A New Way of Looking at Age and Ageing

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Summer School on
"The Demography of Health and Education"
Vienna 6th June – 15th June 2016

This research is supported by a grant from the European Research Council (ERC2012-AdG 323947-Re-Ageing)

Outline

- Introduction
- Conventional definitions of aging
- New measures of aging and a new look at the prospects of aging
- Characteristic-based measures of age and aging
- Conclusion

Headlines

- "The world stands on the threshold of a demographic revolution with few parallels in humanity's past. It's called global aging"
- "…global aging poses a significant threat to global prosperity"
- Aging Population Poses Global Challenges
- No challenge "is as certain as global aging, and none is as likely to have as large and enduring an effect -- on the size and shape of government budgets, on the future growth in living standards, and on the stability of the global economy and even the world order."

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.

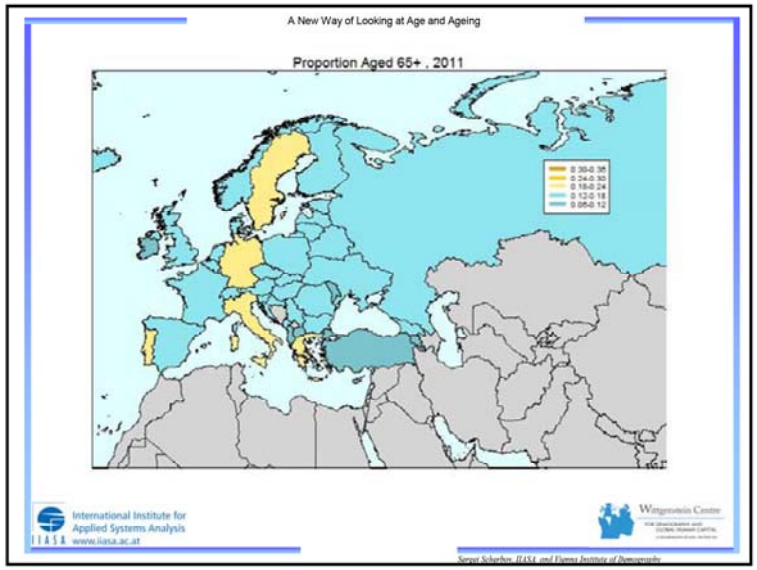
Who is OLD?

- 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

Future Population and Aging

Population projections based on European Demographic Data Sheet 2014

Historical data: Human Mortality Database (HMD)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Proportion Aged 65+ , 2011
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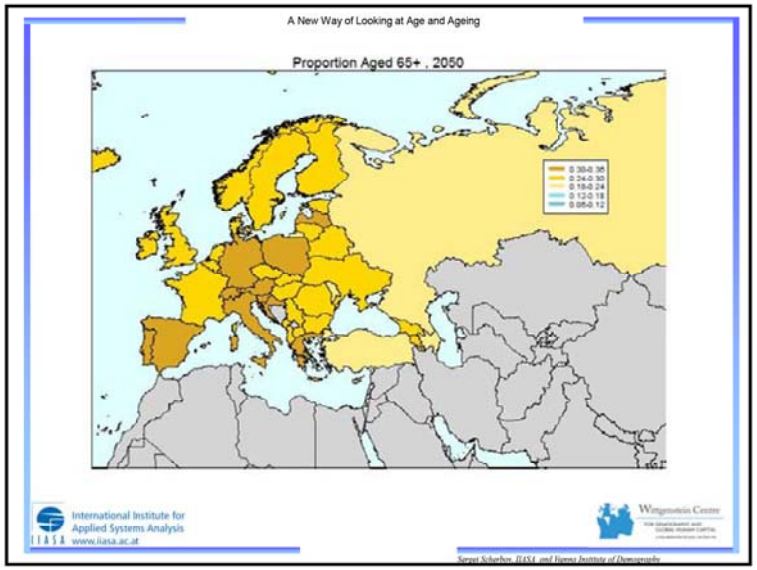
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Proportion Aged 65+ , 2050
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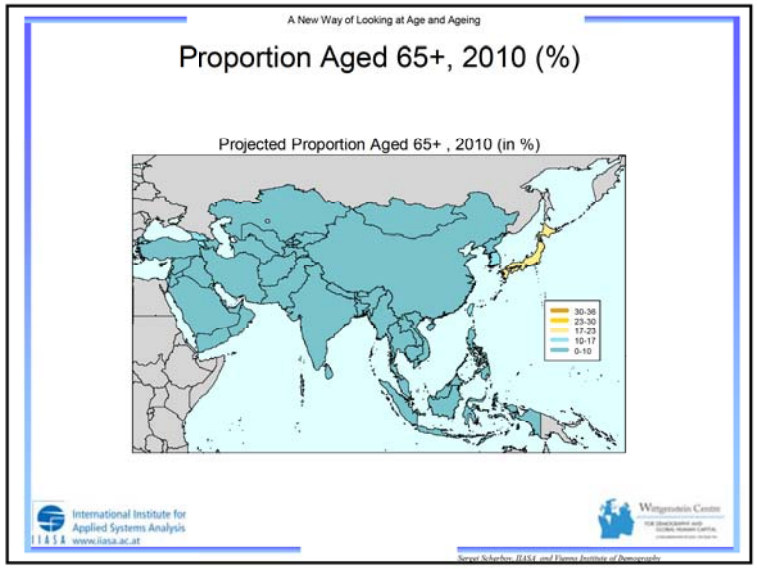
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Proportion Aged 65+, 2010 (%)
Projected Proportion Aged 65+ , 2010 (in %)
30-36
23-30
17-23
10-17
0-10
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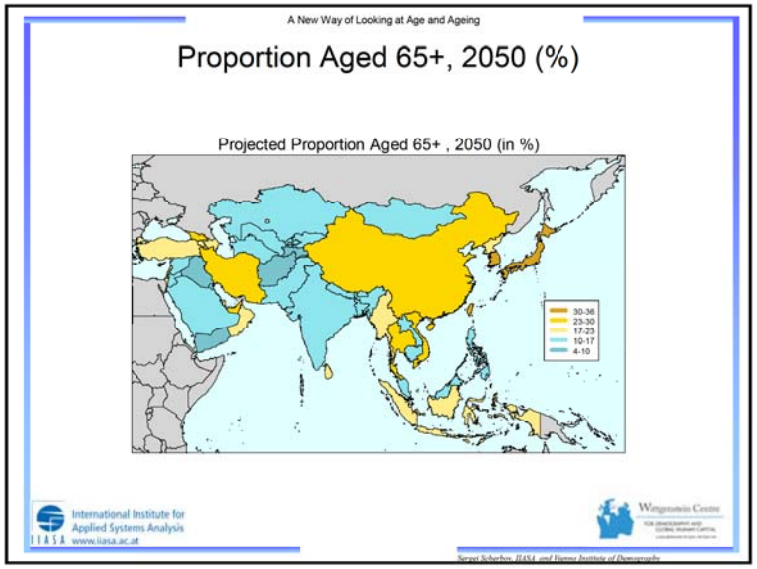
A New Way of Looking at Age and Ageing
Proportion Aged 65+, 2050 (%)
Projected Proportion Aged 65+ , 2050 (in %)
30-36
23-30
17-23
10-17
4-10
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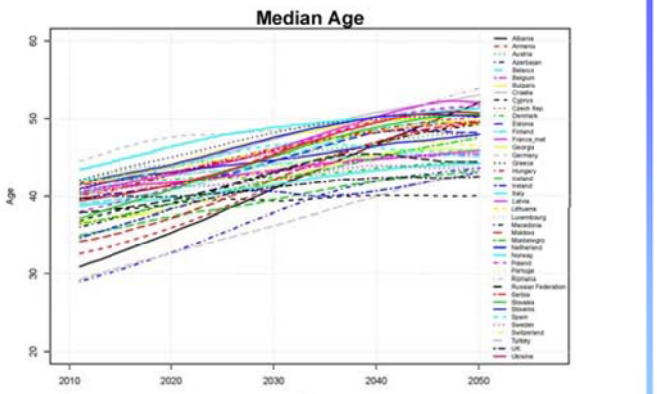


New Measures of Aging

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 almost 90 percent of men survive until that age.

