A Unifying Framework for the Study of Population Aging

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Theme

- Population ageing needs to be studied on the basis of the characteristics of people.

However, …

- As a characteristic, chronological age has one very important advantage.

- People have only one chronological age, but they have many characteristics.

Effects of using characteristic-based measures

- Economic growth
- Health behaviors
- Pension ages
- Economic dependency

Question

- How is it possible to unify such different dimensions of aging?

Alpha-ages

- The unification is based on what we call Alpha-ages.
- Alpha-ages are characteristic-based ages.
- Through the use of alpha-ages, we hope to make the study of population ageing based on the characteristics of people natural, intuitive, and insightful.

Organization of this Presentation

- 1. Introduction
- 2. How to Compute Alpha-Ages
- 3. Example 1: Alpha-Ages and Educational Differentials in Remaining Life Expectancy in Europe
- 4. Example 2: Survival-based Alpha-Age Trajectories
- 5. Example 3: Biomarker-based Alpha-Ages
- 6. Example 4: Alpha-Ages as analytic normal pension ages
- 7. Discussion of subjective age and biological age
- 8. Discussion of thanatological age
- 9. Conclusion

Section 2: How to Compute Alpha-Ages

Alpha-Ages are based on Characteristic Schedules

- A characteristic schedule shows the relationship between chronological age and a quantitatively measured characteristic of people.
- Hypothetically,

Chronological Age	Characteristic Level
60	25
61	24
62	22
63	20
64	17

Characteristic Schedule

- A characteristic schedule shows the relationship between chronological age and a quantitatively measured characteristic of people.
- $C_r(a) = k\,;\qquad a = C_r^{-1}(k),$

Chronological Age	Characteristic Level
60	25
61	24
62	22
63	20
64	17

Alpha-age

- $\alpha = C_s^{-1}\big(C_r(a)\big)$

- An alpha-age is the age in characteristic schedule *s* corresponding to the level of the characteristic observed at chronological age *a* in characteristic schedule *r.*

Section 3: Example 1: Alpha-Ages of 50 Year Old Europeans by Level of Education

Example 1:

Prospective Ages of 50 Year Olds By Education

$\alpha = C_s^{-1}\big(\, C_r(a)\big)$

Characteristic (C( ))	Remaining life Expectancy
Constant Parameters	*a* and *s* *a* = 50 years old, *s* are sex-specific life tables for Italians with at least some tertiary education
Variable Parameters	*r* *r* is a set of 16 European life tables by sex and level of education (latest available year)

Males					Females			
	Low Ed.	Med. Ed.	High Ed.			Low Ed.	Med. Ed.	High Ed.
Eastern Europe								
Macedonia	60.84	58.12	54.67		Macedonia	59.32	57.83	55.85
Slovenia	60.45	54.52	51.90		Slovenia	54.64	52.22	51.32
Average	63.58	57.77	54.58		Average	57.77	55.78	54.03
std. dev.	2.78	1.35	1.65		std. dev.	1.98	1.58	1.68
Western Europe								
Denmark	56.82	54.78	52.77		Denmark	56.27	54.30	53.33
Italy	53.99	50.15	50.00		Italy	52.19	50.16	50.00
Norway	55.48	52.85	50.95		Norway	54.25	52.49	51.61
Average	55.08	53.28	51.74		Average	53.90	52.66	51.84
std. dev.	1.11	1.62	1.09		std. dev.	1.24	1.32	1.04

Alpha-ages of 50 year olds in the indicated country/region (Italians with college education as the standard)

