Module 9: Life Cycle Financial Risks

Table of Contents

Module 9: Life Cycle Financial Risks

Unit 2: The Risks Related to Mortality

Case Study 01: Life Table Example

The typical table used for many actuarial calculations in the United States is known as the Ultimate 2001 Commissioners Standard Ordinary (CSO) Mortality Table. The 2001 mortality table was revised in 2006, as discussed in the “New Mortality Tables” box later.Table 17.1 "Life Table Depicting the Number of Survivors at Age "presents the life table that is derived from the Ultimate 2001 CSO Table. Recall from Chapter 7 "Insurance Operations" that the mortality rates for males and females are different. This fact has implications for the pricing of products used to mitigate mortality risk.

Table 17.1 Life Table Depicting the Number of Survivors at Age *x* out of an Initial Population of 1,000,000 People

Age	Males	Females	Age	Males	Females	Age	Males	Females
0	1,000,000	1,000,000	39	969,354	980,702	78	556,428	663,795
1	999,030	999,520	40	967,861	979,496	79	524,957	639,513
2	998,471	999,170	41	966,264	978,223	80	491,853	613,900
3	998,081	998,910	42	964,534	976,873	81	457,355	586,975
4	997,812	998,711	43	962,644	975,427	82	421,594	558,148
5	997,602	998,521	44	960,574	973,876	83	385,109	527,478
6	997,393	998,341	45	958,279	972,201	84	348,327	495,402
7	997,173	998,161	46	955,739	970,383	85	311,603	462,077
8	996,954	997,952	47	952,967	968,394	86	275,280	427,675
9	996,734	997,742	48	949,947	966,195	87	239,793	393,038
10	996,505	997,533	49	946,783	963,780	88	205,659	357,354
11	996,276	997,313	50	943,451	961,101	89	173,426	321,236
12	996,007	997,084	51	939,903	958,140	90	143,617	285,251
13	995,678	996,815	52	936,087	954,873	91	116,666	250,473
14	995,290	996,516	53	931,903	951,254	92	93,048	218,701
15	994,822	996,187	54	927,309	947,259	93	72,780	188,765
16	994,215	995,838	55	922,208	942,873	94	55,746	160,141
17	993,480	995,450	56	916,518	938,065	95	41,746	132,867
18	992,615	995,042	57	910,213	932,783	96	30,509	107,136
19	991,682	994,614	58	903,259	927,009	97	21,795	84,031
20	990,710	994,156	59	895,789	920,706	98	15,187	63,991
21	989,720	993,689	60	887,736	913,902	99	10,299	48,495
22	988,730	993,212	61	878,983	906,581	100	6,778	36,118
23	987,722	992,715	62	869,366	898,712	101	4,316	26,159
24	986,704	992,219	63	858,717	890,273	102	2,676	18,368
25	985,668	991,703	64	846,944	881,246	103	1,611	12,450
26	984,613	991,168	65	834,036	871,587	104	939	8,104

27	983,511	990,612	66	819,983	861,259	105	528	5,036
28	982,360	990,018	67	804,838	850,218	106	286	2,968
29	981,211	989,394	68	788,668	838,408	107	148	1,652
30	980,082	988,741	69	771,436	825,773	108	73	864
31	978,965	988,069	70	753,199	812,264	109	34	423
32	977,859	987,348	71	733,789	797,797	110	15	192
33	976,754	986,588	72	713,133	782,264	111	6	80
34	975,630	985,779	73	690,798	765,602	112	2	31
35	974,479	984,911	74	666,882	747,763	113	1	11
36	973,300	983,956	75	641,488	728,696	114	0	3
37	972,054	982,942	76	614,603	708,365	115	0	1
38	970,752	981,851	77	586,282	686,739	Total	71,119,302	81,344,455

Sources: Processed by the authors from the American Academy of Actuaries CSO Task Force Report, June 2002,http://www.actuary.org/life/CSO_0702.asp (accessed April 4, 2009); 2001 CSO Ultimate Table. Used with permission.

In Table 17.1 "Life Table Depicting the Number of Survivors at Age ", we see that the number of male survivors at age twenty-five is 985,668. This means that about 98.57 percent of the newborn males survived until the age of 25, and that about 1.43 percent (the difference) of the males are expected to die prior to reaching this age. The number of survivors at age sixty-five is 834,036. We can say that the probability of a twenty-five-year-old male surviving until age sixty-five is 84.6 percent (834,036/985,668). In other words, 14.5 percent of the twenty-five-year-old males will not reach age sixty-five. We can do similar calculations for people in other age groups. Comparable figures taken from a life table that was relevant a few decades ago show much higher probabilities of dying.