In 1800 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 S. Scherbov. "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 1800

A person who was 60 years old 200 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-years old person in the ***standard year***

Prospective Age

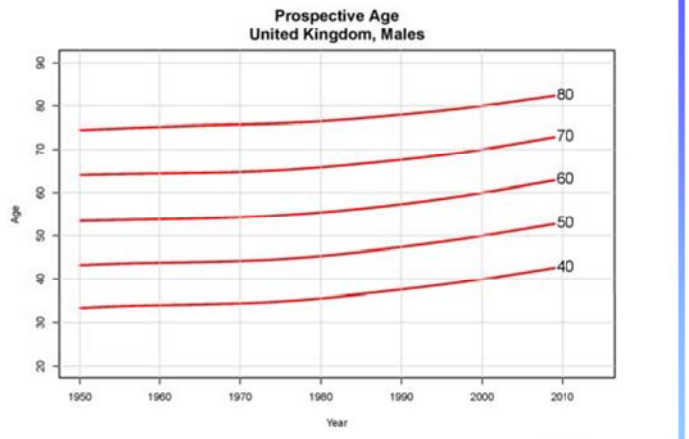
Like a constant dollar is used to compare values from one period to another by taking inflation into account, prospective age serves an analogous purpose by comparing ages and taking the increase in life expectancy into account.

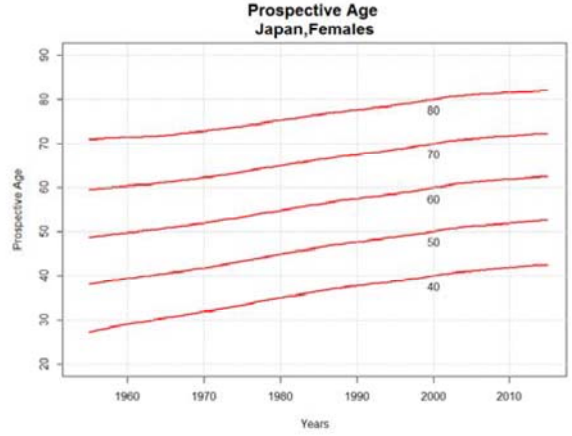
Any kind of financial data that can be represented in dollar terms can be converted into constant dollars by using an appropriate price index. Similarly, age can be converted into prospective age through the use of appropriate life tables.

Constant Prospective Age=40

England & Wales, Standard year=1900

	Females	Males
1900	40.0	40.0
1920	45.8	45.4
1940	45.7	44.2
1960	50.3	47.4
1980	52.0	48.8
1990	53.6	51.0
2001-2003	55.3	54.1
Remaining life expectancy	27.4	25.0





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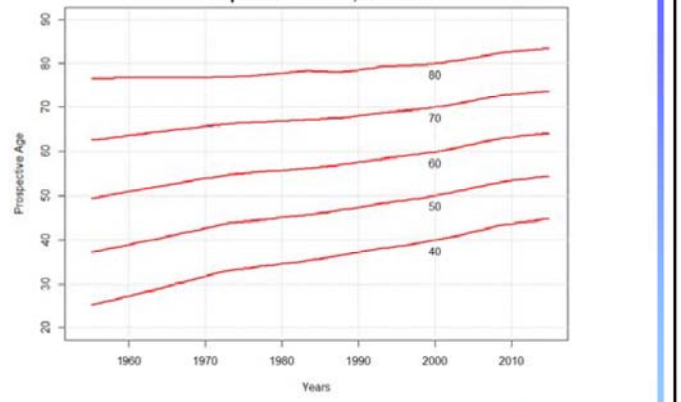
Prospective Age
Republic of Korea,Females



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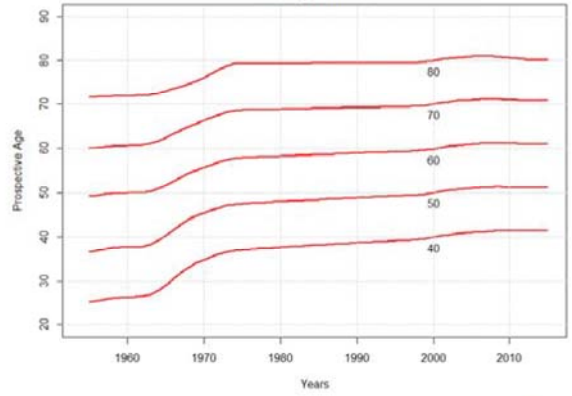
Prospective Age
China,Females



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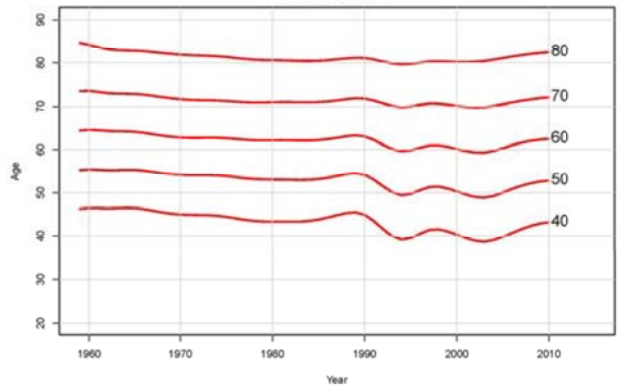
Prospective Age
Russia, Males



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New Look at Aging

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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.

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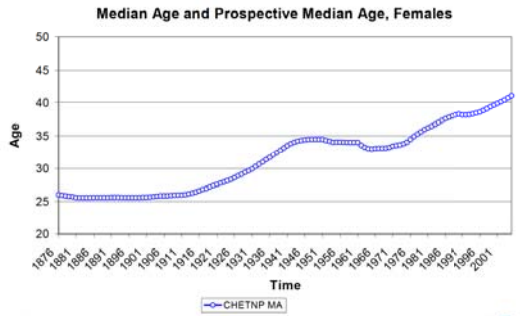
Switzerland



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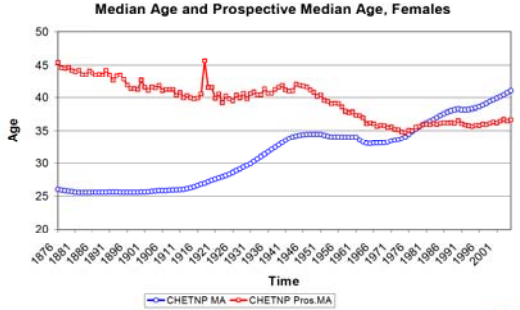
Switzerland



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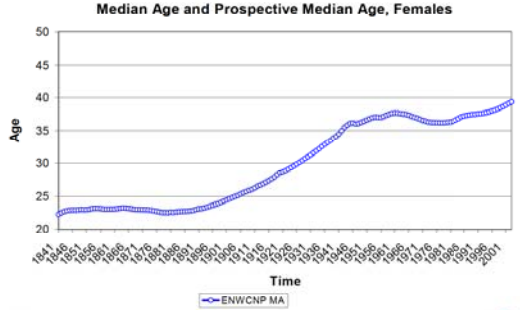
England and Wales



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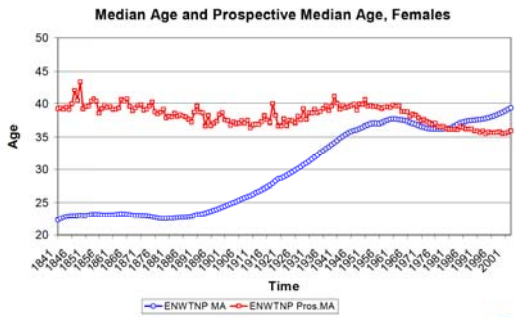
England and Wales



