with 'missing education'***. In some countries (Belgium, the Czech Republic, New Zealand, Norway, Poland and Turkey), significant proportions of both population exposure (the denominator of mortality rates) and of the deceased population are reported without any indication of their educational attainment. In most cases, people with missing education have mortality rates in line with other groups; in these cases, these people were allocated (for the purpose of computing measures of inequalities in longevity) to other educational groups in proportion to the observed distribution of the deceased by education and gender. However, in the case of Belgium and the Slovak Republic, people with missing education display high mortality rates, hence they were allocated to the group with lowest education. Appendix A explains the reasons behind this choice and provides a sensitivity analysis of its effects.

- ***Volatility of estimates***. Mortality rates for detailed education/age/gender groups referring to a single year are often volatile, especially at higher ages. To remedy to this situation, the data of the number of deaths and population exposure were pooled, both across years of observation and across ages of death (into 5-year age groups). By reducing the number of cells in the data base, while increasing the size of each cell, estimates of mortality rates by education were made less volatile and more stable. (See Appendix A for more details)..

- ***Implausible mortality cross-overs***. In some cases (the Czech Republic, Mexico, Poland and Turkey), the raw data provided by national contact points display sudden changes in mortality at some (usually old) ages, or peculiar age-profiles for some educational groups; these statistical anomalies, in turn, produce implausible 'cross-overs' in the age-mortality profiles of different educational categories, implying for example that longevity of people with low education becomes higher, rather than smaller, than longevity of people with higher education[13]. To remedy this problem, this study relies on the statistical modelling of mortality rates above age 90 (based on a Gompertz law)[14], which are then combined with observed mortality rates at lower ages. Appendix A, B and C describes the corrections applied to mortality rates by age, gender and education.

21. While these data treatments increase the robustness of the estimates, they do not remove the problems stemming from differences in the quality of the underlying data.

2.3. Statistical overview

22. Table 3 summarises the main data issues by country, while providing an overall assessment of data quality. Data quality differs across countries. Not surprisingly, country-data based on a linked design are relatively unaffected by the various quality problems mentioned above. Among the country-data based on an unlinked design, those for Belgium, Chile, the Czech Republic and Turkey compound several data-problems, and should ideally be improved in the future. Data for Mexico constitute another limit case, as women with medium education display higher longevity than those with higher education (the only cross-over in the Mexican data). One overall recommendation stemming from this Table is that all countries should seek to switch to a linked design in the future, as data of this type are typically superior in terms of data quality (i.e. fewer mortality cross-overs, more regular age-profiles etc…).

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[13] To a large extent, Eurostat avoids this problem as the coverage of labour force surveys is limited to people aged less than 75. However, truncating mortality differentials at 75 years of age (i.e. by assuming identical mortality rates across educational groups after age 75) comes at the cost of ignoring significant differences in mortality at the ages which are more salient for many public policies (e.g. pensions).

[14] The Gompertz law specifies that, for each gender-education group, the (log) mortality rate rises linearly with age after some age threshold is reached. Based on an analysis of the underlying data, this threshold was set at 70 years in all countries. Predictions from the estimated model were then used to measure mortality rates for people above 90 years of age.

Table 3. Overall Assessment of Data Quality

Country	Source	Method	Main data issues	Data quality assessment
AUS	OECD	linked	-	**high**
AUT	OECD	linked	cause of death missing	**high**
BEL	OECD	unlinked	Missing education among deceased; mortality cross-overs	**low**
CAN	OECD	linked	-	**high**
CHL	OECD	unlinked	Outdated data; puzzling mortality rates among higher education (females)	**low**
CZE	OECD	unlinked	Missing education among deceased; mortality cross-overs	**low**
DNK	OECD	linked	-	**high**
DNK	Eurostat	unlinked		**high**
FIN	OECD	linked	-	**high**
FIN	Eurostat	unlinked		**high**
FRA	OECD	linked	-	**high**
GBR	OECD	linked	-	**high**
HUN	OECD	unlinked	puzzling mortality rates among low and middle education	**medium**
ISR	OECD	linked	puzzling mortality rates among young age	**medium**
ITA	OECD	linked	-	**high**
LVA	OECD	linked	-	**high**
MEX	OECD	unlinked	mortality cross-overs	**low**
NOR	OECD	linked	-	**high**
NOR	Eurostat	unlinked	Missing education among the deceased;	**low**
NZL	OECD	linked	missing education category	**high**
POL	OECD	unlinked	close to mortality cross-overs	**medium**
SVK	Eurostat	unlinked	Missing education among the deceased;	**low**
SVN	OECD	linked	-	**high**
SVN	Eurostat	unlinked		**high**
SWE	OECD	linked	cause of death missing	**high**
SWE	Eurostat	unlinked		**high**
TUR	OECD	unlinked	puzzling mortality rates among medium and high education	**low**
USA	OECD	unlinked	censoring at age 85	**high**

3. Inequalities in longevity between educational groups

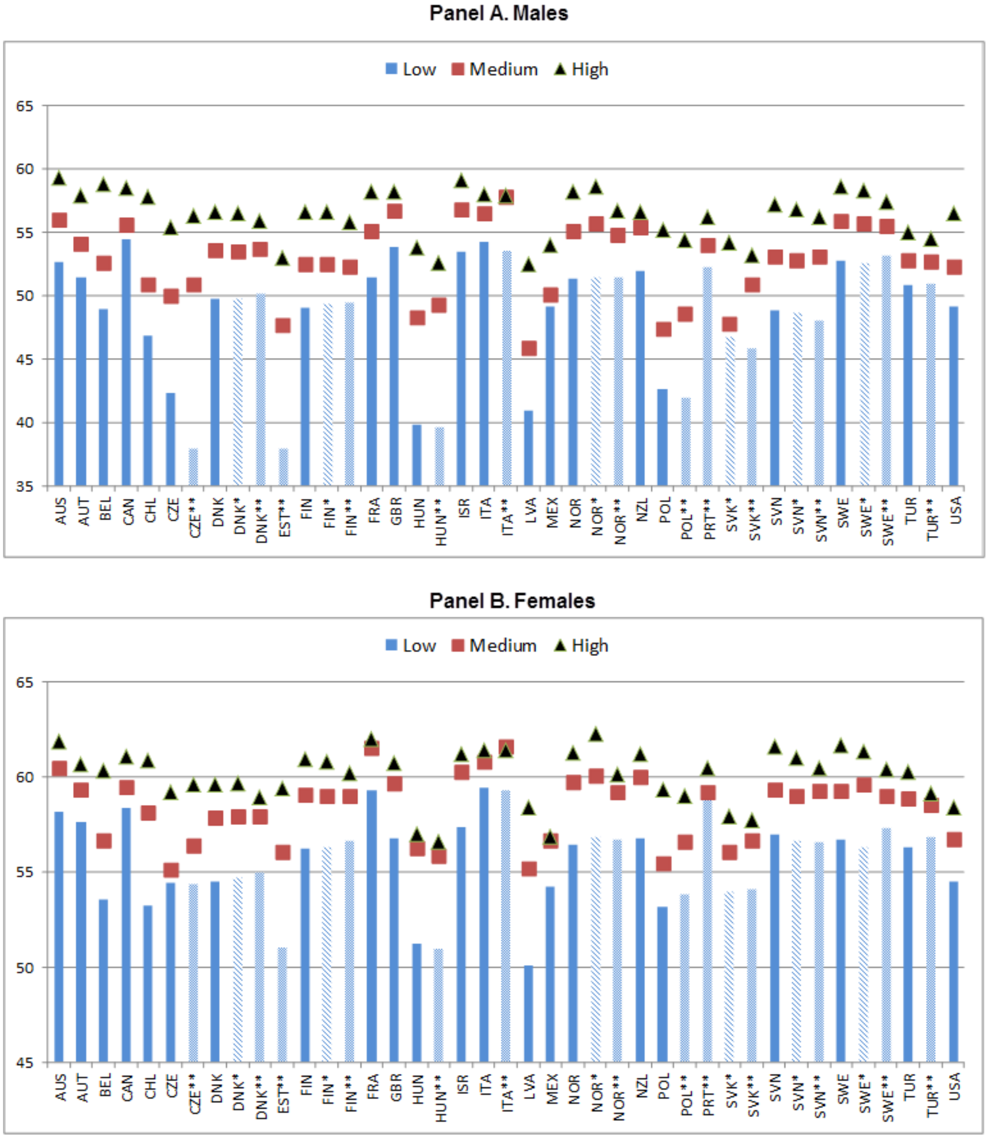
23. This section describes the main results of the study, based on measures of life expectancy at ages 25 and 65 years by people's educational attainment. Estimates are provided separately for men and women. The section also describes inequality in *average age-standardised mortality rates* between educational groups, which are less sensitive to mortality at younger age.

3.1. Life expectancy by education at age 25

24. Life expectancy, also called 'average lifespan', is calculated from "abridged life tables" (i.e. tables including survival probabilities for people in 5-year age groups) following the method proposed by Chiang (1984)[15]. Figure 1 describes life expectancy at age 25 years by education and gender among the 23 OECD countries analysed, plus the 13 European OECD countries on which Eurostat has published comparable statistics. Across the whole set of 23 OECD countries analysed, men record a level of longevity at age 25 years of 48.9 years for people with low education, 52.6 years for those with medium education and 56.6 years for those with tertiary education. The corresponding values for women are 55.5 years, 58.3 years and 60.1 years. These results suggest an absolute gap of 7.7 years, on average, between high and low educated men, and of 4.6 years for women. This absolute gap is almost the same when restricting attention to those countries whose data quality is deemed as "high" or "medium" in Table 3.

[15] In this approach, the time lived in the last year of life is assumed to be 0.5 years, except for the age group 115-119 years where it is assumed to be equal to the inverse of the mortality rate.

Figure 1. Life expectancy at age 25 by education around 2011, by gender



Note: Countries without an asterisk correspond to estimates based on the country-data gathered for this paper and on authors' calculations. Estimates for the Slovak Republic (denoted with an asterisk *) are based on authors' calculation based on detailed Eurostat data; ** denotes Eurostat data and calculations.

25. A closer examination of the differences between the estimates of life-expectancy at age 25 presented in this paper and those published by Eurostat for a sub-sample of European countries does reveal some systematic differences, highlighted in Figure 2 and Table 4. Most importantly, the estimates of life expectancy at age 25 presented here for European countries with medium/high data quality are 0.9 year higher than those released by Eurostat for highly educated men, and 0.8 years higher for highly educated women. This average difference mainly reflects mortality differentials after age 75 years, as this time-span is taken into account in the estimates shown here but not in those by Eurostat. However, the cross-country correlation between the two estimates is close to 0.99 for all educational groups, with the only exception of women with medium education, where the correlation is 0.95.

Figure 2. Comparison of life expectancy at age 25 shown in this paper and Eurostat estimates

Around 2011

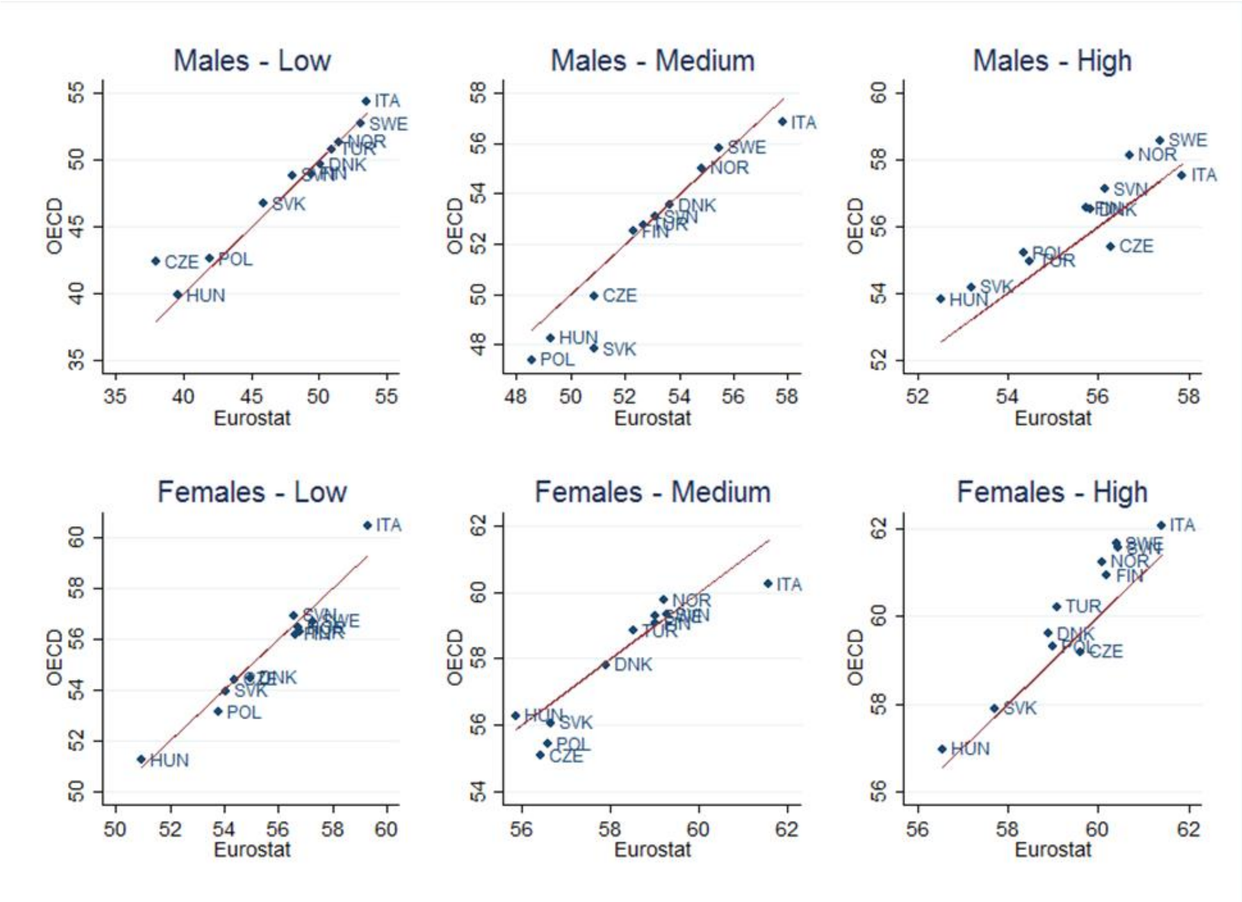


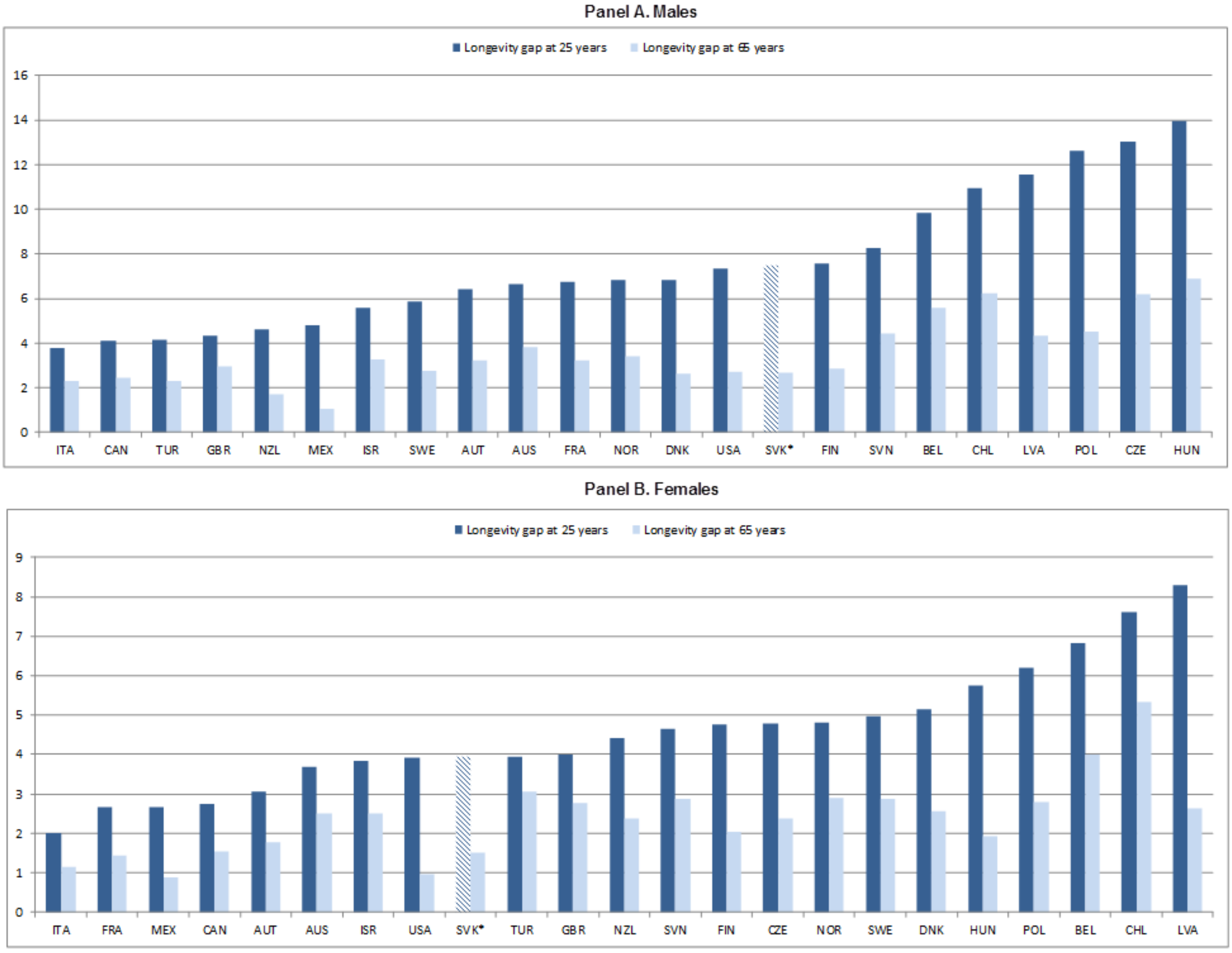
Table 4. Comparison between the longevity estimates in this paper and those released by Eurostat: summary statistics

	Longevity at age 25 years											
	Males						Females					
	Low		Medium		High		Low		Medium		High	
	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat
DNK	49.67	50.10	53.55	53.67	56.52	55.83	54.45	54.97	57.82	57.90	59.60	58.90
FIN	48.98	49.40	52.51	52.30	56.56	55.73	56.18	56.63	59.06	59.00	60.94	60.20
HUN	39.85	39.57	48.25	49.27	53.80	52.53	51.23	50.97	56.27	55.87	56.97	56.57
ITA	54.40	53.50	56.86	57.80	57.54	57.87	60.46	59.27	60.22	61.57	62.08	61.40
NOR	51.34	51.40	55.02	54.80	58.16	56.70	56.44	56.70	59.74	59.20	61.25	60.10
POL	42.57	41.90	47.39	48.57	55.20	54.37	53.11	53.80	55.43	56.57	59.30	59.00
SVN	48.86	48.05	53.10	53.10	57.13	56.15	56.92	56.55	59.32	59.25	61.57	60.45
SWE	52.74	53.10	55.85	55.47	58.59	57.37	56.68	57.27	59.27	59.00	61.66	60.40
CZE	42.34	37.93	49.94	50.87	55.39	56.27	54.40	54.37	55.08	56.40	59.19	59.60
SVK	46.70	45.85	47.81	50.85	54.17	53.20	53.95	54.05	56.07	56.65	57.89	57.70
TUR	50.82	50.90	52.76	52.70	54.97	54.50	56.27	56.80	58.84	58.50	60.22	59.10
Average difference among high/medium data quality countries	**0.17**		**-0.31**		**0.87**		**-0.09**		**-0.15**		**0.79**	

	Longevity at age 65 years											
	Males						Females					
	Low		Medium		High		Low		Medium		High	
	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat	OECD	Eurostat
DNK	16.26	16.70	17.34	17.28	18.89	18.12	18.99	19.50	20.39	20.28	21.55	20.70
FIN	16.57	17.00	17.60	17.43	19.40	18.43	20.68	21.27	21.56	21.57	22.70	21.93
HUN	10.19	12.20	14.16	16.15	17.09	16.03	17.12	17.58	19.36	19.15	19.06	18.88
ITA	18.41	18.15	19.53	19.55	19.29	19.30	22.70	22.05	21.99	22.75	23.60	22.40
NOR	16.68	17.10	18.22	18.10	20.09	18.70	19.93	20.60	21.70	21.30	22.82	21.80
POL	13.64	14.60	13.85	15.30	18.19	17.30	18.34	19.63	18.52	19.75	21.13	20.75
SVN	15.51	15.60	17.65	17.20	19.96	18.67	20.31	20.73	21.65	21.47	23.18	21.87
SWE	17.65	18.03	18.88	18.55	20.42	19.25	20.25	20.68	21.49	21.30	23.11	21.83
CZE	11.63	11.18	14.65	15.85	17.82	17.58	18.52	18.85	17.53	19.20	20.90	20.30
SVK	14.01	11.90	13.70	15.00	16.70	16.20	17.88	17.80	18.63	18.90	19.40	19.57
TUR	15.22	15.65	16.28	16.30	17.51	17.20	18.60	19.15	20.57	20.15	21.66	20.30
Average difference among high/medium data quality countries	**-0.56**		**-0.29**		**0.94**		**-0.46**		**-0.11**		**0.88**	

26. Figure 3 describes the longevity gaps between high and low-education people at age 25 (as well as those at 65 years, which are described later); when alternative sources are available for the same country, estimates based on the data collected for this paper are shown. Differences in life expectancy by education at age 25 for men are above 11 years in Latvia, Poland, the Czech Republic, Hungary and Estonia, while they are below 5 years in Portugal, Turkey, Italy, New Zealand and Mexico (although estimates for Turkey and Mexico are considered as ‘low quality’ in Table 3). In the case of women, inequalities in longevity by education at age 25 are small in Austria, Israel, Portugal, Italy, Mexico and the United States, while they are significantly higher in Latvia, Estonia and Poland and, to a lesser extent, in Belgium and Chile.

Figure 3. Life expectancy gap between the highest and lowest educational groups at the age of 25 and 65

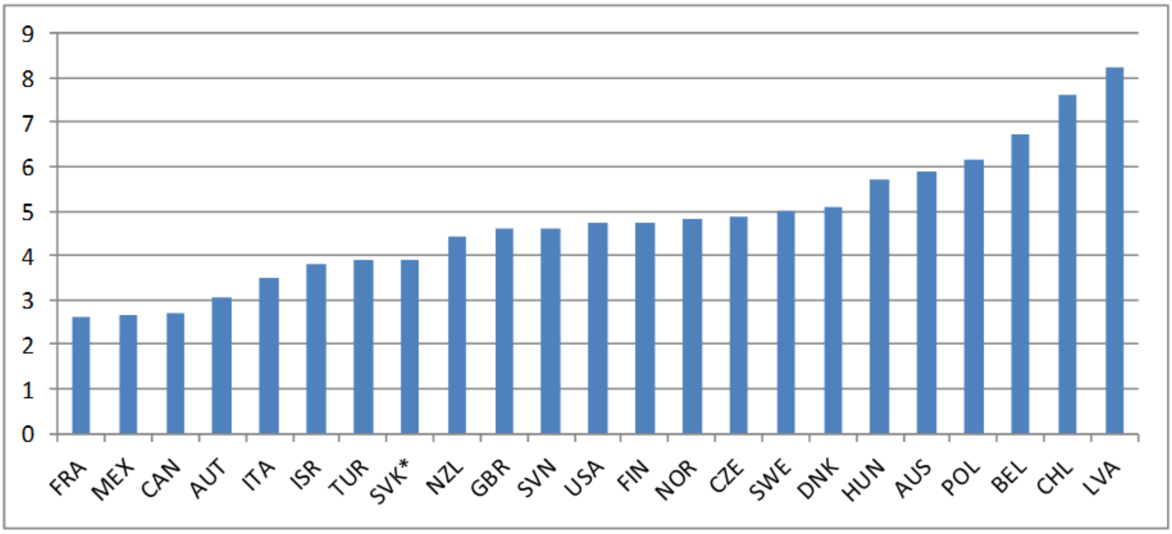


Note: Countries without an asterisk correspond to estimates based on the country-data gathered for this paper and on authors' calculations. Estimates for the Slovak Republic (denoted with an asterisk (*) are based on authors' calculation based on detailed Eurostat data.

27. Another way of describing the higher inequality between educational groups consists of calculating the gain in life expectancy (conditional on survival at age 25) that would be realised if all people were subject to the same survival rates; this benchmark can conveniently be chosen as those of highly educated women, the group that records the highest life expectancy in all countries. Figure 4 describes this potential gain in life expectancy by country. On average, if all individuals had the same vital characteristics as highly educated women, the potential gain in life expectancy would be 4.8 years on average, ranging between around 2.6 years in France and 8 years in Chile and Latvia.

Figure 4. Potential gain in life expectancy at age 25 when assuming longevity of highly educated women for entire population

Around 2011



Note: countries without an asterisk correspond to OECD data and calculations; *denotes OECD calculations based on Eurostat data.

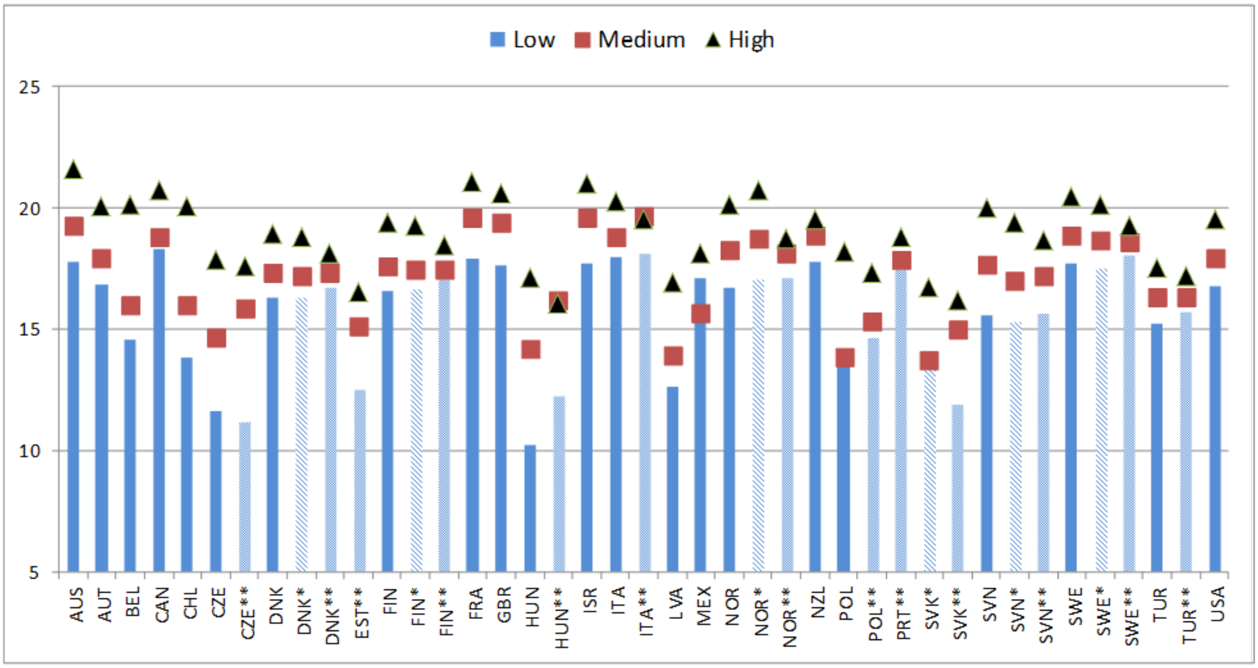
3.2. Life expectancy by education at age 65

28. Figure 5 displays life expectancy at age 65 years by education, separately for men and women, for the 23 OECD countries analysed as well as for the 13 European OECD countries available in Eurostat publications. On average, across the 23 countries analysed, men experience a life expectancy at age 65 years of 15.8 years for those with low education, 17.1 for those with medium education and 19.2 years for those with high education. The corresponding values for women are 19.6, 20.8 and 21.9 years. These values imply that the gap between high and low educational groups at age 65 is 3.5 years for men and 2.3 years for women[16]. Similar gaps are observed when analysing differences in life expectancy across gender for each educational group. Among people low and medium education, women live 3.8 years longer than men, while for those with higher education the gap is 2.7 years.

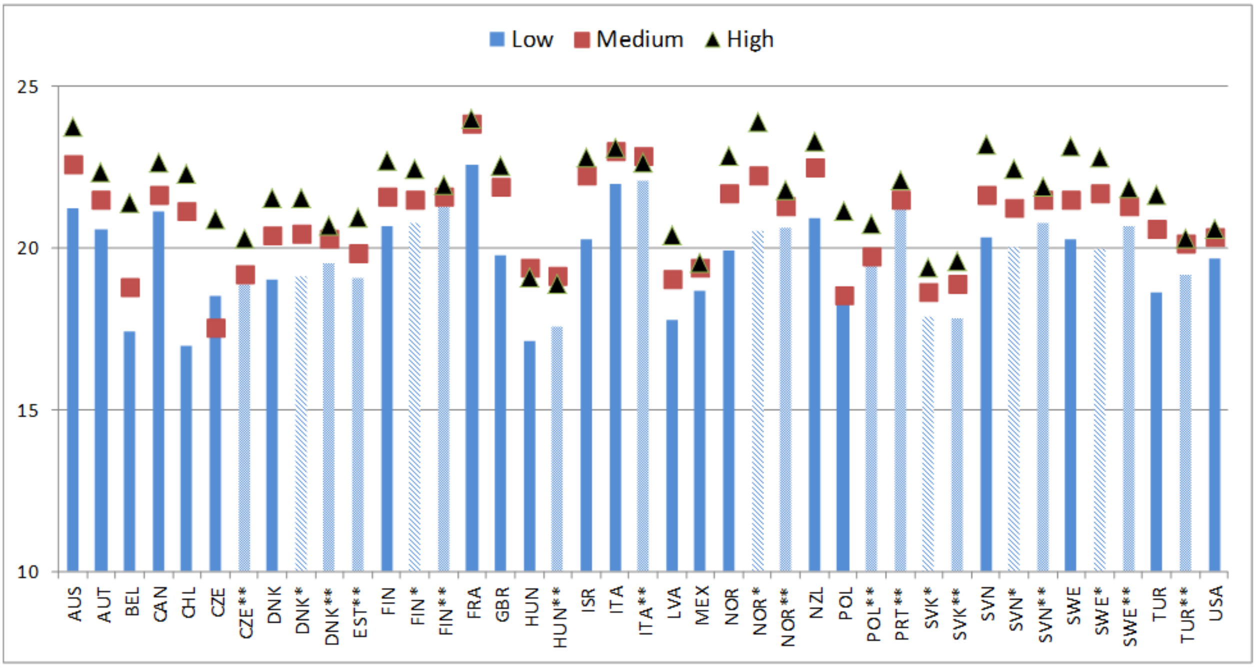
[16] These gaps are almost unchanged when focusing on the subset of countries whose data was deemed as 'high quality' in Table 3.

Figure 5. Longevity at age 65 by gender and education around 2011

Panel A. Males



Panel B. Females



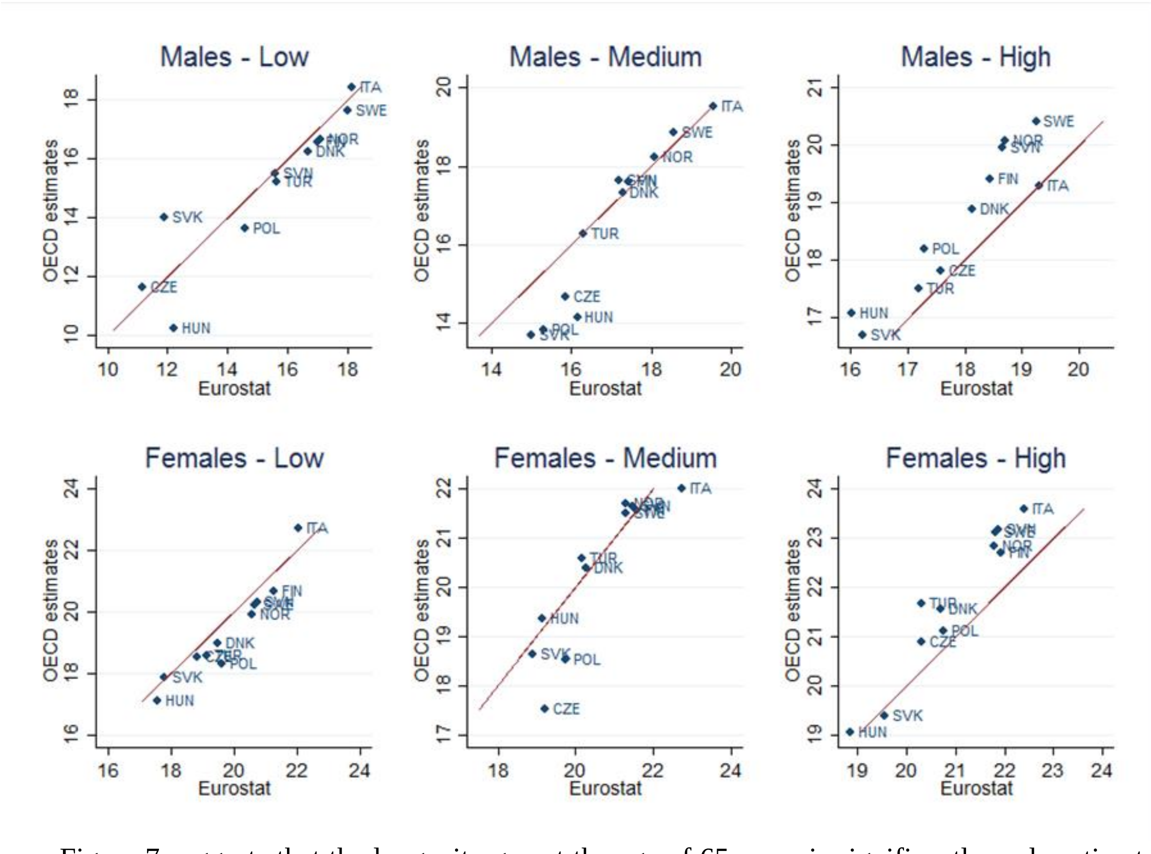
Note: Countries without an asterisk correspond to estimates based on the country-data gathered for this paper and on authors' calculations. Estimates for the Slovak Republic (denoted with an asterisk (*) are based on authors' calculation based on detailed Eurostat data; ** denotes Eurostat data and calculations.

