New Measures of Population Ageing

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www.reaging.org

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Population Aging According to the UN World Population Prospects, 2017 Revision

According to data from World Population Prospects: the 2017 Revision, the number of older persons — those aged 60 years or over — is expected to more than double by 2050 and to more than triple by 2100, rising from 962 million globally in 2017 to 2.1 billion in 2050 and 3.1 billion in 2100

……

Population ageing is poised to become one of the most significant social transformations of the twenty-first century…..

http://www.un.org/en/sections/issues-depth/ageing/

Definition of Population Aging

General definitions:

Population aging - the process by which older individuals become a proportionally larger share of the total population" *UN report on World Population Aging: 1950-2050*

Aging of population is a summary term for shifts in the age distribution (i.e., age structure) of a population toward older ages. *The Encyclopedia of Population, Paul Demeny and Geoffrey McNicoll (Eds.)* , New York, Macmillan Reference USA, 2003

Measures of Population Aging

"…the aging of population is often measured by increases in the percentage of elderly people of retirement ages" *The Encyclopedia of Population*

"The median age -- the age at which exactly half the population is older and another half is younger -- is perhaps the most widely used indicator" *The Encyclopedia of Population*

"population aging occurs when the median age of a country or region rises" *Wikipedia*

Measures of Population Aging

Since the study of population aging is often driven by a concern over its burdening of retirement systems, **old age dependency ratio** (the number of individuals of retirement ages compared to the number of those of working ages usually) is used as a related measure of population aging.

Who is OLD?

- How do we measure the proportion of older people? Obviously we have first to define what old means. UN defines older persons as those aged 60 year or over. On many occasions it is defined as 65+.
- This boundary is kept fixed for calculations

Who is OLD?

"Age 65 is generally set as the threshold of old age since it is at this period of life that the rates for sickness and death begin to show a marked increase over those of the earlier years"

Who is OLD?

"Age 65 is generally set as the threshold of old age since it is at this period of life that the rates for sickness and death begin to show a marked increase over those of the earlier years"

Isaac Rubinow, 1916

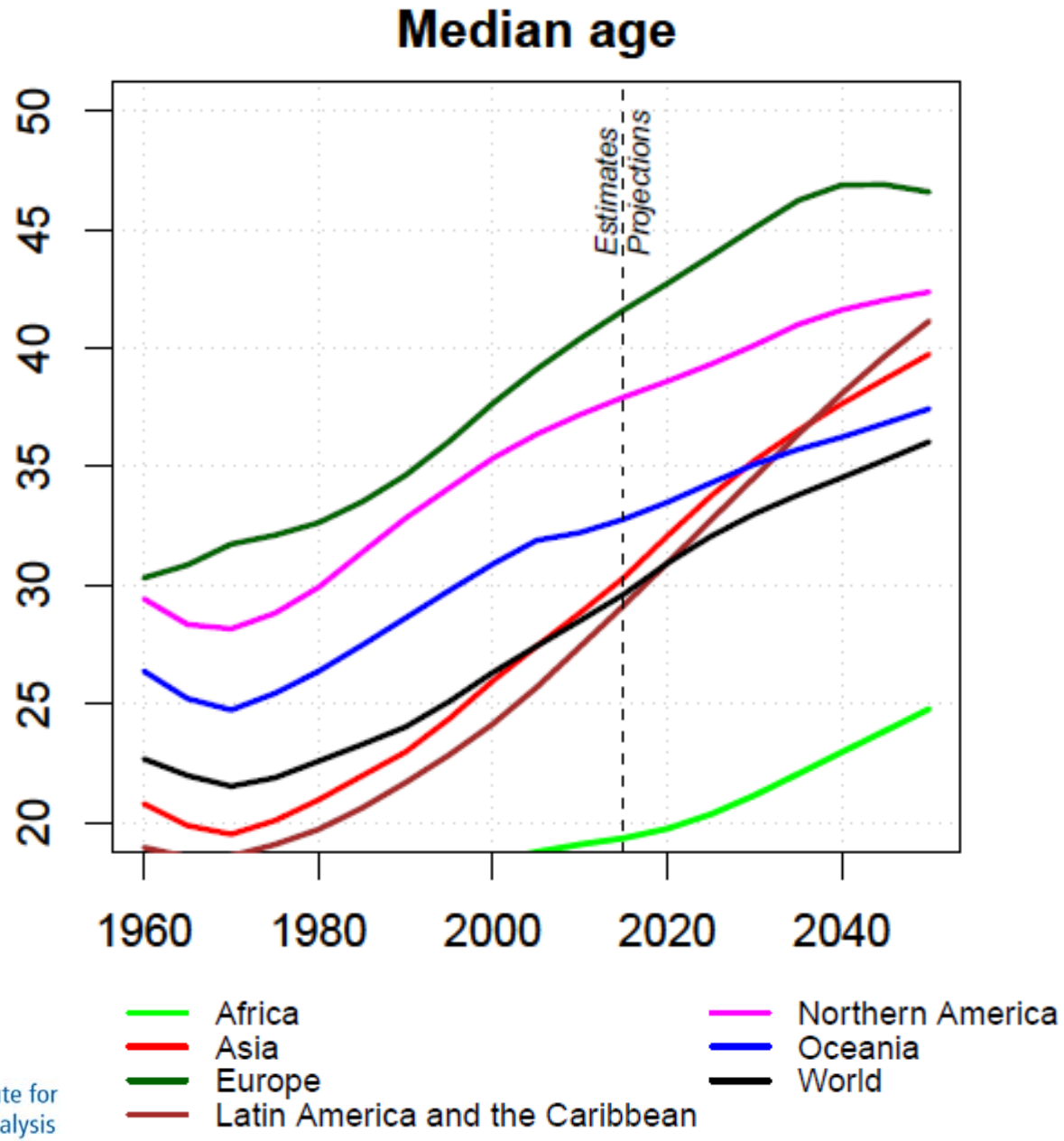
The Record for Oldest Male Summiter, Everest

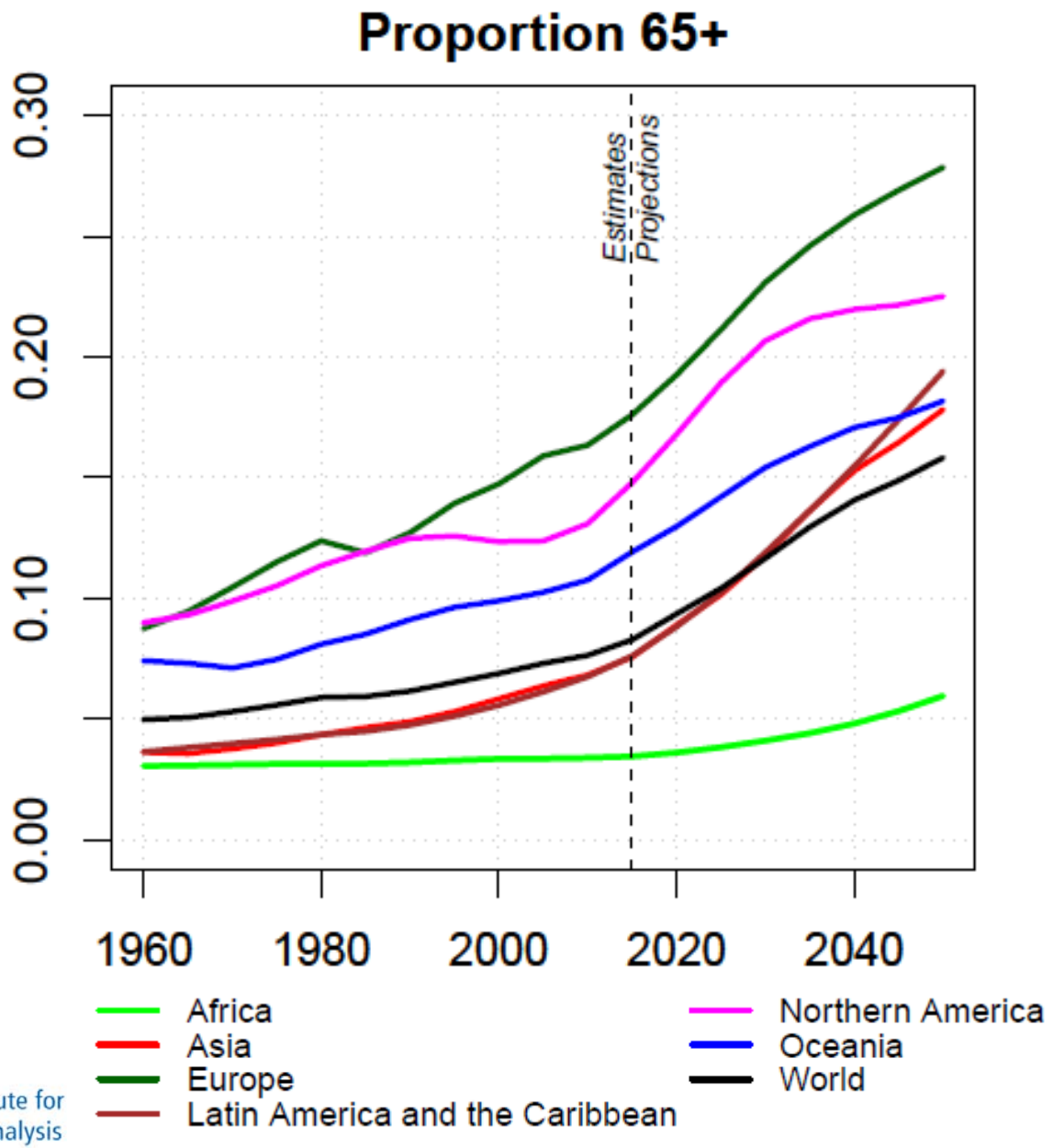
Record	Owner	Nation	Date	Ref
80 years 224 days	Yuichiro Miura	Japan	May 23, 2013	[29]
76 years 340 days	Min Bahadur Sherchan	Nepal	2008	[29][30][31]
75 years 227 days	Yuichiro Miura	Japan	2008	[29][30][31]
71 years 61 days	Katsusuke Yanagisawa	Japan	May 22, 2007	[32][33]
70 years 225 days	Takao Arayama	Japan	May 2006	[33][34]
70 years 222 days	Yuichiro Miura	Japan	May 2003	[29][30][33][34]
65 years 176 days	Tomiyasu Ishikawa	Japan	17 May 2002	[35]
64 years	Sherman Bull	United States	May 25, 2001	[36][37]
63 years 311 days	Toshio Yamamoto	Japan	2000	[38][39]
60 years 161 days	Lev Sarkisov	Georgia	May 12, 1999	[38][40]
60 years 160 days	Ramon Balanca (Blanco) Suarez	Venezuela	1993 (b. 1933)	[41]
55 years	Richard Bass	United States (b. 1929)	April 1985	[41][42]
50 years 118 days	Gerhard Schmatz (b 1929)	West Germany	October 1979	[35][43]
50 years	Chris Bonington (b. 1934)	United Kingdom	April 1985	[41]
50 years	Jozef Psotka (b. 1934, died on descent)	Czechoslovakia	October 1984	[41]
49 years 52 days	Pierre Mazeaud (b 1929)	France	15 Oct 1978	[35]
42 years 6 months	Sonam Gyatso (b 1922)	India (Sikkim)	22 May 1965	[35]
39 years	Tenzing Norgay	Nepal	29 May 1953	[35]

Traditional Measures of Aging

Major Data Sources

1. World Population Prospects 2017 Revisions, United Nations
   https://esa.un.org/unpd/wpp/
2. World Population Prospects 2015 Revisions, United Nations
   https://esa.un.org/unpd/wpp/
3. Human Mortality Database (HMD)
   http://www.mortality.org/
4. European Demographic Data Sheet 2016
   http://edds2016.populationeurope.org/


Median age
20
25
30
35
40
45
50
1960
1980
2000
2020
2040
Estimates
Projections
Africa
Asia
Europe
Latin America and the Caribbean
Northern America
Oceania
World


Proportion 65+
0.00
0.10
0.20
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Estimates
Projections
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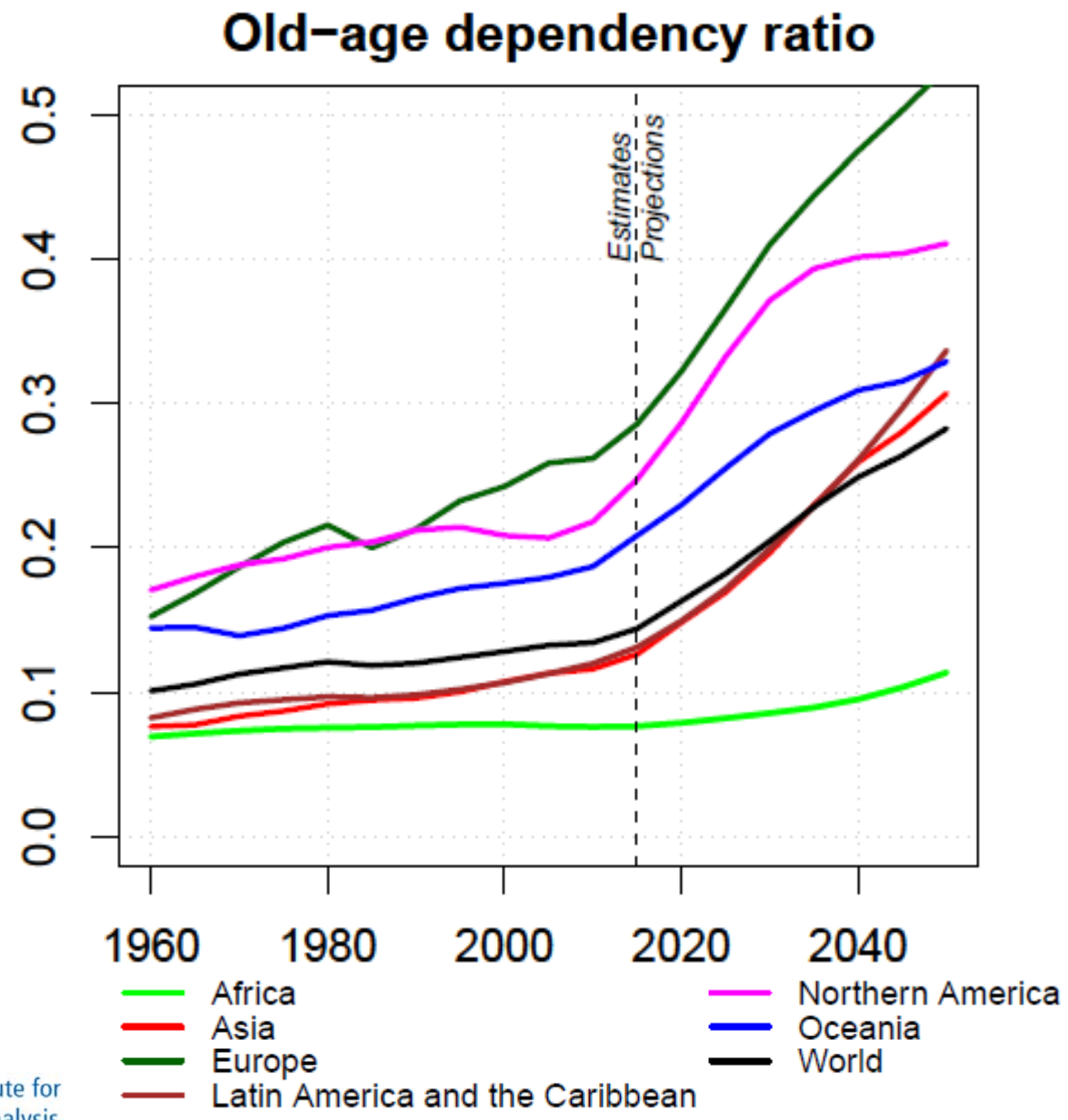

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New Measures of Aging

1. **Prospective Age and Prospective Median Age**
2. Proportion of elderly people

Prospective Age

The literature on population aging is exploding.

Concerns are expressed about the challenges to current economic and social arrangements associated with an ever more elderly population.

in contrast

The concepts used in analyzing aging have remained static.

Prospective Age

To illustrate the concept :

Suppose a man living in Western Europe is going to celebrate his 60th birthday. Is he OLD?

Prospective Age

Today this person would be considered middle-aged, and around 93 percent of men survive until that age.

About 150 year ago less then 25% were celebrating their 60th birthday. And indeed, at those times someone at age 60 was considered an old man.

Prospective Age

Why is a person of the same age considered middle-aged today, while 200 years ago he was considered old?

Prospective Age

The traditional age measure is a backward-looking one. It tells us how many years a person has already lived.

But this is an incomplete measure because it ignores **changes in life expectancy.**

Young and old are relative notions and their common reference point is life expectancy

Prospective Age

In Sanderson W. and Scherbov S. "Average remaining lifetimes can increase as human populations age", ***Nature*** 435: 811-813**,** 2005 June 9

and in Sanderson, W. and Scherbov S. "Remeasuring Aging", ***Science*** 329: 1287-1288, 2010 September 10

we presented and further developed a new forward-looking definition of age called "***prospective age***".

It is important to have a forward-looking measure of age not only because many behaviors are influenced by a person's expected remaining years of life, but because important economic and social magnitudes depend on it as well.

Prospective Age

Prospective age measures how old people are, not only from the date of their birth, but also in relation to their lengthening life expectancies.

Prospective Age

Back to our example:

Using the concept of perspective age we may state that someone who is 60 today, may be in some respect equivalent to a person who was 43 years in 1850

A person who was 60 years old 150 years ago, may resemble someone who is 74 today.

Prospective Age

Essentially, we recognized people as having two different ages:

Chronological age, or as we sometimes call it, “retrospective age”, is a measure of how many years a person has already lived. Everyone of the same age has lived the same number of years.

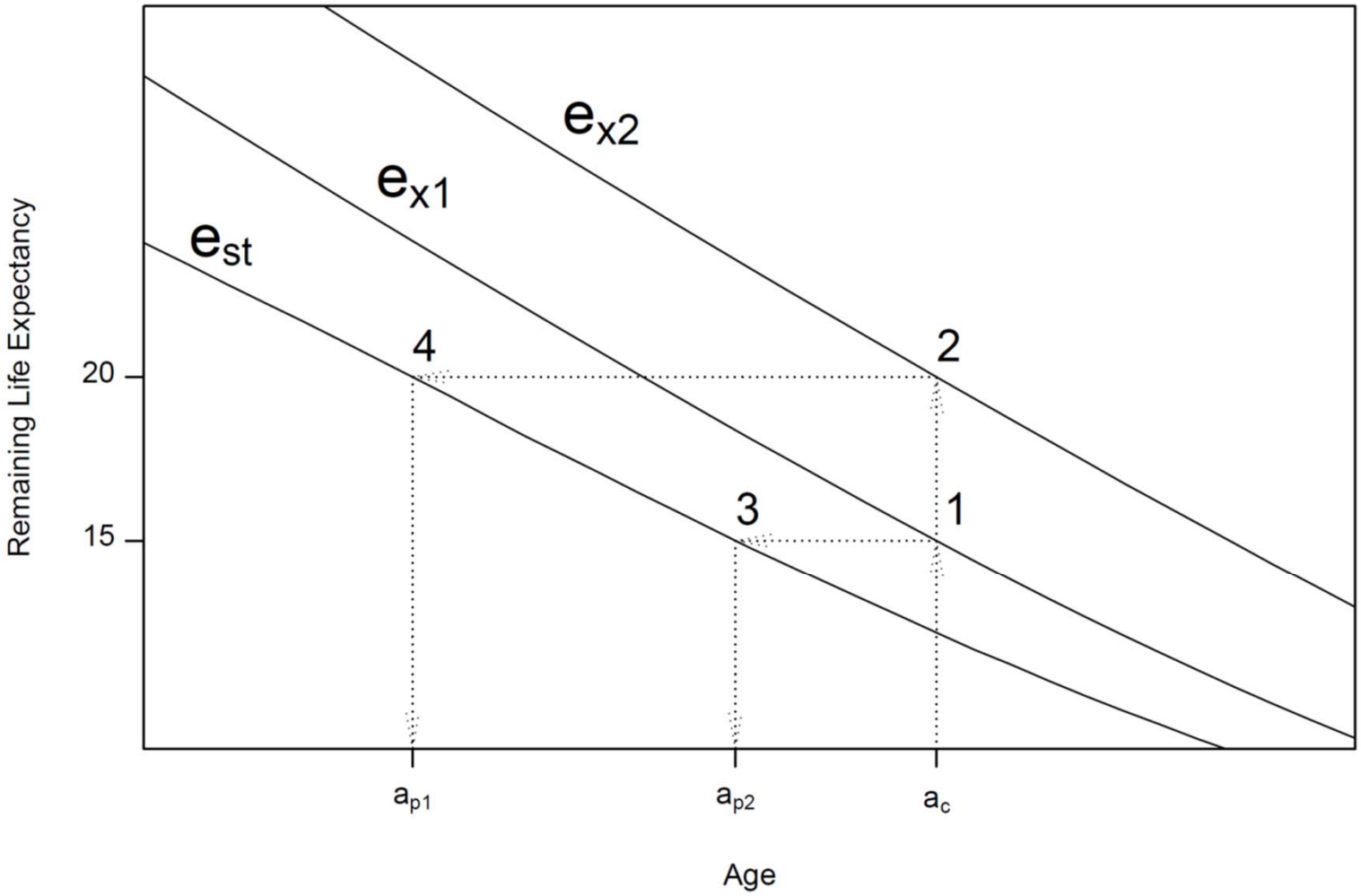
In contrast, ***prospective age*** is concerned about the future. Everyone with the same prospective age has the same expected remaining years of life.

Prospective Age

Prospective age requires a year of reference, called the "***standard year***".

