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THE EFFECT OF VARIATION IN PROSPECTIVE MORTALITY ON LIFE INSURANCE CASH VALUES

ALBERT E. EASTON

ABSTRACT

Suggestions have been made that life insurance cash values should depend on the prospective mortality of the insured evaluated at the time a cash value is applied for. This paper explores a simple model for determining cash values on such a basis and some practical problems associated with it.

I. INTRODUCTION

Many years ago, a friend (who is, by no coincidence, a nephrologist) asked me the following question: "I have a patient with a large life insurance policy who has suffered renal failure. If he does not have dialysis, he will certainly die. If he does, his mortality, while above normal, will eventually be near the insurable level. What proportion of the face amount of that life insurance policy is available to finance his dialysis treatment?"

I hastened to point out to my friend that a life insurance policy insures against only one event (namely, death) and that the premiums have not been calculated to provide benefits for any other event, except in some cases a cash value that is available on the demand of the policyowner and that depends only on a rate of mortality assessed at issue. In other words, the standard life insurance model is a zero-sum game. I left the conversation with an uncomfortable feeling that my answer might not be entirely right and that, in any case, I had not done a good job of explaining the situation.

The question of increased living values in life insurance policies, especially to insureds with serious illnesses, takes on increased importance as medical care costs increase at a rate exceeding the general inflation in living costs. Suggestions have been made about grafting of health insurance benefits onto a life insurance policy—more or less in the same way that income disability benefits were offered as a life insurance rider. This paper explores another aspect of the problem, showing through the use of select mortality theory how the present value of life insurance benefits is affected by the prospective mortality of the insured.

II. DEVELOPMENT OF THE MODEL

As the papers by Levinson [3] and Tenenbein and Vanderhoof [5] point out, a life in the select mortality table may be considered to belong to one of several mortality classes. For the time being, we consider only two:

a. The "select" class (made up of those lives who, based on all available evidence, would be underwritten standard for life insurance); and
b. The "nonselect" class (made up of all other lives—there are a large number of subclasses in this class, which we will consider shortly; for now, let us deal with the class as a whole).

By definition, a life whose insurance is issued standard starts in the select class. By the end of the year, he or she will either still be in the select class, have died, or have entered the nonselect class. Similarly, a nonselect life may remain in the nonselect class, die, or reenter the select class. We assume that: (1) mortality is higher in the nonselect class, and (2) net migration to the nonselect class is nonnegative.

Throughout this paper, we use a model derived from the male rates in the 1980 CSO Table. Select mortality in years 1–15 was set equal to:

$$q_{[x]+t} = (0.25 + 0.05t)\, q_{x+t}$$

for $t < 15$. Ultimate mortality, q_{x+t}, is simply the 1980 CSO male rates. Table 1 shows some values of a family of select life tables, $l_{[x]+t}$, derived on this basis.

For this purpose, l_{25} was set equal to 10,000,000; values of $l_{[x]+t}$ were derived from

$$l_{[x]+t} = \frac{l_{[x]+t+1}}{1 - q_{[x]+t}}$$

for $t < 15$, and

$$l_{[x]+t} = l_{x+t}$$

for $t \geqslant 15$.