29. The estimates in Figure 3 and 5 imply that inequalities in longevity by education are lower, in absolute terms, when observed at higher ages; however, this is a mechanical consequence of the fact that longevity decreases as people age. When the longevity gap between people with different education is expressed as a share of the life expectancy of people with higher education, the opposite conclusion emerges, i.e. *relative* differences in longevity by education are larger at the age 65 years than at age 25 (18.1% versus 13.6% for men, and 10.5% versus 7.6% for women).

30. Differences in life expectancy by education at age 65 between the estimates in this paper and those computed by Eurostat are described in Table 4 and Figure 6. Our estimates are higher than Eurostat ones by 0.9 year for both men and women with higher education, while they are lower by 0.6 and 0.1 years, respectively, for men and women with low education. These differences are explained by the fact that mortality differentials after age 75 years are considered by the estimates presented in this paper, while they are not in Eurostat estimates. While the size of these differences between the two set of estimates does not change the overall conclusion when analysing longevity inequality at age 25, the picture is quite different when considering inequalities at higher ages.

Figure 6. Comparison of life expectancy at age 65 across OECD and Eurostat estimates

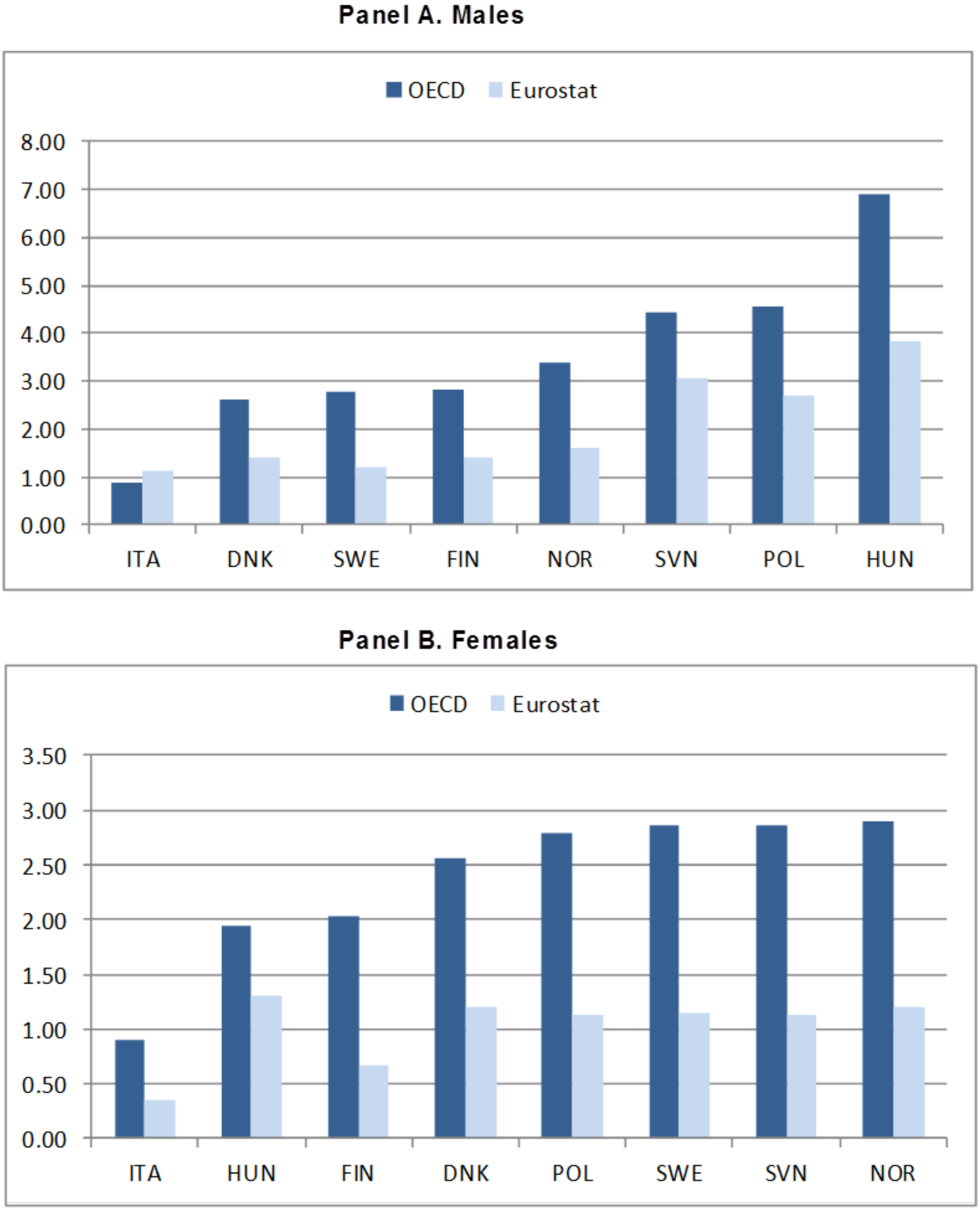
Around 2011



31. Figure 7 suggests that the longevity gap at the age of 65 years is significantly underestimated by Eurostat estimates. Focusing on the 8 countries with high or medium quality data in Table 4[17], the estimates shown in this paper are, on average, 1.7 times larger than Eurostat ones for men and 2.3 times larger for women. Overall, longevity inequality by education at the age of 65 is twice as large in our estimates as in those provided by Eurostat.

[17] Denmark, Finland, Hungary, Italy, Norway, Poland, Slovenia, Sweden.

Figure 7. Longevity gap at the age of 65 between the estimates in this paper and those released by Eurostat



3.3. Other measures of inequalities in longevity by education

32. The measure of inequalities in longevity described above (life expectancy at age 25 and 65) have two specific features that may affect cross-country comparisons:

- First, life expectancy is especially affected by mortality rates at very young ages; in other terms, a reduction in mortality rates among the elderly will, by construction, have a smaller impact on life expectancy than a similar reduction in mortality rates of young people.

- Second, measures of life expectancy by education are also affected by differences across countries in the share of high- and low-educated people among the deceased. These differences are a potential source of bias when measuring inequalities of longevity, as people with low educational attainment may disproportionally include people with special disadvantages (e.g. learning or health problems in young age) in countries where medium and higher education is the norm, as compared to countries where very few people pursue studies until a higher age.

33. Alternative measures of inequalities in longevity have been proposed by the epidemiological literature that control for cross-country differences in the size of education groups. Evidence on these measures is presented below.

Average age-standardised mortality rates

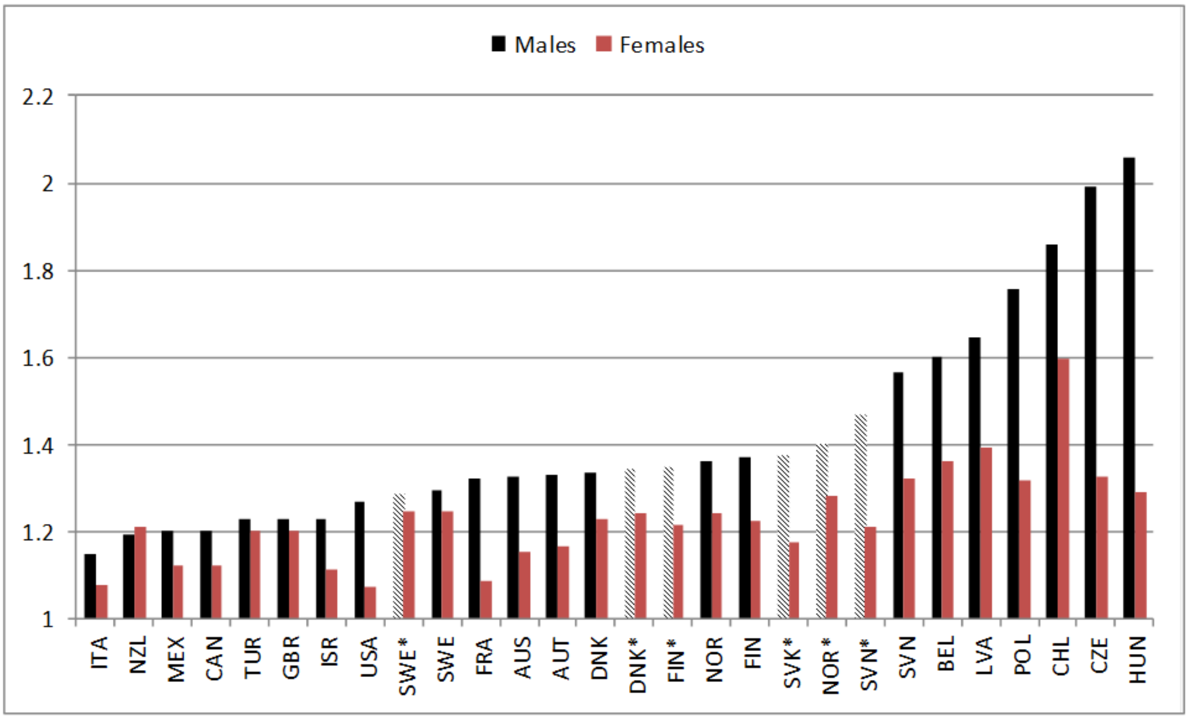
34. Following Mackenbach et al. (2015), it is possible to calculate measures of inequalities in longevity that account for differences in age composition. As a first step, mortality rates for each group are age-standardized, using a standardization method and a common population structure; as a second step, an average of these age standardised mortality rates is computed for all countries and for all educational groups within each country. In this way, mortality at young age does not have the disproportional influence as in the case of life expectancy, as each age group receives a weight that reflects its population share.

35. Mackenbach et al. (2015) recommend looking at both absolute and relative measures of inequality in age-standardised mortality rates, which are respectively equal to the absolute difference between the rates or the ratio between age-standardised mortality rates by education. Estimates of both absolute and relative differences in age-standardised mortality rates by education for the population aged 25 to 89 are shown in Appendix D (Table D1): no significant difference across countries emerges when looking at either of these measures: the cross-country correlation between the absolute and relative difference in age-standardised mortality rates between high and low education groups is 0.90.[18]

36. Does the assessment of country-differences in longevity inequality by education changes when using average age-standardised mortality rates rather the life expectancy measures? Focusing on the relative measure of inequality, Figure 8 shows the ratio of age standardised mortality rates between high and low education people aged between 25 and 89. Countries displaying the highest inequality in longevity for men are the same ones characterised by higher (absolute) gaps in life expectancy at age 25 (see above), namely Hungary, the Czech Republic, Chile, Poland and Latvia. Similarly, countries recording low levels of mortality inequality as measured by age-standardised mortality ratios (Italy, New Zealand, Mexico, Turkey, the United Kingdom, Israel, the United States and Sweden) also feature low (relative) gaps in life expectancy at age 25. The cross-country correlation between ratios of age-standardised mortality rates and relative gaps in life expectancy at age 25 is 0.96 for men and 0.88 for women.

[18] In other terms, countries with a high ratio in average age-standardised mortality rates (relative inequality) also have a high difference in these age-standardised mortality rates (absolute inequality). This is because cross-national differences in the average mortality rate almost entirely reflect cross-country differences in mortality among the less educated, while mortality rates of the high educated people are rather similar among countries.

Figure 8. Ratios of age-standardised mortality rates between high and low education groups



Note: Mortality rates are age-standardised based on WHO European Population structure (old standard) and standardization method.

37. It is also interesting to look at the pairwise correlations, across countries, between several measures of inequality in longevity by education: the (absolute) difference and (relative) ratio of life expectancy at age 25 between high and low educated people; and the (absolute) difference and (relative) ratios in average age-standardised mortality rate between the same two groups. The correlation tables reported in Annex D shows that all measures of inequality in longevity are highly correlated across countries, with pairwise correlations above 0.96 for men and 0.88 for women. This implies that countries rank more or less similarly in terms of longevity inequalities by education whatever the measure used.

Slope index of mortality rates

38. As argued by Mackenbach et al. (2015), mortality inequalities by education are also sensitive to the distribution of the population by education. A simple intuition is that, when the group of people with high education is small in size (e.g. Mexico), this group is also more selective in terms of health. This is less likely to be the case in countries with larger high education groups. Across countries, the correlation between the share of people with higher education and the ratio of average age-standardised mortality rates is -0.50 for men and -0.30 for women (Figure 9); in other terms, countries with higher educational attainment features lower inequalities in longevity. However, there is no systematic association between the two measures with each country. For instance, the high education group was very small in both Finland and Norway in the 1970s, but the increase in the size of this group went together with a widening of inequality in longevity.

39. To obtain measures of inequality in longevity that are not sensitive to the shape of the distribution of the population by education, Mackenbach (1997) has proposed two different measures: the "Slope Index of Inequality" (labelled as SII) and its normalised version, the Relative Index of Inequality (denoted as

RII). The SII consists of the absolute difference in age-standardised mortality rates between the best and worst ranked individuals in the education distribution, while the RII is equal to the SII divided by average age-standardised death rate for entire (total) population.

40. Figure 10 presents both measures and the correlation tables are reported in Annex D. Overall, both SII and RII measures are highly correlated with other (relative or absolute) measures of inequality in longevity, especially for men. For instance, the correlation between the ratio of age-standardised mortality rates and the RII is very high, at 0.94 for men and 0.95 for women; this suggest that accounting for differences in the size of the various educational groups does not change significantly the assessment of countries' rankings. Some countries such as New Zealand, Mexico and Sweden remain in the group of low-inequality countries for both men and women whatever the index (RII or SII) used; similarly, Czech Republic, Hungary, Czech Republic and Chile remain in the group of high-inequality countries based on both measures.

Figure 9. Mortality rate ratio versus share of population with higher education

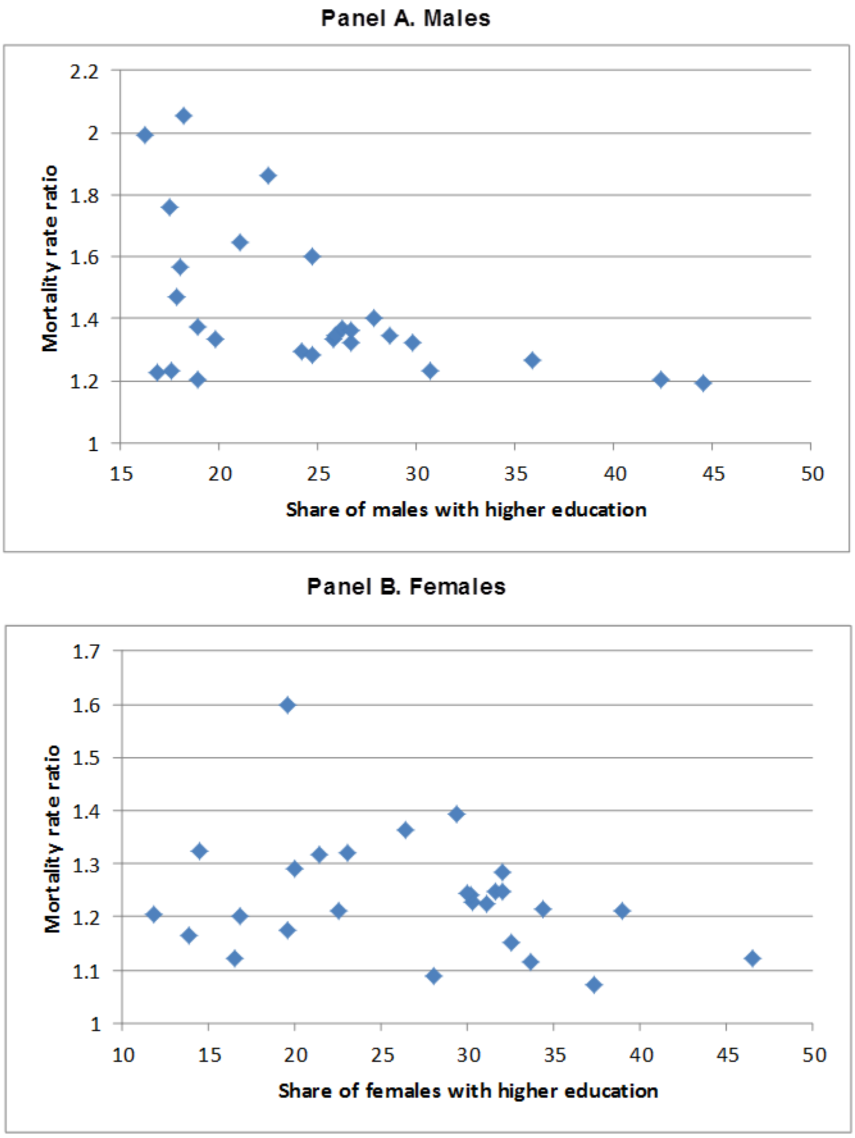
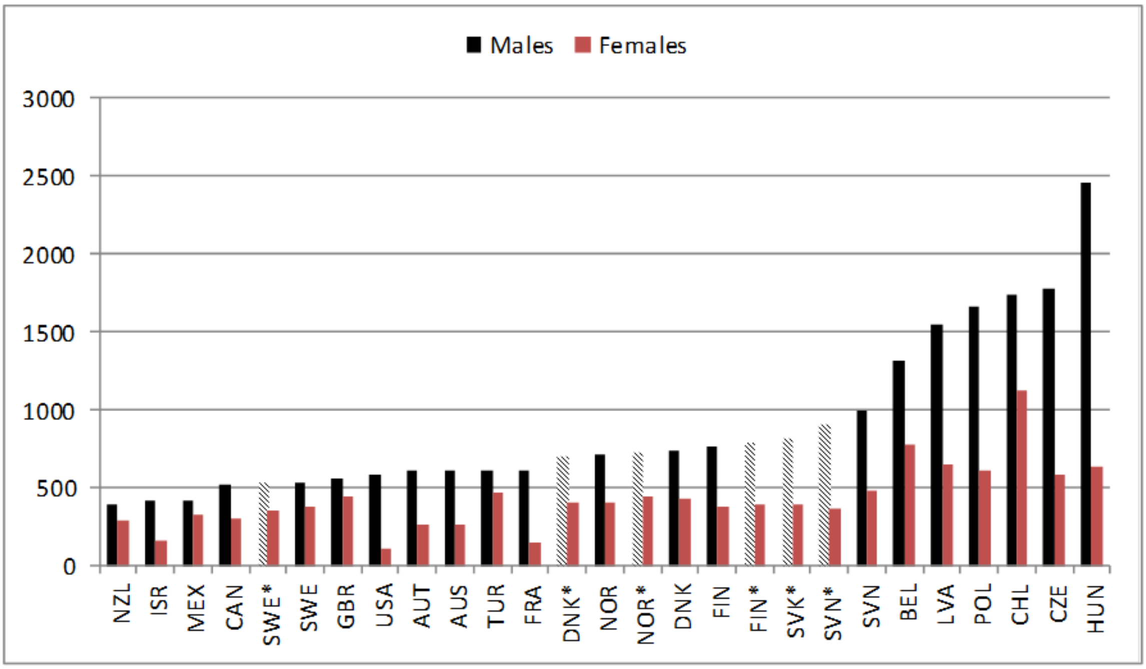
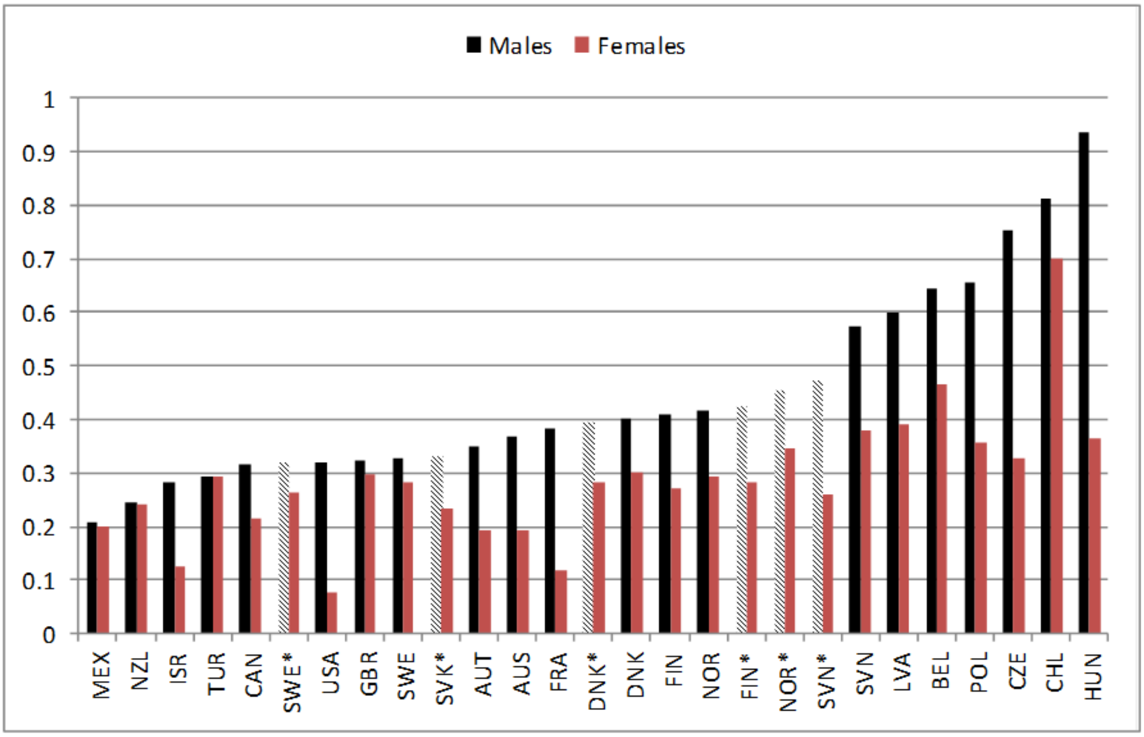


Figure 10. Slope Index and Relative Index of Inequality

Panel A. Slope Index of Inequality



Panel B. Relative Index of Inequality



Note: countries without an asterisk correspond to OECD data and calculations; *denotes OECD calculations based on Eurostat data.

4. Inequalities in longevity within educational groups

41. The previous section has looked at inequalities in longevity between educational groups by focusing on absolute and relative differences between various metrics of *average* mortality between high and low educated people, i.e. *between-group* differences in longevity. This section examines the degree of dispersion *within* educational groups, focusing on one specific part of the lifespan distribution, its left tail, which reflects the degree of premature mortality[19] among educational groups.

4.1. The dispersion of lifespan distributions

42. The distribution of lifespan (*f* in the equation below), conditionally on having survived until age 25, can be derived directly from the mortality rates m_i of various population groups (corrected for various statistical anomalies) used in Section 2 as the basis for constructing the various summary measure of between group inequalities. As shown by van Raalte et al. (2011, 2012), mortality rates can be used to construct life tables for each educational group; in this way, the age-at-death distributions are not confounded by differences in the underlying age structure of each sub-population. For a group *i* of age *t* that has faced the survival function S_i and the mortality rate m_i, one has:

$$f_i(t) = m_i(t).S_i(t)$$
$$S_i(t) = \prod_{a=1}^{t-1}(1 - m_i(a)), t > 25$$
$$S(25) = 1$$

In practice, 5-year age groups mortality rates are interpolated to be expressed as an annual age frequency in order to present smoother distributions. The distribution *f* sums to 1 across all ages, for each population group.

43. Figure 11 depicts the lifespan distributions by gender and education for Sweden and Latvia, countries which display very different life expectancy for men aged 25, especially at the lowest level of educational attainment (52.7 and 41.1 years respectively). This difference is clearly reflected by the shape of the lifespan distributions, which display two noticeable differences across the two countries considered: i) overall, the lifespan distribution is significantly more dispersed for the low-educated men than for the highly-educated men; this is the case in both Latvia and, to a lesser extent, Sweden; and ii) in turn, Latvia displays a much ‘thicker’ left tail for the group of low-educated men. Intuitively, this suggests that much of the cross-country differences in longevity (at national or at subgroup levels) is explained by the shape of the left tail of the lifespan distribution, i.e. premature mortality.

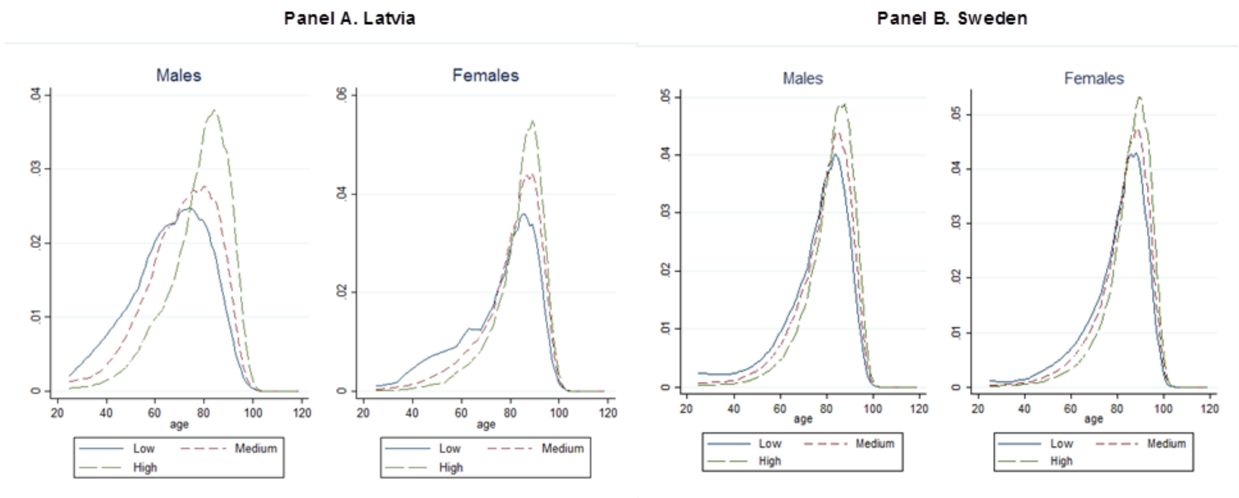
44. To examine this issue, the characteristics of the lifespan distributions are reported in Table 5, which include average lifespan (i.e. the average age at death conditional upon survival to age 25, which is equal to longevity at age 25 years plus 25 years, see Table 4[20]), the modal age at death (i.e. the most frequent age at death among people who survived to age 25), and the standard deviation of ages at death.

[19] Throughout this section, premature mortality refers to death episodes occurring before the modal age at death. This definition differs from the traditional one viewing premature mortality as the number of deaths occurring before age 70.

[20] Longevity at age 25 years and the average lifespan conditional upon survival to age 25 refer to the same concept, but are calculated differently. The former is equal to the integral of the survival function while the latter is the mean of the lifespan distribution. In most cases the two figures are equal, but they sometimes differ by 0.1 years due to numerical rounding.

The latter can be further decomposed into the standard deviation before and after the modal age; only the standard deviation of the left tail of the lifespan distribution, denoted as SD^-, is reported in Table 5.

Figure 11. Lifespan distributions by education in Slovenia and Sweden around 2011



45. Mortality inequality within educational groups can be described with the help of two measures, namely the difference between the average and modal ages at death, and the standard deviation of the lifespan distributions. Several results emerge:

- At the national level, the modal age at death is, on average, 7.6 years higher than the average lifespan. The difference between the two ages is more pronounced for men with low education (8.5 years) and it is substantially smaller for high education group (6.0 years for men and 5.0 years for women). This indicates that lifespan inequality is larger within groups with lower education than within highly educated groups.

- This finding is confirmed by the within-group standard deviation in lifespan, which is about 14 years for low-educated people (14.5 years for men and 13.3 years for women) as compared to 11 years for highly educated people (11.5 years for men and 10.7 years for women).