For example, all people who have a prospective age of 40 have the same remaining life expectancy as a 40-year old person in the ***standard year.***

Prospective Ages

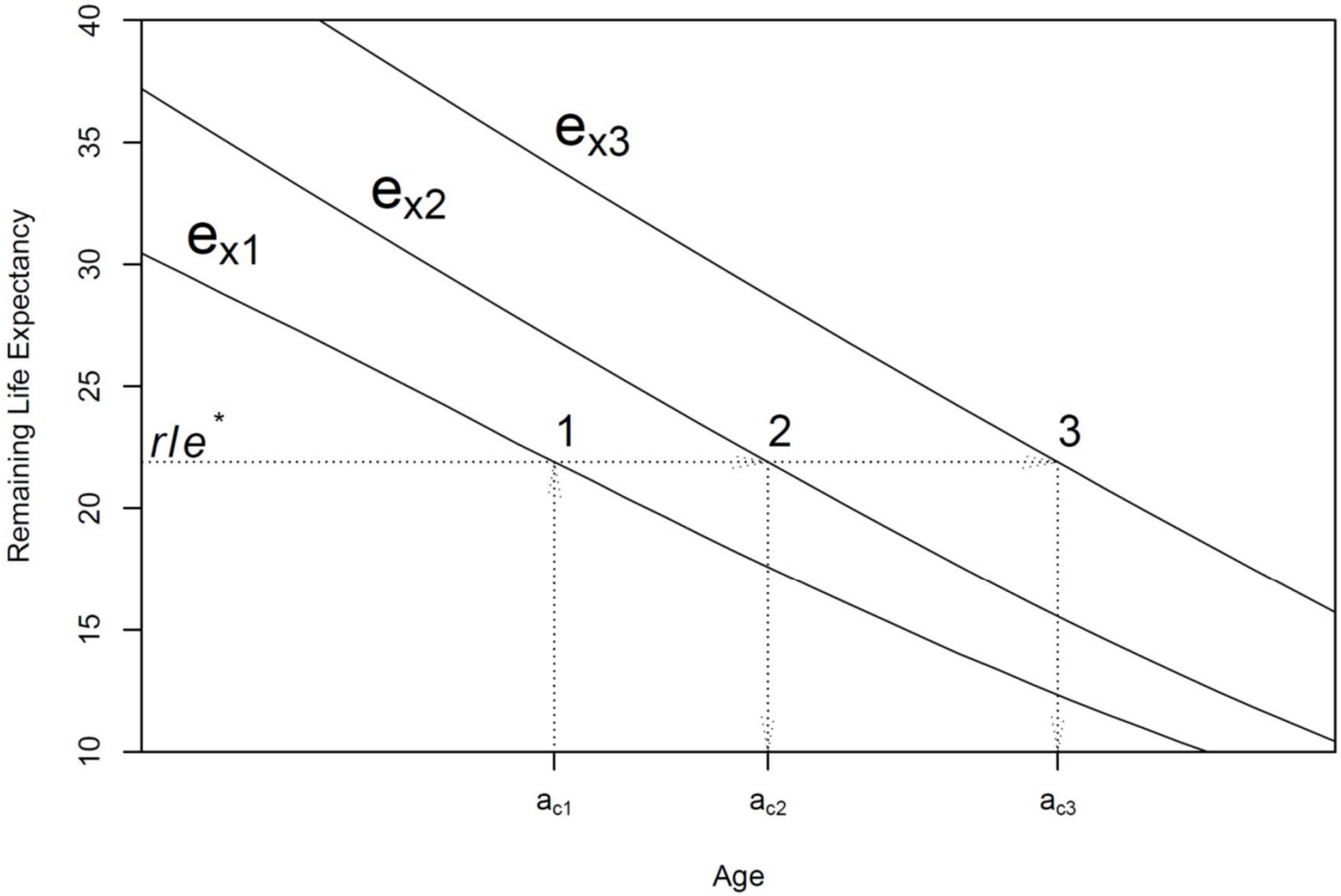


Prospective Age=40

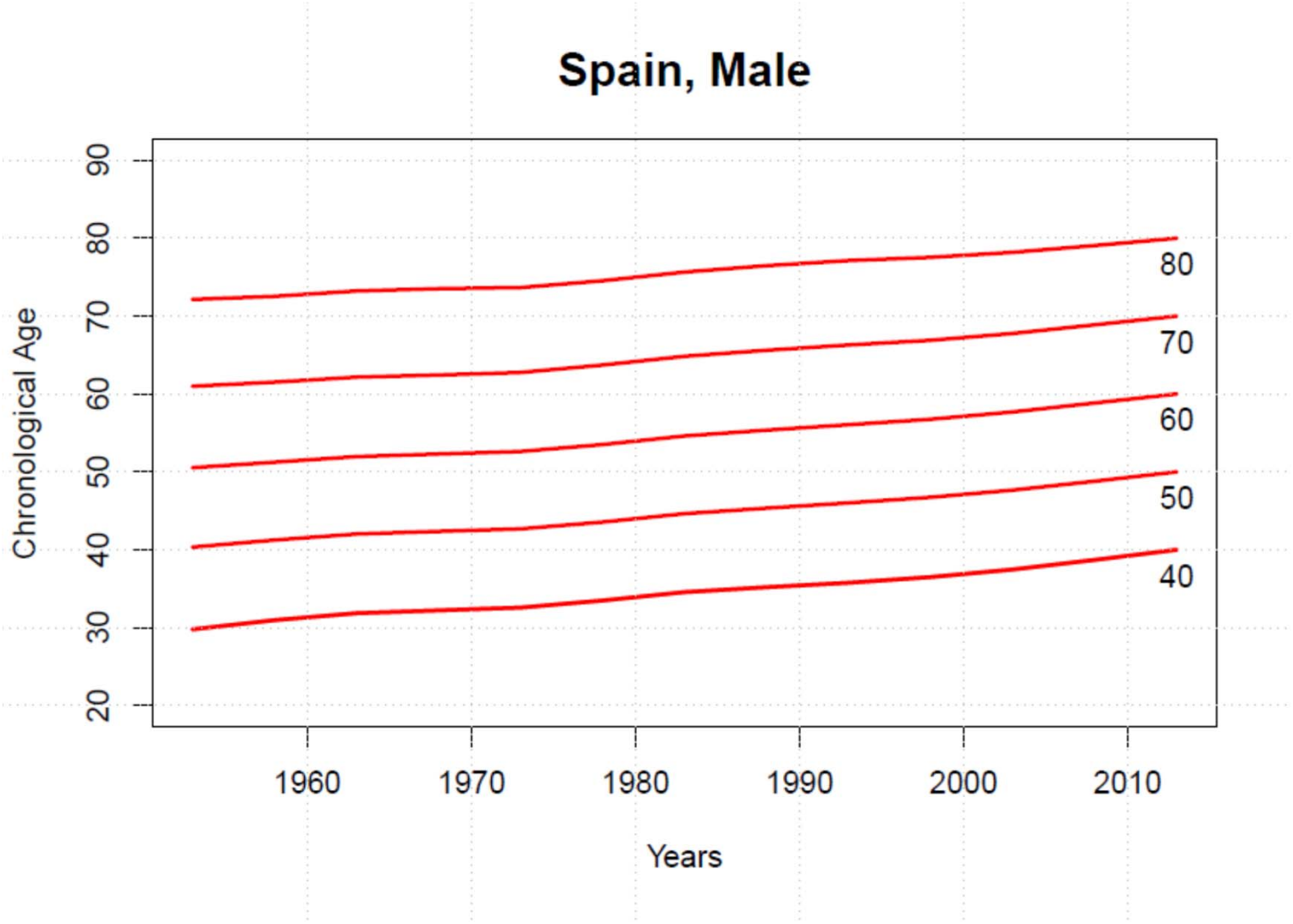
China, Standard Period 1950-1955

Period	Females	Males
1950-1955	40.00	40.00
1970-1975	48.19	48.67
1990-1995	52.09	52.37
2010-2015	54.57	55.21
Remaining life expectancy	25.50	22.51

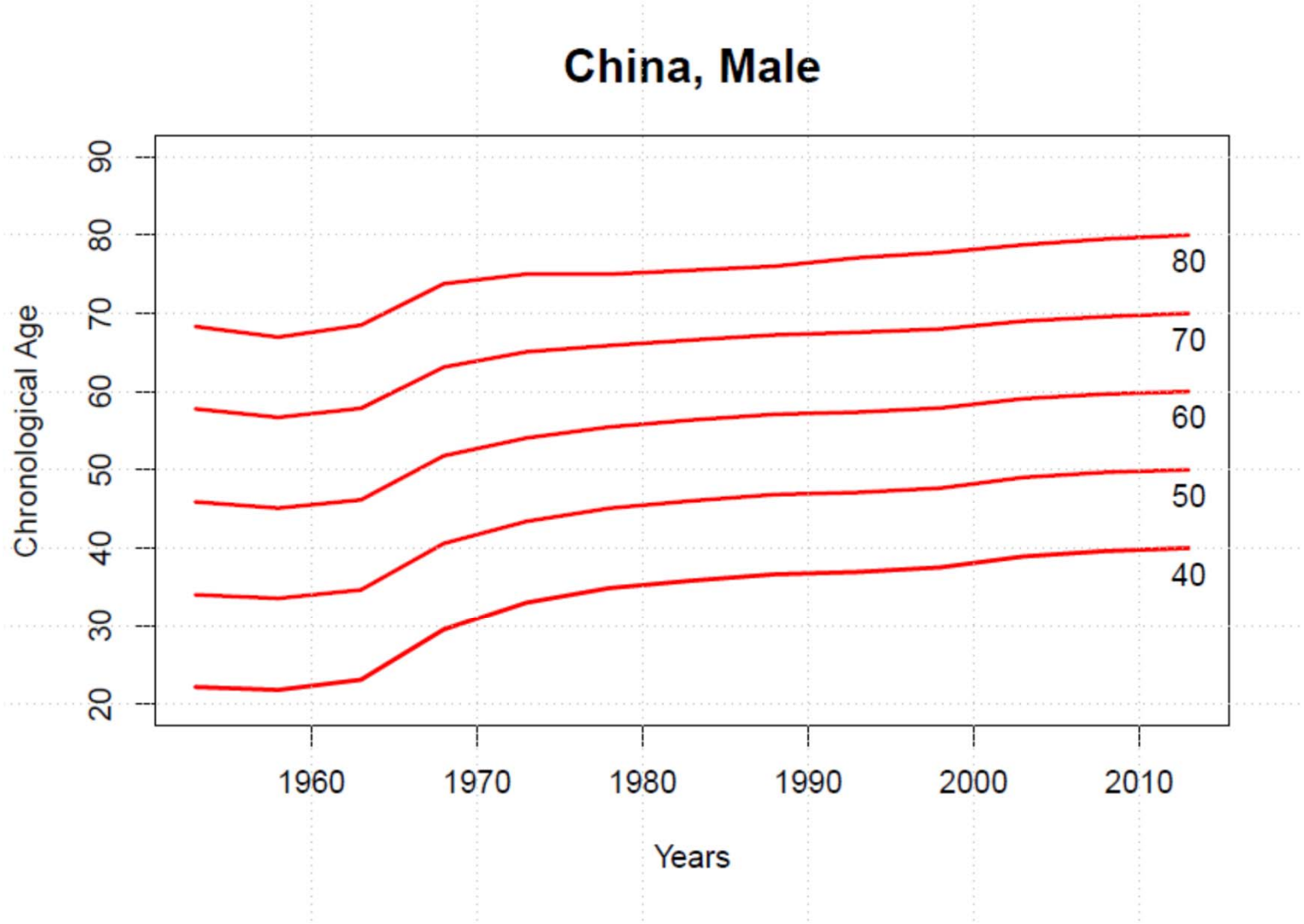
Constant RLE Ages



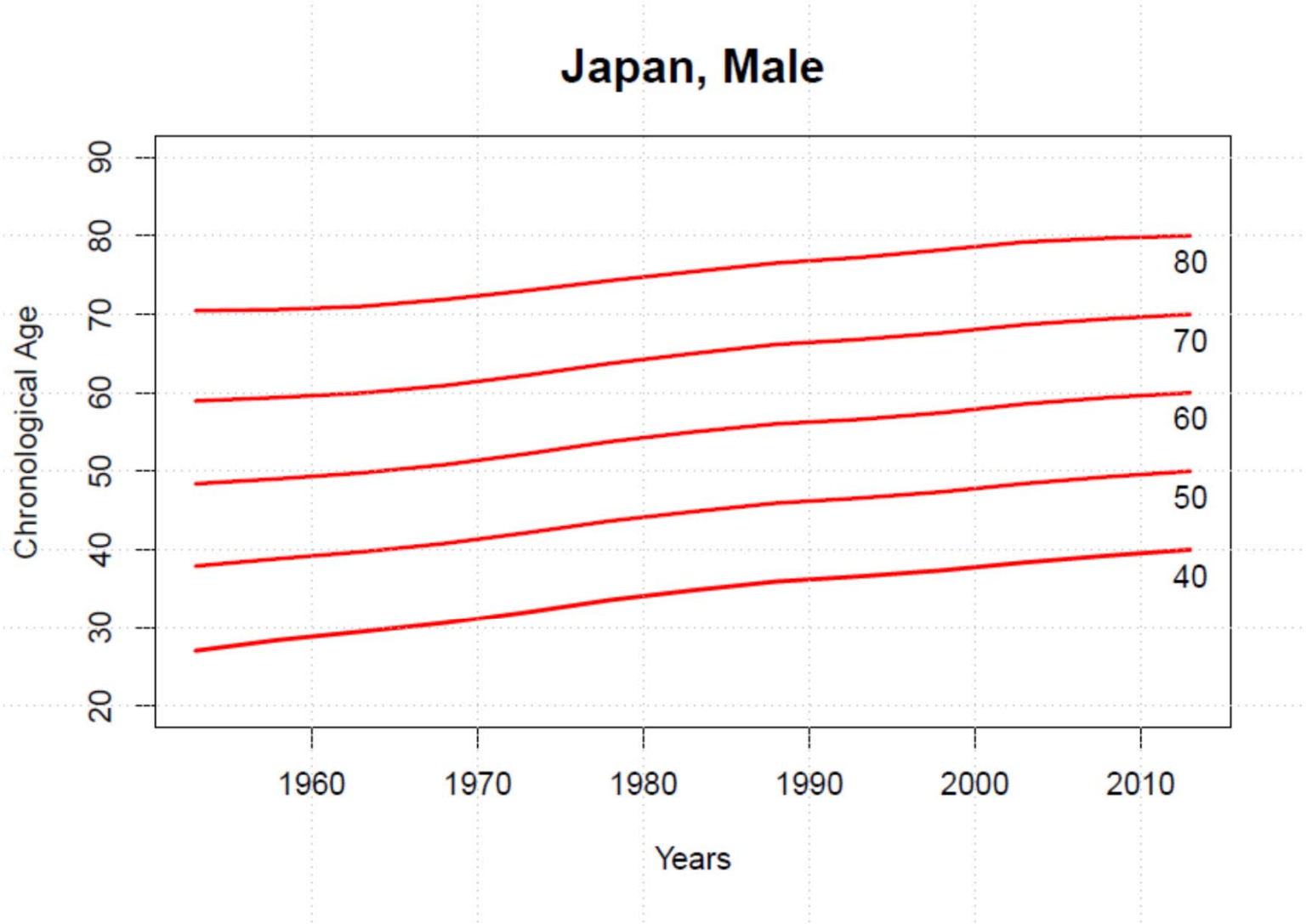
Constant RLE Ages, 2010-2015



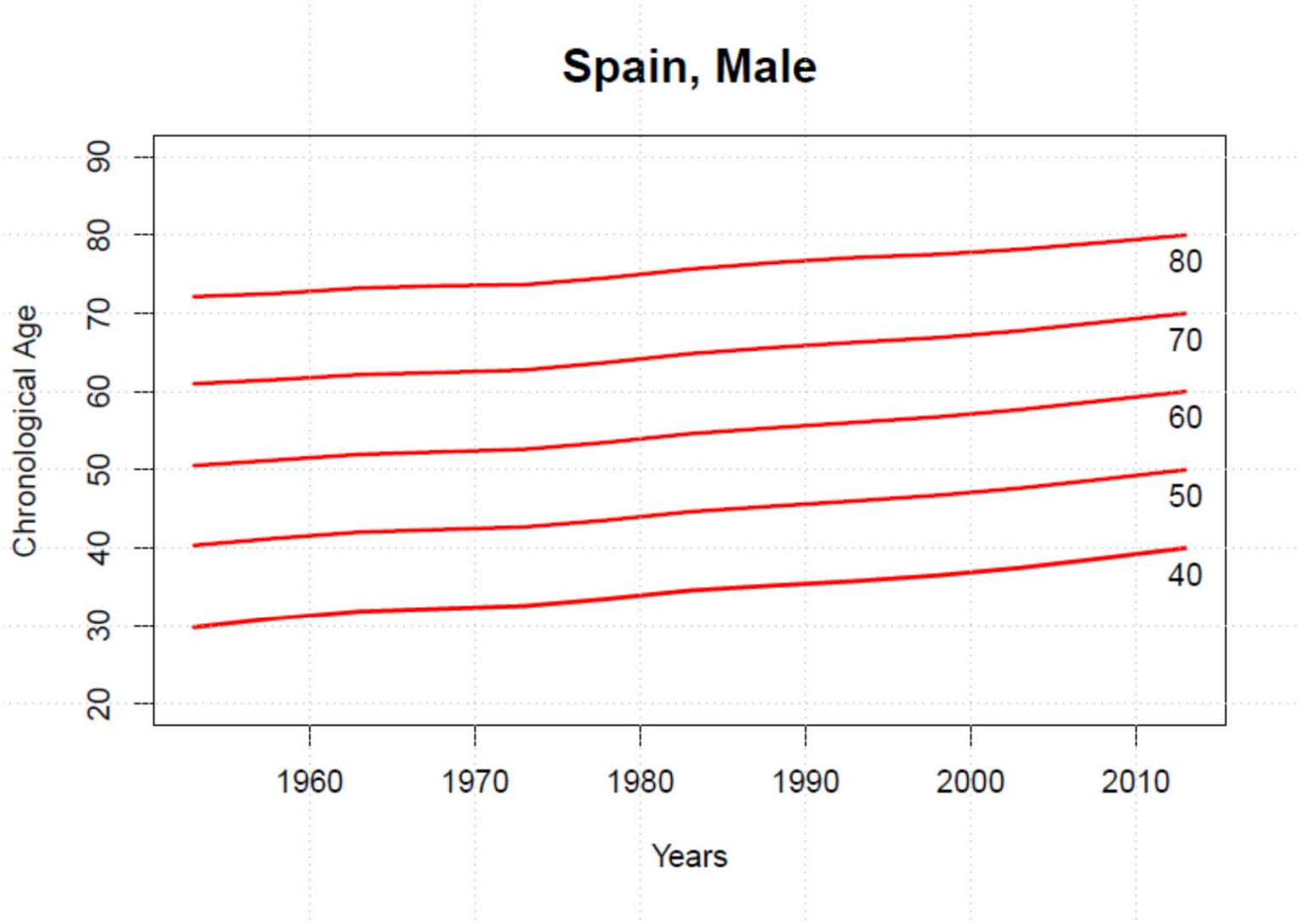
Constant RLE Ages, 2010-2015



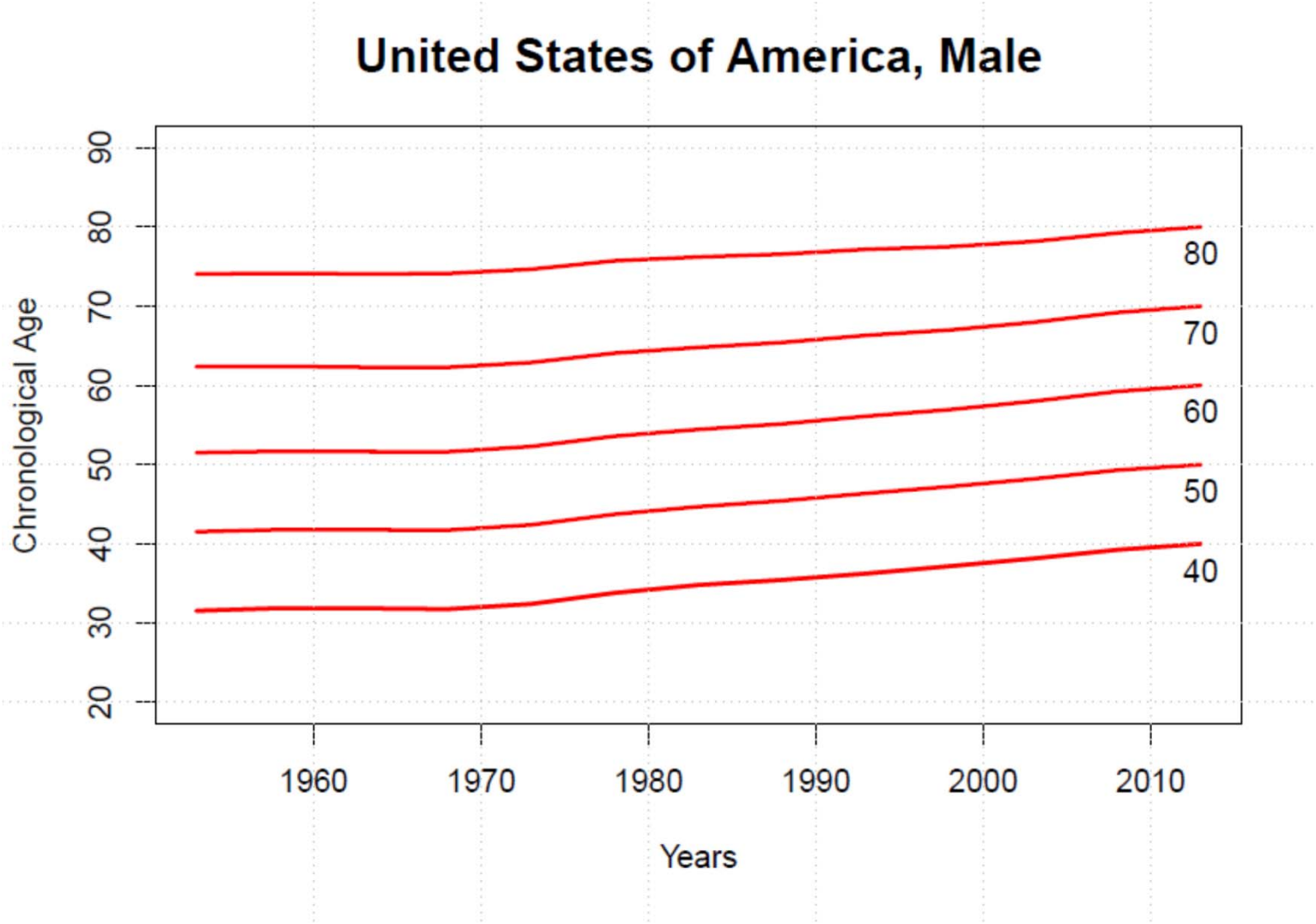
Constant RLE Ages, 2010-2015



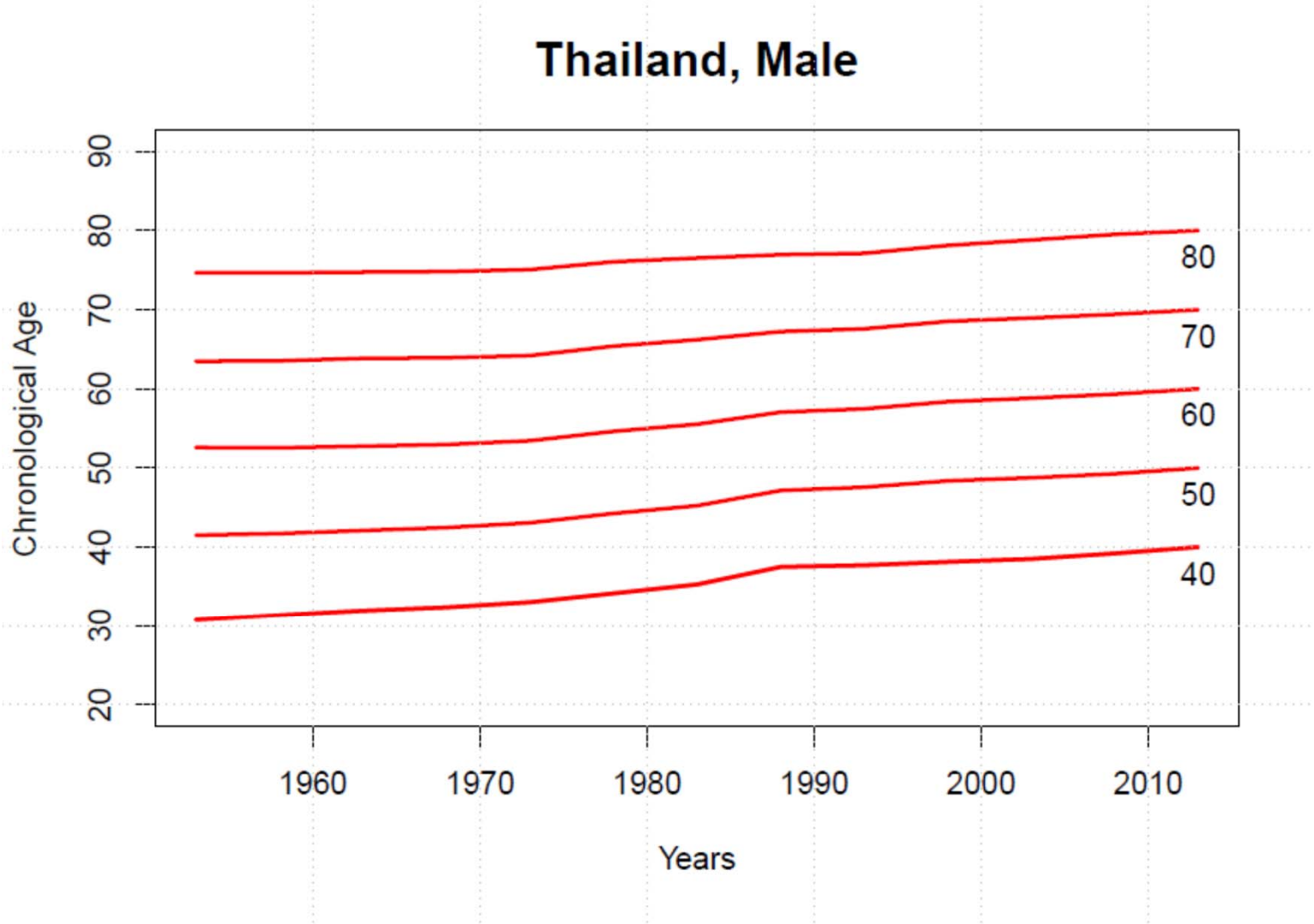
Constant RLE Ages, 2010-2015



Constant RLE Ages, 2010-2015



Constant RLE Ages, 2010-2015



New Look at Aging

Historical data: Human Mortality Database (HMD)

