Comparison of ageing in Europe and Asia: Refining the prospective age approach with a cross-country perspective

Balachandran, Arun; de Beer, Joop; James, K.S. ; van Wissen, Leo; Janssen, Fanny

Working Paper no.: 2017/01

Arun Balachandran, Joop de Beer,
K.S. James, Leo van Wissen and
Fanny Janssen

Comparison of ageing in Europe and Asia: Refining the prospective age approach with a cross-country perspective

NiDi

netherlands
interdisciplinary
demographic
institute

Comparison of ageing in Europe and Asia

Arun Balanchandran[1, 2], Joop de Beer[3], K.S. James[4], Leo van Wissen[1, 3] and Fanny Janssen[1, 3]

Working Paper no.: 2017/01

[1] Population Research Centre, University of Groningen, The Netherlands, a.balachandran@rug.nl (corresponding author)
[2] Institute for Social and Economic Change, Bengaluru, India,
[3] Netherlands Interdisciplinary Demographic Institute (NIDI/KNAW) / University of Groningen, The Hague, The Netherlands,
[4] Centre for Study of Regional Development, Jawaharlal Nehru University, New Delhi, India.

The first author would like to acknowledge funding from funding from the Ubbo Emmius fund (alumnus and friends of the University of Groningen) and Indian-European research networking grant: Ageing and well-being in a globalising world (NWO 465-11-009), funded by NWO-ESRC-ICSSR.

January 2017

Abstract

Measuring population ageing based on a fixed old-age threshold like 65 ignores increasing life expectancy among elderly people. Sanderson and Scherbov introduced the prospective age approach based on the age at which the remaining life expectancy is 15 (RLE15). Their approach is time-horizon consistent, but ignores cross-country differences in reaching RLE15.

We compare population ageing in Europe and Asia using a new method that is consistent over time and between countries.

Our old-age threshold is the age at which the adult survival ratio equals the proportion of adults surviving to the prospective old-age threshold of the benchmark country (Japan). Our old-age threshold is lower and our share of elderly is higher than were found using the prospective age approach for countries with low adult survival. Our method also revealed greater differences between the shares of elderly in Europe (15.7%) and Asia (7.6%) than were found using the RLE15 method.

Acknowledgement

The first author would like to acknowledge funding from funding from the Ubbo Emmius fund (alumnus and friends of the University of Groningen) and Indian-European research networking grant: Ageing and well-being in a globalising world (NWO 465-11-009), funded by NWO-ESRC-ICSSR.

1. Introduction

1.1 Background

In most countries, the numbers of elderly people and their population shares have been increasing rapidly in recent decades, and these trends are expected to accelerate in the coming decades (Lesthaeghe 2010). Population ageing is on track to become one of the most important social changes of the 21st century, as the numbers and the shares of elderly people reach record levels across the world (Lutz, Sanderson, & Scherbov, 2008a). Ageing is occurring especially quickly in Europe and in Asia. A global comparison of ageing trends indicates that the shares of elderly people in the population are highest in European countries, whereas the numbers of older people are highest in Asian countries (World Population Prospects: The 2015 Revision, 2015). Because of the challenges these population ageing trends are posing for policy-makers, the adequate measurement of population ageing is essential.

An important drawback of the existing measures of ageing—like the proportion of people aged 65 or 80 and over, or the old-age dependency ratio (Lutz, Sanderson, & Scherbov, 2008b)—is that they do not take into account the very large increases in life expectancy at different ages that have been observed in almost all parts of the world over the past five decades (Sanderson & Scherbov, 2015). The elderly who are alive today are healthier and have less severe disabilities than their earlier counterparts (Christensen et al. 2009). The conventional measures do not account for these improvements in health and life expectancy. Hence, there is a tendency to overestimate the impact of population ageing when these indicators are used (Spijker & MacInnes 2013).

Of the various approaches that measure ageing (Skirbekk et al. 2012; d'Albis & Collard 2013; Kot, S. M., Kurkiewicz 2004; Chu 1997; Ryder 1975), the prospective age approach that measures remaining life expectancy (RLE) has become increasingly popular (Warren C Sanderson & Scherbov, 2005, 2007, 2008, 2010, 2013). In this approach, the size of the elderly population (i.e., the people who are older than the old-age threshold) is estimated based not on chronological (and thus on retrospective) age, but on a forward-looking approach that defines the old-age threshold based on a constant RLE of 15 years. By redefining ageing based on remaining life expectancy instead of on the number of years lived, this approach captures improvements in the health and life expectancies of populations. Thus, the advantage of using the RLE15 method—and the associated prospective old-age threshold and prospective old-age dependency ratio—is that it takes into account improvements in life expectancy over time.

