REVES 2005

Population Health and Heath Expectancy – Policy Implications

CHANGE IN THREE DIMENSIONS OF THE SURVIVAL CURVE IN JAPAN

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Objectives

• **Analyze changes in three dimensions of the survival curve (i.e. horizontalization, verticalization and longevity extension) and the associated indicators in Japan from 1950 to 1999.**

• **Answer whether the transformations of the three dimensions of the survival curve in Japan have a divergent pattern in which the survival curve is more horizontal and vertical and where its tail moves relatively far from M, suggesting an acceleration in the increase in longevity.**

Organization of the paper

1. Background - heated debates on the rectangularization of the survival curve
2. Theoretical Framework – normal life durations (Lexis 1878 and Kannisto 2001)
3. Data and Methods
4. Results
5. Conclusion and policy implications

Background
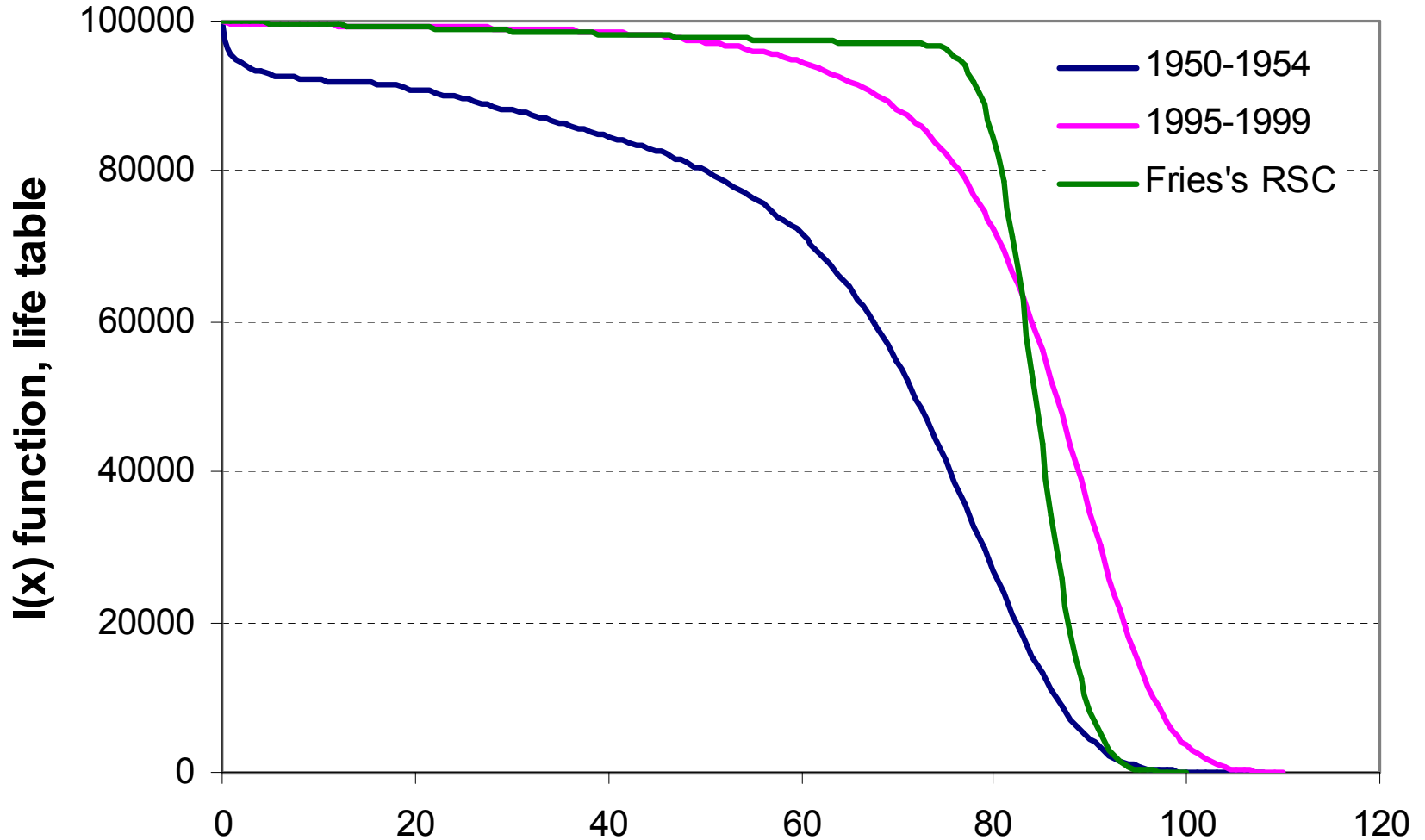
Two camps

evidence of **rectangularization** during the epidemiological transition

a slight tendency to **derectangularization**

A list of indicators

CENTRAL LONGEVITY INDICATORS
Life expectancy (or mean)
Median
Mode
HORIZONTALIZATION INDICATOR:- No indicator found
CONCENTRATION AND/OR VERTICALIZATION INDICATORS
Standard deviation of life spans or of ages at death
Standard deviation above the mode (SD+)
Standard deviation above the 3rd quartile
Interquartile range (IQR)
C-family (C10, C50 and C90)
$_{10}$C50
Prolate index
Entropy Keyfitz' H
Life expectancy at median life span and 3rd quartile
Fastest decline and/or Highest proportion of deaths
RECTANGULARIZATION INDICATORS
Fixed rectangle
Moving rectangle and/or Index of rectangularity (R)
Person-years differential (PD)
Person-years ratio (PR)
MAXIMUM LONGEVITY INDICATORS
Life endurancy
Maximum life span (MLS)
Length of the outer tail of longevity
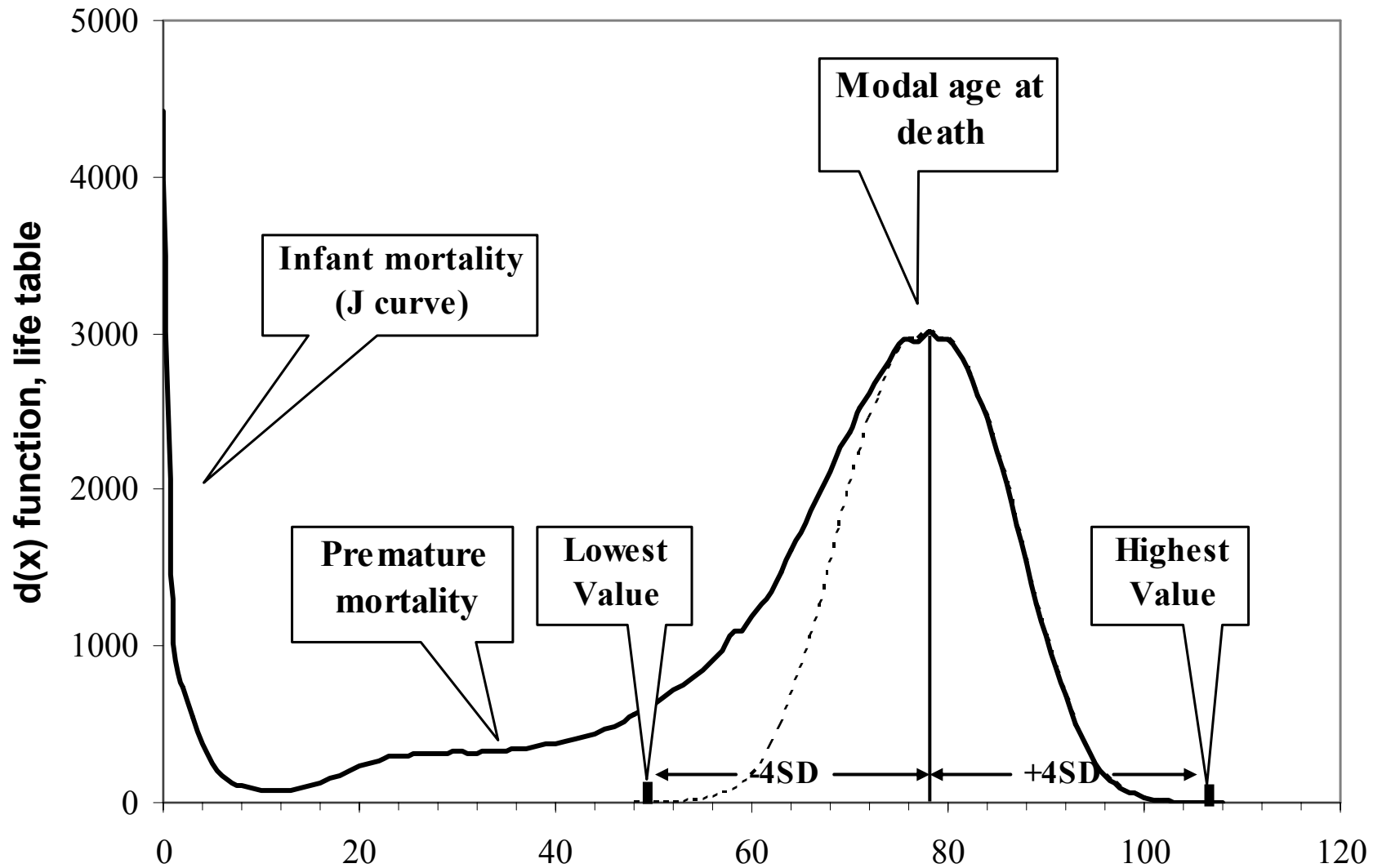**MAPPING INDICATORS**
Percentiles
OTHER INDICATORS
Coefficient of variation (CV)
Numerator of Keyfitz'H (NH)
Gini coefficient