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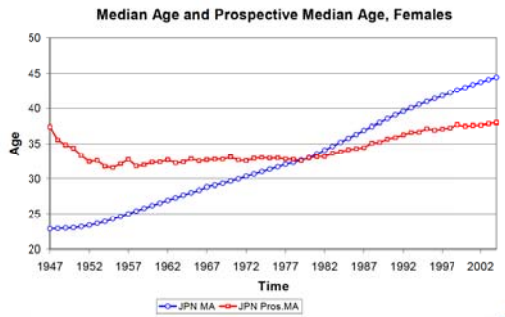
Japan



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Projections

Indicators are calculated using data from
World Population Prospects: The 2012 Revision, United Nations

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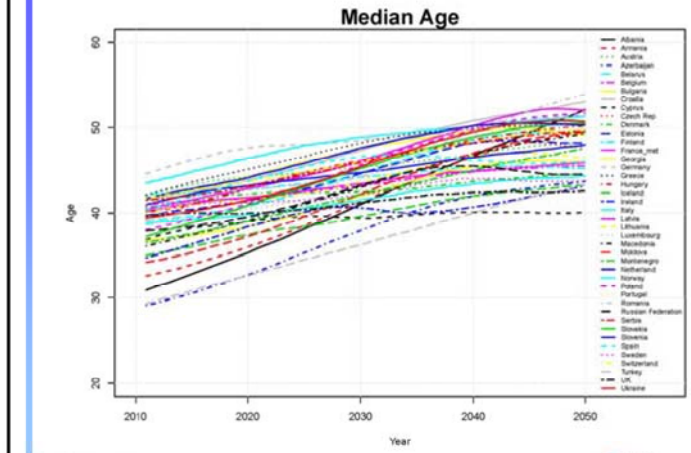

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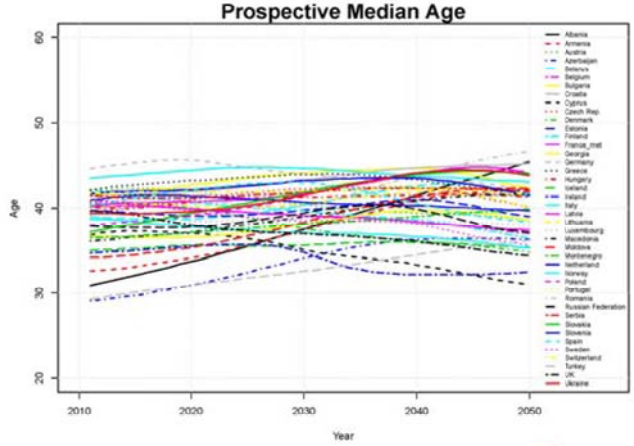
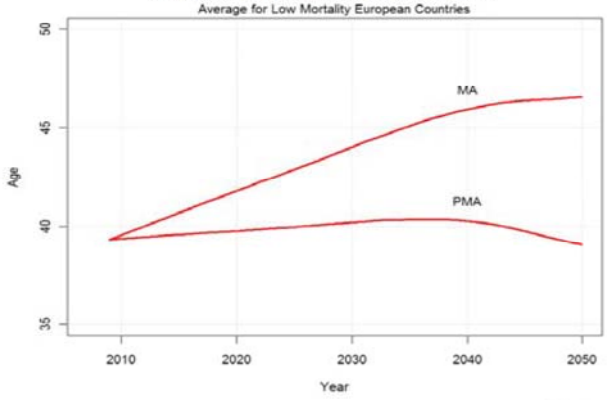
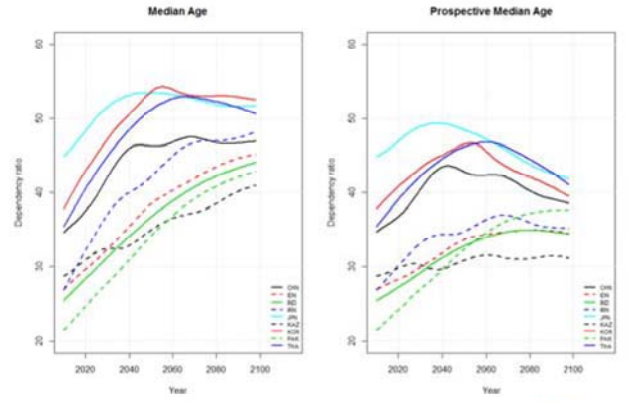
Prospective Median Age



Median and Prospective Median Age, Both Sexes

Average for Low Mortality European Countries





Source: World Population Prospects: The 2012 Revision, United Nations

New Measures of Aging

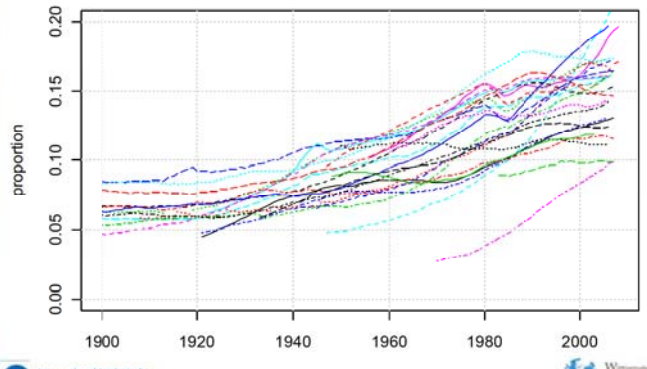
1. Prospective Age and Prospective Median Age
2. Proportion of elderly people

Illustrations of Conventional Approach

Use of proportion 65+

Low Mortality OECD countries

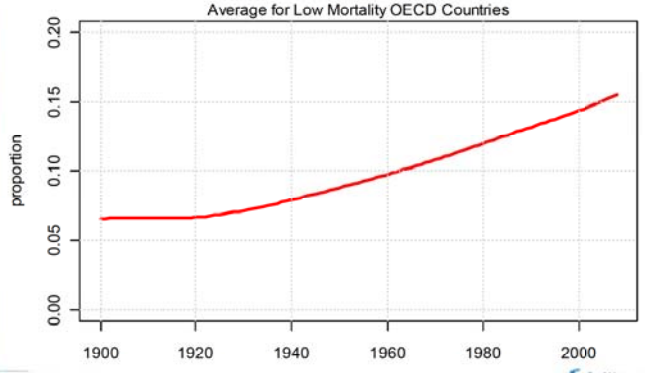
Proportion 65+



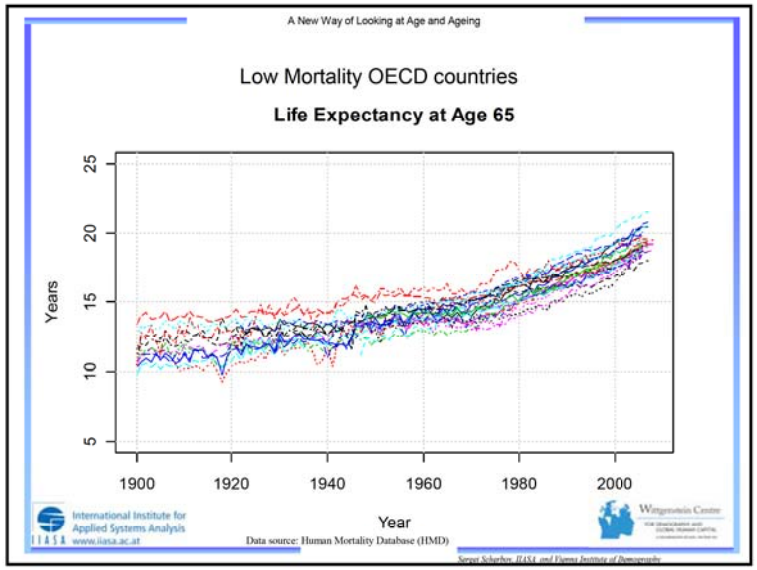
Data source: Human Mortality Database (HMD)