While the RLE15 method has been successful at incorporating improvements in life expectancy within a country, using the same RLE for different countries might not sufficiently account for cross-country differences in ageing. Being of a particular chronological age not only means different things in different countries (for which the RLE15 method controls); the commonality of reaching a RLE of 15 years differs substantially between countries with different mortality experiences. For example, if in a given country only 70 per cent of the population are expected to reach the age at which the RLE is 15 years, whereas in another country 90 per cent of the population are expected to reach the age at which the RLE is 15 years, the people in the latter country who reach a RLE of 15 years are less likely to be considered old than the people in the former country. That is, whether you are considered old in a specific country depends on how exceptional it is to reach a certain age. If many people survive to a certain age, then the people who reach that age are not considered old. Therefore, the old-age threshold as measured through RLE15 and the prospective old-age dependency ratio would have different meanings in a country where reaching RLE15 is more common than in a country where reaching RLE15 is less common.

In this paper, we compare ageing in Europe and Asia with a new method that is consistent both over time and between countries by accounting not only for differences in old-age mortality (RLE15), but also for cross-country differences in the commonality of having a RLE of 15.

Using a selected set of countries from Europe and Asia, we will demonstrate the differences in the estimates of the old-age threshold using our new method and using the RLE15 method. In addition, we will compare the share of elderly using our new method with the share of elderly using the RLE15 method and the chronological age 65. We will use our new measure to compare ageing in Europe and in Asia, and to map the extent of ageing for all European and Asian countries.

Sanderson and Scherbov (2008) illustrated their idea of prospective age by analogising it to the idea of ‘inflation’ from the discipline of economics. Just as the value of one dollar in 1950 is greater than the value of one dollar in 2000 due to inflation; the value of the number of years lived in 1950 -say, 65- is greater than 65 years lived in 2000 due to improvements in life expectancy. The proposal to use a RLE of 15 years was derived from this analogy.

Similarly, our idea can be analogised to the concept of ‘exchange rate’ from the discipline of economics. In economics, all currencies are benchmarked against a common currency (usually the US dollar) when making international comparisons. Similarly, the value of reaching the age at which the RLE is 15 is not the same as the value of reaching the age at which the RLE is 15 in another country because of differences in rates of survival to the age at which the RLE is 15. These values can then be benchmarked against a common ‘benchmark country’ in a cross-country analysis of ageing.

2. Methods

2.1 Issues of comparability across countries using the prospective age approach

In the original prospective age approach, the prospective old-age threshold is defined as the age at which the remaining life expectancy (RLE) is 15 years (Sanderson and Scherbov, 2007). The value of 15 was chosen because in Europe in 1980 the RLE at age 65 was indeed 15 years, and because the use of a RLE of 15 years was considered less sensitive to data issues than the use of other values (Sanderson and Scherbov, 2008) of RLE, such as the 10 years suggested by Ryder (1975). Thus, this approach allows for differences in life expectancy over time, and it acknowledges that being of a certain chronological age means different things in different countries. Table 1 shows that in 2012 the old-age threshold for a RLE of 15 years was 74 in Japan, 71 in the Netherlands, and 64 in India.

Table 1: Old-age threshold with RLE15 and percentage of survivors to the age at which RLE15 for selected countries, 2012

Country	*Old-age threshold with RLE=15*	*Percentage of survivors to the age at which RLE=15*
Japan	74	81%
The Netherlands	71	82%
India	64	70%

However, using the same RLE for different countries cannot sufficiently account for cross-country differences in ageing. That is, the age at which RLE=15 differs across countries. In 2012, 81% of the Japanese population, 82% of the population of the Netherlands, and 70% of the population of India were still alive at the age at which RLE=15 (Table 1). As people living in Japan or the Netherlands were more likely to reach the age at which RLE=15 than people living in a developing country like India, the elderly in Japan and in the Netherlands constituted a less selected group than the elderly in India.

When examining ageing trends across countries, it is essential to take into account the exceptionality of reaching a RLE of 15 years in order to avoid comparing groups that are less or more selected.

2.2 Comparative Prospective Old-Age Threshold

Our new measure, which we call the comparative prospective old-age threshold (CPOAT), advances the prospective old-age threshold (POAT) by taking into consideration the commonality of reaching a RLE of 15 years.

Instead of using the proportion of the population who survive to the age at which the RLE is 15 years (see Table 1), we consider the proportion of adults who survive to the age at which the RLE is 15 years in order to determine the exceptionality of reaching a RLE of 15 years in our new ageing measure. That is, we consider the percentage of survivors at the age at which RLE=15 represents survival at all of the previous ages. However, when developing our ageing measure we were particularly interested in the share of the population who are elderly relative to the share of adults who are of working ages. As is the case for the old-age dependency ratio, we chose age 15 as the onset of adulthood. By considering the survival of adults after age 15, we have excluded infant and child mortality from the survival calculations. This also allows us to consider ageing with reference to the working-age population.

In addition, we use a benchmark country for the cross-country analysis of ageing. This approach is analogous to the use of the US dollar as a benchmark currency for the comparison of currencies across countries.