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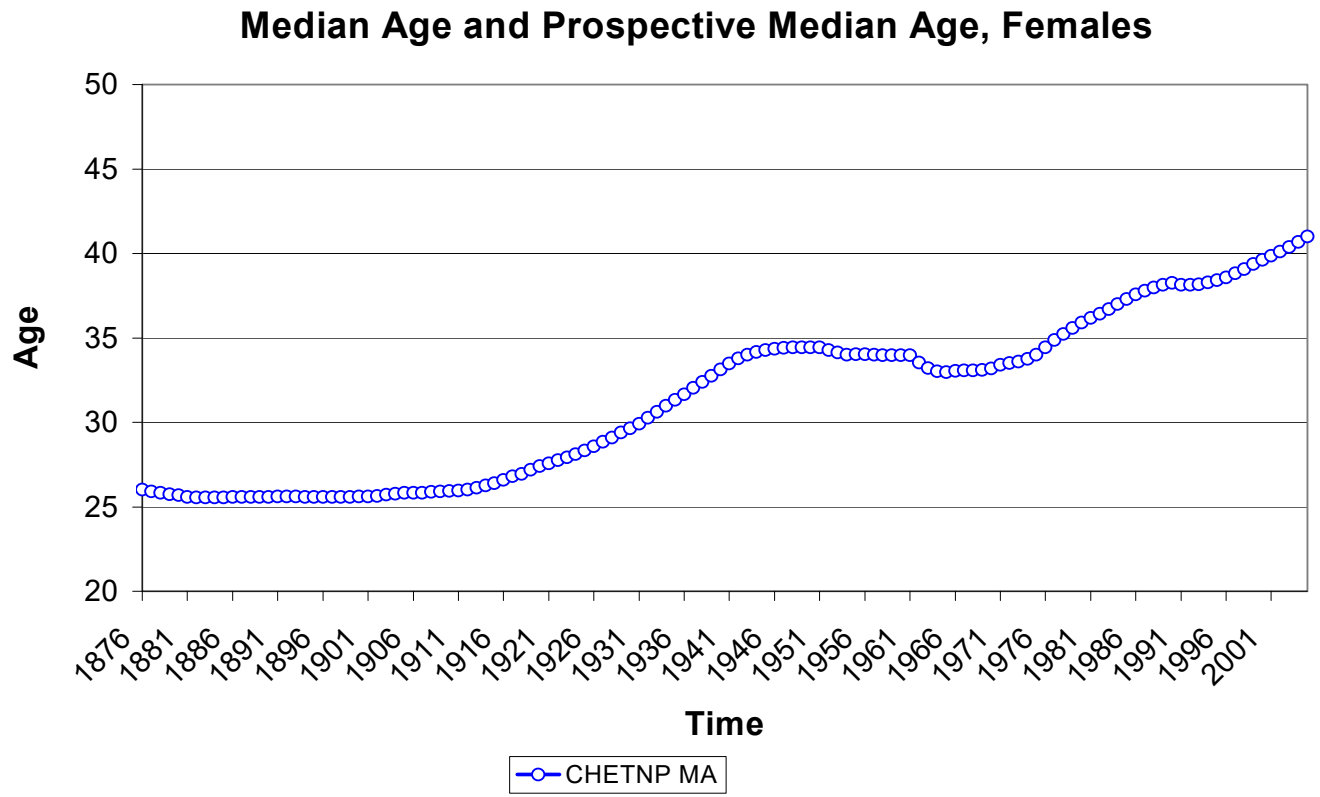
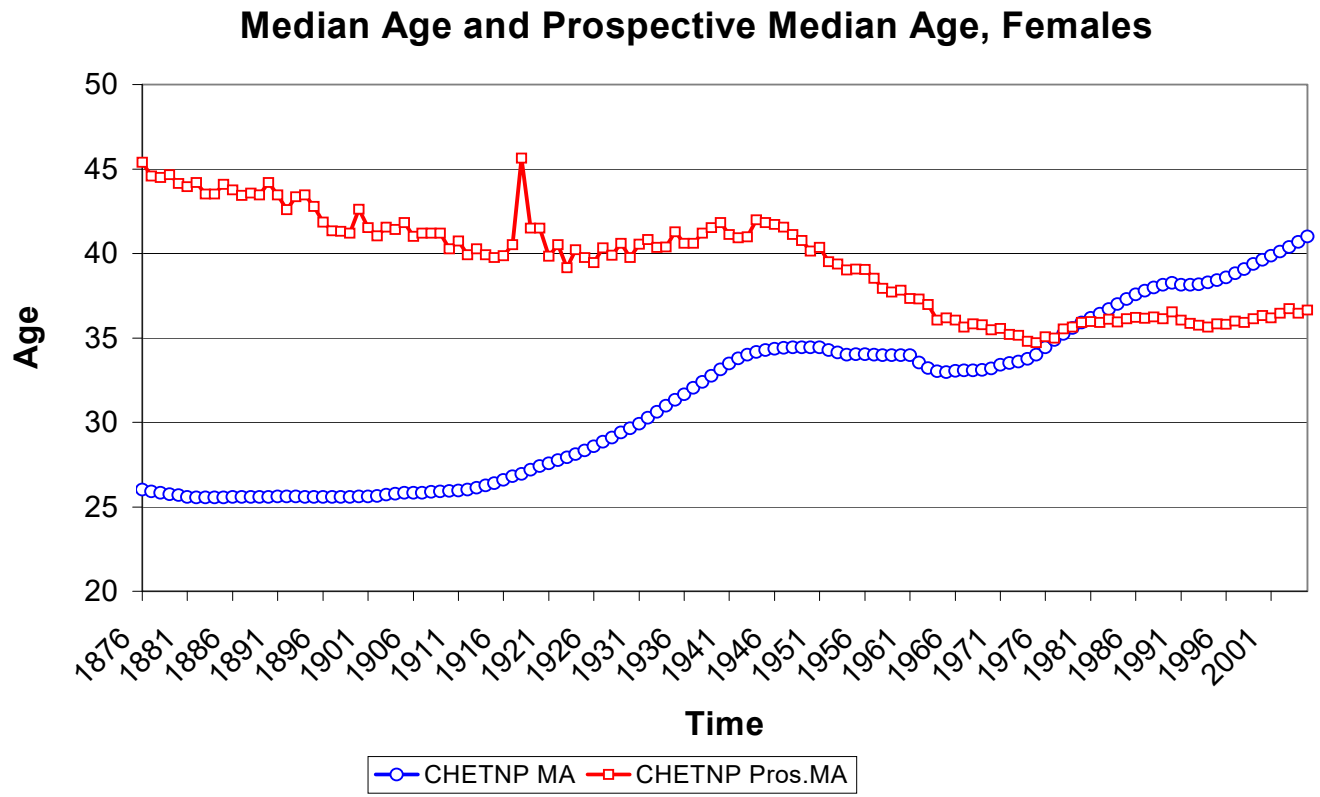
Aging

Using the concept of perspective median age, we may come up to a different conclusion about the history of aging in a particular country.

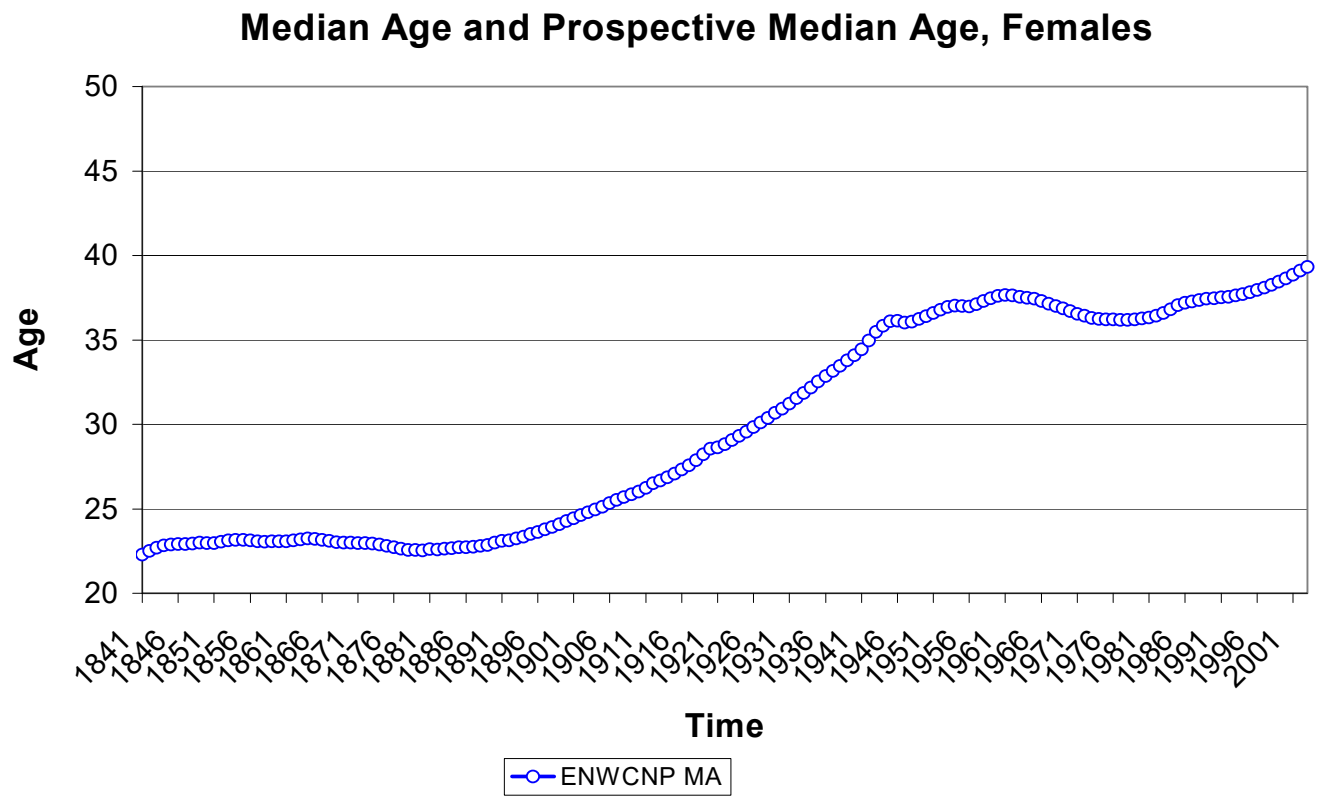
Switzerland



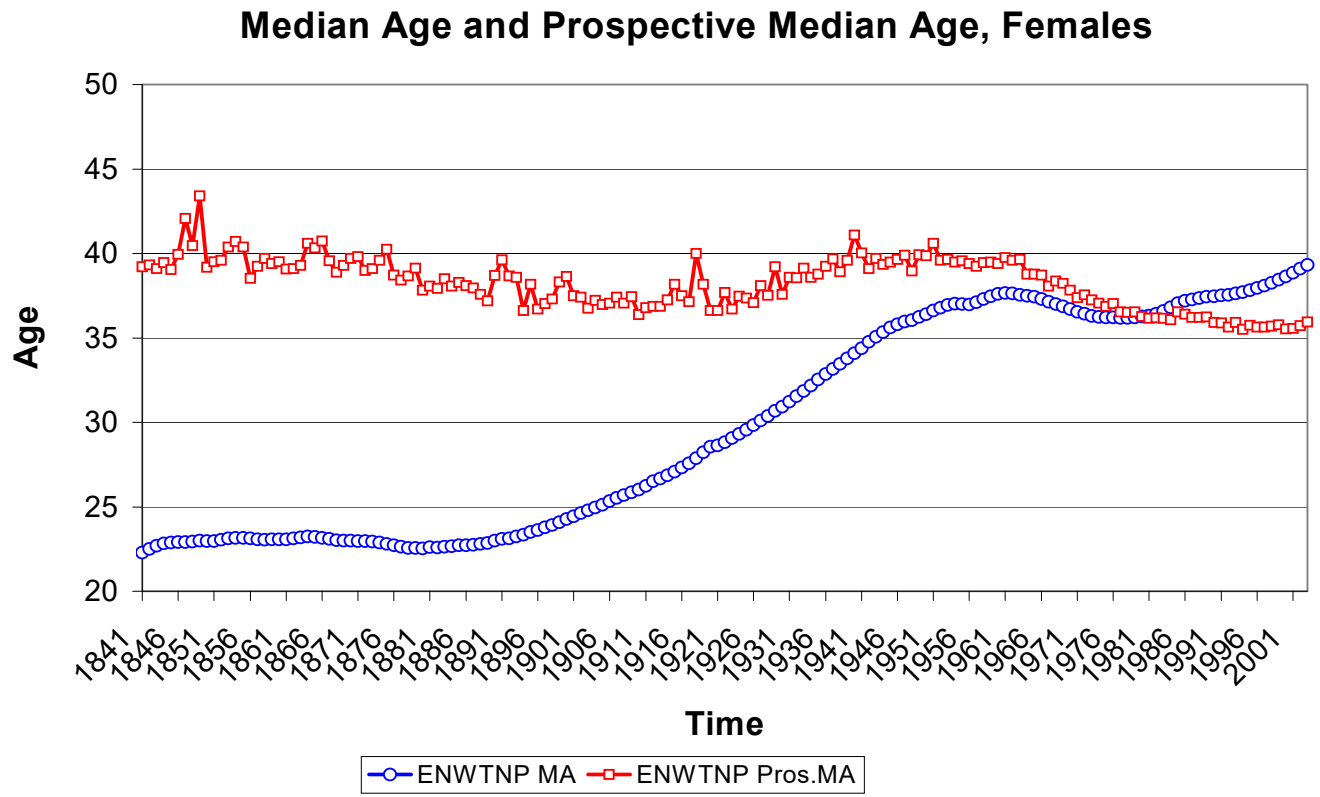
Switzerland



England and Wales



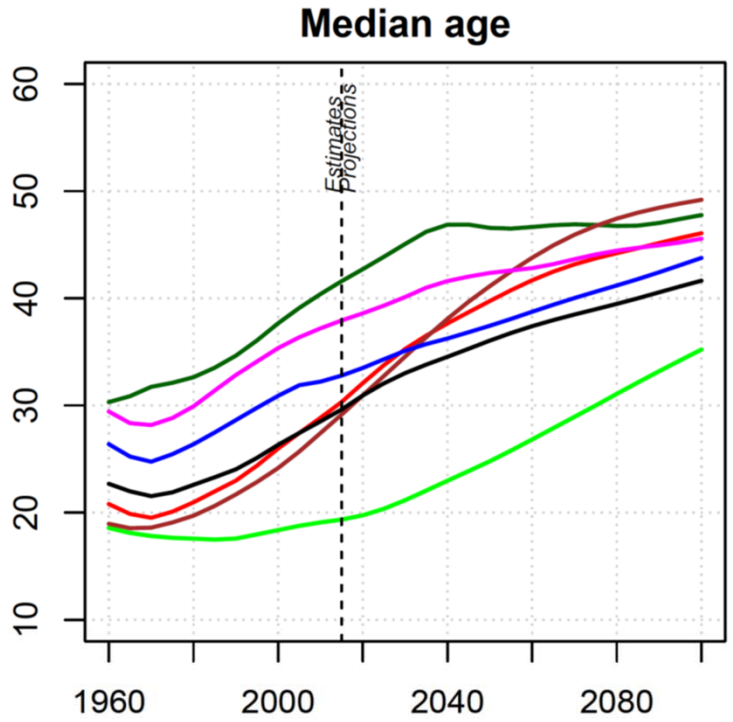
England and Wales

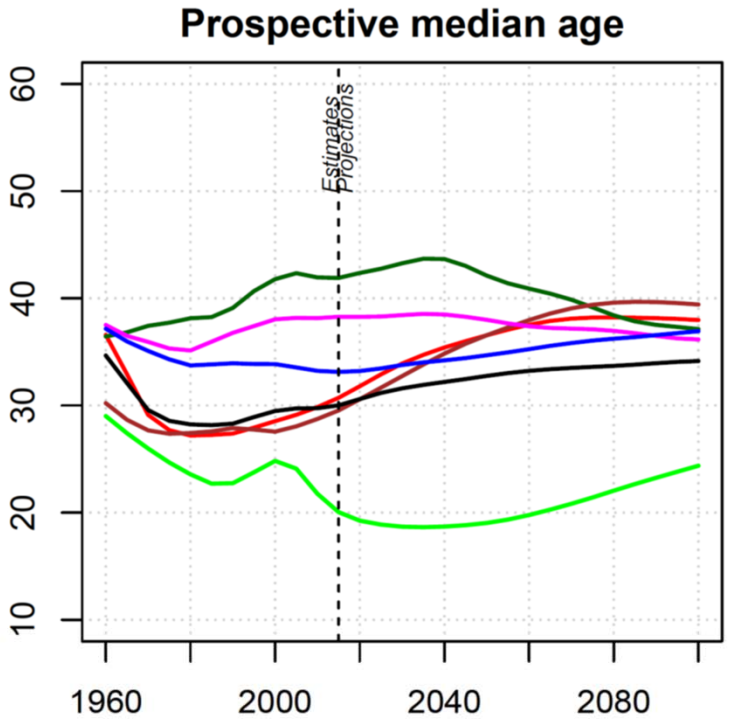


Projections

Indicators are calculated using data from
World Population Prospects: The 2017 Revision, United Nations

Projections

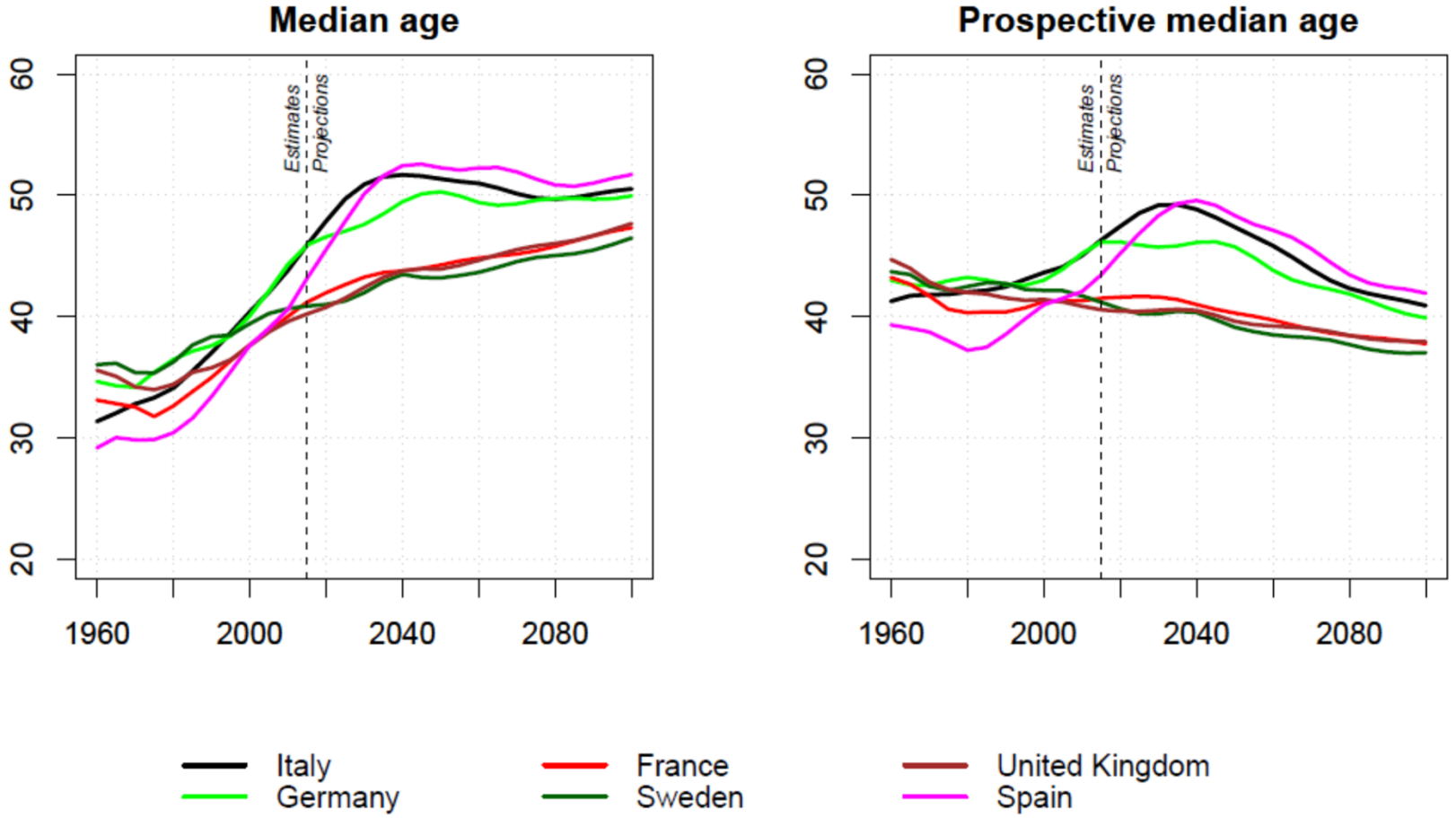




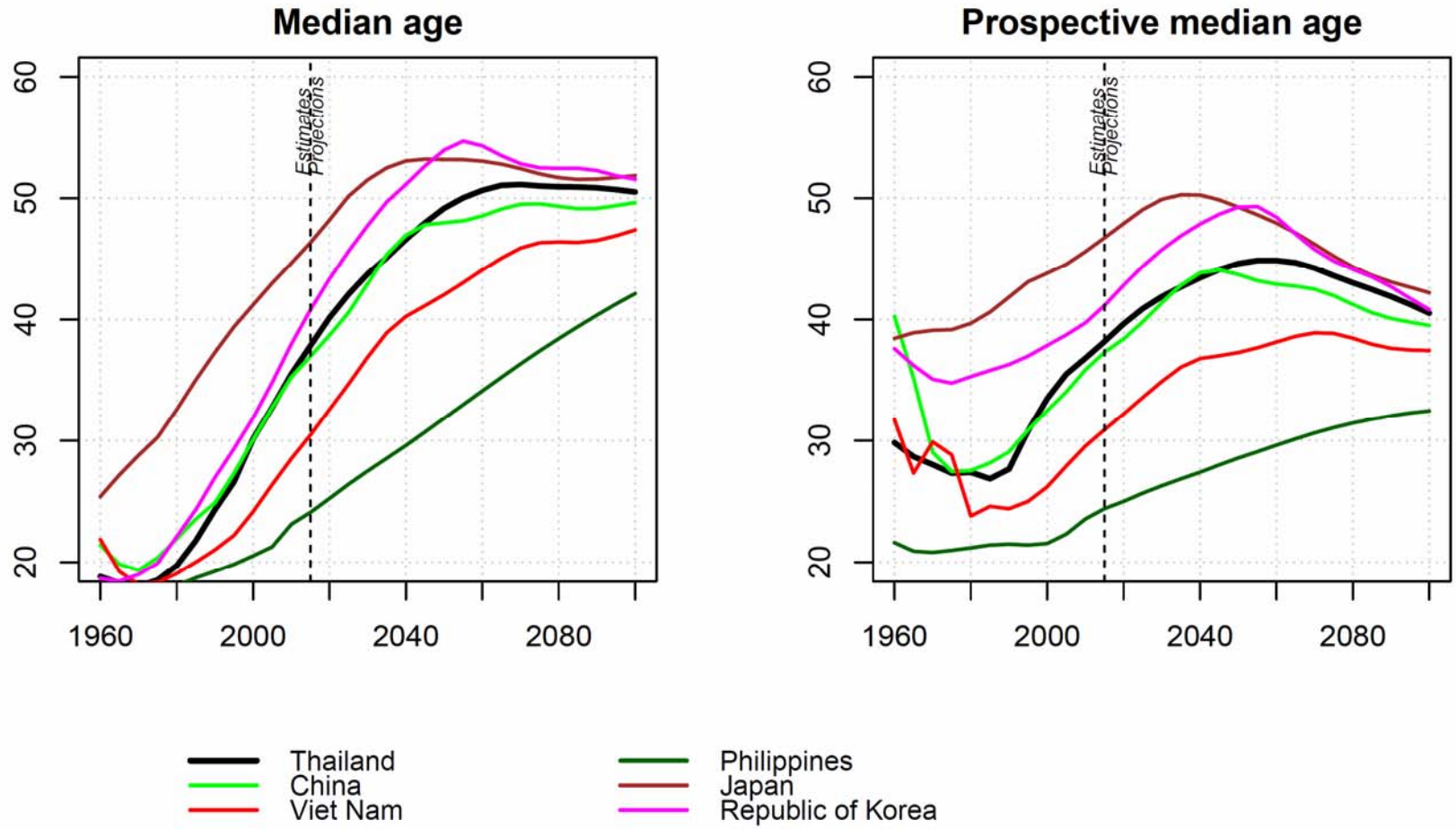
Africa
Asia
Europe
Latin America and the Caribbean

