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Abstract:

While population ageing is rising, the educational composition of elderly is rather heterogeneous. We assess educational differences in future population ageing in Asia and Europe and how future population ageing in Asia and Europe would change if the educational composition of its populations would change.

We do so using a comparative population ageing measure that recalculates old-age thresholds after accounting for differences in life expectancy, and the likelihood of adults surviving to higher ages. We construct projected life-tables (2015-2020, …, 2045-2050) by educational level and sex for different regions of Asia and Europe. Based on these life-tables we calculated the future comparative prospective old-age thresholds by educational level and sex.

We find that in both Asia and Europe and among both men and women, the projected old-age thresholds are higher for higher educated people than for less educated people. While Europe has a larger projected share of elderly in the population than Asia, Europe's older population is better educated. In alternate future scenarios in which populations hypothetically have higher levels of education, the projected shares of elderly in the population decrease across all regions of Asia and Europe, but more so in Asia.

Our results highlight the effectiveness of investing in education as a policy response to the challenges associated with population ageing in Asia and Europe. Such investments are more effective in the Asian regions, where the educational infrastructure is less developed.

Summary Box

What is already known?

- While population ageing is occurring especially rapidly in Europe and Asia, the educational composition of these elderly populations varies.
- Most previous research on future population ageing by educational level relied on traditional measures and did not examine future population ageing scenarios with alternate levels of education.

What are the new findings?

- Old-age is projected to start at higher ages for populations with higher levels of education.
- In alternate future scenarios in which the whole population is better educated, the shares of elderly in the population decline in both Asian and European regions, but the decreases are greater in Asia.

What do the new findings imply?

- Investing in education can be an effective policy tool for slowing the ageing process in regions of Asia and Europe.
- A strategy of investing in education in order to reduce population ageing is more effective in regions where the educational infrastructure is less developed, and the population is relatively young (such as in Asia).

Introduction

In most countries, the elderly population is growing, both numerically and as a share of the overall population. With these trends expected to accelerate in the coming decades, population ageing is poised to become the most important social change of the 21st century. Population ageing is occurring especially rapidly in Europe and Asia. Europe has the largest share of elderly in the population, and Asia has the highest number of elderly people [1]. However, population ageing patterns are rather heterogeneous. Population ageing trends can differ across populations not just because of differences in their age and sex structures, but because of differences in their educational achievement levels[2]. The most fundamental causes of population ageing – i.e., decreasing fertility and increasing life expectancy – are driven by differences in educational levels. Higher educational attainment is associated with increased life expectancy at different ages, and with decreased fertility.

The characteristics of populations vary starkly across educational levels. The educational achievement levels of a population are also indicative of latent socioeconomic gradation variables in that population. In most parts of the world, better educated populations have higher incomes and better health [3]. The characteristics of populations, such as their morbidity and cognition levels, vary depending not only on their age and sex structures, but on their educational levels. Compared to their less educated counterparts, cohorts with higher education have significantly higher life expectancy,[4] lower rates of physical disability, and higher levels of productivity [5,6]. Moreover, differences in mortality rates based on educational level have been widening over time [7]. The World Health Organization has recognized the significance of the relationship between education and health by incorporating an education component into its formulae for forecasting future health scenarios[8]. Given that the characteristics of populations differ significantly based on their educational levels, efforts to project population ageing into the future must account for changes in the educational distributions of populations. Among the elderly in Europe and Asia, the educational distribution is highly diverse, and this heterogeneity must be considered when making projections. Table 1 shows the heterogeneity in the shares of the population aged 65+ by levels of education in Asia, in Europe, and in a selected country from each continent.

Table1: Share of elderly in Asia, Europe, India, and the Netherlands by levels of education, 2015

Region/Country	Share of 65+ population by level of education						Total share of 65+ population
	No Education	Incomplete Primary	Primary	Lower-Secondary	Upper-Secondary	Post-Secondary	
Asia	2.29	0.86	1.90	1.10	0.96	0.45	7.57
Europe	0.32	0.71	3.45	4.31	5.96	2.86	17.60
India	3.33	0.49	0.65	0.33	0.53	0.30	5.64
Netherlands	0.00	0.47	3.29	5.66	5.56	2.93	17.92

Source: Human Capital Database (2018 revision) [9]

Table 1 clearly shows the heterogeneity in the educational composition of the 65+ population in Asia and Europe. Of the people aged 65+ in Asia, the largest share have no education (30.3%), whereas only a small share (5.9%) have the highest educational level (post-secondary). However, of the people aged 65+ in Europe, only a small share have no education (1.8%), while much larger shares have lower-secondary (24.5%), upper-secondary (33.8%), or post-secondary (16.3%) education. Heterogeneity in the educational distribution can also be observed when comparing European and Asian countries. For example, in the Western European country of the Netherlands, 0% of the 65+ population have no education, and around 80% have lower-secondary or higher education; whereas in the South Asian country of India, around 60% of the 65+ population have no education, and only 0.3% have post-secondary education. Thus, the countries where the share of elderly in the population is large differ by educational composition: i.e., in some of these countries (mostly in Europe), a majority of the 65+ population have relatively high levels of education; whereas in other countries (mostly in Asia), a majority of the elderly population are uneducated or have lower levels of education. These differences in the educational composition of the elderly population can contribute to heterogeneity in population ageing trends across these continents.

