

# INSTITUTE AND FACULTY OF ACTUARIES

## EXAMINATION BOOKLET – ONLINE VERSION

February 2016

### CA2: Model Documentation, Analysis and Reporting

#### Paper 2

**This document must be destroyed after the examination has been completed**

**Please note that the content of this booklet is confidential and students are not to discuss or reveal the contents under any circumstances.**

#### **Examination instructions**

1. You must download the exam assignment at the start of the exam time stated. All times given are UK times. Please note that it will not be available to you at any other time. Paper 2 will take place at 14.00hrs to 17.15hrs. The exam paper is three hours plus 15 minutes reading time. **It is your responsibility to ensure that all of your files are submitted within this time limit. Failure to do so will result in your assignment not being marked.** To submit your assignment please upload your documents as instructed or e-mail your files to [online\\_exams@actuaries.org.uk](mailto:online_exams@actuaries.org.uk). Only your first submission will be accepted and marked.
2. You may refer to any written or electronic reference material provided as part of the CA2 exam. You have been supplied with all data electronically at the start of the exam time. It is recommended that you use the first 15 minutes as reading and planning time.
3. The work you submit **MUST** be saved in Microsoft 2007 format, i.e. using docx (Word) or xlsx (Excel) file extensions. Do not embed documents in your spreadsheet.
4. You must build your model from scratch and not use an imported e-template.
5. You are required to work through the exam assignment without assistance from another person. The assessment regulations of the Institute and Faculty of Actuaries apply as set out in the Examination Regulations except that you may refer to reference material. By submitting your files you are confirming that all material is entirely your own work and you wish this to be taken into account for this assessment.
6. Save your work regularly. You do not have to print out your work but you may choose to do so from time to time if you prefer to check a printed copy. Saving your work is your responsibility so failure to do so will not be a significant mitigating circumstance.
7. You must not discuss or disclose the material. To do otherwise may lead to a disciplinary case.
8. You are reminded that by undertaking this exam you are bound by the Institute and Faculty of Actuaries' Examination Rules and Regulations.
9. At the end of the allotted time or when you have completed your exam, you need to submit your work.

Your filenames must include your ARN (e.g. Summary\_90XXXXX.docx) and each file should also contain your ARN as a header or footer on at least one page. You will receive an acknowledgement by email from the Online Exams Team confirming receipt. The Online Exams Team will send you an email after the exam requesting you to delete all your files relating to the exam, together with your planning notes and any print-outs. If you experience difficulties in submitting your work, you must inform the Online Exams Team immediately at [online\\_exams@actuaries.org.uk](mailto:online_exams@actuaries.org.uk) or T. +44 (0)1865 268 255.

**Professional behaviour is mandatory and no material relating to the exam may be disclosed or discussed with others, nor used in a further attempt at the exam.**

**Failure to comply with this will be deemed to be a breach of examination regulations and may result in disciplinary action.**

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## Exam requirements

1. Read the background document, which describes the scenarios that have been modelled and documented for this project. Technical assistance for the modelling work, should you require it, can be found in the additional guidance contained in this booklet.

*No marks will be deducted for the use of this guidance.*

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.**

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) Calculate the overall annual business profits for 10 years of projections, allowing for Sally's expectations of selling one franchise a year starting in year 5.
  - (ii) Determine the latest year in which franchises would need to start being sold if the overall business is to achieve profits of at least \$150,000 when selling two franchises per year.

**You should assume that your colleague's calculations have been checked and are correct.** [8]

4. Illustrate the following using a suitable chart for each:
  - the progression of the children's population under the base scenario, split by age group
  - the progression of the children's population under the base and franchise scenarios
  - the projected profits under the three scenarios

[7]

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 the client.

Your summary should include the following:

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

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

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

**Marks available for the summary:**

<b>Methodology (including purpose, data, method and assumptions):</b>	<b>[20]</b>
<b>Results, including charts</b>	<b>[10]</b>
<b>Commentary on results and conclusions</b>	<b>[20]</b>
<b>Next steps</b>	<b>[25]</b>
<b>Drafting</b>	<b>[10]</b>

**[Sub-total 85]**

**[Total 100]**

# Background

A few years ago a friend of yours, Sally, set up a playgroup for young children, Josie's Jamboree ("JJ's"). JJ's offers a sensory, soft play environment for young children aged between 0 and 4 years old. The children attend age appropriate classes, where they can play and develop in a safe environment.

## Existing business model

Sally charges a fee for children to attend weekly classes. The fee varies depending on the age of the child. In running JJ's, Sally incurs a number of different costs. Some, such as rent, are fixed, while others vary depending on the number of children using the playgroup.

Over the course of the year new children join while others leave. The playgroup's population is constantly evolving.

The profit that JJ's makes is the difference between the fees received and the costs incurred.

## Modelling request

You are a student working for an actuarial consultancy. Sally is a client of the consultancy and has asked your boss, a senior actuary, for assistance in putting together some financial projections to determine the number of children attending and profits she can expect to achieve in 10 years' time.

Sally has been running JJ's for a number of years. Based on her experience to date she has provided your boss with the following, to enable you to undertake the modelling.

### *Existing population*

<i>Age</i>	<i>Number of children</i>
0	-
1	80
2	65
3	50
4	45

### *Children's starting and leaving decrements*

<i>Age</i>	<i>Number of new starters p.a.</i>	<i>Proportion of children leaving p.a.</i>
0	140	40%
1	90	25%
2	75	35%
3	60	50%
4	50	100%

The new starters above reflects the maximum number of new starters the playgroup could expect in any one year. Sally proposes that the following formula is used to estimate the proportion of this number which join in each given year, using the standard normal distribution (the "proportion adjustment" formula):

$$\Phi\left(\frac{\ln(n)}{\text{fac}}\right)$$

where:  $n$  is the year.  
fac is a factor for the given scenario.