Table 5. Characteristics of lifespan distributions, conditional upon survival to age 25, by educational group

		Males												Females												National			
		Low				Medium				High				Low				Medium				High							
		Mean	Mode	SD	SD^{-}	Mean	Mode	SD	SD^{-}	Mean	Mode	SD	SD^{-}	Mean	Mode	SD	SD^{-}	Mean	Mode	SD	SD^{-}	Mean	Mode	SD	SD^{-}	Mean	Mode	SD	SD^{-}
AUS	OECD	77.64	86	14.37	13.35	80.95	90	12.7	11.93	84.22	91	11.84	11.29	83.15	91	12.79	12.43	85.4	91	11.49	11.08	86.82	94	11.3	11.11	80.9	90	12.54	12.42
AUT	OECD	76.42	85	13.88	12.37	79.08	86	12.84	11.46	82.86	90	11.13	10.29	82.59	89	12.28	11.65	84.32	90	11.36	10.59	85.65	89	10.76	9.938	82.59	89	12.28	11.65
BEL	OECD	73.86	81	13.75	12.42	77.63	84	11.68	10.43	83.73	89	9.757	8.917	78.56	85	12.79	11.93	81.67	86	10.66	9.65	85.3	90	9.241	8.489	78.56	85	12.79	11.93
CAN	OECD	79.4	86	12.96	12.03	80.61	86	12.05	11.04	83.45	90	11.3	10.74	83.32	90	12.15	11.72	84.4	90	11.11	10.55	86.02	91	10.28	9.878	83.32	90	12.15	11.72
CHL	OECD	71.81	80	14.41	13.04	75.91	84	13.61	12.32	82.79	89	11.71	10.53	78.22	85	12.23	11.33	83.18	91	12.77	11.93	85.84	91	10.67	9.6	78.22	85	12.23	11.33
CZE	OECD	67.38	80	13.86	12.22	74.97	84	12.48	11.19	80.43	89	10.86	10.18	79.33	89	12.97	12.8	80.11	86	10.81	9.929	84.21	91	10.39	9.883	79.33	89	12.97	12.8
DNK	OECD	74.75	84	14.66	12.95	78.63	85	12.51	10.79	81.56	86	11.1	9.732	79.53	86	13.89	12.28	82.88	90	11.79	10.68	84.64	90	11.07	9.994	79.53	86	13.89	12.28
DNK	Eurostat	74.81	85	14.59	13.15	78.56	85	12.3	10.73	81.5	86	11.04	9.711	79.78	89	13.76	12.58	82.99	90	11.71	10.59	84.66	90	10.99	9.938	79.78	89	13.76	12.58
FIN	OECD	74.02	85	15.9	14.43	77.58	86	13.87	12.49	81.59	87	11.82	10.77	81.19	90	14.36	13.89	84.1	90	11.74	11.16	85.95	90	10.79	10.1	81.19	90	14.36	13.89
FIN	Eurostat	74.37	85	15.74	14.35	77.5	85	13.74	12.29	81.57	87	11.6	10.5	81.26	90	14.36	13.94	84.03	90	11.77	11.18	85.78	90	10.62	9.923	81.26	90	14.36	13.94
FRA	OECD	76.47	86	15.51	13.58	80.12	89	14.24	12.82	83.23	90	12.66	11.5	84.34	91	13.53	12.65	86.54	94	12.35	11.74	86.97	94	11.85	11.19	84.34	91	13.53	12.65
GBR	OECD	78.89	86	12.59	11.62	81.69	89	11.84	10.92	83.16	90	11.51	10.86	81.78	89	11.81	11.25	84.65	90	11.4	10.9	85.73	91	10.91	10.02	81.13	90	11.19	11.21
HUN	OECD	64.92	69	13.18	9.563	73.32	80	12.94	10.58	78.84	85	11.55	10.22	76.27	85	14.15	12.93	81.29	87	11.63	10.85	81.99	87	10.43	9.626	76.27	85	14.15	12.93
ISR	OECD	78.5	85	13.67	11.81	81.84	87	12.24	10.58	84.12	89	11.05	9.704	82.37	87	12.62	11.27	85.28	90	11.45	10.46	86.2	90	10.75	9.593	82.37	87	12.62	11.27
ITA	OECD	79.45	86	13.12	11.76	81.9	86	11.83	10.66	82.55	90	10.88	10.11	85.48	84	11.68	10.43	85.26	88	10.55	9.983	87.09	88	10.82	9.956	83.56	87	11.1	10.16
LVA	OECD	66.05	74	15.76	12.26	70.92	80	14.42	11.94	77.57	84	12.83	11.24	75.14	86	15.83	14.54	80.24	89	12.82	12.06	83.37	89	10.63	9.974	75.14	86	15.83	14.54
MEX	OECD	74.11	84	16.84	14.84	75.1	81	14.17	12.37	79	86	13.56	11.98	79.27	86	13.94	12.16	81.71	86	12.1	10.71	81.92	87	11.95	10.59	79.27	86	13.94	12.16
NOR	OECD	76.32	85	14.24	13.06	80.03	86	12.18	11.09	83.19	90	10.85	9.968	81.44	87	13	12.03	84.78	90	10.96	10.02	86.27	91	10.45	9.668	81.44	87	13	12.03
NOR	Eurostat	76.47	85	14.61	13.11	80.69	86	12.45	11.07	83.64	90	11.42	10.32	81.83	90	13.58	12.52	85.1	91	11.71	10.73	87.24	94	11.06	10.36	81.83	90	13.58	12.52
NZL	OECD	76.98	85	15.23	13.71	80.41	86	13.03	11.73	81.6	87	12.4	11.26	81.78	90	14.42	13.3	85.01	90	12.71	11.4	86.19	91	11.99	10.97	81.78	90	14.42	13.3
POL	OECD	67.57	80	16.16	13.89	72.44	81	13.47	11.6	80.24	89	11.72	10.9	78.12	89	14.31	13.9	80.46	89	11.67	11.08	84.28	90	10.44	9.957	78.12	89	14.31	13.9
SVK	Eurostat	71.71	80	14.33	12.22	72.89	80	12.72	10.41	79.2	85	10.71	9.419	78.98	85	12.82	11.8	81.1	85	11.17	10.08	82.89	89	9.829	8.934	78.98	85	12.82	11.8
SVN	OECD	73.9	82	14.55	12.53	78.18	84	13.7	11.39	82.19	83	12.38	10.35	81.97	89	12.74	12	84.38	89	11.65	10.62	86.59	90	10.95	9.821	81.97	89	12.74	12
SVN	Eurostat	73.69	81	14.4	12.4	77.83	85	12.63	11.22	81.86	87	11.4	10.22	81.59	89	12.66	12.04	83.98	89	11.24	10.48	85.94	91	10.21	9.673	81.59	89	12.66	12.04
SWE	OECD	77.69	86	14.34	13.48	80.87	86	12.19	11.15	83.6	89	10.71	9.878	81.68	89	13.26	12.47	84.3	90	11.55	10.73	86.67	91	10.38	9.705	81.68	89	13.26	12.47
SWE	Eurostat	77.41	85	14.42	13.48	80.7	86	12.04	10.98	83.23	89	10.67	9.81	81.27	90	13.37	12.6	84.58	90	11.44	10.68	86.33	91	10.35	9.64	81.27	90	13.37	12.6
TUR	OECD	75.85	81	12.43	10.92	77.79	84	11.82	10.58	80	85	10.92	9.718	81.28	86	11.02	10.1	83.83	90	10.33	9.712	85.19	90	9.822	9.227	81.28	86	11.02	10.1
USA	OECD	74.16	86	15.78	13.97	77.28	87	14.66	13.56	81.47	89	12.06	11.48	79.51	88	14.7	13.67	81.78	89	13.15	12.52	83.37	89	10.94	10.54	78.62	90	13.8	13.83
Average		**74.5**	**83.0**	**14.5**	**12.8**	**78.1**	**84.9**	**12.9**	**11.4**	**81.9**	**87.9**	**11.5**	**10.4**	**80.8**	**88.0**	**13.3**	**12.4**	**83.5**	**89.3**	**11.6**	**10.8**	**85.3**	**90.3**	**10.7**	**9.9**	**80.5**	**88.2**	**13.2**	**12.4**

46. Overall, the contribution of within-group inequality in ages at death represents the bulk of total inequality. Following van Raalte et al. (2012), the Theil's index of lifespan inequality can be decomposed into: i) inequality in lifespan within educational and gender groups; and ii) inequality between these groups. Table 6 shows that the between-group component represents, on average, 7.6% of total inequality, while ranging between 3% (in Canada and United Kingdom) and 21% in Latvia. In other words, education and gender, taken together, do not explain more than 10% of the total variation in lifespan within countries. The factors explaining the dispersion of lifespan within education and gender groups are plenty and include genetic profiles, exposure to risk factors (smoking, alcohol, pollution), or simply luck.

Table 6. Theil's index of lifespan inequality (x100) by country

		Theil index (x 100)	Within-group inequality	Between-group inequality	Between component as per cent of total
AUS	OECD	1.309	1.242	0.067	5.1
AUT	OECD	1.260	1.185	0.074	5.9
BEL	OECD	1.232	1.114	0.117	9.5
CAN	OECD	1.117	1.081	0.036	3.3
CHL	OECD	1.564	1.381	0.183	11.7
CZE	OECD	1.538	1.295	0.243	15.8
DNK	OECD	1.378	1.299	0.079	5.7
DNK	Eurostat	1.401	1.322	0.080	5.7
FIN	OECD	1.565	1.451	0.114	7.3
FIN	Eurostat	1.598	1.476	0.122	7.6
FRA	OECD	1.528	1.429	0.099	6.5
GBR	OECD	1.122	1.085	0.036	3.2
HUN	OECD	1.720	1.422	0.298	17.3
ISR	OECD	1.172	1.125	0.047	4.0
ITA	OECD	1.081	1.034	0.047	4.4
LVA	OECD	2.125	1.831	0.294	13.8
MEX	OECD	1.775	1.702	0.073	4.1
NOR	OECD	1.346	1.259	0.087	6.5
NOR	Eurostat	1.253	1.174	0.080	6.3
NZL	OECD	1.518	1.450	0.068	4.5
POL	OECD	1.855	1.590	0.265	14.3
SVK	Eurostat	1.433	1.292	0.141	9.8
SVN	OECD	1.360	1.234	0.126	9.3
SVN	Eurostat	1.462	1.331	0.132	9.0
SWE	OECD	1.257	1.196	0.062	4.9
SWE	Eurostat	1.254	1.194	0.059	4.7
TUR	OECD	1.104	1.024	0.081	7.3
USA	OECD	1.692	1.616	0.076	4.5
Average		1.429	1.316	0.114	7.6

4.2. Premature mortality

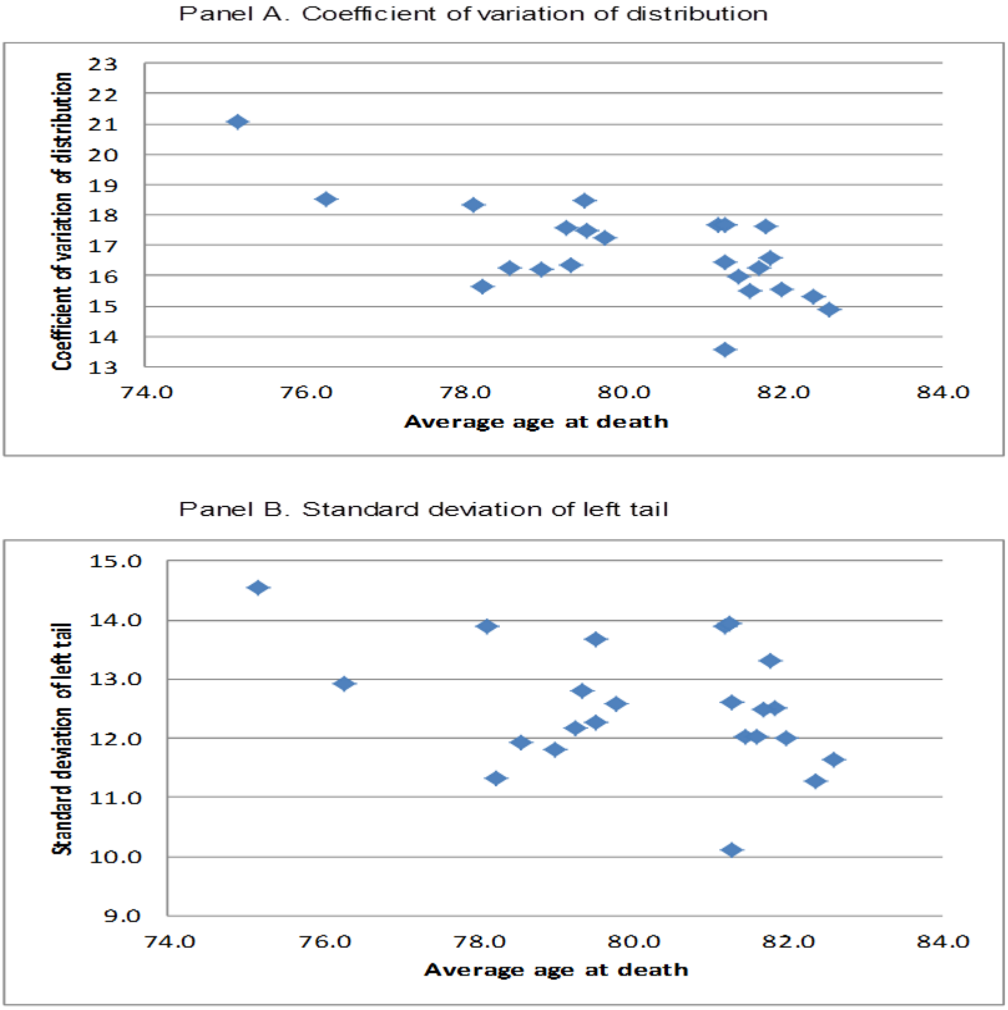
47. The coefficient SD^- in Table 5 measures the standard deviation of the left tail of the lifespan distribution, which provides a convenient measure of premature mortality; it focuses on deaths that occur before the most frequent age at death. Two patterns emerge from Table 5:

- Most of the overall dispersion in ages at death is due to the dispersion before the modal age at death, namely to premature mortality. The measure SD^- indeed represents 94% of the total standard deviation. Consequently, the large inequality in ages at death observed among low-educated people mostly reflects a higher degree of premature mortality among this group.

- Differences in the modal age at death between educational groups are significantly smaller than differences in life expectancy (or average lifespan). While the gap in life expectancy at age 25 between high and low educated people is around 8 years for men and 5 years for women, the corresponding gaps in modal age of death are 4.9 and 2.3 years respectively. This suggests that about half of mortality inequalities between educational groups are explained by deaths occurring before the modal age.

48. The above remarks suggest that both the average longevity and the inequality in lifespan are disproportionately affected by premature mortality. In other terms, premature mortality lowers life expectancy and raises lifespan inequality. This is confirmed by the negative relationship between lifespan inequality and average age at death shown in Panel A of Figure 12, with a correlation of -0.69. A negative relationship also exists between a direct measure of premature mortality (i.e. SD^-) and average age at death, although the correlation in this case is a bit lower (-0.44).

Figure 12. Mortality inequalities versus average age at death around 2011



5. Explaining inequalities in longevity by causes of death

49. Insights on the proximate drivers of these inequalities in longevity by education may be gleaned based on data on mortality rates across educational groups due to four specific causes of death: circulatory problems, neoplasm (cancers), external causes (such as car accidents or violent deaths) and other causes.

5.1. The structure of average mortality by cause of death

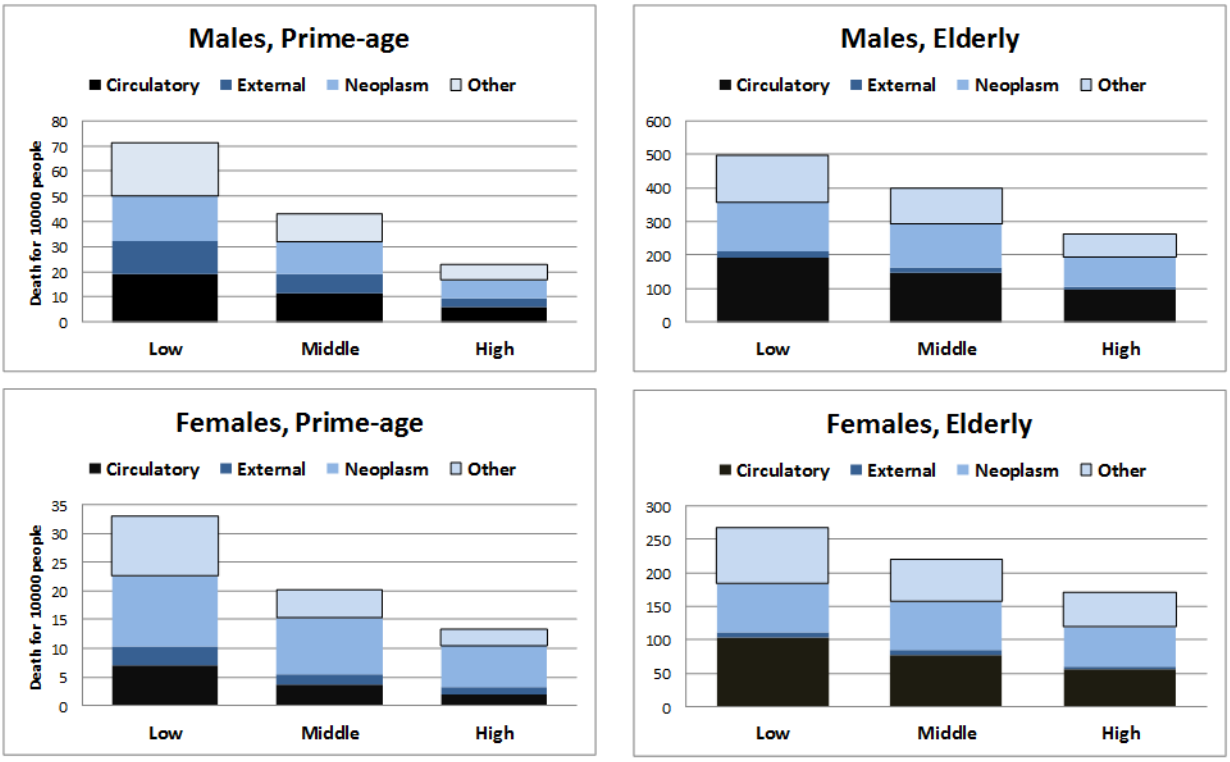
50. Figure 13 decomposes the (age-standardised) mortality rate for each gender, age (25-64 and 65-89 years) and education group by causes of death band it calculates averages across the 23 countries covered in this paper. Several patterns emerge:

- For prime-age men, the contribution of circulatory problems, neoplasms and other causes of death to total mortality is very similar across all educational groups.

- For prime-age women, neoplasms are the first cause of death across the three educational levels.

- Among the elderly, circulatory problems represent the first cause of death for both gender and all educational groups, as they are responsible for about 40% of total mortality, while the contribution of neoplasms and other causes is between 25% and 30% of the total. Circulatory problems are slightly more prevalent among the low education group for both men and women.

Figure 13. Mortality rates by gender, age, education and cause of death around 2011

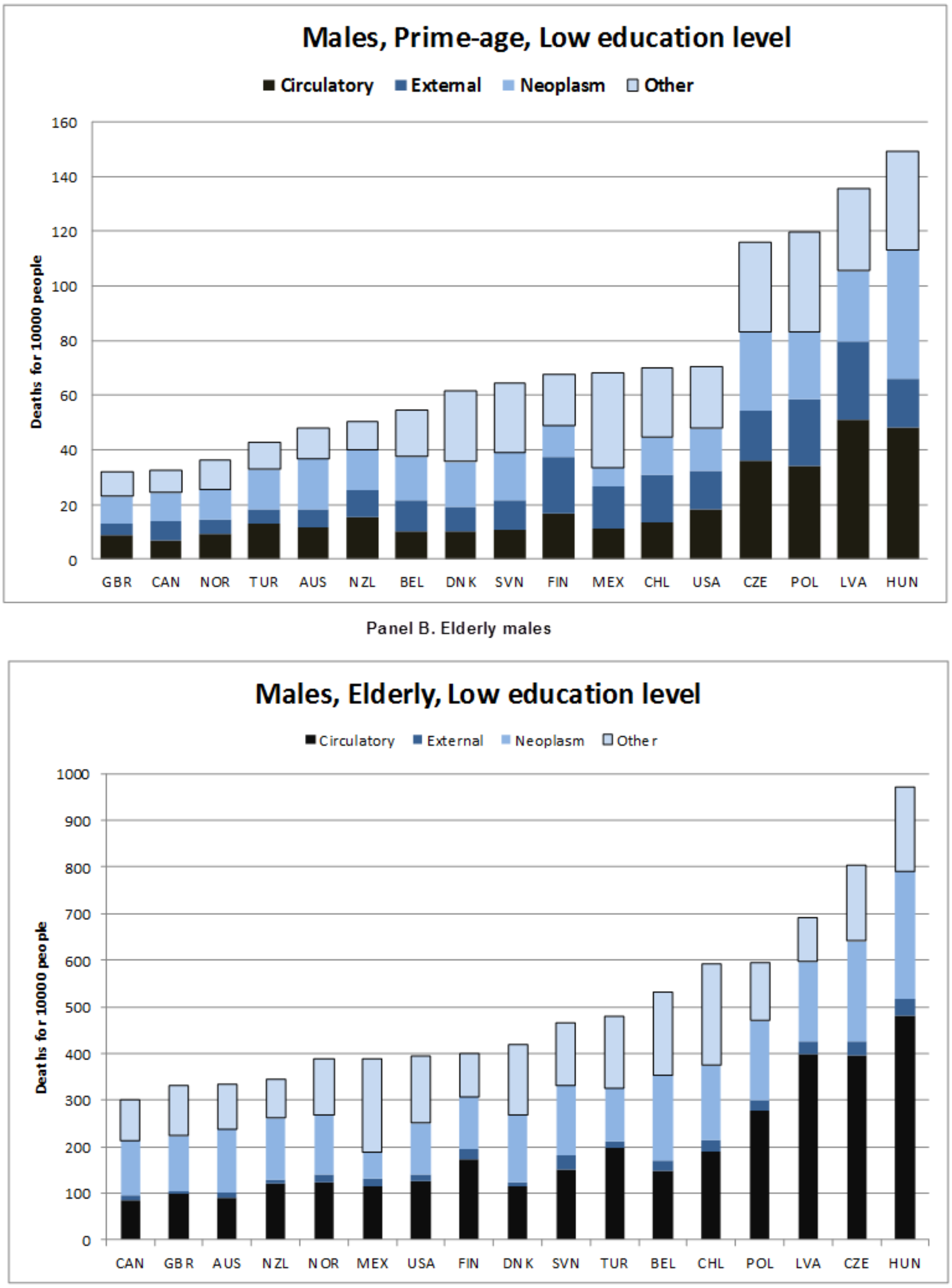


51. It is important to focus on low-educated men, as they feature the highest mortality rates and constitute the bulk of premature mortality. Figure 14, Panel A, breaks down age-standardised mortality rates by country for prime-age low educated men. No single cause of death explains excess mortality for people in this group in countries such as Hungary, Latvia, Poland or the Czech Republic. All countries display approximatively the same structure of mortality by cause of death. For instance, circulatory problems represent 31% of deaths in New Zealand and the Czech Republic, while neoplasms involve 31% of death in Norway and Hungary.

52. For the elderly low-educated men, Figure 14 Panel B shows that circulatory problems are the most frequent cause of death in high-mortality countries such as Latvia, the Czech Republic, Poland and Hungary, where they account for around half of all deaths, as compared to around one third in Canada (28%), the United Kingdom (30%), Norway (37%) and Turkey (31%). Conversely, other causes of death are relatively more prevalent in low-mortality countries.

Figure 14. Mortality by cause of death among low-educated males around 2011

Panel A. Prime-age males

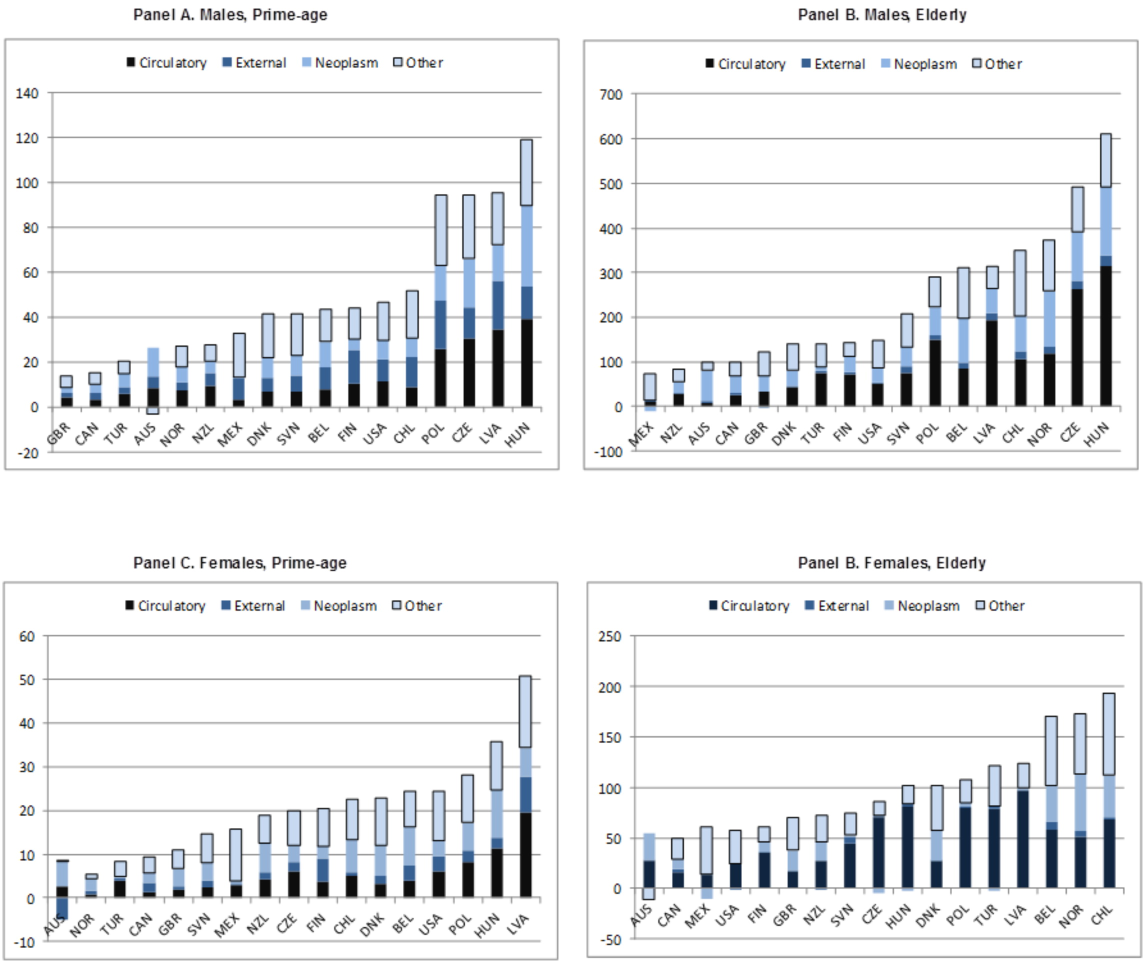


5.2. Explaining mortality inequalities by causes of death

53. While the various population groups display similar structure of mortality by cause of death, they feature very different levels of mortality, which allow analysing the causes of the mortality gap. Figure 15 decomposes the difference in mortality rates between low and high-education groups into the contributions of various causes of death. For prime-age adults, "Other causes" account for most of these mortality differences (32% for men and 39% for women), followed by circulatory diseases and neoplasms (which contribute for around 25% of the rates' difference for both men and women. For elderly men and

women, circulatory diseases contribute to 41% of the difference in mortality for men, and 49% for women; the second main contribution is that of "Other causes", followed by neoplasms (25% for men and 14% for women). Hence circulatory problems are the main factor explaining the mortality gap between educational groups at older age.

Figure 15. Decomposition of the difference in mortality rate by causes of death around 2011



54. Smoking is a very important risk factor for cardio-vascular diseases. According to Mackenbach (2016), smoking accounts for up to half of the observed inequalities in mortality in some European countries; while its contribution to inequalities in longevity has decreased in most countries for men, it has increased among women. In almost all countries analysed by Mackenbach (2016), prime-age people with lower education are more likely to smoke than those with a medium or higher education, for both men and women. On average, 45% of low-educated men aged 18-64 smoke daily or occasionally, as compared to 23% for highly-educated men[21]. The educational gradient of smoking prevalence disappears after age 65, reversing in some countries. This suggests that part of the education gradient of mortality is explained by differential smoking prevalence before age 65. In this regard, when analysing the contribution of smoking to socio-economic inequalities in mortality among 14 European countries between 1990 and 2004, Mackenbach (2016) finds that smoking-related mortality represents a larger fraction of total mortality for people with a lower level of education than for those with higher education, especially for men. In 2000-

[21] Among women, the same proportions are 32% and 17%.

2004, the contribution of smoking to mortality differentials between low and high education groups varied between 19% and 55% for men and between nil and 56% for women. Since the early 1990s, the contribution of smoking to inequalities in mortality by education has fallen in most countries for men, but increased for women.

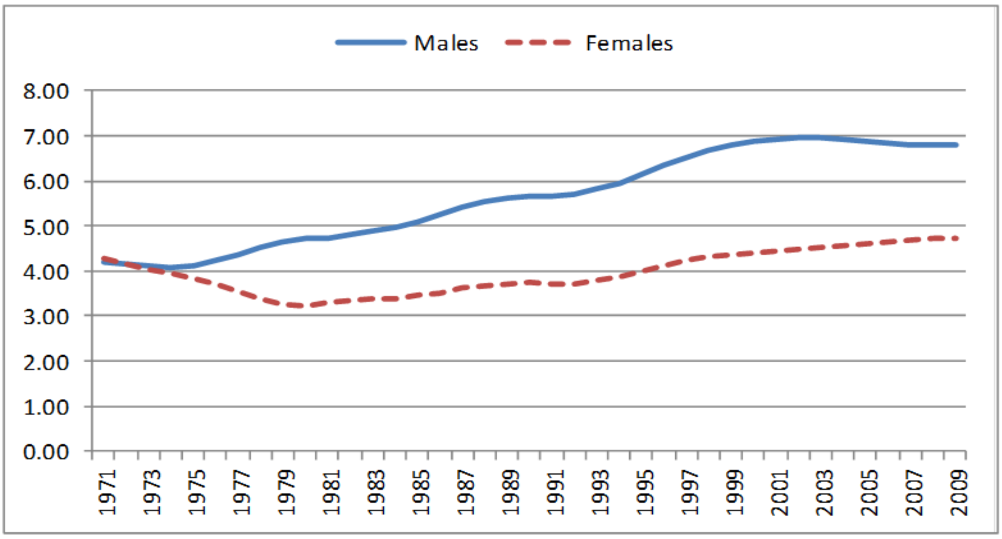
6. Health inequalities over time

55. The analysis conducted so far has relied on measures of mortality rates averaged across both age-of-death and years of observation. While this procedure lead to estimates that are more stable and less affected by abnormal changes in the data, this comes at the cost of potentially hiding changes in these measures over time. To address this limit this section presents point-estimates of longevity at age 25 years by gender and education for each available year, together with an estimate of its confidence interval. As these estimates are subject to measurement errors due to small samples, the time profile of time series can be affected by statistical noise. To reduce it, a moving average filter using a three-year window is applied repeatedly (up to five times) to smooth the time series. These time series are reported in Appendix E together with 95% confidence intervals.

56. Time series are generally too short to assess changes over the recent period. In a review of the literature, James et al. (2015) and OECD (2016) conclude that, in most OECD countries where country-level data are available, the longevity gap between high and low-educated people has remained constant or slightly increased over the last decade.Over the longer term, country-specific evidence yields similar findings. For instance, Figure 16 shows that the longevity gap has increased by 3 years among Norwegian men and by almost 1 year among women over the 1971-2009 period. Similar findings for France are reported by Blanpain (2016).

Figure 16. Longevity gap between high and low educated people in Norway

1971-2009



7. Conclusion

57. Longevity is a fundamental dimension of people's well-being and one of the main drivers of progress in living standards (Boarini et al., 2016). From this perspective, a proper assessment of inequality

in longevity is a natural extension of the OECD Inclusive Growth project, which focuses on average well-being outcomes and their distribution in the population.

58. This paper is based on the collection of new data on mortality and population by age, gender, education and causees of death for 22 OECD countries. These data have been complemented by auxiliary data (i.e. Eurostat detailed data and summery estimates) for a number of other European countries. The main contributions of this paper are twofold:

- On the methodological front, key data issues have been identified and corrected country-by-country. This approach shows that the treatment of deceased people with "missing education" is of crucial importance for the countries whose data are based on a “cross-sectional" (unlinked) design. In general, data quality is significantly higher for countries that have adopted a “longitudinal" (linked) design”.

- On the empirical side, the paper has highlighted several patterns.

  – First, the gap in life expectancy at age 25 years between high and low-educated people is on average around 8 years for men and 5 years for women. Differences in longevity are especially marked in Latvia, Poland and Hungary and relatively small in Italy.

  – Second, gaps in life expectancy at age 65 (at 3.6 and 2.5 years for men and women, respectively) imply that relative inequalities in longevity by education increase with age.

  – Third, other measures of inequalities in longevity by education (such as country averages of age-standardised mortality rates and the slope index of inequality) do not significantly change the assessment relative to one based on life expectancy measures.

  – Fourth, differences in life span between people with low and high education accounts for about 10% of overall inequalities in ages at death. Life span inequalities are larger within low-education groups than within high-education groups, and mainly reflect higher premature mortality.

  – Lastly, cardiovascular problems explain the bulk of mortality differentials between high and low educated people (43% for men and 51% for women).

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APPENDIX A. DATA TREATMENTS

A.1. The treatment of missing education

59. Figure A1 illustrates the issues arising from the missing education category, taking Belgian men as an example. Several problems arise from the raw input data (Figure A1 upper left panel) : people with 'missing education' exhibit disproportionally high mortality rates, while people with 'no education' display low mortality rates; also, people with low education record lower mortality rates than people with medium education, which is implausible. The existence of this "cross-over" in group-specific mortality curves, together with implausible age-specific mortality patterns (i.e. sudden mortality declines at older ages) indicate potential biases in the cross-sectional "unlinked" data for Belgium. These problems are likely to derive from misreporting of educational attainment on death records, as highlighted by a mismatch between the information about education in death certificates and census records ("numerator-denominator bias", Vallin, 1980).

60. While the "no schooling" category can conveniently be merged with the "low level" group (as done in the upper right-hand panel of Figure A1), largely removing the 'mortality cross over', the "missing" category is much harder to treat. When people in this group is distributed proportionally to other educational categories, for each gender and age group (as on the bottom left-hand panel), cross-overs in mortality rates between low and medium education groups are not entirely removed. Alternatively, when the category "missing" education is merged with the "low" education, cross-overs largely disappear but the group with tertiary education now display an implausibly low level of mortality (bottom right panel), suggesting that, in this case, its longevity is overestimated (see below).

61. Overall, the treatment of "missing" category has little influence on the estimates discussed in this paper except in the countries where this group is large and where an unlinked procedure is used, namely the Czech Republic, Belgium, the Slovak Republic and Norway when the Eurostat data are used. As shown in Figure A2, the merging of "missing" and "low" education results in a difference of several years of longevity at the age 25 for the group with tertiary education in Belgium (+4.2 years), the Czech Republic (+6.9 years), Norway based on the Eurostat data file (+5.2 years) and the Slovak Republic (+1.5 years). This is because the group with 'missing education' has abnormally high mortality rates in the data and is likely to include deceased people with tertiary education, who in turn display implausibly low mortality rates as some deceased individuals with higher education as classified as "missing". In contrast, for other countries the way the group "missing" is treated leads to average difference in longevity of less than 0.1 years, depending on the method using (i.e. equi-distribution or allocation to "low education").