Northern America
Oceania
World

Projections



Projections

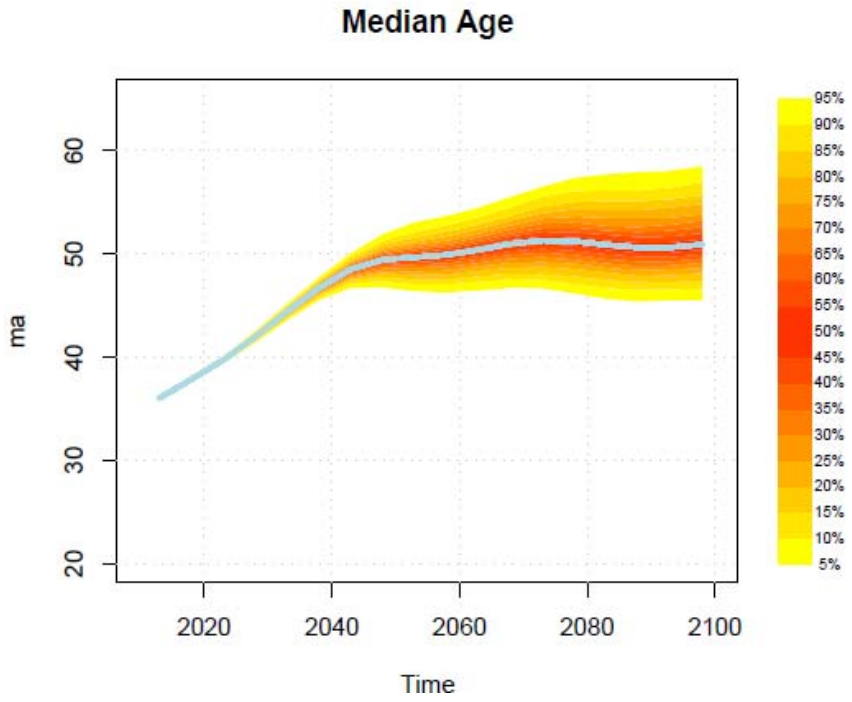


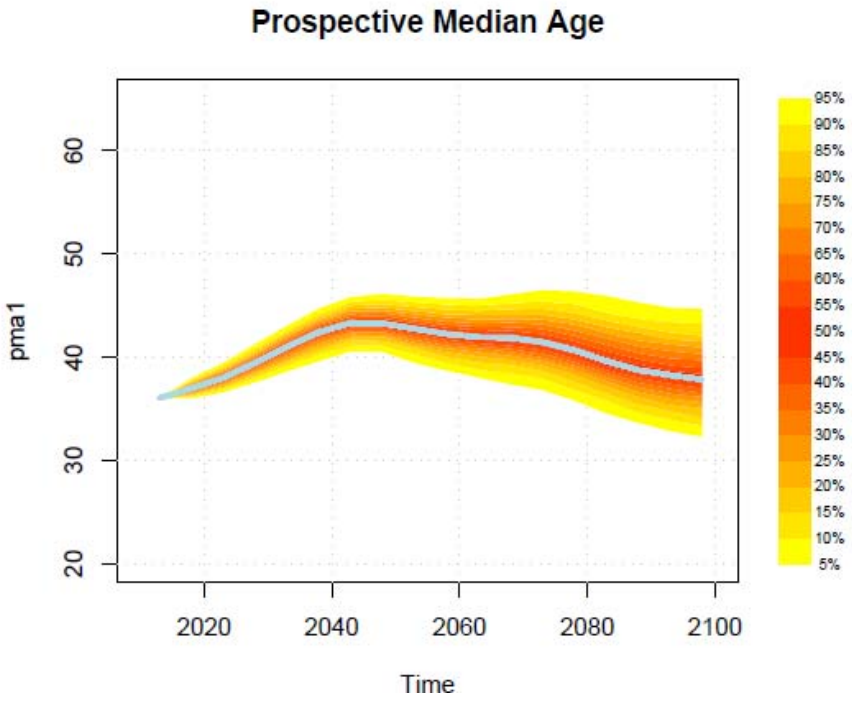
Probabilistic Projections

Results are based on World Population Prospects 2015 revision.

Sanderson WC., Scherbov S., Gerland P. (2017) Probabilistic population aging. ***PLoS ONE,*** 12(6): e0179171

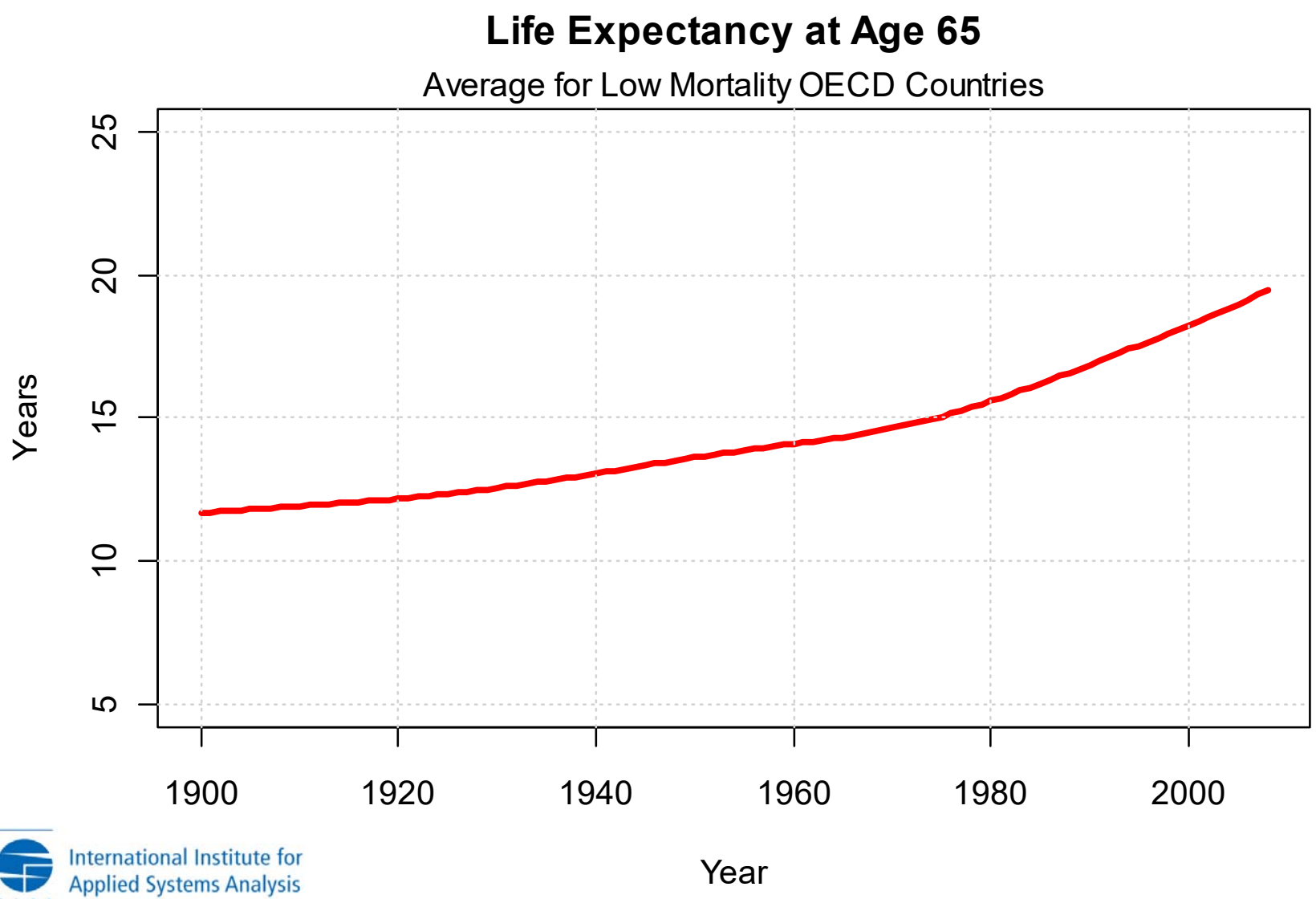
Prospective Age and Prospective Median Age China

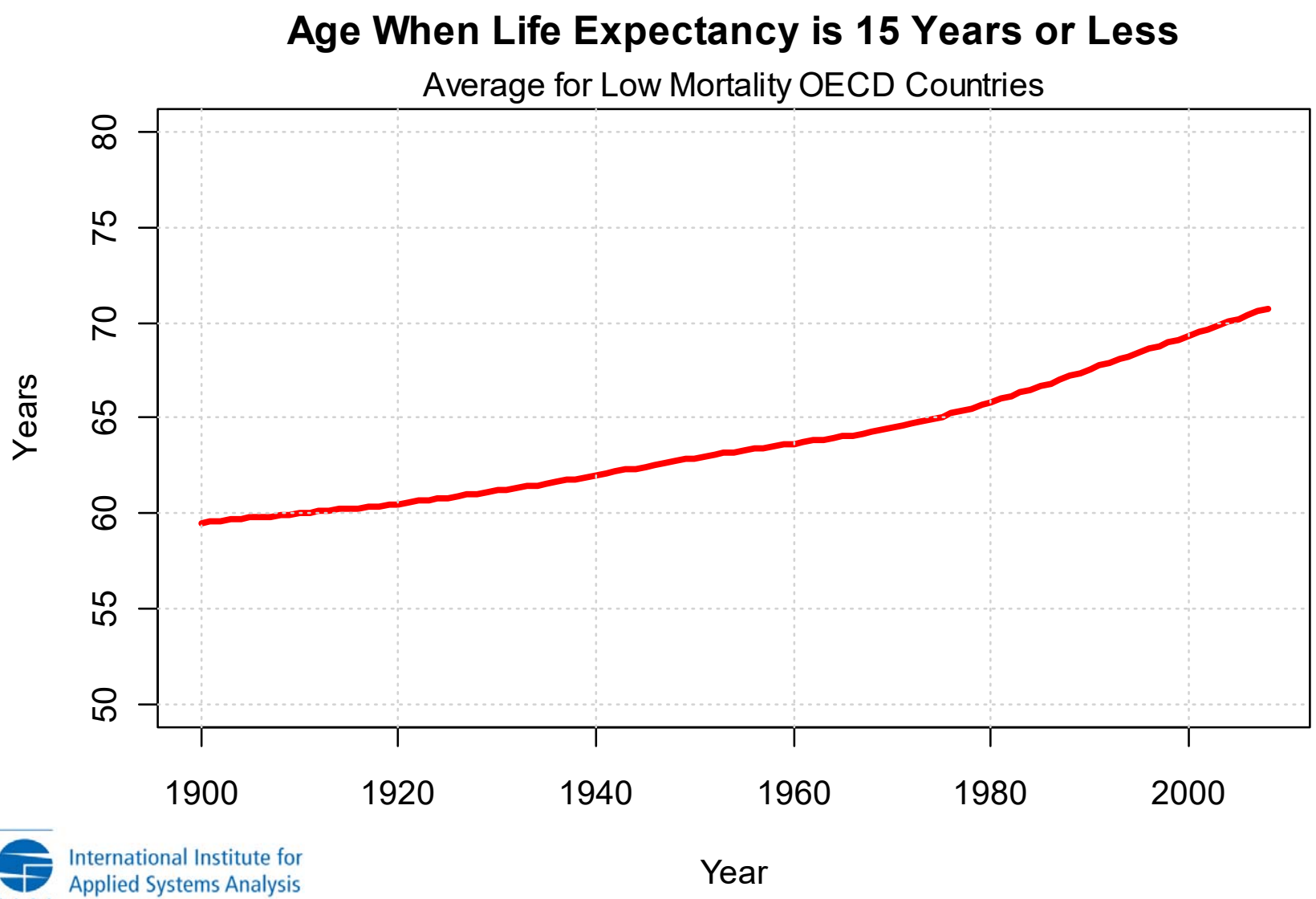




New Measures of Aging

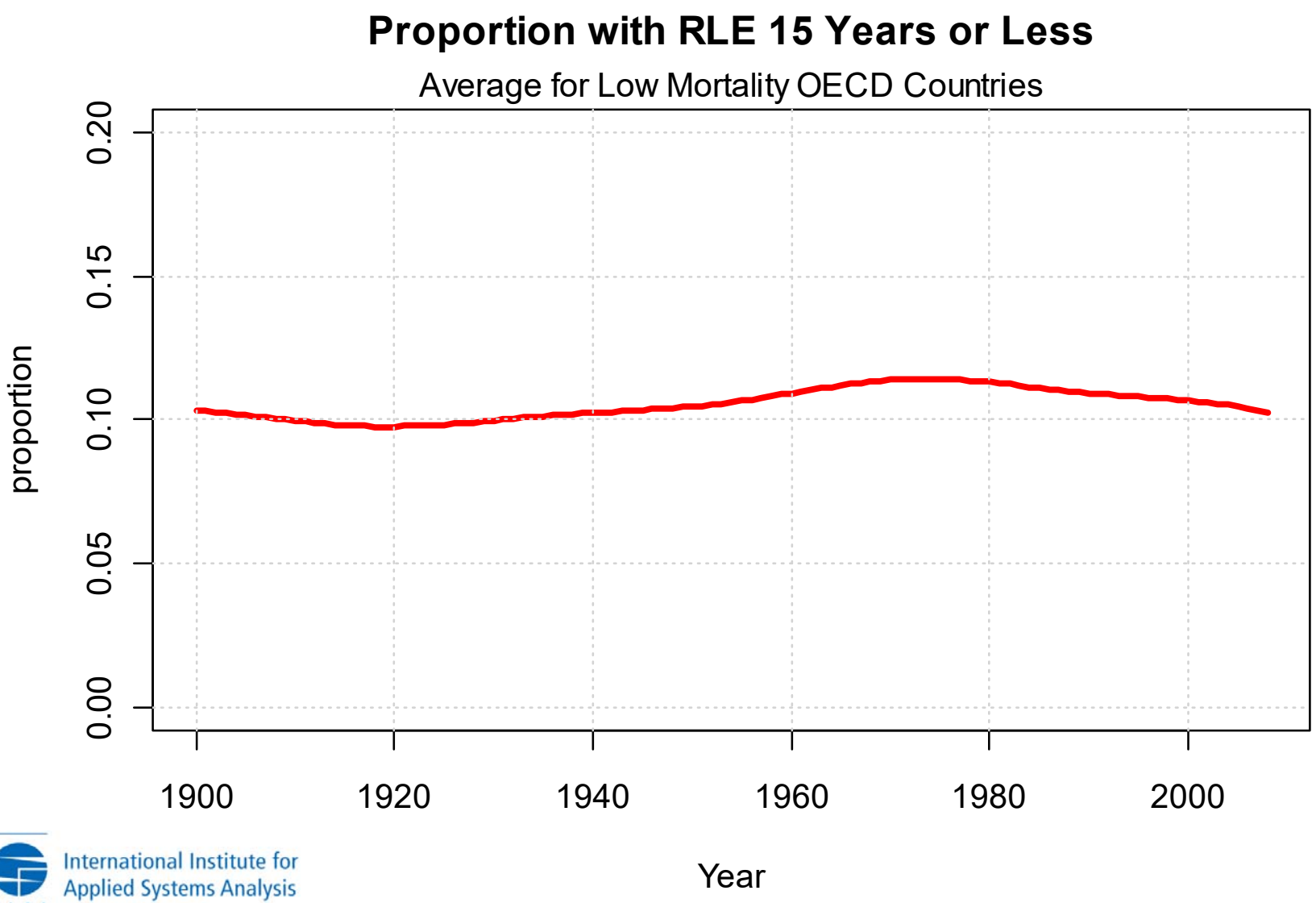
1. Prospective Age and Prospective Median Age
2. Proportion of elderly people


Life Expectancy at Age 65
Average for Low Mortality OECD Countries
Years
25
20
15
10
5
1900
1920
1940
1960
1980
2000
Year


Age When Life Expectancy is 15 Years or Less
Average for Low Mortality OECD Countries
Years
50
55
60
65
70
75
80
1900
1920
1940
1960
1980
2000
Year

Let us assume, that someone is old, when on average remaining years of life are below 15 years.

How would the proportion of old look like with this definition of elderly people?

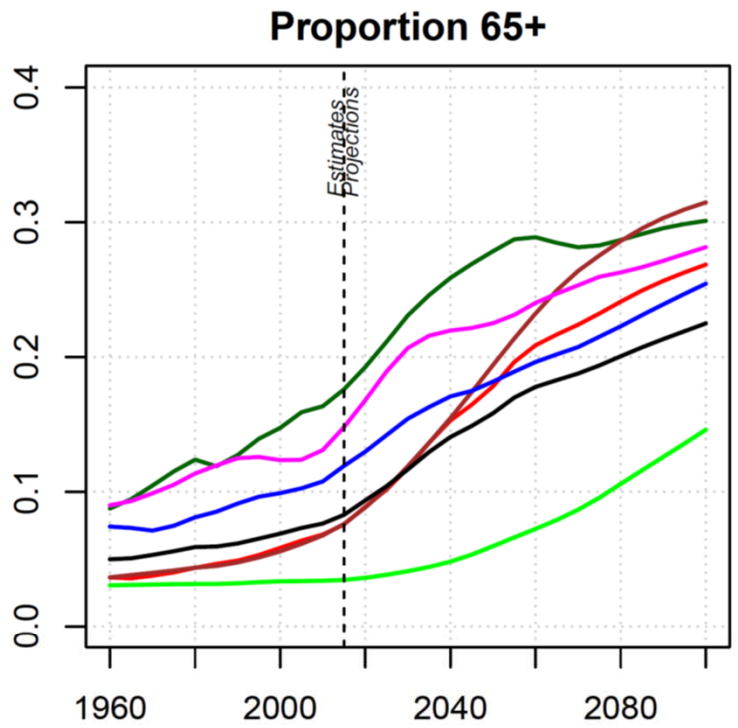

Proportion with RLE 15 Years or Less
Average for Low Mortality OECD Countries
proportion
0.00
0.05
0.10
0.15
0.20
1900
1920
1940
1960
1980
2000
Year

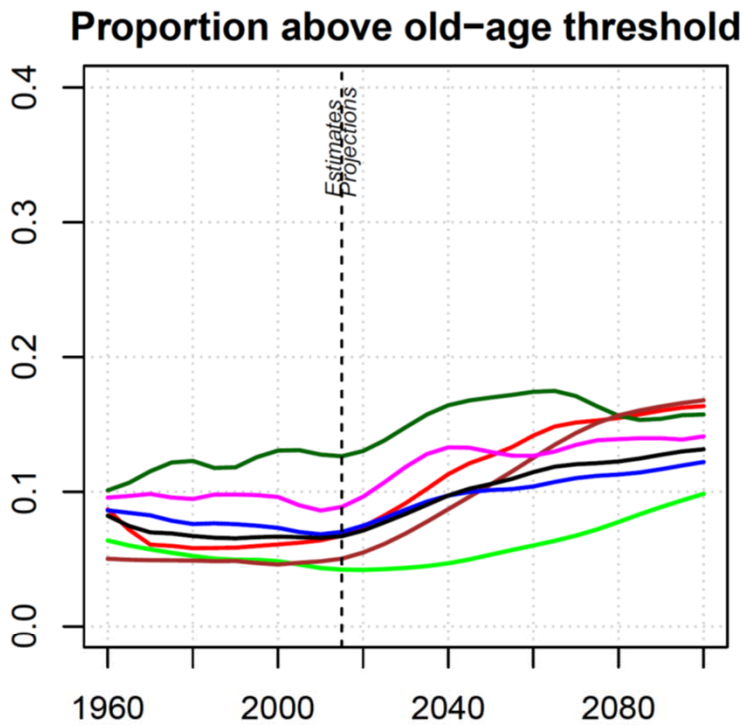
Projections

(assuming that someone is considered old, when on average remaining years of life are below 15 years)

Indicators are calculated using data from
World Population Prospects: The 2017 Revision, United Nations