Using a modern life table leads to a very important conclusion: about 10 to 15 percent of males in the working ages of 20 to forty-five years will die before reaching retirement. If we would have made a similar calculation with a typical life table from the 1960s, we would have reached a figure around 20 to 25 percent! In other words, the probability of dying prior to retirement age declined by approximately half during the last fifty years in most developed countries.

In the United States, only 0.8 percent of females die before they reach age twenty-five (from the life table, 1 − [991,703/1,000,000]). About 88 percent of females at the age of twenty-five will reach age sixty-five (871,587/991,703). This means that about 12 percent of the females will die before retirement. Some other western countries have even higher survival probabilities: often 92 to 94 percent of young females in a developed country are expected to attain age sixty-five. In the 1960s and 1970s, the parallel probability would have been only around 82 to 85 percent.

Module 9: Life Cycle Financial Risks

Unit 2: The Risks Related to Mortality

Case Study 02: New Mortality Tables

New Mortality Tables

Mortality improvements are critical to setting life insurance premiums and reserves (life insurance is a risk management solution for the financial component of life cycle risks and is the subject of Chapter 19 "Mortality Risk Management: Individual Life Insurance and Group Life Insurance"). As mortality rates improve, you may be able to think of yourself as relatively younger as you age. According to the most up- to-date mortality tables, American adults can expect to live, on average, two to four years longer than their parents. The 2001 CSO Preferred Class Structure Mortality Table was adopted by the National Association of Insurance Commissioners in September 2006, a modification of the mortality table issued in 2001.

Age is a very important factor when life insurers assess the classification of an insurance applicant. Others include gender, tobacco use, and health. Like the 1980 tables, the 2001 tables are categorized by gender and show that women as a group live several years longer than men do. (See "Should Life Rates Be Based on Gender?" later in this chapter). Subtables separate tobacco users from nonusers and reflect the decrease in male smokers since 1980 but a slight increase in female smokers. Mortality rates for female smokers in their fifties and sixties are now higher than they were in 1980. Women in that group can expect to pay higher life insurance premiums when the new tables are adopted. Note that race is not a category in the mortality tables. Race-based discrimination is not permitted.

Changes in aggregate health status are difficult to determine (and the tables do not even try), but it is generally accepted that any improvements are offset by more and better medical testing. That is, if more seventy-year-olds are diagnosed with prostate cancer in 2002 than there were in 1982, it is possible the cancer rate has increased—but also true that the detection test is more widely given these days, and that men in 1982 were more likely to die of other causes before even reaching that age. One factor that has clearly worsened since 1980—in fact, it has more than doubled—is the nation's rate of obesity. Since overweight people are very likely to develop health problems as they grow older, most life insurers will charge higher premiums or even decline to cover people who weigh 30 percent or more above their ideal weight (see "Obesity and Insurance—Litigation or Self-Discipline?" in Chapter 12 "The Liability Risk Management").

Other factors contributing to America's overall life expectancy have clearly progressed in the last twenty years: medical breakthroughs, including antibiotics and vaccines; public health and environmental efforts; and increased standards of living such as better housing and safer foods. Thanks to developments like these and more, the general mortality rate in the United States has improved about 1 percent per year since early last century. If this trend holds, in 2020 you can take another three years off your age.

Sources:

- Dr. Rick Rogers, "Will Mortality Improvements Continue?" *National Underwriter*, *Life & Health/Financial Services Edition*, August 26, 2002; American Academy of Actuaries, "June 2002 CSO Task Force Report," June 2002, accessed April 4, 2009,http://www.actuary.org/life/cso_0702.htm;
- National Association of Insurance Commissioners, "Recognition of the 2001 CSO Mortality Table for Use in Determining Minimum Reserve Liabilities and Nonforfeiture Benefits Model Regulation,"http://www.naic.org/1papers/models/htms/cso-summary.htm;
- Insurance Information Institute, "Life Insurance Premium Rates to Continue Downward Trend," October 5, 2005, accessed April 4, 2009, http://www.iii.org/media/updates/archive/press.744841/;

Module 9: Life Cycle Financial Risks

Unit 2: The Risks Related to Mortality

Case Study 03: Assessing Economic Value by Lost Future Income Streams

Assessing Economic Value by Lost Future Income Streams

Here, we try to estimate the economic value of a human life by calculating the value of the future income stream that will be lost in case of the person's death. For that purpose, there is a need to estimate the future income stream. The forecast should be limited to a certain period (say, an expected retirement age) when these income streams are expected to discontinue anyhow, even if the person survived beyond that period.

