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Agenda item 6: Population projections

**POPULATION PROSPECTS OF THE LOWEST FERTILITY WITH THE LONGEST
LIFE: THE NEW OFFICIAL POPULATION PROJECTIONS FOR JAPAN
AND THEIR LIFE COURSE APPROACHES**

Invited Paper

Submitted by Japan¹

Abstract

1. In this paper, first I briefly discuss on the results and methods of new round of the official Population Projections for Japan released in December, 2006. They provided a sketch of expected demographic changes over a 50 years of period from 2006 up to 2055. The eventual total fertility rate is 1.26 (ranging from 1.06 to 1.55), and the female life expectancy 90.3 (ranging from 89.2 to 91.5). As a result, the population is expected to fall by 30% by 2055, and the proportion elderly rises up to as high as 40.5%, which is twofold of 20.2% in 2005, already the world highest. The projections are unique not only in their world lowest fertility assumptions with the highest life expectancy, but also in their sophisticated life course approach in constructing assumptions on vital rates. Through this framework they provide measures for the projected life of women via the multistate life table techniques applied to the projected population. For instance, life time probability of childlessness and having no grandchild are estimated as 38.1% and 50.2% respectively in cohort born in 1990. Average life time spent in never married status increases to 42.5 years (or 47% of the life expectancy) in cohort born in 1990 from 25.3 years (31%) in those born in 1950. These measures indicate that the long, but less-reproductive and non-familial lives prevail among news generations resulting drastic increase in elderly who have no offspring or family in its current sense.

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Introduction

2. In this paper, first I discuss on the results and methods of new round of the official Population Projections for Japan released in December, 2006. They provided a sketch of expected demographic changes over a 50 years of period from 2006 up to 2055, indicating persuasive view that a substantial population decline with unprecedented population aging was an unavoidable part of the future of the society. The projections are unique not only as those from the world lowest fertility assumptions with the highest life expectancy, but also in their sophisticated life course approach in constructing assumptions on vital rates. In this connection, I attempted to construct the multistate life table for the projected life of Japanese women to obtain their life course measures mainly by ultimate family status. The measures include life time probability of never marrying, childless, having no grandchild and so on. The probabilities incorporate incidences from premature death before the events. Average life time spent in each family status such as never married state, childless state, and only-child state, are also examined. For example, the life time probability of childlessness and having no grandchild are 38.1% and 50.2% respectively in cohort born in 1990. They were 18.4% and 22.2% in cohort born in 1950. Besides, the average life time spent in never married status increases to 42.5 years (or 47% of the life expectancy) in cohort born in 1990 from 25.3 years (31%) in those born in 1950. These changes set off drastic increase of elderly who do not have offspring to live with or rely on in this society of near future. I also briefly discuss on possibilities of the life course approach to be the basis of next framework of population projection.

Population Prospects

3. Based on the results of the 2005 population census and the newly obtained vital statistics, the National Institute of Population and Social Security Research announced a new population projection for Japan in December 2006. In this section, the outlines of this projection are briefly explained.

4. The projection covers the total resident population of Japan which is also the target population of the Census. The projection starts from the population at the time of the 2005 Census, and covers the period up to 2055, enumerating the population as of October 1 each year. It also includes calculations of the population up to 2105 in order to examine the long term demographic development assuming constant vital rates at the level of 2055. The population (classified by sex and single year of age) is projected through the cohort component method with assumptions on vital events and international migrations based on the past statistical trends. Because of the uncertainty in future movements of birth and death, three assumptions are made for each factor to produce a range of forecasts for the future population by means of the nine variants, i.e. 3×3 .

5. The assumed total fertility rate in 2055 is 1.26 for the medium fertility variant, 1.55 for the high variant, and 1.06 for the low variant. These are a set of the world lowest fertility assumptions for official population projections. The life expectancy at birth in 2055 is 90.34 years, and 83.67 years respectively for female and male for the medium mortality variant, 89.17 years and 85.41 years for the high variant, and 91.51 years and 84.93 years for the low variant. These are the mortality assumptions of the world highest life expectancy.

6. When the results of the medium fertility variant are combined with the medium mortality level the total population is projected to fall from 127.8 million in 2005 to 89.9 million in 2055 (Table 1, Figure 1). This is a loss of 37.8 million or 30% of the initial population. Initially, the

decline takes place slowly, but after 2039 it accelerates to a pace of more than one million every year. The population changes that occur over the 50 years of period are significantly unevenly distributed across age groups. The age group under 15 reduces by 10.1 million, the working age group (age 15 to 64) does by 38.5 million, while the group of the elderly, aged 65 and over increases by 10.7 million. The uneven changes of the three age groups results in an age structure that is totally different from the starting population. In 2050 the proportion of children under 15 is down to 8.4 per cent from 13.8 per cent in 2005. The working age group 15 to 64 is reduced to 51.1 per cent from 66.1 per cent in 2005. And the proportion of the elderly doubles from 20.2 per cent in 2005 to 40.5 per cent during the next 50 years (Table 1, Figure 1, see also Figure 2).

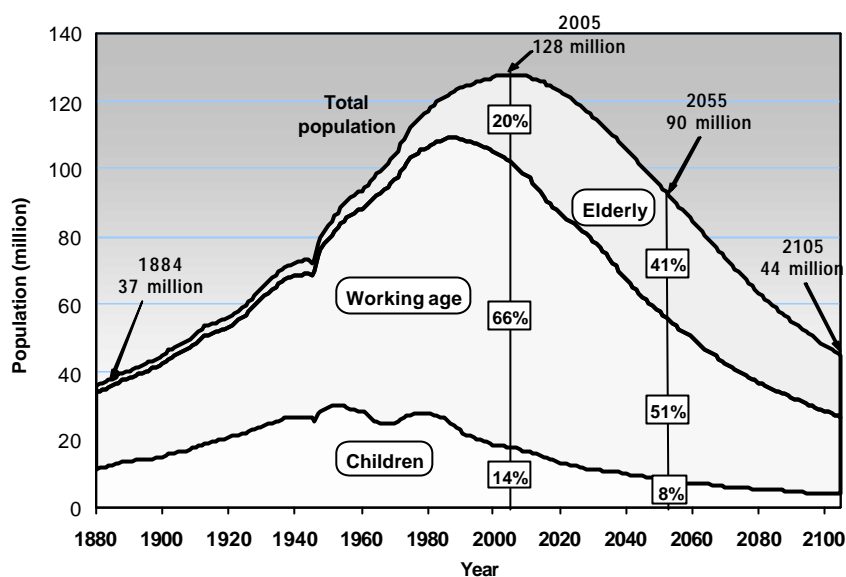
Table 1 Projected Future Population and Proportion by Age Group, 2005-2105:
the Variant with Medium-Fertility, Medium-Mortality Assumptions

