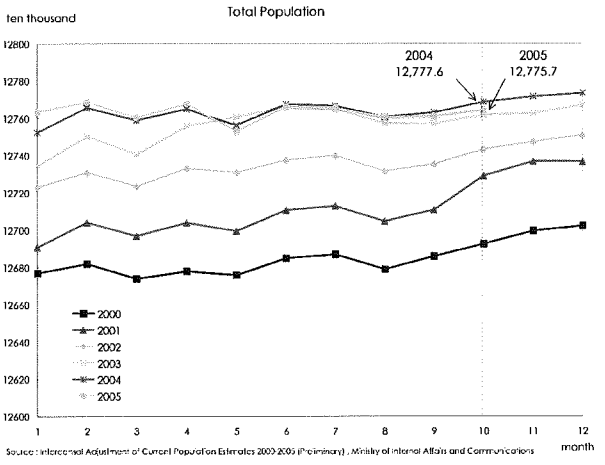
Decreasing Population - 2

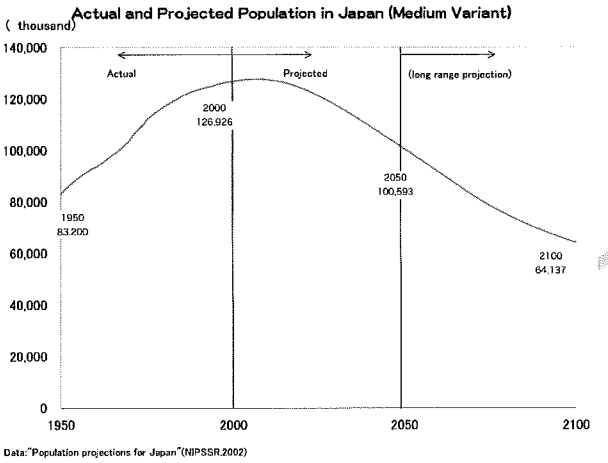
According to "the Summary Sheets of the 2005 Population Census"etc. , Japanese Population is supposed to be decreasing in 2005.



Source : Interpolated Adjustment of Current Population Estimates 2000-2005 (Preliminary) , Ministry of Internal Affairs and Communications

Population Projection

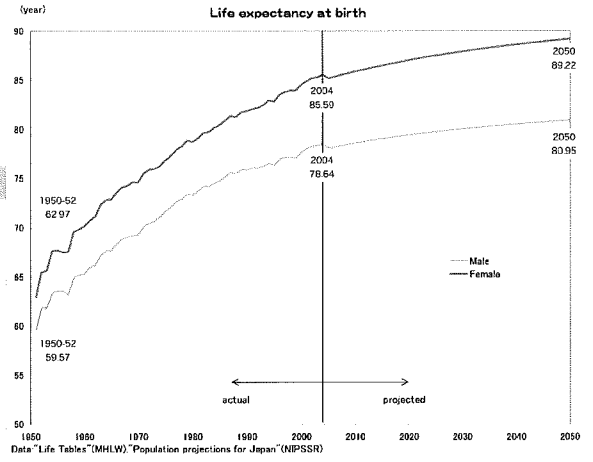
National Institute of Population and Social Security Research (NIPSSR) has been making "population projections for Japan" every 5 years based on latest Population Censuses. The latest projection was released in 2002("Population projections for Japan"(2002)).



Data:"Population projections for Japan"(NIPSSR,2002)

Mortality Projection

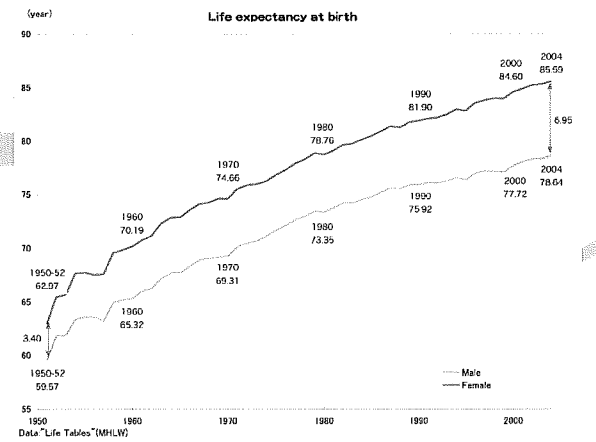
In "Population projections for Japan(2002)", life expectancy at birth in 2050 is estimated to 89.22 for male and 80.95 for female.



Mortality Situation in Japan

Latest available life table shows that the Japanese life expectancy at birth is 78.64 for male and 85.59 for female.