Our comparative prospective old-age threshold is therefore the age at which the proportion of adults who survive to this age (adult survival ratio) equals the proportion of adults who survive to the prospective old-age threshold (the age at which RLE=15) of a benchmark population. The adult survival ratio (ASR) is calculated as:

$$ASR_{x,i} = l_{x,i}/l_{15,i}$$

The ASR for an age x for a country i is the ratio of the population surviving to the age x in country i to the population surviving to age 15. The values of $l_{x,i}$ and $l_{15,i}$ are obtained from the life tables of the respective countries.

For the benchmark country (i.e., the country whose ASR at RLE=15 is compared with those of other countries), we selected Japan in 2012, mainly because Japan has high survival rates at different ages, and has the highest share of elderly by traditional measures of ageing (World Population Prospects: The 2015 Revision, 2015). It may be noted, however, that we could have used any country as the benchmark country, given our interest.

Box 1: Estimation of Comparative Prospective Old-Age Threshold

Panel (I)

Country	*Prospective Old-Age threshold*	*ASR x, i*
Japan in 2012 (Benchmark country)	Age at which RLE=15. This is **74.**	ASR_{74} for Japan = 0.818 = **81.8%**

Panel (II)

Country	*Comparative Prospective Old-Age threshold*
India in 2012	Age at which the ASR for India is 0.818. This is **60.**
The Netherlands in 2012	Age at which the ASR for the Netherlands is 0.818. This is **72.**

Box 1 illustrates the calculation of the CPOAT. For Japan in 2012, the POAT was 74, and 82% of adults were still alive at age 74. The age at which the adult survival ratio equals 82% was 60 in India and 72 in the Netherlands. The CPOAT values of 74, 60, and 72, respectively, were comparable across countries, and accommodate the cross-country differences between countries.

The POAT values for India and the Netherlands were 64 and 71, respectively (see Table 2). Thus, for India, the CPOAT value turns out to be four years higher than the POAT value; whereas for the Netherlands, the CPOAT value turns out to be one year higher than the POAT value. These differences can be related to the ASR values for India and the Netherlands. For India, the ASR to age 64 was 0.74; whereas for the Netherlands, the ASR to age 71 was 0.83. The finding that this value was slightly larger for the Netherlands than for Japan (0.818) means that it was slightly less exceptional for Dutch people than for Japanese people to reach the age at which the RLE is 15 years (74). We can therefore assume that for the Netherlands age 71 was an underestimate of the age that could be considered old. For India, on the other hand, the ASR_{64} was lower than the ASR_{74} for Japan; thus, surviving to age 64 was more exceptional in India than surviving to age 74 was in Japan. We can therefore assume that for India the age at which a person was considered old in 2012 should lie before the age of 64.

Table 2: Comparison of the comparative old-age threshold (CPOAT) with the prospective old-age threshold (POAT), for selected countries, 1960, 2000, 2012

Year	*Country*	*Comparative prospective old-age threshold (CPOAT) with Japan 2012 as benchmark*	*Old-age threshold with RLE15 method (POAT)*
1960			
	Japan	55	62
	The Netherlands	66	64
	India	49	56
2000			
	Japan	71	71
	The Netherlands	68	68
	India	58	61
2012			
	Japan	74	74
	The Netherlands	72	71
	India	60	64

Our method not only takes into account of cross-country differences in the commonality of reaching RLE=15; it also preserves the same trend across time as the trend used in the RLE15 method.

Table 2 shows the CPOAT and POAT values for Japan, the Netherlands, and India for 1960, 2000, and 2012. We can observe that for each year, the CPOAT and POAT values resulted in the same order between the countries with respect to the old-age threshold. In 1960, both the POAT and the CPOAT values were lowest in India and highest in the Netherlands among the countries considered. In 2012, both the POAT and the CPOAT values were highest in Japan and lowest in India. Our method is thus consistent both between countries and over time.

2.3 Empirical Application of the CPOAT

In our empirical application, we will demonstrate our method using Japan as the benchmark. In addition, we will compare the shares of elderly using our new method with the shares of elderly using the RLE15 method and the chronological age 65. We will make this comparison for countries from different geographical locations in Europe and in Asia that have a range of age structures in order to represent the diversity of the results across these two land masses. Moreover, using the new measure we will compare ageing in Europe and in Asia, and map (using QGIS 2.14.3) the extent of ageing for all European and Asian countries. To this end, we used life table and population data for the year 2012 from two sources. For the OECD member countries in Europe and in Asia, we used the available data from the Human Mortality Database (Human Mortality Database, 2015). For the remaining countries, we used data from the Revision of World Population Prospects (United Nations, 2015) that were prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations (UN) Secretariat. Whereas the Human Mortality Database provides annual population and life table data by single year of age, the UN database provides data by five-year age groups for five-year periods. We used UN data for 2010-2015 as an estimate for the year 2012. To obtain data by single year of age based on the UN data by five-year age groups we applied linear interpolation to the population data (Shryock et al. 1976) and the TOPALS technique for smoothing age-specific probabilities of death (Beer, 2012). The probabilities of death by single year of age were subsequently used as the basis for the life table calculations.

