A STUDY ON RISK OF VOLATILITY IN MORTALITY RATES FOR ANNUITY PRODUCTS (STANDARD LIABILITY RESERVE SYSTEM IN JAPAN)

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Abstract. For annuity products, a decrease in mortality rates may increase loss probability as the period after annuitization becomes longer. In this paper, we will summarize "Standard Liability Reserve System" in Japan, and analyze the effects of such volatility risk on future cash flows, and present some suggestions on how one should cope with such risk.

Key-words: annuitization, improvement of mortality rates, Standard Liability Reserve System

1 Introduction

When we set up mortality rates after annuitization for annuity products, it is safe that we set up low mortality rates, for annuity products are supposed to pay survivors every year. Generally, population mortality rates are improving, so life insurance companies have high risk that they will suffer a loss from the annuity products. Not until 1990 there are a lot of annuity products in Japan (see fig. 1.), and there are very few in-force sum insured after annuitization. Therefore we have not suffered serious losses now, but there may be a big problem for the future.

Figure 1. In-force sum insured (accumulated capital) of private annuity products in Japan (hundred million yen)
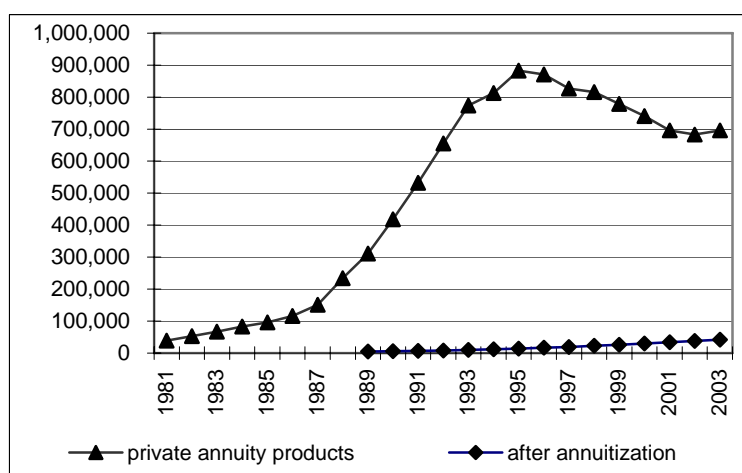
2 Summary of Japanese Insurance Law

Japanese insurance law was revised in April 1996. This revision was part of insurance system reforms, carried out to deal with changes in the insurance business environment due to financial liberalization and globalization, as well as secure a level of soundness in the insurance industry.

From the perspective of dealing with risk to maintain soundness, "Standard Liability Reserve System", "Solvency Margin Regulation" and "Appointed Actuarial Business Standards" are specified, and each are organized and function within the following framework:

- Standard liability reserves are built for risk in the range that can normally be forecasted
- The possibility of building liability reserves in the future is confirmed by a future cash flow analysis carried out by Appointed Actuary
- Solvency margin provides security for risk that exceeds normal forecasts

The next section will introduce "Standard Liability Reserve System" in the Japanese insurance industry.

3 Summary of Standard Liability Reserve System in Japan

The purpose of "Standard Liability Reserve System" is to maintain soundness by regulating the level of the valuable reserves, while the level of the premiums is liberalized.

Target policy: policies after April 1996 (except some kinds of policies such as the policies whose premium reserve are always equal to zero.)

Valuation method: reserve on net level premium method

Expected interest rate:
policies from April 1996 to March 1999 :   2.75%
policies from April 1999 to March 2001 :   2%
policies from April 2001   :   1.5%
(decided by a measure of the long-term government bonds)

Expected mortality rates:
Standard Mortality Rates 1996(which are made by Institute of Actuary of Japan and approved by authorities.)

The next section describes how to make "Standard Mortality Rates 1996".

4 The Way that Standard Mortality Rates were Made

There are two "Standard Mortality Rates", for death protection products and for the period after annuitization of private annuity products. Here we introduce how to make the latter rates.