There is relatively little previous research on future population ageing by educational level. Most of the existing studies on this topic relied on traditional measures, such as the share of people aged 65+ in the population, or the age dependency of the elderly population [10]. However, these measures do not account for differences in educational composition across populations. Age-specific characteristics like age-specific mortality and survival rates may vary by educational group. For example, highly educated people tend to have a longer remaining life expectancy and greater chances of surviving to higher ages. Thus, highly educated individuals may enter "old-age" at higher ages than their less educated counterparts. Among the alternate approaches aimed at redefining "old-age" based on changes in the age-specific characteristics of populations [11–15], the comparative prospective old-age threshold (CPOAT) measure of population ageing by Balachandran et al. (2019)[16] provides a framework for robust comparisons of ageing across populations with varying mortality experiences. The CPOAT provides a dynamic "old-age threshold" that changes across time and populations based on adults' remaining life expectancy and survival rates to higher ages. In addition, how a change in the future educational composition of the population would affect projected population ageing has not previously been investigated.

In this paper, we illustrate future ageing scenarios by different levels of education across Asia and Europe using the CPOAT. We also look at how future scenarios of population ageing in Asia and Europe would change if the levels of education among these populations changed.

2 Data and Method

2.1 Data

To estimate future population ageing in a comparative and prospective manner, we used projected age- and sex-specific life-table data and projected age-specific survival ratios by different levels of education for Asia and Europe (and its different regions). Both datasets are available for five-year periods between 2015 and 2050.

For the projected life-table data, we used the medium-fertility variant data from the Population Division of the Department of Economic and Social Affairs, United Nations [17]. For the projected data on age-specific survival ratios by different levels of education, the medium scenario (under the assumption of Shared Socio-economic Pathway 2, SSP2) provided by the Human Capital Database (2018 revision) [9] of the Wittgenstein Centre for Demography and Global Human Capital are used. The medium scenario (SSP2) of age-specific survival ratios is based on a combination of medium fertility, medium mortality, medium migration, and the Global Education Trend education scenario. The Global Education Trend scenario assumes that educational participation is steadily improving over time. The medium scenario is the most likely path for each country or region [9]. Thus, the medium scenarios provided by Human Capital Database are comparable to the medium variant in the UN life-table data. In line with the International Standard Classification of Education (ISCED), which is used to compare education statistics across countries with distinct educational systems, the data from the Human Capital Database is available across six educational categories. In the order of increasing educational attainment, the categories are (i) no education, (ii) incomplete primary education, (iii) primary education, (iv) lower-secondary education, (v) upper-secondary education, and (vi) post-secondary education.

While the UN dataset provides data by five-year age groups from age zero to age 85+, the Human Capital Database provides data by five-year age groups from age zero to age 100+. In order to compare the data across the two datasets, we make a logistic fit of the mortality rates from the 75-80 and 80-85+ age groups in the UN life-table data, and then use the fit to recalculate the UN life-table across countries for five-year age groups from age zero to age 100+ [18,19].

2.2 Methods

The comparative prospective old-age threshold (CPOAT) proposed by Balachandran et al. (2019) stipulates an "old-age threshold" after accounting for differences in life expectancy and adult survival levels across populations. The authors have used the CPOAT to compare different populations against a *benchmark population;* Japan of 1972. The remaining life expectancy (RLE) at age 65 in Japan in 1972 was 15 years, and the proportion of the adult population (population above age 15) surviving to age 65 was 0.829 (called the adult survival ratio (ASR) at age 65). A multiplication of these ASR and RLE (ASR*RLE) values yields 12.4. The CPOAT of other populations is defined as the age at which their ASR*RLE value is closest to 12.4. The authors

analogize their measure to the concept of comparing purchasing power across currencies with a benchmark currency (usually the US dollar). Unlike traditional thresholds that do not change over time or across populations, the CPOAT is a dynamic and forward-looking measure of population ageing. It has been found to be robust for comparisons across populations with varied mortality patterns. The CPOAT is a realization of the characteristics approach, [20] which sought to explain population ageing based on age-specific characteristics.

To empirically estimate the CPOAT for countries in Asia and Europe by educational levels and sex for every five-year period between 2015 and 2050, we adopt three steps:

Step 1: Formulation of life-tables by educational levels and by sex

Using the age-specific survival rate, we formulate life-tables by six educational levels and by sex for Asian and European regions in the following order: (i) using the age-specific survival rate, the number of person-years lived ($_nL_x$ in the life-table) is obtained for six levels of education for both sexes; (ii) using the UN life-table data, the region and the sex-specific average years lived in an age interval by a person who dies in the interval ($_na_x$ in the life-table) is obtained; (iii) keeping $_na_x$ constant across different levels of education, the age-specific mortality rates ($_nm_x$ in the life-table) are obtained; and (iv) the resulting age-specific mortality rates are used to formulate life-tables for the corresponding educational level by sex.