Theoretical framework

Data and Methods

Age-specific death counts and population estimates, available from the Human Mortality Database (HMD), are grouped into five years (i.e. 1950-54, 1955-59, 1960-64, 1965-69, 1970-74, 1975-79, 1980-84, 1985-89, 1990-94 and 1995-99) for each sexes to estimate the central death rates.
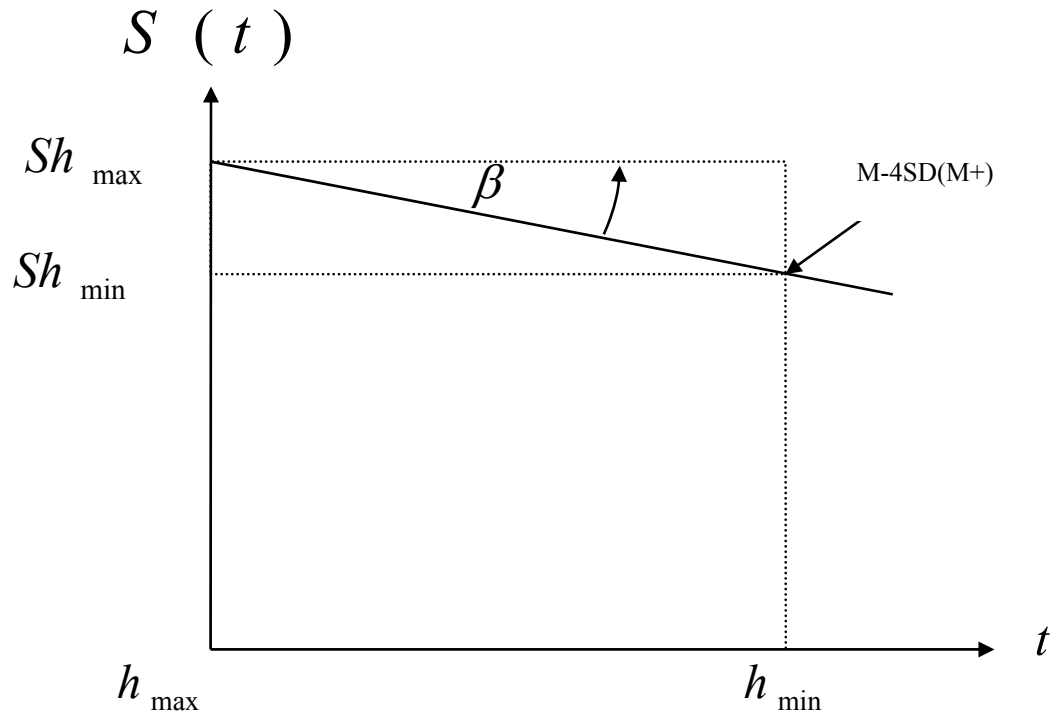
Standard period life tables are, then, constructed without using any modeling and closing techniques.

In a life table, the dx column displays the number out of an original birth cohort (usually a radix of 100,000) who die after attaining age *x* exact and before their (*x*+1)-th birthday.

The degree of horizontalization (*β*)

$$\beta \;\equiv\; \arctan \;\left| \frac{Sh_{min} - Sh_{max}}{h_{min} - h_{max}} \right|$$

The degree of verticalization (θ and θ*)

θ proposed by Eakin and Witten (1995) is based on the angle located on the diagonal line, connecting the point of maximum acceleration in attrition to the point of maximum deceleration on the actual survival curve.

θ* by (Cheung et al. 2005)

