INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATIONS

12 April 2018 (am)

CA2: Model Documentation, Analysis and Reporting

Paper 2

Time allowed: 3 hours + 15 minutes reading time

INSTRUCTIONS TO THE CANDIDATE

1. You have 15 minutes reading time at the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have 3 hours to complete the paper.

2. You must not use imported e-templates for your spreadsheet work.

3. You must write the Summary document without the use of template headings and without copying large sections of the audit trail within this paper.

4. At the end of the examination you have 5 minutes to upload your submission.

Your file names must include your ARN, the name of the document and the paper sat (e.g. 9000000-Summary-Paper2) and each file should contain your ARN as a header or footer.

Please note that the content of this booklet is confidential and students are not to discuss or reveal the contents under any circumstances nor are they to be used in a further attempt at the exam.

If you encounter any issues during the examination please contact Examination team
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Exam requirements

1. Read the background document, which describes the scenarios that have been modelled and documented for this project.

You can take the scenario at face value. You do not need to consider laws, rules or regulations that apply in any one country.

2. Read the audit trail which has been written by your colleague, another actuarial student, for the calculations that they performed. This will assist you in following and understanding the calculations performed in the Excel model provided.

You are not required to add to or amend the audit trail.

You should assume that your colleague's calculations have been checked and are correct.

3. Expand the spreadsheet model to produce the required additional calculations for the proposed approach. You should ensure that the additional work you undertake on the spreadsheet contains appropriate self-checks. The model should include the following:

i. Additional balance sheet projections to determine the fixed additional yield per annum that would need to be added to the NBI yields for the investment return on the assets, such that, with the campaign donations, the deficit will be projected to be zero at the end of 15 years (i.e. under the 'Additional Return' scenario 3 described in the 'Background' section).

[5]

ii. Additional balance sheet projections to determine the level of starting donations that would be required for the deficit to be zero at the end of 10 years (i.e. under the 'Reduced Timeframe' scenario 4 described in the 'Background' section). The projections should be completed for 15 years in total.

[5]

4. Construct, for each of the following, a suitable chart to illustrate:

i. The projection of Hilltop's assets and liabilities under the 'Campaign' scenario 1 over the next 15 years.

ii. The projection of Hilltop's assets and liabilities over the next 15 years under the 'Donation Target' scenario 2; the 'Additional Return' scenario 3 and the 'Reduced Timeframe' scenario 4.

iii. The annual increase to Hilltop's assets over the 15 years for the 'Additional Return' scenario 3, split between campaign donations and investment returns, with the investment returns split between NBI yields and the fixed additional yield.

[7]

[Sub-total 17]

5. Prepare a summary document of around five to seven pages, capturing the main features and results of the work done by you and your colleague. You can assume that the summary is being prepared for your boss, a senior actuary, who will present the work to Peter.

Your summary should include the following:

- purpose of the project, data, assumptions and method used by you and your colleague
- results, including charts
- commentary on the results
- key conclusions
- suggested next steps

Commentary on the results should cover, but not be limited to:

- analytical comments on each stage of the results, including explaining patterns in the results and any unusual features.

- an explanation of the differences between the results under the various scenarios modelled.

Next steps need to be specific to the project, with some mention of why each is a valid next step.

The summary should cover the full scope of the project, including the current approach which was modelled in the spreadsheet provided.

Marks available for the summary:

Methodology (including purpose, data, assumptions and method)	**[25]**
Results, including charts	**[8]**
Commentary on results and conclusions	**[20]**
Next steps	**[20]**
Drafting	**[10]**

[Sub-total 83]

[Total 100]

Background

You are an actuarial student working at Actuarial Calculations Ltd (AC Ltd), an actuarial consultancy firm. AC Ltd provide advice to a number of organisations, including Hilltop, a children's charity.

Peter is the chairman of Hilltop. As at 1 January 2018, Hilltop's balance sheet showed that it had assets of $760,000, and liabilities of $950,000. Hilltop therefore had a deficit (i.e. liabilities minus assets) of $190,000 at 1 January 2018.

Peter has indicated that the main reason for the current deficit is that Hilltop has received no new donations over the last few years because of its current low profile relative to other charities.

Hilltop's Trustee board adopt a low risk investment strategy. All of Hilltop's assets are invested in a range of high quality bonds, which are valued in its balance sheet at market value. Hilltop's liabilities consist of a range of future financial outgo (e.g. ongoing running costs, charity payments etc.). In its balance sheet, Hilltop's liabilities are determined as the present value of its expected future outgo discounted to 1 January 2018 using the yields that are expected to be achieved on the National Bond Index (NBI).