Section 4: Example 2: Alpha-Age Trajectories of Survival Rates

Alpha-age trajectories

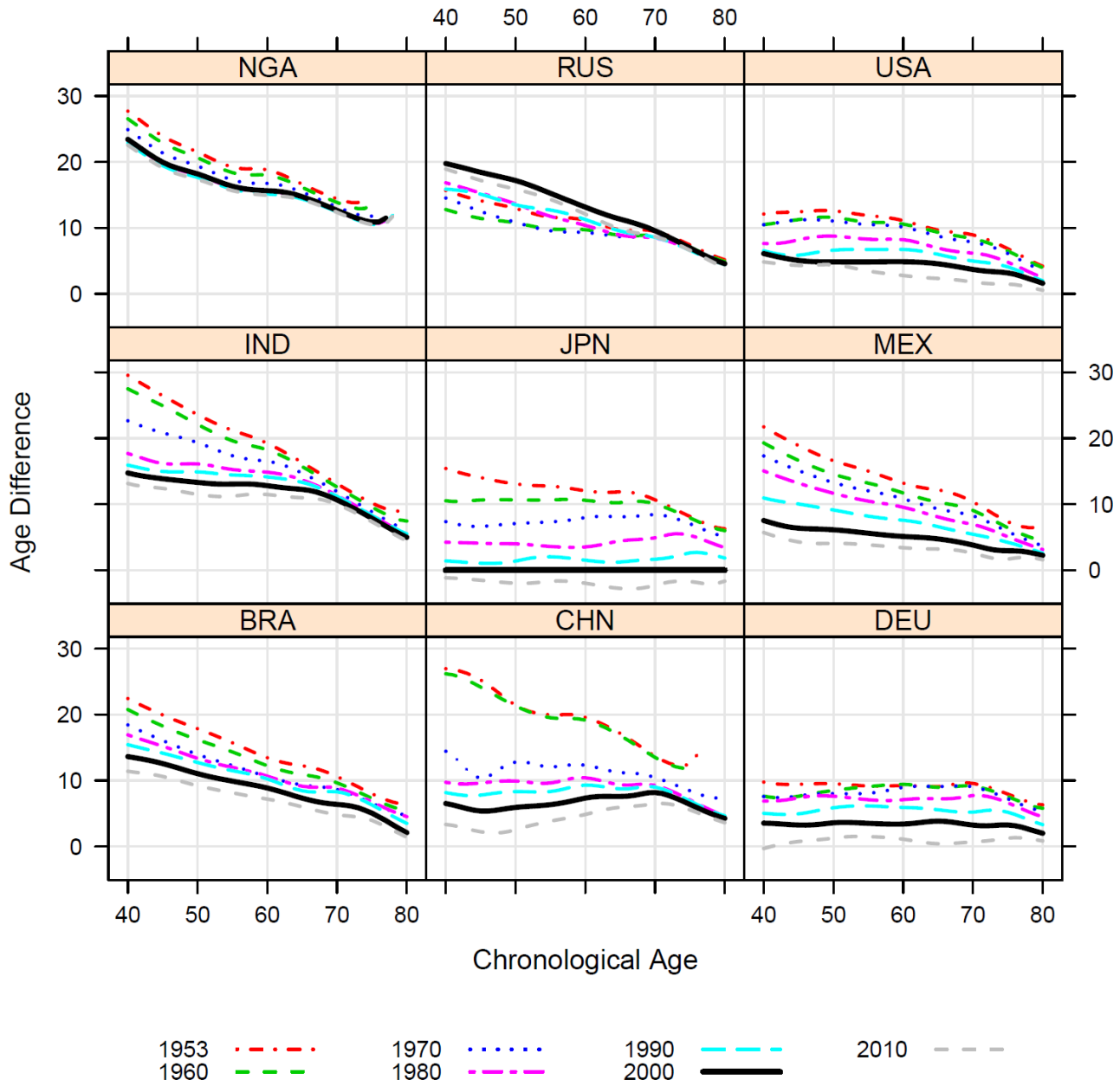
- Alpha-age trajectories are alpha-ages minus chronological ages.
- They are useful in visualizing patterns of aging across ages.
- By using a country considered the “best” with respect to a particular characteristic, we can easily visualize how far countries are from the “best” at each age.