3. Results

Table 3 compares the old-age thresholds obtained by our new method (CPOAT) with the old-age thresholds obtained by the RLE15 method (POAT). Since Japan is our benchmark country, the threshold age using the CPOAT and the POAT methods is the same for Japan. For Thailand, India, Vietnam, and Ukraine, the old-age threshold obtained by our method is lower than the old-age threshold obtained by the RLE15 method. For Spain, the Netherlands, Germany, France, and China, adding the cross-country perspective leads to a slightly higher old-age threshold. Thus, the old-age threshold obtained by our new method is lower than the old-age threshold obtained by the RLE15 method for countries that have low survival rates at different adult ages: e.g., for most Asian countries and for Eastern European countries, like Ukraine. The CPOAT is therefore lower than the POAT for Asia.

Table 3: Threshold ages for selected Asian and European countries with the CPOAT method and with the RLE15 method, 2012

With Japan as benchmark country (ASR of 0.818 at RLE 15= 74)			
Country	*Threshold with CPOAT*	*Threshold with RLE15 method (POAT)*	*Difference between the methods (CPOAT-POAT) in years*
Japan	74	74	0
China	67	66	+1
Thailand	63	69	-6
India	60	64	-4
Vietnam	66	71	-5
Spain	74	72	+2
Netherlands	72	71	+1
Germany	71	71	0
Ukraine	59	66	-7
France	72	71	+1
Asia	64	67	-3
Europe	66	70	-4

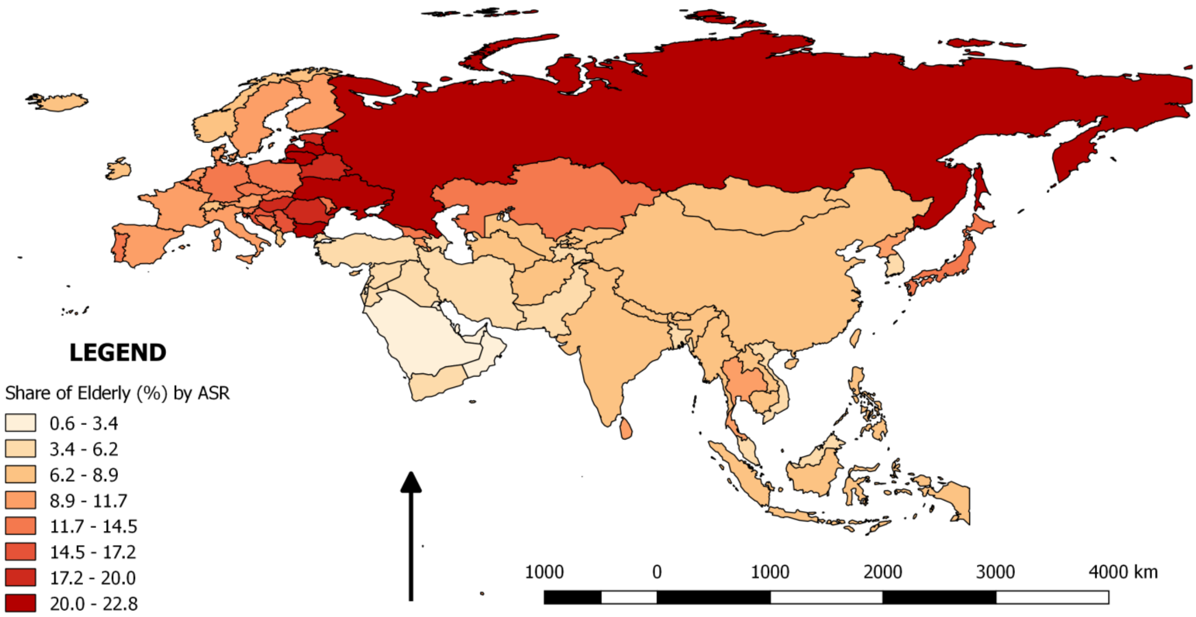
Table 4: Share of elderly for selected European and Asian countries, 2012

With Japan as benchmark country (Threshold for Japan with RLE 15=74)			
Country	*Share of elderly with new method*	*Share of elderly with RLE15 method*	*Share of elderly with traditional method (65+)*
Japan	12.8	12.8	32.08
China	7.26	7.93	9.47
Thailand	11.05	6.79	10.42
India	8.20	5.77	5.59
Vietnam	6.15	4.45	6.99
Spain	9.76	11.03	21.58
Netherlands	9.36	10.19	19.85
Germany	14.44	14.44	26.36
Ukraine	22.45	14.31	18.47
France	11.30	10.54	17.31
Asia	7.64	5.93	7.03
Europe	15.73	12.16	16.77

Table 4 compares the shares of elderly in selected European and Asian countries using our new method, the RLE15 method, and using the traditional method of based on 65 as the old-age threshold. In line with our results in Table 2, we can see that the shares of elderly obtained for countries with low survival rates at different ages (Thailand, India, Vietnam, and Ukraine) are higher when our new method is used than when the RLE15 method is applied. The shares of elderly obtained for these countries using the new method are also higher than or are almost equal to (Vietnam) the shares obtained using the traditional method; whereas for these countries -and indeed for all countries- the use of the RLE 15 method results in lower or almost equal shares of elderly. For Spain, the Netherlands, Germany, France, Japan, and China, the shares of elderly obtained are much more similar when our new method and the RLE15 method are used, and are much lower when the traditional method is used.