*Step 2: Estimation of ASR*RLE by age across educational levels and sex*

ASR by age group for each educational level is calculated for the corresponding life-tables by dividing the number of survivors of a particular age by the number of survivors at age 15. RLE across different age groups are calculated from the same life-tables. By multiplying ASR by RLE, the corresponding ASR*RLE values are estimated across age groups.

A linear interpolation is then executed to obtain ASR*RLE values by single ages from the five-year age group values. Such a linear interpolation is warranted, as a sensitivity analysis in which we used more advanced interpolation techniques (e.g., TOPALS; Beer 2012) also generated the same results. Moreover, another sensitivity analysis with separate linear interpolations for ASR and RLE prior to their multiplication produced the same age-specific results.

Step 3: Estimation of CPOAT and shares of elderly

The projected CPOAT is obtained for six different levels of education by sex by finding the age at which the age-specific projected values of ASR*RLE in the corresponding life-tables is closest to 12.4. We also estimate the shares of elderly in the population across Asia and Europe using the CPOAT by comparing the percentage of the population above the CPOAT to the total population. The results of this calculation are called the *baseline* scenario, which is based on the Global Education Trend scenario.

2.3 Alternate scenarios of future education

We formulated two alternative future scenarios in which the populations hypothetically have higher educational levels than in the baseline scenario. In scenario (1), the whole population have at least upper-secondary education. In scenario (2), the whole population have the highest

educational level (i.e., post-secondary education). We call the results obtained from *step 3* the *baseline scenario.* In scenario (1), we assume that the entire population of a particular region have the same CPOAT as that of the population with upper-secondary education, with the exception of the population with post-secondary education. For the population with post-secondary education, the CPOAT is unaltered compared to baseline scenario. In scenario (2), we assume that the entire population of a region have the same CPOAT as the population with post-secondary education.

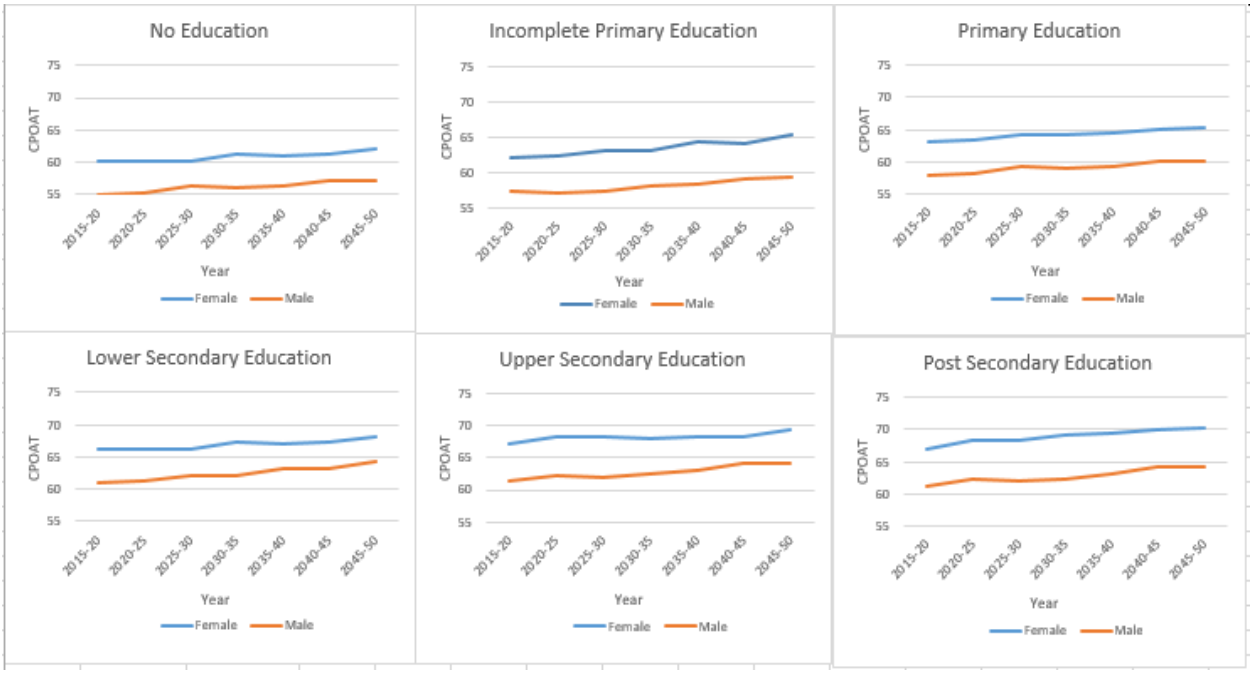
3 Results

Section 3.1: Projected CPOAT for Asia and Europe by educational levels and by sex

