



SOCIETY OF ACTUARIES

Article from:

The Actuary

February 1968 – volume 2 - Issue 2

TRUTH IN LENDING — COMPUTING INTEREST ON A CREDIT TRANSACTION

by Robert J. Myers

(Reproduced with permission from *The New York Statistician*, September-October, 1967, vol. 19, no. 1)

In the April 1967 issue of the *New York Statistician*, Dr. M. R. Neifeld cites a problem of determining the true interest rate on a short-term credit transaction. He then states that computations thereof were made by several marketing professors and government economists, with the results ranging from 80% to 130% per annum and not having any computational errors. This is impossible. There can be only one answer for a discrete problem such as was posed. Dr. Neifeld should have consulted an actuary, not a marketing professor or a government economist!

The problem was to find the true annual interest rate involved when an immediate payment of \$20 is to be financed by four \$5 payments made 4, 18, 32, and 46 days later and a \$2 payment made 60 days later:

The way to solve the problem is first to set up the exact equation in terms of the daily interest rate, as in the following Equation of Value:

$$5(v^4 + v^{18} + v^{32} + v^{46}) + 2v^{60} = 20 \quad (1)$$

where $v = (1 + i)^{-1}$ and i is the daily rate of interest.

Next, we use the Method of Equated Time to find a first approximation to " i ". The following expression gives the weighted average time (in days):

$$\frac{5(4 + 18 + 32 + 46) + 2(60)}{22} = 28.1818 \quad (2)$$

Using this value, we determine the first approximation to " i " from the equation:

$$22(1 + i)^{-28.1818} = 20 \quad (3)$$

By the use of logarithms, we find that " i " is .0034 (i.e. .34% per day). Then, by trial and error, through direct computation in Formula (1), we find that the exact true interest rate " i " can be bracketed by " i " equals .003456 and " i " equals .003457 (since the former results in the left side of the equation equalling 20.00008, while the latter produces a value of 19.99953). Therefore, the true daily rate of interest, correct to four decimal places is .3456%.

Finally, we may obtain the true annual rate of interest, " j ", from the following formula:

$$1 + j = (1.003456)^{365} \quad (4)$$

Using logarithms, we find that for " i " equal to .3456% " j " equals 252.6, or a rate of 252.6%. If we wish to bracket " j ", we find that for " i " equal to .3457%, " j " equals 252.7%. Therefore, the correct precise answer for the true annual rate of interest — to the nearest percent, is 253%.

Carter

(Continued from page 1)

come taxes, but foreign companies pay no Canadian income tax. It seems clear that the life insurance company is not carrying its weight in comparison with other financial institutions.

Premium Tax Cited

The standard reply is that insurers pay a special premium tax which produces rather more than \$16 million a year. This, however, is a provincial tax, in the general nature of a sales tax on services, and is no substitute for income tax. I fully agree of course that in order to avoid over-taxation, the premium tax should be taken into account when the basis of income tax on life insurance is formulated.

The critics of the Carter Report take exception to the recommendation that no deduction be allowed for free surplus and contingency reserves in calculating an insurance company's taxable gain from operations, and have suggested that this seriously impairs the solvency of the companies. They apparently overlook the fact that if it were ever necessary to draw on the surplus and contingency reserves, in order to maintain

statutory reserves, a tax credit would arise which would be equivalent to repayment of the tax previously imposed. It appears that the solvency of the company would not be affected, except perhaps to the extent of the interest on the income tax paid.

With respect to the taxation of the policyholder, I hold no brief for the particular method recommended by the Royal Commission. In fact, I believe it would be appallingly complicated to tax the income element in each life insurance policy each year on an accrual basis — and that if income tax is imposed on the policyholder it should be payable only when the policy matures. The Commission was certainly conscious of these problems and two alternative methods are set out in an Appendix to the Report. Moreover the Report states:

"The recommendations we have made in this chapter are set out in general terms. It will be necessary for the tax authorities to work out, in association with the representatives of the life insurers and the Department of Insurance, detailed regulations that would apply."