$$\theta \equiv \arctan \left| \frac{M - v_{\max d}}{Sv_M - Sv_{\max d}} \right|$$
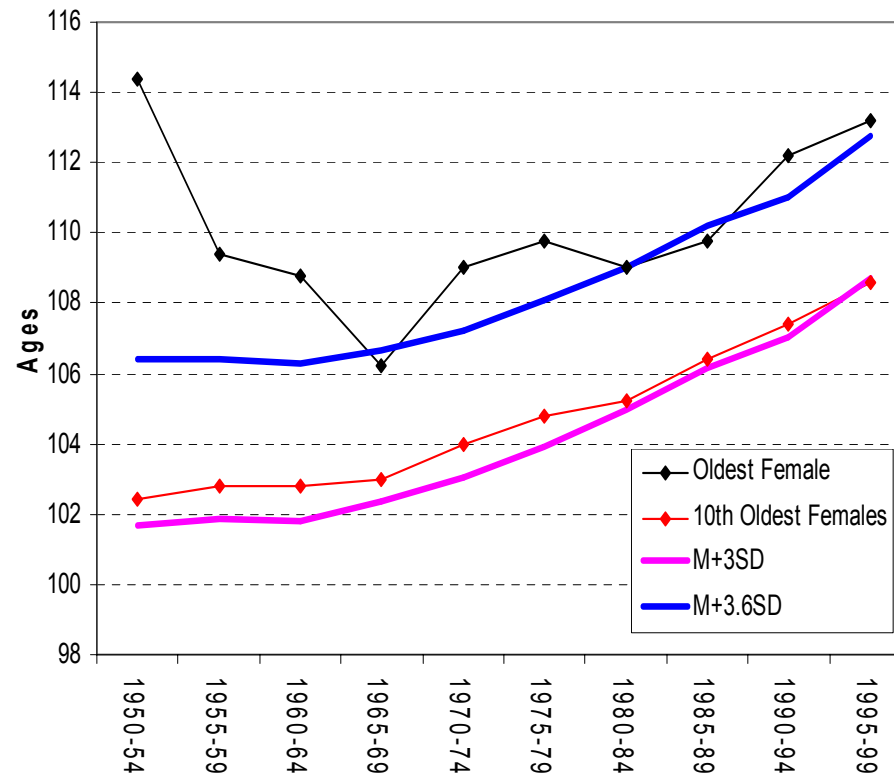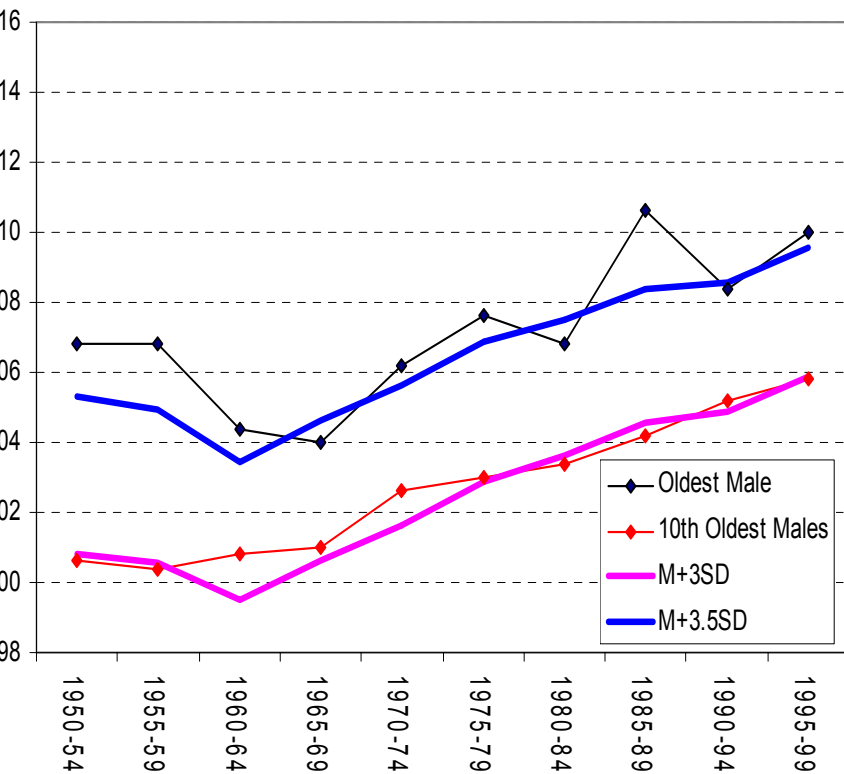
THREE DIMENSIONS OF TRANSFORMATIONS OF