[The method of making the expected mortality rates after annuitization]
The mortality rates after annuitization of private annuity products were made by anticipating future improvement of mortality rates from population mortality rates in 1955 and those in 1980.

(1) We use the population mortality rates in 1980 as the basic rates.

(2) We compare the population mortality rates in 1980 with those in 1955 by each sex and age, and calculate the improvement level per year.

For example: 60 years old man's mortality rate
Mortality rate in 1955: 0.02297
Mortality rate in 1980: 0.01245
Improvement level per year r(60) is calculated as below.
r(60) = 1 – (0.01245/0.02297)^(1/25) = 2.42%

(3) We assume that the improvement levels calculated at (2) continue from 1980, and we calculate "future mortality rates". The "future" is basically the year at which people born in 1945 will reach each age. Then the mortality rates that improvement of mortality rates from 1980 to the "future" is added to mortality rates in 1980 are "the future mortality rates". However, the improvement should be added at least 20 years, so we add 20 years' improvement for the ages under 55 years old.

This table indicates the "future" for each age.

Ages	Estimated "future"	Improvement years
55 or younger	2000	20 (=2000-1980)
60	2005 (=1945+60)	25 (=2005-1980)
80	2025 (=1945+80)	45 (=2025-1980)
100	2045 (=1945+100)	65 (=2045-1980)

For example: 60 years old man's mortality rate
We estimate the mortality rate in 2005 (=1945+60) (25 years' improvement are added to the mortality rate in 1980).
Mortality rate in 1980: 0.01245
Estimated mortality rate q(60) is calculated as below.
q(60) = 0.01245 × (1−r(60))^25 = 0.01245 × (1−2.42%)^25 = 0.00675

(4) We smooth the "future mortality rates" calculated as above and complement upper ages' rates, and we complete making the Standard Mortality Rates after annuitization.

5 Cash Flow Analysis with Current mortality rates

Life expectancy of the standard mortality rates and the latest population mortality rates (for men)

Age	Standard Mortality Rates (1)	Population Mortality Rate		(Simply) Population Mortality Rates				A	B
		(1995)	(2000) (2)	(2000)	(2001)	(2002	(2003) (3)	(1) - (2)	(1) - (3)
30	50.16	47.59	48.69	48.58	48.97	49.19	49.21	1.47	0.95
35	45.27	42.77	43.89	43.78	44.16	44.38	44.40	1.38	0.86
40	40.45	38.00	39.13	39.02	39.41	39.62	39.65	1.32	0.80
45	35.74	33.31	34.45	34.34	34.73	34.94	34.98	1.29	0.76
50	31.23	28.78	29.91	29.80	30.19	30.39	30.44	1.32	0.79
55	26.83	24.43	25.58	15.46	25.84	26.04	26.10	1.25	0.73
60	22.52	20.30	21.44	21.33	21.70	21.90	21.95	1.08	0.57
65	18.33	16.50	17.54	17.42	17.76	17.94	18.00	0.79	0.33
70	14.35	12.98	13.97	13.85	14.15	14.29	14.32	0.37	0.02

Life expectancy of the standard mortality rates is longer than that of the latest population mortality rates, so they are safe for mortality rates after annuitization.

Cash flows of a life (immediate) annuity from 60 years old (for men)
[Assumptions]

1. Expected mortality rates are the Standard mortality rates, and expected interest rate is 1.5%, and we calculate valuation reserves (accumulated capitals) of a life immediate annuity from 60 years old every year.

2. Cash flows are only annuity payouts and expected interests. (Annuity payouts are occurred due to population mortality rates (2003).)

3. We calculate the difference between valuation reserves in the end of the years and valuation reserves in the first of the years minus annuity payouts plus expected interests every year. These are profits every year produced by the difference between expected mortality rates and real ones.

Cash flows are below (Say annuity payment at age 60 is 1).