Figure 1 shows the shares of elderly for all of the European and the Asian countries calculated using our method for the year 2012. We can see differences in the ageing patterns between and within these two continents. There was wide variation within the two continents with respect to the shares of elderly. Using our new method, we find that the shares of elderly in 2012 were 7.64% for Asia and 15.73% for Europe. Within Asia, we find that the United Arab Emirates and Qatar had the lowest shares of elderly (0.61% and 0.77%, respectively), whereas Thailand and Japan had the highest shares of elderly (over 11%). There was also considerable diversity within Europe, with Iceland and Ireland having the lowest shares of elderly (6.44% and 6.77%, respectively), and the Russian Federation and Ukraine having the highest shares of elderly (over 22%).

Figure 1: Shares of elderly in Europe and Asia using our new method, with Japan as the benchmark country, 2012



4. Discussion

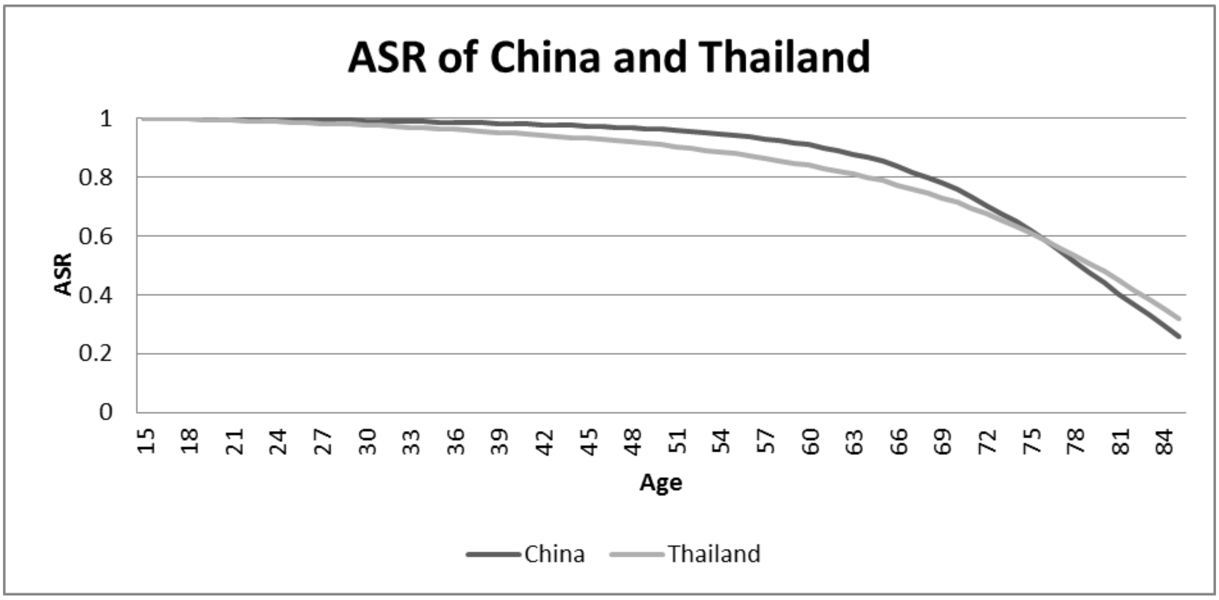
4.1 Summary of results

The old-age thresholds are lower and the shares of elderly are higher when we use the new measure than when we use the prospective age approach for countries that have relatively low adult survival ratios: i.e., for most Eastern European and Asian countries. This is because in these countries a person is regarded as old at a younger age than in the low-mortality countries. Moreover, the differences between the shares of elderly in Europe (15.7%) and in Asia (7.6%) are smaller when chronological age 65 is used (16.8% and 7.0%, respectively), but are larger than when the RLE15 method is used (12.2% and 5.9%, respectively). Within Europe and Asia, we can see clear diversity in ageing patterns.

4.2 Explanation of the observed results

The old-age thresholds are lower and the shares of elderly are higher when we use the new measure than when we use the RLE15 method for countries that have relatively low adult survival ratios. The main difference between the RLE15 method and our method is that we take into account differences in survival rates across the life course, whereas the RLE method focuses only on mortality in later life. In Figure 2, we illustrate why Thailand had a higher prospective old-age threshold (POAT) than China (69 vs. 66), whereas the reverse was true for our comparative prospective old-age threshold (CPOAT) (63 for Thailand but 65 for China). The survival rates were higher for China than for Thailand until age 75. Relative to China, mortality at young adult ages was higher but mortality at old ages was lower in Thailand. Once a person reached a certain age, her prospects of survival were better in Thailand than in China, but her chances of reaching that age were lower in Thailand. This explains why the POAT was higher but the CPOAT was lower for Thailand than for China. A person is considered old at a younger age in Thailand than in China, but older people are in better health in Thailand than in China, assuming the remaining life expectancy can be considered an indicator of health.