Proportion 65+

Average for Low Mortality OECD Countries



How Life Expectancy Was Growing at age 65?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Low Mortality OECD countries
Life Expectancy at Age 65
Years
Year
Data source: Human Mortality Database (HMD)
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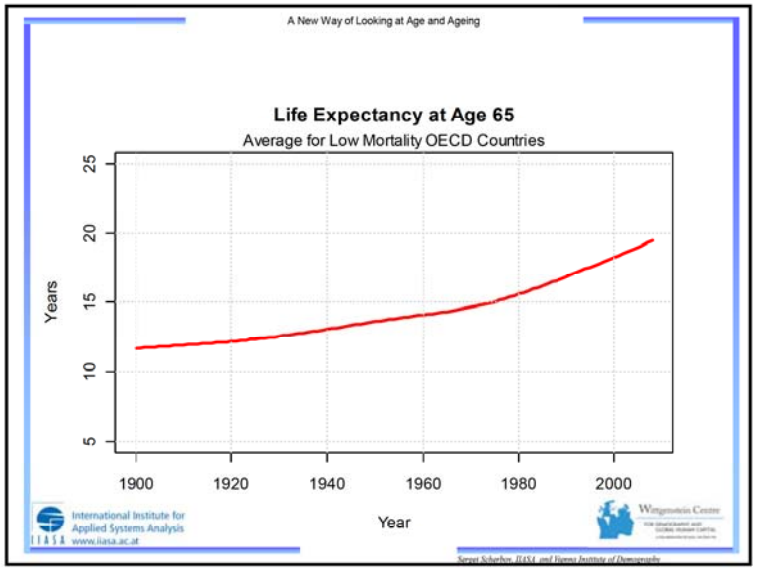
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Life Expectancy at Age 65
Average for Low Mortality OECD Countries
Years
Year
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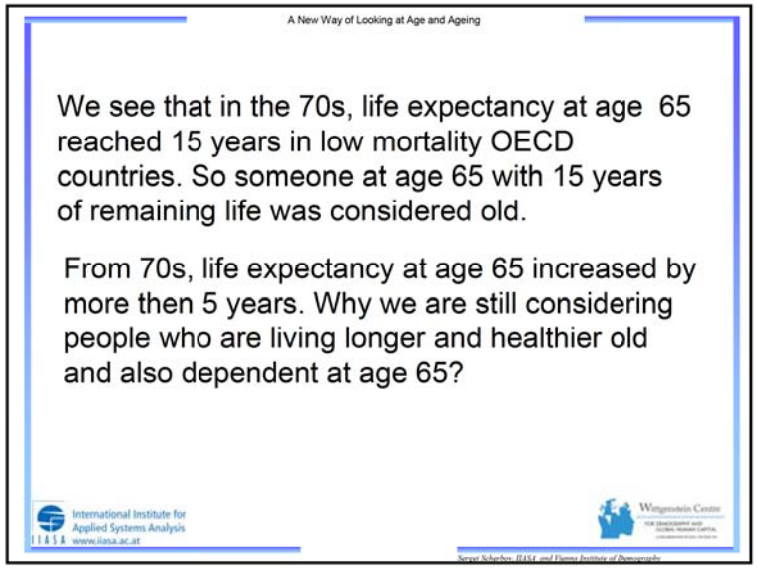
A New Way of Looking at Age and Ageing
We see that in the 70s, life expectancy at age 65 reached 15 years in low mortality OECD countries. So someone at age 65 with 15 years of remaining life was considered old.
From 70s, life expectancy at age 65 increased by more then 5 years. Why we are still considering people who are living longer and healthier old and also dependent at age 65?
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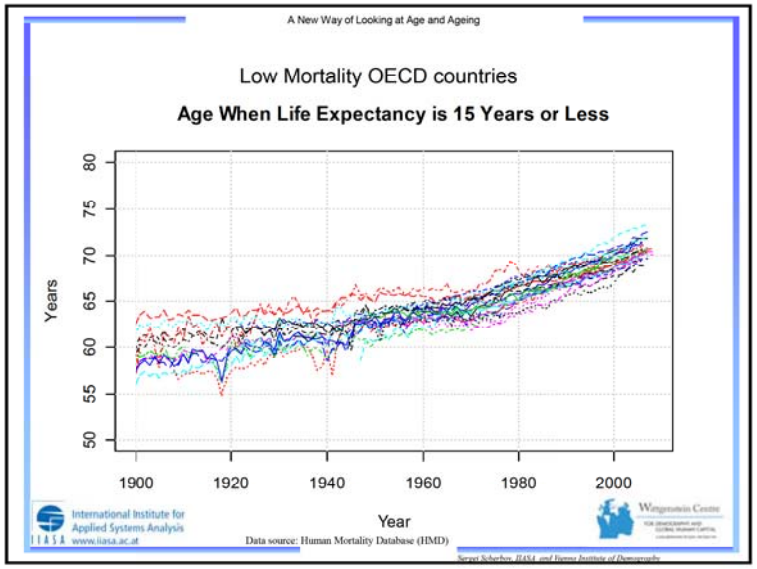
A New Way of Looking at Age and Ageing
Low Mortality OECD countries
Age When Life Expectancy is 15 Years or Less
Years
Year
Data source: Human Mortality Database (HMD)
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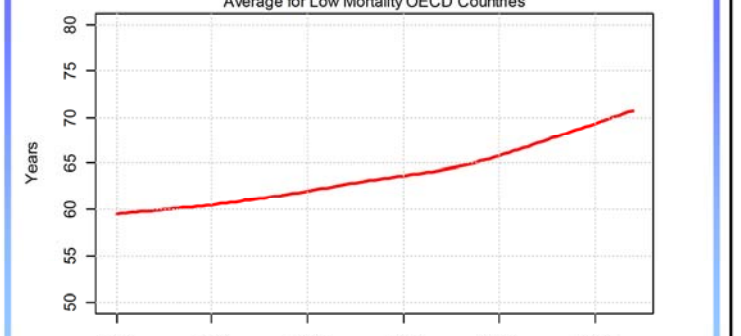
Age When Life Expectancy is 15 Years or Less

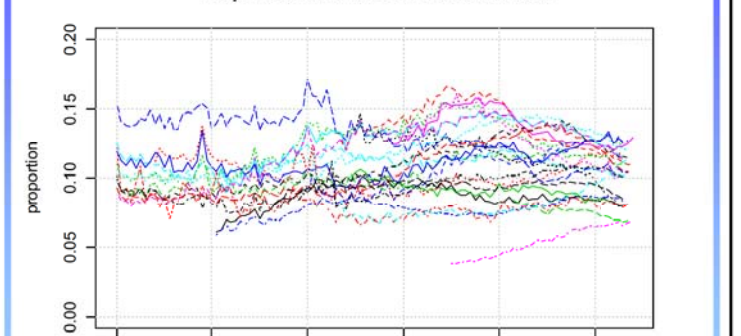
Average for Low Mortality OECD Countries



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

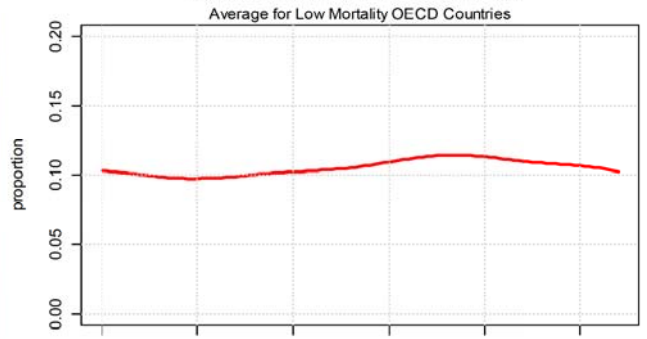
How would proportion of old look like with this definition of elderly people.