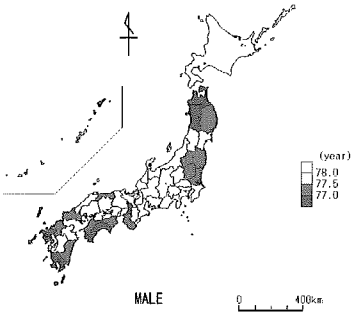
Difference by sex has increased from 3.40 years(1950-52) to 6.95 years(2004).

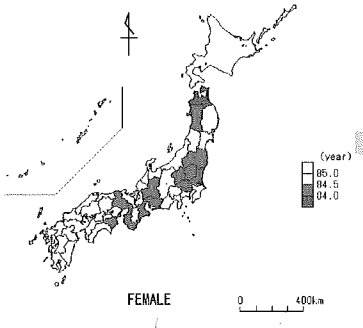


3

Difference by prefecture -1

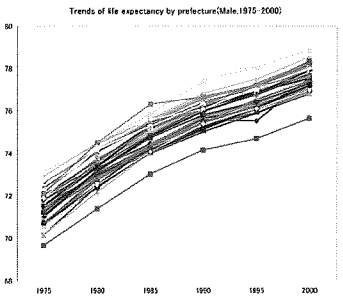
Life table by prefecture 2000 shows that the highest life expectancy is 78.90(Nagano) for male and 86.01(Okinawa) for female, the lowest is 75.67(Aomori) for male and 83.69(Aomori) for female.
(All Japan : 77.71 for male and 84.62 for female)

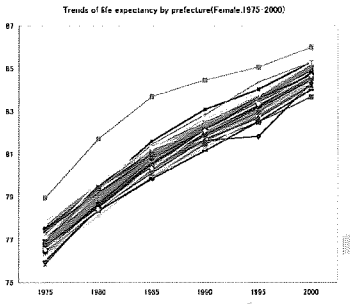




Difference by prefecture -2

Trends for Differences by prefecture are decreasing. During 1975-2000, coefficient variances of life expectancy decreased from 0.0104 to 0.0073 for male and from 0.0074 to 0.0052 for female.





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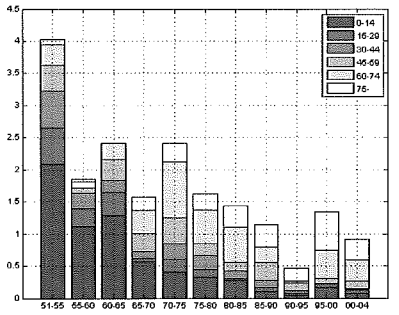
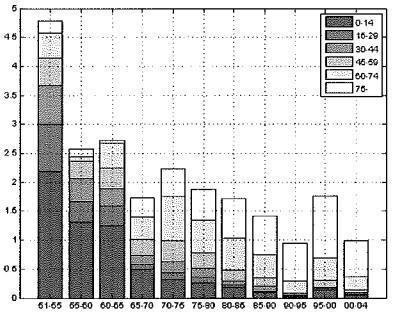
Prolongation of life expectancy (by age)

Recently, mortality improvements in older ages play a great role for prolongation of Japanese life expectancy.

Male



Female

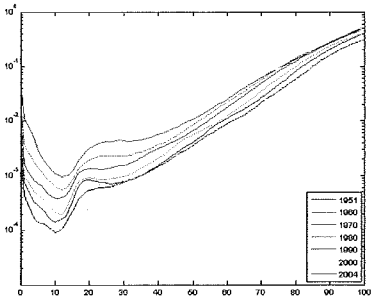


Decompositions of difference in life expectancies by age

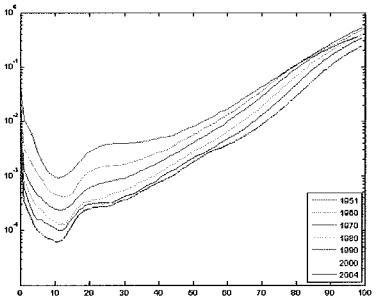
Trends of mortalities

After 1950, Japanese mortality was improved first in young age, then recently in old age.