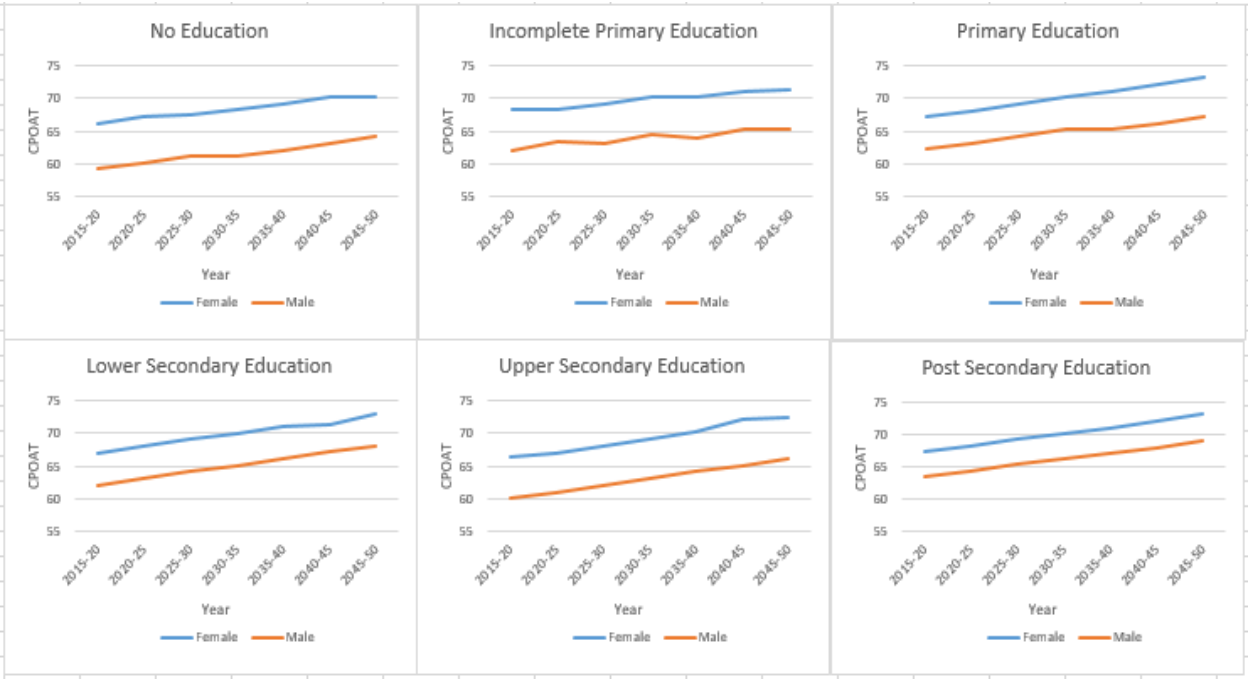
Figure 1 shows the results of the projected CPOAT by six different educational levels and by sex for the 2015-2050 period for Asia and Europe.

Figure 1: Comparative prospective old-age threshold by educational levels and by sex, 2015-2050

a) Asia



b) Europe



Between 2015 and 2050, the CPOAT is increasing over time across all six educational levels in Asia and Europe. For any given level of education, the corresponding CPOAT values are higher for Europe than for Asia. The CPOAT generally rises with the level of education. For any given level of education, the CPOAT is higher for females than for males. However, the changes in the CPOAT have distinct patterns by levels of education across Asia and Europe.

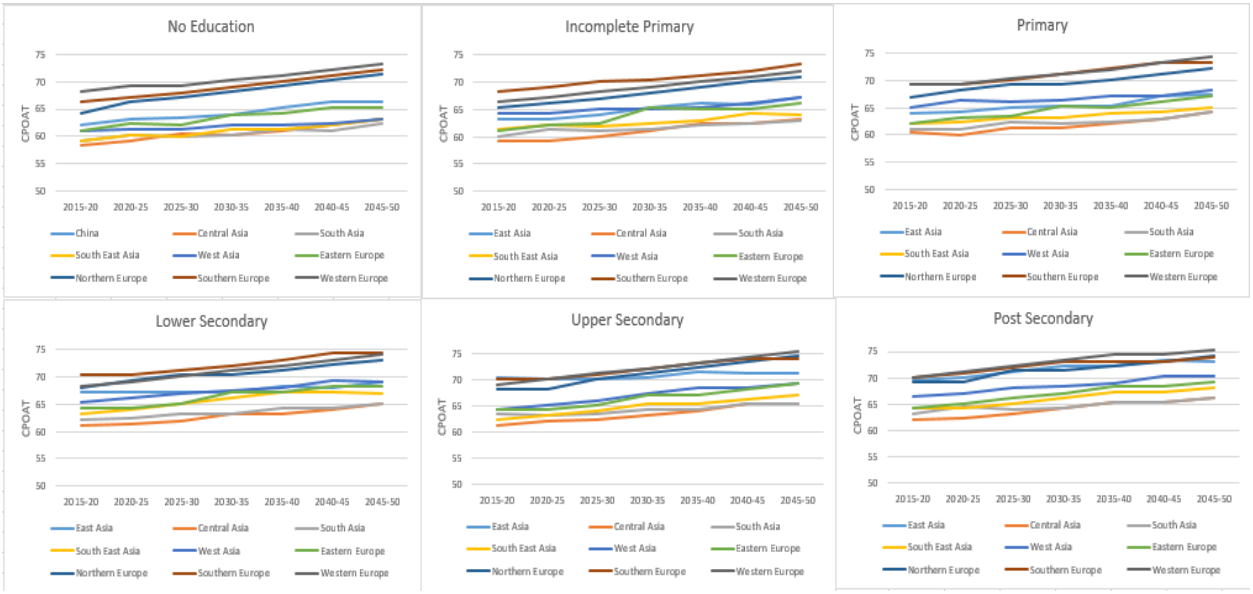
For the uneducated, the projected CPOAT values for the 2015-2020 period are as low as 60.15 (females) and 55.04 (males) in Asia, compared to 66.21 (females) and 59.19 (males) in Europe. Likewise, for the highly educated (post-secondary level), the projected CPOAT values for the 2015-2020 period are 67.02 (females) and 63.32 (males) in Asia and 67.39 (females) and 63.34 (males) in Europe.