Proportion with RLE 15 Years or Less



Proportion with RLE 15 Years or Less

Average for Low Mortality OECD Countries



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Average Decennial Increase in Old Age Threshold, 2000-2013

Republic of Moldova	0.26	Italy	1.55
Russian Federation	1.67	Serbia	0.94
Ukraine	0.82	Slovenia	2.28
Northern Europe	1.96	Spain	1.68
Estonia	1.99	Austria	1.68
Finland	2.17	France	1.67
Latvia	1.04	Germany	1.58
United Kingdom	2.13	Netherlands	1.75

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Projections for European Countries

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

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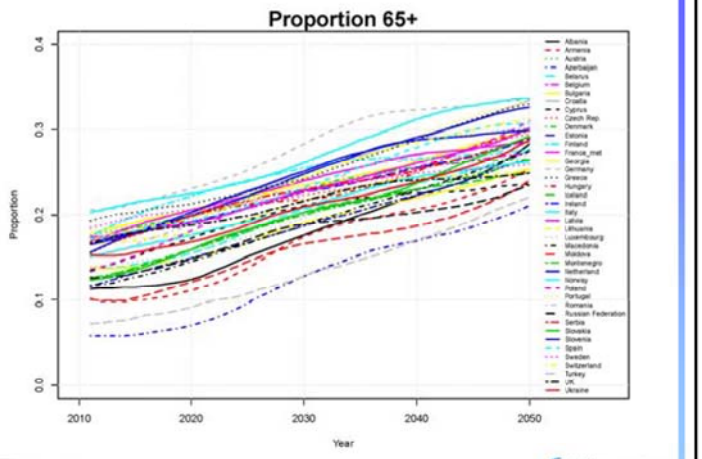

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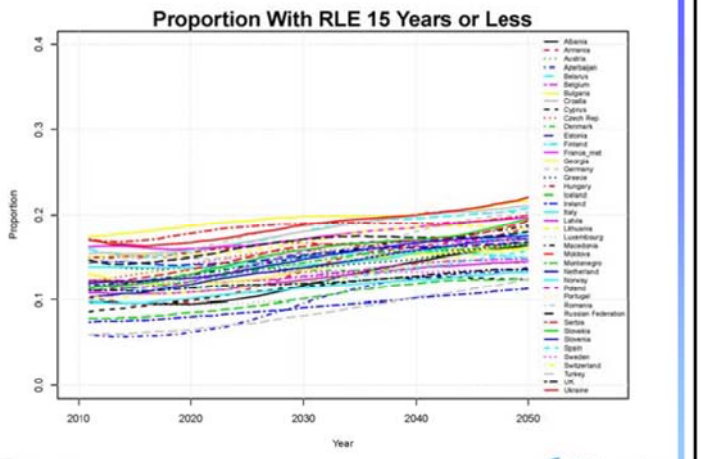

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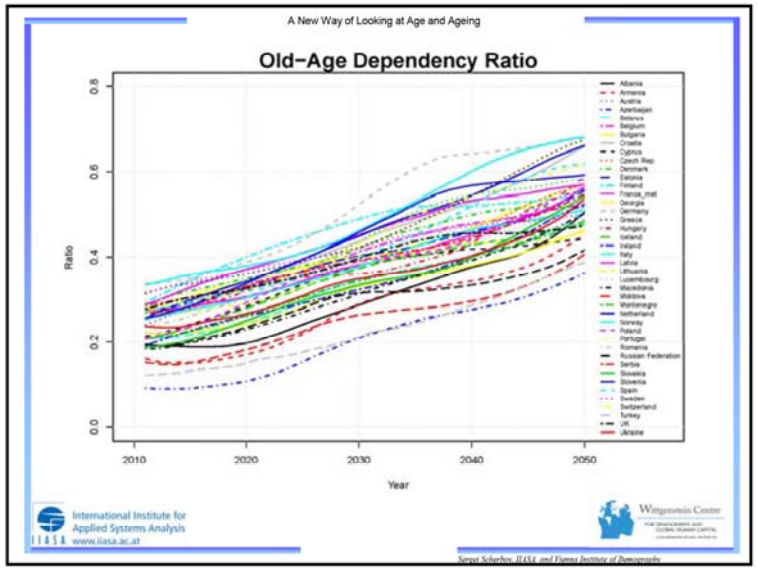
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Old−Age Dependency Ratio
Ratio
Year
2010
2020
2030
2040
2050
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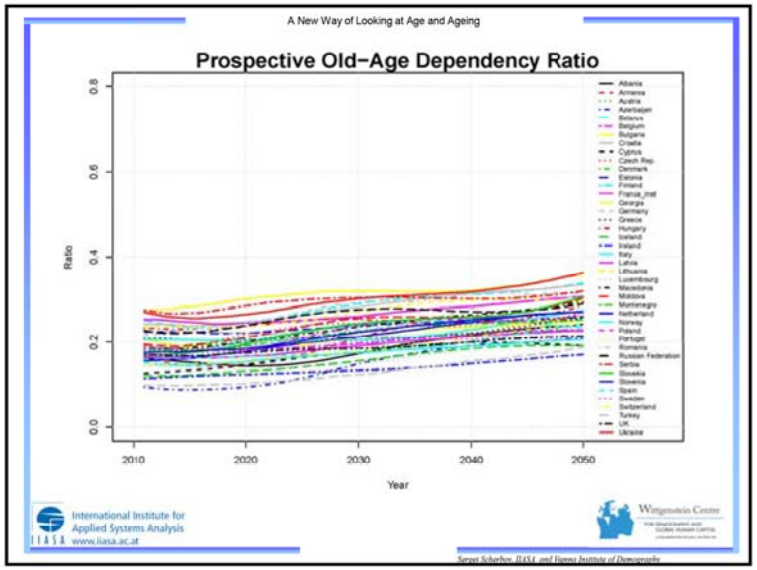
A New Way of Looking at Age and Ageing
Prospective Old−Age Dependency Ratio
Ratio
Year
2010
2020
2030
2040
2050
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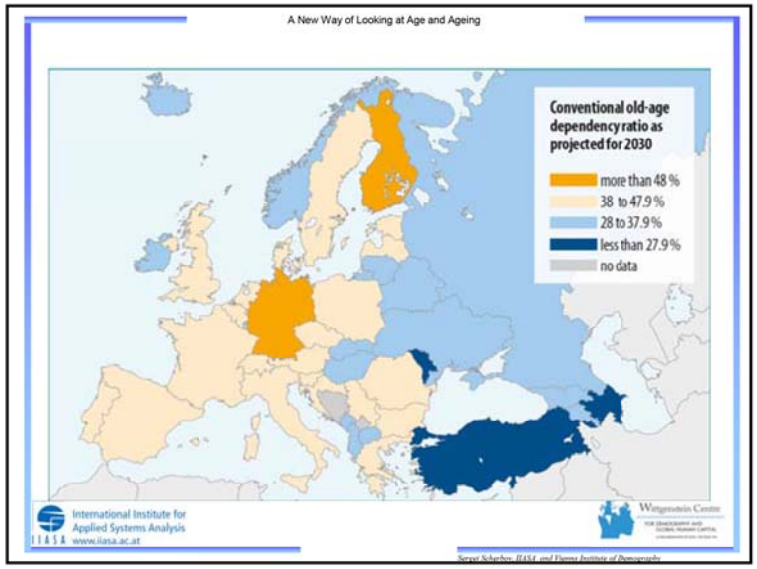
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Conventional old-age dependency ratio as projected for 2030
more than 48 %
38 to 47.9 %
28 to 37.9 %
less than 27.9 %
no data
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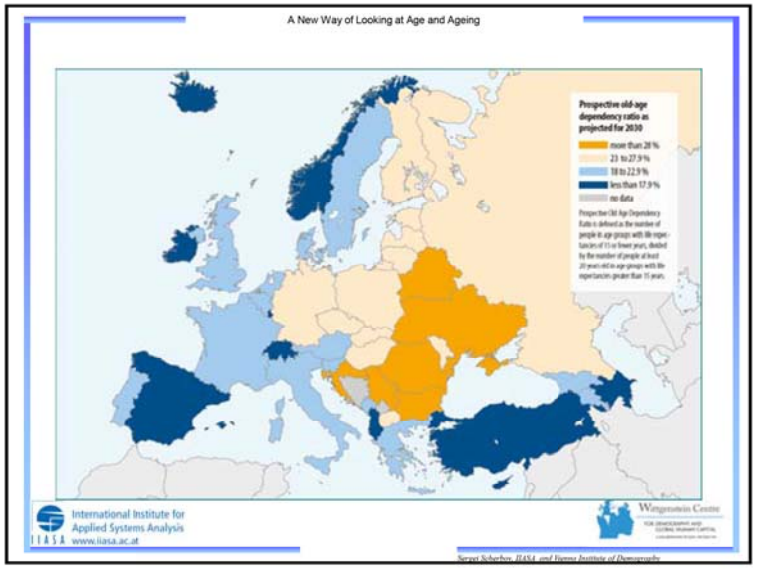
A New Way of Looking at Age and Ageing
Prospective old-age dependency ratio as projected for 2030
more than 28 %
23 to 27.9 %
18 to 22.9 %
less than 17.9 %
no data
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Conventional and Prospective OADR