Year	Population in 1,000				Proportion (%)			Dependency ratio (%)		
	Total	0-14	15-64	65+	0-14	15-64	65+	Total	Child	Old-age
2005	127,768	17,585	84,422	25,761	13.8	66.1	20.2	51.3	20.8	30.5
2010	127,176	16,479	81,285	29,412	13.0	63.9	23.1	56.5	20.3	36.2
2015	125,430	14,841	76,807	33,781	11.8	61.2	26.9	63.3	19.3	44.0
2020	122,735	13,201	73,635	35,899	10.8	60.0	29.2	66.7	17.9	48.8
2025	119,270	11,956	70,960	36,354	10.0	59.5	30.5	68.1	16.8	51.2
2030	115,224	11,150	67,404	36,670	9.7	58.5	31.8	70.9	16.5	54.4
2035	110,679	10,512	62,919	37,249	9.5	56.8	33.7	75.9	16.7	59.2
2040	105,695	9,833	57,335	38,527	9.3	54.2	36.5	84.3	17.2	67.2
2045	100,443	9,036	53,000	38,407	9.0	52.8	38.2	89.5	17.0	72.5
2050	95,152	8,214	49,297	37,641	8.6	51.8	39.6	93.0	16.7	76.4
2055	89,930	7,516	45,951	36,463	8.4	51.1	40.5	95.7	16.4	79.4
2060	84,592	6,987	42,778	34,827	8.3	50.6	41.2	97.7	16.3	81.4
2070	73,488	6,158	36,325	31,005	8.4	49.4	42.2	102.3	17.0	85.4
2080	63,387	5,304	31,505	26,578	8.4	49.7	41.9	101.2	16.8	84.4
2090	54,925	4,600	27,674	22,651	8.4	50.4	41.2	98.5	16.6	81.8
2100	47,712	4,093	24,144	19,475	8.6	50.6	40.8	97.6	17.0	80.7
2105	44,592	3,856	22,631	18,105	8.6	50.8	40.6	97.0	17.0	80.0

Source: NIPSSR(2006), *Population Projection for Japan:2006-2055*, the medium-fertility and medium-mortality variant. The results for the period 2056-2105 are ancillary calculation with constant vital rates as of 2055.

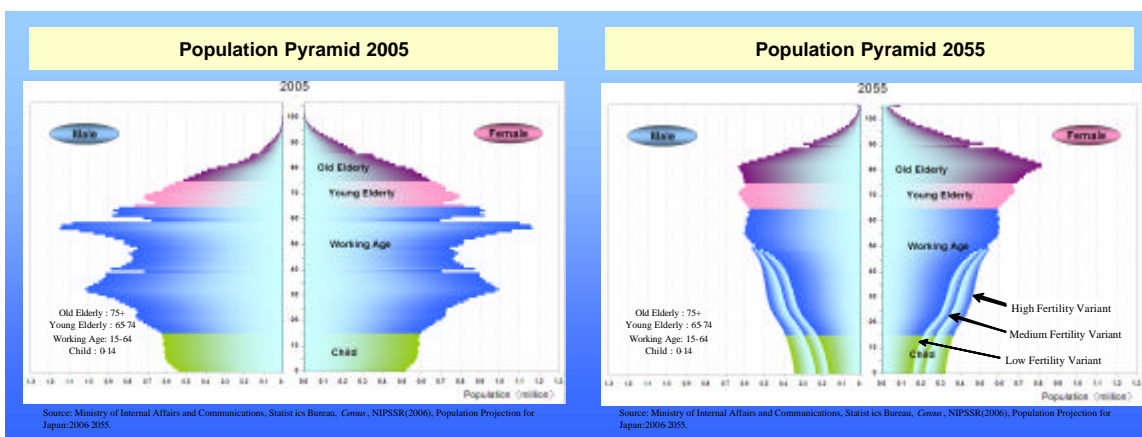
7. The amount of population loss over the 50 years ranges from 28.2 million in the high fertility with low mortality-variant to 45.4 million in the low fertility with high-mortality -variant. The proportion elderly ranges from 36.3 per cent in the high fertility with high mortality-variant to 44.4 per cent in the low fertility with low mortality-variant. The ancillary calculation of the population in 2105 with vital rates assumed constant at the 2055 level is 44.6 million or 35 per cent of the initial population in the medium fertility with medium mortality-variant. The assumption of low fertility combined with high mortality results in the smallest total population of 33.6 million or 26 per cent of the starting population, while the result of the high fertility with low mortality-variant is the largest 62.7 million or 49 per cent of the 2005 population size.

Figure 1. Growth and Reduction of Population of Japan: 1880-2105



Source: Ministry of Internal Affairs and Communications, Statistics Bureau, *Census*, NIPSSR(2006), *Population Projection for Japan:2006-2055*, the medium-fertility and medium-mortality variant..

Figure 2. Growth and Reduction of Population of Japan: 1880-2105



Source: Statistics Bureau, *Census 2005*, NIPSSR (2006), *Population Projection for Japan:2006-2055* (three fertility variants with medium-mortality).

Assumptions

8. This unprecedented population comes out from assumptions of the world lowest fertility prospects combined with the longest life expectancy. The eventual total fertility rate is 1.26 (ranging from 1.06 to 1.55), and the female life expectancy 90.3 (ranging from 89.2 to 91.5). How could it be possible for fertility to remain so low for some 50 years of period? How could be the life expectancy highest?