In brief, the proposals in the Carter Report are considerably more reason-

able and realistic than they have been made to appear. If actuaries are to play a constructive part they should not automatically oppose any changes in life insurance taxation but should seriously consider how to apply the Report's principles in a fair and practical manner. □

REVIEW

by Karl M. Davies

J. Truett, J. Cornfield, and W. Kannel, "A Multivariate Analysis of the Risk of Coronary Heart Disease in Framingham," *Journal of Chronic Diseases*, vol. 20, p. 511, July 1967.

Various aspects of the Framingham Study, which has received considerable attention in medical and insurance circles, have been reported in several journals. The purpose of this Study, which is being conducted by the National Heart Institute, is to learn more of the epidemiology of coronary heart disease.

The Study started in 1949 with a group of 2,187 men and 2,669 women, age 30 to 62, who were free of coronary disease at that time. Seven risk factors were measured on the initial examination and the incidence of coronary heart disease in relation to these factors has been observed and analyzed.

(Continued on page 8)

Review*(Continued from page 7)*

The present article is essentially an exposition of the mathematical methods used and the test of their validity. In particular, it investigates the consequences of using the multivariate normal assumption. Although the authors acknowledge that in fact the underlying distribution is markedly lacking in multivariate normality, the assumption produces reliable and valuable results. The authors conclude: "This method of analysis appears, therefore, to provide a powerful method of analyzing the simultaneous effect of many risk factors on incidence, even in the absence of multivariate normality."

It might be well to remind actuaries and underwriters of the substantive results of the Framingham Study which have previously been observed in articles using less sophisticated mathematics and which are repeated briefly in this paper. The observed risk factors were: age, serum cholesterol, systolic blood pressure, relative weight, hemoglobin, cigarettes per day, and the electrocardiogram (normal or abnormal).

As might be expected, age is the most important single risk factor. Within individual age groupings, the most important factors are number of cigarettes smoked, serum cholesterol, systolic blood pressure and ECG abnormalities. The effect of weight is considerably less significant than the other factors. □

Mortality Session*(Continued from page 1)*

My own paper, "Statistical Approaches to Mortality Estimation," reported on research done by James Steelman, a graduate student at the University of Iowa, in developing and testing alternative methods of mortality estimation. Maximum likelihood and product limit estimates were developed. Various assumptions about probabilities of death for a period less than one year were used. A computer was used to generate random samples of times until death or withdrawal and to maximize the likelihood functions. Numerical results were produced which enabled certain empirical comparisons to be made. These appear to indicate a slight negative bias in the classical actuarial method of estimating mortality probabilities.

Mortality Variation

In a paper "Mortality Variation," John Woody pointed out that the unpublished data collected by the Society's Committee on Mortality is a mine of information. The availability of data on a company-by-company basis would permit study of the actual variation from the expected with that implied by the usual assumptions of the mathematical theory of risk. These deviations would contain trend and company-characteristic components but these could be removed on an overall basis by modifying the Basic Tables to give tables for each experience year and each company. The resulting

deviations would be more nearly random variations on an age-duration basis.

Further improvement would result if data were available on the basis of lives. Given a distribution of claims by size, net stop-loss premiums could be calculated. These often provide a convenient summary of the characteristics of a life insurance portfolio. In conclusion, Mr. Woody pointed out that, since mortality improvement can no longer be taken for granted as in the past, variations from mean values may be more significant to the soundness of the institution of life insurance than the mean values themselves. A large scale application of risk theory to actual data is needed to see how well the usual mathematical models represent reality.

Random Process

Paul Kahn's paper "Mortality as a Random Process" reviewed recent non-actuarial research in this field, including the work of Professor Strehler, who appeared at an earlier session of the Annual Meeting. Some of the fundamental notions of stochastic processes were presented, as well as a brief history of the work in studying mortality as a stochastic process. Recent research by biologists and physicists in which aging is viewed as a random process with death as an absorbing barrier was outlined and some actuarial implications of this line of research were indicated. □

The Actuary

c/o Mortimer Spiegelman
14th Floor
1740 Broadway
New York, N. Y. 10019