Figure A1. Log mortality rates in Belgium by education status

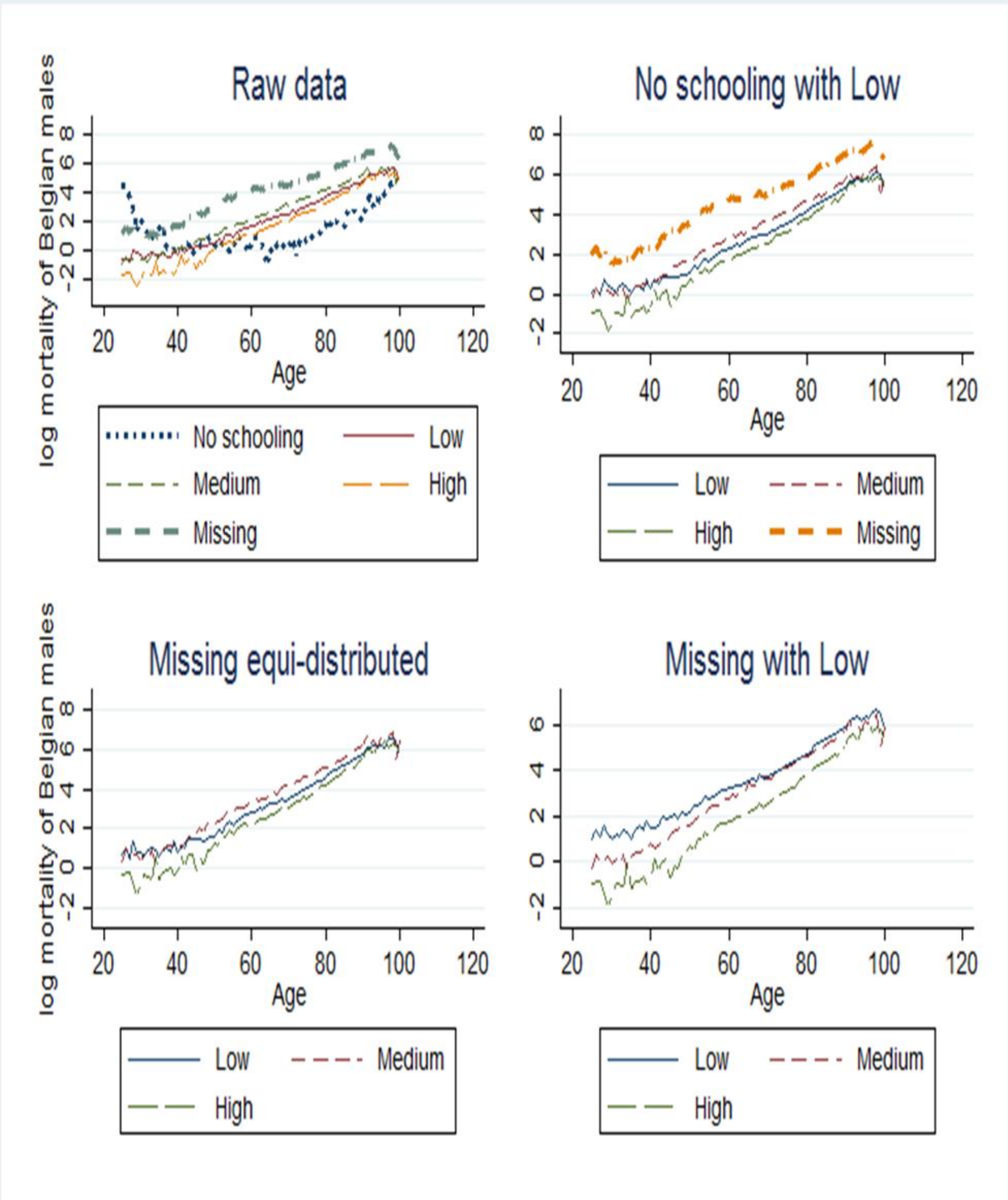
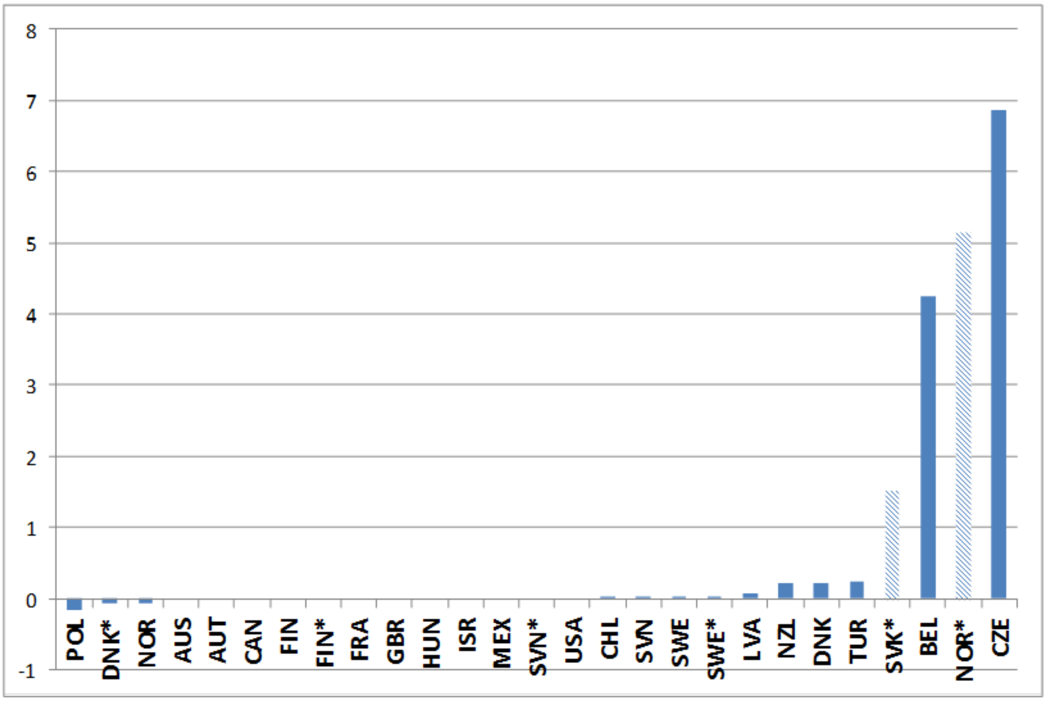


Figure A2. Differences in estimated longevity at age 25 between two treatments of data for people whose education is reported as 'missing'

Imputation of category "missing" to low education versus equi-distribution

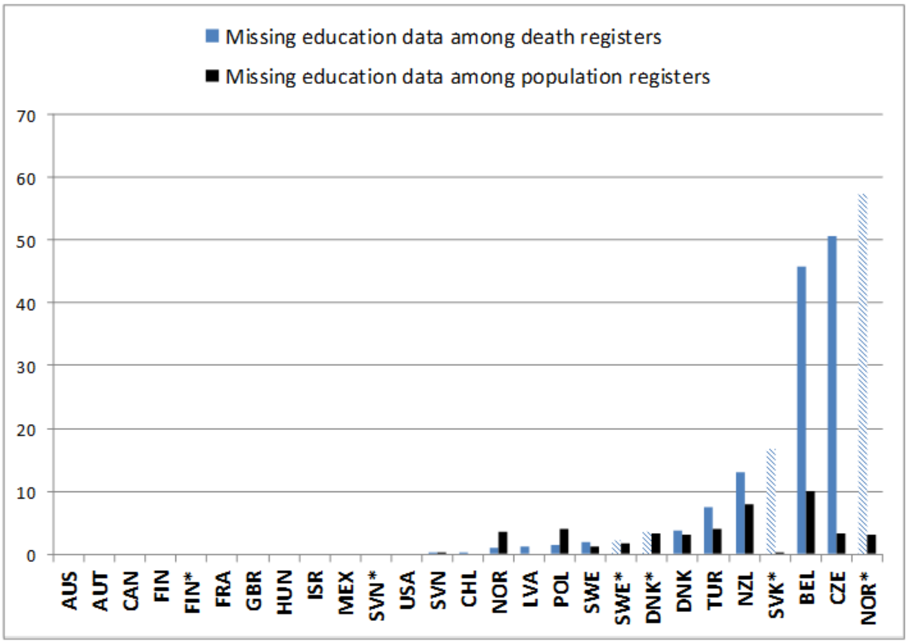


Note: * indicates OECD calculations based on Eurostat data.

62. Figure A3 further illustrates the severity of the problem by plotting the percentage of people with missing education *among the deceased* as compared to the total population. In the four problematic samples highlighted above, the percentage of people with missing education among the deceased is extremely large. In the Slovak Republic for instance, the percentage of people with missing education represents only 0.1% of population, but it represents as much as 17% of the deceased population. Similarly, in Belgium, the Czech Republic and Norway (Eurostat sample) there is a large gap between the shares of people with 'missing' education among the deceased and the population at large. In these three countries, the very large share of deceased population with missing education (above 40%) lowers the credibility of the results. The percentage of people with missing education is also significant in New Zealand, but this share is similar for the deceased and for the total population, as this country follows a linked methodology. As a result, estimates for New Zealand are less sensitive to the treatment applied to this group (Figure A2).

Figure A3. Percentage of people with missing data on education among the deceased and among the total population

Average across gender and age groups



Note: * indicates OECD calculations based on Eurostat data.

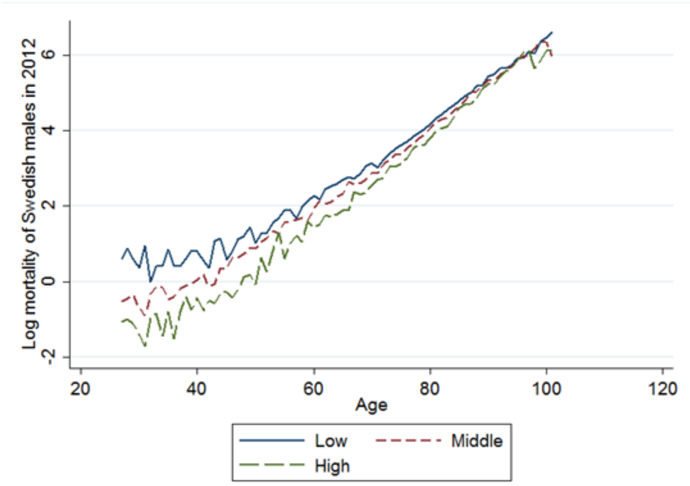
63. In this paper, the "equi-distribution assumption" is used as a benchmark, and the group with missing education is distributed across the other educational categories observed among each age and gender group. The same assumption is made by Eurostat. However, Belgium and the Slovak Republic are two exceptions to this rule, as the existence of large cross-overs suggests that merging "missing" and "low" education groups is the best treatment for these two countries.

A.2. The volatility of annual mortality rates and the use of abridged life tables

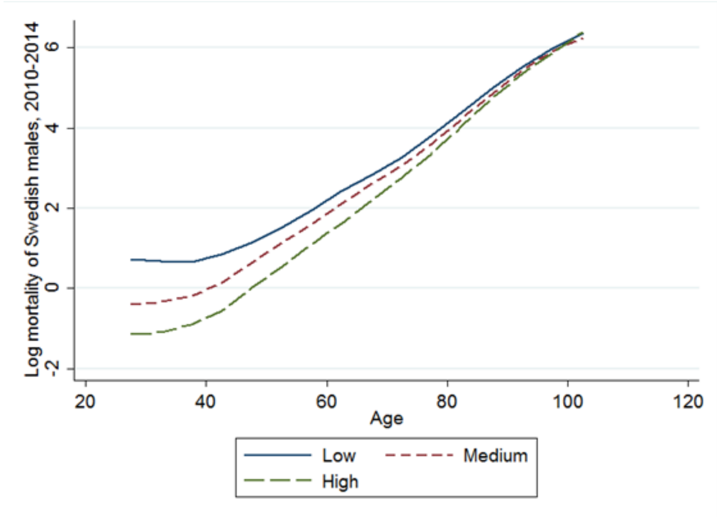
64. The detailed data on the deceased by single year of age provided by national contact points have been pooled across several years following or around the census date into 5-year age groups. Even in a country with high-quality data such as Sweden, which displays little missing education data and relies on a census-linked methodology, the mortality rates for detailed education/age/gender groups derived from a single year of observation and from annual age frequency are volatile, especially at lower ages (Figure A4 panel A). To remedy to this problem, the analysis in this paper refers to people grouped into 5-year age bands and pools several years of observation. This procedure yields smoother mortality rates as shown on Figure A4, Panel B. For example, in the case of Sweden, this approach implies using 25 times more observations in the pooled data (5-year age-band times 5 years of observation) relative to the case of annual age frequency and single year data. This pooling methodology offers two additional advantages: first, it increases comparability with those countries whose death data are provided as 5-year groups; and, second, it increases the robustness of the estimates, especially when mortality data are broken down by cause of death.

Figure A4. Log mortality rates of Swedish males

Panel A. Annual age frequency and single year of observation (2012)



Panel B. 5-year age frequency and multiple years of observation (2010-2014)



A.3. Treatment of small sample bias of mortality rates at older age and mortality cross-overs

65. The data pooling methodology does not solve all data issues. Appendix B provides a detailed examination of the remaining problems affecting mortality age profiles by gender and education. There are two types of issues:

- ***Plausibility of age-specific mortality curves and cross-overs*** in mortality. This refers to implausible sudden declines or increases in mortality at some (usually) old ages, which produce cross-overs in group-specific mortality rates. For instance, people with medium education above a certain age may suddenly display higher mortality rates than people with low education. Four countries in our dataset display implausible age-specific mortality patterns and mortality cross-overs: the Czech Republic (between low and medium education for men), Mexico (between medium and high education for women), Poland (between men and women of low and medium education) and Turkey (between men and women with low, medium and high education at older age). In theory, mortality cross-overs between different educational groups are possible, but they usually occur at very high ages after some gradual convergence. However, most of the cross-overs observed in our dataset, with the exception of Turkey, occur when mortality rates drop suddenly for the lower education group, becoming smaller than those of a higher education group; this pattern suggests a data quality problem.

- ***Misreporting*** of mortality rates. This problem reflects the very small number of deceased people especially at older age, when the numbers of deceased and living people shrink to zero. This problem takes various forms: abnormally low mortality rates for some groups at prime-age people in Israel (for medium and high education at young age) and Hungary (medium education after age 65), with random fluctuations in a very small number of deaths (i.e. a numerator problem); mortality rates above 100% at older age in the Czech Republic, due to the very small size of underlying population (i.e. a denominator problem); mortality rates declining with age beyond 90 or 95 years, as observed in Belgium, Chile, the Czech Republic, Denmark, Finland, Hungary, Israel, Latvia, Poland, Slovenia and Turkey. These implausible patterns indicate some problems in the data. Although some research suggests that the growth of mortality rates with respect to age decelerates after the age of 90-100 years (ONS, 2016)[22], there is no evidence about sudden drops in mortality rates.

66. The small number of observation observed at older age has led Eurostat to restrict the calculation of longevity across educational groups to the 25-74 years age group. While this procedure avoids the problem of small number of deaths at higher ages, it also misses differential mortality after age 75. While this problem is perhaps less important for the calculation of longevity at age 25 (the measure preferred by Eurostat), as this measure is less sensitive to mortality differentials at very old age, it becomes a critical issue for the calculation of longevity at age 65 and for the accurate evaluation of differences across educational groups, which have implications for the design and fairness of pension systems.

67. This paper departs from the censoring practice used by Eurostat to take into account mortality differences *after age 75 years*. The key reason to do so is that the data appears to be of good quality until age 90 or 94 years in most countries, as illustrated by Appendix B. In practice, the age profile of mortality is predicted after age 94 years with the help of a classical Gompertz model where, for each gender *i* and education groups *j*, the following model is estimated:

$$\log m_{i,j,t} = a_{i,j} + b_{i,j}.t + \varepsilon_{i,j,t} \qquad (1)$$

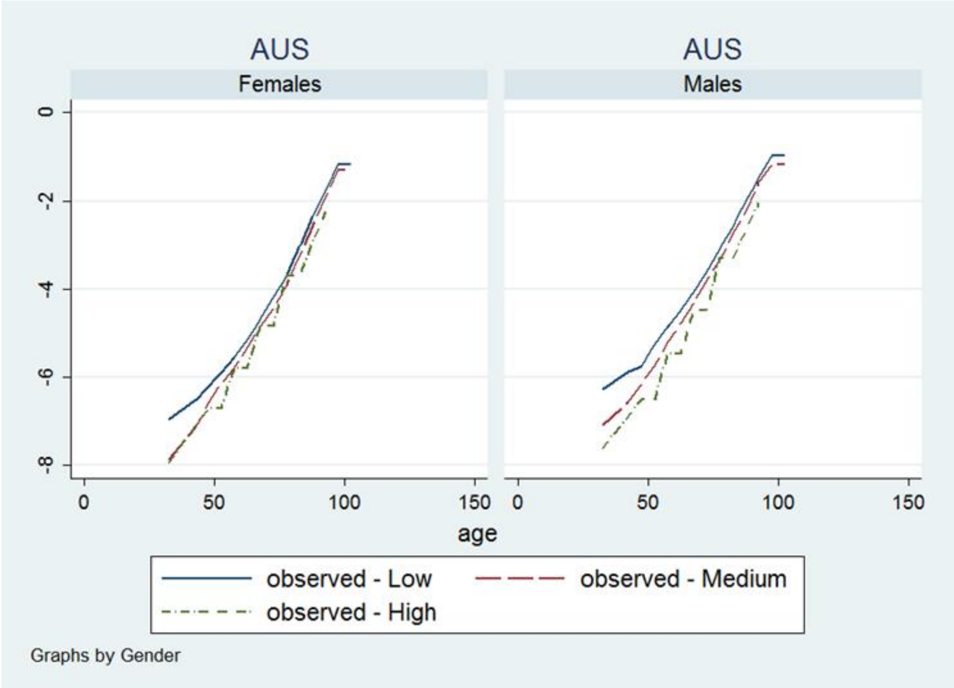
where $m_{i,j,t}$ is the mortality rate of group (*i,j*) at age *t* (taken as equal to the middle of the 5-year age group). This regression is run between age 70 and 94 years for most countries, in order to focus on the mortality age-profile at older ages. Then, the predicted mortality rates are selected after age 95 and combined with the observed mortality rates between 25 and 94 years. As shown in Appendix B, the Gompertz model fits the pooled data well, overall and especially over the 70-94 years age band, over which the mortality age-profile is almost linear.

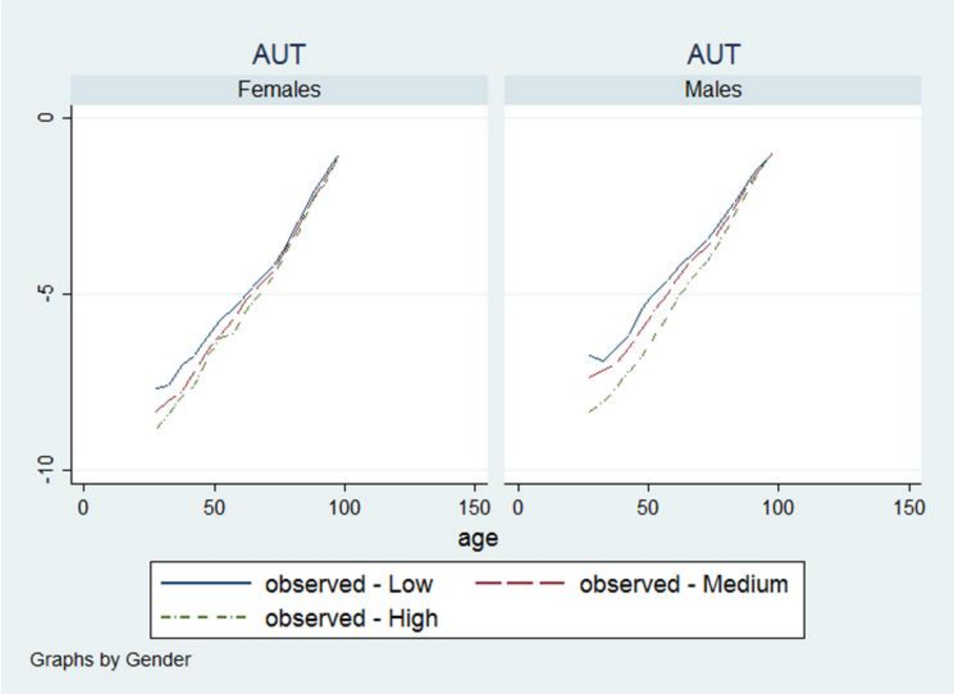
68. Addressing the problem of mortality cross-over issues is more difficult, as this problem stems from the low quality of the raw data due to misreporting of education observed especially, but not always, at older ages. In this case, observations that were deemed to be 'dubious' were censored after some age threshold and replaced by log-linear extrapolations of mortality rates. In some cases, the censoring was done at relatively low ages; this implies that that the estimates reflect a significant degree of imputations and should therefore be taken with caution. Countries in which the data have been censored are: Belgium (after age 70 years); Chile (after 65 years for high education and between 65 and 75 years for women with

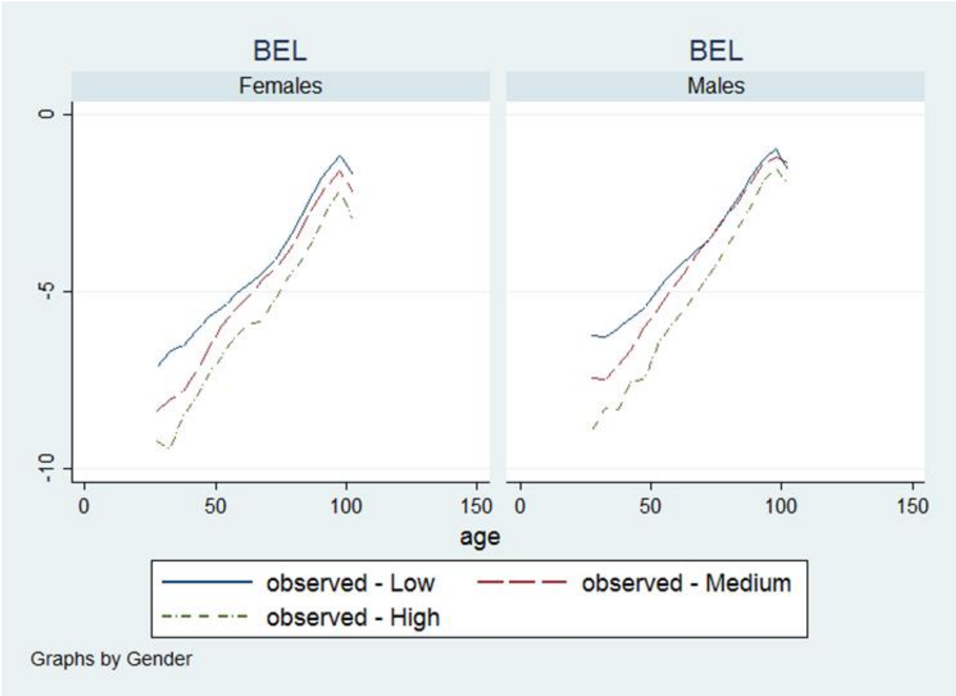
[22] ONS, 2016, "Estimates of the Very Old (Including Centenarians)", *UK Statistical Bulletins*.

medium education); Hungary (between 65 and 80 years for men with low and medium education); Turkey (after age 70 years); the Czech Republic (between age 45 and 59 years); Norway (before age 34 years for medium and high education); Norway based on Eurostat data (after age 85 years); Mexico (after 60 years for medium education); the Slovak Republic (after 60 years for high education); and Israel (before age 34 years for medium and high education). For all countries, annual mortality rates were censored upward at a maximum rate of 50% per year. Appendix C displays both the original and the treated mortality rates. This treatment allowed eliminating most of cross-over problems in all countries.