Male



Female



Trend of ln(qx)

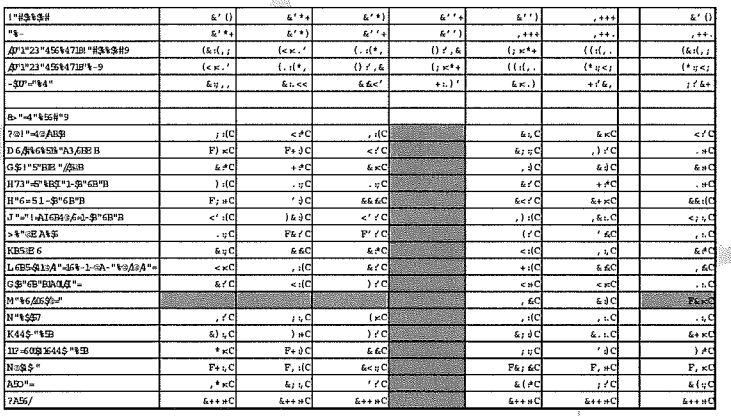
(1951 means 1950-52)

5

Prolongation of life expectancy (by cause of death)-1

After 1975, mortality improvement of cerebrovascular disease is main cause of prolongation of male life expectancy. Recently improvement of malignant neoplasms has become an important factor.

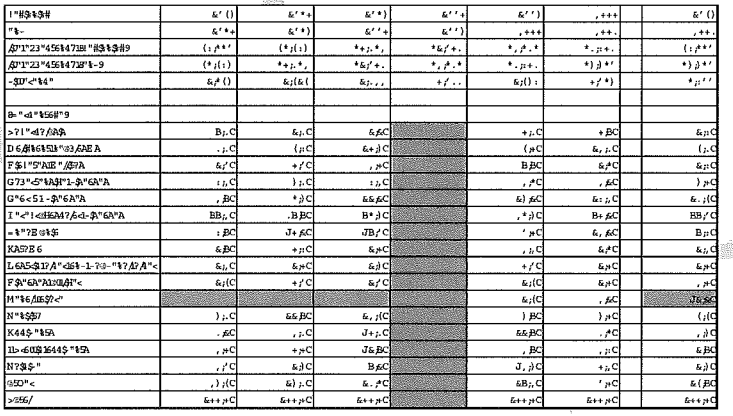
Male



Prolongation of life expectancy (by cause of death)-2

For female, mortality improvement of cerebrovascular disease is also main cause.

Female



Analysis for mortality projection -1

Method used in Lee-Carter model (Lee and Carter, 1992)

$\ln(m_{x,t})$: natural logarithm of central death rate.

$$\ln(m_{x,t}) = a_x + k_t b_x + e_{x,t} \quad (x = 0, \cdots, 100,\ t = 1965, \cdots, 2004)$$

where

$$a_x = \frac{1}{40}\sum_{t=1965}^{2004} \ln(m_{x,t})$$

With Singular Value Decomposition of "$\ln(m_x) - a_x$",

$$\ln(m_x, t) - a_x = \sum_{k=1}^{101} u_{ik}\, q_k\, v_{jk}$$

$\mathbf{U} = (u_{ik})$: 40×101 – *Matrix*, $i = t - 1964$

$\mathbf{Q} = diag(q_k)$: 101×101 – *Matrix*

$\mathbf{V} = (v_{jk})$: 101×101 – *Matrix*, $j = x + 1$

with q_k(Singular values)

$$q_1 \geq q_2 \geq \cdots \geq q_{101}$$

Set

$$k_t = u_{t1}\, q_1$$

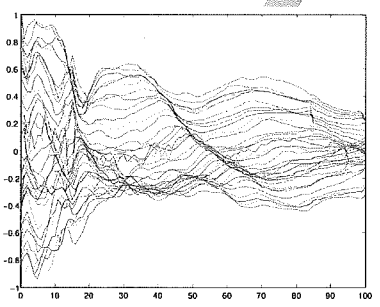
$$b_x = v_{j1}$$

We applied this model (a little modified version) in the 2002 projection. But actual mortality, especially for old people, turned out to be lower than the estimated.