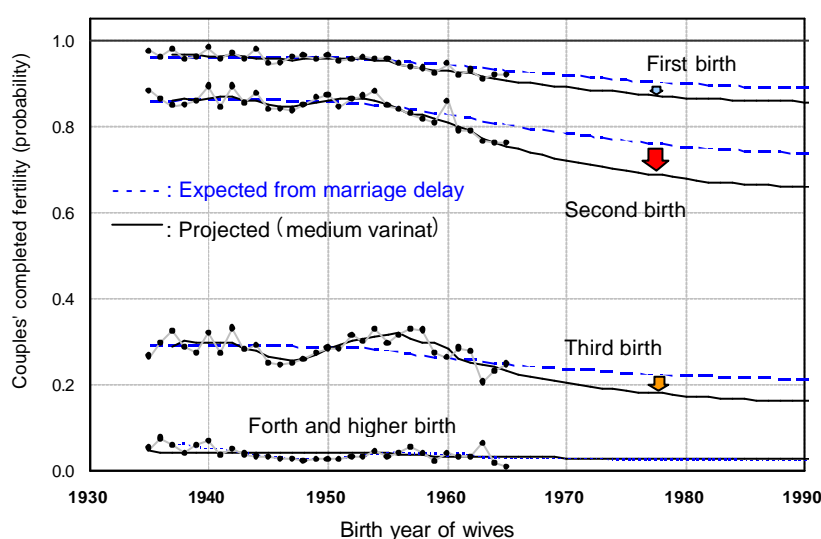
Fertility Assumptions

9. Fertility assumptions underlying the projection were made on the basis of the cohort-fertility method, or the life course approach. That is a statistical projection of the level of completed fertility and the birth timing of each female birth cohorts including those who have not completed yet their reproductive processes. Future annual age-specific and total fertility

rates, which are required for the projection with the cohort component method can be obtained by converting the cohort rates into the period rates. The age-specific fertility rates of cohorts were estimated or assumed separately by birth order using models with parameters for lifetime birth probability, birth timing and some other traits of the process.

10. For cohorts that had completed a substantial part of their reproductive processes, the entire processes were constructed by estimating the parameters through statistical method. For younger cohorts for which scant or no data were available, the fertility schedules are generated through reconstruction of reproductive life course formed by such behaviors as marriage and marital childbearing. Assumptions are setup with the following four parameters of reproductive behaviours; (1) the mean age at first marriage, (2) the proportion of never married, (3) the completed number of births from married women, and (4) the coefficient of divorce, bereavement and remarriage. Each of the parameters is projected according to trend derived from recorded data compiled for cohorts so that the completed life courses of future generations are assembled. For example, estimates and prospective trends of couple's birth probabilities by birth order, which sum up to (3) the average completed number of births from the couple, is illustrated in Figure 3. For details of the construction of fertility assumptions, see elsewhere (Iwasawa and Kaneko 2007).

Figure 3. Expected and Prospective Trends of Couple's Probability Having Birth of Each Order by Wife's Birth Year



Source: NIPSSR (2006), the Thirteenth National Fertility Survey, 2005.

11. The assumptions on those four parameters of the female cohort born in 1990 are shown in Table 2 for three alternative projection variants, i.e. Medium, High and Low². All of the assumed values of the components change to the same direction for fertility reduction even in the high variant, resulting in substantial decreases of the total fertility rate (TFR)³.

² The cohort born in 1990 served as a reference whose values of parameters were most carefully examined.

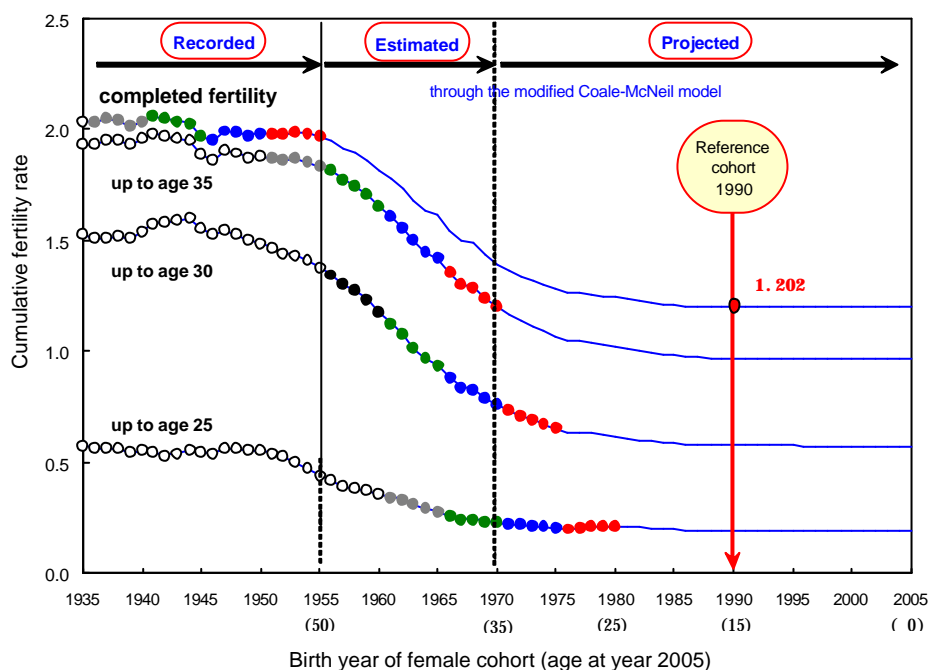
³ This construction is applied only for Japanese women. The fertility rates of women with foreign nationalities are produced in relation to those of Japanese, using the observed relationships to be fixed for future.

Table 2 Assumptions for Measures of Fertility Components and Total Fertility Rates for the Reference Cohort (born in 1990)

Measures of Fertility Components	Observed: cohort born in 1955		Assumptions of Population Projection: cohort born in 1990		
			Medium	High	Low
(1) Mean age at first marriage	24.9		28.2	27.8	28.7
(2) Proportion never married at age 50	5.8 %	➔	23.5 %	17.9 %	27.0 %
(3) Couples' completed fertility	2.16		1.70	1.91	1.52
(4) Effect of divorce, widowhood and remarriage	0.952		0.925	0.938	0.918
Cohort Total Fertility Rate (Japanese women)	1.94	➔	1.26 (1.20)	1.55 (1.47)	1.06 (1.02)