APPENDIX B. MORTALITY RATE AGE-PROFILE ACROSS COUNTRIES



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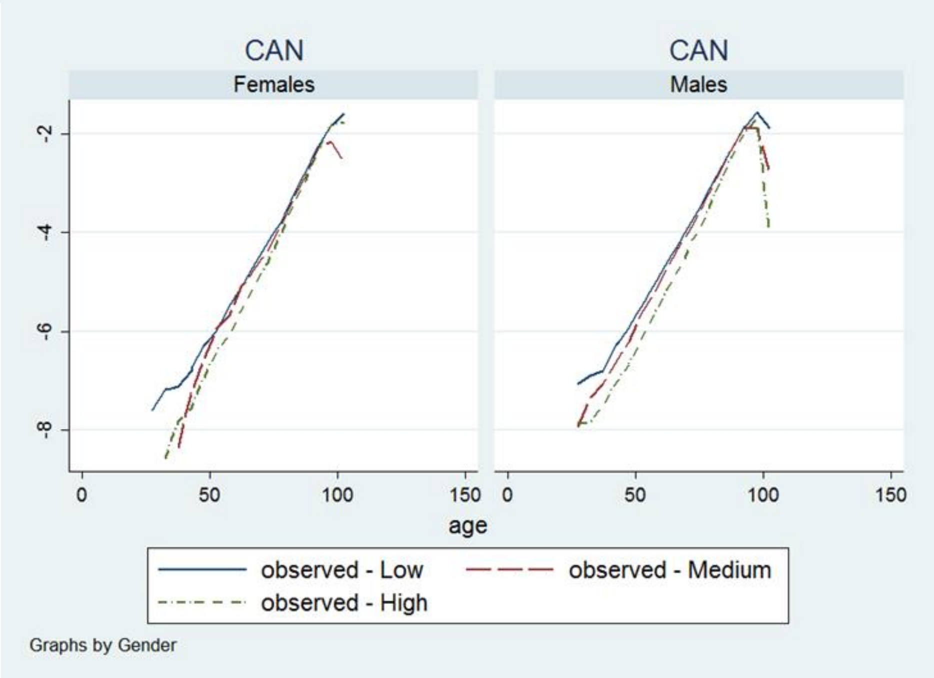
Graphs by Gender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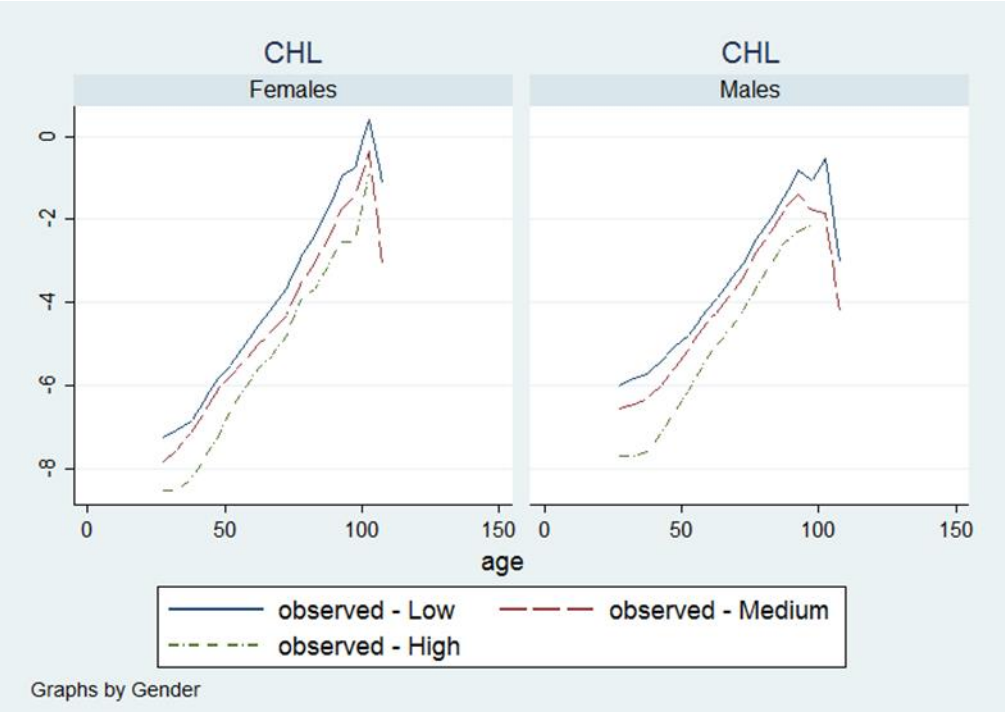
Graphs by Gender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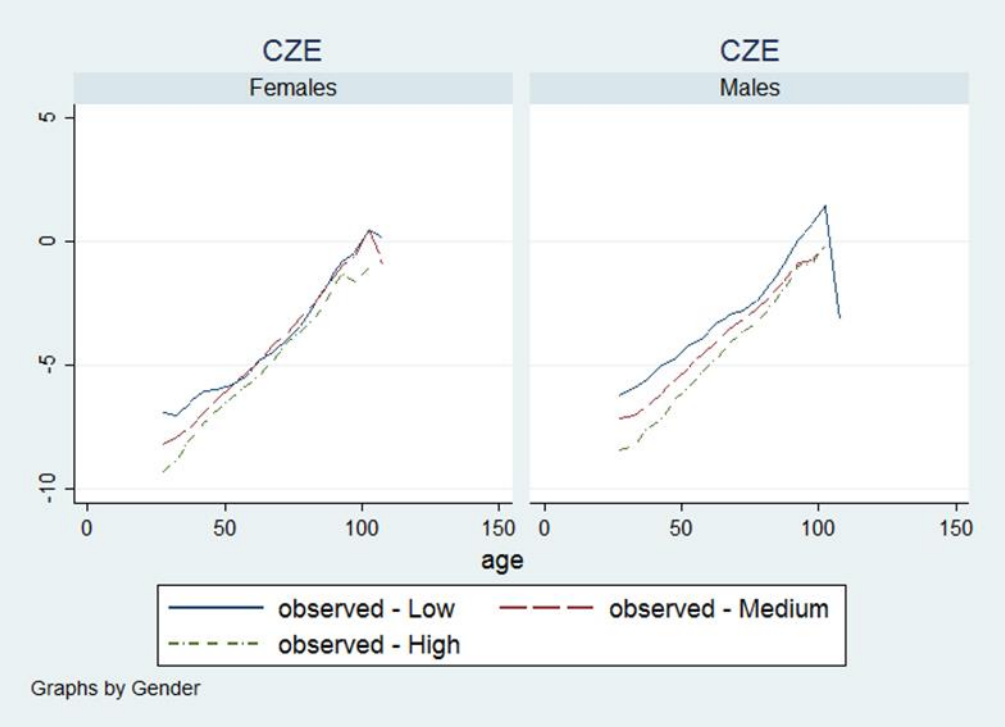
Graphs by Gender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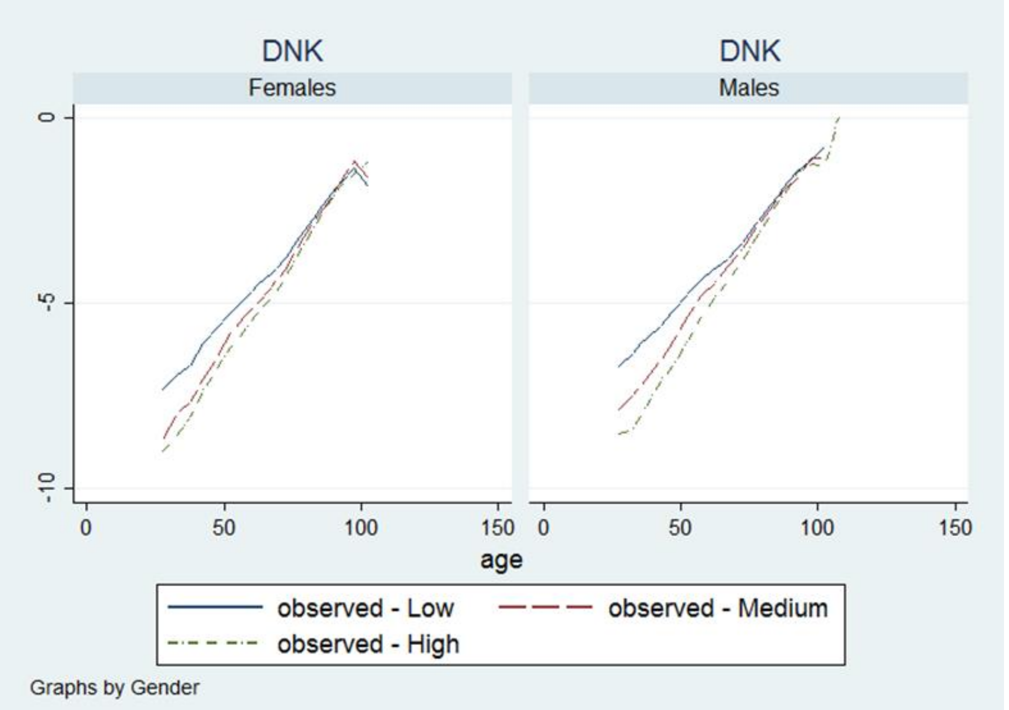
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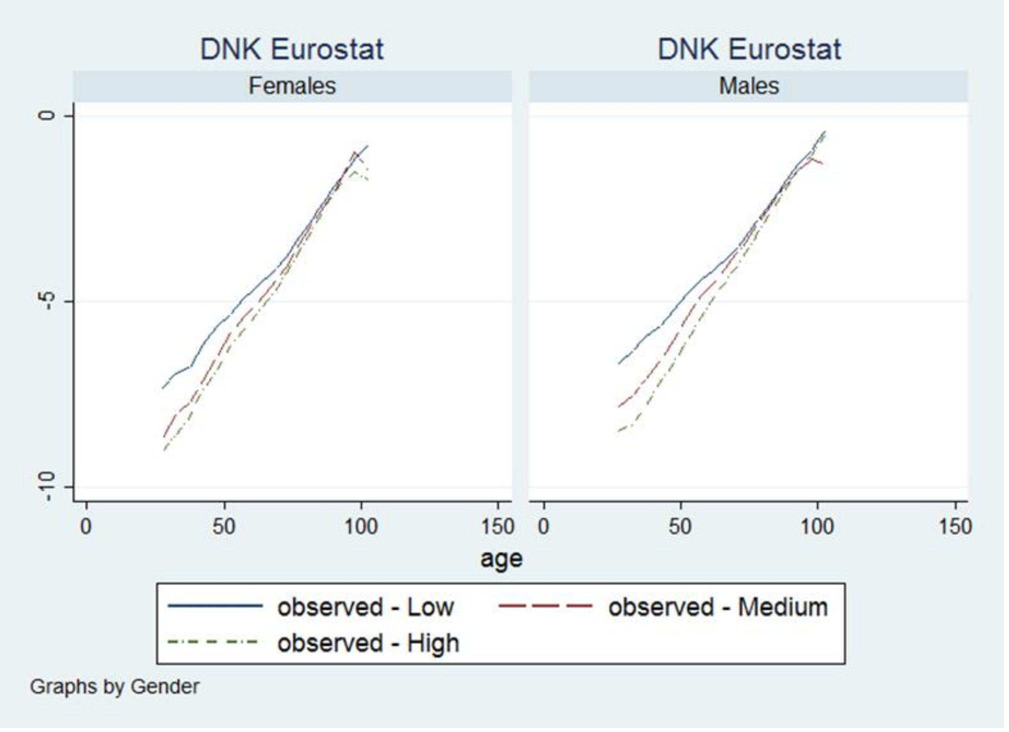
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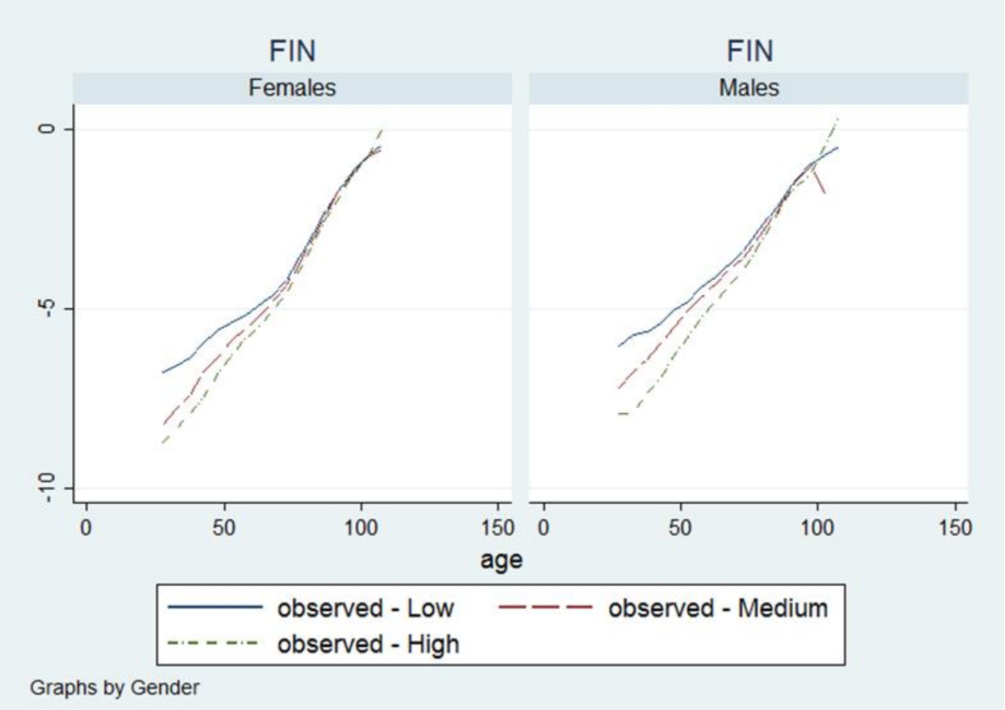
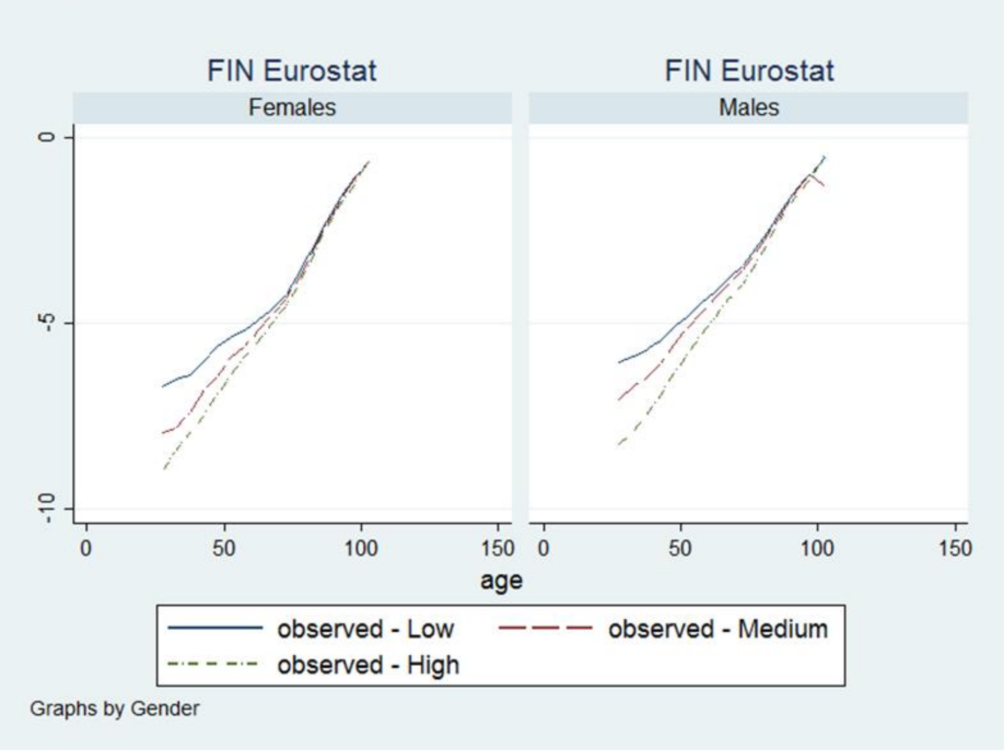
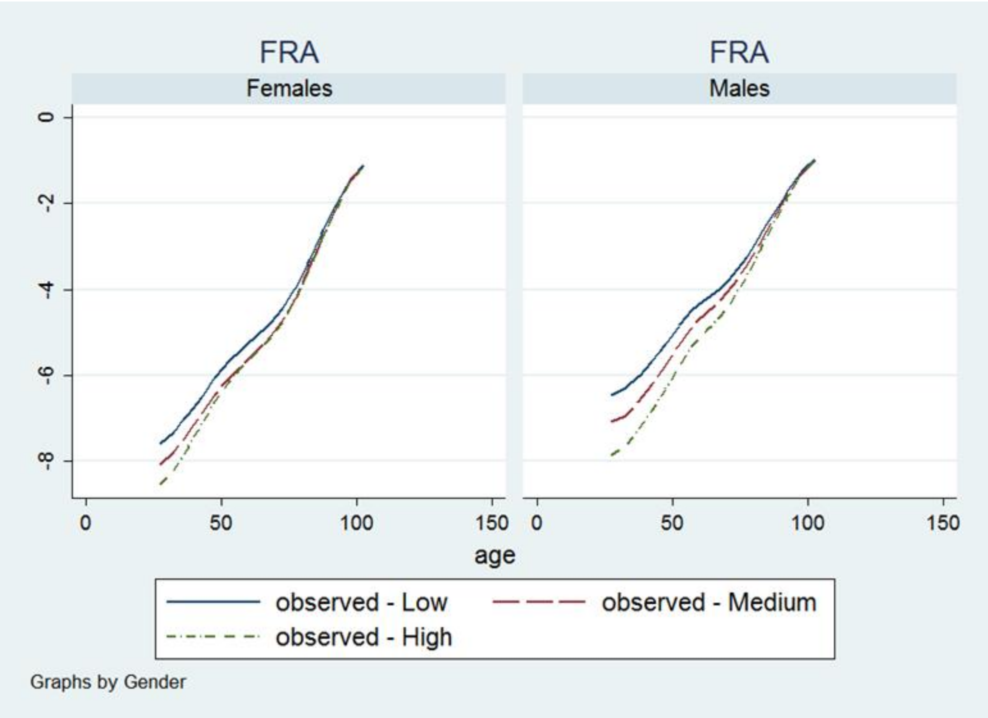
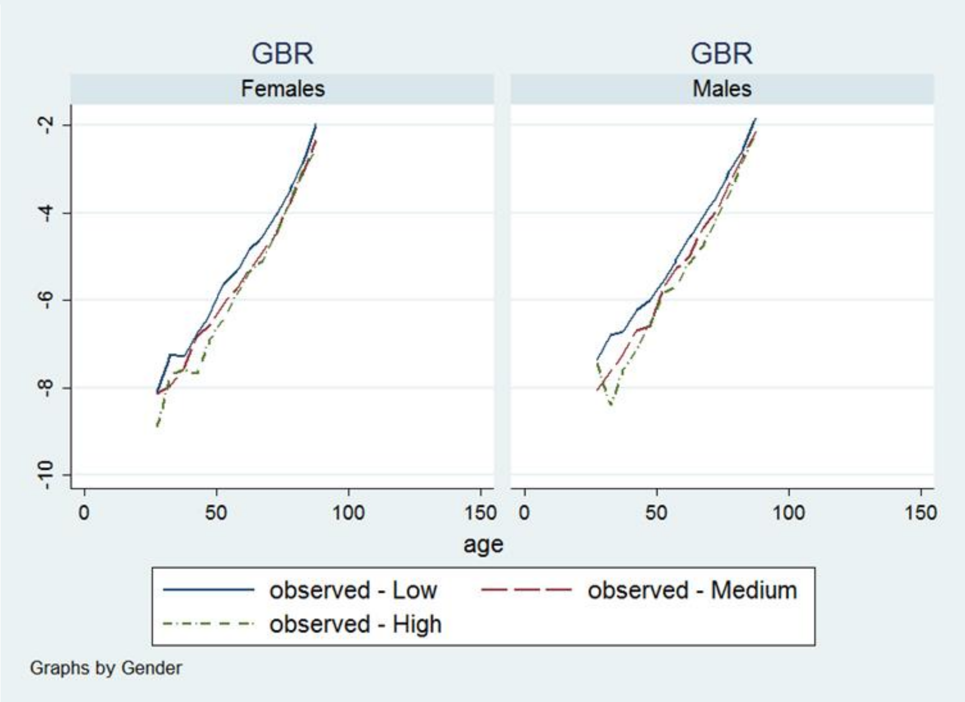
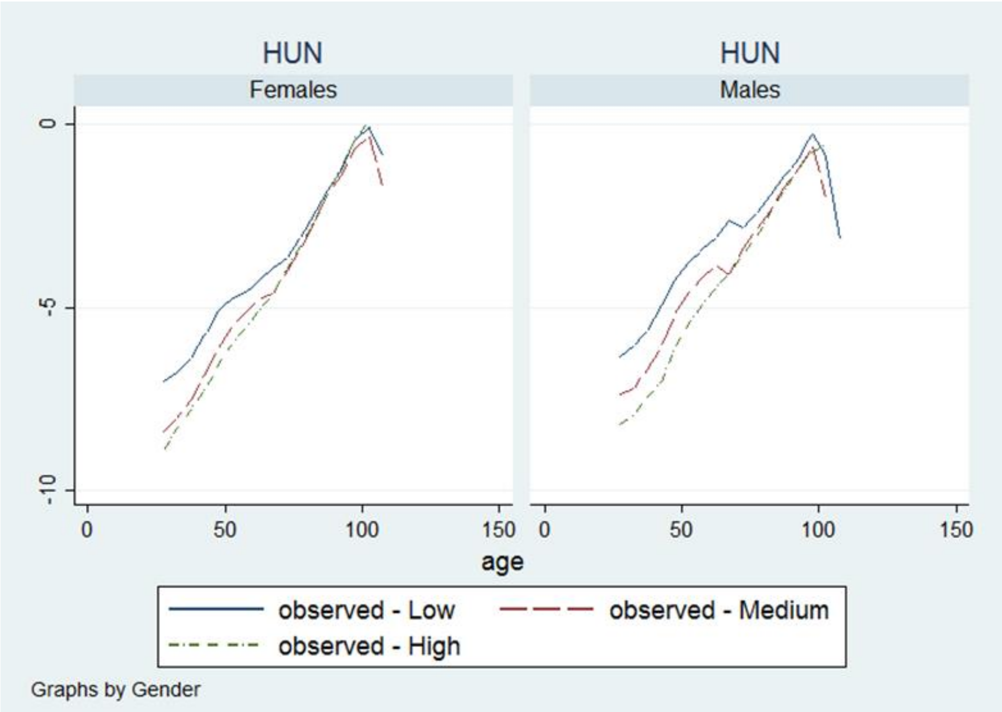
observed - High
Graphs by Gender

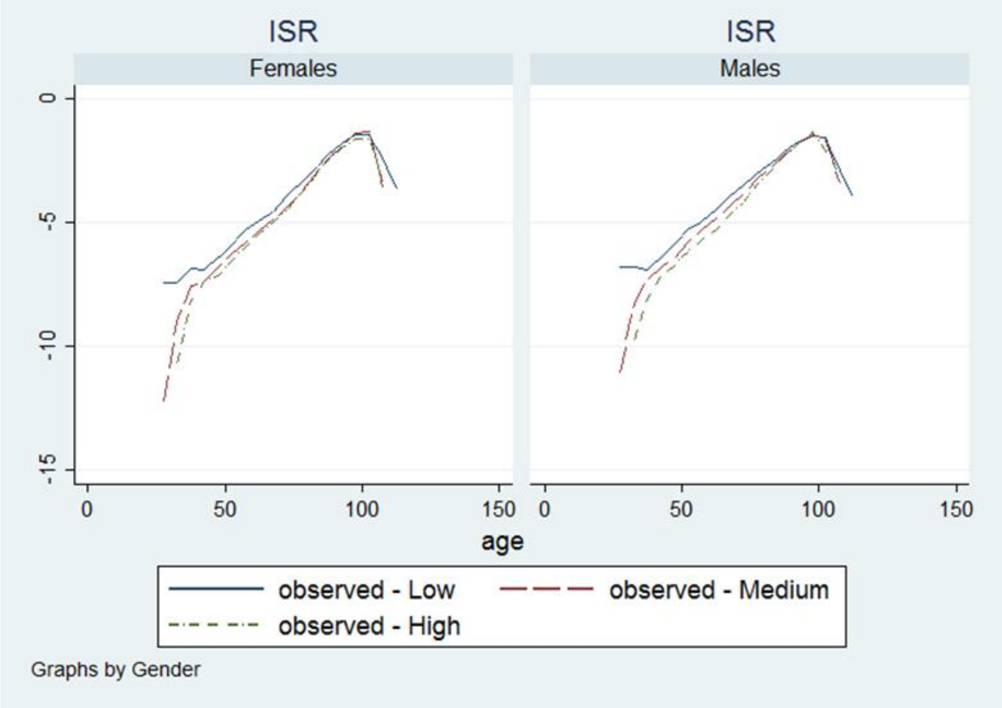

FIN
Females
FIN
Males
0
-5
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

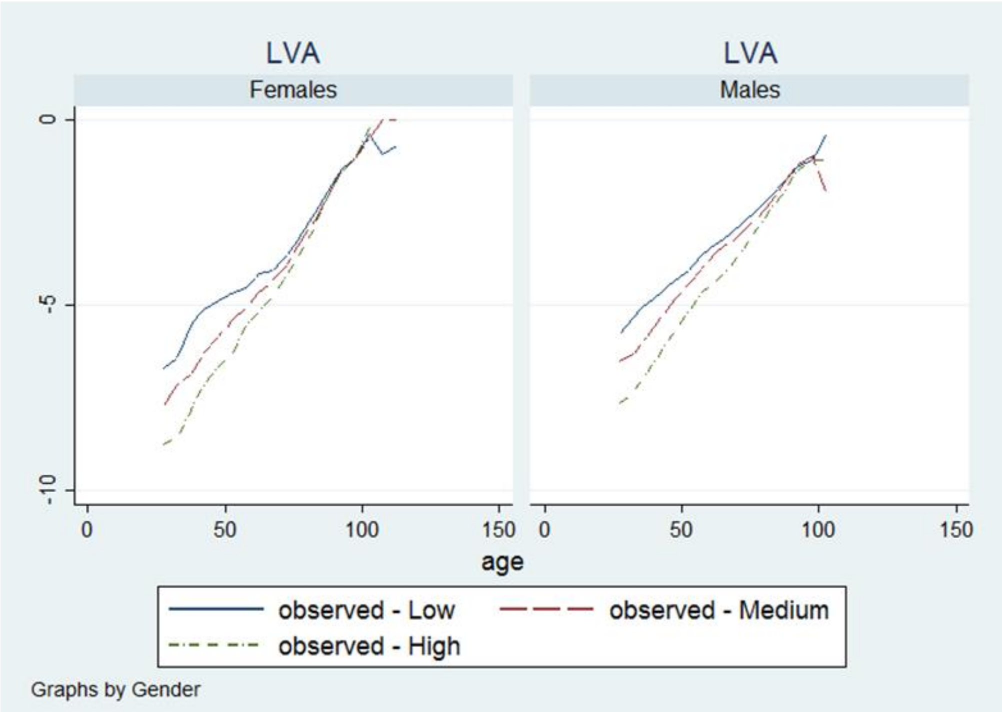

FIN Eurostat
Females
FIN Eurostat
Males
0
-5
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

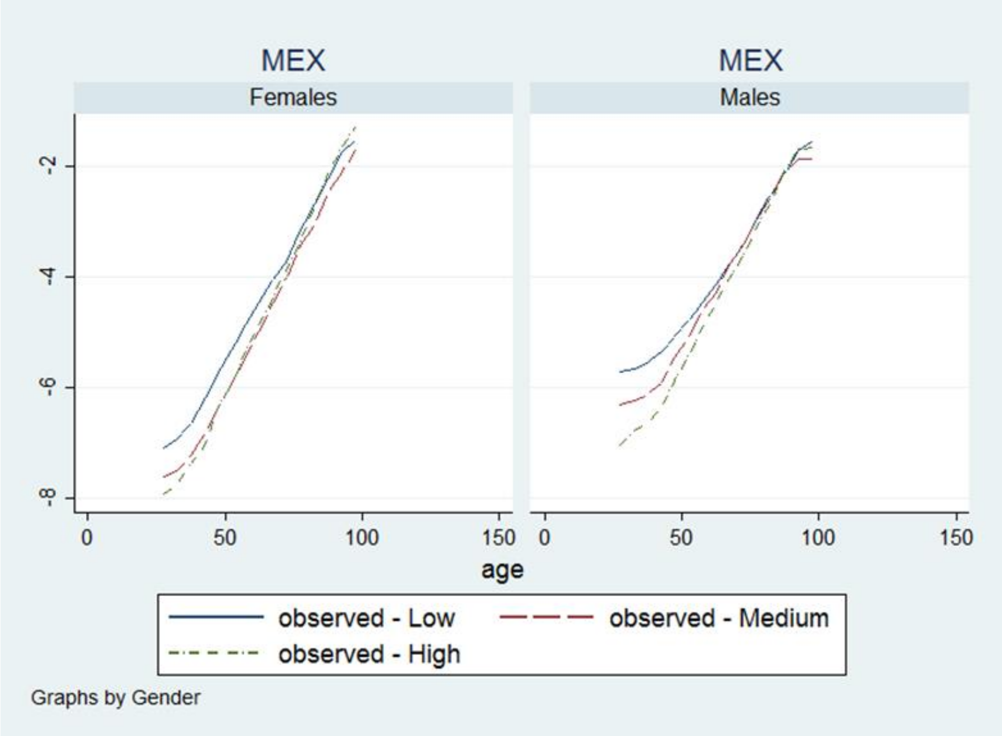

FRA
Females
FRA
Males
0
-2
-4
-6
-8
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

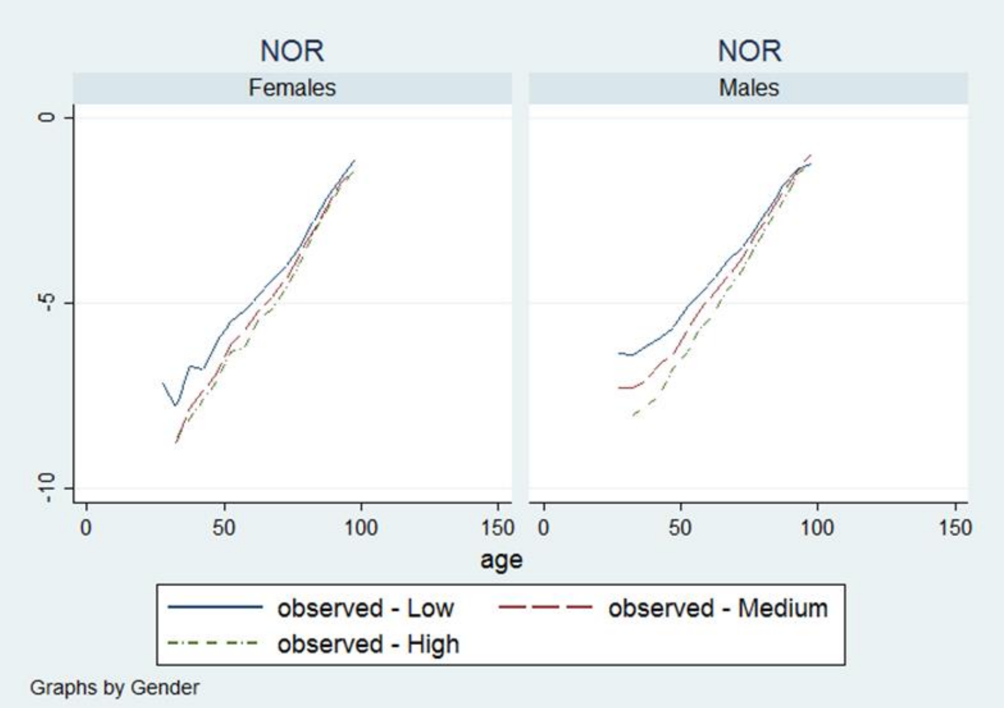

GBR
Females
GBR
Males
-2
-4
-6
-8
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

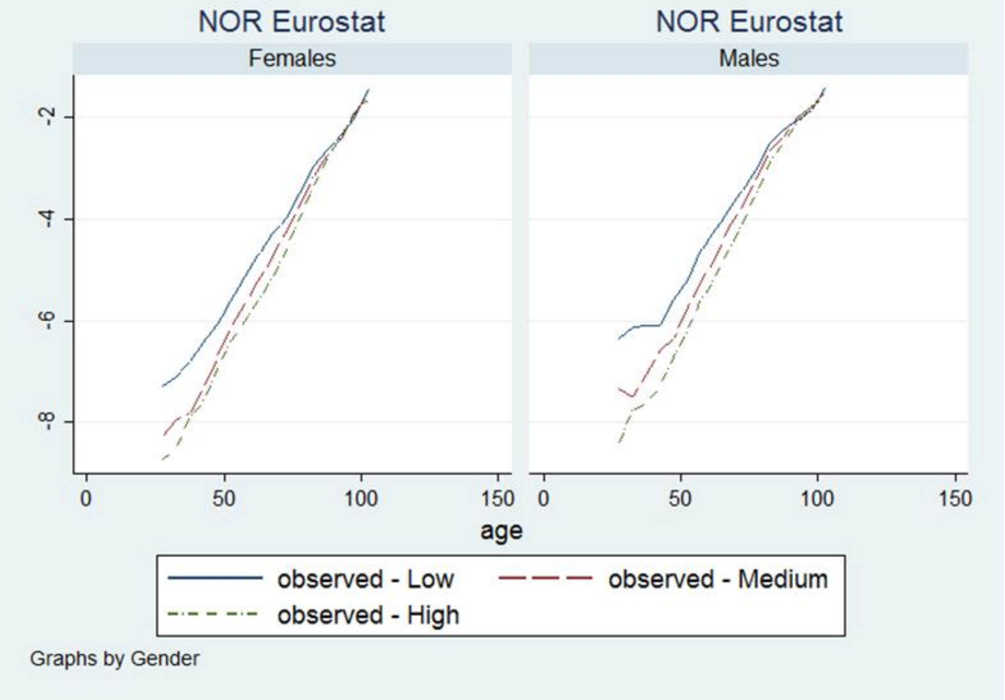

HUN
Females
HUN
Males
0
-5
-10
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

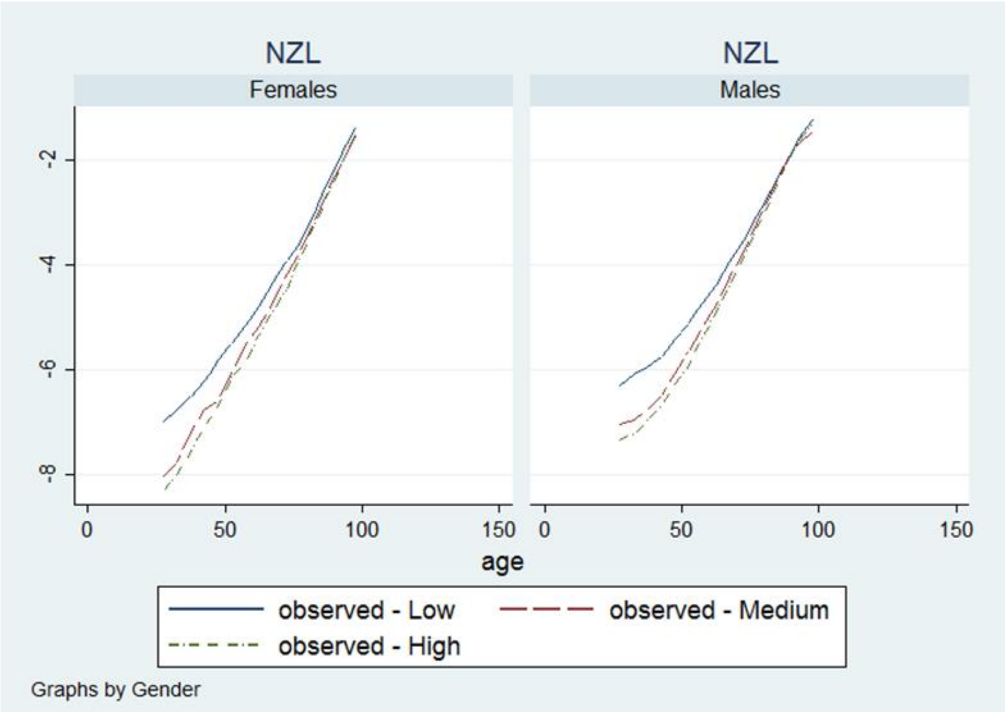

ISR
Females
ISR
Males
0
-5
-10
-15
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender


LVA
Females
LVA
Males
0
-5
-10
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

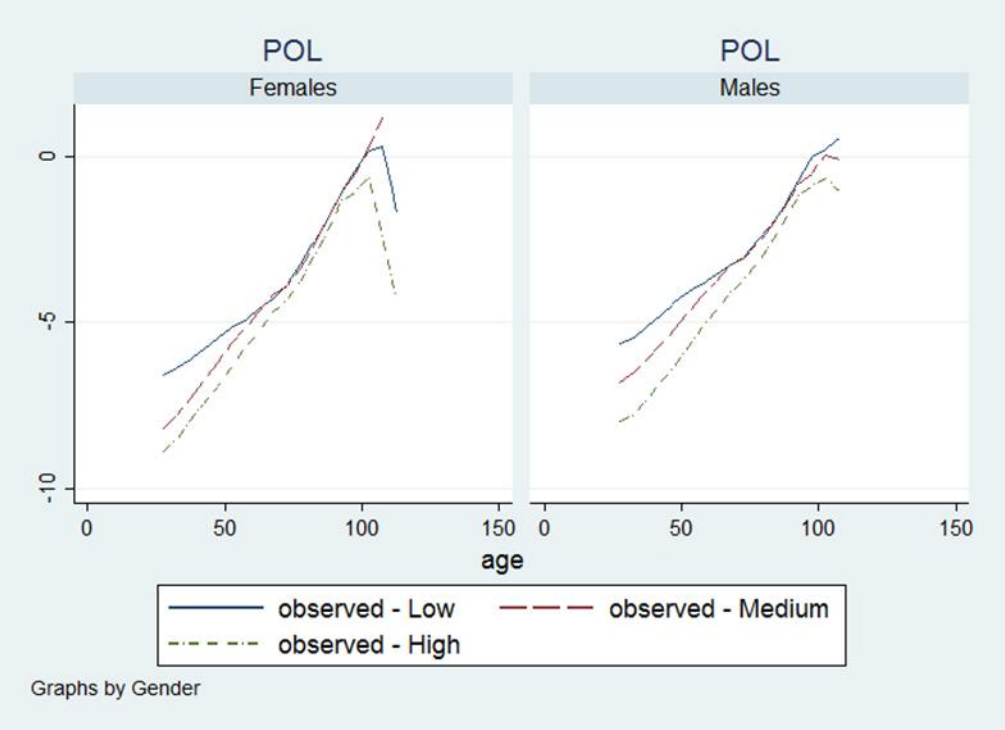

MEX
Females
MEX
Males
-2
-4
-6
-8
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender


NOR
Females
NOR
Males
0
-5
-10
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

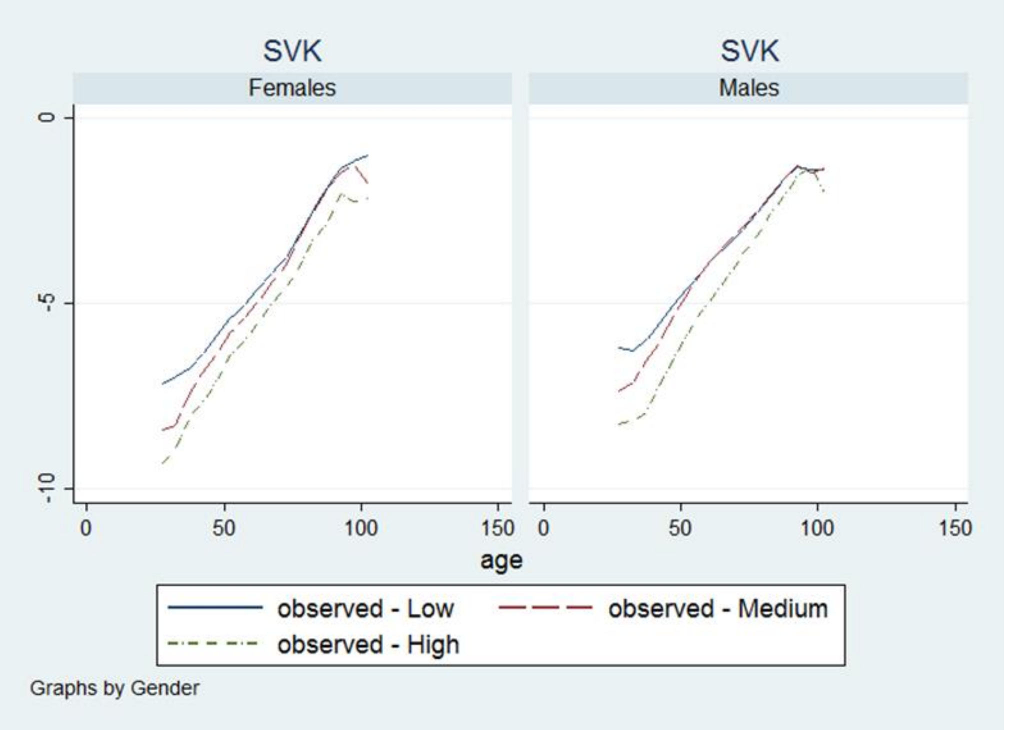

NOR Eurostat
Females
NOR Eurostat
Males
-2
-4
-6
-8
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