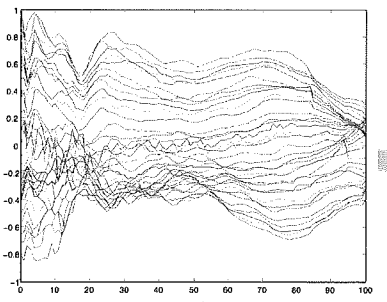
Analysis for mortality projection -2

Trends of ln(mx)-ax

Male



Female

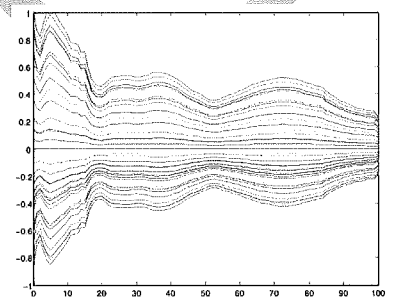


7

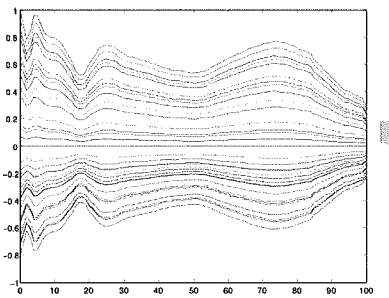
Analysis for mortality projection -3

Estimated "ln(mx)-ax" using terms related to the first singular value

Male



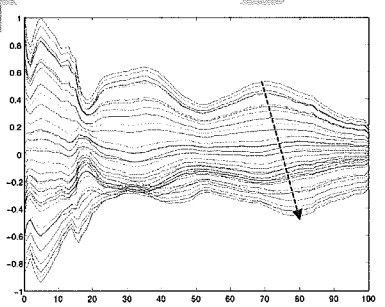
Female



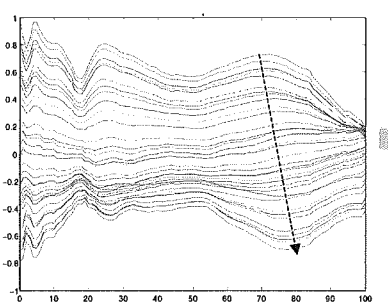
Analysis for mortality projection -4

Estimated "ln(mx)-ax" using terms related to the first and second singular values

Male



Female



8

Shifting logistic model -1

Shifting logistic model (Bongaarts, 2005)

$$\mu(x,t) = \frac{\alpha(t)e^{\beta x}}{1+\alpha(t)e^{\beta x}} + \gamma(t)$$

Define S(t) :

$$S(t) = -\frac{\ln(\alpha(t)/\alpha(t_0))}{\beta}$$

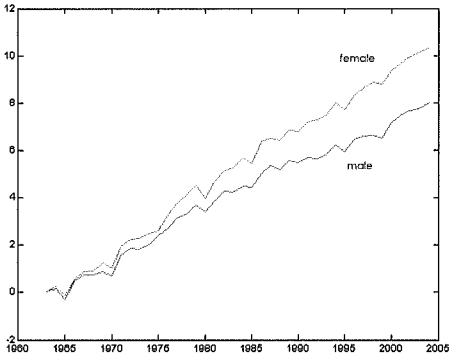
Then S(t) is regarded as the shift amount, since we can rewrite μ(x,t) as follows:

$$\mu(x,t) = \frac{\alpha(t_0)e^{\beta(x-S(t))}}{1+\alpha(t_0)e^{\beta(x-S(t))}} + \gamma(t)$$

Shifting logistic model -2

With shifting logistic model, the shift amount is estimated as about 8-10 years.

Estimated S(t)

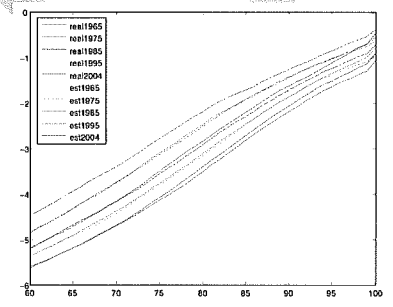


9

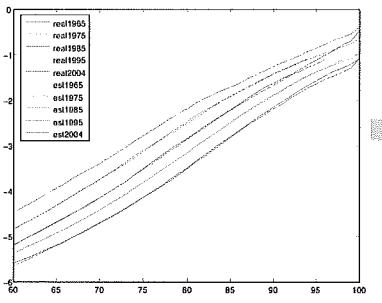
Improvement for singular value decomposition

Reflecting age shifting structure in singular value decomposition improve the fitting for the old-age mortality curve.

Simple Singular Value Decomposition



Reflecting age shifting structure



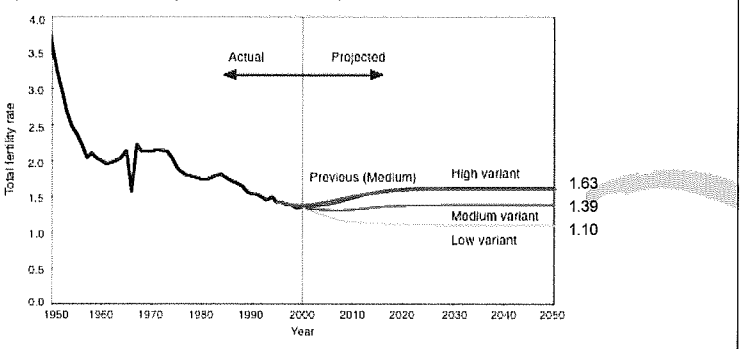
estimated ln(mx) (female)

Stochastic projection -1

In the 2002 projection, fertility assumptions are based on three scenarios, high, medium and low variant.