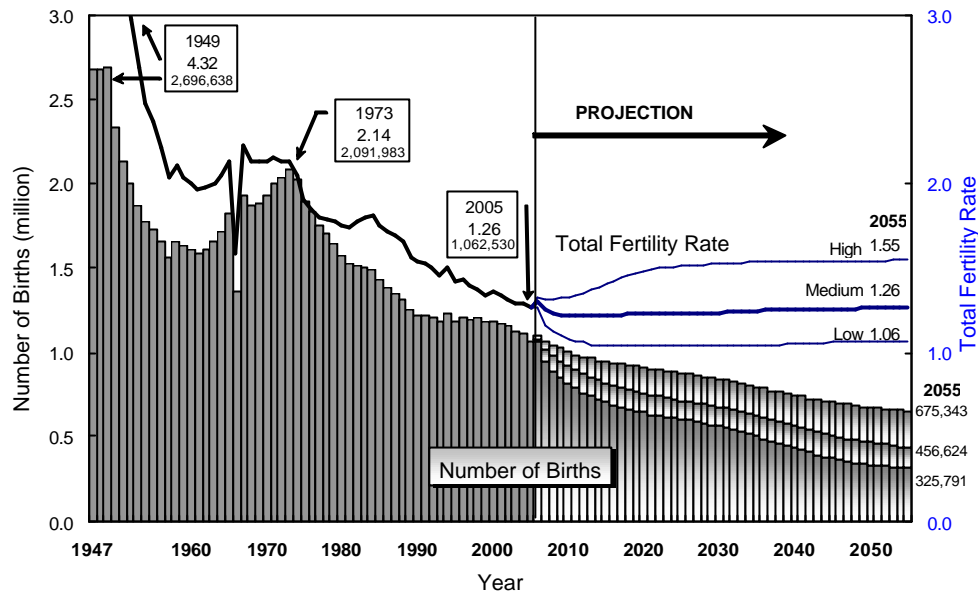
12. The parameters are translated into fertility schedules separately by birth order through demographic model called the Generalized Log-gamma model (an extension of the Coale-McNeil model) with empirical adjustments specific to Japanese unique pattern (Kaneko, 2003). The resulted cohort trends of the cumulative fertility rate are shown in Figure 4. As stated above, these cohort fertility rates were converted into the period fertility rates as assumptions of the cohort component procedure. The transitions of assumed TFR are shown in Figure 5 along with projected number of births, which exhibit extensive reductions.

Figure 4. Recorded and Projected Cohort Trends of the Cumulative Fertility Rate at Selected Age: 25, 30, 35, and Completed (Age 50)



Source: NIPSSR (2006), Population Projection for Japan:2006-2055 [the medium-fertility assumption].

Figure 5. Number of Births, and Total Fertility Rate in Japan
Trends and Prospects: 1947-2055



Source: Ministry of Health, Labor and Welfare, *Vital Statistics*. NIPSSR (2006), *Population Projection for Japan:2006-2055* (the three fertility variants with medium-mortality assumption).

13. The assumption building through estimation and projection of cohort measures of life course components of fertility in the projections enables us to construct the projected life course in relation to the relevant life events. I constructed the multistate life tables for those projected life by family status. Those are examined in the next section. The results indicate that the less-reproductive and non-familial lives prevail among the today's young and future generations reflecting rapid transformation of partnerships and family formation pattern observed in the current cohorts.

Mortality Assumptions

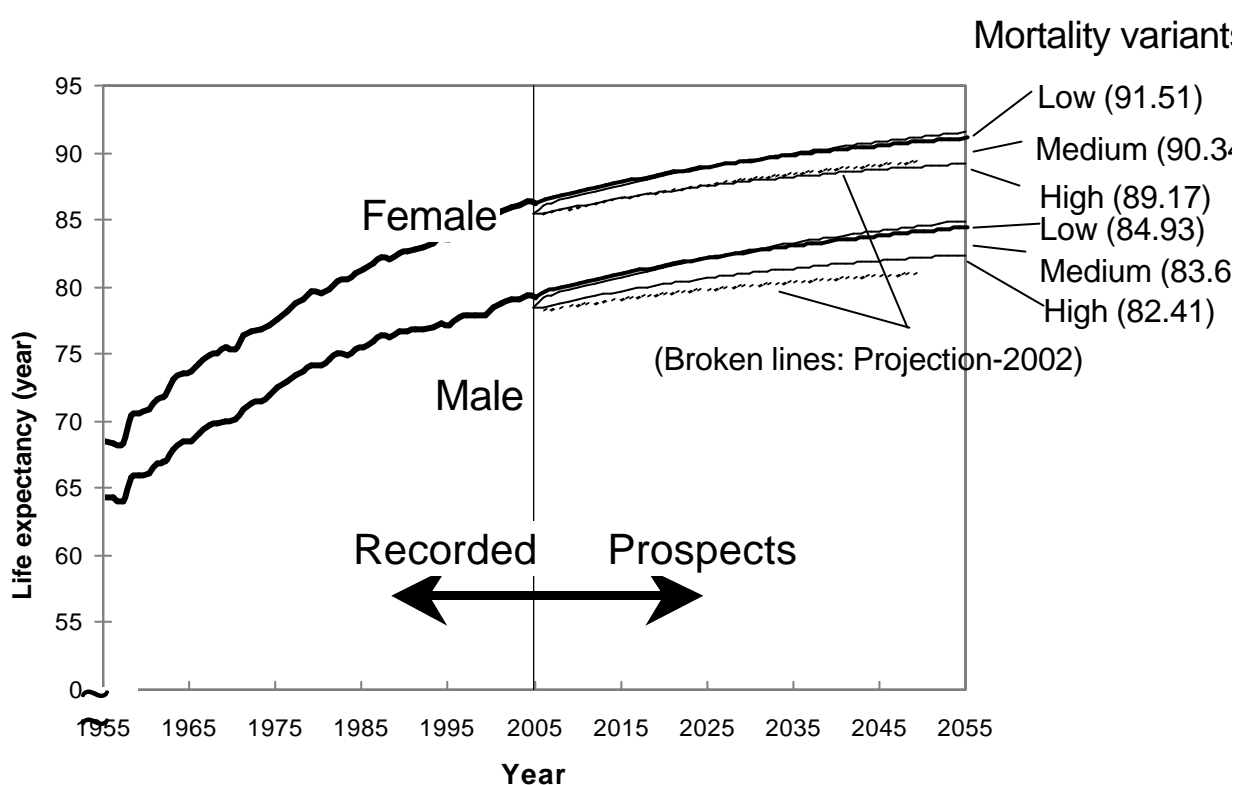
14. The Lee-Carter model was adopted as a basis to construct future annual life tables. The procedure is, however, modified by introducing new technique called the shifting logistic model method (Bongaarts 2005), which identifies improvements in the mortality rates as shifts of the aging process toward older ages. This modification is a reflection of actual mortality trend observed in Japan as continuing gain of life expectancy especially in old ages. Combining the Lee-Carter model with the shifting logistic model is considered to be a better way of accounting for this trend, and in fact exhibits more sensible age patterns of future mortality than those from the Lee-Carter model alone.