THE SURVIVAL CURVE AND ITS INDICATORS, ACTUAL AND THEORETICAL SURVIVAL CURVES AFTER AGE NORMALIZATION
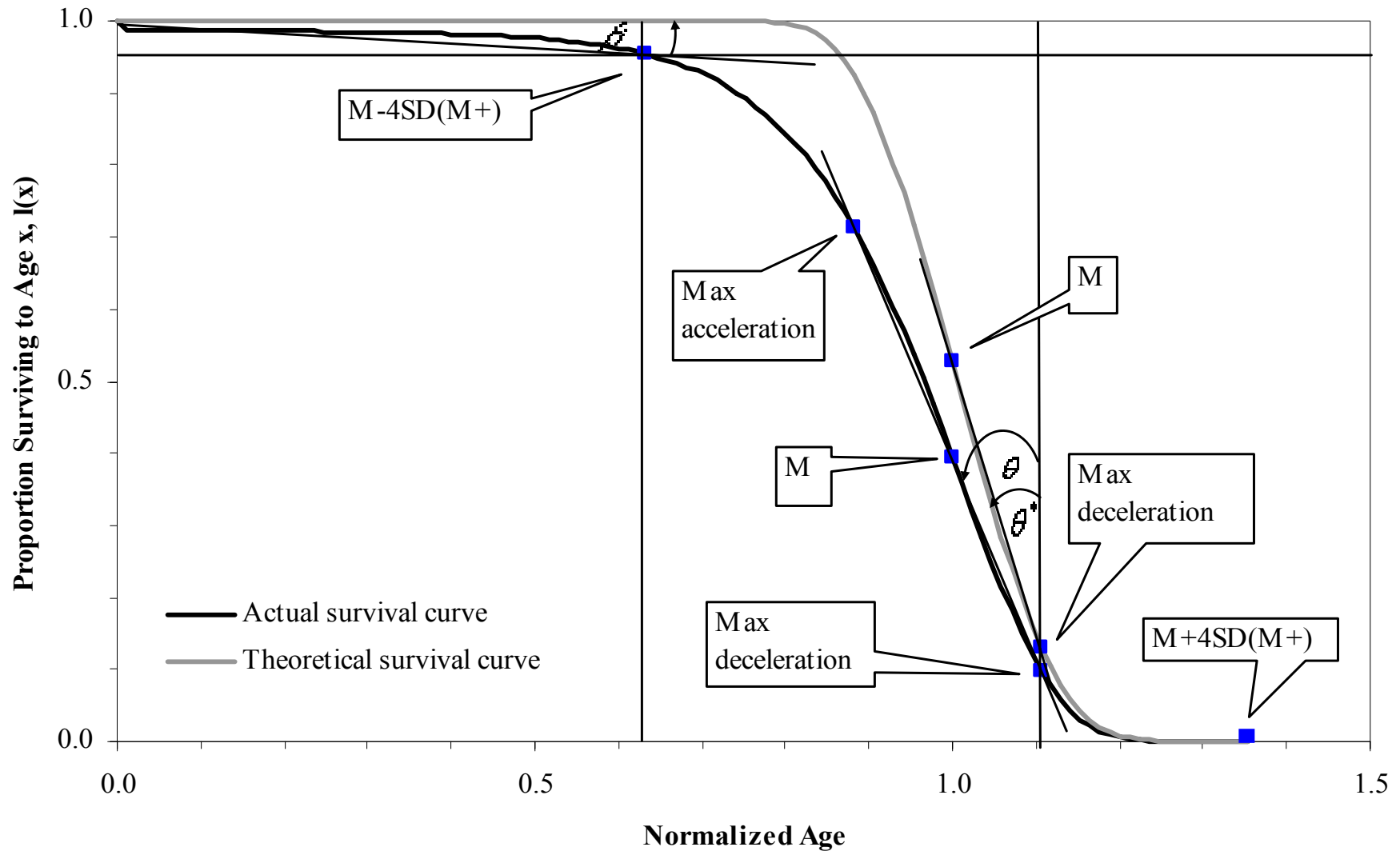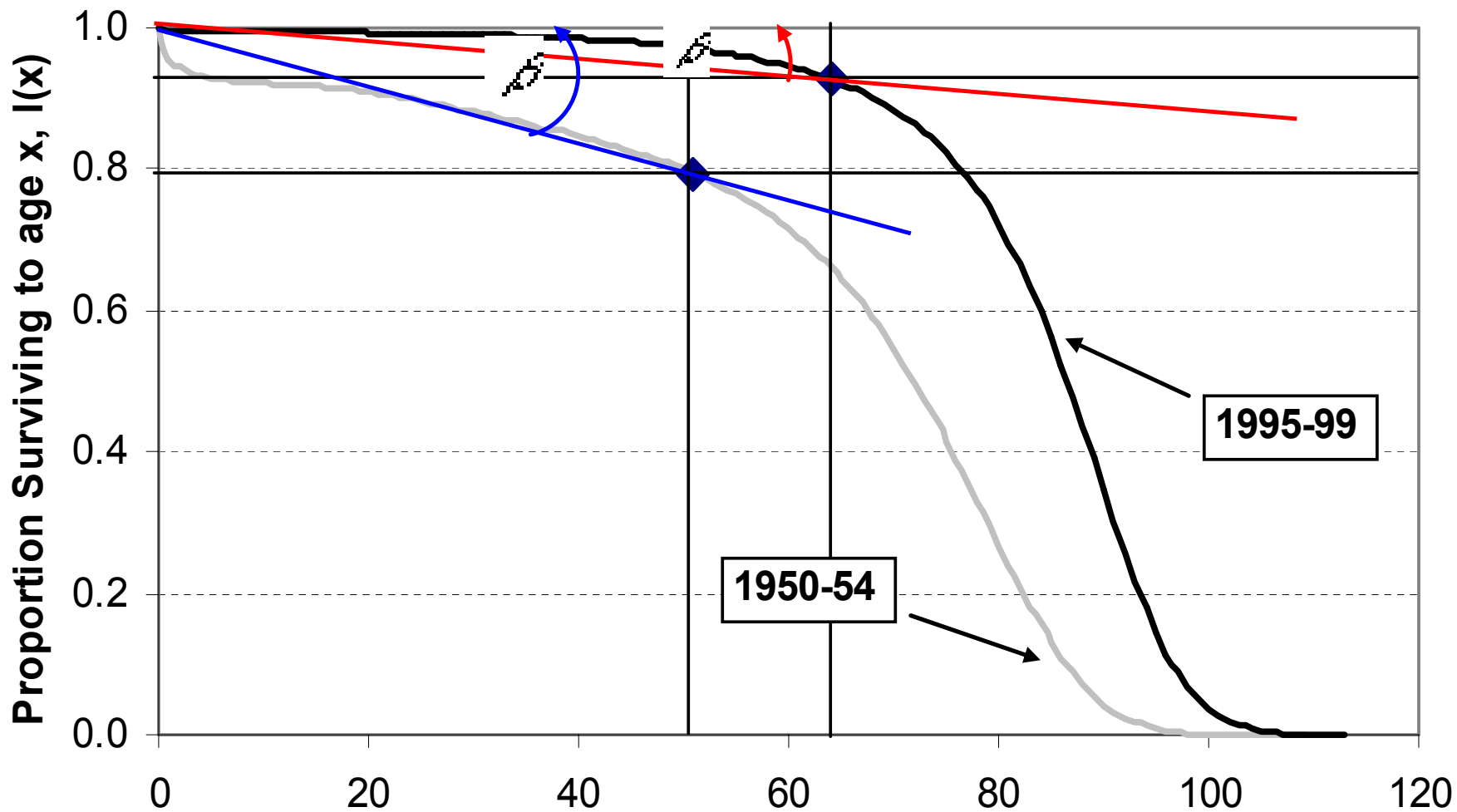
M+4SD(M+) Vs MRAD

