Generating the dynamic life tables Modified by subjective indices for retirement planning

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Abstract. In recent years, the poverty of the elderly people becomes a big social problem in Japan. Therefore, it is an important issue for the elderly to estimate the appropriate mortality rate and to manage the longevity risk in order to make retirement plans. Hibiki and Nishioka (2010) examine how the subjective health feeling relates to the mortality rate. Hibiki and Oya (2015) generate the dynamic life tables based on the Lee-Carter method, and modify it with the subjective health feeling. In our paper, we analyze some subjective indices related to the mortality rate, in addition to the subjective health feeling. Our goal is to generate the dynamic life tables over 65 years old adapted to personal characteristics for making more appropriate retirement plans. Using the six waves of panel data (every three years from 1987 to 2002) by the National Survey of Japanese Elderly, we analyze the relationship between survival rates and subjective indices such as the feelings of satisfaction and happiness, and estimate the cumulative survival rates for the several combinations of the subjective indices at the time of 65 years old.

Keywords: retirement planning, life table, subjective index

1. INTRODUCTION

In recent years, there are many elderly people suffering from poverty that cannot even pay food expenses and it might become a big social problem in the future in Japan. The main reason is that the life expectancy is prolonged due to the progress in medicine and people live longer than their own expectation. We have to prepare more money after retirement due to the graying population and the low fertility rate. In addition, we need to bear no-income period for several years due to the gap between retirement age and pensionable age. Therefore, it is necessary to saving, investing and consuming retirement funds systematically in order to avoid bankruptcy after retirement. The goal of our research is to generate life tables after 65 years old according to personal characteristics for more appropriate retirement plan.

Subjective health feeling is said to relate life prognosis and early death. Hibiki and Nishioka (2010) reflect the feeling in the life tables of elderly people and generate four types of male and three types of female life tables. Hibiki and Oya (2015) develop them into the dynamic life tables using the Lee-Carter model.

In addition, *subjective well-being* measured by SUBI or Morale Scale etc. is said to relate depression symptoms and adaptability to society. Singh-Manoux et al. (2003) have shown that *subjective social status* influences the incidence and mental state of chronic diseases.

In this paper, we generate the life tables reflecting them comprehensively. By reflecting many indices, it becomes possible to predict the survival curves appropriately, which are useful for planning the financial plan.

This paper is organized as follows. In Section 2, we generate the dynamic life tables modified by subjective indices. In Section 3, we consider the dynamic life tables we generated. Section 4 explains how to apply them to retirement planning. Section 5 provides our concluding remarks.

2. GENERATING THE LIFE TABLES

We generated the dynamic life tables modified by subjective indices through the following steps.

1. Generate the dynamic life tables based on the Lee-Carter method.
2. Examine how the subjective indices relate to t he mortality rate.
3. Smooth the survival curves and determine the adjusted ratio of mortality rate for each index by reflecting the subjective indices.
4. Modify the dynamic life tables generated in st ep 1.

2.1 Generating the dynamic life tables

In this paper, we generated the dynamic life tables based on Lee-Carter method using Japanese Mortality Database (1970-2010). These life tables are the same as those generated in Hibiki and Oya (2015).

Figures 1 and 2 show the survival curves for mal e and female, respectively. The values on the red line are the estimates in 2010, and the blue line shows the survival curve of people who is 65 years old in 2010.