The risk manager must find a way to create a similar cash flow to replace the lost income once the person dies. Because the timing of the death cannot be predicted, it is common to calculate the present value of the income stream to derive a single number (present value was explained in Chapter 4 "Evolving Risk Management: Fundamental Tools"). If we hold this amount and invest it at the same interest rate that is used for the computation of the present value, we can generate the same cash flow whenever it is needed. The use of the present value concept is practical because it can also give us one figure for the estimated economic value of the person.

The purpose of the discussion is to get an idea of the order of magnitude of the value of the lost income stream and to gain certain insights concerning the needs of a typical person. Therefore, we are making some simplifying assumptions: we shall assume a person is expected to retire at age sixty-five and has an expected constant annual income level of $1 (or a constant annual income) to work and earn money beyond retirement age. This approach replaces a more specific calculation for a particular person. Such a calculation would have to forecast the future development of the personal income stream and would involve a prediction of career patterns, promotions, future tax rates, price levels, and so forth.

The importance of the present value technique lies in its use as a tool for planning the needed financial protection against the case of a premature death. The present value of a future stream of earnings is affected by interest rates and by time. The values in Table 17.2 "Present Value of a Future Earnings Stream at 0, 3, and 6 Percent Interest for Period to Retirement" can be used to get a rough estimate for the economic value of our lives, and thus to set the financial protection plan for a family. At 3 percent interest, the economic value of a person in the twenty- to forty-year-old range (or forty-five to twenty-five years to retirement) is about 17.9 to 25.1 times the annual income, or roughly twenty times the assumed fixed annual income. At higher interest rates, say, 6 percent, the present value figure is lower. The present value at 6 percent for the same person would be 13.5 to 16.3 times the annual income, or we could say roughly fifteen times the annual income.

Table 17.2 Present Value of a Future Earnings Stream at 0, 3, and 6 Percent Interest for Period to Retirement

Duration or Time to Retirement	**Age**	**Discount Rate**		
(Years)	**(Years)**	**0%**	**3%**	**6%**
5	60	5	4.7	4.5
15	50	15	12.3	10.3
25	40	25	17.9	13.5
35	30	35	21.4	14.5
45	20	45	25.1	16.3

In other words, the economic value of a person with $100,000 annual income is about $2 million (twenty times the income) when the calculation is made under the assumption that we can invest the money at 3 percent, or it is only $1.5 million (fifteen times the annual income) at 6 percent interest. These figures remain steady for almost any age within the range of twenty to forty years. The amount of needed protection declines only at older ages. This present value technique serves as the basis for certain rules of thumb that are often used in the insurance industry and state that the economic value of a person is a certain multiplier of the annual income. [2]

Nevertheless, common life insurance literature talks about death benefits that are only five to seven times one's income. A possible explanation to this alarming discrepancy between the needed amount of protection and the actual one may be related to other forms of protection held by U.S. families. One should not deduce that there is a need to run and buy insurance covering fifteen or twenty times the annual income in case of a premature death. One should consider existing properties and other sources of protection (Social Security, pension plans, savings—all discussed in later chapters) that may be included in the portfolio. A person needs to buy protection only for the uncovered balance.

Other explanations may be related to the subjective preferences of families: the desire or need to prefer current consumption over future savings, natural optimism, and so forth. These topics are related to complex economic theories that are not handled in this book.

In real life, an income level does not remain constant over long periods. However, the above instrument can also be used for the case that the income stream *grows* at a constant rate. Income growth (and inflation) has the opposite effect compared to discounting. If we assume, for example, that the cash flow grows at an annual rate of 3 percent, and the relevant interest rate is 6 percent, we can assume instead a constant income stream and discount it at a net interest rate of approximately 3 percent (i.e., 6 percent minus the 3 percent growth rate). This is a good approximation. Note that using this method with fast- growing income streams results in a low net interest rate, which in turn increases sharply the present value of the stream. To handle streams that are not constant and do not grow at a constant rate, one must perform a detailed present value calculation, a technique beyond the scope of this text.

Discounting in the present value method makes the distant future cash flows less significant. The present value of $1 received forty-five years from now is only $0.26 at an interest rate of 3 percent, and it is only $0.07 with a discount factor of 6 percent (refer to the appendixes at the back of the text for computation tables to aid in such analyses). Because of that, our unrealistic assumption that the annual income is constant over time is not that important because the future income streams have a smaller effect on the total present value of the lifetime income stream.