Conventional and Prospective Measures of Aging

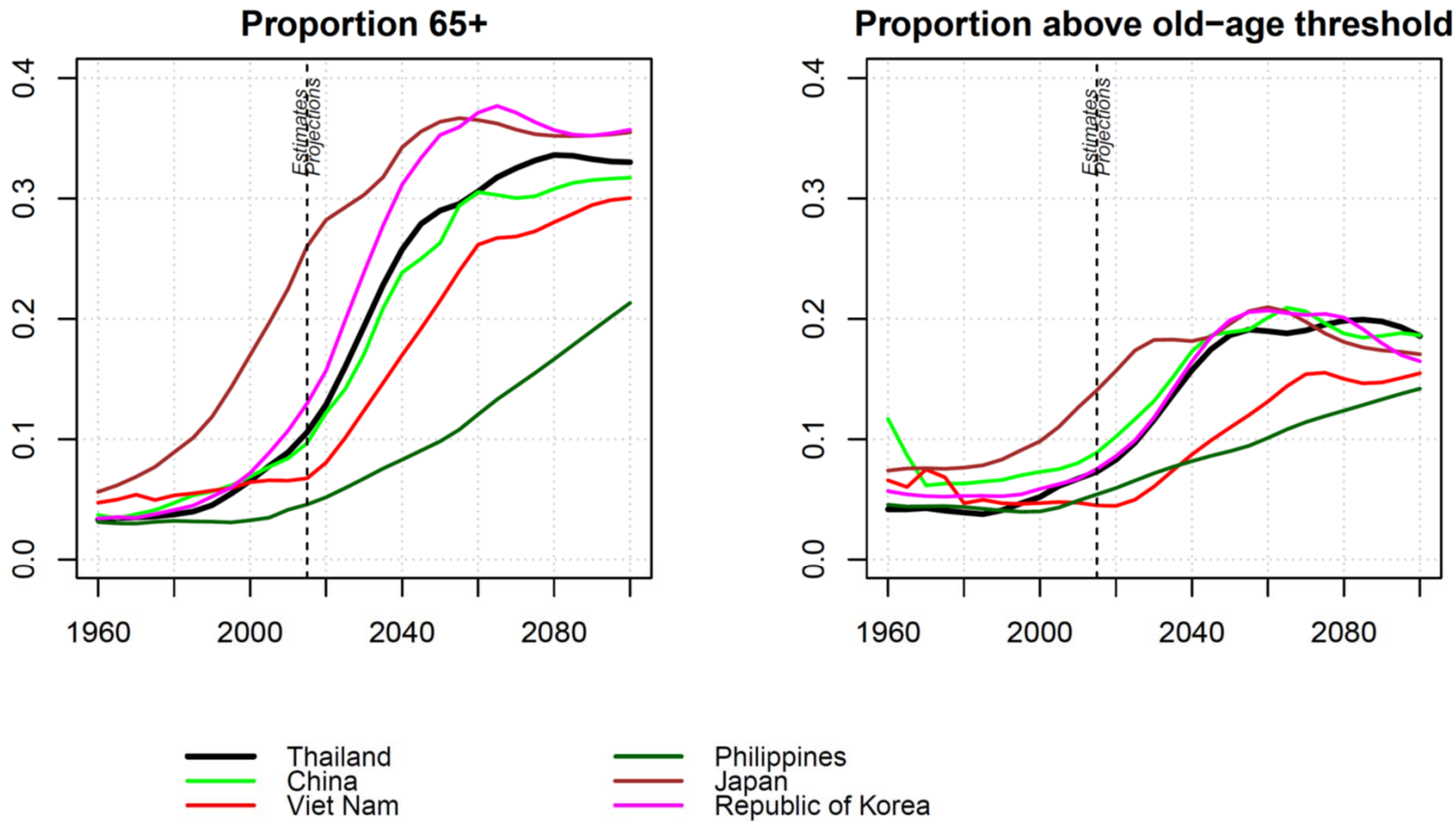




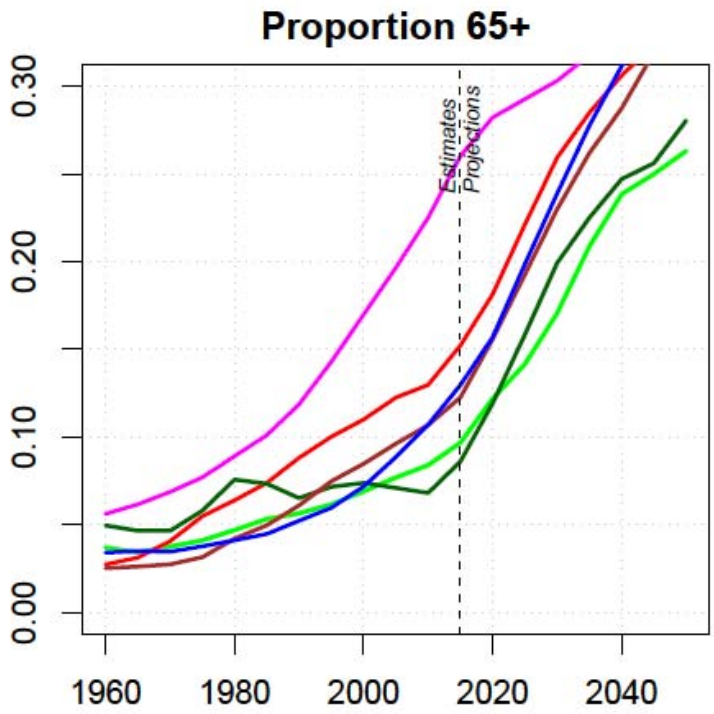
Africa
Asia
Europe
Latin America and the Caribbean

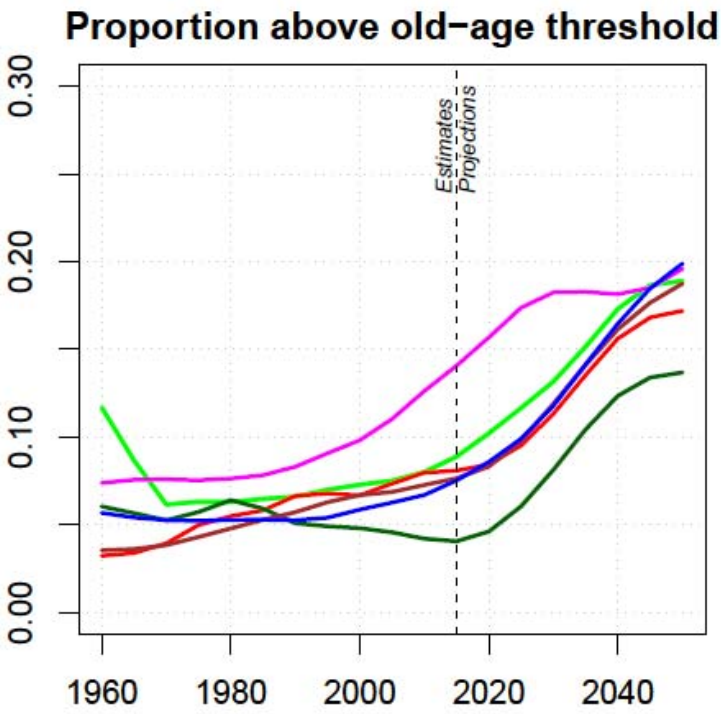
Northern America
Oceania
World

Conventional and Prospective Measures of Aging



Conventional and Prospective Measures of Aging

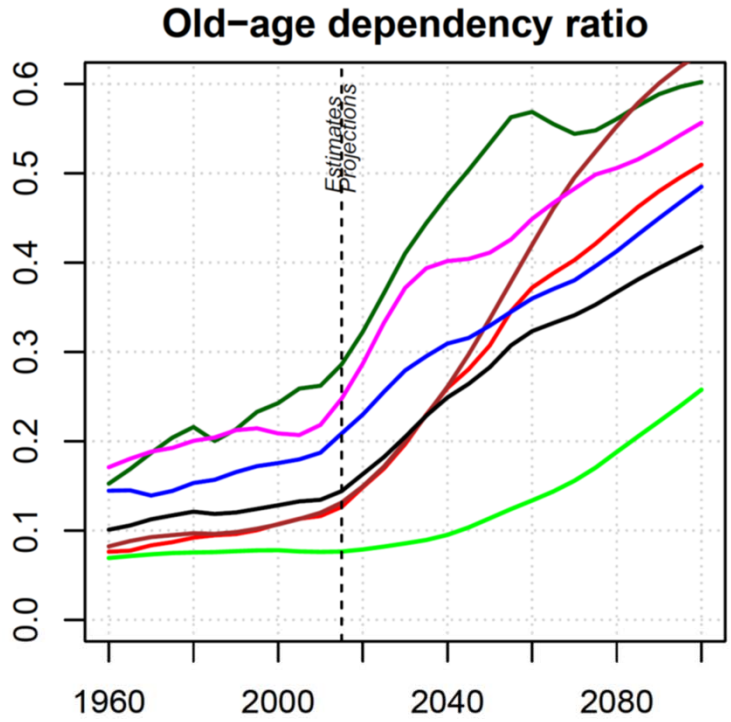


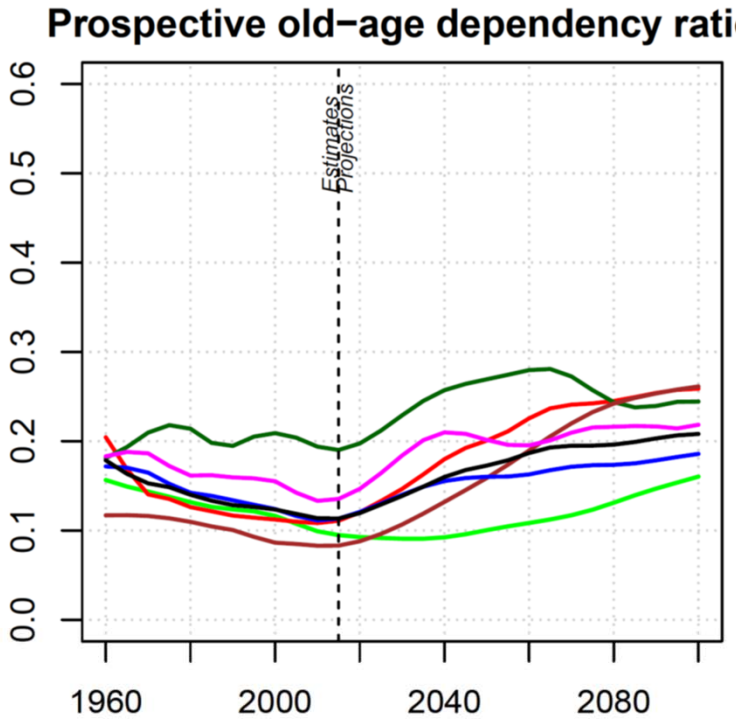


China
China, Hong Kong SAR
China, Macao SAR

China, Taiwan Province of China
Japan
Republic of Korea

Conventional and Prospective Measures of Aging





Africa
Asia
Europe
Latin America and the Caribbean

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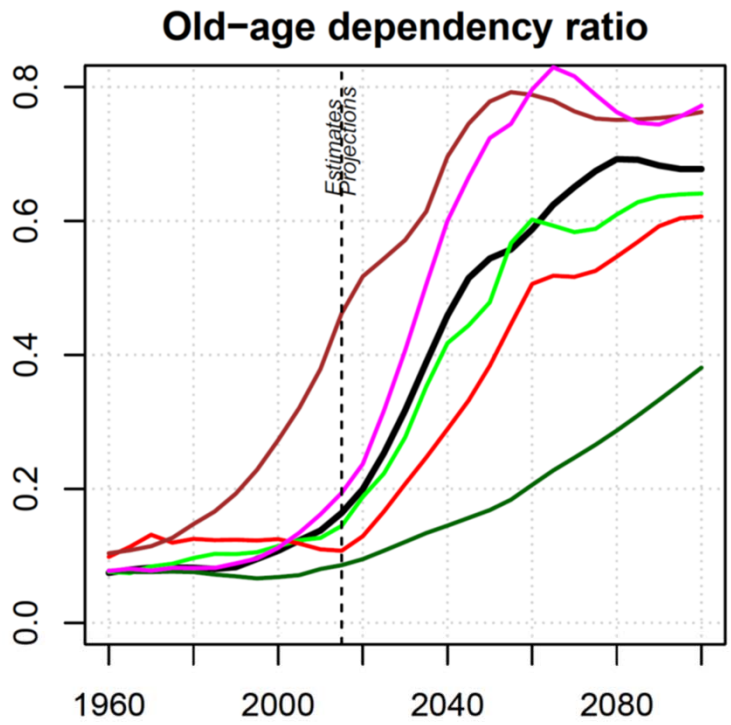
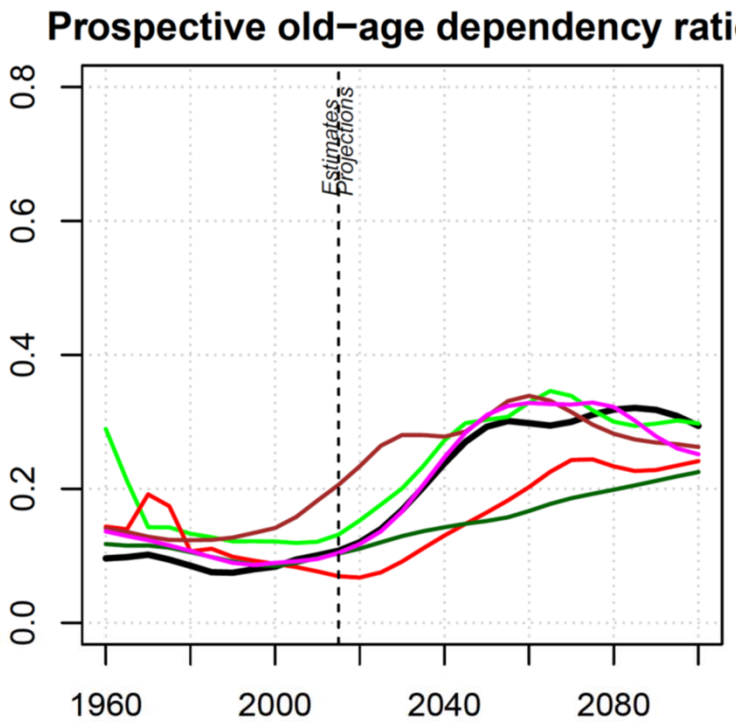
Oceania
World

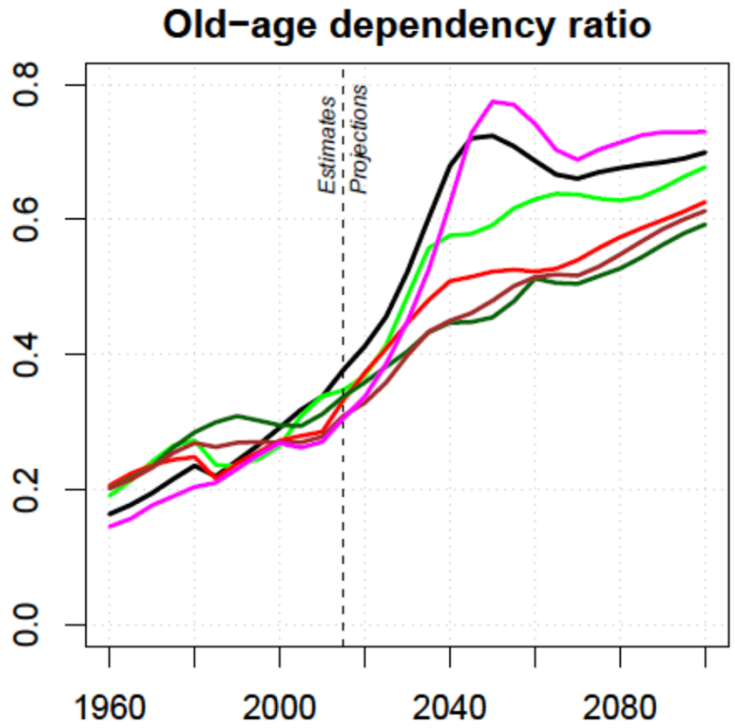
Conventional and Prospective Measures of Aging

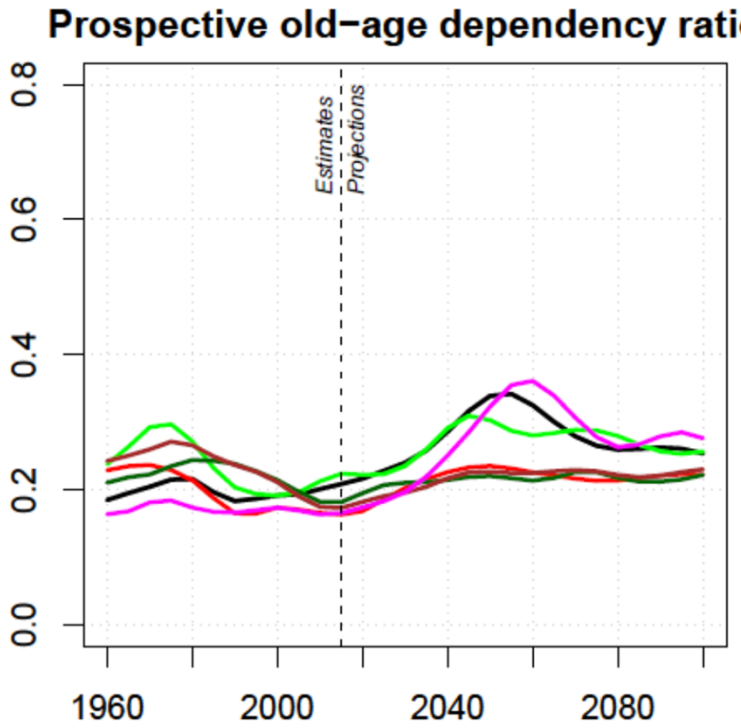




Thailand
China
Viet Nam
Philippines
Japan
Republic of Korea

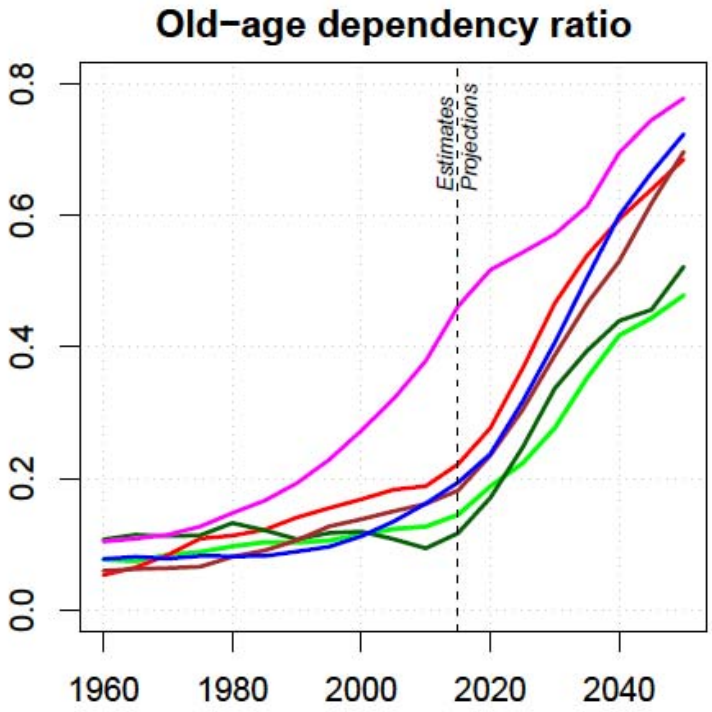
Conventional and Prospective Measures of Aging

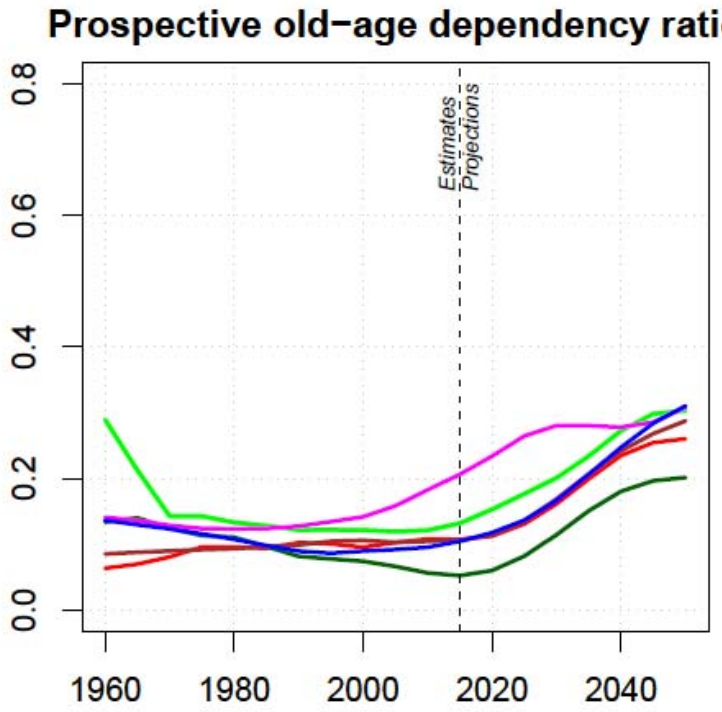




Italy
Germany
France
Sweden
United Kingdom
Spain

Conventional and Prospective Measures of Aging

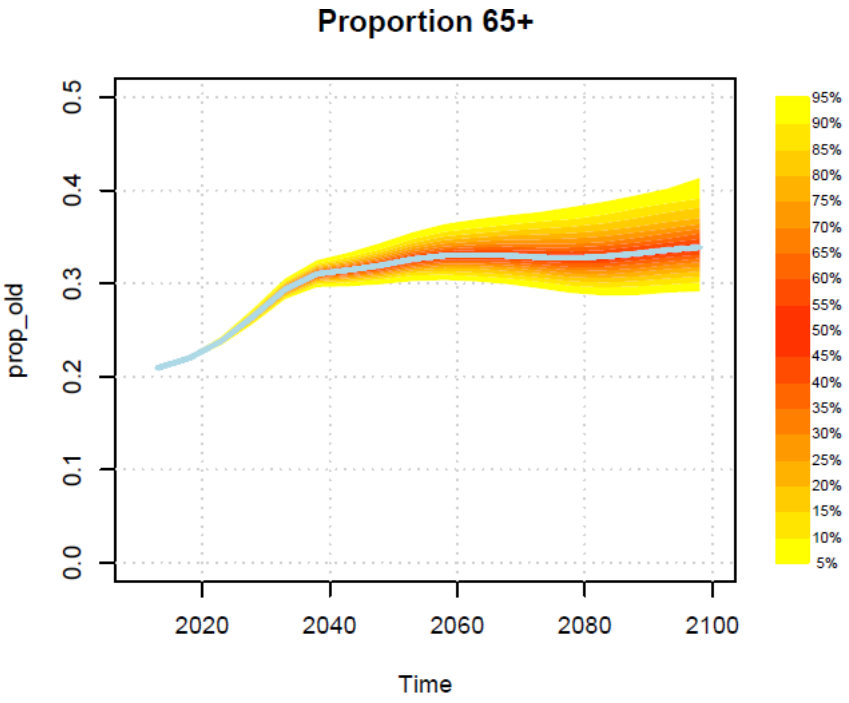


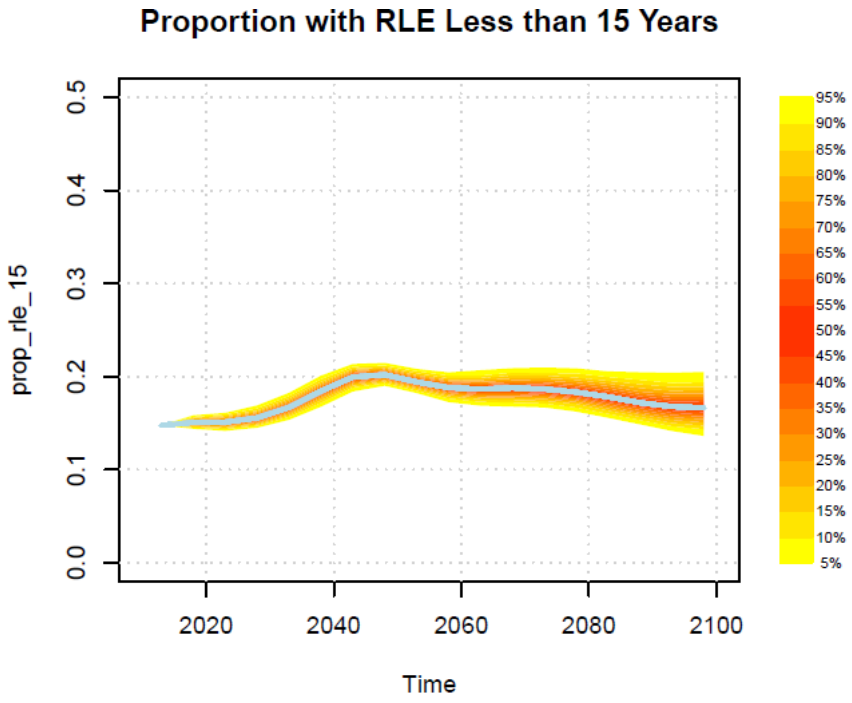


China
China, Hong Kong SAR
China, Macao SAR

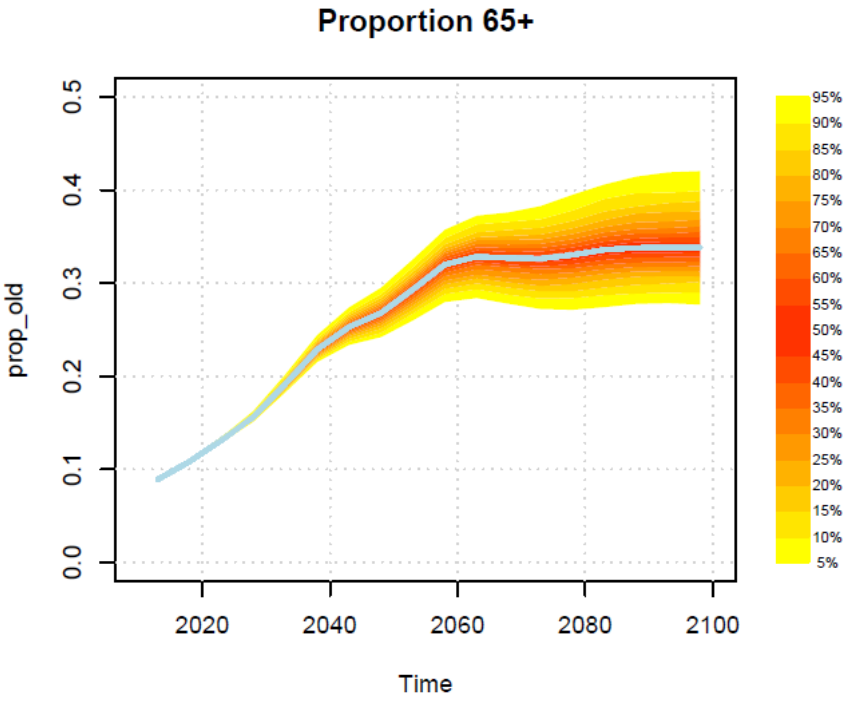
China, Taiwan Province of China
Japan
Republic of Korea