15. Because of the unpredicted life expectancy gains in recent years of low mortality countries including Japan (Oeppen and Vaupel 2002, Tuljapurkar et al. 2000), a higher degree of uncertainty was anticipated for future of mortality. This was coped with by making multiple assumptions just like those in fertility. The high and low variants of mortality, however, are derived from the boundaries of the 99 per cent confidence interval of the mortality level parameter of the Lee-Carter model (denoted by k_t in the original formulation).

16. According to the principal future life tables or the medium variant assumption of mortality, the life expectancy, which in 2005 was 78.53 years for males and 85.49 years for females, is expected to extend to 79.51 years for males and 86.41 years for females by 2010, 81.88 years for males and 88.66 years for females by 2030, and to 83.67 years for males and 90.34 years for females in 2055.

17. The assumed mortality rate for the high mortality variant will be higher, and consequently the life expectancy will be shorter, than for the medium variant. According to this assumption, the life expectancy in 2055 will be 82.41 years for males and 89.17 years for females. Similarly in the low mortality assumption, the mortality rate will be lower, and therefore the life expectancy will be longer than in the medium variant. The life expectancy by 2055 according to this assumption will be 84.93 years for males and 91.51 years for females. The assumed course of life expectancies are shown in Figure 6.

Figure 6. Trends and Prospects of the Life Expectancy: 1955-2055



Source: Ministry of Health, Labor and Welfare, *the Abridged Life Table*. NIPSSR (2006), *Population Projection for Japan:2006-2055*.

Life Course Construction

18. The life-course construction is characterized approach employed in the projection for Japan since 90's. It requires a good deal of quality data and somewhat complicated model system. Series of the census, vital statistics, and micro data from national representative fertility surveys were brought together into play in the construction of fertility assumptions. It is often the case with population projection that excessive complications do not contribute to accuracy. However, our experience indicates that complexity to some extent would deserve, since it provides detailed information on the way how life of the future would be. It offers many distinct

traces to improve the models through monitoring and contrasting the actual drift of the measures with those projected. In addition, it contributes to fulfilling the accountability on preposition of the projections to the public. I briefly discuss the roles, uses, prospects and some limitations of the approach as well.

19. I attempted to construct the multistate life table for the projected life of Japanese women to obtain their life course measures mainly by ultimate family status. The measures include life time probability of never marrying, childless, having no grandchild and so on. The probabilities incorporate incidences from women's immature deaths before the events. Average life time spent in each family status such as never married state, childless state, and only-child state, are also examined.

20. In Table 3, the woman's life time probabilities and distributions by family status are indicated for female birth cohorts born in every five year since 1950 through 1990. The cohorts born in 1950 and 55 had completed their reproductive life processes by the time of projection, thus their figures are regarded as the actually recorded. On the other hand, the cohorts born in 1960 and after have yet completed the processes, and their figures are all for projected life by the assumption based on the trends of relevant parameters, though length of projected period varies by cohort to cohort in relation to their age at projection.

21. Life time probability of a woman who is eventually marrying, assessed at her birth, is 86.4% for anyone among cohort born in 1950. The figure gradually decreases from a cohort to the next until 75.7% for a woman born in 1990. These figures are somewhat lower than those calculated from nuptiality rate among the fertility assumption, since the formers include effects from premature death before marriage.

22. The probability of never marrying, childlessness and having no grandchild are 24.3%, 38.1% and 50.2% respectively in cohort born in 1990 (see also Figure 7). If compared with those in preceding cohorts, these figures indicate rapid prevalence of less-reproductive and non-familial life styles toward an unprecedented level in this society.

Average life times spent in certain family status for female cohorts born in 1950-90 are presented in Table 4, with their proportion in the life expectancies. For instance, the average life time spent in never married status increases to 42.5 years (or 47% of the life expectancy) in cohort born in 1990 from 25.3 years (31%) in those born in 1950. Figure 8 illustrates that amount of life spent in never married state will drastically increase for Japanese women of young generations.

23. The changes in woman's life course cause tectonic movements in population composition as well. In Table 5 and Figure 9, I indicated the composition of female population by family status at three chronological time, year 2005, 2030, and 2055. They give us a manifest view that these life course changes observed above initiate the drastic increase of elderly who do not have any offspring in this society of near future. 30.9% of women age 65 and higher do not have child in 2055, while 8.0% in 2005. Although only the situations in women are indicated here, the view should be expanded over the whole nation.

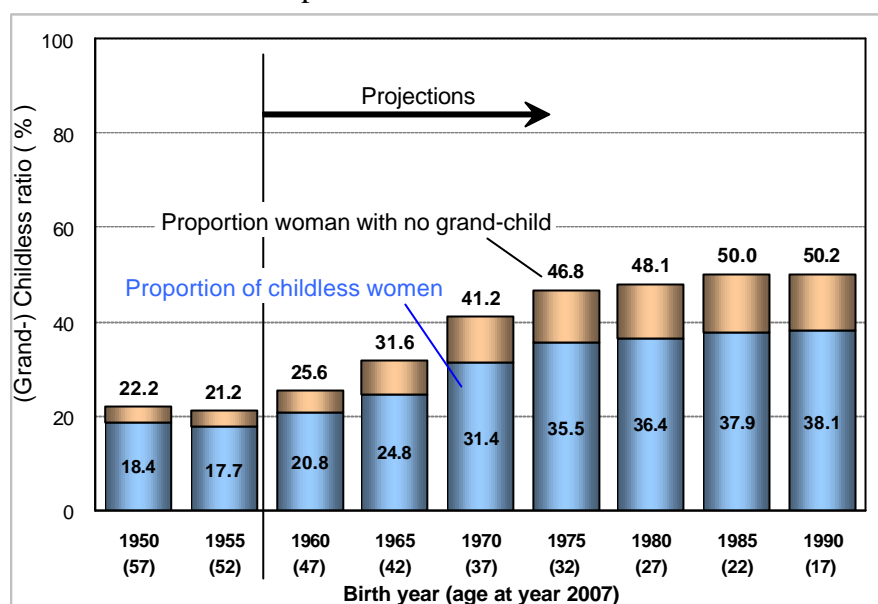
Table 3. Woman's Life Time Probabilities and Distributions by Family Status: Perspectives from the Medium Variant for Cohorts Born in 1950-90

(%)