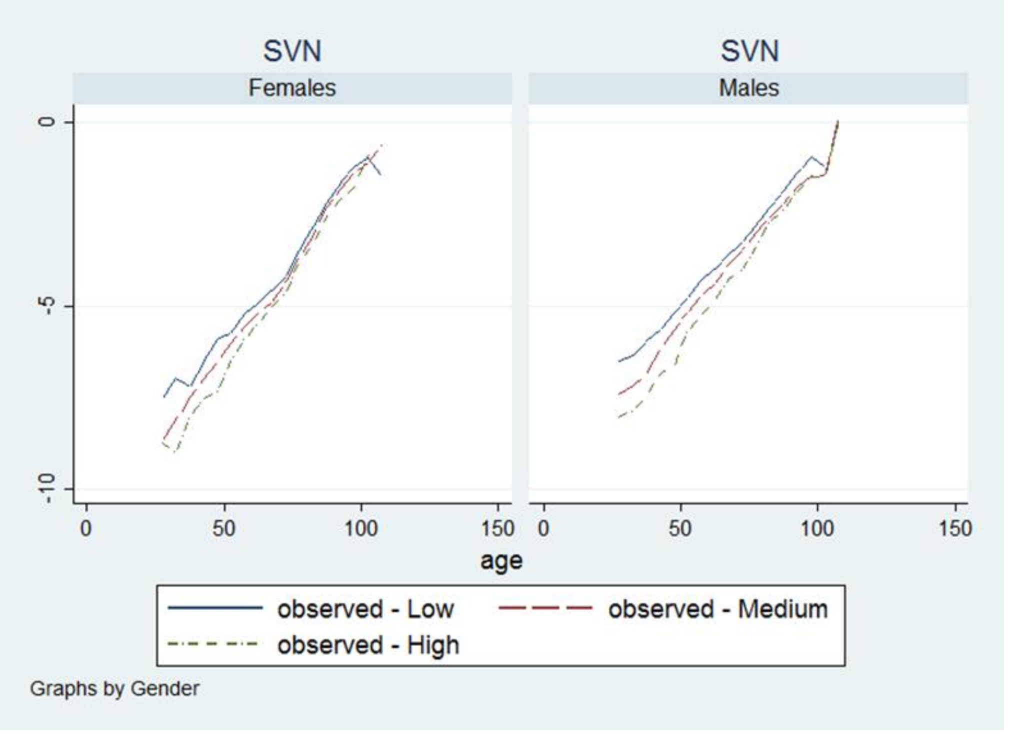


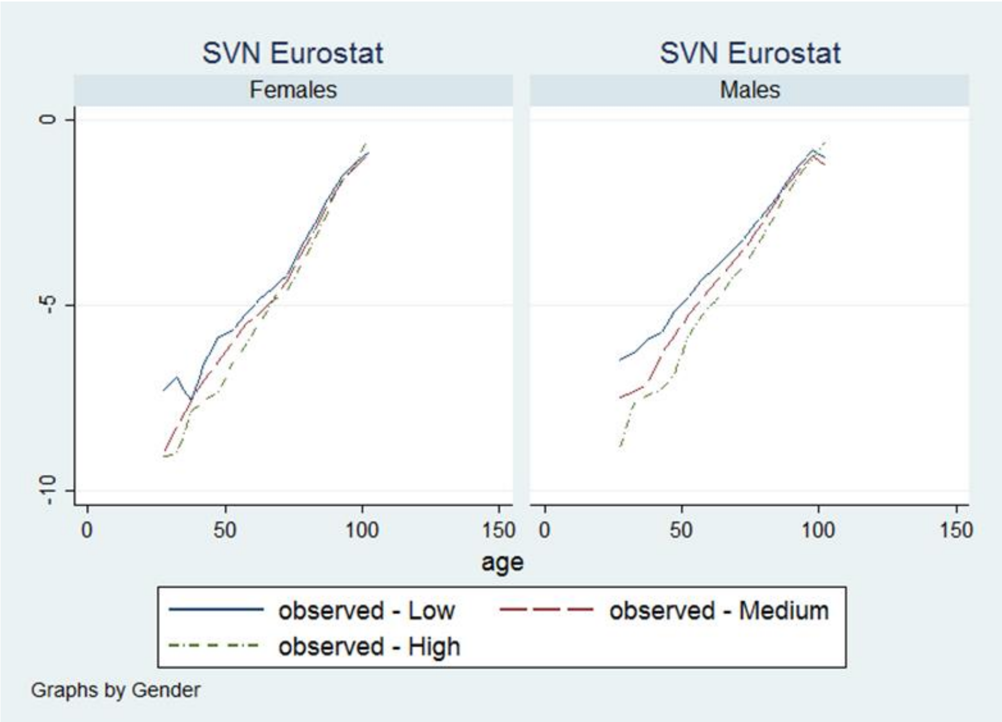
NZL
Females
NZL
Males
-2
-4
-6
-8
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

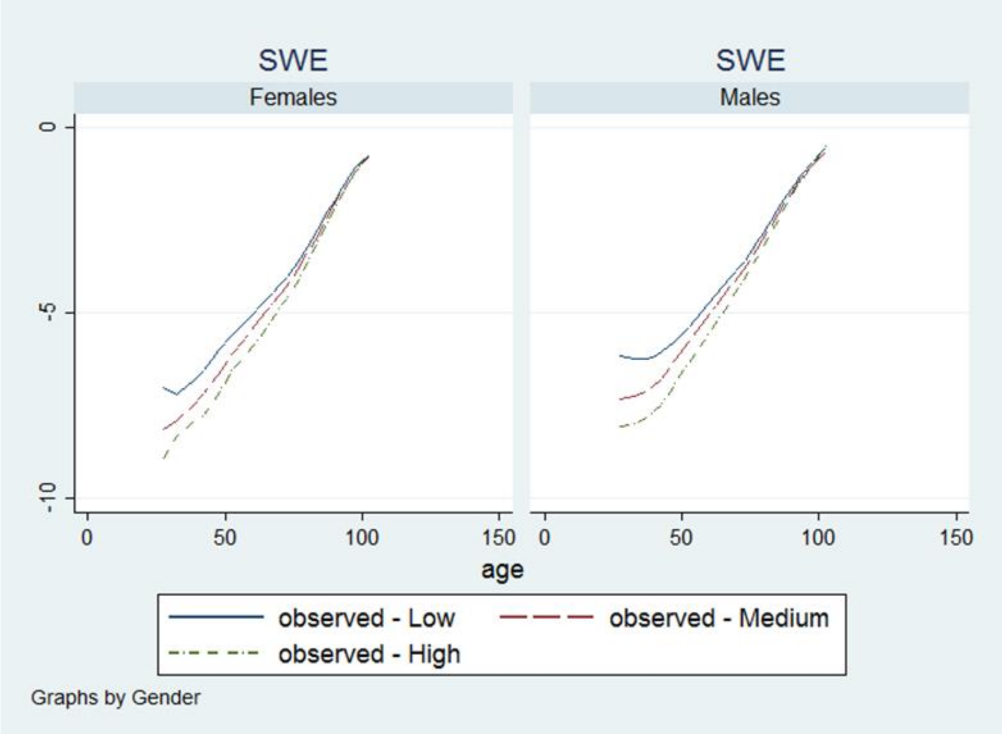


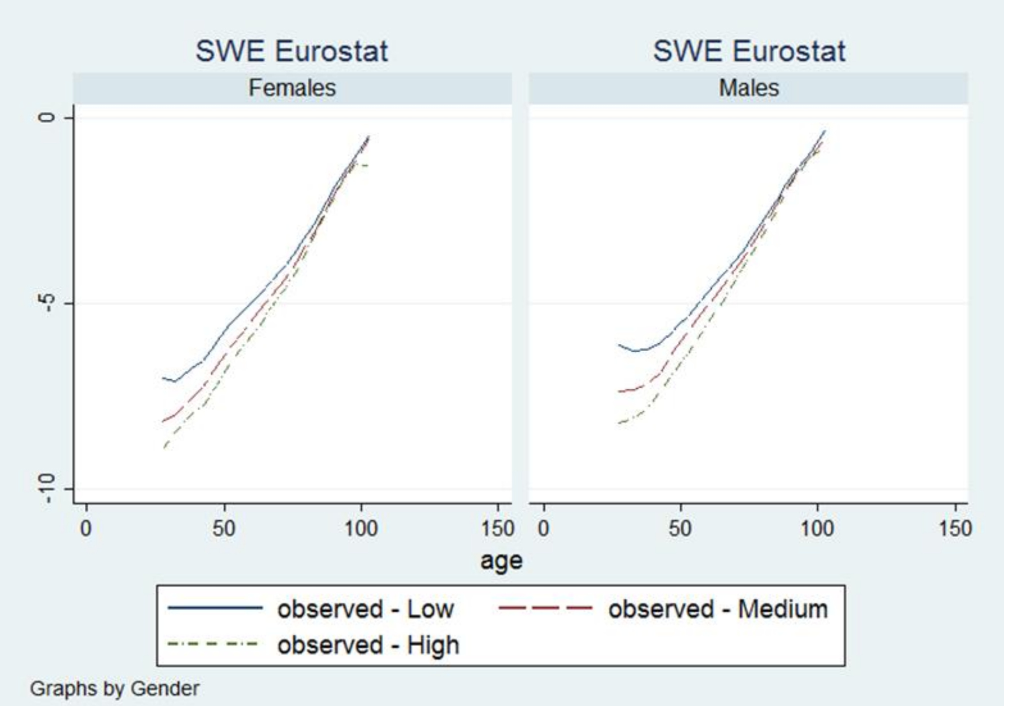
POL
Females
POL
Males
0
-5
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

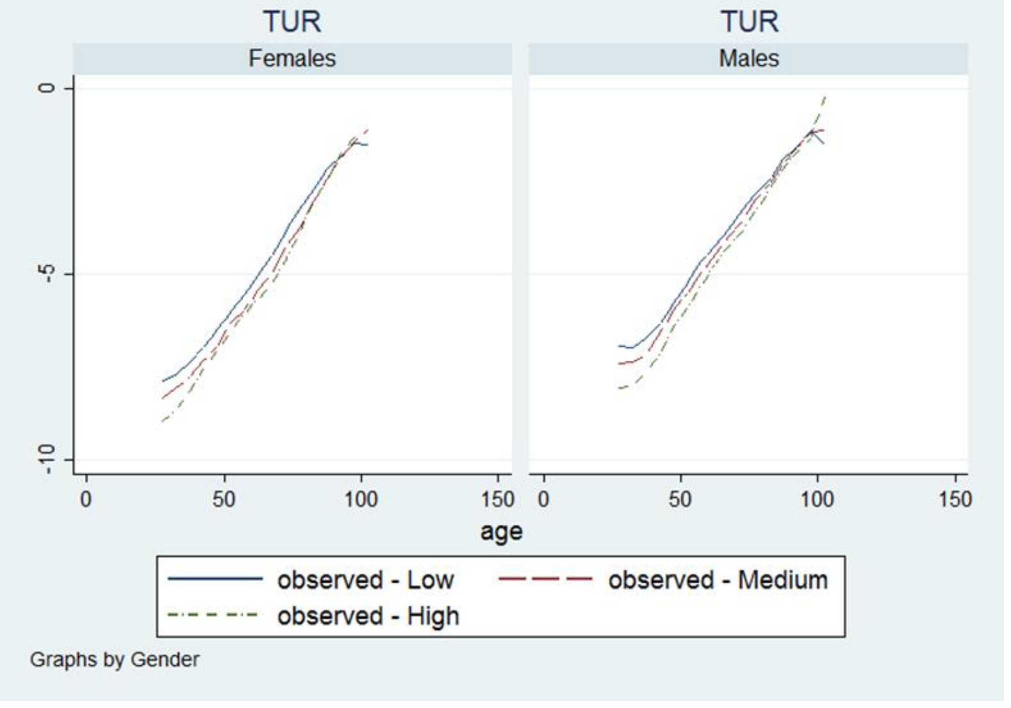

SVK
Females
SVK
Males
0
-5
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

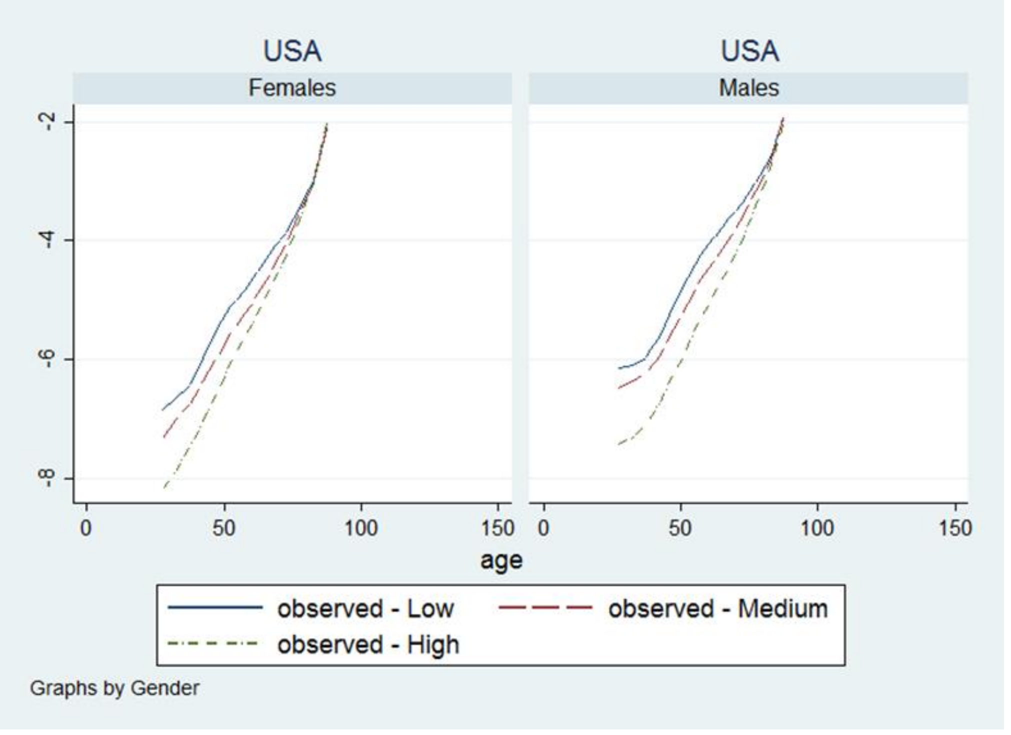

SVN
Females
SVN
Males
0
-5
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender


SVN Eurostat
Females
SVN Eurostat
Males
0
-5
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

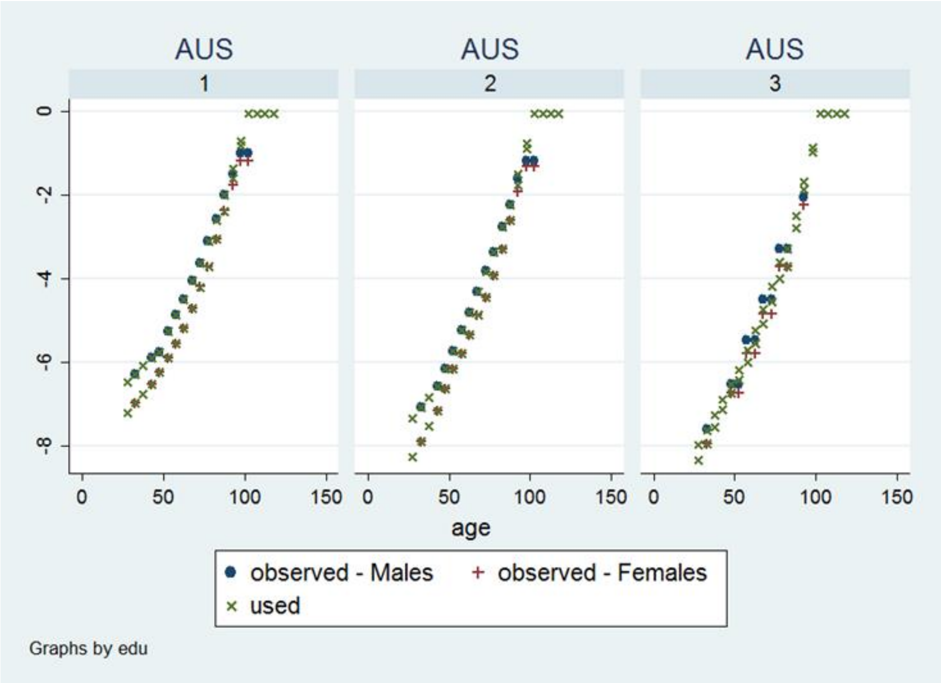

SWE
Females
SWE
Males
0
-5
-10
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

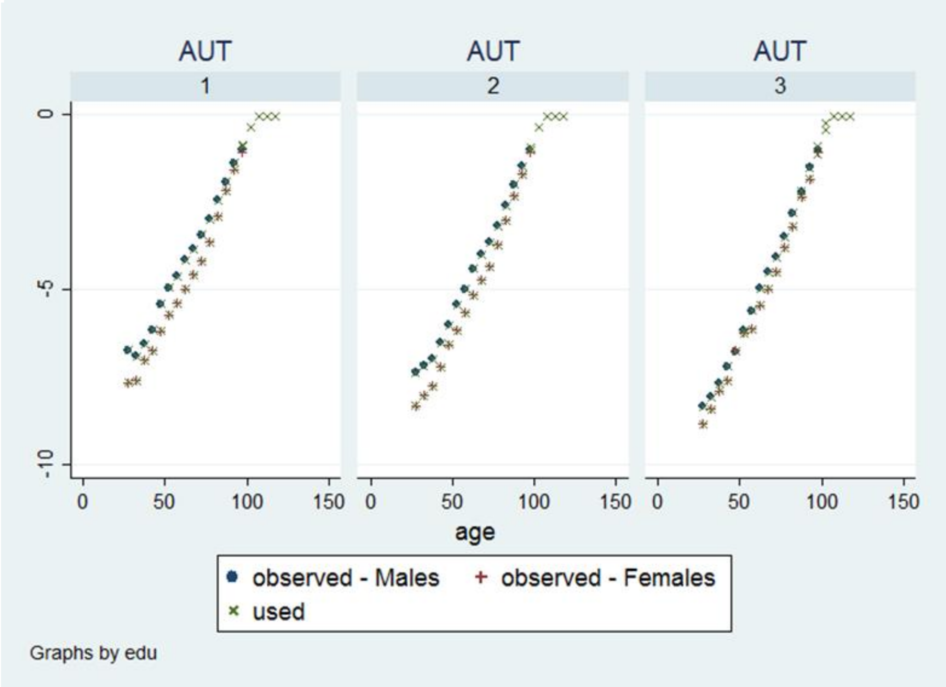

SWE Eurostat
Females
SWE Eurostat
Males
0
-5
-10
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

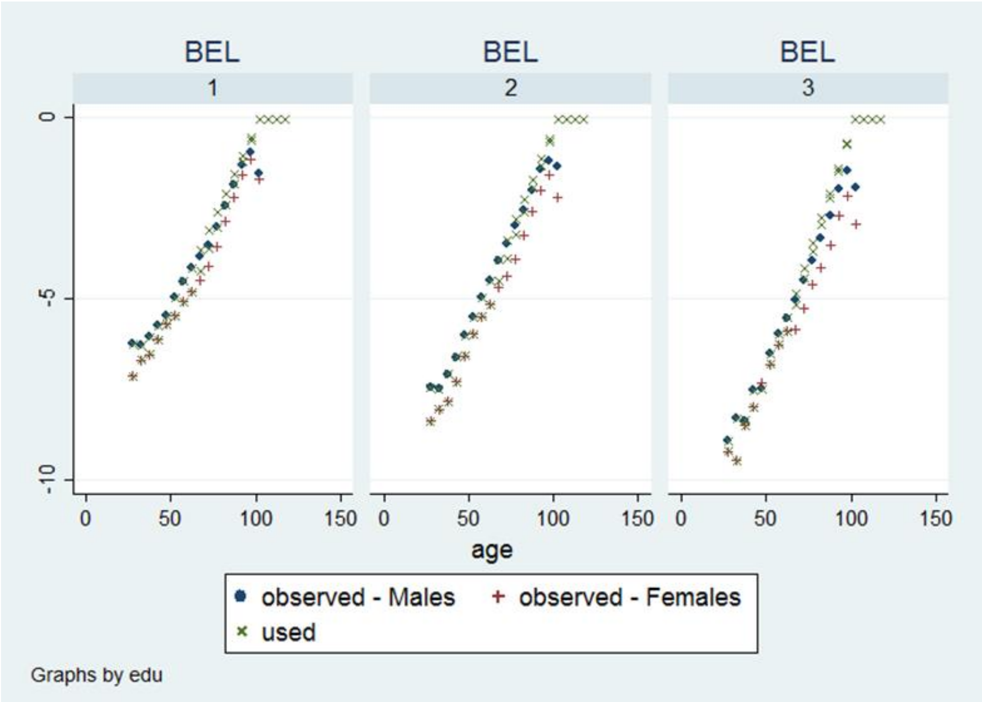

TUR
Females
TUR
Males
0
-5
-10
0
50
100
150
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

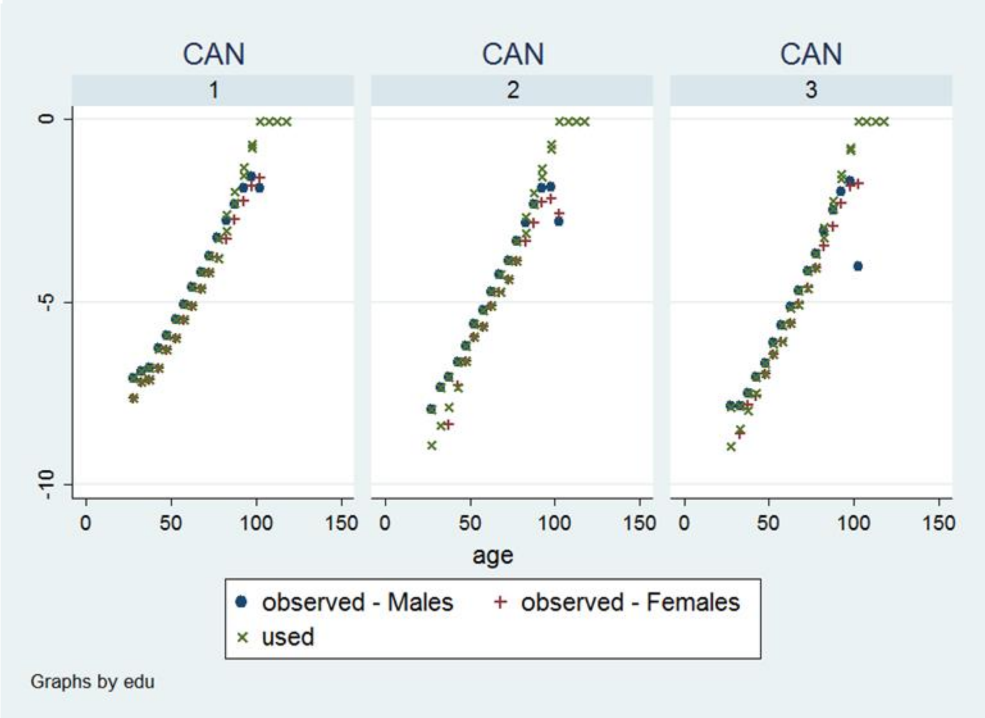

USA
Females
USA
Males
-2
-4
-6
-8
0
50
100
150
age
observed - Low
observed - Medium
observed - High
Graphs by Gender

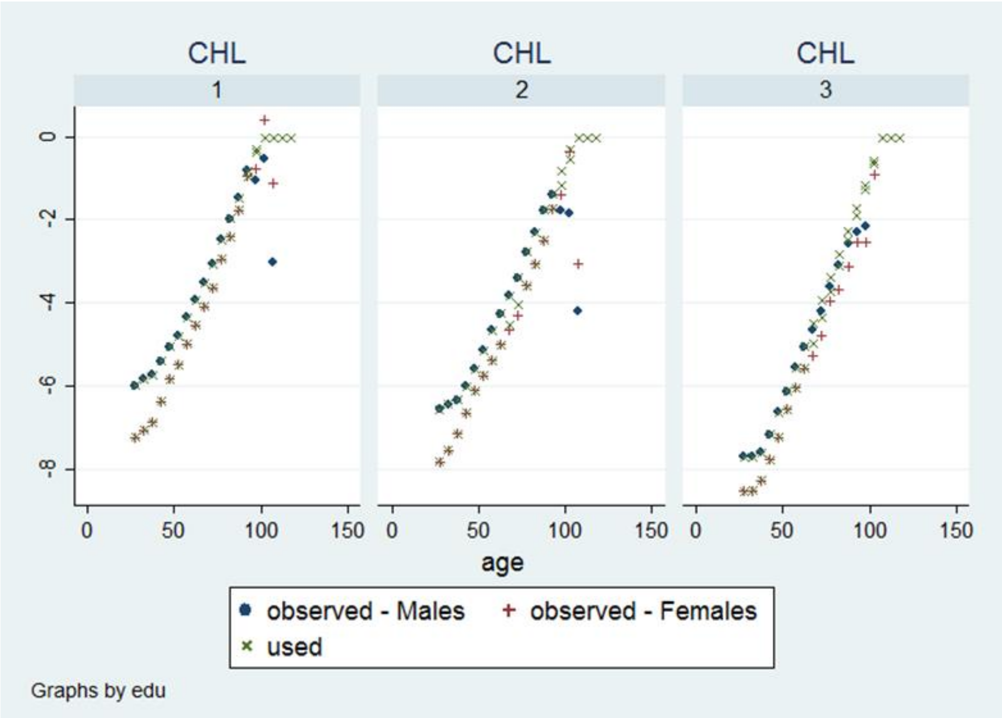
APPENDIX C. MORTALITY RATES AGE-PROFILE BY EDUCATION AND GENDER

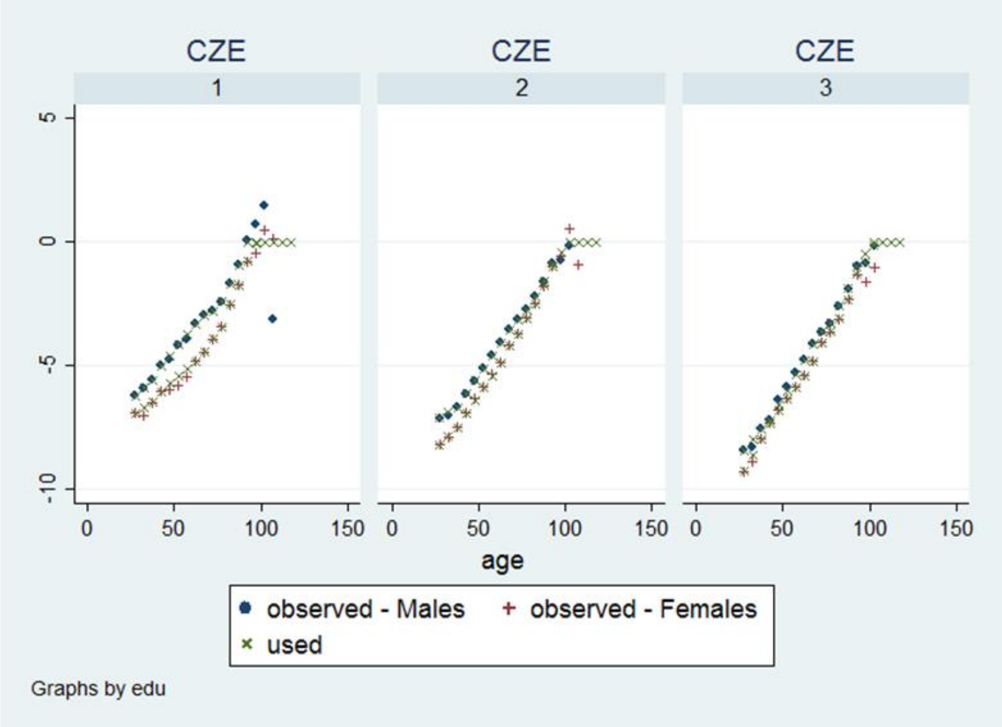


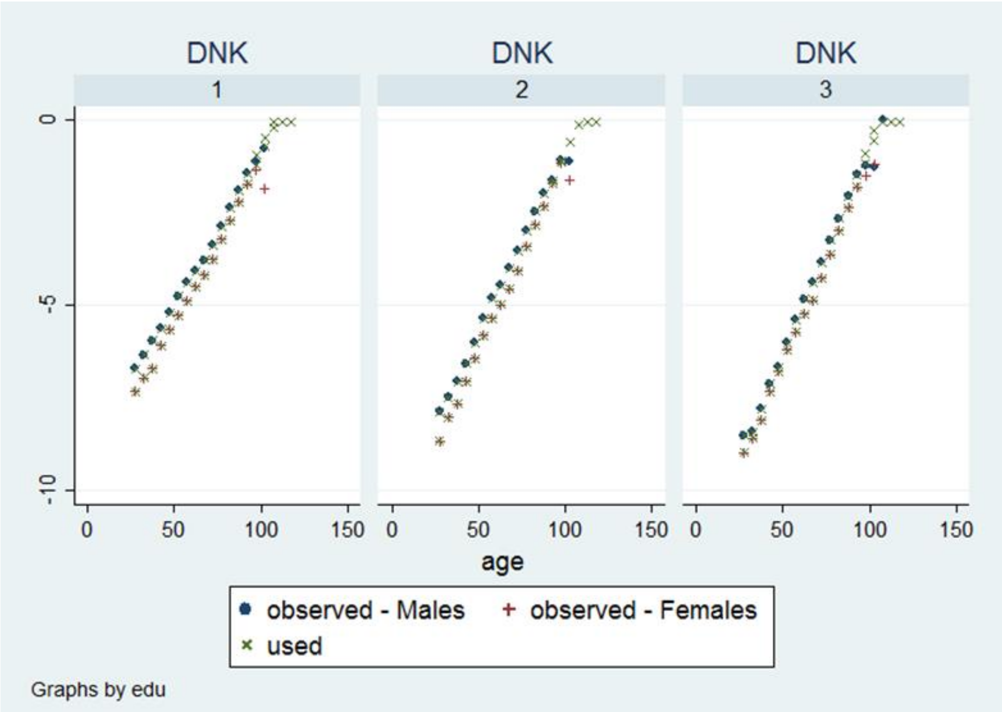


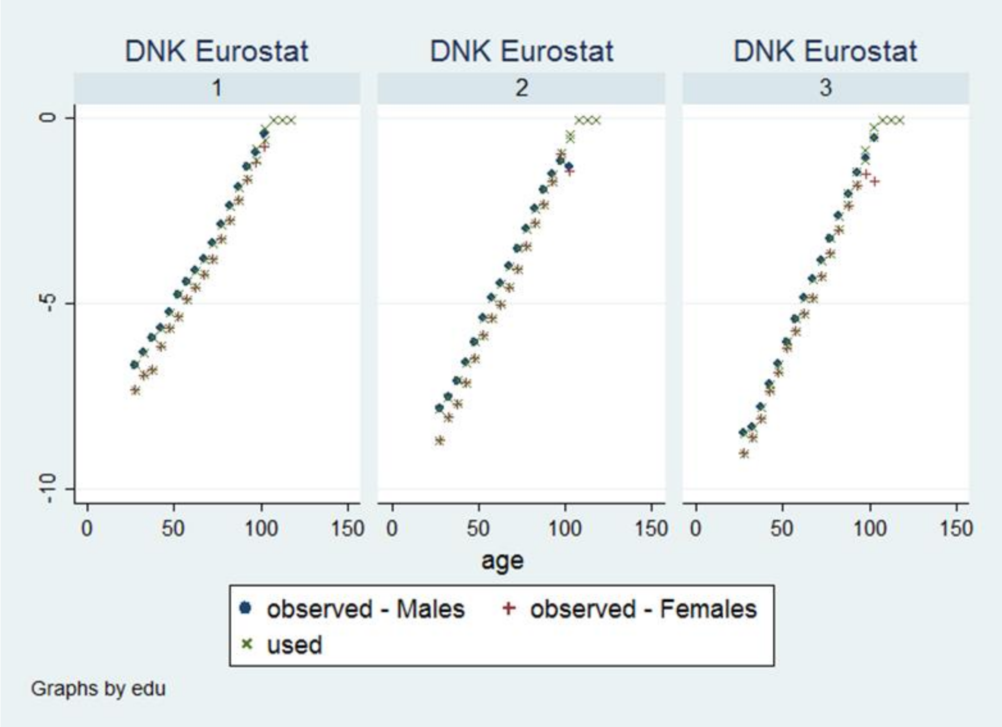

BEL
1
BEL
2
BEL
3
0
-5
-10
0 50 100 150
age
observed - Males
observed - Females
used
Graphs by edu

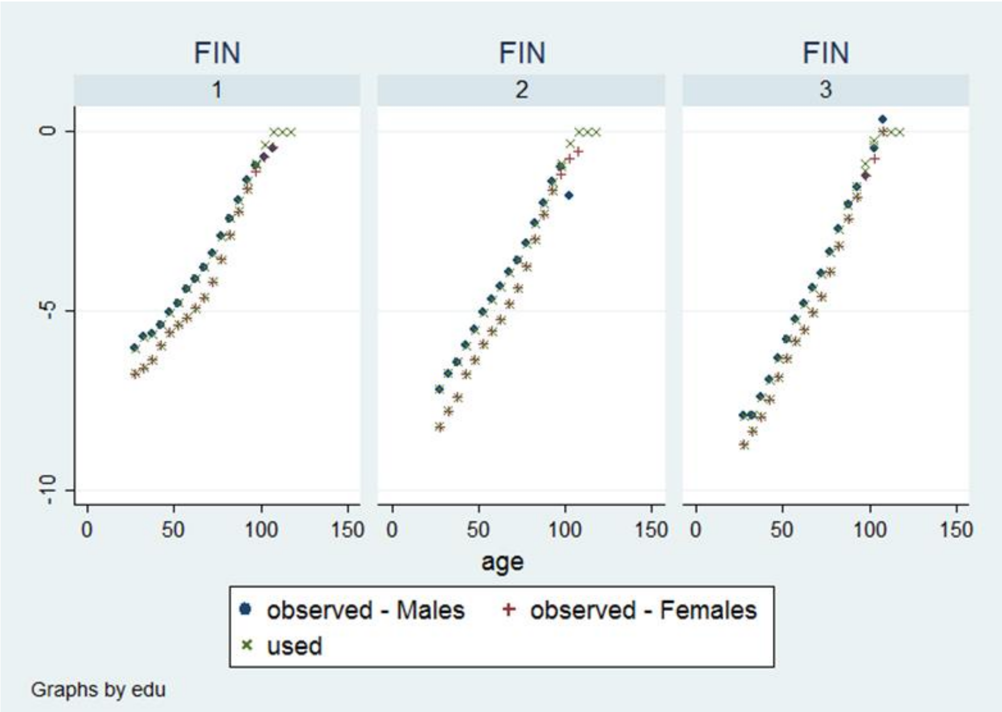

CAN
1
CAN
2
CAN
3
0
-5
-10
0 50 100 150
age
observed - Males
observed - Females
used
Graphs by edu