OLD-AGE DEPENDENCY RATIO (65+/20–64)

Rank	Old-age dependecy ratio, 2013 (%)		Rank	Projected old-age dependecy ratio, 2050 (%)	
	Japan	*43.7*		*Japan*	*78.4*
1	Italy	35.2	1	Italy	71.6
2	Germany	33.9	2	Spain	70.4
3	Greece	33.4	3	Greece	66.6
4	Sweden	32.9	4	Germany	65.7
5	Portugal	32.0	5	Romania	62.5

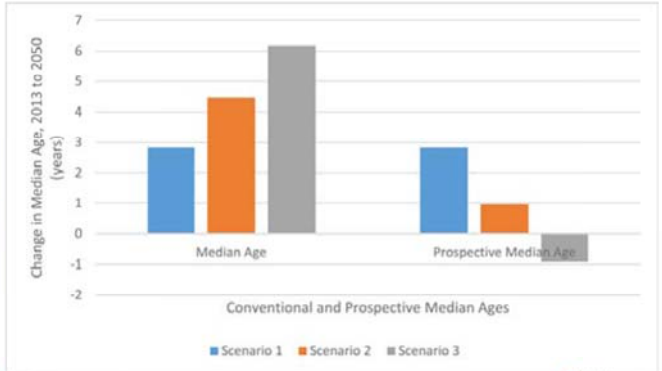
PROSPECTIVE OLD-AGE DEPENDENCY RATIO (SEE BOX ON THE FRONT SIDE)

Rank	Prospective old-age dependecy ratio, 2013 (%)		Rank	Projected prospective old-age dependecy ratio, 2050 (%)	
1	Bulgaria	28.6	1	Moldova	36.4
2	Serbia	27.5	2	Bulgaria	36.1
3	Latvia	27.2	3	Romania	35.0
4	Ukraine	25.4	4	Latvia	31.8
5	Lithuania	25.3	5	Ukraine	31.2

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.

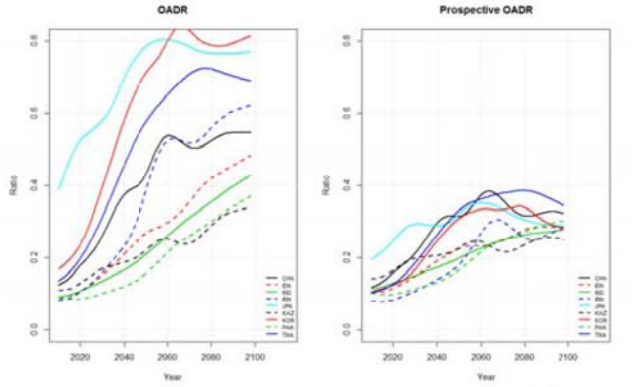


Projections for Asian countries

(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 2010 Revision, United Nations

OADR and POADR



Characteristic-based measures of age

In Sanderson, W. and S. Scherbov, 2013, The Characteristics Approach to the Measurement of Population Aging , ***Population and Development Review,*** 39(4)

we introduce 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 by other researchers.

α-ages

Let $C_t(\alpha)$ be a schedule of some characteristic of population aging (such as remaining life expectancy)

If $C_t(\alpha)$ is continuous and monotonic in α, it can be inverted to obtain the schedule of chronological ages associated with each particular value of the characteristic at time t. We call these ages ***α-ages***

α-ages

Thus the chronological age $\alpha_{\kappa,t}$ at which the level of a specified characteristic is κ at time t would be given by

$$\alpha_{\kappa,t} = C_t^{-1}(\kappa_t)$$

In the simplest case the level of the characteristic does not change over time, so that κ has no t subscript.

α-ages

For example, if the time-invariant characteristic was a remaining life expectancy of 15 years, the α-age - the age at which that remaining life expectancy was attained.

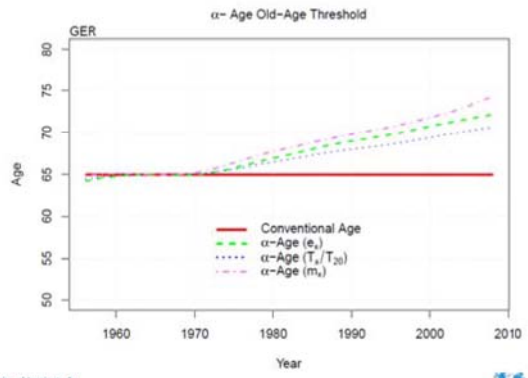
We call the α-ages based on invariant characteristics constant characteristic ages.

α-ages

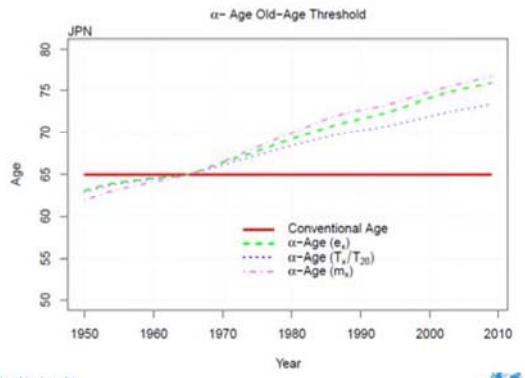
- The characteristics approach to the measurement of population aging includes the conventional measure of chronological age but is far more general. Here, we focus on four characteristics:

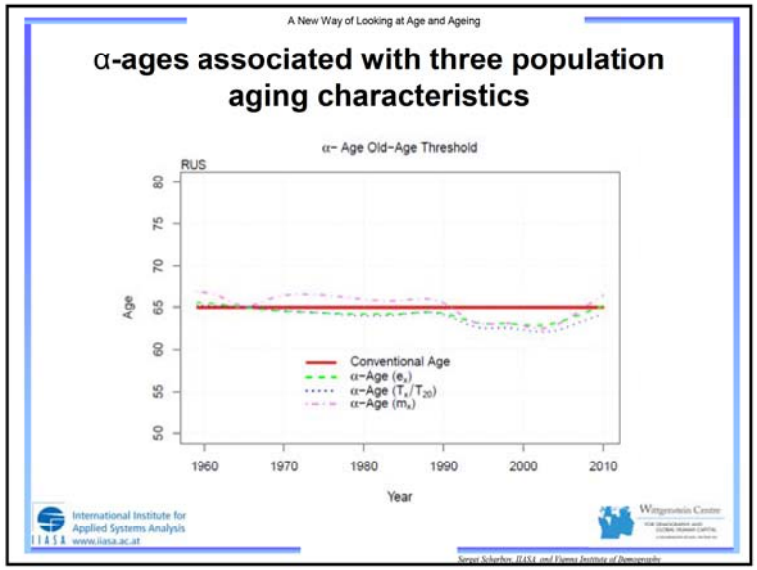
1. chronological age
2. remaining life expectancy
3. the mortality rate
4. the proportion of adult person-years lived after a particular age