	Birth year of woman's cohort								
	Recorded		Projected						
	1950	1955	1960	1965	1970	1975	1980	1985	1990
Life time probability of woman ... (at birth)									
Marrying	86.4	88.8	87.1	85.6	82.1	78.3	76.4	75.7	75.7
Having 1st birth	81.6	82.3	79.2	75.2	68.6	64.5	63.6	62.1	61.9
Having 2nd birth	70.4	71.1	65.8	58.6	49.8	45.7	44.8	43.9	43.9
Having 3rd birth	23.6	26.7	24.1	19.1	14.7	12.8	11.7	11.3	11.2
Having 4th and higher birth	4.2	4.7	4.5	3.8	3.2	2.7	2.3	2.0	1.9
Never marrying	13.6	11.2	12.9	14.4	17.9	21.7	23.6	24.3	24.3
Childless	18.4	17.7	20.8	24.8	31.4	35.5	36.4	37.9	38.1
Never having 2nd child	29.6	28.9	34.2	41.4	50.2	54.3	55.2	56.1	56.1
Never having 3rd child	76.4	73.3	75.9	80.9	85.3	87.2	88.3	88.7	88.8
Never having 4th child	95.8	95.3	95.5	96.2	96.8	97.3	97.7	98.0	98.1
Life time distribution of woman by number of child (at birth)									
Childless	18.4	17.7	20.8	24.8	31.4	35.5	36.4	37.9	38.1
Never married	13.6	11.2	12.9	14.4	17.9	21.7	23.6	24.3	24.3
Ever married	4.8	6.5	7.9	10.5	13.5	13.8	12.8	13.6	13.8
Only child	11.2	11.2	13.3	16.5	18.7	18.8	18.8	18.1	18.0
Two children	46.8	44.4	41.8	39.5	35.2	32.9	33.0	32.6	32.8
Three children	19.4	22.0	19.6	15.3	11.5	10.1	9.4	9.3	9.3
Four and more children	4.2	4.7	4.5	3.8	3.2	2.7	2.3	2.0	1.9
Net Reproduction Rate	87.5	90.0	84.5	76.3	66.3	61.2	59.6	58.1	57.9
No grandchild	22.2	21.2	25.6	31.6	41.2	46.8	48.1	50.0	50.2
Life time proportion of woman (without mortality effect = directly derived from fertility assumption)									
Never married	5.0	5.8	9.3	12.0	16.2	20.4	22.6	23.5	23.5
Childless	10.3	12.7	17.5	22.7	30.0	32.8	35.7	37.1	37.4
No grandchild	12.1	15.0	21.3	28.8	39.3	42.9	46.8	48.9	49.4

Source: From the projection 2006, medium-fertility and medium-mortality variant. The life time proportions of woman never married and childless (without mortality effect) are officially provided numbers. Other numbers are calculated by the author from the assumption. The sex ratio at birth for the net reproduction ratio is officially provided assumption and is 105.4 (fixed value from average over year 2001-05).

Figure 7. Childless and Non-grandchild Ratio among Women by Cohort:
The Medium Assumption for Female Cohort born in 1935-1990



Source: From the projection 2006, medium-fertility and medium-mortality variant. Proportions are calculated by the author from the assumption of the projection 2006, medium-fertility and medium-mortality variant.

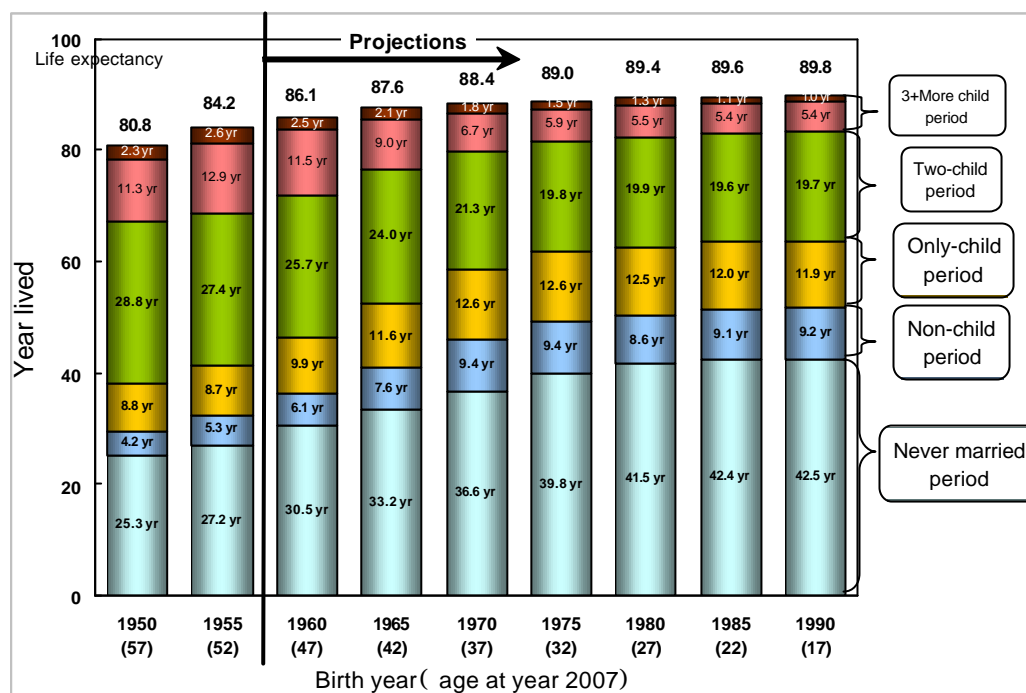
Table 4 Woman's Average Life Time Length of Period Spent in Each Family Status:
Perspectives from the Medium Variant for Cohorts Born in 1950-90

	(year)								
	Birth year of woman's cohort								
	Observed		Projected						
	1950	1955	1960	1965	1970	1975	1980	1985	1990
Average life time length of period spent in each family status									
Life expectancy	80.8	84.2	86.1	87.6	88.4	89.0	89.4	89.6	89.8
Never married	25.3	27.2	30.5	33.2	36.6	39.8	41.5	42.4	42.5
Childless	29.5	32.5	36.5	40.9	46.0	49.2	50.2	51.4	51.7
Never had 2nd child	38.3	41.2	46.4	52.5	58.7	61.8	62.7	63.5	63.7
Never had 3rd child	67.1	68.7	72.1	76.5	79.9	81.6	82.6	83.1	83.4
Never had 4th child	78.5	81.5	83.6	85.5	86.7	87.5	88.1	88.5	88.8
Ever married	55.4	57.0	55.6	54.3	51.8	49.2	47.8	47.3	47.3
Having Child(ren)	51.2	51.7	49.6	46.7	42.4	39.8	39.2	38.2	38.1