Regional variations in projected CPOAT in Asia and Europe

Given the vastness of and regional variations within Asia and Europe, the overall patterns in the CPOAT do not necessarily reflect its regional distinctions. Based on the UN classification on geographical locations, we explore CPOAT variations across five Asian and four European regions. Figure 2 (a-b) shows the results of the projected CPOAT in regions of Asia and Europe across six educational levels and by sex for the 2015-2050 period.

Figure 2: Comparative prospective old-age threshold for regions in Asia and Europe across educational levels, 2015-2050

a) Females



b) Males

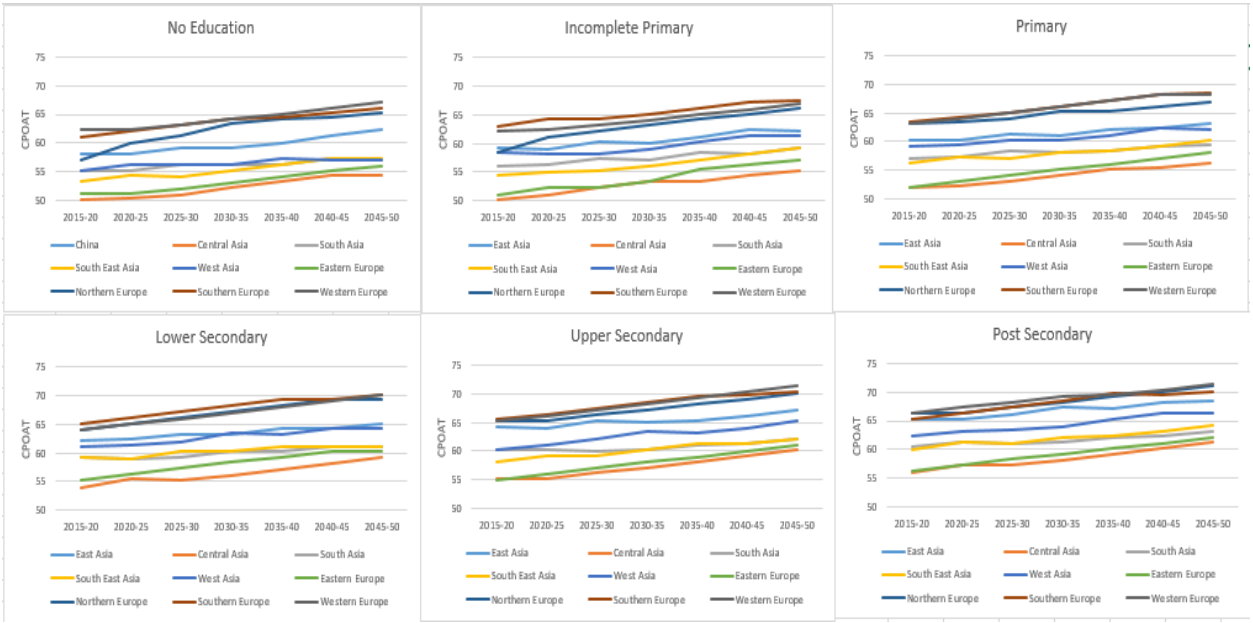


Figure 2 (a-b) clearly shows that across educational levels, Western Europe and Northern Europe have the highest CPOAT values for different years, while Central Asia has the lowest CPOAT values. South Asia and South East Asia also have lower CPOAT values at lower educational levels. Southern Europe has considerably higher CPOAT values for certain levels of education (especially

at the lower-secondary level). For females with no education, the CPOAT in 2015-2020 is 68.18 for the region with the highest values (Western Europe), and is 58.33 for the region with the lowest values (Central Asia). For males with no education, the CPOAT in 2015-2020 is 62.36 in Western Europe and 50.15 in Central Asia.

Section 3.2: Future population ageing by educational levels

We estimate the projected shares of elderly by educational levels in Asia and Europe using the CPOAT values estimated in Figures 1 and 2. Table 2 (a-b) shows the shares of elderly across educational levels for the 2015-2020 and 2045-2050 periods for females and males.