In this approach, we cannot present the confidence intervals of the results.

Figure **Actual and projected total fertility rate, 1950-2050**



10

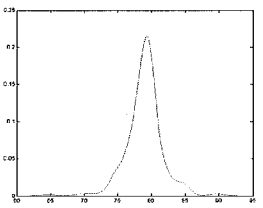
Stochastic projection -2

For stochastic projection, the uncertainty of the assumptions are needed.
There are several approaches :

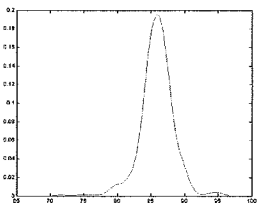
- Ex post analysis
- Expert opinions
- Time series analysis

In this paper, the distributions of "expert opinions" are used.

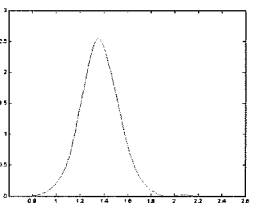
Smoothed distributions of expert opinions



Life expectancy in 2050 (male)



Life expectancy in 2050 (female)



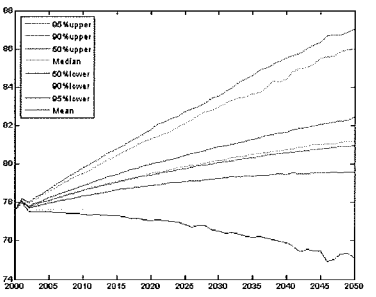
TFR in 2025

Stochastic projection -3

"The survey about future prospects of low fertility for experts" is performed in 2001. In this survey,

- life expectancy at birth in 2050
- total fertility rates in 2025

are surveyed. These distributions (after smoothing) are used as those of assumptions. The distributions are linearly transformed taking the same mean values as official projection's assumptions at 2050(life expectancy) or 2025(TFR). In other points, coefficient variances are set by linear interpolations with 2000 as 0.

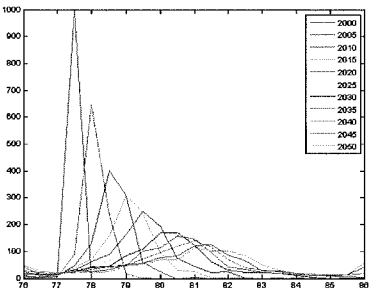


Confidence intervals for life expectancy(male)

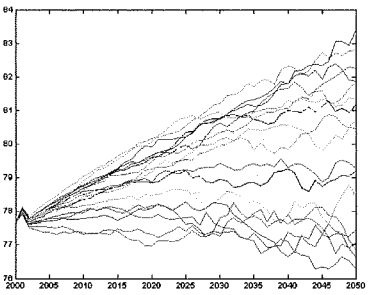
11

Stochastic projection -4

It is essential that the temporal correlation of errors for fertility and mortality. In this projection, temporal correlations are expressed using normal copulas. Using this method, the distribution in every year is transformed expert opinions' one and has correlation with another year.



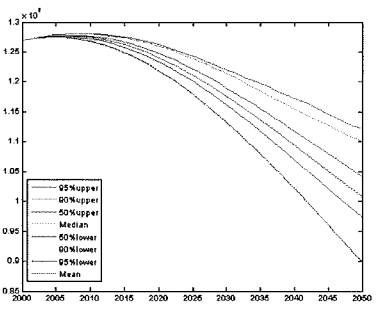
Distributions for life expectancy(male)



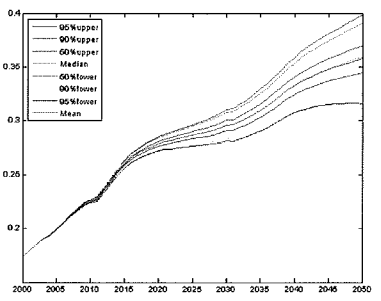
Trajectories for life expectancy(male,example)

Stochastic projection -5

Using this process, the confidence interval for total population and ratio of population over 65 are estimated.



Confidence intervals for total populations



Confidence intervals for ratio of population over 65

12

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Komatsu, R. (2002) "A Construction of Future Life Table in Japan Using a Relational model", Journal of Population Problems, Vol.58, No.3, pp.3-14

4 将来人口推計の手法と仮定に関する総合的研究：研究行程の流れ