Another implication of this effect is that the economic value of our life is roughly similar for a wide range of ages. For example, at 6 percent interest, the present value of the stream for twenty-five years is only somewhat lower than the value of a stream for forty-five years (13.5 versus 16.3). If we assume that people plan to retire at age sixty-five, this means that the lost value for a person who dies at age twenty (loss of forty-five years) is not much higher than that of a person who dies at the age of forty (loss of twenty-five years).

Module 9: Life Cycle Financial Risks

Unit 3: **The Risks Related to Longevity**

Case Study 04: Should Life Insurance Rates be Based on Gender?

Should Life Insurance Rates Be Based on Gender?

As a group, young male drivers cause more automobile insurance losses than do young female drivers. A few states, however, no longer allow automobile insurers to charge different rates for males and females. Similarly, over a decade ago, the Supreme Court ruled that employers using annuities to fund retirement benefits could no longer collect higher contributions from women, who were expected to live longer than men, in order to make equal annuity payments during retirement. Employers continuing to pay retirement benefits through annuities were forced by the Supreme Court to use unisex tables. That is, the men alone and less than that for women alone. Retirement benefits went up for the women and down forthe men involved.

Should life insurance rates be made gender neutral as well? The quotes displayed here were requested from Insweb (http://www.insweb.com), an online insurance quotes and distribution company, in August 2005. They show that the premiums for a ten-year term life insurance policy (described inChapter 19 "Mortality Risk Management: Individual Life Insurance and Group Life Insurance") of $250,000 for a twenty-five-year-old male of perfect health and family history, weight appropriate to height, and no tobacco use, are higher than those for a female with the same attributes. For example, the rate is $13.18 per month for a male as opposed to $11.90 for a female, as shown in the table of quotes below. For newer quotes for your specific age and needs, you can check on line.

When we compare a particular man to a particular woman of the same age and seemingly the same state of insurability (health, lifestyle, occupation, financial condition, and so forth), the man may outlive the woman, but, as you know, insurers pool cohorts of insureds rather than the individual. Insurers observe difference in average experience for large groups of males and females to justify different life rates based on gender, arguing that doing so creates actuarial equity. That is, premiums should differ because expected outcomes (death benefits multiplied by probabilities) are different for groups of males and females. In the past two decades, the gender mortality gap has begun to close. While female longevity has risen, male life spans have increased at a faster rate, due in part to medical advances in treating conditions like heart disease, which traditionally kills more men than women. Recently, companies have begun to incorporate data from the early 1990s. Yet even with a smaller gap between men's and women's longevity, insurance rates for women are still lower than for equally aged and healthy men.

Questions for Discussion

1. Is it ethical for life insurers to charge different rates for men and women? If it is not legal to charge different rates based on race, why should gender be different?

2. Does this practice represent unreasonable discrimination (sometimes called “social inequity”) against males based on a factor over which they have no control?

3. Given the possibility that the gap between male and female mortality may close during the next few decades, is it really fair to charge different rates to men and women for a policy that runs

Monthly Premium for a 10-year Level Term Life Policy*								
Male	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
100,000	$8.76	8.76	9.01	10.88	13.01	17.94	24.57	33.25
250,000	13.18	13.18	13.39	15.73	22.10	28.00	41.65	62.48
500,000	20.83	20.83	21.25	25.08	32.63	46.55	73.10	112.63
1,000,000	27.13	27.13	26.97	33.93	55.68	87.87	141.95	221.00
Female	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
100,000	$8.33	8.33	8.50	10.03	11.48	14.71	18.45	26.35
250,000	11.90	11.90	12.11	14.45	19.55	25.71	30.23	43.50
500,000	17.85	17.85	18.28	22.53	26.54	37.85	53.13	78.20
1,000,000	32.04	31.45	32.30	29.58	46.11	67.86	102.00	152.15

*** Quotes based on a composite of participating carriers, which have at least an A rating by S&P. Your rate may differ due to your health, smoking, or other activities. Rates subject to underwriting and state availability. InsWeb is a service offered by InsWeb Insurance Services, Inc., a licensed agency in most states (CA #0C24350).**

Source: InsWeb, rates effective as of August, 2005, used with permission

Sources: Ron Panko, “Closing the Gender Gap,” *Best’s Review*, August 2000, accessed April 4, 2009,http://www3.ambest.com/Frames/FrameServer.asp?AltSrc=23&Tab=1&Site=bestreview&refnu