Example 2:

Survival-Based Age Trajectories for Countries –(Japan in 2010 as a standard)

$$C^{-1}{}_{s}\left(C_{r}\left(a\right)\right)-a=\alpha-a$$

Characteristic ($C(\ )$)	Probability of Surviving for the Next Five Years (l_{x+5}/l_x)
Constant Parameters	***s***, *s* is a sex-specific life table for Japan in 2000
Variable Parameters	***a*** and ***r*** *a* is a set of ages between 40 and 80, *r* is one of a set of sex-specific life tables for the country of interest for the years 1953, 1960, 1970, …, 2010


NGA
RUS
USA
IND
JPN
MEX
BRA
CHN
DEU
Age Difference
Chronological Age
0
10
20
30
40
50
60
70
80
1953
1960
1970
1980
1990
2000
2010

Section 5: Example 3: Alpha-Ages Based on a Biomarker – Handgrip strength

Example 3: **Alpha-Ages of Population Subgroups Based on Hand-Grip Strength** $\alpha = C_s^{-1}\big(\, C_r(a)\big)$	
Characteristic (C( ))	Hand-grip strength, measured in kilograms
Constant Parameters	r and s, r is the age-specific hand-grip strength of people in a specific gender and race group with more education s is the age-specific hand-grip strength of people in a specific gender and race group with less education
Variable Parameters	a a is a set of ages between 60 and 80,

Hand Grip Paper

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Example 4:
Alpha-Ages as Normal Pension Ages –(German 2013 basis)

$$C^{-1}{}_{s}\left(C_{r}\left(a\right)\right)$$

Characteristic (C( ))	Proportion of adult person-years lived after age a , $\left(\frac{T_a}{T_{20}}\right)$
Constant Parameters	a and r, a is age 65, r is the characteristic schedule for German women in 2013
Variable Parameters	s s is a set of characteristic schedules for women in selected European countries in the years 2013, 2020, 2040 and 2050.

Women, German basis

Country	2013	2020	2030	2040	2050
Bulgaria	61.70	62.09	63.26	64.43	65.67
France	66.90	67.57	68.82	70.01	71.29
Georgia	62.17	62.53	63.67	64.85	66.06
Germany	65.00	65.82	67.09	68.34	69.62
Greece	64.98	65.95	67.30	68.57	69.86
Ireland	64.94	65.62	66.80	68.00	69.24
Italy	66.28	66.93	68.20	69.47	70.73
Latvia	62.49	63.15	64.31	65.52	66.72
Russian Federation	60.99	61.34	62.41	63.41	64.46
Serbia	61.21	61.81	63.02	64.25	65.50
Slovakia	62.81	63.58	64.81	66.03	67.29
Spain	66.29	66.70	67.93	69.18	70.45
Sweden	65.13	65.83	67.03	68.27	69.54
United Kingdom	64.99	65.67	66.96	68.18	69.40

Intergenerationally Fair Pension Ages

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Section 7: Subjective Age and Biological Age – Unifying what appear to be opposites

Subjective Age and Biological Age

- HRS (Health and Retirement Survey – US) and its sister surveys include questions which can be used to compute subjective life expectancies and subjective life expectancies can be used to compute subjective ages.
- NHANES III (National Health and Nutrition Examination Survey III – US) includes questions on biological variables that can be used to compute biological ages.

Both are based on characteristic schedules

- Subjective age uses characteristic schedules based on subjective life expectancy.

- Levine and Crimmins (*American Journal of Human Biology*, 2014) use nine biological measures. The first step in the process of producing biological age is to compute characteristic schedules for each of the nine measures.

Section 8: Thanatological Age

Thanatological Beta-ages

- Let $D_r(b)$ be a characteristic schedule defined over thanatological ages.
- The analog of an alpha-age is:
- $\beta = D_s^{-1}\big(D_r(b)\big)$

- Subjective thanatological beta-ages might be interesting to explore in the future.

Section 9: Conclusion

Studying Population Aging on the Basis of Characteristics Without Fear

- There are many interesting characteristics that we might want to study.
- Each might be measured in different units.
- In this paper, we have shown that different characteristics can be analyzed within a unified framework by translating them into ages.