α-ages associated with three population aging characteristics



α-ages associated with three population aging characteristics




A New Way of Looking at Age and Ageing
α-ages associated with three population aging characteristics
α- Age Old-Age Threshold
RUS
Age
Year
Conventional Age
α-Age (e_x)
α-Age (T_x/T_{20})
α-Age (m_x)
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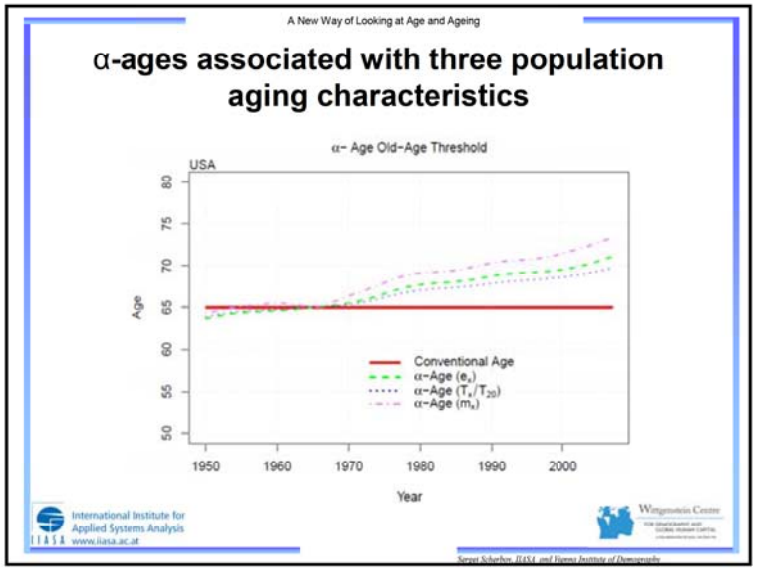
A New Way of Looking at Age and Ageing
α-ages associated with three population aging characteristics
α- Age Old-Age Threshold
USA
Age
Year
Conventional Age
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α-Age (T_x/T_{20})
α-Age (m_x)
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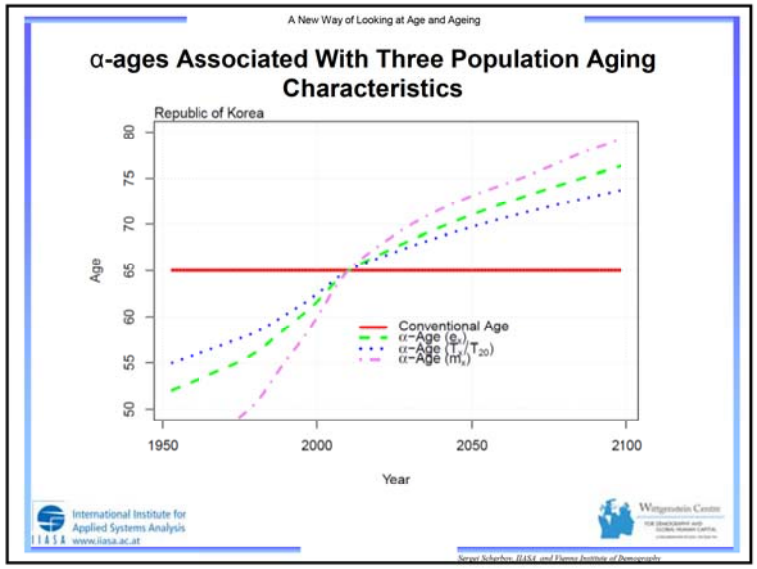
A New Way of Looking at Age and Ageing
α-ages Associated With Three Population Aging Characteristics
Republic of Korea
Age
Year
Conventional Age
α-Age (e_x)
α-Age (T_x/T_{20})
α-Age (m_x)
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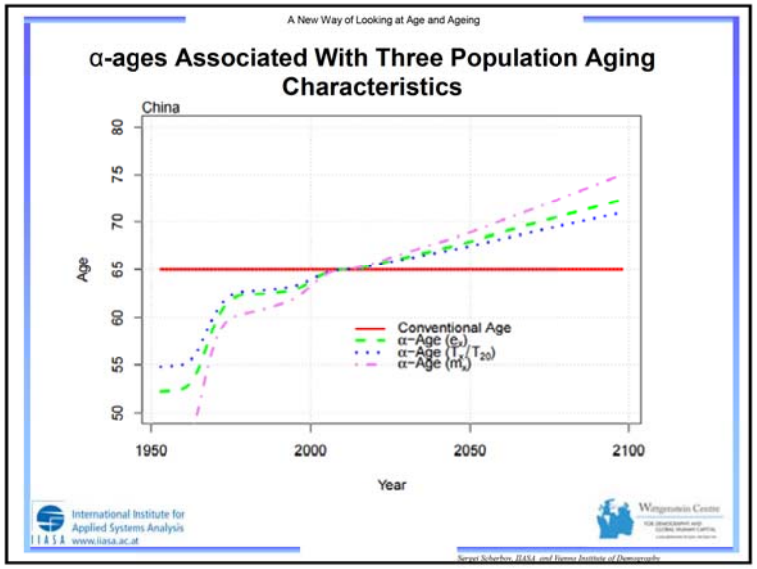
A New Way of Looking at Age and Ageing
α-ages Associated With Three Population Aging Characteristics
China
Age
Year
Conventional Age
α-Age (e_x)
α-Age (T_x/T_{20})
α-Age (m_x)
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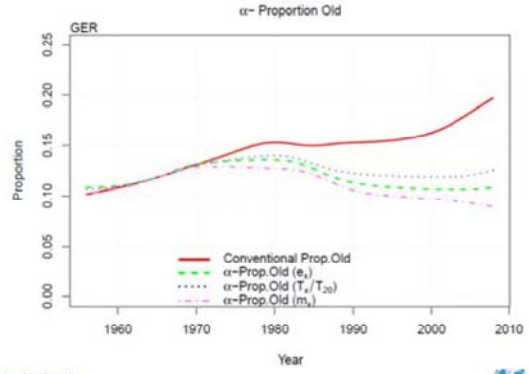
A New Way of Looking at Age and Ageing

α-ages

At α-ages associated with different characteristics we can calculate different measures of aging such as 1) elder proportions and 2) elder ratios.