On 1 January 2018 Hilltop launched a major marketing campaign to raise its profile, from which Peter expects to receive significant new charitable donations. These donations can contribute towards the outgo and thereby help to reduce its balance sheet deficit.

Peter has approached your boss, a qualified actuary, and asked her to assist in projecting Hilltop's future balance sheet position. Peter would like AC Ltd to determine whether the charity's campaign will provide sufficient donations to remove Hilltop's deficit (i.e. for assets to equal liabilities) within the next 15 years.

Scenario 1 – Campaign

Peter believes the campaign will result in $10,000 of new donations being received in 2018. Assuming the campaign remains active, he expects annual donations to be maintained at this level in real terms i.e. each year donations will increase in line with inflation. In recent years inflation has been around 2.5% per annum.

Peter would like to understand the impact the campaign could have on Hilltop's balance sheet position. To do this he would like AC Ltd to project forward Hilltop's balance sheet position each year for the next 15 years, allowing for the campaign donations.

<u>Assets</u>

Hilltop's asset portfolio aims to achieve annual investment returns in line with the NBI. AC Ltd's statistics department produces forward yields for the NBI for the next 15 years. These are available with an effective date of 1 January 2018.

Outgo will be met from Hilltop's assets. These cashflows can be assumed to occur uniformly over the year. Peter has provided 15 years of expected outgo for the purpose of calculating the projections over the required timeframe. The expected outgo does not need to be adjusted for inflation.

The costs relating to the new campaign are already included in the outgo provided by Peter.

Donations received will be added to Hilltop's asset portfolio.

Liabilities

Each year the liabilities will increase in line with the NBI. They will also reduce by the outgo paid over the course of the year.

Having completed their investigation of scenario 1, AC Ltd informed Peter that the campaign's donations would be insufficient to remove the deficit within 15 years. Peter has therefore asked for further investigations to be undertaken to determine the charity's options:

Scenario 2 – Donation Target

Peter would like to understand what level of new donations would be required to remove Hilltop's deficit in 15 years' time.

In particular, assuming annual donations increase in line with inflation, Peter would like to know what starting level of annual contributions would be required in 2018, such that Hilltop's deficit was removed by 31 December 2032.

Scenario 3 – Additional Return

Peter would like to consider increasing the risk taken in Hilltop's investment strategy with the objective of increasing the investment return achieved on the assets.

Peter would like to know what investment return the assets would need to achieve for the deficit to be zero in 15 years' time, while receiving donations in line with the campaign's expectations (as set out in Scenario 1). He would like this return to be expressed as NBI yields + a fixed additional yield.

Additional guidance:
The approach taken to determining the liabilities under this scenario is the same as the Campaign and Donation Target scenarios 1 and 2.

The annual yield achieved on the assets is assumed to be increased by a fixed additional amount, as compared to the yields which applied to the 'Campaign' scenario 1. The additional yield is the same for each year of the projections.

Scenario 4 – Reduced Timeframe

Peter would also like to understand what level of new donations would be required to remove Hilltop's deficit in 10 years' time. In particular what starting level of annual contributions would be required in 2018, such that Hilltop's deficit was removed by 31 December 2027 using the original investment returns. After the deficit is removed the campaign would cease and no further donations would be expected, however projections of assets and liabilities should continue for the full 15 years.

Modelling required

To provide Peter with the information he has requested, your boss instructed your colleague to produce a model to determine the following:

i. The deficit in 15 years' time based on the campaign's expected donations (i.e. under the 'Campaign' scenario 1).
ii. The starting donation that would be required for the deficit to be zero at the end of 15 years (i.e. under the 'Donation Target' scenario 2).
iii. The fixed additional yield that would be required in excess of the NBI yields for the investment return on the assets to be such that, with the campaign donations, the deficit will be projected to be zero at the end of 15 years (i.e. under the 'Additional Return' scenario 3).
iv. The starting donation that would be required for the deficit to be zero at the end of 10 years (i.e. under the 'Reduced Timeframe' scenario 4).

Unfortunately your colleague has been taken ill before being able to complete the modelling required. She had produced a first draft of her audit trail for the calculations which have been completed, covering steps (1) and (2) above. Your boss has asked you to complete the outstanding work, using the existing model as your starting point.

Your boss would also like you to construct, for each of the following, a suitable chart to illustrate:

i. The projection of Hilltop's assets and liabilities under the 'Campaign' scenario 1 over the next 15 years.

ii. The projection of Hilltop's assets and liabilities over the next 15 years under the 'Donation Target' scenario 2; the 'Additional Return' scenario 3 and the 'Reduced Timeframe' scenario 4.

iii. The annual increase in Hilltop's assets over the 15 years for the 'Additional Return' scenario 3, split between campaign donations and investment returns, with the investment returns split between NBI yields and the fixed additional yield. (The effect of the annual outgo on the investment returns should be allowed for but the actual negative annual outgo does not need to be included in the chart.)