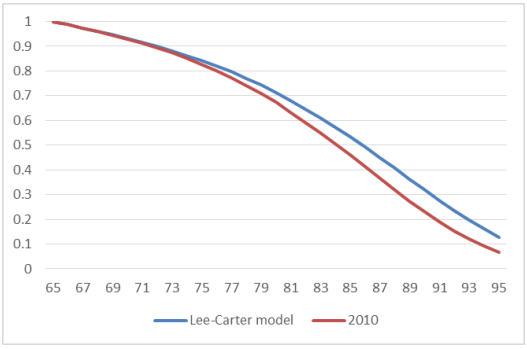

Figure 1: Dynamic life table for male

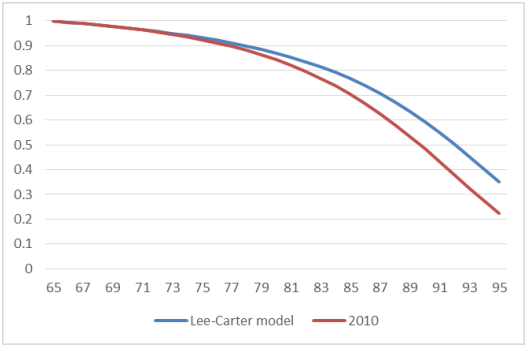

Figure 2: Dynamic life table for female

2.2 Examining the relationship between the subjective indices and mortality rate

In this paper, we use six datasets of "National Survey of the Japanese Elderly" of Wave 1 (1986) to Wave 6 (2002) which are currently published. In addition to the basic indices, we use subjective indices such as satisfaction and happiness feeling, and objective indices which relate to each subjective index.

In this study, we estimate the cumulative survival curves using the Kaplan-Meier method for each group of answers to each question. We conduct the chi-squared test in order to judge whether each group is significantly different at a significance level of 5%. In the case three or more answer groups lie next to each other, we can regard them as one group, and organize the answer group so that the significance probability can be minimized. We set th e lower limit to the number of data of each group which is 10% of the number of valid data of the corresponding index. We determine the largest follow-up period each inde x is significantly different within 15 years, the maximum follow-up period of panel data. We test the cumulative survival curve for each age at the beginning of the survey, and use the data included in the maximum range where no significant difference from the 65 year old curve was observed for each follow-up age.

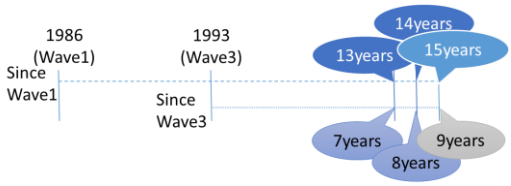

Figure 3: Summary of follow-up period

Using the above-mentioned procedure, we examine the relationship between 16 subjective and 7 objective indices and the survival rate, respectively (Table 1). The s urvival rate is significantly affected by five subjective/ one objective indices for male and three subjective/one objective indices for female. These indices are colored in yellow in Table 1. "+(1)" in *evaluation level* shows "No ne" is included in the choice. "+/-" in *Expectation and Results* shows the survival rate is higher as the evaluation is high/low or the number is large/small. "?" shows we cannot expect the specific result because we may expect multiple hypothesis. The number in parenthesis in *Results* shows the maximum follow-up years which the relationship between the index and the survival rate was observed.

To clarify the relationship between each index and the life table, we attempt to integrate indices.

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Table 1: Indices used for analysis and results.

Indices			Maximum follow-up years	Evaluation level	Expectation	Results	
						male	female
Subjective	Health	Evaluation overall health condition	15	5	+	+(14)	
		Health condition compared to others of the same age		3	+	+(14)	
		Health condition compared to oneself last year		3	+	(10)	
		Satisfaction with health		5	+		(11)
		Whether you are fine as well as last year or not	9	2	+		(8)
Objective		Whether you have a disease or not	15	2	+		
Subjective	Satisfaction	Household economic condition	15	5	+		(11)
		Work	9	5+(1)	?		
		Husband		5+(1)	?		-(8)
		Families		5+(1)	?		-(8)
		Friends		5+(1)	?	-(9)	
		Whole		5	+	-(7)	
Objective		Couple's annual income	15	6	+		
		Household annual income		6	+		(15)
		Whether you work regularly or not		2	+		
		Marital status		5	?		
Subjective	Others	Frequency of feeling loneliness	15	3	+	-(10)	
		Whether you are satisfied with your current life or not		2	+		+(10)
		Whether you are happiest now		3	+		(14)
		Whether you are somewhat satisfied with your life or not	9	3	+		
		Whether you look forward to the future or not		3	+		
Objective		Number of friends	15	100	+	+(15)	
		Number of educated years		18	+	(15)	-(15)

2.2.1 Male

Two subjective health feelings, *Satisfactions with friends* and *whole*, *Frequency of feeling loneliness* and *Number of Friends* relate to survival rate for male. However, *Satisfactions with Friends* and *Whole* have too few samples to include in the analysis, and therefore we exclude them.