"Chance of Death" (Pearson 1897) proposed 3 standard deviations
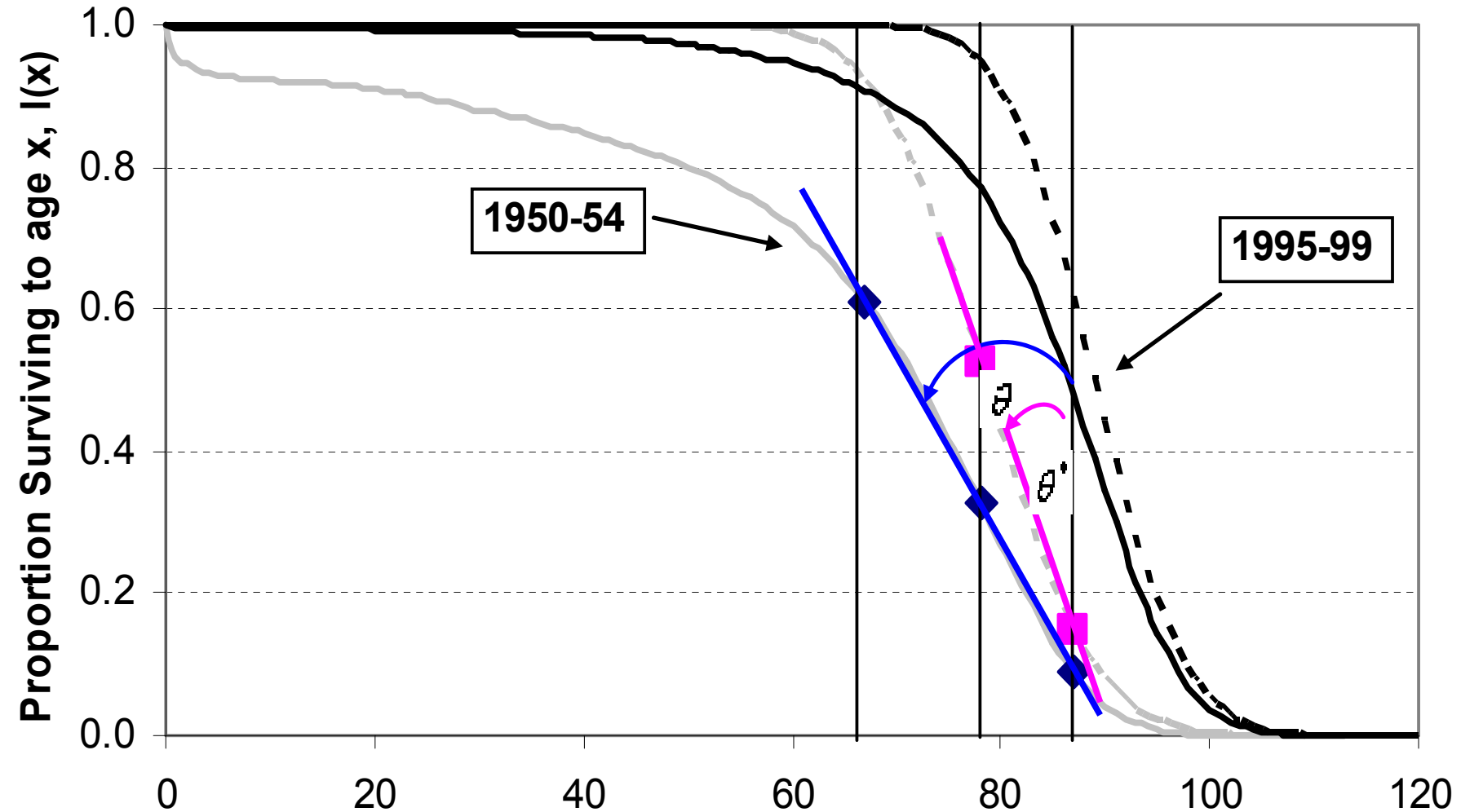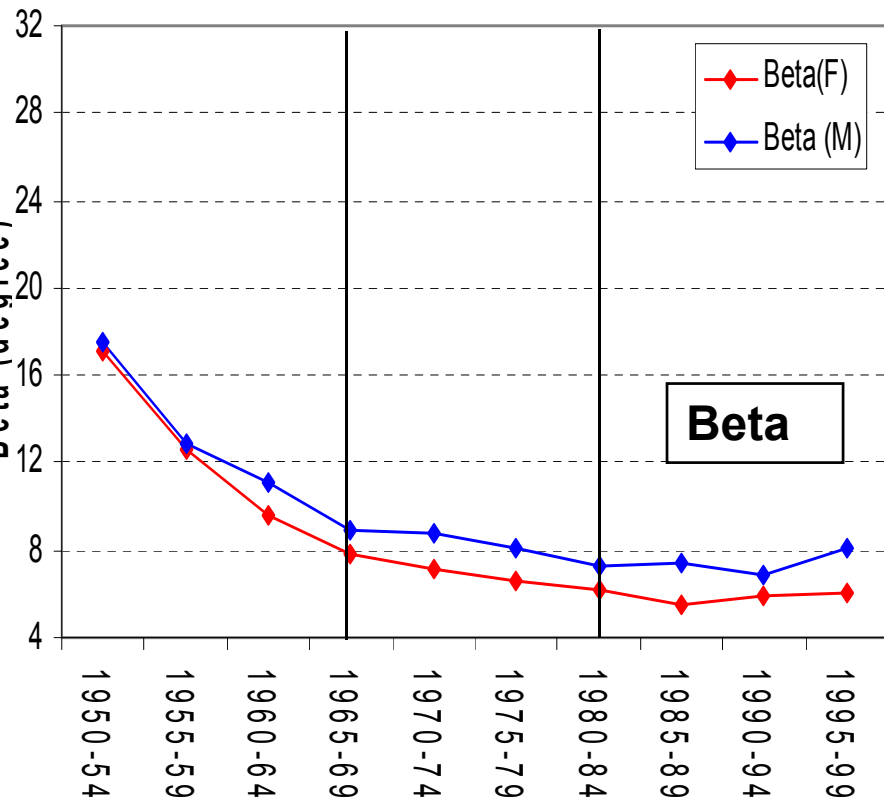
$$X = \frac{MRAD - M}{SD(M+)}$$

