Actuaries Institute Australia

LIFE INSURANCE AND RETIREMENT VALUATION

ASSIGNMENT SEMESTER 1 2019

Education Program
ACTUARIES INSTITUTE

Education that Counts

Preamble

The main purpose of this assignment is to help you develop skills required to pass examinations at Fellowship level (formerly Part III). These skills are also required by employers.

You are required to apply knowledge to specific situations in the time-constrained end of semester examination. The assignment provides an opportunity for you to think more deeply and spend more time preparing a detailed answer.

The specific skills that are being developed, and examined, are:

- being comfortable with basic manipulation of spreadsheets;
- the ability to apply the subject material in an unfamiliar context;
- the necessity to state the obvious in a manner appropriate to the audience;
- understanding the business requirement for your material to be neat and tidy; and
- the ability to write so that the reader can follow your logic, with a coherent beginning, middle and end to your story

The assignment will require you to create a set of assumptions. Consequently, there is no single right answer, but we want to understand *how* you derive your assumptions.

Marking guide

This assignment represents 20% of the available marks for the Subject name subject.

Marking will be completed using a rubric system. The rubric will be posted on the LMS to guide you as to what is required to achieve full marks for each part of the assignment.

Submission

The deadline for submission is 8 a.m. March 25.

In general, late submissions will not be accepted. You should anticipate potential delays by preparing your work in advance of the deadline.

The submitted documents should consist of a pdf file and an excel file. Files in other formats will not be marked. The naming convention for both files is: 2019_S1_Assignment_LIaRV_identifier.(extension for excel or pdf as appropriate). The identifier will be your candidate number that will be sent to you during the semester. Marks will be deducted if the file name does not follow the required naming convention as that will incur additional work by the marker.

Plagiarism

By submitting you work, you are implicitly stating that the work is your work. You may include references to other sources, if required.

Assignment context

You work for a life insurance company that has seen significant growth in recent years via the purchase of liabilities from other life insurance companies. Up until recently, the focus has been on the purchase of participating business funds that are closed to new business.

A merchant bank has approached your company's Board regarding an opportunity in the post-retirement market. A medium-sized mutual life company is seeking to divest from its immediate annuity business. Expressions of interest in the purchase are sought and to facilitate discussions the merchant bank has policy data that is indicative of the size of the annuity portfolio for sale.

The supplied data contains:

- in-force annuity portfolio as at 31 December 2017
- in-force annuity portfolio as at 31 December 2018.
- The best estimate mortality table for 2018[1]
- A history of previous mortality tables[2]

All the annuities sold by the mutual are tax-preferred 'pension' annuities and are taxed at 0%. The annuity for each policy is purchased using the individual's defined contribution superannuation fund benefits. The superannuation rules in the country require 50% of the individual's superannuation fund benefits to be used to purchase an annuity at age 60. There is no access to the superannuation fund below age 60. There is a very competitive market and annuity prices at age 60 across the industry are broadly equivalent. All annuity benefits must be paid to the annuitant monthly in advance.

[1] Source: Australian Bureau of Statistics
[2] Source: Australian Bureau of Statistics

Local legislation requires a spouse's pension be paid annually to the annuitant's spouse, following the death of the annuitant. The spouse's pension is paid at a rate of 15% of the initial income payable in the first policy year. The spouse's pension payments start on the first day of the policy year after the death of the annuitant. Payments remain constant for the remaining life of the spouse. The annuitant and spouse must have been legally recognized as partners as at the date of the annuitant's 60th birthday. The onus is on the insurance company to check if a spouse's benefit is payable. The check is performed via an external company that charges a $50 fee in 2018. This fee is expected to increase each year in line with general salary inflation.

The data for the in-force portfolio contains one record per annuitant. The policy record is limited to:

- an identifier;
- month of birth;
- year of birth;
- the value of the first annuity payment; and
- the product code.

(For modelling simplicity, we have ignored gender. There is no need to comment on this in your written work.)

The mutual has sold two different types of annuity and both types have two variations. These four possibilities are identified through a product code that takes a value from one to four.

Product Code 1 represents a non-participating annuity that provides a level monthly income for the life of the annuitant. It has an attached benefit that pays a lump sum at the end of the policy year in which the annuitant dies.

The value of the death benefit reduces each policy month in line with the formula:

$$\text{death benefit in policy month } t = \max[0, (61 - t) * \text{original monthly income}]$$

Product Code 2 represents a non-participating annuity that increases at each annual policy anniversary. The increase is the lower of 2.5% or the change in the consumer price index over the preceding 12 months.

Product Code 3 represents an investment-linked annuity where the annuitant has pre-selected zero percent growth in the value of the investment-linked fund. See Appendix A for a description of the investment-liked annuities.

Product Code 4 represents an investment-linked annuity where the annuitant has pre-selected three percent growth in the value of the investment-linked fund.

The traditional annuities offer a 2% initial commission and are priced using the then best estimate mortality tables, $20 per month expenses (in 2015 prices, inflating by CPI each year), and with a discount rate equal to the then ten-year government bond yield less 0.25%.

The annuity payments are net of a charge to recover the initial commission. A local law requires initial expense recovery to occur using a specific formula: the charge applies in the first 10 years and is equivalent to 3% of the purchase price divided by a 10-year annuity certain discounted at 4%. At the end of ten years, the charge is set to zero and the annuity payments increase.