Finally, your boss needs you to prepare a summary document covering all elements of the work (both the original work your colleague completed and the additional modelling you are undertaking).

Your summary should include the following:

- purpose of the project, data, assumptions and method used by you and your colleague
- results, including charts
- commentary on the results and key conclusions
- suggested next steps

You are not expected to add to or amend the audit trail, but a description of the method for both the existing and your additional modelling and results should be included in the summary.

Audit trail

The following audit trail should be read alongside the model provided.

Objective

Hilltop, a children's charity, has a balance sheet deficit which the chairman, Peter, would like to remove. On 1 January 2018 the charity launched a campaign which they anticipate will result in new donations being received.

The purpose of the spreadsheet is to project forward the charity's balance sheet position and investigate how the deficit can be removed.

NB: Input cells are shown in blue. Cells shaded in orange do not copy down/across.

"Parameters" worksheet

This worksheet details the inputs used in the projections.

Several data items are required in order to perform the projections.

Peter provided the following information for Hilltop:

- the present value of the liabilities at 1 January 2018
- the value of the assets at 1 January 2018
- the anticipated 2018 donation, arising as a result of the campaign, and the expected increase rate for future years
- the anticipated annual outgo for the charity for each of the next 15 years.

The statistics department at AC Ltd has provided:

- forward yields for the NBI for each of the next 15 years, with an effective date of 1 January 2018.

NB: Where cell names have been defined these are shown in red next to the relevant cells.

In rows 29 to 32 checks have been performed on the outgo and forward yields. These use the following functions: COUNT() for the number of entries provided which is then checked against the expected count of 15, MIN() for the minimum, MAX() for the maximum and AVERAGE() for the average. The results found give no reason to doubt the data.

A chart of the annual outgo over time has been plotted. This shows a fairly smooth upward trend which seems reasonable. A chart of the forward yields over time has also been plotted. There are two periods of downward forward rates in the curve however we have no reason to doubt the yields and therefore have left these unchanged.

Assumptions

The following assumptions are applied to the projections:

- The data provided by Peter and the statistics department are correct.

- Inflation is assumed to remain constant each year over the course of the projections.
- Hilltop's assets are assumed to achieve NBI index returns in line with their aim.
- Cashflows are assumed to occur, on average, half way through the year.

"Campaign" worksheet

This worksheet performs the projection of the assets and liabilities, allowing for the donations anticipated from the campaign.

Liabilities

The liability at the start of year 1 (1 January 2018) is the figure provided by Peter in cell B5. The liability at the start of all future years (the rest of Column B) is equal to the liability at the end of the previous year.

The outgo and interest rate (Columns C and D) are taken from the parameters worksheet using VLOOKUP() based on the year of the projection. The outgo is divided by 1000 as all other figures are expressed in $000s.

Interest on the liabilities (Column E) is calculated approximately as:

(liability at the start of the year – half of the outgo) x that year's interest rate

Liability at the end of the year (Column F) is equal to:

(liability at the start of the year – outgo + interest)

Assets

The value of the assets at the start of year 1 (1 January 2018) is the figure provided by Peter in cell H5. The assets at the start of all future years (the rest of Column H) are equal to the value of assets at the end of the previous year.

The outgo (Column I) is equal to the figure in Column C.

Donations (Column J) are equal to the 2018 expected donations amount (camp_cont) as provided by Peter increased by (1 + inflation) for the number of years since 2018.

The investment return on the assets (Column K) is calculated approximately as:

(assets at the start of the year – half of the outgo + half of the donations) x that year's investment return

where the investment return rate is equal to the yield in Column D.

Assets at the end of the year (Column L) are equal to:

(assets at the start of the year – outgo + donations + investment return)

The deficit at the start and end of the year are also calculated (Columns N and O) as the liabilities minus the assets at each point in time.

Projections are completed for 15 years.

"Donation target" worksheet

This worksheet performs the projection of the assets and liabilities, however rather than using the campaign's donations a starting level of donations is found which would result in the deficit being removed by 31 December 2032.

The calculations from the "Campaign" worksheet are copied and the following changes made:

- The donation calculations (Column J) are updated to refer to the campaign target donations parameter (target_cont).

- This level of donations is found using Goal Seek:

    - The deficit at the end of the 15th year (cell O19) is set to zero
    - By changing the campaign target donations parameter
    - A check on whether the goal seek needs to be re-run is performed in cell P19

END OF PAPER