Results

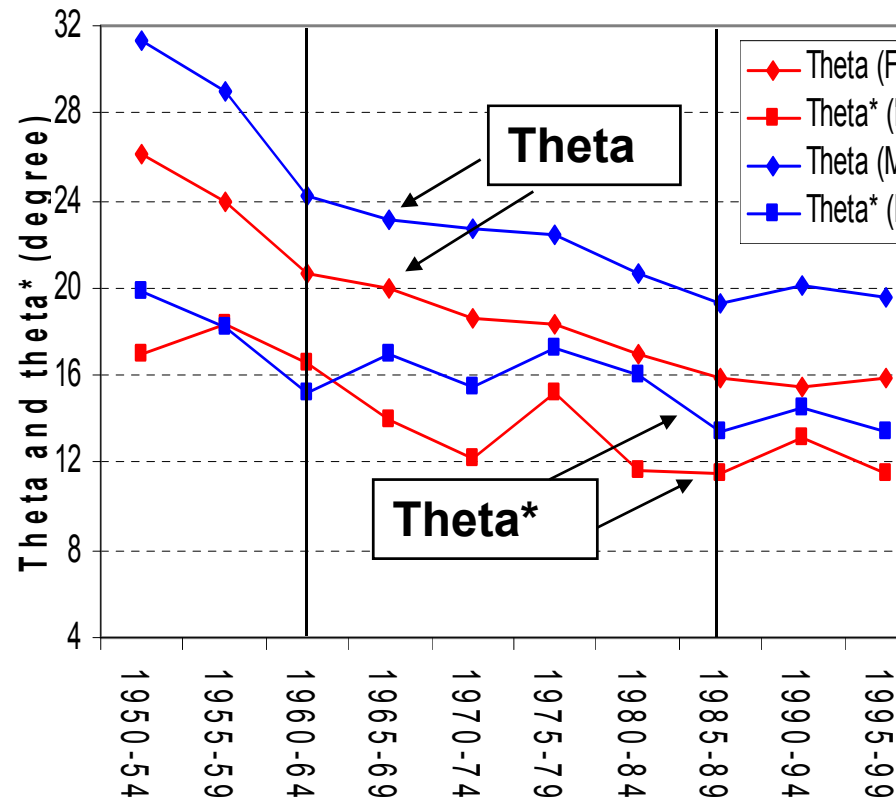Change in horizontalization for females in Japan, from 1950-54 to 1995-99