Number of friends is integrated with *Evaluation overall health condition* and *Health condition compared to others of the same age*, respectively. However, the ranking of survival rates is inconsistent with the latter index. Therefore we judged the former index is employed well because the latter cannot be reflected appropriately. Integrated index is significantly different up to follow-up period of 12 years. And since two subjective health feelings are strongly correlated, we decided to exclude the latter.

Consequently, we introduce the following two indices in the life table for male; "*Evaluation overall health condition* and *Number of friends*" (12 years) and "*Frequency of feeling loneliness*" (8 years).

2.2.2 Female

Satisfaction with husband and *families*, *Whether you are satisfied with your current life or not* and *Number of educated years* affect the survival rate for female.

Since *Satisfaction with husband* and *families* are strongly correlated each other, we adopt the latter which has more samples. We exclude the index, *Whether you are satisfied with your current life or not*, because the adjusted ratio of mortality rate calculated by the procedure described later was extremely high, but we have no valid reason. We introduce *Number of educated years* on the entire life table, because it shows the significant difference over the maximum follow-up period of 15 years.

Consequently, we introduce the following two indices in the life table for female; "*Satisfaction with families*" (7 years) and "*Number of educated years*" (all periods).

2.3 Determining adjusted ratios of mortality rate

We smooth the cumulative survival curves by moving average of 12 months and obtained the adjusted ratio of the mortality rate for each group using Equations (1) and (2). In the period of observing the significant difference, we assume the mortality rate per year is constant.

$$d_{i,j} = 1 - (1 - d_{i,j,n})^{1/n} \quad (1)$$

$$r_{i,j} = d_{i,j} / d_i \quad (2)$$

d_i : annual mortality rate in index i

$d_{i,j}$: mortality per year in index i and answer group j

$d_{i,j,n}$: cumulative mortality rate after n years in index i and answer group j

$r_{i,j}$: adjusted ratio of mortality rate of index i and answer group j

Table 2: Adjusted ratios of mortality rate for male

Follow-up period (years)	Indices		Group A (better/many)	Group B (poor/less)
12	Health condition A (excellent/very good/good)	Number of friends	0.726 (1~10)	1.279 (none)
	Health condition B (fair/poor)		1.425	
8	Frequency of feeling loneliness		1.272 (rarely)	0.311 (often)

Table 3: Adjusted ratios of mortality rate for female

Follow-up period (years)	Indices	Group A (better/many)	Group B (poor/less)
7	Satisfaction with family	1.828 (very satisfied)	0.753 (satisfied～dissatisfied/none)
All	Number of educated years	2.414 (over 12 years)	0.742 (11 years or less)

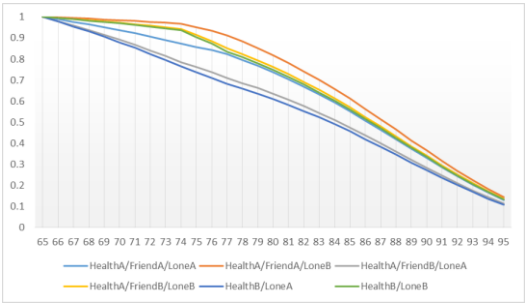

Figure 4: Dynamic life table modified by subjective indices for male

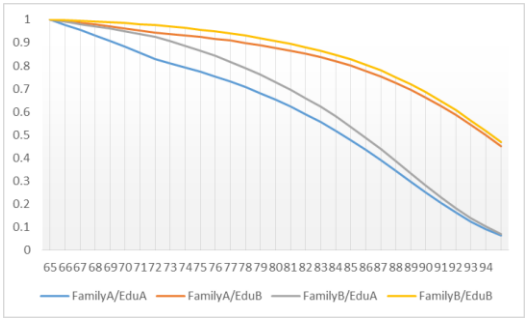

Figure 5: Dynamic life table modified by subjective indices for female

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2.4 4. Modifying the dynamic life tables