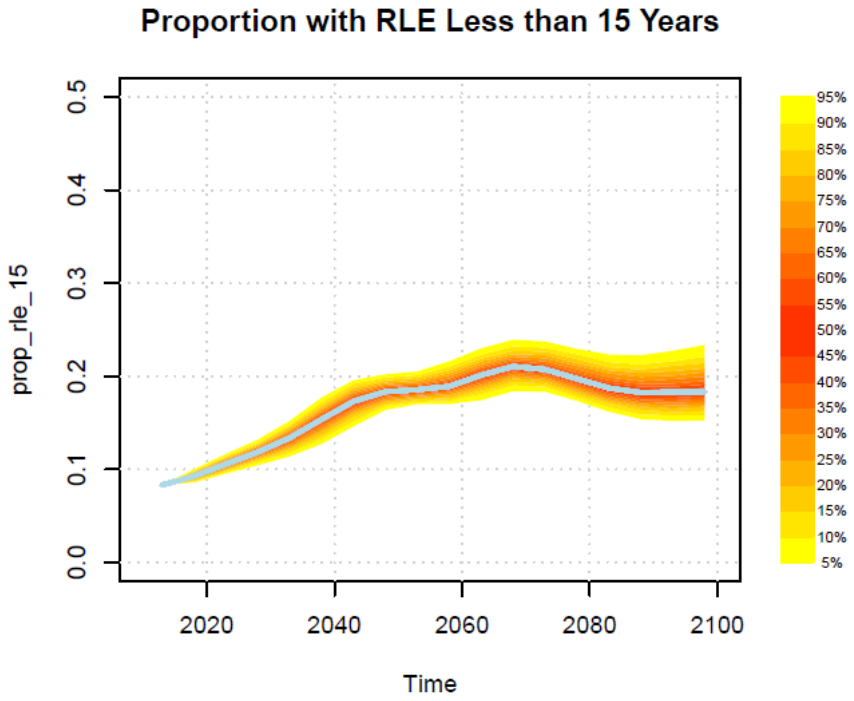
Proportion 65+ and Proportion with RLE less then 15 Germany



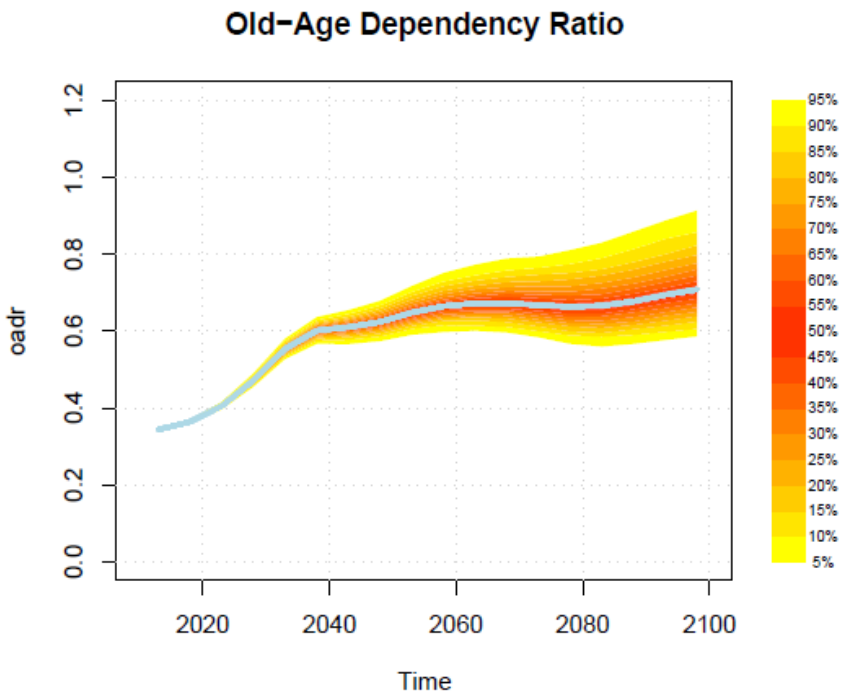


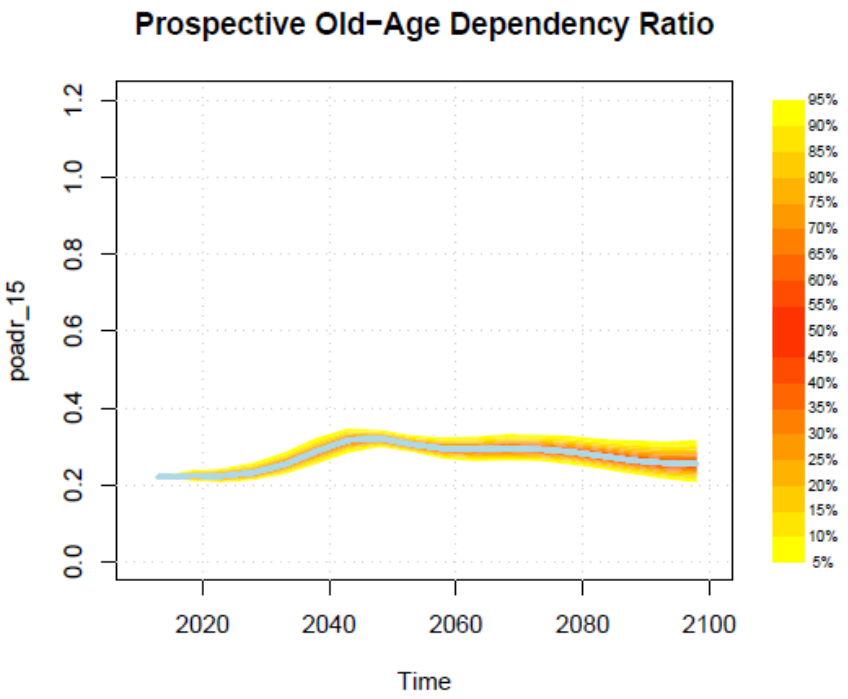
Proportion 65+ and Proportion with RLE less then 15 China



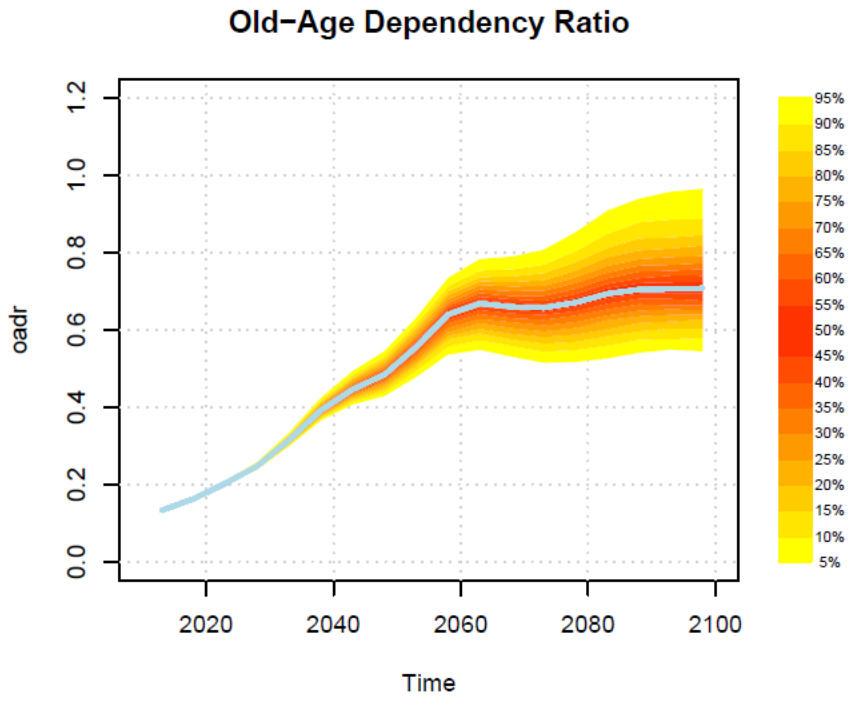


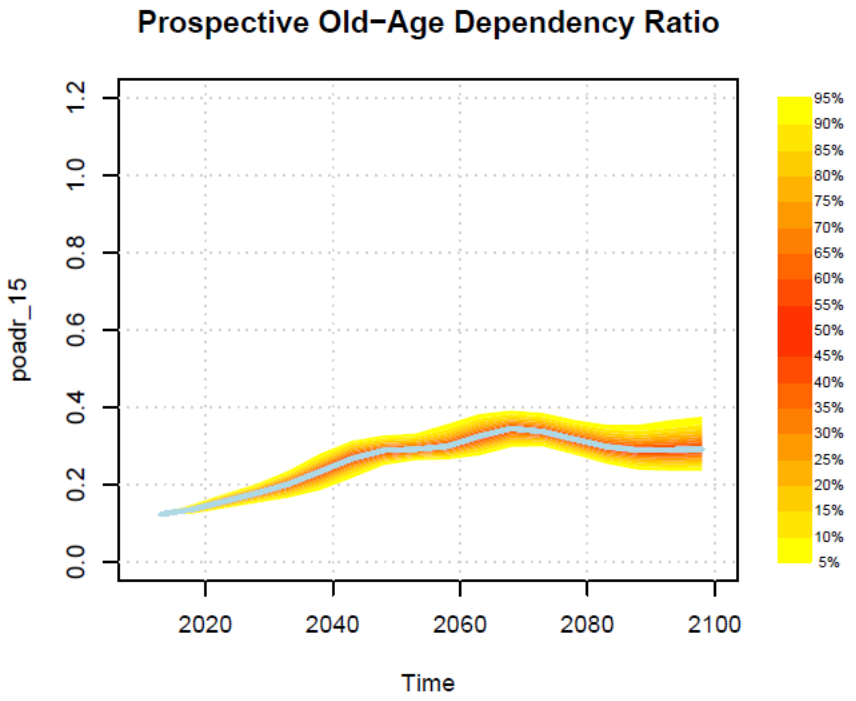
OADR and Prospective OADR Germany





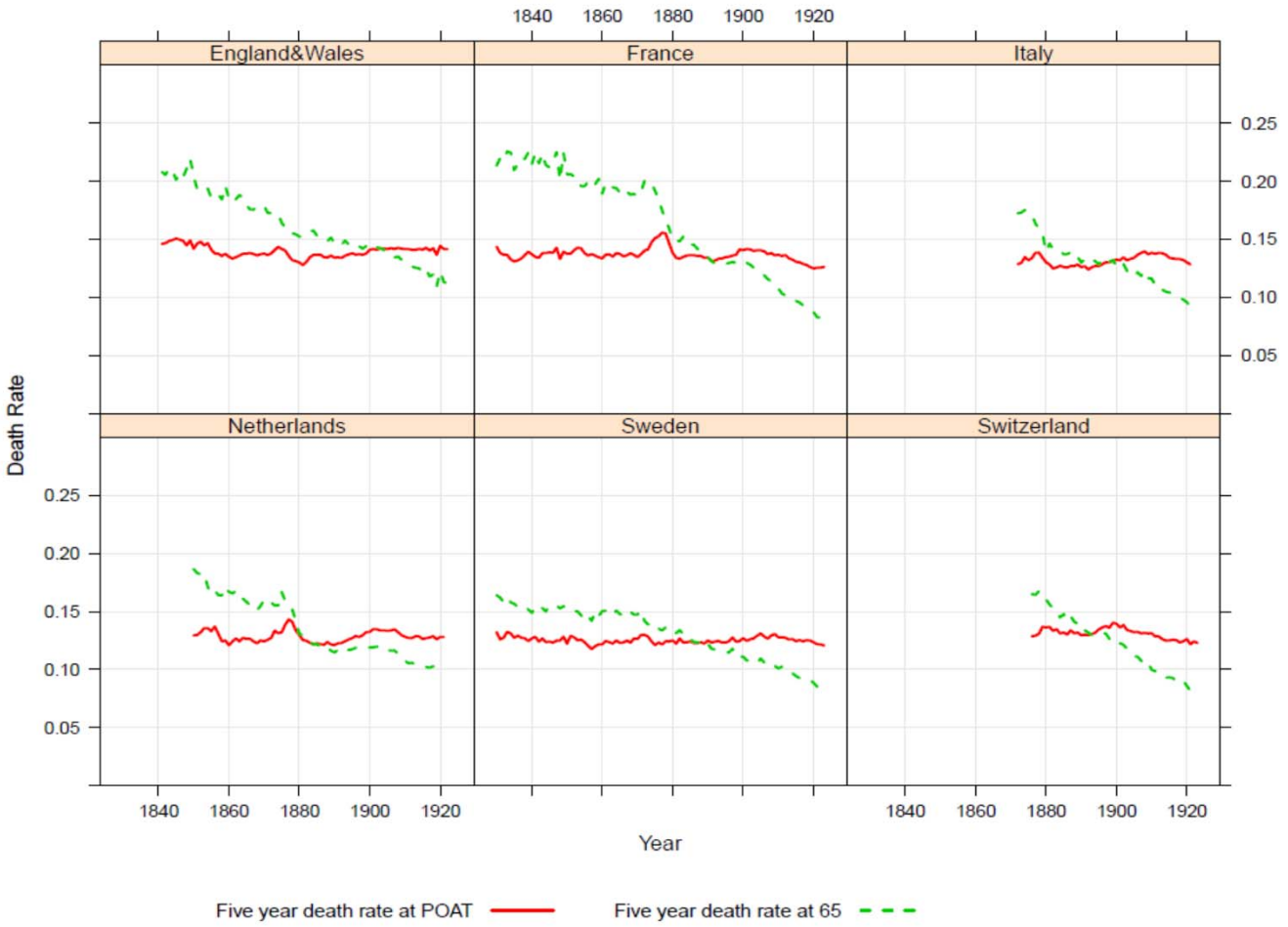
OADR and Prospective OADR China





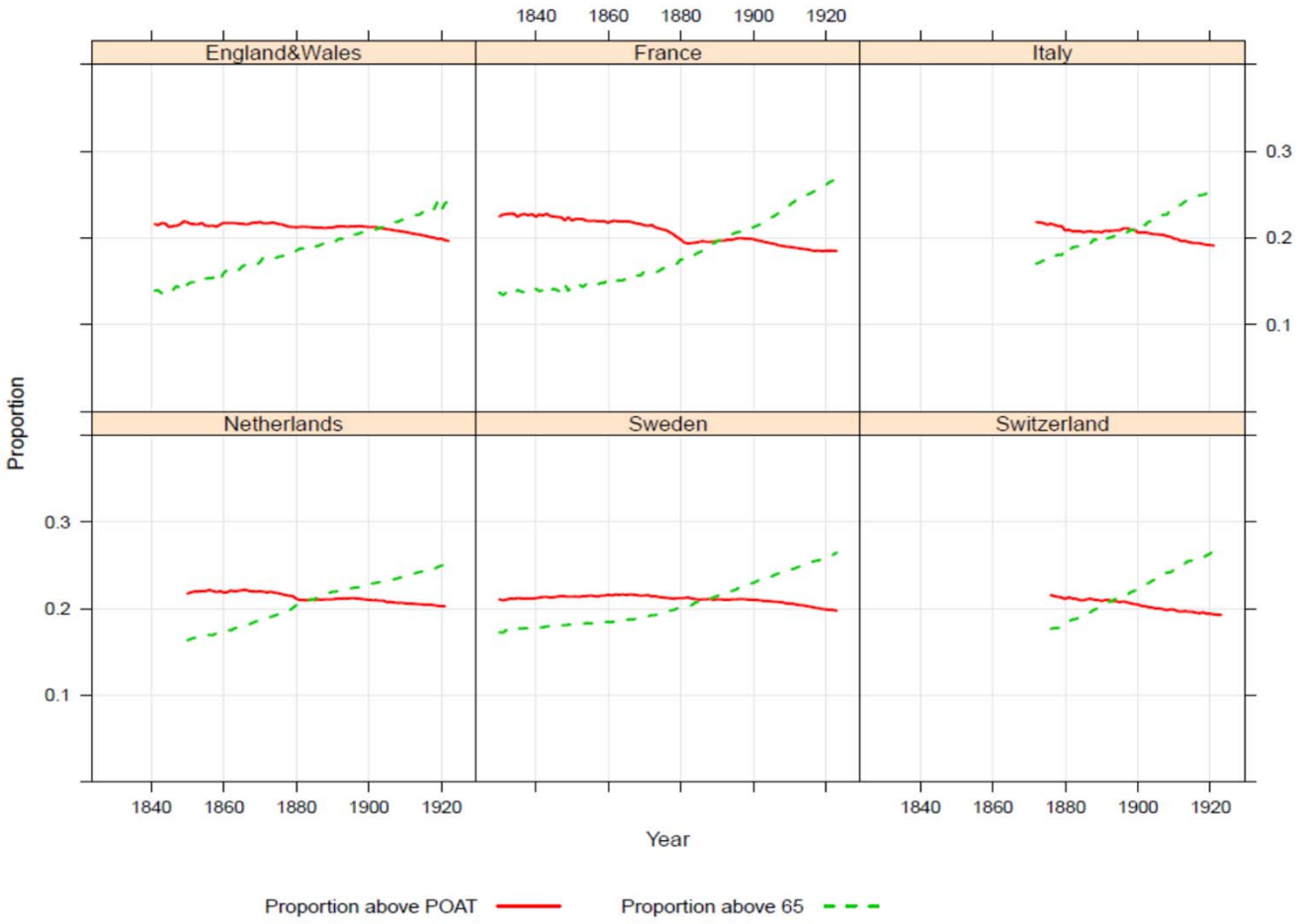
More Examples

5-Year Death Rates at Two Old-Age Thresholds, Cohorts



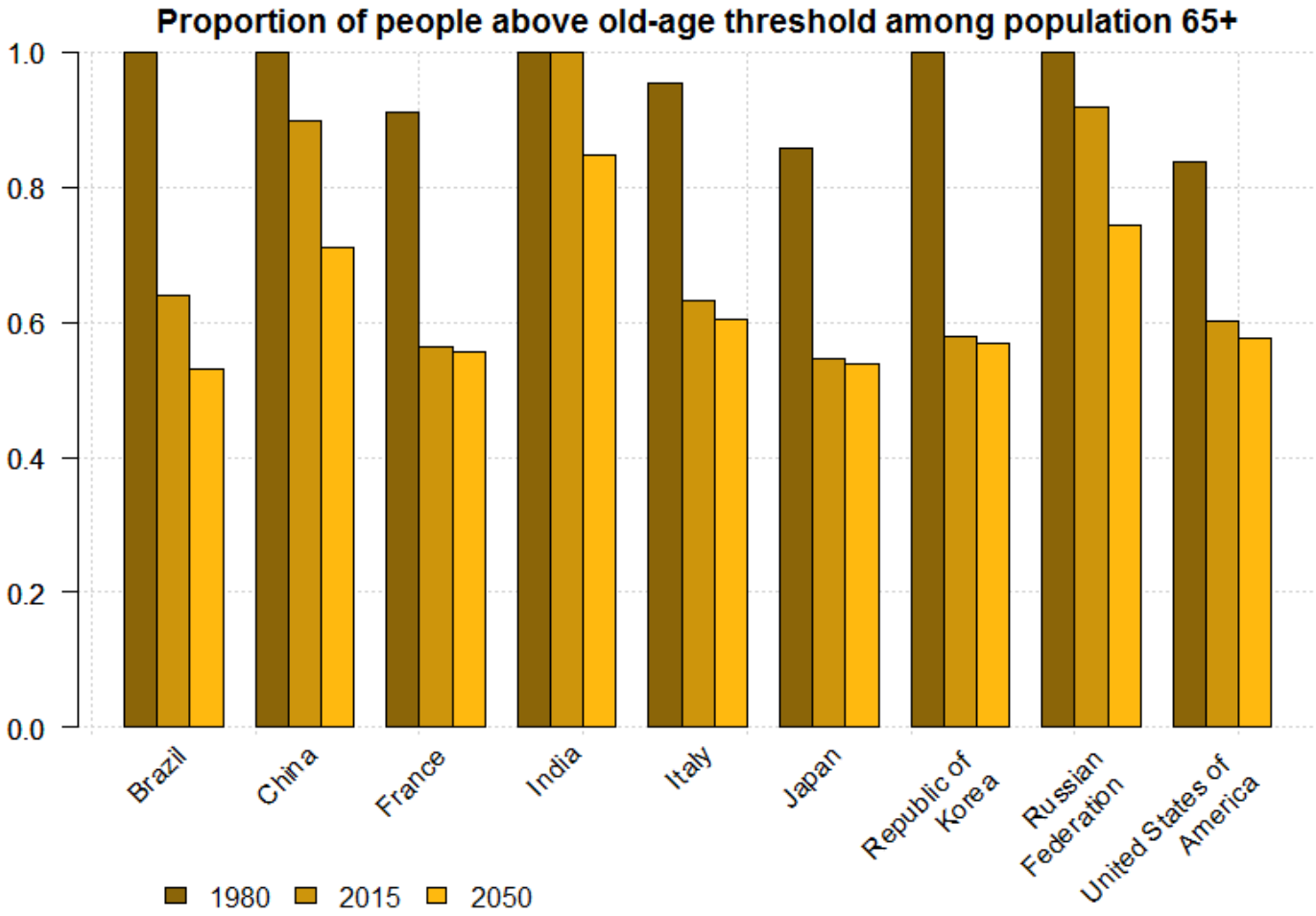
Source: Human Mortality Database and Authors' Calculations