	Proportion of life time spent in each family status								
	Proportion of life time spent in each family status (%)								
	1950	1955	1960	1965	1970	1975	1980	1985	1990
Life expectancy	100	100	100	100	100	100	100	100	100
Never married	31	32	35	38	41	45	46	47	47
Childless	37	39	42	47	52	55	56	57	58
Never had 2nd child	47	49	54	60	66	69	70	71	71
Never had 3rd child	83	82	84	87	90	92	92	93	93
Never had 4th child	97	97	97	98	98	98	99	99	99
Ever married	69	68	65	62	59	55	54	53	53
Having Child(ren)	63	61	58	53	48	45	44	43	42

Source: From the assumption of the projection 2006, medium-fertility and medium-mortality variant. The life expectancies are officially provided numbers. Other numbers are calculated by the author

Figure 8. Woman's Average Life Span and It's Composition by Family Status for Birth Cohorts born in 1950-1990



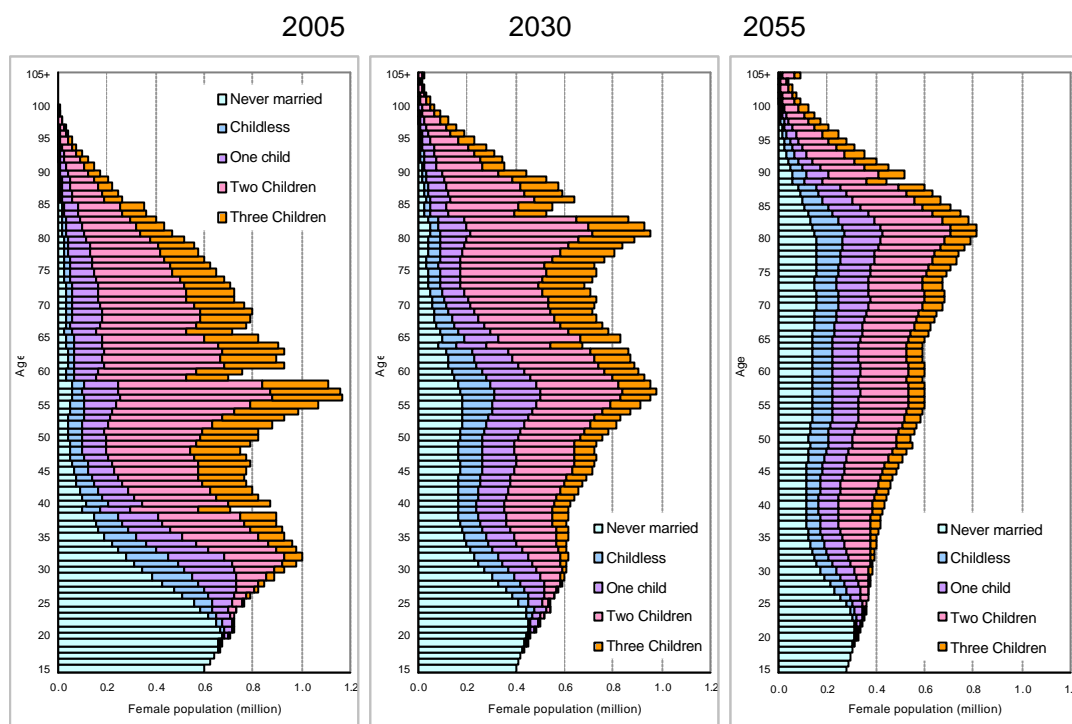
Source: From the projection 2006, medium-fertility and medium-mortality variant. The life expectancies are officially provided numbers. Other numbers are calculated by the author from the assumption.

Table 5 Composition of Woman in Each Age Group by Family Status: Perspectives from the Medium Variant in Year 2005, 2030, and 2055

Age Group	2005			2030			2055		
	Never married	Childless	Less than two children	Never married	Childless	Less than two children	Never married	Childless	Less than two children
15-19	99.2	99.3	99.9	99.2	99.4	99.9	99.2	99.4	99.9
20-24	88.4	91.9	97.9	89.2	92.6	98.1	89.3	92.6	98.1
25-29	57.5	72.4	88.6	62.6	75.2	89.3	62.8	75.3	89.4
30-34	29.3	46.1	68.1	38.5	54.0	73.4	38.5	53.9	73.4
35-39	17.6	30.0	48.5	28.6	41.9	60.3	28.7	41.9	60.3
40-44	11.4	20.7	36.1	25.1	37.9	55.9	25.1	37.9	56.1
45-49	7.3	14.6	27.4	23.3	36.5	55.1	23.9	37.5	55.7
50-54	5.0	11.5	23.3	21.9	35.0	54.1	23.6	37.5	55.7
55-59	5.2	9.6	22.2	17.9	32.2	51.7	23.6	37.5	55.7
60-64	4.6	7.5	20.7	14.3	26.8	44.8	23.5	37.4	55.6
65-69	4.1	7.7	22.4	10.7	20.4	35.8	23.5	37.4	55.6
70-74	4.4	8.1	23.1	7.2	14.6	27.4	22.9	36.5	55.1
75-79	4.4	8.1	23.1	5.0	11.5	23.3	21.9	35.0	54.1
80-84	4.4	8.1	23.1	5.2	9.6	22.2	17.9	32.2	51.7
85-89	4.4	8.1	23.1	4.6	7.5	20.7	14.3	26.9	45.0
90-94	4.4	8.1	23.1	4.1	7.7	22.3	10.8	20.6	36.1
95-99	4.4	8.1	23.1	4.4	8.1	23.1	7.4	14.9	27.9
100+	4.4	8.1	23.1	4.4	8.1	23.1	5.1	11.3	23.2
15+	22.8	29.8	43.6	24.8	34.3	49.4	28.9	41.2	58.1
15-49	41.6	51.4	65.3	48.0	58.9	73.4	48.2	59.0	73.4
65+	4.3	8.0	22.9	6.3	12.2	25.6	18.2	30.9	48.8

Source: From the projection 2006, medium-fertility and medium-mortality variant. Numbers are calculated by the author

Figure 9. Composition of Female Population by Family Status :
Perspectives from the Medium Variant in Year 2005, 2030, and 2055



Source: From the projection 2006, medium-fertility and medium-mortality variant. Numbers are calculated by the author

Discussion

24. In this paper, first I described results and methods of the latest Japanese official Population Projections. Besides their unprecedented demographic perspectives on population decline and aging through the world lowest fertility assumptions with the highest life expectancy, the projections provide some pictures of people's life course changes making use of their life course approaches employed mainly in constructing fertility assumptions. Hence, I attempted to build multistate life tables for the projected life of Japanese women in relation to family status. As a consequence, it is revealed that historically unparalleled increases both in proportion of never married and childless women and in average life time spent in those statuses would be witnessed within scope of next few decades. It also sets up an expansion of elderly people who have no offspring or family. These insights in individual aspect of the population projection should rouse public awareness of necessity for fundamental alteration in life course related institutions, in addition to reforms of macro socioeconomic organizations such as labor market or social security system. For example, the society could not rely any more on individual families caring elderly in a manner it dose up to today.