We summarize the results as shown in Table 2 and 3.We modify the original dynamic life tables, and generate six types of life tables for male and four types for female, as shown in Figures 4 and 5. In the first 8 years of the life table for male and the first 7 years for female, each adjusted ratio of is multiplied with the original mortality rate.

3. DISCUSSION

In this paper, we have a different result from Hibiki and Nishioka (2010), and we conclude that the subjective health feeling affects life expectancy only for male. This is due to the fact that the number of samples in this study is larger than that in the previous study dealing with only three datasets; Wave1 to Wave3. The another reason is th at we limit the data based on the result of the chi-squared test, while the previous study limits the data within the r ange of 60 to 70 years old as the age at the start of survey.

The result is in agreement with Haga et al. (1991) which implement the study limited to the elderly in some areas. We find the features are not always specifi c to the region. However, we have some indices with fewer than 300 samples due to the inclusion of "no ans wer". Therefore, we need to pay attention to the inter pretation of the results obtained by our research.

We find the elderly live longer as the rating is lo wer with regard to the subjective indices of interpersonal relationship, including those that are not reflected in the life table because of high correlation with others. In addition, the shorter the number of educated years is, the longer females live. Consequently, we find that people with a lower education tend to have lower social and economic status, and they are less likely to be exposed to stress in work, but more likely to be dissatisfied with familiar people. Moreover, we can guess that stress caused by work gives negative effects on survival rate more than stress caused by interpersonal relationship.

4. APPLICATION TO RETIREMENT PLANNI NG

The life tables can be applied to retirement planni ng model, instead of the life tables used in Hibiki and Oya(2015), which is called “previous study” hereafter.

In the previous study, the life table for male is m odified by subjective health over all periods. However, it was modified only in twelve years in this paper. T herefore, the individual characteristics have limited effe ctiveness in later years. On the other hand, *Number o f educated years* affects the life table for female over all periods, and the difference of survival rate is up to 40% after 30 years. This result is consistent with the previous study modified by subjective health, which s hows the large effect on the survival rate of female.

The household consists of householder and spouse, which have a big influence on retirement planning, re spectively. In this study, we conclude that *Number of educated years* is greatly related to the longevity risk for female. Therefore, when *Number of educated year s* of spouse is 12 years or more, the household will u nlikely fall short of funds and the surplus consumption ratio can increase. On the other hand, the longevity r isk is high and the surplus consumption rate is at a lo wer level for the household whose spouse has an elev en educated years or less. The lowest survival rate fo r female generated in our paper is higher than the sur vival rate for the worst subjective health of the previo us study. Therefore, it is expected that the surplus co nsumption rate becomes lower than that of the previou s study.

The previous study states that the combination of the survival rates of the couple affects the initial asset allocation and the private pension. The amount of pr ivate pension for male (female) is larger than the amo unt for female (male) in the case that the survival rate for male (female) exceeds the survival rate for female (male). In our study, the same results are expected t o be obtained.

The results of our paper show that the effect of s ubjective health on the survival rate for male is expect ed to be smaller, compared with the previous study. However, these are the expected results, and it is nece ssary to apply them to the retirement planning model and conduct the analysis. These are our future researc h.

5. CONCLUSIONS

In this paper, we analyze the relationship between mo rtality rate and satisfaction and happiness, in addition to the subjective health feeling, which is related to the life prognosis in the previous study. We also estimate the survival rate more appropriately, and generate the life table. In the future research, we attempt to update dyn amic life tables, using Wave7 (2006) and Wave8 (2012) which are not currently published, but are expected to be published. We can analyze the interaction between indices in detail due to the increase in dataset, and we expect to obtain more appropriate results.

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