The investment-linked annuities do not pay initial commission but do pay an annual trail commission of 0.25%. The underlying funds have a mandated 1% annual management charge and 50% of the charge is retained by the external firms providing the investment-linked funds. The cash fund has a 0.5% annual management charge and the annuity provider retains 0.25%. Trail commission is not payable on monies in the cash fund.

(For modelling simplicity, we have only included in the accompanying spreadsheet historic returns for one of the underlying funds. Assume that this is the only fund available.)

Assignment questions

1. Calculate the policy liability as at 31/12/2017 and 31/12/2018.
    a. You will need to construct a mortality table that varies by calendar year of birth and project into the future. You have been provided with a current best estimate table and a historical record of past mortality tables. Do some research on likely future changes in longevity and consider carefully the message in the 'Actuarial Judgment' video on the LMS featuring Ian Laughlin regarding data and information.
    b. Produce documentation for the actuarial department that describes how you have completed this task. The documentation should contain the following subsections:
        i. source of data, with commentary;
        ii. actuarial bases for the valuations, with explanation on how you derived your assumptions;
        iii. a description on how the spreadsheet works;
        iv. a discussion on reliances and limitations of your work.

2. Analyse and comment on the differences between the two valuation results.
    a. Explain to the CFO how you completed the analysis of surplus and provide appropriate caveats on any conclusions.
    b. You may assume that assets held at the end of 2017 backing the annuity portfolio were 115% of the liability you calculate as at the end of 2017.
    c. Assume assets are held in ten-year government bonds. The bond yields started at 4.5% and fell to 4% as at the end of 2018. You may assume that the government bond yield curve at the start of 2018 increases linearly, starting at 2% and is flat after 15 years. The 0.5% fall in bond yields occurred across the entire bond yield curve.

3. Propose three shocks, at the 99.5% confidence level over a one-year period, for risk-based capital for the annuity business. You may ignore diversification with other business lines. You need to describe the derivation of the shocks. (Hint: you may want to use the Normal distribution, suitably parameterized for each shock, to determine the size of the shock that corresponds to the 99.5% confidence level.)

4. Calculate an appraisal value for the annuity business, assuming the capital held complies with the shocks set out in question three.
    a. You will need to calculate the amount of capital using your proposed shocks in question three. Calculate the capital required for each shock and then aggregate to determine the total capital.
    b. You may assume new business received in 2018 is indicative of likely future sales.
    c. Make as many simplifying assumptions as you deem necessary.

d. Write a short memo to the Board that outlines your conclusion as well as your assumptions. Briefly outline further work required to determine a firmer price.

5. Assume you have a ten-minute presentation to the Board. Produce a two-page infographic that captures the salient features of the inputs and outputs of your calculations in questions 1-4. You are not required to provide a transcript of what you may say at that presentation.

Appendix A: Description of investment-linked annuities

In exchange for a single premium, the insurance company offers a defined number of 'pension' units per annum at the start of each policy year, provided the annuitant is alive at the end of the previous policy year. The number of units is the same each policy year.

The number of units per dollar invested varies by contract start date and growth option. (We are ignoring gender in this example.) Variations by contract start date are a consequence of the company changing its best estimate mortality table from time to time.

The annuitant may choose a 0% growth option or 3% growth option. A higher number of guaranteed units are provided to those who choose the 3% option.

The value of the units on day one of the policy is equal to $1. The value changes in line with the underlying investments selected by the annuitant, net of charges and the growth option.

At the start of each policy year, the value of that policy year's guaranteed units are transferred to a cash fund. The value of one-twelfth of the units in the cash fund are paid at the start of each policy month to the policyholder, provided they are alive.

Example 1: Suppose an annuitant chose the 0% growth option and was guaranteed 1,000 units per annum.

On day one, the annuitant would receive $1,000/12* 1 = $83.33. At the start of month two, this would increase by the increase in the value of units in the cash fund, and so on, provided the annuitant is still alive.

On day one of the second policy year, the annuitant would be granted 1,000 units. The value of those units will change by the growth in the underlying investment-linked funds chosen by the annuitant, net of charges. If the underlying investment-linked fund prices went up by 10%, net of the 1% charge, then the income would rise by 10%. If the underlying fund fell by 15% then the income would fall by 15%. In either case, the new pension unit priced would reflect the change in the value of the underlying investment-linked funds, net of the 1% charge.

Example 2: Suppose the above annuitant chose the 3% growth option and was guaranteed a higher number of units per annum – say, 1,100.

On day one, the annuitant would receive $1,100/12* 1 = $91.67. At the start of month two, this would increase by the increase in the value of units in the cash fund, and so on, provided the annuitant is still alive.

On day one of the second policy year, the annuitant would be granted 1,100 units. The value of those units will change by the growth in the underlying investment-linked funds chosen by the annuitant, net of charges and the 3% anticipated growth rate. If the underlying investment-linked fund prices went up by 10%, net of the 1% charge, then the income would rise by 10% less the 3% already anticipated i.e. by 7%. If the underlying fund fell by 15% then the income would fall by 18%. In either case, the new pension unit priced would reflect the change in the value of the underlying investment-linked funds, net of the 1% charge, less the 3% growth anticipated at contract outset.