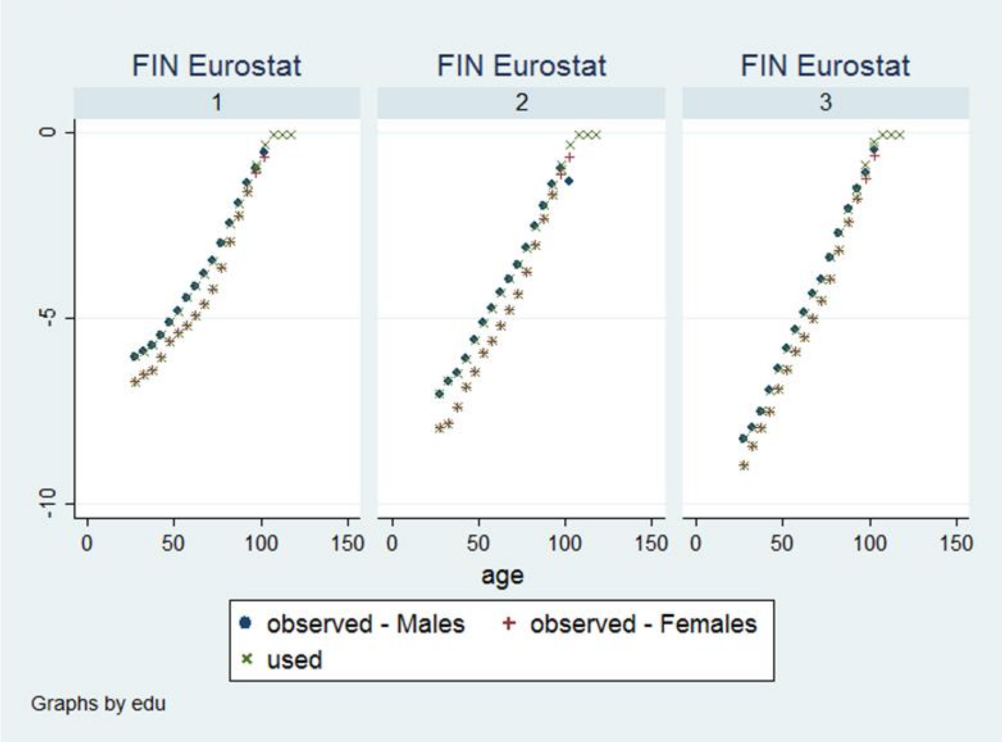

CHL
1
2
3
0
-2
-4
-6
-8
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

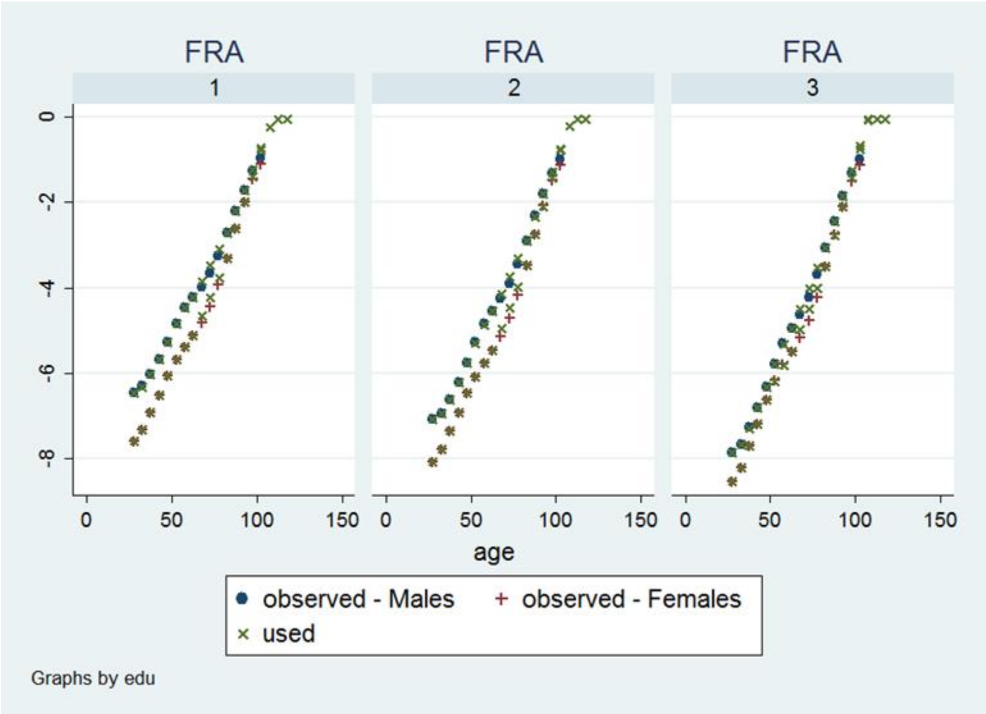

CZE
1
2
3
5
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

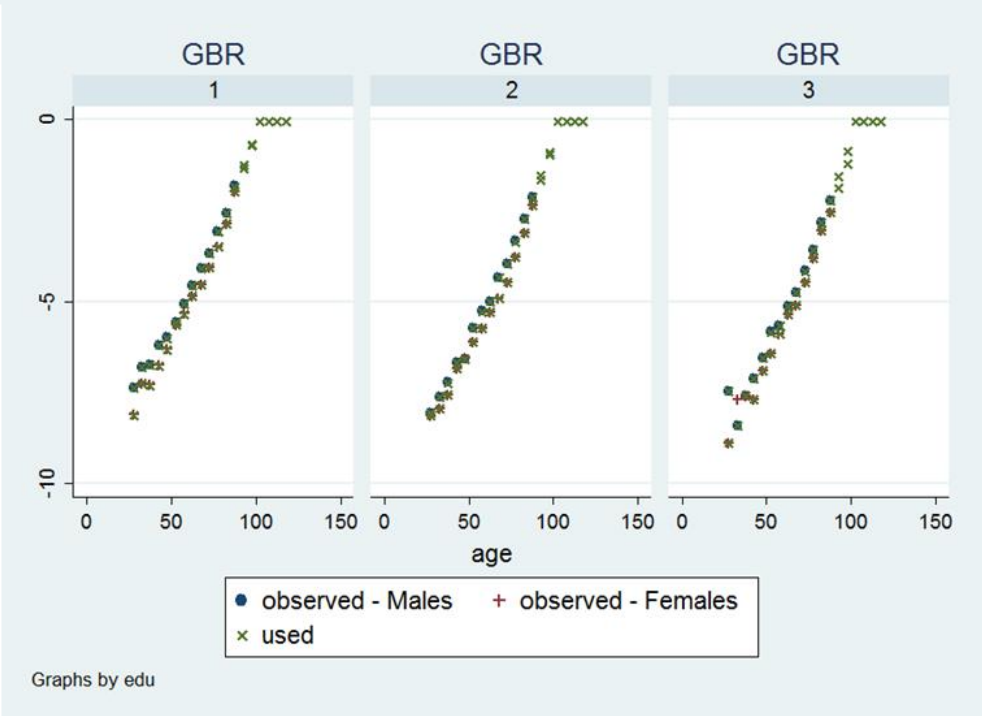

DNK
DNK
DNK
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

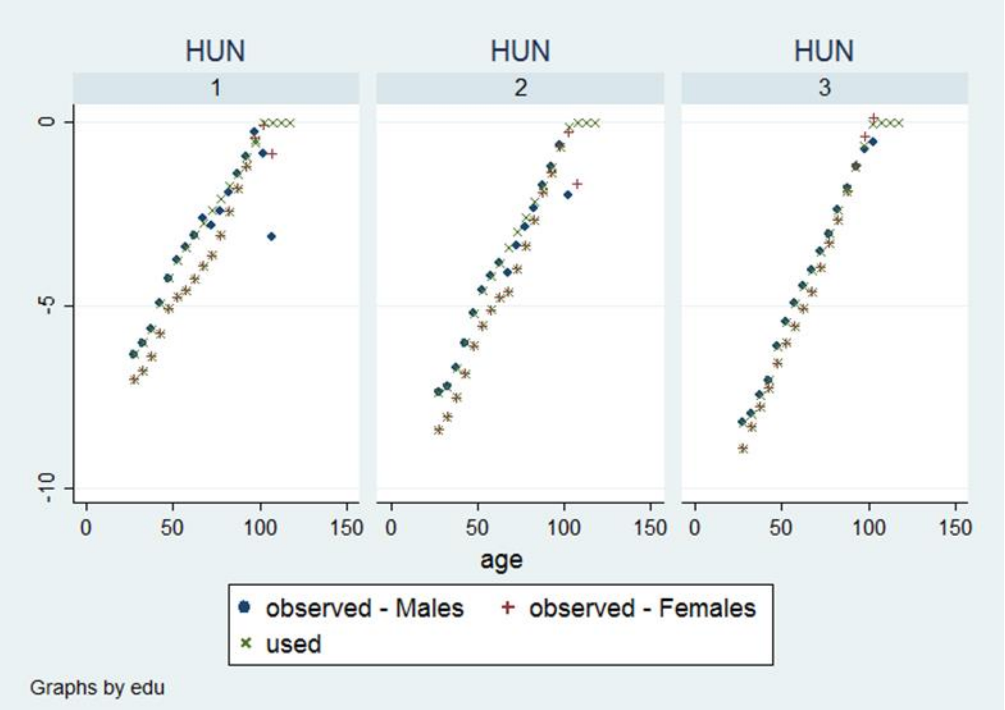

DNK Eurostat
DNK Eurostat
DNK Eurostat
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

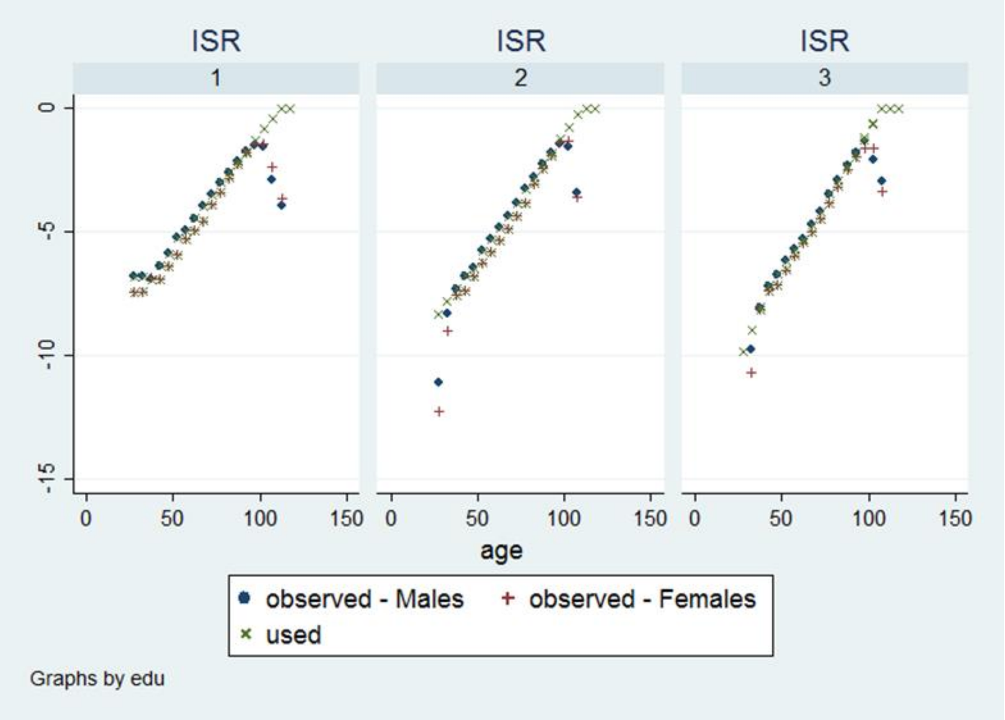

FIN
1
FIN
2
FIN
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

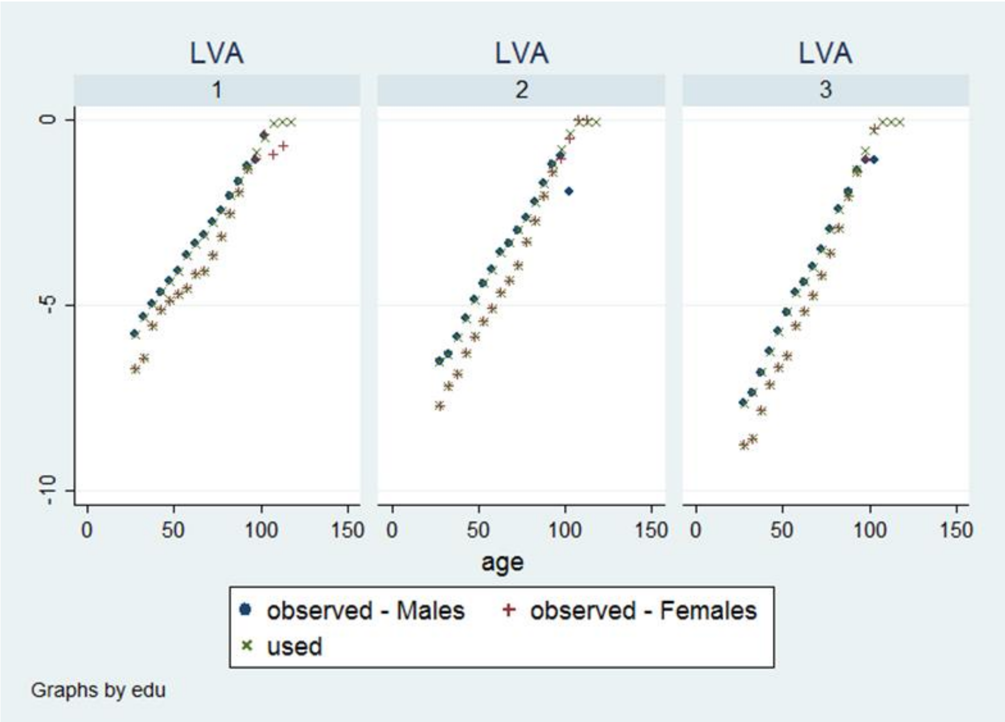

FIN Eurostat
1
FIN Eurostat
2
FIN Eurostat
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

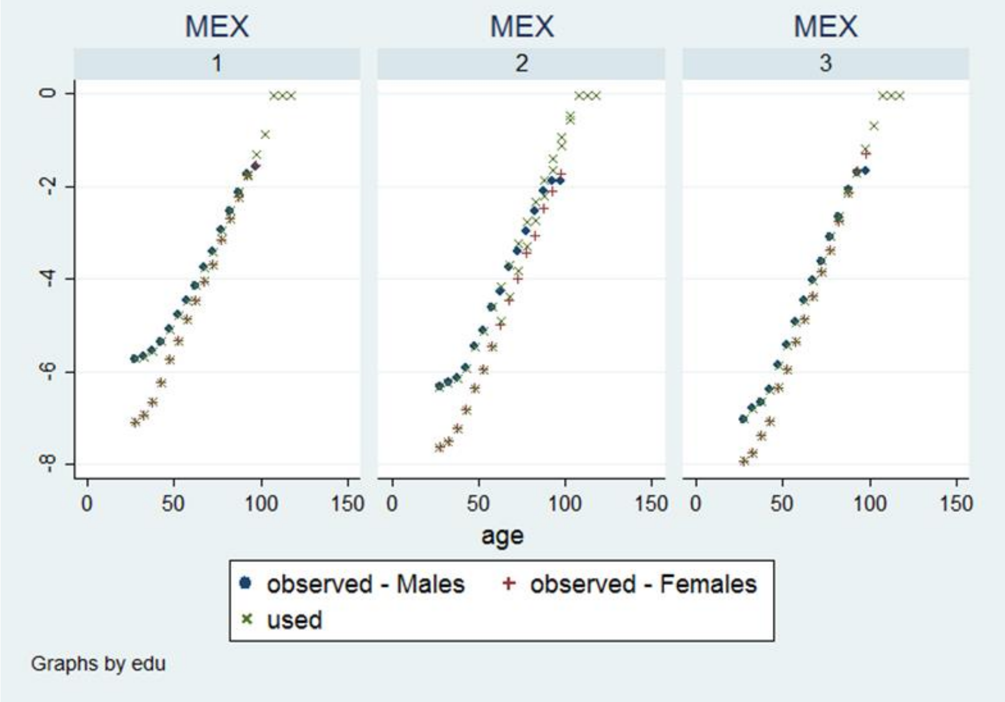

FRA
1
FRA
2
FRA
3
0
-2
-4
-6
-8
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

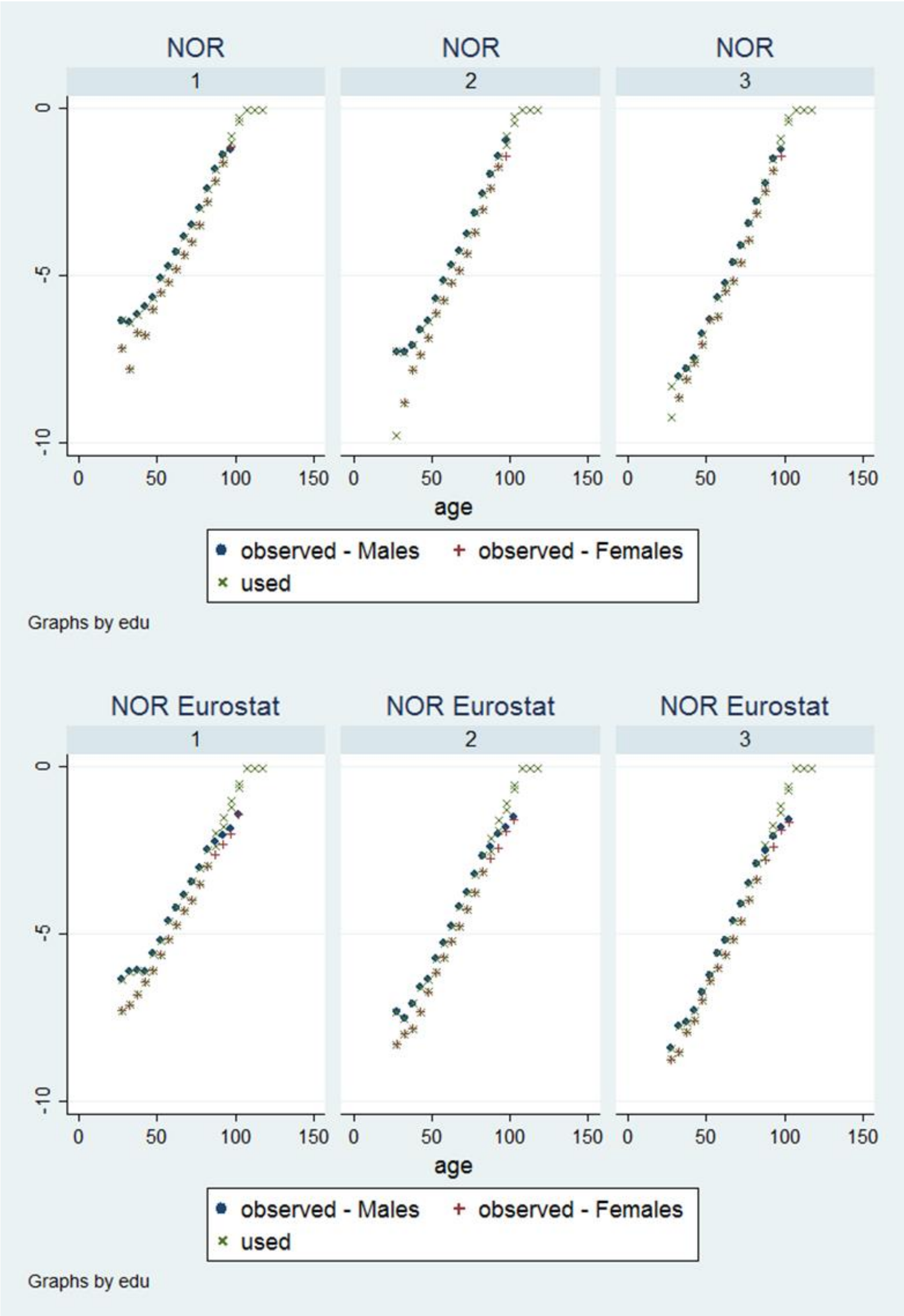

GBR
1
GBR
2
GBR
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

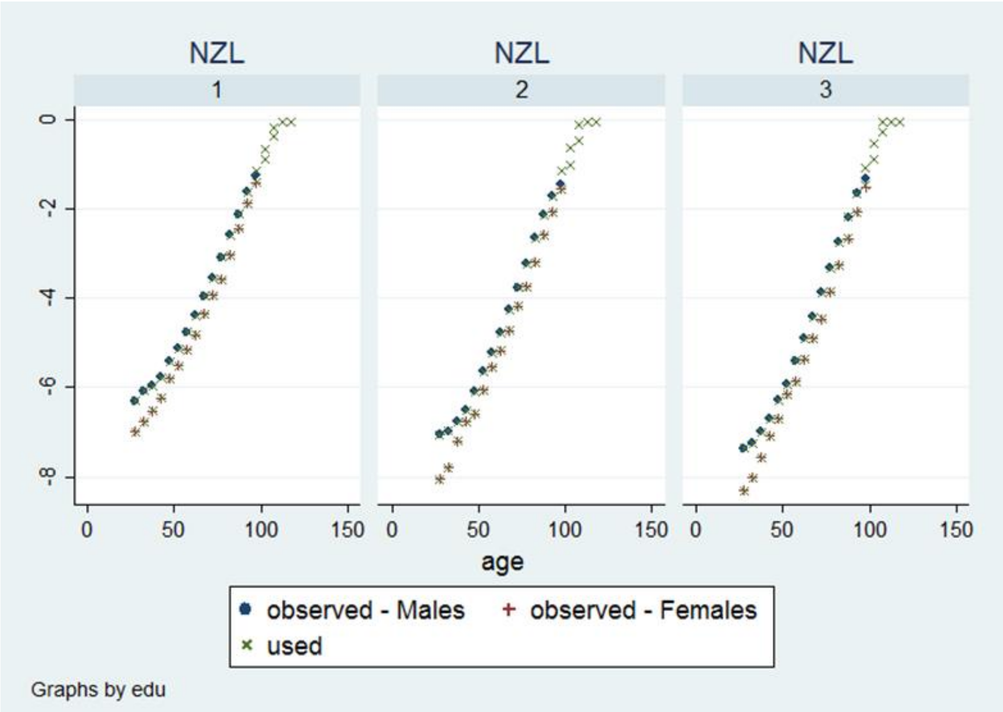

HUN
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

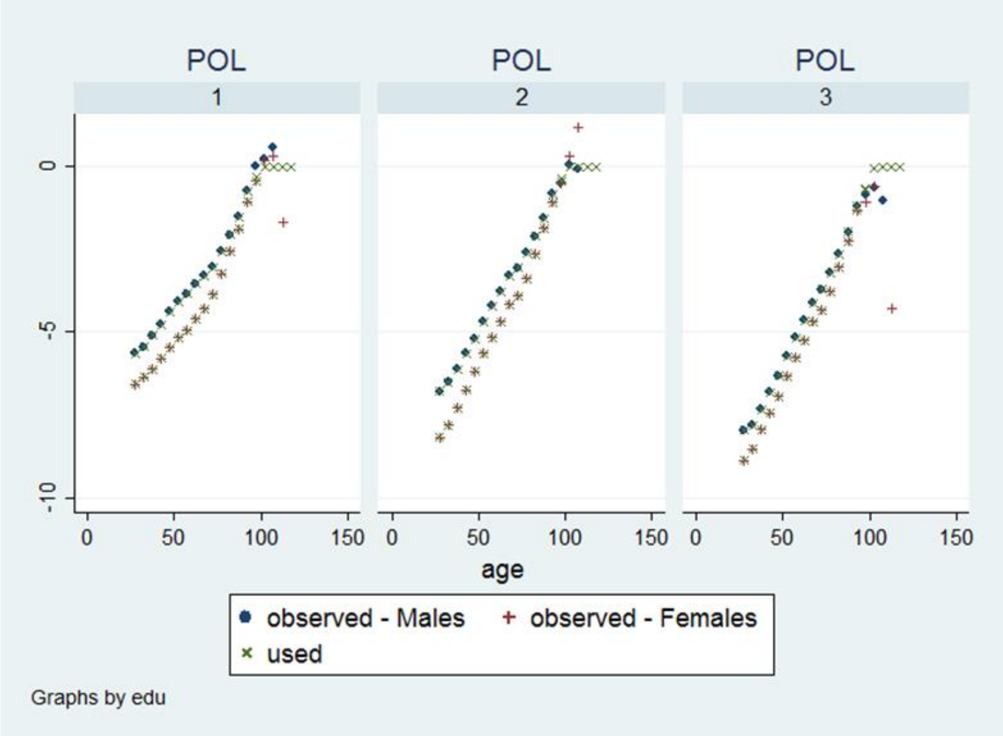

ISR
1
2
3
0
-5
-10
-15
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

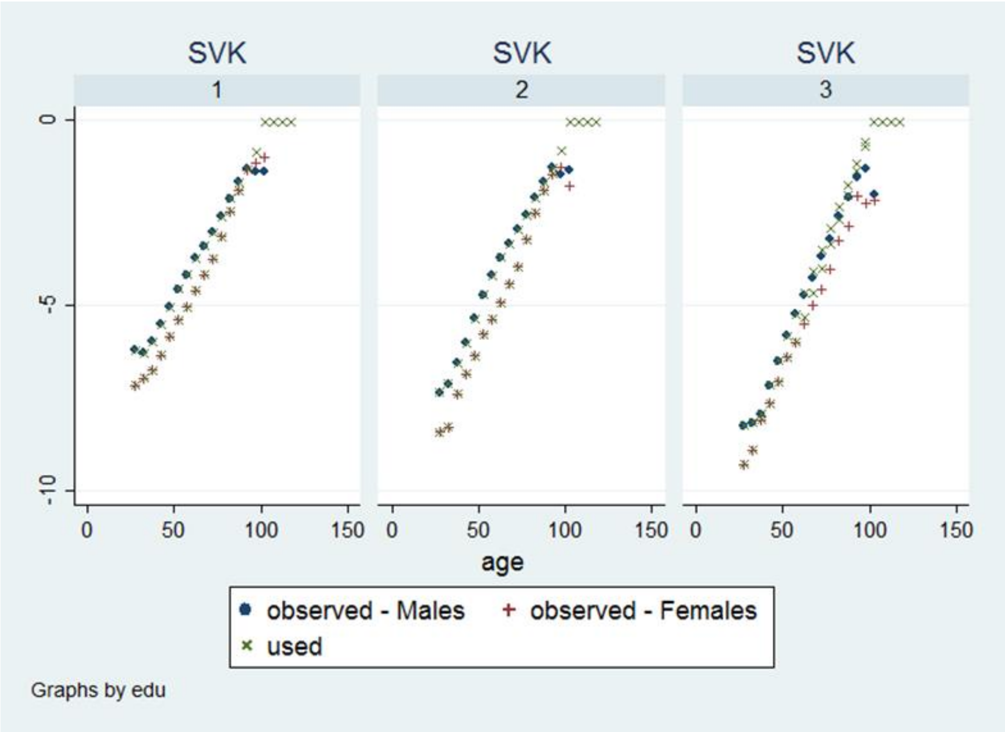

LVA
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

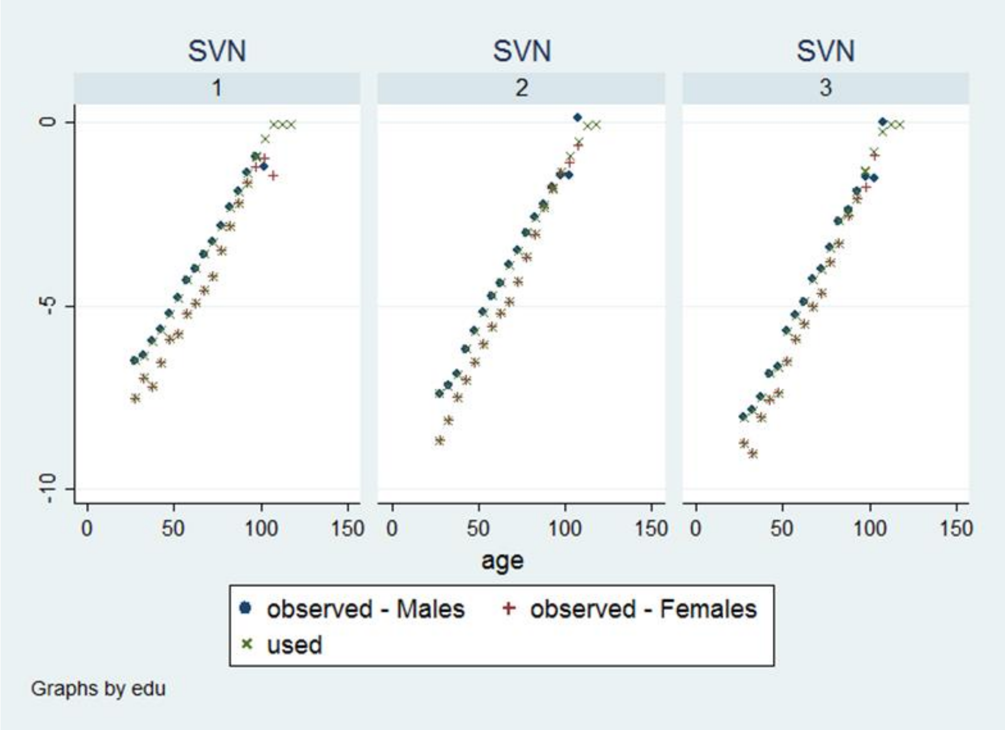

MEX
1
2
3
0
-2
-4
-6
-8
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

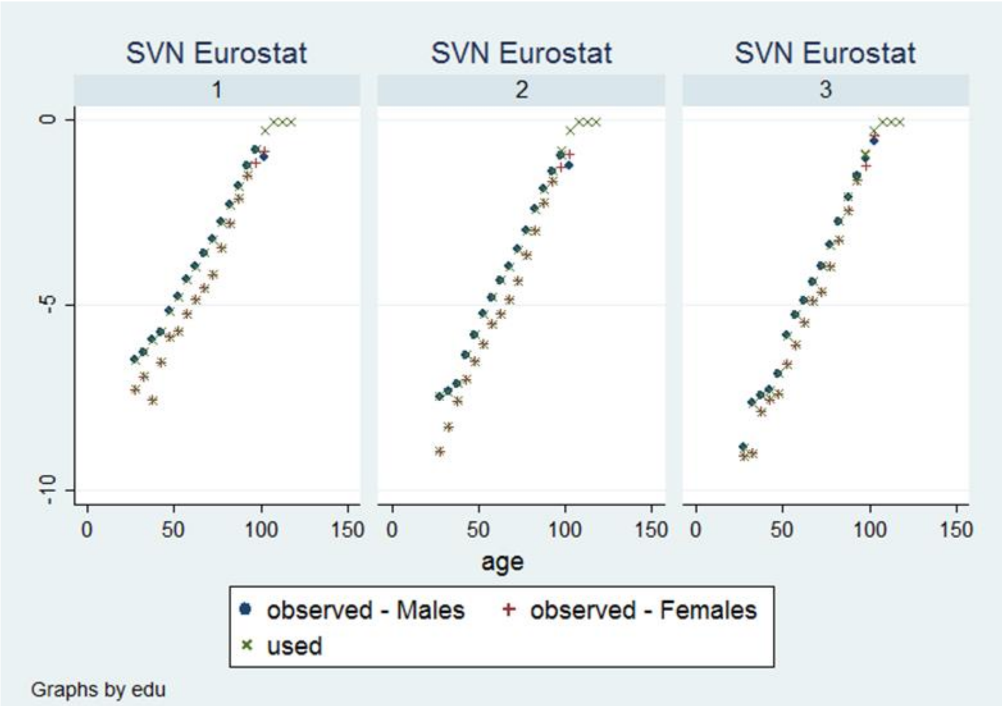

NOR
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu
NOR Eurostat
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