Figure 2: Conditional Survival Curves of China and Thailand, 2012



With Japan as the benchmark country, our method shows that the old-age threshold for some countries with relatively low adult survival ratios was lower than age 65, the age that has traditionally been used to mark the beginning of ‘old age’; while when RLE15 was used as the criterion the threshold age was above 65 for most countries. This criterion does not take into account that in countries with high mortality at adult ages, many people do not survive to age 65. High mortality at adult ages has a downward effect on the number of elderly if a fixed old-age threshold age is used. Obviously, this cannot be considered a positive situation. When applied to a country with low mortality rates at old ages, the RLE15 method results in a higher threshold age, as the health status of older people tends to be better. Based on this reasoning, our method results in a lower threshold age if mortality at adult ages is relatively high.

In addition to controlling for cross-country differences in ageing, our method is capable of preserving diversity in ageing as well. The cross-country differences that we observed in Europe (range of 16.38 years) were even higher than the differences in ageing we found using the RLE15 method (range of

8.85 years) (see Appendix I). For Asia, the cross-country differences were similar when both methods were used (range of 12.19 years). The bigger differences that we observed within Europe can most likely be linked to the considerably lower adult survival rates in Eastern European countries than in the rest of Europe (World Population Prospects: The 2015 Revision, 2015). It should also be noted that some of the differences in ageing we observed between countries may well be due to differences in data quality, with the developed countries having better data than the developing and the Eastern European countries (Pyrozhkov, S., N. Foygt 2011). For example, the very low old-age threshold value found for Ukraine (59 years) could be partly attributable to data quality issues.

4.3 Evaluation of our new method

Our new method is able to capture differences in ageing between countries. However, an important feature of the RLE15 method is that it is also able to take into account life expectancy developments over time. Our analysis, which used Japan 2012 as a benchmark, revealed that the rankings of countries over time by shares of elderly based on the CPOAT is the same regardless of whether the new method or the RLE15 method was used. Hence, the improvements in life expectancy and survival rates are accounted for in the same way in the new method as in the RLE15 method.

An important decision that must be made in applying the new method is the choice of a benchmark country. We chose Japan because it has high adult survival ratios at different ages. A sensitivity analysis revealed that using another benchmark country has no effect on the ranking of countries, but it does affect the levels of the estimates. This is analogous to the use of different standard populations in standardisation. The benchmark country that is chosen should therefore always be mentioned. We recommend Japan as a benchmark for worldwide comparisons. But if countries in a specific region like Africa are being studied, we suggest using an African country as the benchmark. For comparisons over time (see the previous paragraph), any ‘normal’ year (in which there was no significant improvement or deterioration in life expectancy and survival rates) can be used as the benchmark.

We used RLE15 for the benchmark country, as our objective was to improve upon the prospective age approach for measuring ageing, which also uses a remaining life expectancy of 15 years. A sensitivity analysis further revealed that the relative positions of countries with respect to the shares of elderly were hardly affected by the use of the RLE of 15 years or of values other than 15 years for the benchmark country. Because our method concentrates mainly on providing a cross-country perspective that considers the survival of populations across all adult ages, our results will be less affected than the prospective age approach by whether 15 years or another value is chosen.

The main argument for using the RLE15 and the ASR together is that (1) the RLE takes into account that older people are likely to be healthier if their life expectancy is higher (and, thus, that people are considered old at an older age), and that (2) the ASR takes into account how common it is for people to reach a certain age (if many people survive to a certain age, that age is not considered old). Attitudes towards the elderly vary across countries due to social and demographic factors. (Giles & Reid 2005; Angus & Reeve 2006). The attitudes towards and the status of the elderly also differ depending whether the share of elderly people in the population is high or low (Dowd & Bengtson 1978). Thus, the health status of the elderly and the attitudes regarding who is considered elderly differ across countries. Our measure captures both of these aspects.

Population ageing can be due to both an increase in life expectancy (living longer) and a decline in fertility. Thus, generations can vary in size. To the extent that increasing life expectancy is accompanied by improvements in the health status of the elderly population, the onset of poor health will be delayed to older ages. As people remain active at higher ages and the age at which they become dependent increases, the age at which people are considered old also rises. For this reason, an increase in life expectancy should result in an older threshold age for calculating the share of the elderly population. In this respect, the effect of mortality on population ageing differs from that of the decline in fertility, which leads to differences in the relative sizes of generations independent of health status.

4.4 Recommendations

Our observation that the old-age threshold in countries with low adult survival ratios is lower -and that, as a result, the old-age dependency ratio is larger than was estimated using the RLE15 method- has important implications for policy-makers. These countries not only perform worse on health measures; they appear to have larger shares of elderly people than were previously estimated.