Proportions of Adult Life in Old-Age at Two Old-Age Thresholds, Cohorts

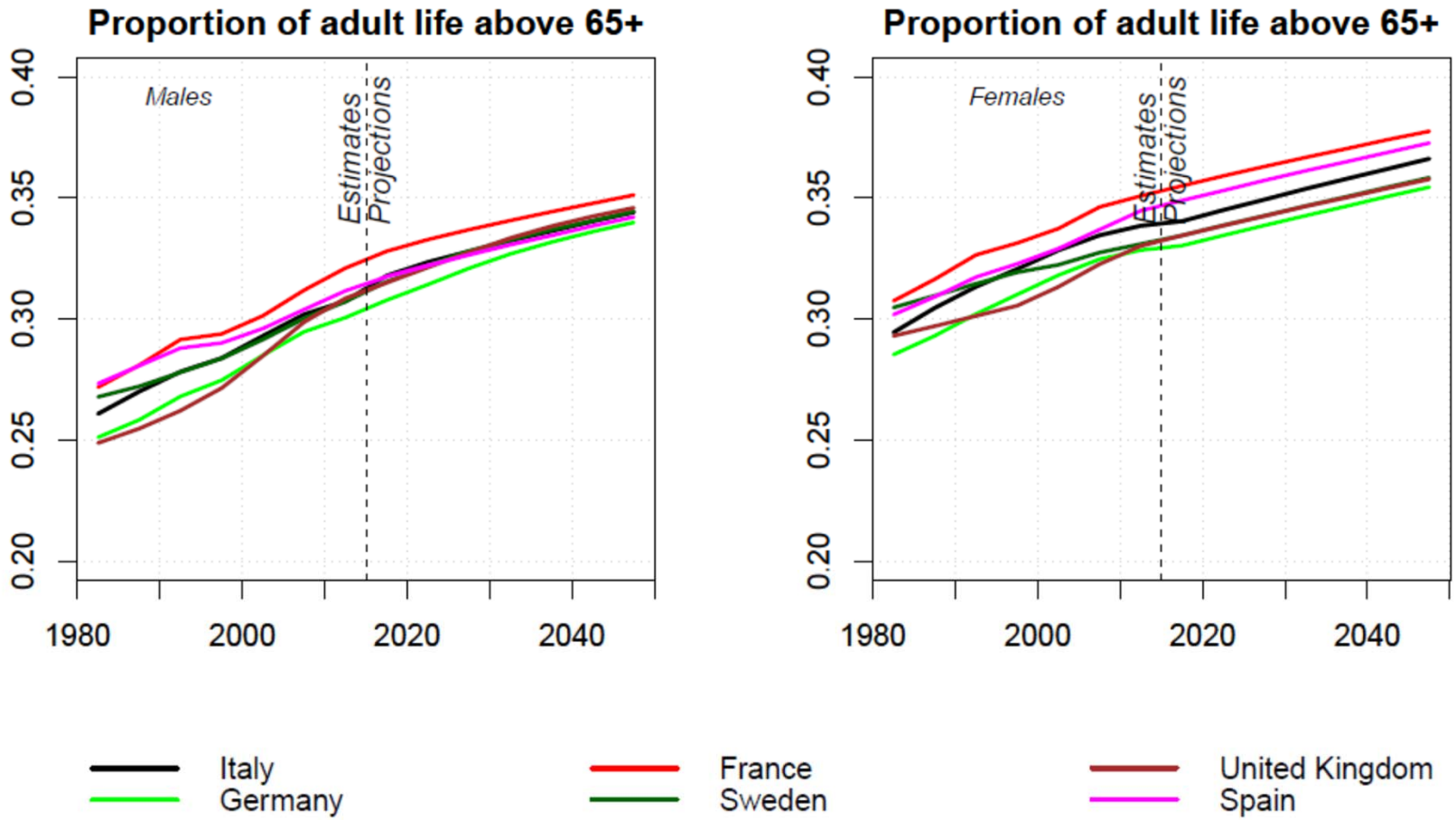


Source: Human Mortality Database and Authors' Calculations

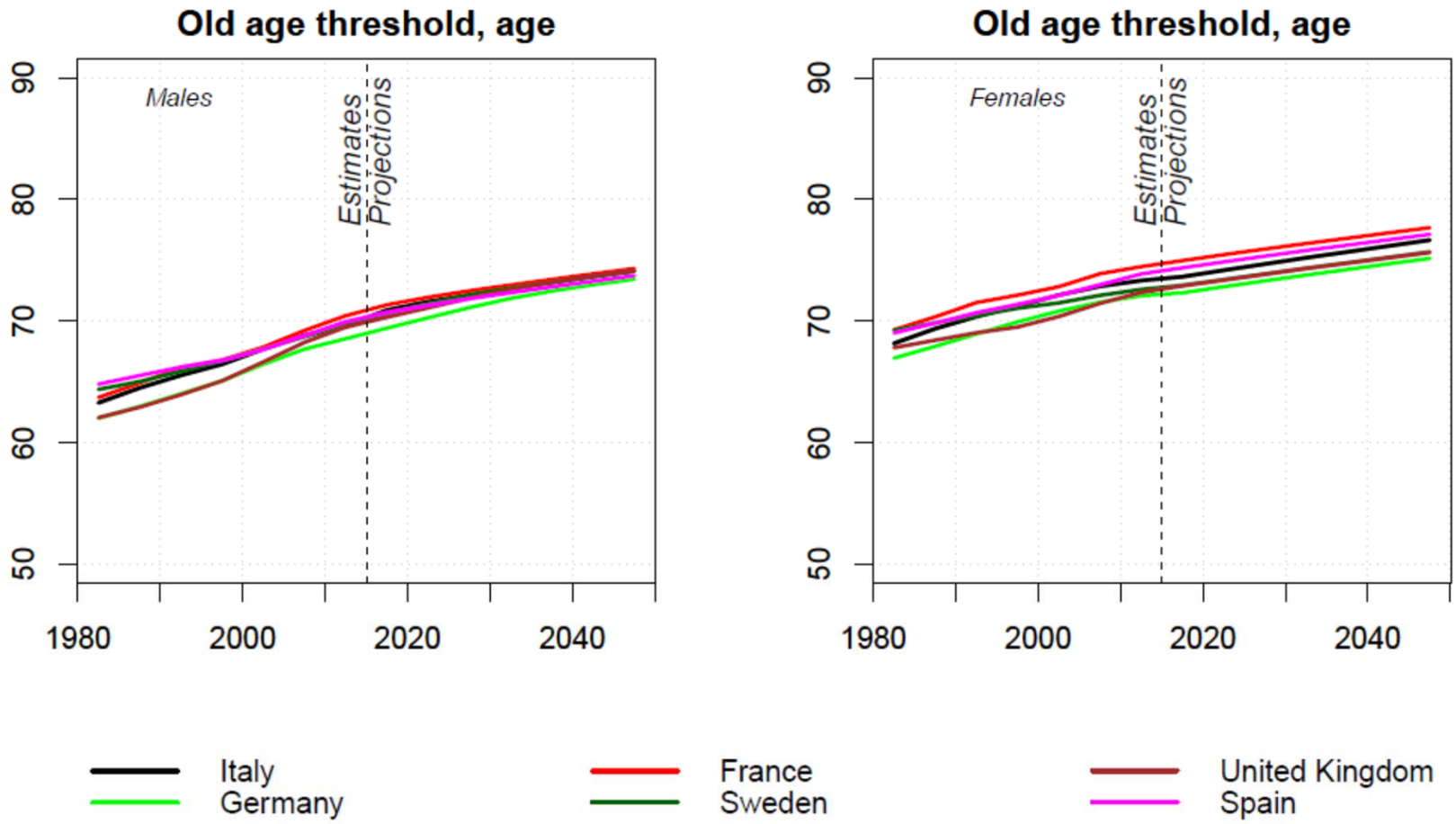
Who is Really Old at 65+?



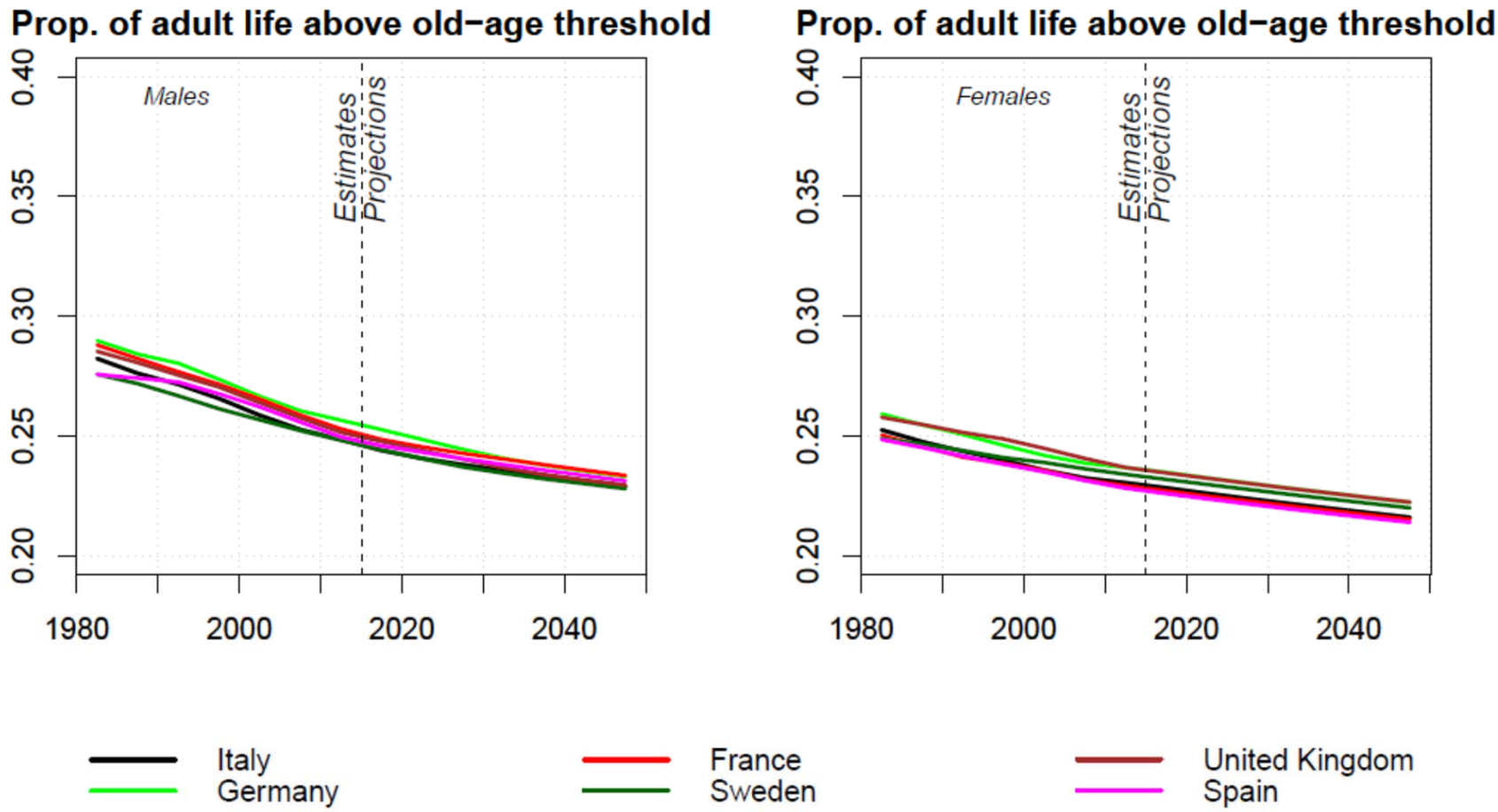
Adult Life Above Age 65



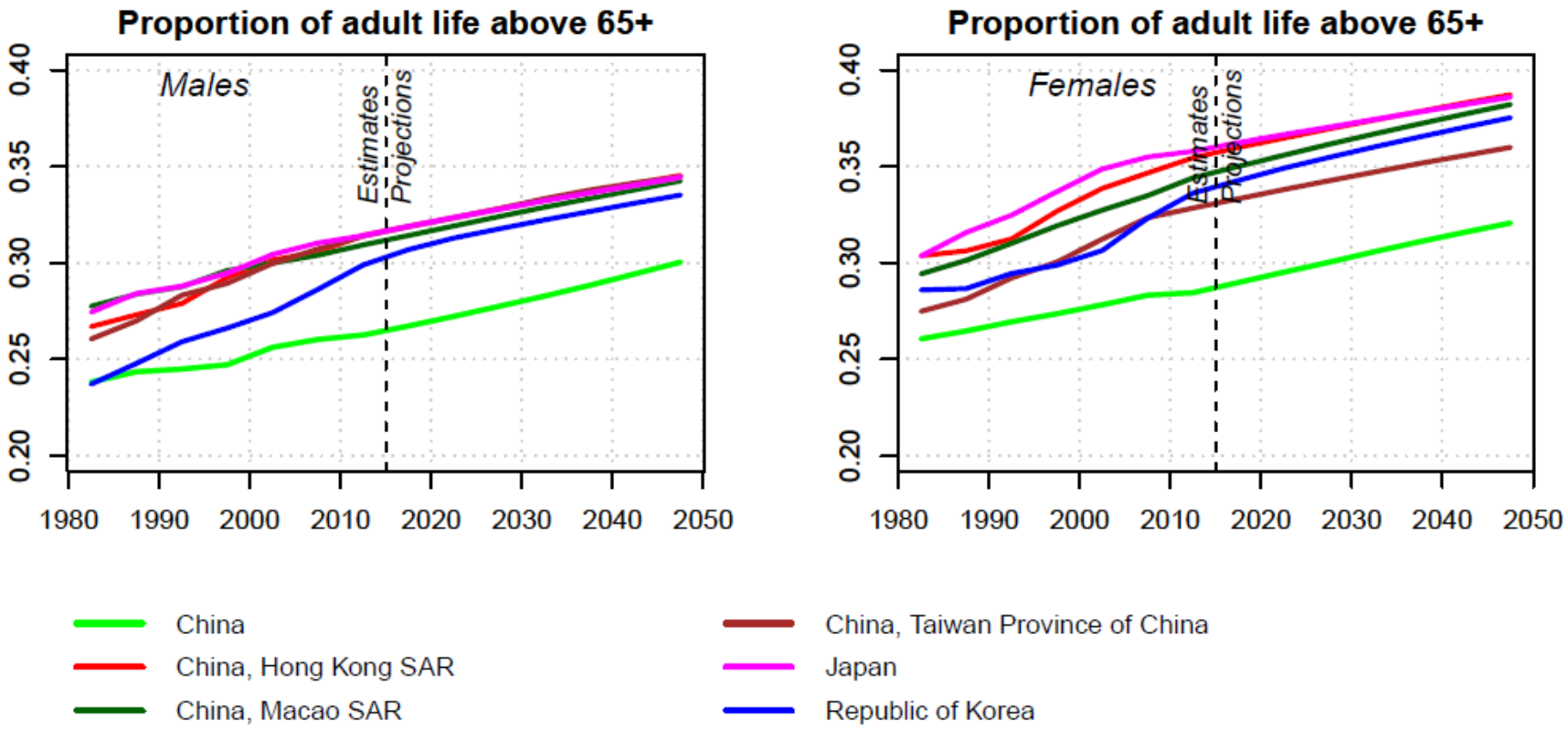
Old age threshold



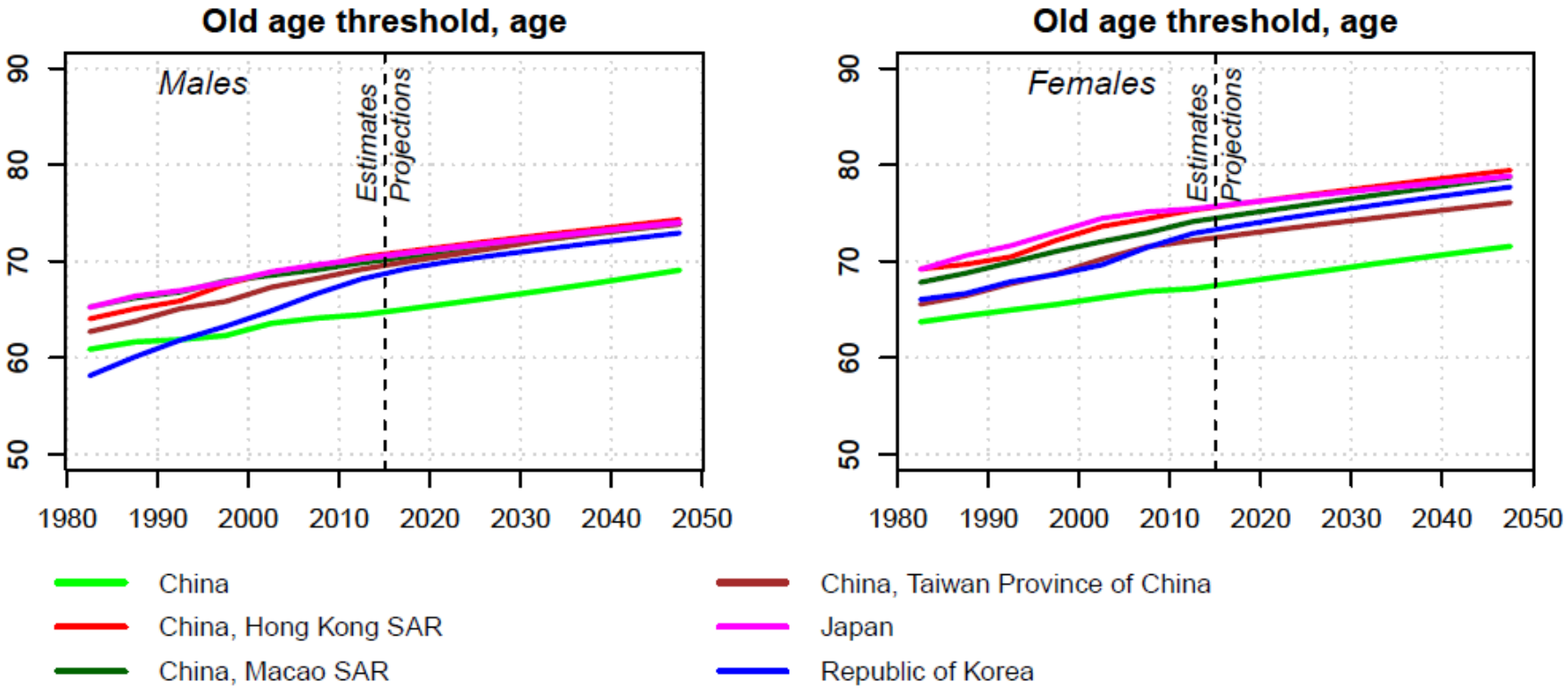
Adult Life Above Old-Age Threshold



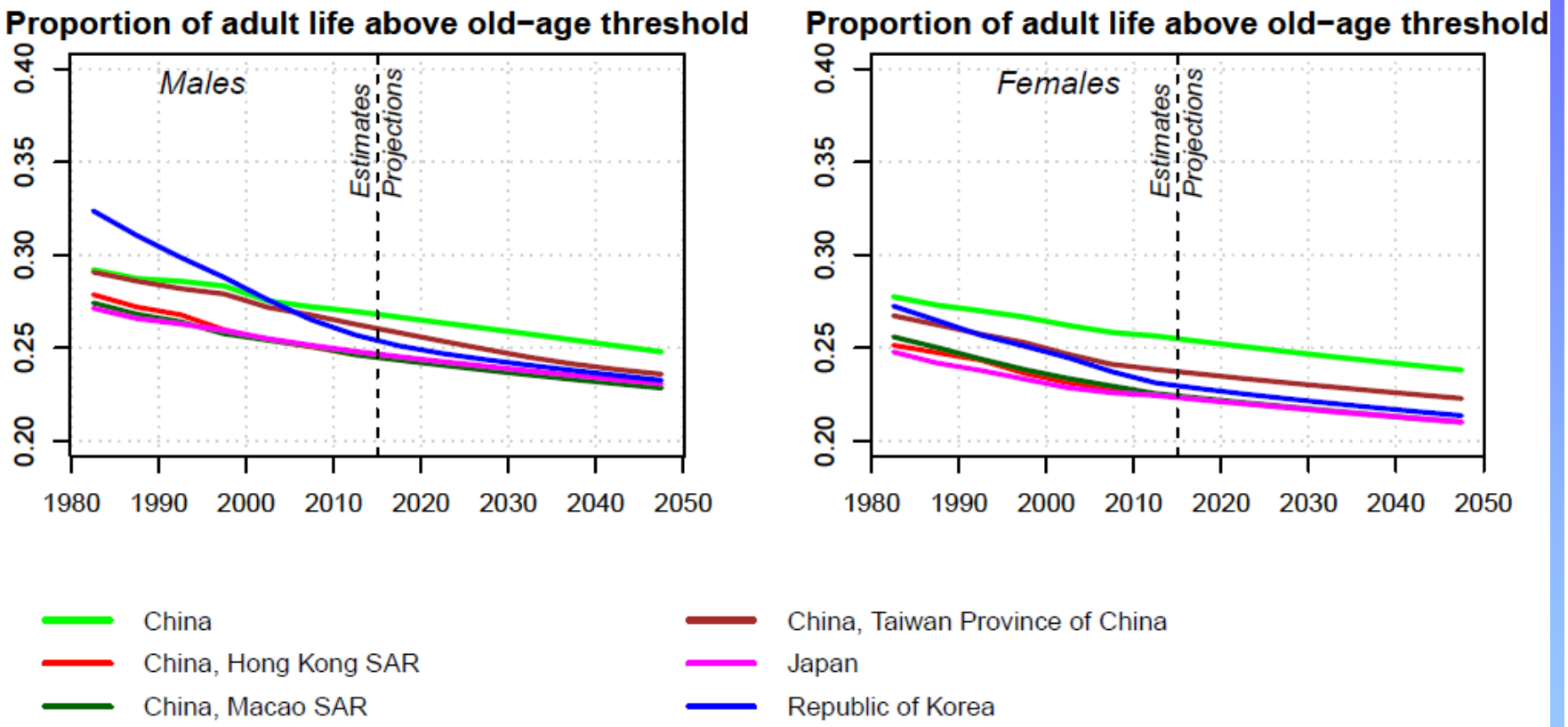
Adult Life Above Age 65



Old age threshold



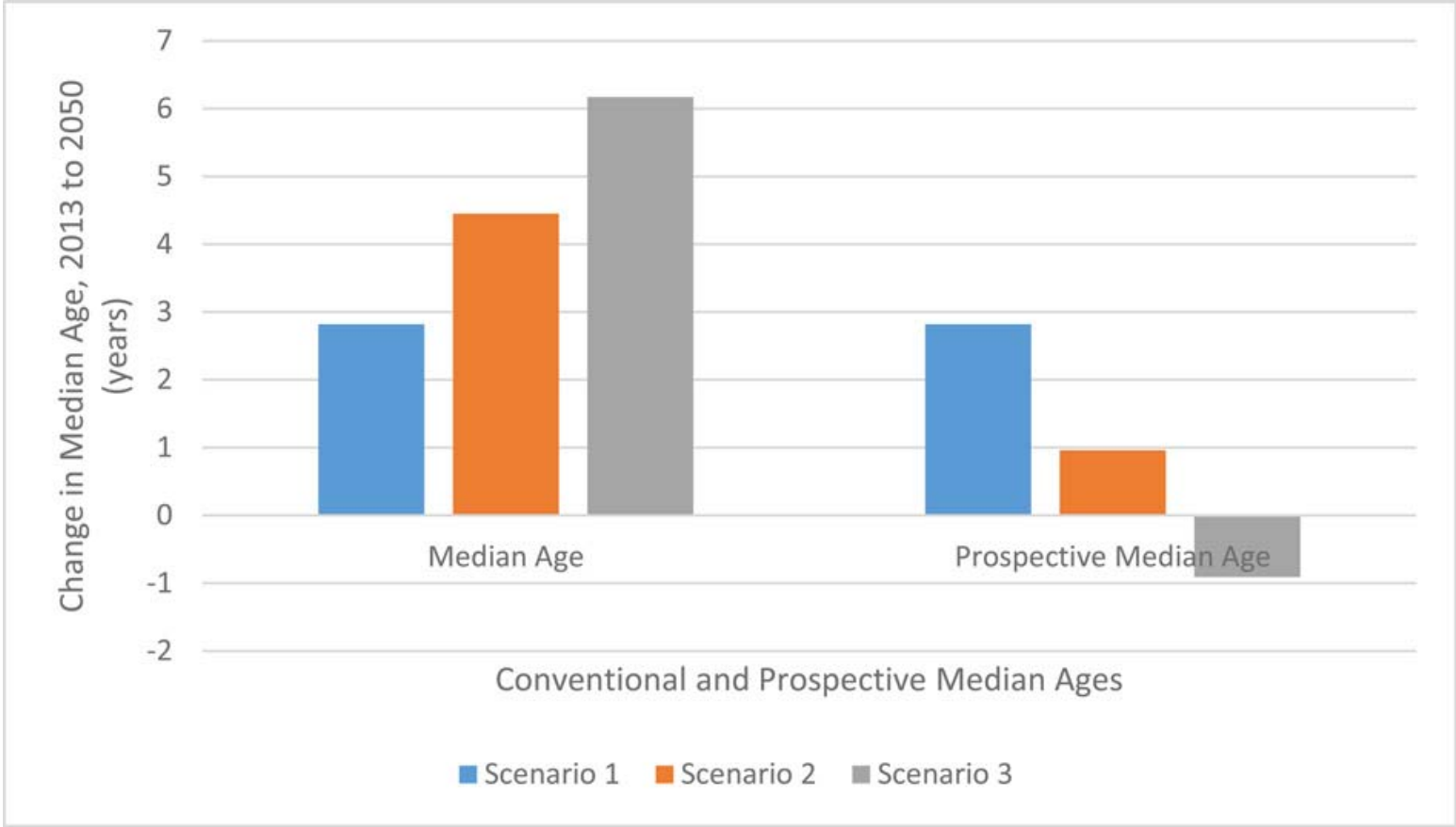
Adult Life Above Old-Age Threshold



Faster Increases in Human Life Expectancy Could Lead to Slower Population Aging

- The conventional view that faster increases in human life expectancy would lead to faster population aging is based on the assumption that people become old at a fixed chronological age.
- Using prospective measures of ageing, we show that faster increases in life expectancy would lead to slower population aging

Changes in Median Age from 2013 to 2050, Germany.