Change in verticalization for females in Japan, from 1950-54 to 1995-99

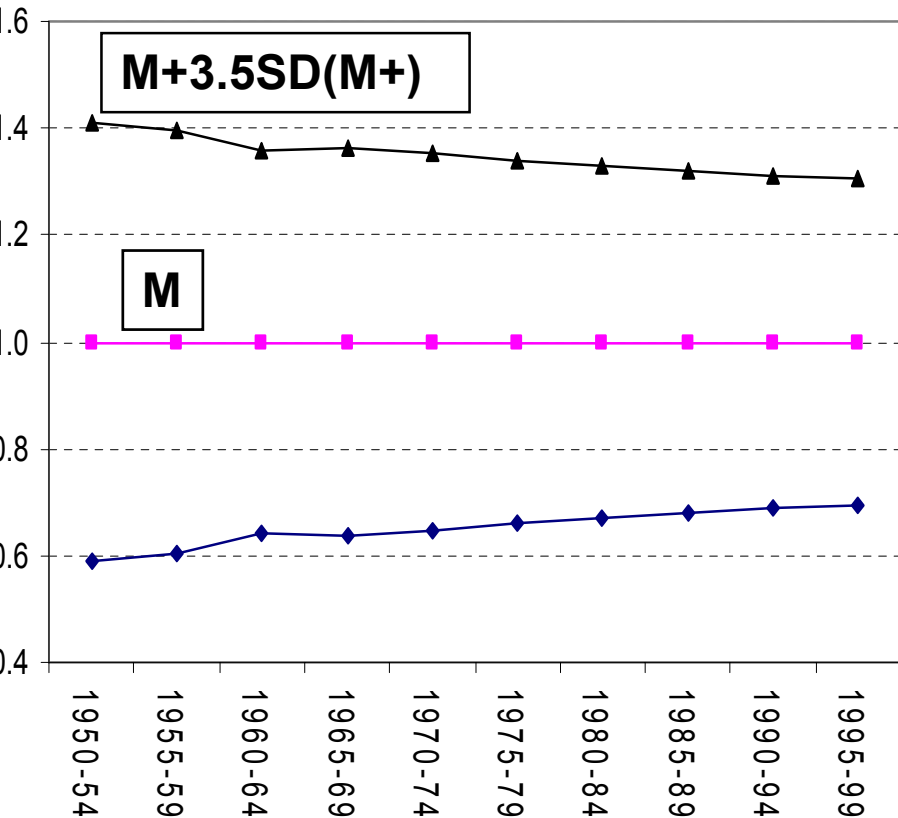Proportion Surviving to age x, l(x)

1950-54
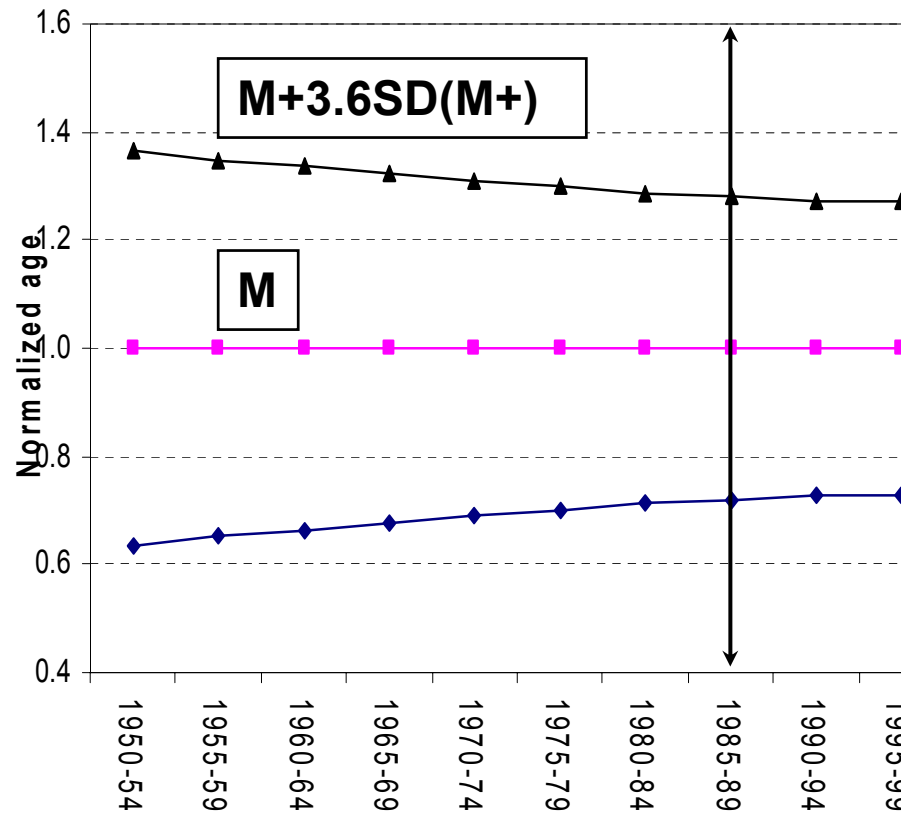
1995-99

Horizontalization

Verticalization

LONGEVITY EXTENSION

Males

Females

Conclusion:

We measured a strong horizontalization and verticalization of the survival curve in Japan from 1950-54 to 1985-1989 with the longest life durations coming relatively closer to the modal age at deaths (corresponding to a compression of mortality). Since 1985-89, the shape of the survival curve remains exactly the same for females, the survival curve is no longer becoming more rectangular.
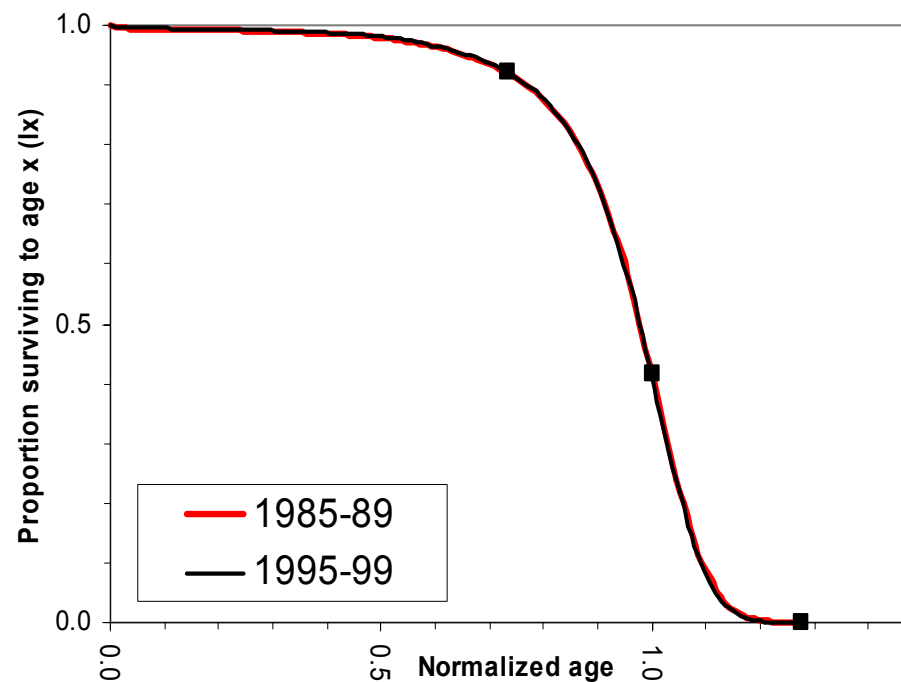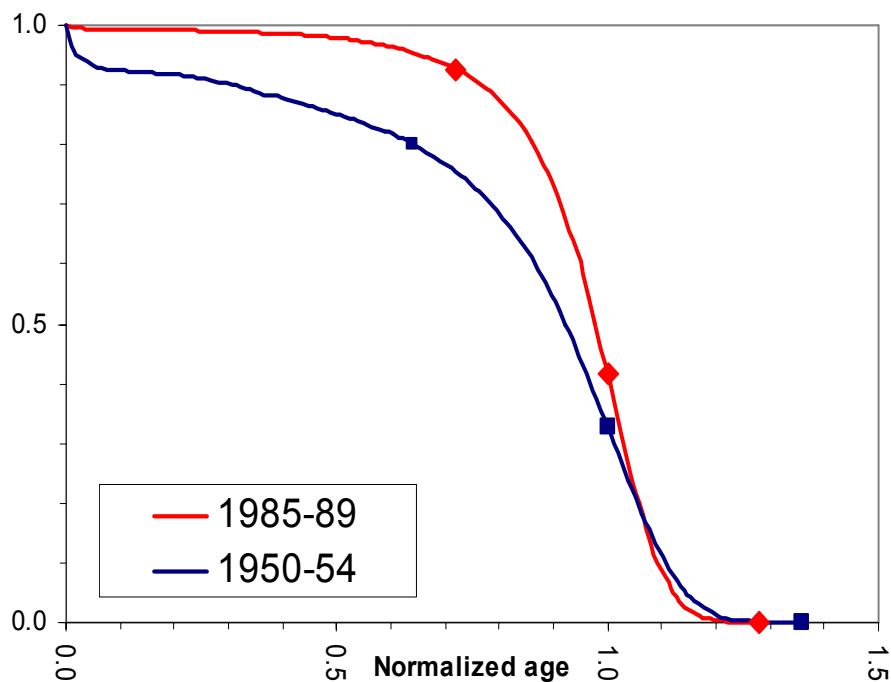
Policy implications:

• A new phase of the demographic transition where an increase in life expectancy at birth and in the modal age et death is no longer accompanied by a rectangularization of the survival curve: all deaths remain in proportion of the increase in the modal age at death, including the longest life durations.

• These results challenge the concept of limits in longevity in a country having already the highest female life expectancy at birth.

• The introduction of three dimensions of the transformation of the survival curve and their indicators helps to evaluate various competing hypotheses between the lengthening of life and the improvement of health.