We believe that our new measure also has implications for other social science disciplines like economics, sociology, and political science. For example, our measure can readily substitute current traditional measures of ageing in many macro-economic models that study savings, expenditure, health care reforms, and fiscal burdens due to ageing.

Our new measure already advances the previous methods in that it takes into account not only improvements over time in health (life expectancy) at older ages, but also differences between countries in the commonality of reaching a particular remaining life expectancy threshold. However, to improve our estimates of the elderly population shares, future research should consider the human capital differences between countries as well (Skirbekk 2004; Day & Dowrick 2004; Engelhardt et al. 2010; Skirbekk et al. 2012). That is, in addition to differences in health, differences in productivity, skills, cognition, and labour force participation signal the age at which the elderly become dependent. These differences should be studied over time and across countries.

Moreover, given the differences in life expectancy between men and women (Rieker & Bird 2005; Luy & Minagawa 2014; Crimmins et al. 2011; Crimmins & Saito 2001), and the differences in human capital in general between the sexes (Blau & Kahn 2000; Becker 1985), it might be worthwhile for these and future measures of ageing to provide sex-specific estimates.

References:

Angus, J. & Reeve, P., 2006. Ageism: A threat to “aging well” in the 21st century. Journal of Applied Gerontology, 25(2), pp.137–152.

Becker, G.S., 1985. Human Capital , effort , and the sexual division of labor. Journal of Labour Economics, 3(1), pp.S33–S58.

Beer, J.A.A. de, 2012. Smoothing and projecting age-specific probabilities of death by TOPALS. Demographic Research, 27(20), pp.543–592.

Blau, F.D. & Kahn, L.M., 2000. Gender differences in pay. Journal of Economic Perspectives, 14(4), pp.75–100.

Christensen, K. et al., 2009. Ageing populations: the challenges ahead. The Lancet, 374(9696), pp.1196–1208.

Chu, C.Y., 1997. Age-distribution dynamics and aging indexes. Demography, 34(4), pp.551–63.

Crimmins, E.M., Kim, J.K. & Solé-Auró, A., 2011. Gender differences in health: Results from SHARE, ELSA and HRS. European Journal of Public Health, 21(1), pp.81–91.

Crimmins, E.M. & Saito, Y., 2001. Trends in healthy life expectancy in the United States, 1970-1990: Gender, racial, and educational differences. Social Science and Medicine, 52(11), pp.1629–1641.

d’Albis, H. & Collard, F., 2013. Age Groups and the measure of population aging. Demographic Research, 29(September), pp.617–640.

Day, C. & Dowrick, S., 2004. Ageing Economics: Human capital, productivity and fertility. Agenda, 11(1), pp.3–20.

Dowd, J.J. & Bengtson, V.L., 1978. Aging in minority populations. An examination of the double jeopardy hypothesis. Journal of gerontology, 33(3), pp.427–436.

Engelhardt, H. et al., 2010. Social involvement, behavioural risks and cognitive functioning among older people. Ageing and Society, 30(5), pp.779–809.

Giles, H. & Reid, S.A., 2005. Ageism across the lifespan: Towards a self-categorization model of ageing. Journal of Social Issues, 61(2), pp.389–404.

Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research. (Germany). Available at: www.mortality.org (data downloaded on June 16, 2015)

Kot, S. M., Kurkiewicz, J., 2004. The new measures of population aging. Studia Demograficzne (Demographical Studies), 146(2), pp.17–29.

Lesthaeghe, R., 2010. The unfolding story of the second demographic transition. Population and Development Review, 36(2), pp.211–251.

Lutz, W., Sanderson, W. & Scherbov, S., 2008. The coming accleration of population ageing. Nature, (451), p.716.

Lutz, W., Sanderson, W.C. & Scherbov, S., 2008. Global and regional population ageing: How certain are we of its dimensions? Journal of Population Ageing, 1(2008), pp.75–97.

Luy, M. & Minagawa, Y., 2014. Gender gaps - life expectancy and proportion of life in poor health. Health Reports, 25(12), pp.12–19.

Pyrozhkov, S., Foygt, N. and Jdanov, D., 2011. About mortality data for Ukraine. The Human Mortality Database. Background and documentation. https://www.demogr.mpg.de/publications/files/2523_1172249421_1_UKRcom.pdf

Rieker, P.P. & Bird, C.E., 2005. Rethinking gender differences in health: why we need to integrate social and biological perspectives. The Journals of Gerontology: Series B, Psychological Sciences and Social Sciences, 60B(II), pp.40–47.

Ryder, N.B., 1975. Notes on stationary populations. Population Index, 41(1), pp.3–28.

Sanderson, W. & Scherbov, S. 2008, Rethinking age and aging, Population Bulletin, vol. 63, no. 4.

Sanderson, W.C. & Scherbov, S., 2007. A new perspective on population aging. Demographic research, 16(2), pp.27–58.