If we take e_x as the net increase in lives in the impaired class,

$$l_{[x+1]} = l_{[x]} - d_{[x]} - e_{[x]},$$

and in general,

$$l_{[x+1]+t} = l_{[x]+t} - d_{[x]+t} - e_{[x]+t}.$$

TABLE 1

FAMILY OF SELECT LIFE TABLES

Age	l_x	t	$l_{[25]+t}$	t	$l_{[26]+t}$	t	$l_{[27]+t}$	t	$l_{[39]+t}$	t	$l_{[40]+t}$
25	10,000,000	0	9,890,349								
26	9,982,300	1	9,885,972	0	9,870,519						
27	9,965,030	2	9,880,841	1	9,866,250	0	9,850,056				
28	9,947,990	3	9,874,928	2	9,861,188	1	9,845,845				
29	9,931,078	4	9,868,213	3	9,855,321	2	9,840,824				
30	9,914,096	5	9,860,619	4	9,848,540	3	9,834,934				
31	9,989,845	6	9,852,090	5	9,840,913	4	9,828,128				
32	9,879,328	7	9,842,445	6	9,832,154	5	9,820,256				
33	9,861,249	8	9,831,638	7	9,822,258	6	9,811,270				
34	9,842,414	9	9,819,432	8	9,811,002	7	9,800,964				
35	9,822,729	10	9,805,684	9	9,798,247	8	9,789,202				
36	9,802,003	11	9,790,167	10	9,783,775	9	9,775,776				
37	9,780,047	12	9,772,623	11	9,767,339	10	9,760,448				
38	9,756,575	13	9,752,687	12	9,748,585	11	9,742,879				
39	9,731,403	14	9,730,041	13	9,727,207	12	9,722,770	0	9,485,240		
40	9,704,252	15	9,704,252	14	9,702,782	13	9,699,712	1	9,478,624	0	9,438,272
41	9,674,945	16	9,674,945	15	9,674,945	14	9,673,349	2	9,470,036	1	9,431,146
42	9,643,115	17	9,643,115	16	9,643,115	15	9,643,115	3	9,459,132	2	9,421,838

So at age 25,

$$d_{[25]} = 4377,\ e_{[25]} = 15453$$

$$d_{[25]+1} = 5131,\ e_{[25]+1} = 14591.$$

Note that

$$d_{[26]} = 4269,\ e_{[26]} = 16194.$$

Thus, the 862 deaths from $d_{[25]+1}$ not in $d_{[26]}$ are from $e_{[25]}$, the impaired group, suggesting (as expected) a very high mortality rate ($862/15453 = 0.0558$) for this group (129 times the select rate of 0.0004325). By the fifteenth year, the group of nonselect lives has grown to 265,980 of the total 9,704,252 still living. Of the total 29,307 deaths in the fifteenth year, 22,181 are among the impaired lives, giving them a mortality rate of 0.0834, 110 times the select rate of 0.000755 at that age.

(The numerical examples are, of course, based on a model that only intuitively reflects reality, not on any actual data. The purpose is not to suggest their use in applications, but to give the reader a sense of the operation of the select mortality functions. The model was chosen to be reasonably close to the pattern that appears in published select tables, so that the financial functions that follow would give a sense of the results expected in actual operation of such a policy.)

III. APPLICATION OF THE MODEL TO CASH VALUES

The present value of benefits for a select life can be evaluated as

$$A_{[x]} = \sum_{t=0}^{\infty} v^{t+1} \cdot {}_t p_{[x]} \cdot q_{[x]+t}$$

A single-premium insurance issued to a group of select lives at age x should have reserves of $A_{[x]+t}$. However, if we consider the cash value to lives still in the select group as $A_{[x+t]}$, the excess reserve $A_{[x]+t} - A_{[x+t]}$ is available as additional cash value for lives in the nonselect group. Some numerical examples can illustrate this. Table 2 shows values of $A_{[25]+t}$ and $A_{[25+t]}$ using 5 percent interest and the select mortality model previously described.

Many (probably most) of the nonselect lives will have a relatively minor or temporary impairment that will raise their mortality only slightly above the select values. A few will have impairments that significantly increase their mortality and hence their cash values. For example, consider the values of $A_{[40]}$ with the following modifications in mortality:

TABLE 2

SELECT CASH VALUES AND RESERVES

Age	Curtate Duration, t	$A_{[25]+t}$	$A_{[25+t]}$
25	0	117.27	117.27
26	1	122.75	121.89
27	2	128.43	126.73
28	3	134.34	131.78
29	4	140.47	137.05
30	5	146.83	142.53
31	6	153.44	148.23
32	7	160.29	154.15
33	8	167.39	160.28
34	9	174.74	166.64
35	10	182.33	173.21
36	11	190.17	180.00
37	12	198.24	187.02
38	13	206.53	194.26
39	14	215.04	201.72
40	15	223.73	209.40

A. If mortality is a uniform multiple of select, then $A_{[40]}$ equals:

1x	209.40
2x	277.24
3x	322.56
4x	356.93
5x	384.65

B. If mortality is 5,000 percent of select for the first year; 4,000 percent of select, second year; 3,000 percent of select, third year; 2,000 percent of select, fourth year; 1,000 percent of select, fifth year; and 100 percent of select thereafter, then $A_{[40]}$ equals 309.30. (Under this mortality pattern, the value will *decrease* if the insured does not terminate immediately; thus, the value at 41 will be $285.58; at 42, $266.89; at 43, $254.44; at 44, $248.98; and at 45, $251.05, which is the normal select level at that age. This is an important result, because it mirrors the effect of many impairments. Mortality is markedly elevated at first, but the effect decreases with time if the insured survives.)

