

Interest Rates and Insurance Premiums

Standard Rates—Interest and Reserves—Annuities

By George Gilbert

A reliable mortality table would alone be sufficient for the calculation of life insurance premiums were it not for the interest factor which enters into practically all financial transactions extending over a period of years. The two necessary factors for the computation of mathematically correct life insurance rates are accordingly the interest on money and the mortality affecting those who insure.

Interest is defined as the compensation paid for the use of money. The rate per cent. per annum is the form of measurement most familiar to us. The standard rate prescribed by the Dominion Government for computing policy values is $3\frac{1}{2}$ per cent. This involves the assumption that the funds of the life insurance companies can be invested to realize that rate of interest. The necessity of a safe rate of interest as the standard rate is obvious. If the investments yield a higher rate, the additional receipts form a source of profit to the company. The lower the interest rate assumed in the calculation of the policy values, the higher will be the reserve required to be held by the company. On the other hand, the higher the interest rate assumed, the lower the reserve. Some companies have voluntarily adopted a lower interest rate than the standard rate, on the ground that it puts them in a stronger position and enables them to earn larger margins of surplus interest in future years.

The Om (5) Mortality Table, the Dominion Government Standard, shows that of 100,770 persons living at age of 20, 657 will die within the year, and that accordingly the probability of a life aged 20 dying within the year is .00652, which we find by dividing the number dying by the number exposed, 657 — 100,770. If \$1,000 was to be received in the event of the life dying within the year, the value of this expectation at death would be \$1,000 multiplied by .00652, or \$6.52. For purposes of calculation, it is assumed that all deaths occur at the end of the year, while premiums are payable at the beginning of the year. To find the value of the \$6.52 at the beginning of the year, we discount it at the rate of interest on which it is decided to base our calculations. Using the government standard rate of $3\frac{1}{2}$ per cent., we find the present value of the \$6.52 to be \$6.30. As this is the present value at the beginning of the year of the expectation of receiving \$1,000 at the end of the year, it is therefore the net single premium necessary to provide an insurance of \$1,000 for one year only on a life aged 20. This is the net premium, it should be noted, to which there has been nothing added for expense.

Mathematical Calculation

The same process is followed in calculating the net single premium required to insure a life aged 20, so that the \$1,000 will be paid provided the life dies between the ages of 21 and 22. The mortality table shows that there are 100,770 living at age 20 and that there are 660 deaths between the ages 21 and 22. The probability of death occurring between these ages is therefore 660 divided by 100,770, or .00654. Multiplying this by the amount of insurance, \$1,000, we get \$6.54 as the value of the expectation at the end of the year of insurance. As the premium is payable in advance, to find the value at the date of the policy we discount this \$6.54 for two years, which gives us \$6.11 as the present value, or, in other words, the net single premium for the insurance of \$1,000 in the event of a life aged 20 dying between the ages 21 and 22.

Adding the \$6.30 which we found to be the net premium at age 20 for an insurance of \$1,000 against death occurring between the ages 20 and 21, to this \$6.11, the net premium for \$1,000 of insurance between ages 21 and 22, we get \$12.41, which is the net single premium required to furnish an insurance of \$1,000 at age 20 in the event of the life dying within the two years from age 20 to 22.

In the same way we may calculate the net single premium required to provide for an insurance of \$1,000 to be payable in the event of a life, now

aged 20, dying in any year throughout life and by adding together all these net single premiums we finally obtain the net single premium for an insurance of \$1,000, on a life aged 20, payable in the event of death whenever that may occur. The net single premium, according to the Om (5) Table of Mortality and three and a half per cent. interest is \$279.76.

Figuring Annual Premiums

The net annual premium for an insurance of \$1,000 at age 20 is the exact mathematical equivalent of the net single premium of \$279.76, or \$13.14. In the one case the premium is paid in one sum; and in the other case the premium is paid every year throughout life. To understand how the net annual premium is derived from the net single premium, it is necessary to know something of the principle of the life annuity.

An annuity is a sum of money to be paid yearly to a designated person, who is called the annuitant. If the annuity is to be paid for a fixed term of years, it is known as an annuity-certain. If it is to be paid every year until the annuitant dies it is termed a life annuity. If the first payment is due at the date of the purchase it is called a life annuity due. In calculating the net single premium required for an insurance of \$1,000, it was shown to be necessary to take into consideration the probability of the life dying the first year, the second year, the third year, and every year through life as shown by the mortality table. In calculating the purchase price of a life annuity, it is necessary to take into consideration the probability of the life surviving the first year, the second year, etc., as shown by the mortality table. The calculation is the converse of that required to find the life insurance premium. Performing the necessary calculation, we find that the value of a life annuity of \$1 per annum at the age of 20 is \$20.299, and the value of a life annuity due at the same age is accordingly \$20.299 — \$1 or \$21.299. If \$21.299 is the mathematical equivalent for \$1 to be paid at the beginning of each year during life, then \$279.76 must be the mathematical equivalent of as many dollars to be paid yearly during life as \$21.299 is contained times in \$279.76, or \$13.14. In other words, \$13.14 paid at the beginning of each year during life is the exact equivalent of the net single premium of \$279.76, which is paid in one sum.

PRELIMINARY CROP REPORT

A preliminary estimate of the areas sown to grain crops has been issued by the census and statistics office. The total area sown to wheat is 13,450,250 acres as compared with 14,807,000 acres, the area sown, and with 12,900,000 acres, the area harvested in 1916. Thus the area sown this year, whilst nearly 10 per cent. less than the area sown for 1916, is about four per cent. more than the area harvested for 1916. As compared with the areas sown for 1916 the returns this year indicate small increases under wheat in each of the Atlantic provinces and in British Columbia, and an increase of 25,000 acres in Quebec; but for each of the remaining provinces decreases are reported to the extent of 154,000 acres in Ontario, 254,000 acres in Manitoba, 927,000 acres in Saskatchewan and 158,000 acres in Alberta.

The average condition on May 31 in percentage standard representing a full crop is for all wheat for Canada, 84 per cent. as compared with 90 per cent., the average condition on the corresponding date for the seven years ended 1916. For oats the average is 11,781,900 acres as compared with 11,376,346 acres, the area sown, and 9,875,346 acres, the area harvested last year. Barley is sown to 1,954,100 acres as against 1,287,780 acres, the area sown, and 1,681,180 acres, the area harvested in 1916. Rye has a sown area of 135,470 acres, compared with 139,640 acres; mixed grains, 558,250 acres as compared with 410,726 acres; hay and clover 7,661,800 acres, against 7,827,922 acres, and alfalfa 84,900 acres against 89,472 acres.

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