Source: Sanderson WC, Scherbov S (2015) Faster Increases in Human Life Expectancy Could Lead to Slower Population Aging. *PLoS ONE* 10(4): e0121922.

Characteristic-based measures of age

Recently we introduced a new paradigm in conceptualizing population aging. We call it the *characteristics approach* and it generalizes the notion of prospective age and the work in this field.

Characteristic-based measures of age

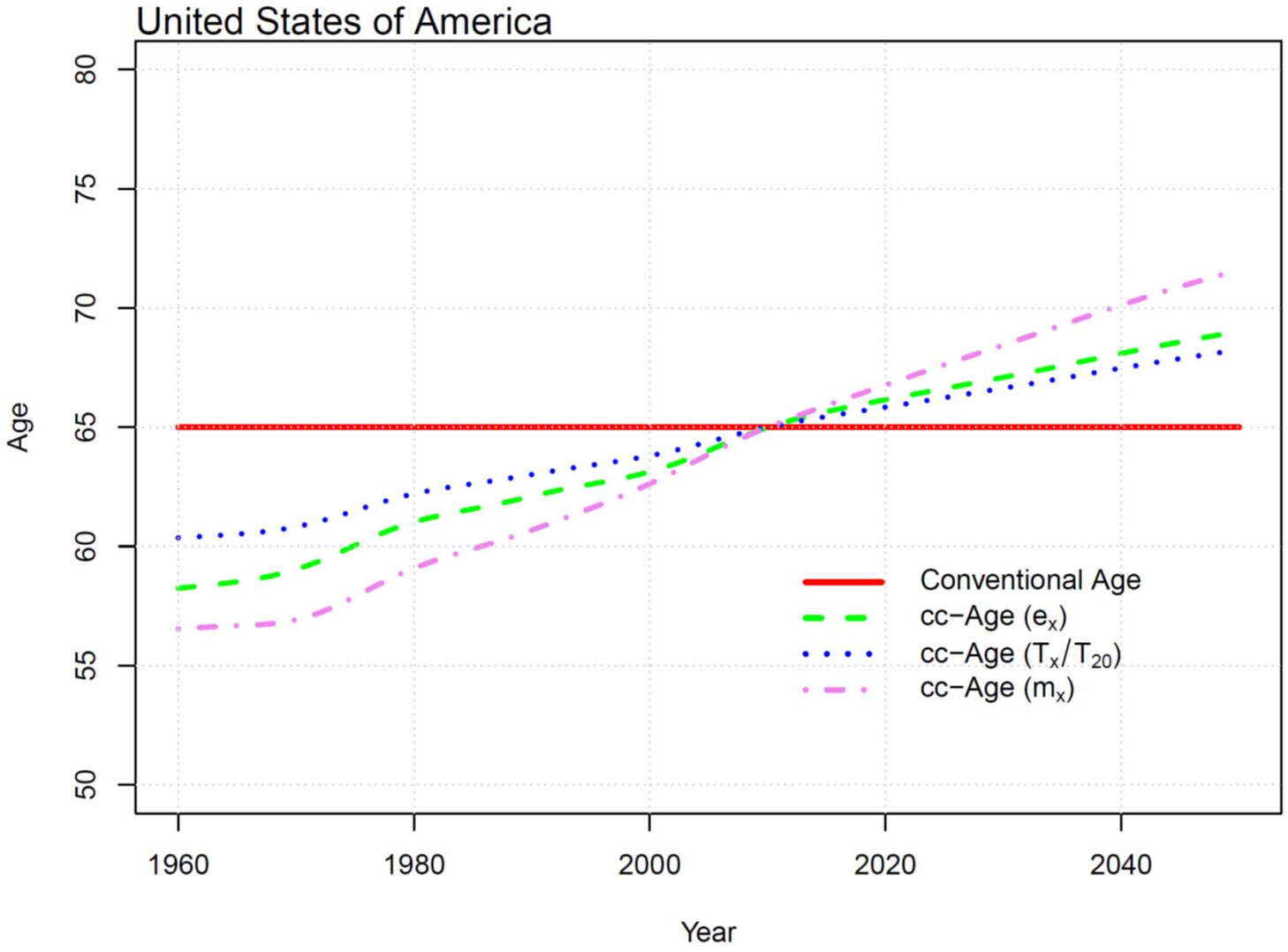
Using this approach we may study aging and the speed of aging along different dimensions each corresponding to a particular characteristics such as life table characteristics, physical and cognitive health characteristics etc.

Old-age thresholds could be different depending on what characteristic is used.

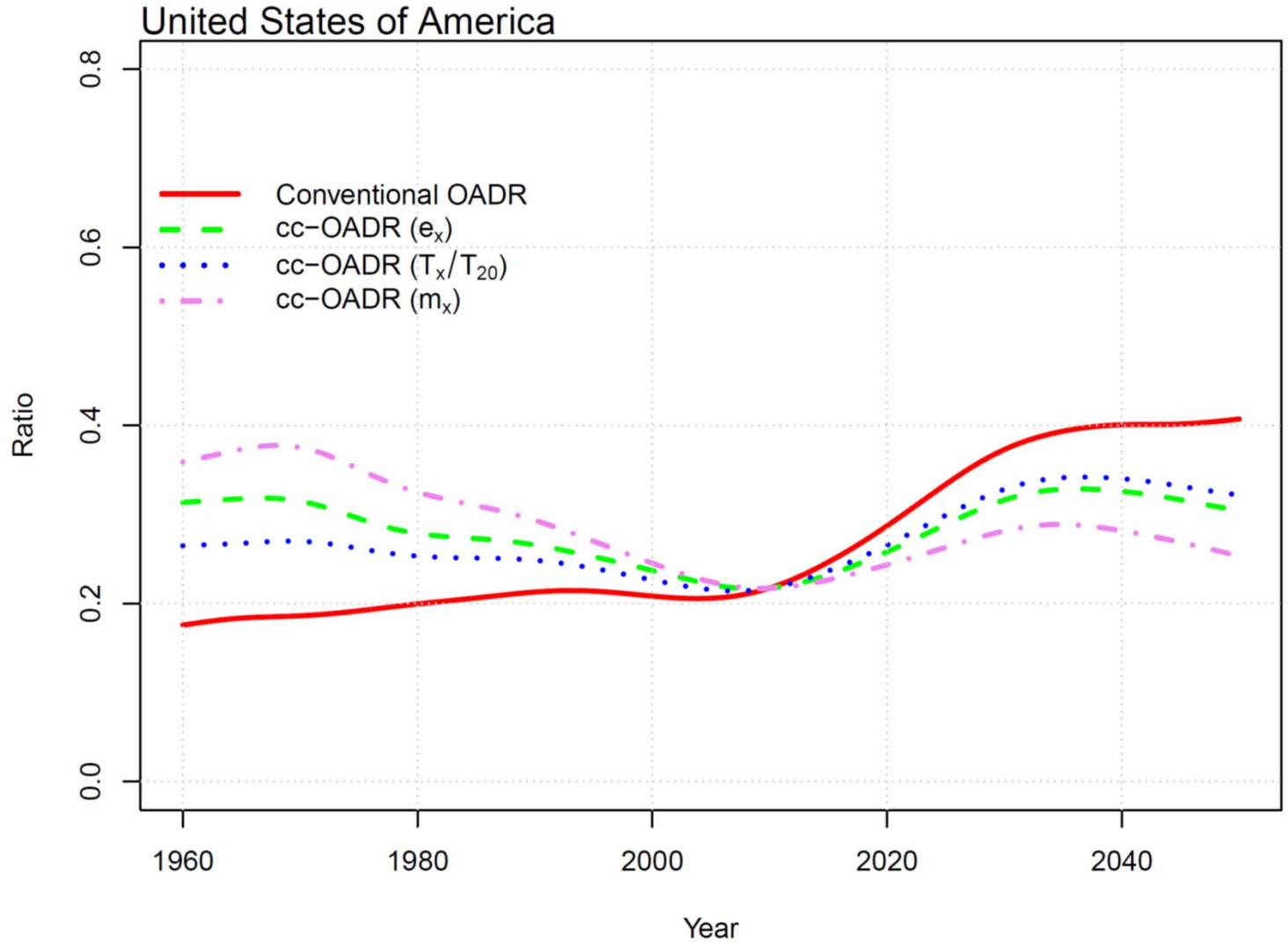
Characteristic-based measures of age

Differences in characteristics are always translated into age metric. This allows to create an aggregate measures based on different characteristics of aging.

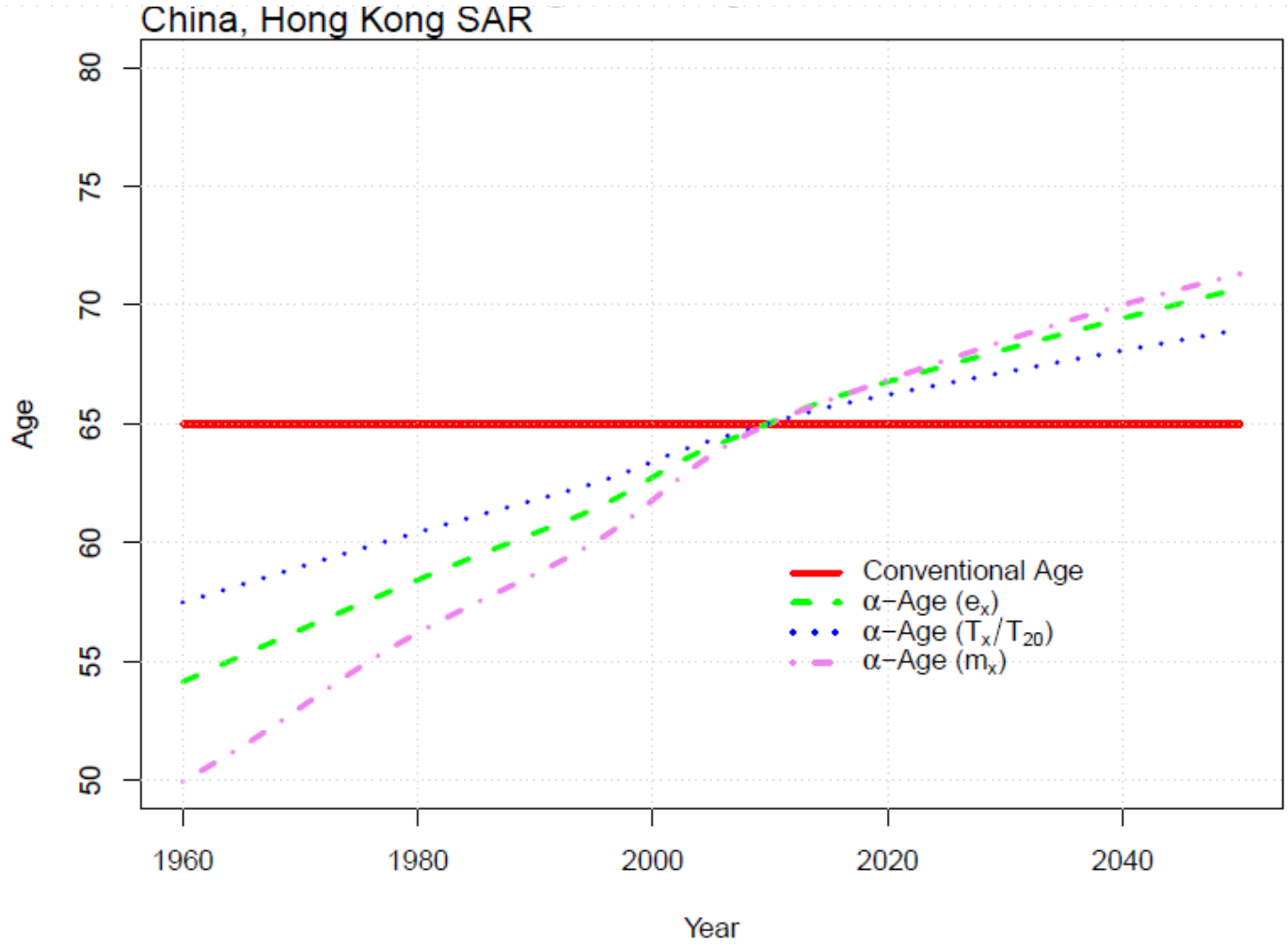
Constant Characteristic Ages



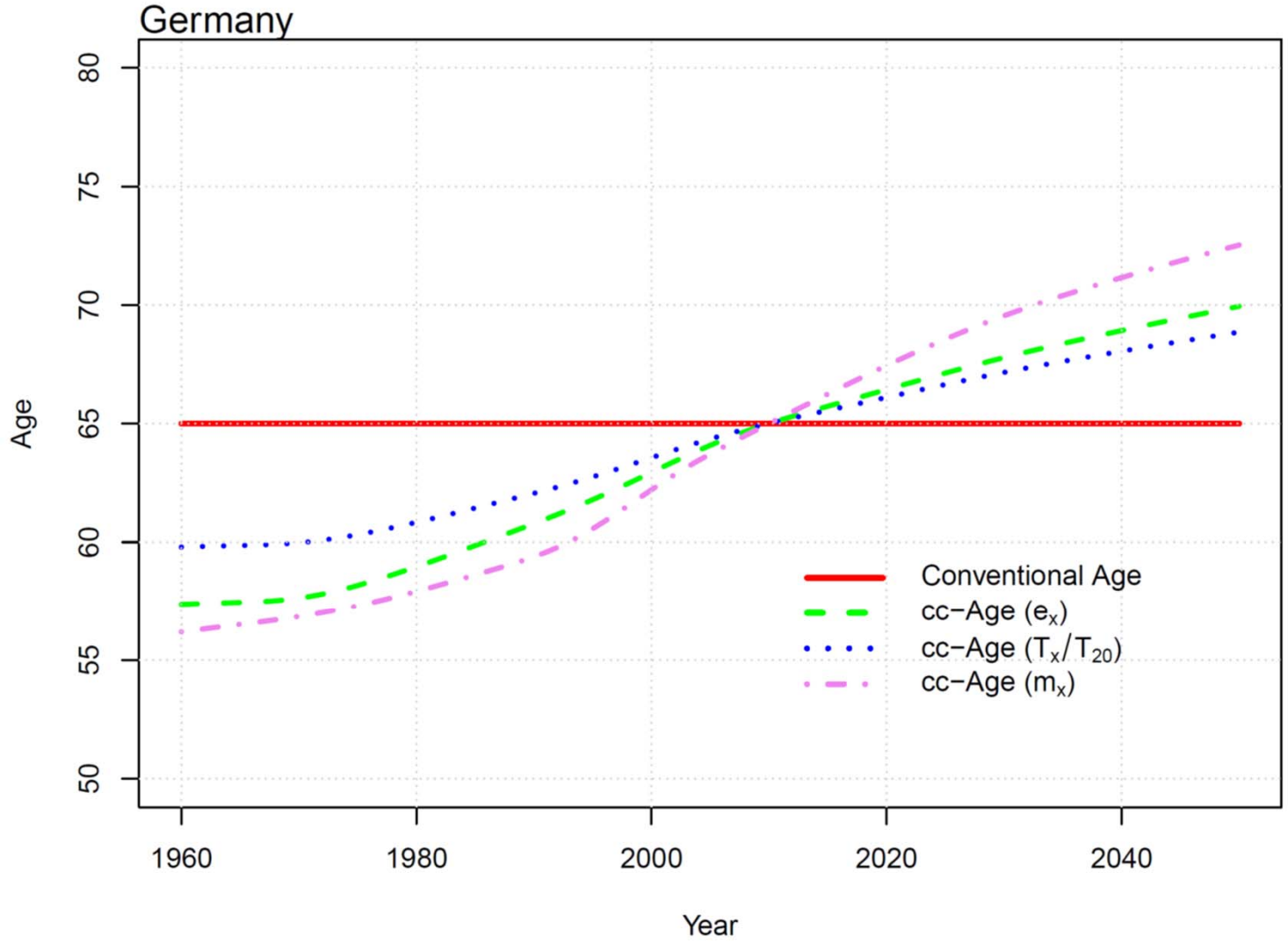
Dependecy Ratios based on CC Ages



Constant Characteristic Ages



Constant Characteristic Ages



People with the same hand-grip strength based age, by age, gender, race, and education, means and 95% confidence intervals.

	Whites – More Educated	
Reference Age of Less Educated	**Male**	**Female**
60	65.8 (63.9,67.7)	65.7 (63.9,67.3)
65	69.6 (68.2,70.9)	69.4 (68.2,70.7)
70	73.4 (72.3,74.5)	73.3 (72.3,74.3)
75	77.3 (76.4,78,3)	77.2 (76.4,78.1)
80	81.3 (80.2,82.3)	81.2 (80.2,82.2)

Sanderson WC, Scherbov S (2014) Measuring the Speed of Aging across Population Subgroups. PLoS ONE 9(5): e96289. doi:10.1371/journal.pone.0096289

Pension Ages Based on the Ratio $\frac{T_{65+}}{T_{20\text{-}65}}$ Observed in Germany in 2013

German basis

	Women		Men	
Country	***2013***	***2030***	***2013***	***2030***
Bulgaria	61.70	63.26	60.25	62.14
France	66.90	68.82	65.83	68.36
Georgia	62.17	63.67	60.52	62.97
Germany	65.00	67.09	65.00	67.45
Greece	64.98	67.30	64.91	67.48
Ireland	64.94	66.80	65.18	66.88
Italy	66.28	68.20	65.89	67.74
Latvia	62.49	64.31	59.34	62.03
Russian Federation	60.99	62.41	57.30	59.56
Serbia	61.21	63.02	60.86	63.07
Slovakia	62.81	64.81	61.15	63.53
Spain	66.29	67.93	65.52	67.57
Sweden	65.13	67.03	65.75	67.63
United Kingdom	64.99	66.96	65.49	67.32

MEN, 2013=65 Country	2013	2020	2030	2040	2050	Months per year
Bulgaria	65.00	65.60	66.96	68.31	69.69	1.5
Czech Republic	65.00	65.99	67.58	69.16	70.61	1.8
France	65.00	66.09	67.52	68.74	70.02	1.6
Georgia	65.00	66.17	67.54	68.89	70.27	1.7
Germany	65.00	66.00	67.45	68.70	69.99	1.6
Greece	65.00	66.19	67.58	68.84	70.15	1.7
Ireland	65.00	65.56	66.71	67.89	69.10	1.3
Italy	65.00	65.57	66.84	68.14	69.40	1.4
Latvia	65.00	66.17	67.80	69.39	70.83	1.9
Russian Federation	65.00	65.69	67.33	68.81	70.22	1.7
Serbia	65.00	65.97	67.27	68.54	69.85	1.6
Slovakia	65.00	65.92	67.46	68.85	70.26	1.7
Spain	65.00	65.61	67.05	68.35	69.64	1.5
Sweden	65.00	65.66	66.87	68.07	69.34	1.4
UK	65.00	65.58	66.82	68.00	69.23	1.4
AVERAGE						1.6

Reports by International Organizations

www.reaging.org

Conclusions

- Population aging will certainly be the source of many challenges in the 21st century. But there is no reason to exaggerate those challenges through mismeasurement.
- We will be able to address those problems better with a larger array of measures of aging, using those that are appropriate to the task at hand.
- The presented approach reconceptualizes age based on the characteristics of people and allows the construction of new multidimensional measures of aging.

Additional Materials on the Topic

- Sanderson W, Scherbov S (2005). Average remaining lifetimes can increase as human populations age. ***Nature*** 435: 811-813, June 9
- Sanderson W, Scherbov S (2010). Remeasuring aging. ***Science*** 329: 1287-1288 , 10 September
- Sanderson W, Scherbov S (2008). Rethinking age and aging. ***Population Bulletin***, 63(4)
- Lutz W, Sanderson W, Scherbov S (2008). The coming acceleration of global population ageing. ***Nature*** 451: 716-719
- Sanderson W, Scherbov S (2013). The characteristics approach to the measurement of population aging , ***Population and Development Review,*** 39(4): 673-685
- Sanderson W, Scherbov S (2014), Measuring the speed of aging across population subgroups. ***PLoS ONE*** 9(5): e96289.
- Sanderson W, Scherbov S (2015). Are we overly dependent on conventional dependency ratios?, ***Population and Development Review***, 41(4):687-708
- Sanderson WC, Scherbov S, Gerland P (2017) Probabilistic population aging. ***PLoS ONE,*** 12(6): e0179171.

Harvard

Prospective Longevity

A New Vision of Population Aging

Warren C. Sanderson and Sergei Scherbov

Aging is a complex phenomenon. We usually think of chronological age as a benchmark, but it is actually a backward way of thinking about our life course. It tells us how long we've lived so far, but what about the rest of our lives?

Today's 65-year-olds have different characteristics from those who were born earlier, and tomorrow's 65-year-olds are likely to be different from today's in ways that are pertinent to the study of population aging.
In this pathbreaking book, Warren Sanderson and Sergei Scherbov provide a new way to measure individual and population aging. They show that aging can be measured not only using how many years we have lived, but also using other characteristics, such as the number of years we have left to live, our disabilities, and our cognitive abilities.
Sanderson and Scherbov show how we can generate better demographic estimates, which inform better policies. Characteristic-based measures of age and ageing help make sense of observed patterns of survival, reorients understanding of health in old age, and clarifies the burden of old-age dependency. The metric also brings valuable data to debates over equitable intergenerational pension ages.

Sanderson and Scherbov's pioneering results have already been adopted by the United Nations. *Prospective Longevity* offers us all an opportunity to rethink aging, so that we can make the right choices for our societal and economic health.

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