25. The life course approach to making assumptions of vital rates requires significant amount of quality data and sophisticated models. There are arguments that complexity of models do not necessarily contribute to precision in prediction, especially for systems consist of many factors. Population projection, in particular, can be carried out with a jump-off population and three assumed vital rates (fertility, mortality, and migration). Incorporation of other components such as marriage makes model complex, and requires additional assumptions on future course of the component, whose future is often more uncertain than those of the basic three factors. Seeking too much reality in projection models often leads to a morass of technical difficulties with little

gain in accuracy. However, to the extent that each rate is consist of several behavioral factors which changes disjointedly, preparing different assumptions for their future courses is essential for sensible prediction⁴. Therefore better policy about the degree of reality to seek in a population projection depends on what kinds of data are available and how confidently we see the future of each component involved, providing the present knowledge and technology. Then, what is the direction we should take to expand “the present knowledge and technology?” We live in an era of difficulty in forecasting demographic future of the society due to unpredictable developments in all vital rates. In many counties of the developed world, the traditional cohort component method with naive vital assumptions has continually shown its limitations along with the development of institutional changes so called the Second Demographic Transition (Lesthaeghe 1994, Van de Kaa 1987) in the last quarter of the former century⁵⁶. Demographers have increasingly become aware of projection’s uncertainty, and some new “paradigms” have emerged as solutions. Among them the probabilistic population projection is a most pronounced exemplar that enhances projection’s practical applicability explicitly indicating its inherent uncertainty. It bestowed the scientific outline on population projection. Beside techniques that specify uncertainty, however, we should seek frameworks to reduce uncertainty on the other side. The life course approach or statistical life course construction of relevant cohorts should be the basis of the novel framework for that function, since it offers distinct traces by each lifetime behaviors to improve the models through monitoring and contrasting the actual drift of the measures for them. The measures are free from annoying disturbances so called tempo effects, and rarely violently fluctuate.

26. The present study combined with the above discussion suggests that the life course approach in population projection may deserve all efforts to overcome the difficulties that have been preventing it to work such as unavailability of data it requires and model complexities it induces. It provides essential information on people’s life in upcoming society, and be an effective basis of more reliable demographic prediction tools. The instruments are ample. The event history models, micro-simulation techniques possibly with agent-based design, and decision making theories, for instance, should play central roles in developing such a framework. However, what is most required for the approach to work is cohort data of many aspects. In most cases, an enhancement of the statistical systems and starting a new series of survey may be required. The public consent should be necessary. For that purpose, international cooperation is indispensable, and developing a communal outline for data collection may be effective.

Conclusion

27. According to the multistate life table constructed from the principal assumptions of the latest official population projections of Japan, the life time probability of childlessness and having no grandchild among women born in 1990 are respectively 38.1% and 50.2%, while the corresponding proportions are 18.4% and 22.2% in those born in 1950. Similarly, the average life time spent in never married status increases to 42.5 years (or 47% of the life expectancy) in cohort born in 1990 from 25.3 years (31%) in those born in 1950. These changes set off drastic increase of elderly who do not have offspring to live with or rely on in this society of near future.

⁴ For example in fertility, coupling and having babies among couples are separate behaviors and their propensities have own trends.

⁵ The precursors in demographic projection experienced similar difficulties during the first Demographic Transition accompanied with the post-war baby booms.

⁶ The author thinks it reasonable that the shifts in mortality improvement recognized as the fourth stage of the Epidemiologic Transition (the age of delayed degenerative diseases, Olshansky and Ault 1986) being experienced by the most developed countries since late 60’s should be included in the same stream of the Second Demographic Transition to the extent that they were concurrent phenomena unexpected in the context of the first Demographic Transition.

27. The life course approach in population projection provides rich information on people's life in upcoming society on the one hand, it should be a promising basis of new "paradigm" of the projection in the era of the Second Demographic Transition on the other. The development of the new framework should be accompanied with enhancement of the data collection via upgrading national statistical systems toward demographic formulation of individual life courses.

References

- Bongaarts, John, 2005, "Long-range trends in adult mortality: Models and projection methods." *Demography*, Vol.42, No.1, pp.23-49.
- Iwasawa, Miho, and Kaneko, Ryuichi, 2007, "Trends in Partnership Behaviours in Japan from the Cohort Perspective." paper presented to Joint Eurostat-UNECE Work Session on Demographic Projections (Bucharest, 10-12 October 2007).
- Kaneko, Ryuichi, 2003, "Elaboration of the Coale-McNeil Nuptiality Model as the Generalized Log Gamma Distribution: A New Identity and Empirical Enhancements." *Demographic Research*, Vol. 9-10:223-262. <http://www.demographic-research.org/>
- Lesthaeghe, Ron, 1994, "The second demographic transition revisited: Theories and expectations." In *Population and Family in the Low Countries 1993*, Amsterdam: Lisse, Zwets and Zeitlinger.
- National Institute of Population and Social Security Research (NIPSSR), 2007. *Nihon no Syorai Suikei Jinko (Population Projection for Japan: 2006-2055)*, Tokyo: Kosei Tokei Kyokai.
- Oeppen Jim, Vaupel Jim., 2002, "Broken limits to life expectancy." *Science* 296:1029-31.
- Olshansky, S. Jay, Ault, Brian, 1986, "The Fourth Stage of the Epidemiologic Transition: The Age of Delayed Degenerative Diseases." *The Milbank Quarterly* 64(3):355-391.
- Tuljapurkar, Shripad, Li, Nan, and Boe, Carl, 2000 "A Universal Pattern of Mortality Decline in the G7 Countries." *Nature* 405, 789-792.
- Van de Kaa, Dirk J. 1987, Europe's second demographic transition. *Population Bulletin*, Vol.42(1).