Sanderson, W.C. & Scherbov, S., 2005. Average remaining lifetimes can increase as human populations age. Nature, 435(7043), pp.811–813.

Sanderson, W.C. & Scherbov, S., 2010. Demography. Remeasuring aging. Science (New York, N.Y.), 329(5997), pp.1287–1288.

Sanderson, W.C. & Scherbov, S., 2015. Faster increases in human life expectancy could lead to slower population aging. PLoS ONE, 10(4).

Sanderson, W.C. & Scherbov, S., 2013. The characteristics approach to the measurement of population aging. Population and Development Review, 39(4), pp.673–685.

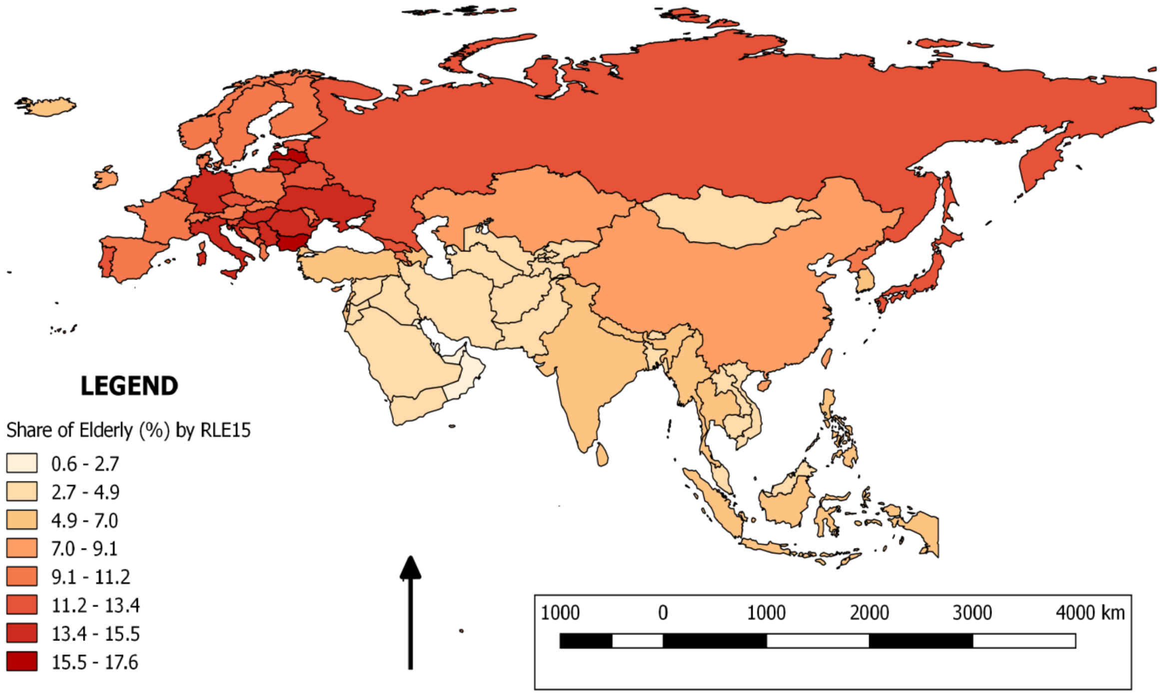
Skirbekk, V., 2004. Age and individual productivity: A literature survey. Vienna yearbook of population research, pp.133-153.

Skirbekk, V., Loichinger, E. & Weber, D., 2012. Variation in cognitive functioning as a refined approach to comparing aging across countries. Proceedings of the National Academy of Sciences of the United States of America, 109(3), p.770.

Spijker, J. & MacInnes, J., 2013. Population ageing: the timebomb that isn't? BMJ, 347, pp.f6598-6603.
Shryock, H.S.S., Stockwell, J.S. and Edward, G., 1976. Methods and materials of demography/Henry S. Shryock, Jacob S. Siegel, and associates.
World Population Prospects: The 2015 Revision 2015, Department of Economic and Social Affairs, United Nations, New York..

Appendix I

Share of Elderly (%) in Europe and Asia, using RLE15 method, 2012



Measuring population ageing based on a fixed old-age threshold like 65 ignores increasing life expectancy among elderly people. Sanderson and Scherbov introduced the prospective age approach based on the age at which the remaining life expectancy is 15 (RLE15). Their approach is time-horizon consistent, but ignores cross-country differences in reaching RLE15.
We compare population ageing in Europe and Asia using a new method that is consistent over time and between countries.
Our old-age threshold is the age at which the adult survival ratio equals the proportion of adults surviving to the prospective old-age threshold of the benchmark country (Japan). Our old-age threshold is lower and our share of elderly is higher than were found using the prospective age approach for countries with low adult survival. Our method also revealed greater differences between the shares of elderly in Europe (15.7%) and Asia (7.6%) than were found using the RLE15 method.

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.

NIDI is a research institute of the Royal Academy of Arts and Sciences (KNAW).