Table 2a: Shares of elderly using CPOAT by educational levels for different regions, females (in %), 2015-2020 and 2045-2050

Region	*No Education*		*Incomplete Primary*		*Primary*		*Lower-Secondary*		*Upper-Secondary*		*Post-Secondary*		*Total*	
	2015-2020	*2045-2050*	*2015-2020*	*2045-2050*	*2015-2020*	*2045-2050*	*2015-2020*	*2045-2050*	*2015-2020*	*2045-2050*	*2015-2020*	*2045-2050*	*2015-2020*	*2045-2050*
Asia	4.36	3.60	1.26	1.25	2.39	3.25	0.87	4.24	0.76	2.80	0.25	1.53	9.88	16.68
East Asia	2.50	0.69	1.90	1.62	4.31	4.31	2.38	10.24	1.54	4.55	0.27	2.28	12.90	23.69
Central Asia	0.20	0.08	0.37	0.05	0.88	0.12	1.78	1.14	4.01	9.75	1.16	2.79	8.39	13.92
South Asia	5.54	6.67	0.66	0.96	0.82	1.92	0.34	1.31	0.40	1.92	0.18	1.00	7.94	13.78
South East Asia	2.04	1.10	2.26	1.68	3.52	5.49	0.57	2.81	0.55	3.19	0.34	1.60	9.29	15.87
West Asia	2.64	2.13	1.17	1.07	1.49	2.84	0.33	1.45	0.59	1.97	0.53	1.58	6.74	11.05
Europe	0.44	0.18	0.82	0.20	4.09	1.12	4.96	3.87	4.91	10.36	2.03	5.97	17.26	21.71
Eastern Europe	0.13	0.14	0.24	0.05	3.38	0.23	4.88	1.90	8.50	14.46	2.91	6.54	20.03	23.33
Northern Europe	0.02	0.09	0.03	0.03	1.52	0.23	8.27	4.72	3.75	6.07	3.31	6.79	16.91	17.92
Southern Europe	1.44	0.30	3.74	0.78	6.92	2.49	3.17	6.94	1.97	8.30	1.07	6.01	18.32	24.82
Western Europe	0.31	0.22	0.05	0.06	4.58	1.61	5.26	2.92	6.40	9.44	1.84	5.93	18.44	20.18

Table 2b: Shares of elderly using CPOAT by educational levels for different regions, males (in %), 2015-2020 and 2045-2050

Region	*No Education*		*Incomplete Primary*		*Primary*		*Lower-Secondary*		*Upper-Secondary*		*Post-Secondary*		*Total*	
	2015-2020	2045-2050	2015-2020	2045-2050	2015-2020	2045-2050	2015-2020	2045-2050	2015-2020	2045-2050	2015-2020	2045-2050	2015-2020	2045-2050
Asia	2.65	2.14	1.31	1.04	3.15	2.88	2.04	5.30	1.59	4.12	0.75	2.45	11.50	17.92
East Asia	1.04	0.23	1.58	0.83	4.60	2.53	3.86	11.88	1.82	5.10	0.91	3.70	13.81	24.26
Central Asia	0.08	0.09	0.18	0.06	0.43	0.14	1.62	1.29	6.02	9.86	2.17	3.06	10.50	14.50
South Asia	4.71	4.00	1.01	1.00	1.52	2.59	0.83	2.34	1.24	3.50	0.72	1.95	10.03	15.38
South East Asia	1.43	0.73	1.88	1.38	4.72	4.96	1.13	3.90	1.38	4.63	0.61	1.95	11.15	17.56
West Asia	1.70	1.50	0.91	1.28	2.35	2.70	0.65	2.79	0.94	3.19	0.89	2.72	7.44	14.18
Europe	0.22	0.18	0.55	0.18	2.70	0.92	3.70	3.61	7.38	10.61	3.65	5.86	18.20	21.36
Eastern Europe	0.07	0.17	0.07	0.09	1.50	0.33	3.61	2.41	14.28	16.28	4.50	6.05	24.03	25.33
Northern Europe	0.01	0.09	0.01	0.05	1.31	0.23	6.10	4.68	5.10	6.80	3.94	6.53	16.48	18.37
Southern Europe	0.56	0.29	2.42	0.61	5.52	2.10	4.03	7.53	3.28	8.55	2.28	5.72	18.10	24.80
Western Europe	0.26	0.19	0.03	0.07	2.95	1.30	2.24	2.08	7.99	9.84	4.10	7.11	17.57	20.59

Table 2 (a and b) shows clear differences in the shares of elderly across educational levels in Asia and Europe. Europe has larger shares of female and male elderly than Asia in both 2015-2020 and 2045-2050. Although the overall shares of elderly are increasing over time across the regions, the changes in the shares of elderly by educational composition paints a different picture. In Europe, the shares of elderly are larger among the higher educated groups (lower-secondary, upper-secondary, and post-secondary levels) and smaller among the lower educated groups. The reverse is true for Asia, where the shares of elderly are larger among the less educated groups. Broadly, these patterns hold for the regions within each continent. For instance, the shares of elderly among the uneducated group are especially large in South Asia. Similarly, Northern Europe has the largest shares of elderly with post-secondary education.

Section 3.3: Can future scenarios of population ageing be changed by increased investments in education?