For the existing business a fac of 2 is applicable.

### *Weekly class fees*

<i>Age</i>	<i>Cost per child per class (\$)</i>
0	7.50
1	8.00
2	8.00
3	10.00
4	10.00

It is assumed that fees are received for 52 weeks of the year.

### *Costs*

Fixed costs	\$14,000 p.a.
Semi-fixed costs	\$11,000 p.a. per 40 children*
Variable costs	\$2.50 per child per month

\* i.e. for 0-40 children a cost of \$11,000 p.a. would be incurred, for 41-80 children a cost of \$22,000 p.a. would be incurred etc.

Your boss has cited government data which indicates that inflation has remained at 0% a year for several years.

## Franchise opportunity

Now Sally has established her business she is considering offering up franchise opportunities, for other entrepreneurs to take advantage of her business model, and to expand the JJ's brand across the country.

In return for an upfront fixed payment, entrepreneurs will be able to set up their own JJ's playgroup, making use of Sally's branding, class plans, and website. In addition, the new franchise owner will pay an annual fee, which is a proportion of their profits.

Sally hopes to start selling franchises for JJ's four years from now (i.e. at the start of year 5), selling one franchise each year. Sally intends to sell a franchise for an upfront cost of \$10,000 (this cost will be incurred at the start of the year the franchise is started), and, for each year, charge an annual fee in line with the following structure depending on the profit for that year. (This annual fee will be incurred at the end of each financial year):

- profits between \$0 and \$10,000  
fee of 10% of profits
- profits over \$10,000  
fee of 20% of profits
- subject to a minimum fee of \$250

Going forward, Sally's overall business' annual profits will therefore consist of:

- profits achieved in her existing business.
- plus, income, in the form of upfront charges and annual fees, received from franchises.

To estimate Sally's overall business' annual profits it will first be necessary to project the profits for a franchise business on an annual basis. Sally has proposed a smaller starting population for franchises, as follows:

<i>Age</i>	<i>Number of children</i>
0	-
1	45
2	38
3	31
4	18

She has indicated that a franchise may expect to see new starters using the same decrements and 'proportion adjustment' formula as for her existing playgroup, but with a fac of 5.

The annual income from Sally's own playgroup can then be combined with the annual income (upfront charges plus annual fees) she can expect to receive from each franchise she sells.

Sally would like to know:

1. The annual business profits a franchise could expect to achieve for the first 10 years of the franchise's operation.
2. The progression of the children's population for the first 10 years of a franchise's operation.
3. The overall annual business profits in year 10 i.e. the profits from her existing business plus the income (i.e. upfront charges plus annual fees) achieved from selling 1 franchise p.a from year 5. (See additional guidance for more details on these calculations.)

### **Franchise opportunity – two per year**

Sally would also like to model the potential profits from a more ambitious overall business plan where more franchises would be sold each year, with franchises being sold as soon as possible. In this scenario, Sally would aim to make overall annual profits of at least \$150,000 by the end of year 10 by selling two franchises a year (i.e. the total combined annual income from her existing business plus the income achieved from selling franchises is in excess of \$150,000).

She would like to know the latest year in which she would need to start selling two franchises a year for this to be achieved.(e.g. if she started selling franchises in year 5 then two franchises would be opened in year 5, another two in year 6 to make four and another two in year 7 to make six etc.)

Your boss asked your colleague to commence work on the projections. Your colleague completed the financial projections for the existing business and a single franchise business, but has gone on holiday before having a chance to finish the requested work. The calculations completed have been checked and are correct and have been written up in an audit trail. A copy of the audit trail is contained in this booklet and an electronic copy of the model will be provided.

In your colleague's absence your boss has asked you to complete the model in order to finish the work requested.

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

**You are not expected to include the additional modelling you undertake in the audit trail, but your results should be included in the summary.**

# Additional guidance

## Franchise income

The first franchise will be sold at the start of year 5. The upfront charge is paid at the start of the year in which franchise is sold, and the annual fee is paid at the end of that same year (i.e. at the end of the franchise's first year of operation) and annually thereafter.

So if one franchise is set up a year (i.e. franchise A in year 1, franchise B in year 2, franchise C in year 3, etc.) then the amount Sally would receive would be:

Year 1    Upfront fixed cost (from A) + Annual Charge\_yr 1 (from A)

Year 2    Annual Charge\_yr 2 (from A) + Upfront fixed cost (from B) + Annual Charge\_yr 1 (from B)

Year 3    Annual Charge\_yr 3 (from A) + Annual Charge\_yr 2 (from B) + Upfront fixed cost (from C) + Annual Charge\_yr 1 (from B)

etc.

## Determining the year franchises should first be sold

The number of franchises being sold each year has been specified as 2. You will need to vary the year in which franchises are first sold until the "profit after franchises" in year 10 is at least \$150,000.

You could use a goal seek or trial and error.

## Useful Excel functions

The following Excel function may be useful in modelling the amounts Sally receives from the sale of franchises. (Note – alternative approaches not making use of this function are equally valid.)

The **SUMPRODUCT()** function in Excel can be used to multiply corresponding components in the given arrays, and return the sum of those products. For example, **SUMPRODUCT [A1:A3, B1:B3]** will return the result of  $A1 \times B1 + A2 \times B2 + A3 \times B3$ . The arrays must have the same dimension (number of rows/columns) for the function to return a value.

**END OF PAPER**