These examples (based on a mortality model intended to be realistic) suggest that a single-premium insurance on this basis could make available substantial additional amounts of cash value without a very large cash value sacrifice on the larger pool of select lives.

Because there is an additional decrement besides death from the select class,

$$A_{[x]} \neq vq_{[x]} + vp_{[x]} \cdot A_{[x+1]}.$$

So the usual "cost of insurance" applied in interest-sensitive-type single-premium business cannot be evaluated from the select mortality rate. Instead, the cost of select mortality plus the extra mortality for lives that become nonselect must be evaluated as:

$$r_{[x]} = (1 + i) A_{[x]} - A_{[x+1]} \frac{l_{[x+1]}}{l_{[x]}}.$$

The portion of $r_{[x]}$ not used to pay select mortality benefits will be added to the reserve. Although the necessary level of reserves will ultimately depend on the relative level of terminations among the two groups of lives, a simplifying assumption for the initial period will be that lapses are at the same level for both groups, resulting in a reserve of $A_{[x]+t}$.

Although single-premium insurance seems the clearest way to illustrate the effect of the select mortality model on cash values, it is certainly not the only plan of insurance for which select and nonselect cash values can be developed. It is not difficult to apply the same approach to the development of cash values for any whole life plan or to develop cash values (for nonselect lives only) for a term insurance with premiums based on the cost of insurance rate, $r_{[x]}$.

The effect of increased mortality in plans with cash values less than the net single premium is generally a larger percentage increase in cash value. For example, Table 3 compares the level of cash values (taken as net level-premium reserves) for a level-premium whole life policy originally issued at age 25 on a select basis with those in which the insured, at age 40, falls prey to an impairment that elevates his mortality by 5,000 percent of select for the first year; 4,000 percent, second year; 3,000 percent, third year; 2,000 percent, fourth year; 1,000 percent of select in the fifth year; and back to 100 percent thereafter.

IV. PRACTICAL CONSIDERATIONS

A number of practical problems will be associated with development and use of such a policy, as follows.

TABLE 3

LEVEL PREMIUM CASH VALUES AND RESERVES

Age	Duration from Issue	Duration from Impairment	Select Cash Value	Impaired Cash Value
40	15	0	104.36	217.54
41	16	1	113.31	190.67
42	17	2	122.50	169.50
43	18	3	131.94	155.40
44	19	4	141.62	149.21
45	20	5	151.55	151.55
46	21	6	161.73	161.73

A. Legal Problems

The cash values provided by a typical policy are, on this model, lower than those required under the Standard Nonforfeiture Law for the 1980 CSO Table. This might seem to present a nearly insurmountable legal problem. However, because the only function being modified for policies of this type is the mortality function, using the type of model based on the 1980 CSO table, it may be possible to overcome this difficulty.

Many nonforfeiture laws include a provision that allows the Insurance Commissioner to approve values for certain risks based on an approved mortality basis that is a modification of the 1980 CSO Table. For example, New York Section 4221(k)(9)(vi) allows: "...(or any modifications thereof for any specified class or classes of risks), that are approved by the superintendent... ." On that basis, a product like this might be approvable in some states without any revisions in statutes. Note that the "select mortality basis" specified in the Standard Valuation Law is such a modification and comes close to the appropriate level for reserves.

Another legal problem, perhaps more theoretical than practical, is the question of insurable interest. Accepted practice has been that an individual has an unlimited insurable interest in his own *life*, but if values are to be paid in situations other than death, there may be a question raised concerning the insured's right to receive payment on such a basis. There needs to be an answer to the man-on-a-ledge scenario in which an insured threatens suicide to receive a higher cash value. It would seem logical that no excess cash value payments should be made in situations in which a clear insurable interest is lacking. On the other hand, in situations in which the insured's health has deteriorated substantially, especially when increased values are needed to pay for treatments that could affect the insured's health, there would be a clear insurable interest.