As we mentioned in the methodology section, we will consider two alternate future scenarios in Asia and Europe with hypothetical changes in educational investments, and compare them with the *baseline scenario.* The resulting shares of elderly across the two alternate scenarios and the baseline scenario for the 2045-2050 period are displayed in Table 3. To facilitate comparisons, we also show the shares of elderly for the 2045-2050 period based on the traditional old-age threshold of 65.

Table 3: Shares of elderly with assumed higher levels of education for different regions in Asia and Europe by sex (in %), 2045-2050

	Shares of elderly (%) in 2045-2050							
Region	*Shares of elderly (%) based on old-age threshold of 65*		*Baseline Scenario: Medium scenario of future educational distribution*		*Scenario 1: The whole population have at least upper- secondary education*		*Scenario 2: The whole population have post-secondary education*	
	Female	Male	Female	Male	Female	Male	Female	Male
Asia	18.16	15.26	16.68	17.92	14.36	16.46	13.50	14.77
East Asia	28.33	23.73	23.69	24.26	21.56	22.62	19.04	21.63
Central Asia	12.21	8.62	13.92	14.50	13.89	14.34	13.22	13.59
South Asia	12.37	10.81	13.78	15.38	12.46	13.65	11.67	12.81
South East Asia	16.92	13.38	15.87	17.56	14.69	16.26	13.83	14.41
West Asia	13.25	11.83	11.05	14.18	10.00	12.52	9.30	11.79
Europe	29.74	24.16	21.71	21.36	20.67	20.67	19.42	18.62
Eastern Europe	27.54	19.20	23.33	25.33	21.70	24.00	21.70	22.48
Northern Europe	26.20	23.22	17.92	18.37	16.57	17.47	16.57	16.43
Southern Europe	36.28	31.12	24.82	24.80	23.64	23.04	23.64	23.04
Western Europe	30.18	26.21	20.18	20.59	19.96	20.26	18.69	19.16

Using Table 3, the shares of elderly in the Asian and European regions can be compared across different scenarios by sex. Compared to the baseline scenario, the shares of elderly are smaller for all of the regions across both scenario (1) and scenario (2). In addition, the shares of elderly are smaller in scenario (2) than in scenario (1). In scenario (1), the shares of elderly are 14.36% for females and 16.46% for males in Asia and are 20.67% for both females and males in Europe. In scenario (2), the shares of elderly decrease to 13.50% for females and 14.77% for males in Asia and to 19.42% for females and 18.62% for males in Europe. Among the regions, Southern Europe has the largest shares of female elderly and Eastern Europe has the largest shares of male elderly in scenario (1); and Southern Europe has the largest shares of both female and male elderly in scenario (2). West Asia has the smallest shares of elderly in both scenarios. Across the regions, the shares of elderly are smaller in scenario (2) than in scenario (1), and are, in turn, smaller than in the baseline scenario. The shares of elderly in Europe and of elderly females in Asia are smaller in the *baseline scenario* than when the traditional old-age threshold of 65 is used, but the shares of elderly males in Asia are slightly larger in the former scenario.

It is also worth noting that the decreases in the shares of elderly in scenario (1) and scenario (2) relative to the baseline scenario are not same across the regions or by sex. The decreases are

quantified in Appendix Table A1. The decreases in the shares of elderly across scenarios is larger in Asia than in Europe. In general, within Asia, the decreases are larger for East Asia. In Europe, Eastern Europe has the largest decreases. In regions with high CPOAT values such as Western Europe, the decreases in the shares of elderly from the baseline scenario to scenario (1) are not large (less than 0.5%), whereas the decreases are considerably greater from the baseline scenario to scenario (2).

4 Discussion

Summary of results

We compared the educational differentials in future population ageing trends in Asia and Europe using a measure that enabled us to compare population ageing across populations and over time. We found that the projected values of the comparative prospective old-age threshold (CPOAT) are higher among populations with higher levels of education. This pattern is shown to hold over time for both women and men in all regions of Asia and Europe, although there are regional variations in the trajectory of the increasing trend. While the total projected share of elderly is smaller in Asia than in Europe, the shares of elderly with higher educational levels are much larger in Europe. Correspondingly, Asian regions have much larger shares of elderly who have little or no education. The shares of elderly with the highest level of education are larger among males than females in both continents. An analysis of future scenarios with higher levels of education for the whole population showed decreases in the future shares of elderly in Asia and Europe and its regions, with the decreases being larger in Asia than in Europe. In developed regions (such as Western Europe), the shares of elderly decrease substantially only when the highest educational levels are attained for the whole population.

Explanation of the results

Our finding that the CPOAT is higher for populations with higher educational levels is explained by the higher life expectancy levels and adult survival ratios among populations with higher education [22]. A higher CPOAT value means that "old-age" starts at higher ages. Thus, population ageing seems to be occurring at varying paces depending on the educational level of a population. In an educated population, "old-age" begins at higher ages. Similarly, females have higher life expectancy levels than their male counterparts, which explains their higher CPOAT values[23]. The lower life expectancy and adult survival levels in Asia (except in East Asia) and Eastern Europe [24,25] shed light on why these regions have lower CPOAT values than Western and Northern Europe. Similarly, the lower adult survival ratios in Central Asia are well-documented, [26] and explain the lower CPOAT values in the region.