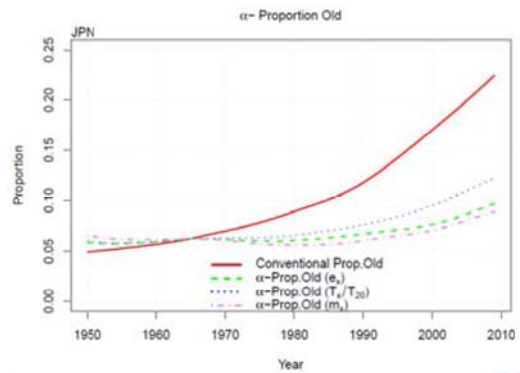
A New Way of Looking at Age and Ageing

Elder proportions



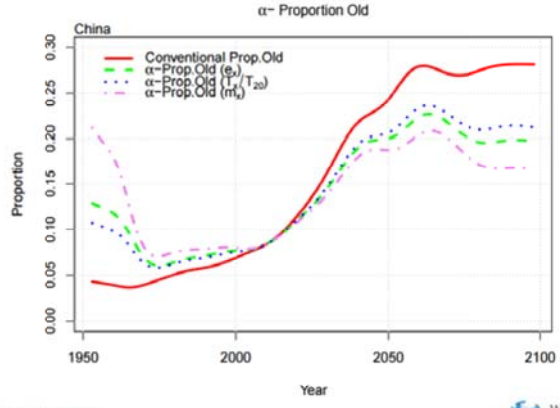
A New Way of Looking at Age and Ageing

Elder proportions



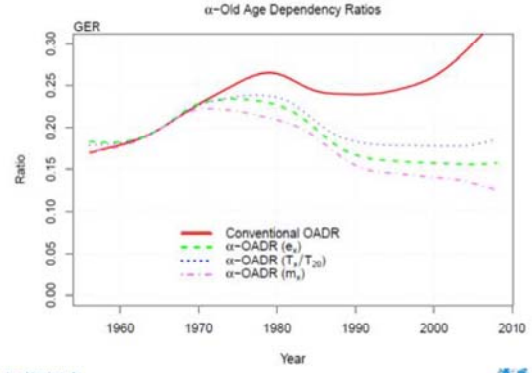
A New Way of Looking at Age and Ageing

Elder proportions



A New Way of Looking at Age and Ageing

Elder ratios



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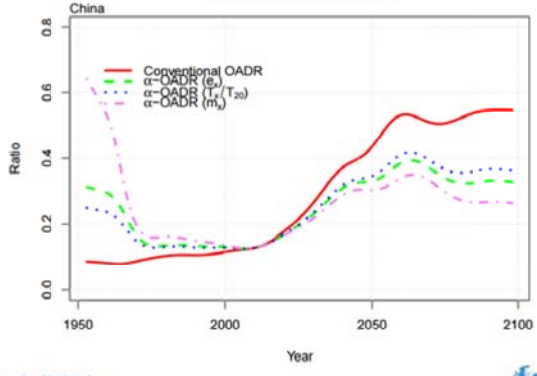
A New Way of Looking at Age and Ageing

Elder ratios



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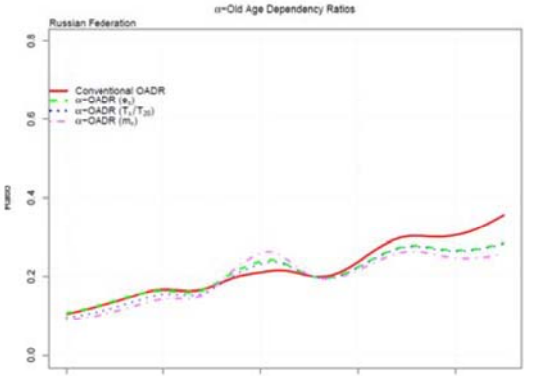
A New Way of Looking at Age and Ageing

Elder ratios



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A New Way of Looking at Age and Ageing

Pension Ages Based on the Ratio $\frac{T_{20}}{T_{65}}$ 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

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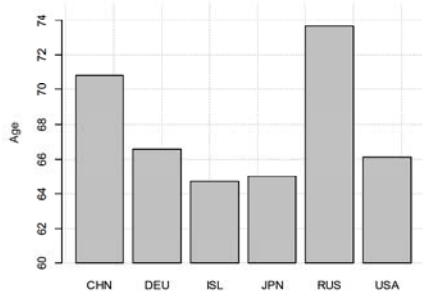
Pension Ages Based on the Ratio $\frac{P_{65+}}{P_{20\text{-}65}}$ Observed in 2013

Country basis

	Women			Men		
Country	**ratio**	**2013**	**2030**	**ratio**	**2013**	**2030**
Bulgaria	0.37	65.00	68.63	0.25	65.00	68.04
France	0.35	65.00	70.09	0.26	65.00	70.11
Georgia	0.26	65.00	69.61	0.17	65.00	69.57
Germany	0.39	65.00	69.09	0.29	65.00	69.70
Greece	0.37	65.00	68.69	0.30	65.00	67.89
Ireland	0.22	65.00	69.93	0.19	65.00	69.45
Italy	0.40	65.00	69.02	0.30	65.00	68.58
Latvia	0.40	65.00	68.43	0.20	65.00	68.67
Russian Federation	0.26	65.00	70.06	0.13	65.00	70.13
Serbia	0.32	65.00	69.10	0.24	65.00	68.91
Slovakia	0.25	65.00	71.23	0.15	65.00	71.24
Spain	0.33	65.00	69.15	0.24	65.00	69.15
Sweden	0.36	65.00	67.43	0.29	65.00	67.69
United Kingdom	0.32	65.00	68.59	0.26	65.00	68.46

Alfa Ages



α-ages of 65 year old men in China, Germany, Iceland, Japan, Russia and the USA. As a standard, we use remaining life expectancy of Japanese men in 2013

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

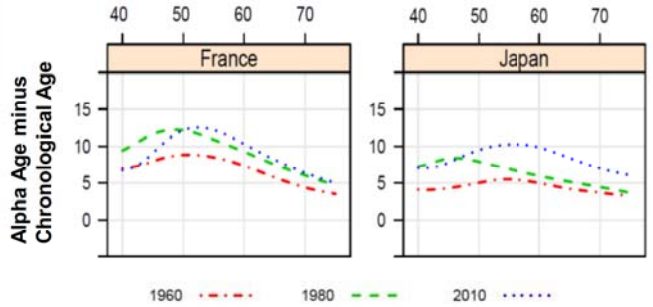
Whites – More Educated

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

PLOS | ONE

Characteristic Impact Trajectory



Characteristic impact trajectory associated with 5-year survival probability, France and Japan. As a standard characteristic the schedule of females is selected.

Are We Overly Dependent on Conventional Dependency Ratios?

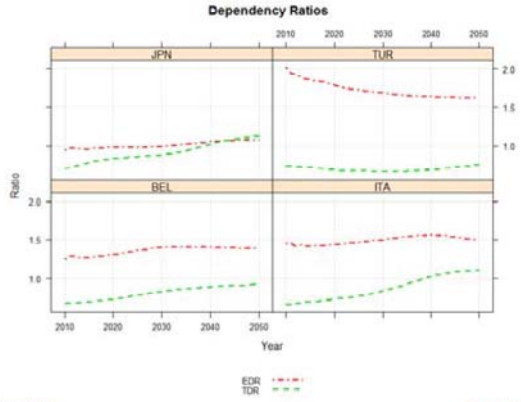
Support ratio first appeared in 1913 (Ballod 1913)

It's inverse – Dependency Ratios are used as a proxy for:

Economic dependency - Economic Dependency Ratio
Financial dependency -NTA economic support ratios
Old-Age Dependency – Prospective Old-Age Dependency
Medical costs - Health care cost old-age dependency ratios
Pension Cost - Pension cost dependency ratios

Sanderson WC, Scherbov S . Are we overly dependent on conventional dependency ratios?, *Population and Development Review*, 41(4):687-708 [December 2015]

Economic dependency - Economic Dependency Ratio



Conclusions

- Population aging will certainly be the source of many challenges in 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

- Sanderson, W. and S. Scherbov. Average remaining lifetimes can increase as human populations age. ***Nature*** 435: 811-813 (June 9, 2005).
- Sanderson, W. and S. Scherbov. Remeasuring Aging. ***Science*** 329: 1287-1288 , 10 September 2010
- Sanderson, W. and S. Scherbov. 2008. Rethinking age and aging. ***Population Bulletin***, 63(4). ISSN 0032-468X
- Lutz, W., W. Sanderson, and S. Scherbov. 2008. The coming acceleration of global population aging. ***Nature*** 451: 716-719
- Sanderson, W. and S. Scherbov, 2013, The Characteristics Approach to the Measurement of Population Aging , ***Population and Development Review,*** 39(4)
- Sanderson WC, Scherbov S, 2014, Measuring the Speed of Aging across Population Subgroups. ***PLoS ONE*** 9(5): e96289. doi:10.1371/journal.pone.0096289