B. Schedule of Medical Prognosis

The most serious practical difficulty would lie in the fact that there is currently no reliable schedule of medical prognosis for each condition that could be used in setting the revised mortality on which cash values would be based. Before any company could introduce a product of this type, it would have to make a commitment to providing an extensive list of conditions, including related conditions with overlapping mortality effects. Probably it would be best to file this schedule with the insurance department (as part of the nonforfeiture filing) with the understanding that it would be subject to frequent future revisions. It would also be logical that no payments should be made under the policy except in accordance with the currently filed schedule.

The periodic adjustments in the schedule would probably result not only in new impairments being added but also in reductions in the mortality rates expected for other impairments. Some impairments (we hope many) would enjoy an improved prognosis as medical technology advances.

Although there may be some experience available for this purpose from substandard annuity writers, the problem at first seems almost overwhelming. Substandard annuity experience is made conservative by interpreting a condition in the most favorable light, so it gives the least extra mortality. The same is true for a cash benefit life insurance policy.

Clearly, there are different degrees of the same impairment, and some clear and precise way has to be established for determining the degree in each case. An impairment may result in one pattern of mortality at age 35 and a completely different pattern at age 65. Only by means of a carefully compiled and limited schedule can payments be made. The insured is always eligible, at a minimum, for the fully select cash value and must be prepared to prove very precisely that he is entitled to more.

An advantage of a schedule is that it can omit certain self-induced impairments. There is no logic in making payments for a threatened suicide or resumption of a previously discontinued smoking habit. Quite conceivably, the policy could use the "waiver" concept once popular in disability income insurance, in which the insured (by rider) waives coverage for certain impairments to which he may already be predisposed. This concept could only be used sparingly, because the death benefit would still be due in full at the occurrence of death.

C. Expenses

One important feature of such a policy is the requirement of substantial expenses at the time of any payment of surrender values. Because there will be extensive "medical underwriting" at the time a cash value is requested (on other than a wholly select basis), a surrender charge will be required for surrenders at all durations of the policy. The surrender charge, moreover, will not necessarily be a function of policy size but is much more likely to be a constant amount such as \$200 to \$300. Probably, this amount will increase in future years as inflation takes its toll. The best way to build a feature like this into the policy would be to specify a given surrender charge (such as \$300) subject to an increase of 5 percent for every year that the policy is in force.

Use of a surrender charge of this type will make possible the fairly frequent requests for partial surrenders that may be required under such policies. For example, it is likely that an insured with a terminal disease may wish to withdraw only a fraction of his or her policy and leave the remainder intact for the use of his or her beneficiary. This becomes a matter of very little importance to the company provided it has adequately charged for the cost of underwriting the surrender, even though not the entire policy was surrendered.

D. Lapse Rates and Cash Flow

One practical problem the policy probably will not have is the cash flow problems that have been associated in recent years with regular level-premium life insurance. Because a true insurance element exists with respect to the cash value, the insured will have less incentive to make decisions relative to withdrawal of his or her cash value that are purely investment related. It would appear, for that reason, that such a policy could have longer duration investments than are appropriate for other level-premium life insurance.

Because of the lower cash values available, there would appear to be somewhat less incentive to lapse among the select lives. Perhaps more important, in terms of keeping the mortality of the entire group homogeneous, is the increased incentive to terminate for the nonselect lives. This suggests that pricing of insurance with cash values developed in the select and ultimate model would be less sensitive to lapse rates than insurance not based on this model.

V. CONCLUSION

Fifty or even twenty-five years ago, development of a contract whose cash value varied with prospective mortality would not have been feasible. Today, however, as life insurance policies allow almost unlimited flexibility in premiums and death benefits, they should also enjoy the cash value benefit flexibility associated with variations in mortality assumptions. A contract with such a feature would seem to have an important competitive advantage over contracts without it. It might even be feasible for an insured to "convert" an existing cash value contract to the new basis (that is, by accepting, with evidence of insurability, lower current cash values in return for higher future values if his or her health becomes impaired).

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