Although the future shares of elderly are larger in the European regions, the shares of less educated elderly are larger in the Asian regions. The higher income levels, better educational infrastructure, and greater investments in education in Europe are chiefly responsible for this pattern.

An important observation of our analysis is that in alternate future scenarios in which less educated populations have higher levels of education, the projected shares of elderly decrease. This finding holds across regions and among women and men. The increases in life expectancy and adult

survival ratios associated with increases in education are mainly responsible for the decreases in the shares of elderly. In such alternate future scenarios, we also find that decreases in the shares of elderly are much larger in Asia than in Europe. Because the current educational infrastructure in Asia is of worse quality, the life expectancy and adult survival ratios in Asia are also lower. Because the base levels in Asia are low, improvements in life expectancy and adult survival ratios in Asia would be greater if improvements in education are also implemented. This explains why Asia gains more in terms of shares of elderly in alternate future scenarios with higher educational levels. Our analysis also shows that in developed regions like Western Europe, the future share of elderly declines substantially only when the whole population reach the highest educational level. This suggests that given the already high levels of basic education in Europe, substantial changes in life expectancy and adult survival ratios would occur there only if investments were made in the highest educational levels.

Evaluation of the method

For our analysis, we used a comparative and prospective measure of ageing instead of the conventional chronological age 65. The educational heterogeneity across elderly populations is high, and the remaining life expectancy and ratios of adults surviving to higher ages vary across educational levels [27]. Hence, our method provides a more holistic perspective on population ageing than earlier analyses, and highlights ageing differentials within and across populations. Therefore, it provides a much clearer view on future ageing as a result of increased educational attainment than the existing measures, which consider future population ageing based on either an abstract chronological age such as 65 or on one characteristic only (such as RLE). As educational levels rise, the future shares of elderly are projected to be lower than the conventional measures and analysis based on one characteristic indicate [9,28].

Recommendations

The results of the scenario exercise have important implications for policymakers. A higher level of investment in education can be an effective tool for regions of Asia and Europe to tackle the ageing process. Such investments in education are more effective in regions where the educational infrastructure is less developed and younger cohorts form a large part of the population, such as Asia. Long-term investments in education are vital in these regions. Likewise, regions where the shares of elderly in the population are expected to be large, such as Western Europe, can prepare for population ageing by helping to close the educational gap through investments in the highest levels of education.

The measure we used in this study advances existing methods by accommodating the improvements in life expectancy over time, as well as the differences across populations in the likelihood of reaching higher ages. However, alongside changes in life expectancy and survival rates, there may be differentials in morbidity, cognition, productivity, labour force participation, and healthy life expectancy by levels of education [29–31]. Thus, we recommend that future research on ageing consider a more diverse range of human capital factors across populations, including educational gradients.

Appendix

Table A1: Decrease in the shares of elderly across scenarios for different regions in Asia and Europe by sex (in %), 2045-2050

Region	Baseline scenario - Scenario (1)		Baseline scenario - Scenario (2)	
	Female	*Male*	*Female*	*Male*
Asia	2.32	1.46	3.18	3.16
East Asia	2.13	1.64	4.66	2.63
Central Asia	0.03	0.16	0.70	0.91
South Asia	1.33	1.73	2.11	2.57
South East Asia	1.17	1.30	2.04	3.15
West Asia	1.05	1.66	1.74	2.39
Europe	1.03	0.69	2.29	2.74
Eastern Europe	1.62	1.33	1.62	2.85
Northern Europe	1.35	0.91	1.35	1.94
Southern Europe	1.18	1.77	1.18	1.77
Western Europe	0.22	0.33	1.49	1.43

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While population ageing is rising, the educational composition of elderly is rather heterogeneous. We assess educational differences in future population ageing in Asia and Europe and how future population ageing in Asia and Europe would change if the educational composition of its populations would change.

We do so using a comparative population ageing measure that recalculates old-age thresholds after accounting for differences in life expectancy, and the likelihood of adults surviving to higher ages. We construct projected life-tables (2015-2020, ..., 2045-2050) by educational level and sex for different regions of Asia and Europe. Based on these life-tables we calculated the future comparative prospective old-age thresholds by educational level and sex.

We find that in both Asia and Europe and among both men and women, the projected old-age thresholds are higher for higher educated people than for less educated people. While Europe has a larger projected share of elderly in the population than Asia, Europe's older population is better educated. In alternate future scenarios in which populations hypothetically have higher levels of education, the projected shares of elderly in the population decrease across all regions of Asia and Europe, but more so in Asia.

Our results highlight the effectiveness of investing in education as a policy response to the challenges associated with population ageing in Asia and Europe. Such investments are more effective in the Asian regions, where the educational infrastructure is less developed.

The Netherlands Interdisciplinary Demographic Institute (NIDI) is an institute for the scientific study of population. NIDI research aims to contribute to the description, analysis and explanation of demographic trends in the past, present and future, both on a national and an international scale. The determants and social consequences of these trends are also studied.

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