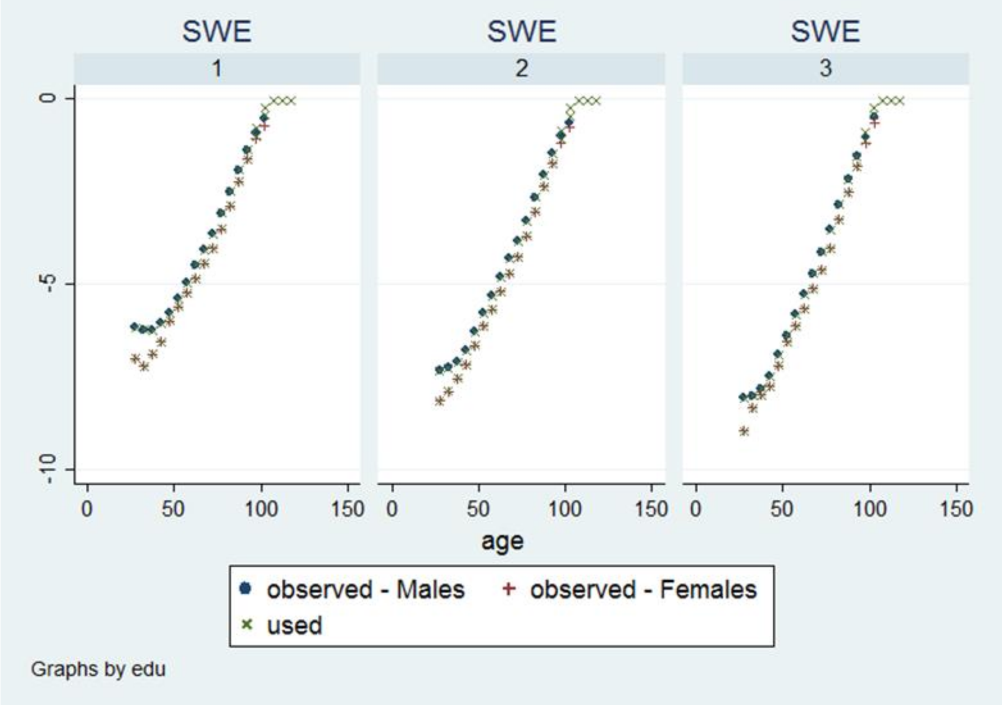

NZL
1
NZL
2
NZL
3
0
-2
-4
-6
-8
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

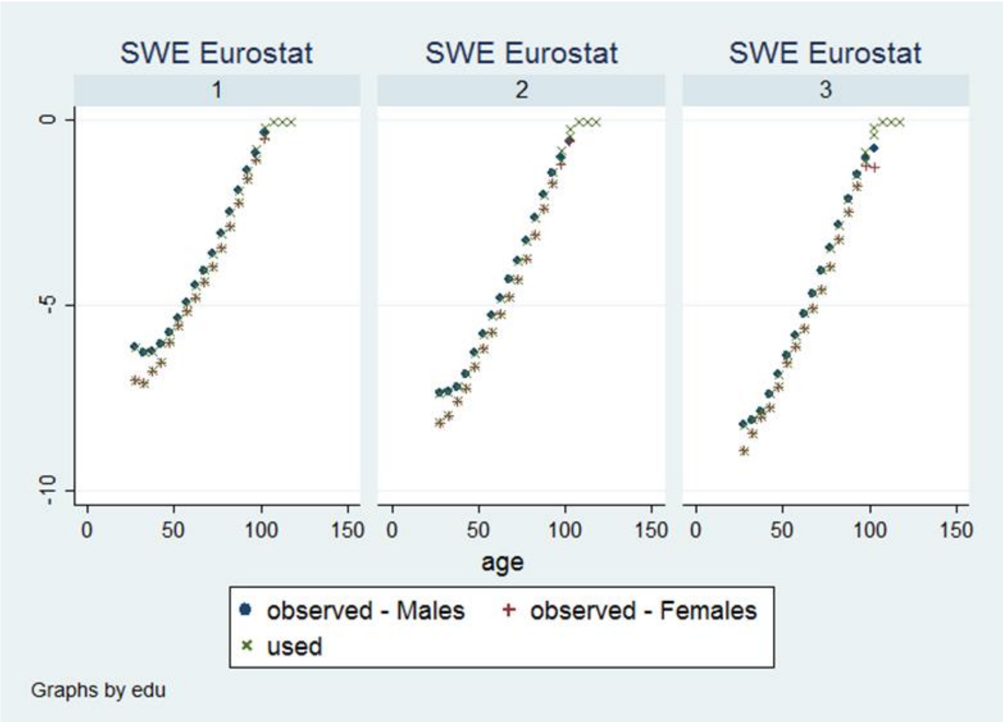

POL
1
POL
2
POL
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

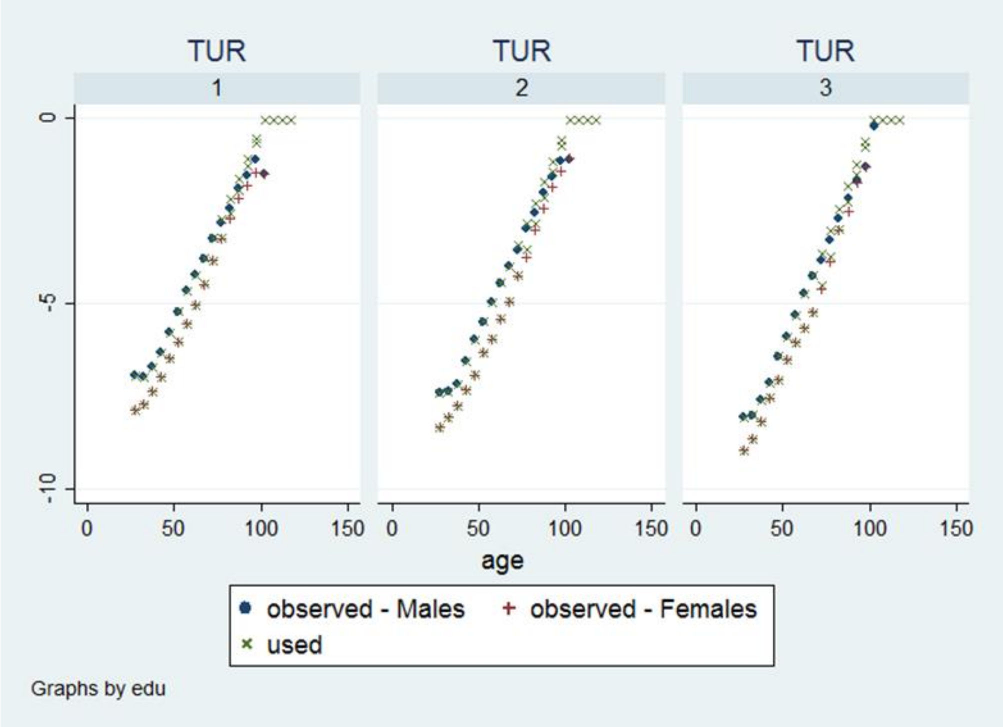

SVK
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

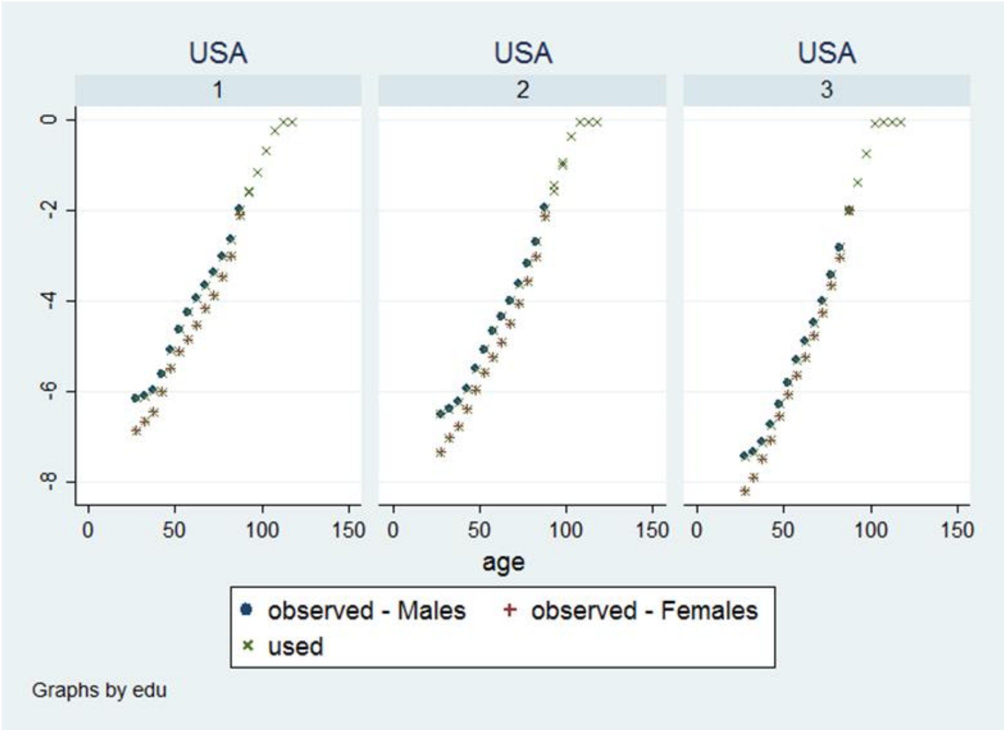

SVN
1
2
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu


SVN Eurostat
1
SVN Eurostat
2
SVN Eurostat
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu


SWE
1
SWE
2
SWE
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu


SWE Eurostat
1
SWE Eurostat
2
SWE Eurostat
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu


TUR
1
TUR
2
TUR
3
0
-5
-10
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu


USA
1
USA
2
USA
3
0
-2
-4
-6
-8
0
50
100
150
age
observed - Males
observed - Females
used
Graphs by edu

APPENDIX D. LONGEVITY BY EDUCATION AND GENDER AROUND 2011

Table D1. Longevity at age 25 and age-standardised mortality rate between age 25 and 89 (per 100 000 people) around 2011

		Males						Females					
		Low		Medium		High		Low		Medium		High	
Country	Data source	LE(25)	M(25-89)	LE(25)	M(25-89)	LE(25)	M(25-89)	LE(25)	M(25-89)	LE(25)	M(25-89)	LE(25)	M(25-89)
AUS	OECD	52.63	1940	55.93	1690	59.27	1465	58.17	1521	60.41	1394	61.86	1320
AUT	OECD	51.4	2000	54.03	1766	57.83	1501	57.58	1489	59.29	1376	60.63	1278
BEL	OECD	48.87	2394	52.6	2030	58.73	1495	53.52	1893	56.65	1651	60.34	1388
CAN	OECD	54.39	1811	55.57	1725	58.47	1508	58.33	1514	59.41	1452	61.06	1349
CHL	OECD	46.82	2676	50.89	2069	57.76	1440	53.2	1985	58.13	1427	60.82	1243
CZE	OECD	42.34	3569	49.94	2350	55.39	1793	54.4	1907	55.08	1827	59.19	1440
DNK	OECD	49.67	2161	53.55	1810	56.52	1606	54.45	1647	57.82	1439	59.6	1328
FIN	OECD	48.98	2145	52.51	1901	56.56	1593	56.18	1565	59.06	1397	60.94	1288
FRA	OECD	51.42	1858	55.07	1575	58.18	1404	59.3	1287	61.53	1171	61.95	1183
GBR	OECD	53.84	1862	56.65	1625	58.19	1515	56.74	1626	59.64	1417	60.73	1354
HUN	OECD	39.85	3897	48.25	2467	53.8	1896	51.23	2092	56.27	1640	56.97	1621
ISR	OECD	53.46	1663	56.77	1449	59.07	1352	57.33	1362	60.24	1219	61.17	1221
ITA	OECD	54.2	1732	56.5	1456	58	1510	59.4	1287	60.8	1243	61.4	1197
LVA	OECD	40.96	3178	45.86	2640	52.51	1934	50.08	2025	55.19	1675	58.36	1455
MEX	OECD	49.14	2045	50.08	2103	53.94	1704	54.2	1663	56.67	1519	56.87	1483
NOR	OECD	51.34	1938	55.02	1597	58.16	1383	56.44	1501	59.74	1291	61.25	1170
NZL	OECD	51.94	1824	55.37	1587	56.56	1527	56.73	1406	59.94	1185	61.15	1162
POL	OECD	42.57	3093	47.39	2628	55.2	1760	53.11	1919	55.43	1769	59.3	1459
SVK	Eurostat	46.7	2595	47.81	2545	54.17	1887	53.95	1833	56.07	1672	57.89	1559
SVN	OECD	48.86	2305	53.1	1909	57.13	1569	56.92	1577	59.32	1413	61.57	1301
SWE	OECD	52.74	1901	55.85	1661	58.59	1480	56.68	1559	59.27	1347	61.66	1251
TUR	OECD	50.82	2211	52.76	2007	54.97	1800	56.27	1678	58.84	1483	60.22	1394
USA	OECD	49.14	2070	52.26	1882	56.47	1633	54.46	1603	56.74	1531	58.38	1496
Average		49.22	2299	52.77	1933	56.76	1598	55.59	1650	58.33	1458	60.14	1345

Table D2. Cross-country correlation between different longevity inequality indices

Males	LE^H-LE^L	LE^H/LE^L	M^L-M^H	M^L/M^H	RII
LE^H-LE^L	1.000				
LE^H/LE^L	0.992	1.000			
M^L-M^H	0.958	0.974	1.000		
M^L/M^H	0.961	0.958	0.984	1.000	
RII	0.949	0.959	0.980	0.979	1.000
SII	0.929	0.915	0.938	0.972	0.972

Females	LE^H-LE^L	LE^H/LE^L	M^L-M^H	M^L/M^H	RII
LE^H-LE^L	1.000				
LE^H/LE^L	0.996	1.000			
M^L-M^H	0.912	0.911	1.000		
M^L/M^H	0.892	0.880	0.982	1.000	
RII	0.817	0.810	0.961	0.950	1.000
SII	0.805	0.786	0.930	0.950	0.979

Note: LE^H and LE^L denote the longevity at age 25 of people with high and low education respectively; M^H and M^L denote the age-standardised mortality rate of people with high and low education respectively;

APPENDIX E. LONGEVITY BY EDUCATION AND GENDER BY SINGLE YEAR

			Males						Females					
			Low		Middle		High		Low		Middle		High	
iso	year	source	Longevity at age 25	95% confidence interval (+/-)	Longevity at age 25	95% confidence interval (+/-)	Longevity at age 25	95% confidence interval (+/-)	Longevity at age 25	95% confidence interval (+/-)	Longevity at age 25	95% confidence interval (+/-)	Longevity at age 25	95% confidence interval (+/-)
AUS	2011	OECD	52.63	0.04	55.93	0.03	59.23	0.04	58.17	0.03	60.41	0.05	61.83	0.05
AUT	2012	OECD	51.40	0.06	54.03	0.04	57.83	0.08	57.58	0.04	59.29	0.05	60.63	0.14
BEL	2010	OECD	48.59	0.03	53.05	0.06	59.07	0.08	53.32	0.03	57.49	0.06	60.98	0.08
BEL	2011	OECD	48.53	0.03	53.18	0.06	59.13	0.07	53.29	0.03	57.64	0.06	61.09	0.08
BEL	2012	OECD	48.49	0.03	53.27	0.06	59.17	0.08	53.27	0.03	57.75	0.06	61.17	0.09
CAN	2006	OECD	54.13	0.03	55.59	0.06	58.26	0.05	58.31	0.03	59.74	0.10	61.18	0.05
CAN	2007	OECD	54.16	0.03	55.55	0.05	58.27	0.04	58.29	0.02	59.69	0.07	61.17	0.04
CAN	2008	OECD	54.22	0.02	55.53	0.04	58.31	0.04	58.28	0.02	59.64	0.07	61.17	0.04
CAN	2009	OECD	54.31	0.02	55.55	0.04	58.37	0.04	58.30	0.02	59.61	0.07	61.18	0.04
CAN	2010	OECD	54.40	0.03	55.60	0.05	58.44	0.04	58.32	0.02	59.61	0.07	61.19	0.04
CAN	2011	OECD	54.45	0.03	55.63	0.06	58.47	0.04	58.34	0.03	59.61	0.07	61.20	0.04
CHL	2004	OECD	46.80	0.04	50.83	0.06	57.72	0.13	53.20	0.03	58.09	0.07	60.77	0.16
CZE	2010	OECD	41.87	0.08	50.29	0.03	58.82	0.15	54.37	0.05	55.45	0.04	63.75	0.44
CZE	2011	OECD	42.18	0.08	50.12	0.03	57.65	0.11	54.41	0.05	55.30	0.03	62.31	0.23
CZE	2012	OECD	42.63	0.08	49.93	0.03	56.16	0.11	54.52	0.05	55.14	0.03	60.51	0.21
CZE	2013	OECD	43.07	0.08	49.77	0.03	54.87	0.07	54.65	0.05	55.02	0.03	58.96	0.10
CZE	2014	OECD	43.32	0.08	49.68	0.03	54.16	0.06	54.72	0.05	54.95	0.03	58.11	0.10
DNK	2009	OECD	49.43	0.07	53.36	0.08	56.23	0.09	54.23	0.06	57.83	0.08	59.43	0.10
DNK	2010	OECD	49.57	0.07	53.51	0.06	56.39	0.09	54.36	0.06	57.93	0.07	59.56	0.11
DNK	2011	OECD	49.74	0.07	53.66	0.08	56.58	0.09	54.53	0.06	58.04	0.08	59.69	0.10
DNK	2012	OECD	49.88	0.07	53.78	0.06	56.75	0.09	54.68	0.06	58.13	0.07	59.79	0.11
DNK	2013	OECD	49.96	0.07	53.83	0.06	56.84	0.09	54.76	0.06	58.17	0.07	59.84	0.10
DNK	2007	Eurostat	49.13	0.06	52.64	0.07	55.49	0.09	54.24	0.05	57.34	0.08	58.80	0.14
DNK	2008	Eurostat	49.23	0.07	52.78	0.06	55.66	0.08	54.31	0.06	57.44	0.07	58.95	0.10
DNK	2009	Eurostat	49.39	0.07	53.00	0.07	55.90	0.08	54.42	0.06	57.59	0.08	59.16	0.10
DNK	2010	Eurostat	49.59	0.07	53.26	0.06	56.18	0.09	54.58	0.06	57.78	0.07	59.39	0.11

DNK	2011	Eurostat	49.80	0.07	53.50	0.06	56.44	0.09	54.76	0.06	57.96	0.07	59.58	0.10
DNK	2012	Eurostat	49.97	0.07	53.67	0.06	56.64	0.09	54.90	0.06	58.10	0.07	59.71	0.10
DNK	2013	Eurostat	50.07	0.07	53.76	0.06	56.75	0.08	54.99	0.06	58.17	0.07	59.77	0.10
FIN	2006	OECD	48.62	0.06	52.25	0.10	56.11	0.10	56.16	0.06	59.03	0.09	60.75	0.12
FIN	2007	OECD	48.69	0.07	52.31	0.09	56.21	0.10	56.17	0.06	59.04	0.09	60.79	0.12
FIN	2008	OECD	48.80	0.07	52.38	0.09	56.34	0.10	56.18	0.06	59.06	0.08	60.83	0.12
FIN	2009	OECD	48.90	0.07	52.45	0.09	56.44	0.10	56.19	0.07	59.07	0.08	60.87	0.11
FIN	2010	OECD	48.96	0.07	52.49	0.09	56.50	0.10	56.19	0.07	59.07	0.08	60.89	0.11
FIN	2007	Eurostat	48.80	0.07	52.02	0.09	56.16	0.10	56.25	0.06	58.82	0.09	60.56	0.12
FIN	2008	Eurostat	48.94	0.07	52.12	0.09	56.25	0.10	56.26	0.06	58.87	0.08	60.60	0.12
FIN	2009	Eurostat	49.13	0.07	52.26	0.09	56.37	0.09	56.26	0.07	58.94	0.08	60.66	0.11
FIN	2010	Eurostat	49.35	0.07	52.43	0.09	56.51	0.09	56.27	0.07	59.02	0.08	60.73	0.11
FIN	2011	Eurostat	49.53	0.07	52.56	0.08	56.62	0.09	56.27	0.07	59.09	0.08	60.78	0.10
FIN	2012	Eurostat	49.63	0.07	52.64	0.08	56.68	0.09	56.27	0.07	59.12	0.08	60.81	0.10
FRA	2012	OECD	51.42	0.02	55.07	0.02	58.18	0.03	59.30	0.02	61.53	0.02	61.95	0.04
GBR	2004	OECD	52.73	0.06	55.06	0.19	57.33	0.21	56.05	0.05	59.40	0.33	60.18	0.34
GBR	2007	OECD	52.90	0.06	55.29	0.17	57.47	0.17	56.16	0.05	59.44	0.25	60.27	0.26
GBR	2011	OECD	53.02	0.06	55.44	0.14	57.55	0.14	56.23	0.05	59.46	0.15	60.34	0.16
HUN	2010	OECD	39.74	0.05	48.54	0.06	54.01	0.08	51.20	0.04	56.68	0.07	57.37	0.10
HUN	2011	OECD	39.83	0.05	48.29	0.05	53.85	0.07	51.26	0.04	56.38	0.06	57.09	0.10
HUN	2012	OECD	39.92	0.05	48.04	0.05	53.69	0.07	51.32	0.04	56.07	0.06	56.79	0.09
HUN	2013	OECD	39.98	0.05	47.90	0.04	53.59	0.07	51.36	0.04	55.89	0.05	56.62	0.08
ISR	2008	OECD	53.53	0.16	56.38	0.21	58.87	0.21	57.41	0.14	60.33	0.20	61.14	0.21
ISR	2009	OECD	53.49	0.16	56.56	0.21	58.93	0.21	57.41	0.15	60.32	0.20	61.22	0.22
ISR	2010	OECD	53.46	0.16	56.78	0.21	59.01	0.20	57.39	0.14	60.28	0.20	61.29	0.21
ISR	2011	OECD	53.45	0.16	56.96	0.21	59.07	0.20	57.36	0.15	60.25	0.19	61.33	0.19
ISR	2012	OECD	53.45	0.16	57.05	0.21	59.11	0.19	57.34	0.15	60.23	0.20	61.35	0.18
ITA	2012	OECD	54.95	.	56.76	.	57.34	.	58.87	.	61.40	.	62.39	.
LVA	2011	OECD	40.81	0.16	45.69	0.09	52.35	0.17	49.93	0.18	55.07	0.08	58.27	0.16
LVA	2012	OECD	40.76	0.16	45.63	0.08	52.30	0.14	49.88	0.18	55.02	0.07	58.23	0.12
MEX	2010	OECD	49.14	0.01	50.08	0.06	53.94	0.05	54.20	0.01	56.67	0.07	56.87	0.07
NOR	1971	OECD	47.57	0.06	49.41	0.09	51.76	0.19	53.42	0.05	55.77	0.12	57.69	0.33
NOR	1972	OECD	47.61	0.06	49.41	0.08	51.76	0.18	53.50	0.05	55.77	0.11	57.65	0.40
NOR	1973	OECD	47.67	0.06	49.43	0.08	51.78	0.18	53.62	0.05	55.77	0.10	57.66	0.24
NOR	1974	OECD	47.74	0.06	49.47	0.08	51.83	0.19	53.76	0.05	55.80	0.10	57.71	0.27

NOR	1975	OECD	47.80	0.06	49.53	0.08	51.93	0.18	53.91	0.05	55.87	0.10	57.76	0.29
NOR	1976	OECD	47.83	0.06	49.59	0.08	52.06	0.17	54.05	0.05	55.96	0.09	57.76	0.23
NOR	1977	OECD	47.83	0.06	49.64	0.08	52.21	0.18	54.18	0.05	56.07	0.09	57.72	0.24
NOR	1978	OECD	47.83	0.06	49.68	0.08	52.36	0.18	54.31	0.05	56.17	0.09	57.68	0.22
NOR	1979	OECD	47.84	0.06	49.74	0.08	52.49	0.17	54.46	0.05	56.27	0.09	57.71	0.21
NOR	1980	OECD	47.87	0.06	49.82	0.08	52.58	0.17	54.61	0.05	56.36	0.09	57.85	0.20
NOR	1981	OECD	47.90	0.06	49.91	0.07	52.65	0.16	54.75	0.05	56.46	0.08	58.04	0.20
NOR	1982	OECD	47.92	0.06	49.97	0.08	52.71	0.16	54.84	0.05	56.55	0.08	58.20	0.23
NOR	1983	OECD	47.90	0.06	50.01	0.07	52.78	0.16	54.90	0.05	56.62	0.08	58.28	0.21
NOR	1984	OECD	47.87	0.06	50.04	0.07	52.84	0.15	54.91	0.05	56.68	0.08	58.31	0.20
NOR	1985	OECD	47.82	0.06	50.08	0.07	52.91	0.15	54.91	0.05	56.72	0.08	58.35	0.19
NOR	1986	OECD	47.79	0.06	50.15	0.07	53.03	0.15	54.88	0.05	56.75	0.08	58.41	0.20
NOR	1987	OECD	47.79	0.06	50.24	0.07	53.18	0.15	54.86	0.05	56.78	0.08	58.47	0.19
NOR	1988	OECD	47.83	0.06	50.36	0.07	53.36	0.14	54.86	0.05	56.82	0.07	58.54	0.18
NOR	1989	OECD	47.92	0.06	50.50	0.07	53.54	0.15	54.89	0.05	56.87	0.07	58.62	0.19
NOR	1990	OECD	48.04	0.07	50.65	0.07	53.69	0.14	54.95	0.05	56.95	0.07	58.69	0.19
NOR	1991	OECD	48.18	0.07	50.83	0.07	53.84	0.14	55.02	0.06	57.03	0.07	58.75	0.18
NOR	1992	OECD	48.31	0.07	51.03	0.07	54.03	0.14	55.11	0.06	57.12	0.07	58.84	0.17
NOR	1993	OECD	48.43	0.07	51.25	0.07	54.25	0.13	55.20	0.06	57.23	0.07	58.97	0.16
NOR	1994	OECD	48.54	0.07	51.49	0.07	54.50	0.14	55.27	0.06	57.37	0.07	59.13	0.17
NOR	1995	OECD	48.64	0.07	51.71	0.06	54.78	0.13	55.31	0.06	57.50	0.07	59.29	0.17
NOR	1996	OECD	48.71	0.07	51.92	0.07	55.04	0.13	55.34	0.06	57.62	0.07	59.45	0.16
NOR	1997	OECD	48.76	0.07	52.11	0.06	55.28	0.13	55.36	0.06	57.71	0.07	59.59	0.16
NOR	1998	OECD	48.82	0.07	52.30	0.06	55.50	0.13	55.40	0.06	57.80	0.07	59.71	0.16
NOR	1999	OECD	48.90	0.07	52.51	0.06	55.70	0.12	55.45	0.06	57.90	0.07	59.81	0.15
NOR	2000	OECD	49.02	0.07	52.74	0.06	55.91	0.12	55.50	0.06	58.02	0.07	59.91	0.15
NOR	2001	OECD	49.20	0.07	53.00	0.06	56.13	0.12	55.59	0.06	58.19	0.07	60.04	0.15
NOR	2002	OECD	49.44	0.07	53.29	0.06	56.39	0.12	55.70	0.06	58.38	0.06	60.20	0.15
NOR	2003	OECD	49.72	0.08	53.57	0.06	56.67	0.12	55.84	0.06	58.56	0.07	60.37	0.15
NOR	2004	OECD	50.01	0.08	53.83	0.06	56.92	0.12	55.98	0.06	58.72	0.07	60.54	0.15
NOR	2005	OECD	50.29	0.07	54.06	0.06	57.15	0.11	56.11	0.07	58.87	0.06	60.71	0.14
NOR	2006	OECD	50.54	0.08	54.26	0.06	57.36	0.11	56.22	0.07	59.03	0.06	60.87	0.13
NOR	2007	OECD	50.75	0.08	54.44	0.06	57.55	0.11	56.31	0.07	59.19	0.06	61.00	0.14
NOR	2008	OECD	50.92	0.08	54.59	0.06	57.70	0.11	56.37	0.07	59.32	0.06	61.09	0.14
NOR	2009	OECD	51.00	0.08	54.66	0.06	57.79	0.11	56.39	0.07	59.40	0.06	61.14	0.13

NOR	2007	Eurostat	50.90	0.08	54.85	0.06	57.92	0.11	56.52	0.07	59.67	0.07	61.46	0.15
NOR	2008	Eurostat	50.99	0.08	55.02	0.06	58.10	0.11	56.59	0.07	59.78	0.07	61.63	0.14
NOR	2009	Eurostat	51.13	0.08	55.26	0.06	58.29	0.12	56.66	0.07	59.86	0.07	61.83	0.15
NOR	2010	Eurostat	51.29	0.08	55.48	0.06	58.42	0.12	56.71	0.07	59.91	0.07	62.01	0.15
NOR	2011	Eurostat	51.44	0.08	55.63	0.07	58.46	0.11	56.72	0.07	59.94	0.06	62.13	0.14
NOR	2012	Eurostat	51.55	0.08	55.71	0.06	58.44	0.11	56.71	0.07	59.96	0.06	62.20	0.14
NOR	2013	Eurostat	51.60	0.08	55.75	0.06	58.42	0.10	56.70	0.07	59.98	0.06	62.22	0.13
NZL	2001	OECD	51.34	0.04	54.50	0.04	56.23	0.05	56.26	0.04	59.30	0.04	60.73	0.07
NZL	2006	OECD	51.36	0.04	54.54	0.05	56.24	0.04	56.28	0.04	59.33	0.05	60.75	0.06
POL	2010	OECD	42.53	0.04	47.72	0.02	55.61	0.06	53.20	0.03	55.88	0.03	59.87	0.09
POL	2011	OECD	42.58	0.04	47.47	0.02	55.35	0.05	53.18	0.03	55.59	0.02	59.50	0.07
POL	2012	OECD	42.64	0.04	47.22	0.02	55.09	0.05	53.16	0.03	55.28	0.02	59.12	0.06
POL	2013	OECD	42.67	0.04	47.07	0.02	54.94	0.04	53.15	0.03	55.11	0.02	58.90	0.06
SVK	2011	OECD	42.91	0.11	53.01	0.07	54.14	0.11	52.85	0.08	59.48	0.09	57.93	0.18
SVK	2012	OECD	42.91	0.11	52.99	0.06	54.13	0.11	52.84	0.08	59.46	0.07	57.91	0.16
SVK	2011	Eurostat	46.03	0.05	49.32	0.11	54.23	0.11	54.05	0.05	57.21	0.14	58.00	0.19
SVK	2012	Eurostat	46.96	0.05	48.17	0.09	54.22	0.11	54.38	0.05	56.48	0.11	57.98	0.17
SVK	2013	Eurostat	47.59	0.06	47.40	0.06	54.22	0.11	54.60	0.05	55.99	0.06	57.97	0.16
SVN	2011	OECD	48.86	0.12	53.71	0.08	57.79	0.17	56.93	0.09	60.50	0.10	62.45	0.26
SVN	2012	OECD	48.86	0.12	53.65	0.57	57.72	0.94	56.98	0.10	60.35	0.62	62.32	1.30
SVN	2013	OECD	48.86	0.12	53.61	0.08	57.67	0.17	57.01	0.09	60.24	0.10	62.24	0.25
SVN	2011	Eurostat	48.63	0.12	52.80	0.08	56.83	0.17	56.60	0.09	58.93	0.10	60.97	0.26
SVN	2012	Eurostat	48.63	0.12	52.81	0.08	56.83	0.18	56.60	0.09	58.93	0.10	60.98	0.25
SWE	2011	OECD	52.73	0.05	55.78	0.04	58.53	0.07	56.67	0.06	59.25	0.05	61.66	0.08
SWE	2012	OECD	52.71	0.06	55.84	0.04	58.61	0.07	56.65	0.05	59.30	0.05	61.68	0.08
SWE	2013	OECD	52.69	0.06	55.90	0.04	58.70	0.07	56.62	0.06	59.35	0.04	61.69	0.08
SWE	2014	OECD	52.68	0.07	55.93	0.04	58.75	0.07	56.61	0.07	59.38	0.04	61.70	0.07
SWE	2010	Eurostat	52.55	0.05	55.56	0.05	58.19	0.07	56.52	0.05	59.33	0.05	61.28	0.08
SWE	2011	Eurostat	52.45	0.05	55.68	0.04	58.22	0.07	56.24	0.05	59.58	0.05	61.32	0.08
SWE	2012	Eurostat	52.33	0.05	55.82	0.04	58.25	0.07	55.92	0.05	59.85	0.04	61.36	0.08
SWE	2013	Eurostat	52.26	0.06	55.90	0.04	58.26	0.07	55.73	0.06	60.02	0.05	61.38	0.08
TUR	2012	OECD	51.06	0.01	52.90	0.05	55.05	0.06	56.38	0.01	58.87	0.08	60.26	0.13
TUR	2013	OECD	51.05	0.01	52.89	0.05	55.05	0.06	56.37	0.01	58.87	0.08	60.26	0.12
USA	2011	OECD	49.08	0.01	52.17	0.01	56.33	0.01	54.18	0.01	56.41	0.01	58.20	0.01
USA	2012	OECD	49.11	0.01	52.19	0.01	56.35	0.01	54.20	0.01	56.42	0.01	58.22	0.01