Age	Valuation Reserve	Annuity Payment	Expected Interest	Profit
60	19.22	- 1.00	0.27	0.00
61	18.50	- 0.99	0.26	0.00
62	17.77	- 0.98	0.25	0.00
63	17.03	- 0.97	0.24	0.01
64	16.29	- 0.96	0.23	0.01
65	15.55	- 0.95	0.22	0.01
66	14.81	- 0.94	0.21	0.02
67	14.07	- 0.92	0.20	0.02
68	13.32	- 0.91	0.19	0.02
69	12.58	- 0.89	0.18	0.03
70	11.84	- 0.87	0.16	0.03
71	11.10	- 0.85	0.15	0.03
72	10.37	- 0.83	0.14	0.04
73	9.64	- 0.81	0.13	0.04
74	8.92	- 0.79	0.12	0.04

Age	Valuation Reserve	Annuity Payment	Expected Interest	Profit
75	8.22	- 0.76	0.11	0.05
76	7.52	- 0.73	0.10	0.05
77	6.85	- 0.70	0.09	0.05
78	6.19	- 0.67	0.08	0.05
79	5.55	- 0.64	0.07	0.04
80	4.94	- 0.61	0.07	0.04
81	4.36	- 0.57	0.06	0.03
82	3.82	- 0.53	0.05	0.03
83	3.30	- 0.49	0.04	0.02
84	2.83	- 0.45	0.04	0.02
85	2.40	- 0.41	0.03	0.01
86	2.00	- 0.37	0.02	0.01
87	1.65	- 0.33	0.02	0.00
88	1.34	- 0.29	0.02	- 0.00
89	1.07	- 0.25	0.01	- 0.01
90	0.85	- 0.21	0.01	- 0.01
91	0.66	- 0.18	0.01	- 0.02
92	0.50	- 0.15	0.01	- 0.02
93	0.38	- 0.12	0.00	- 0.02
94	0.28	- 0.09	0.00	- 0.02
95	0.21	- 0.07	0.00	- 0.01
96	0.15	- 0.06	0.00	- 0.01
97	0.11	- 0.04	0.00	- 0.01
98	0.08	- 0.03	0.00	- 0.01
99	0.05	- 0.02	0.00	- 0.00
100	0.04	- 0.01	0.00	0.02

- Standard liability reserves are built for risk in the range that can normally be forecasted
- The possibility of building liability reserves in the future is confirmed by a future cash flow analysis carried out by Appointed Actuary
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[Summary]
- Profits occur in the first half.
- The discounted present profit (discount rate = 1.5%) is 0.025 (per valuation reserve of 60 years old).
- (0.009 in the case mortality rates decrease 5%. –0.008 in the case mortality rates decrease 10%.)
- The discounted present profit is plus, but losses are occurred in the latter half, so we should not divide the profits, but reserve them.
- If there is a lot of improvement of mortality rates, profits reduce.

6 Conclusion

[Development of annuity products which can be changed expected mortality rates]
Up to now, annuity products which guarantee annuity payouts at conclusion of insurance contract (i.e. expected mortality rates are fixed). For reduction of the risk, for example, annuity products which can be changed expected mortality rates and recalculated annuity payout at the start of annuitization, are much better. In the

past, from the national character, Japanese tend to wish that the future annuity payouts are guaranteed. However, recently, in the lowest interest rates, the expected interest rate in the Standard Liability Reserve System is 1.5%. So we want annuity products of higher interest rates, and variable annuity products and interest adjusted ones are developed. Most of these annuity products can be changed expected mortality rates to the latest ones at the start of annuitization. These kinds of annuity products are increasing now.

[Continuous analysis of mortality rates]
We can easily verify from the figure 1 in the Section 1 that mortality rates data after annuitization are not enough now, so we can only analyze population mortality rates. But as data after annuitization are increasing in the near future, we have to analyze experienced data.

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