Subject CA2 2015 – specimen exam papers

The specimen exam papers below show how the syllabus will be examined across the two parts of the CA2 exam from March 2015

- In Paper 1 you will build a model and provide a clear audit trail.
- In Paper 2 you will be given a model to analyse, interpret and summarise.

In this specimen exam (published September 2014), both parts of the paper use the same model. In future CA2 exams, each part of the exam will use a different model.

The marks shown on each paper are indicative of the balance of marks which will apply to each part. The marks for each exam will differ to reflect the precise details of each assignment.

INSTITUTE AND FACULTY OF ACTUARIES

SPECIMEN EXAMINATION BOOKLET

2015

CA2: Model Documentation, Analysis and Reporting

Paper 1

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Exam Requirements

1. Read the background document, which describes the scenarios that need to be 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 penalty marks will be deducted for the use of this guidance.*

2. Construct a spreadsheet model that produces the following calculations and charts. You should ensure that your spreadsheet contains appropriate self-checks and that you have performed robust reasonableness checks at each stage of your calculations.

   (i)   Scenario A: Build a model that uses the data provided to project the numbers of future sales of each of the four classes up to and including the year 2021, using each of the three suggested approaches and ignoring any adjustment for the Yodelle album. [You have been provided with a spreadsheet which contains the data exactly as shown in Appendix 1 of this booklet.]

   (ii) Illustrate these projections using three suitable charts, one for each of the suggested approaches.

   (iii) Demonstrate that your results support the decision to use projection method Approach 3, other than for physical albums where Approach 1 has been chosen.

   (iv) Scenario B: Repeat step (i) using the chosen approaches (i.e. Approach 1 for physical albums and Approach 3 for the other data classes), after removing sales of the Yodelle album from the data provided. [You are not required to repeat steps (ii) and (iii).]

   (v)   Project the expected annual sales revenue under these chosen approaches (i.e. Approach 1 for physical albums and Approach 3 for the other data classes), both ignoring and allowing for the Yodelle adjustment.

   (vi) Determine the year in which annual revenue from digital sales is first expected to exceed that from physical sales for each scenario.

   (vii) Illustrate the following sales revenue projections using two suitable charts:

   - Projected total physical and total digital annual sales revenue in each year to 2021, with no adjustment for the Yodelle album.

   - Projected total overall annual sales revenue in each year to 2021, without and with adjustment for the Yodelle album.

   Marks available for spreadsheet model:

Model accuracy, completeness and good modelling techniques	**20 marks**
Checks	**10 marks**

3. Produce an audit trail for your spreadsheet model which includes the following aspects:

- purpose of the model

- data and assumptions used

- methodology, i.e. description of how each calculation stage in the model has been produced

- explanation of the checks performed

You should ensure that your audit trail is suitable for both a senior actuary, who has been asked to approve your work, and a fellow student, who has been asked to peer review and correct your model, or to continue work on it, or to use it again for a similar purpose in the future.

Marks available for audit trail:

Audit approach	**30 marks**
Audit methodology – clarity and labelling	**25 marks**
Audit methodology – coverage of techniques	**15 marks**
Total marks for paper	**100 marks**

Background

In the country of Actuaria, musical artists distribute their output to the general public in the form of albums (i.e. several tracks packaged together) and/or singles. Albums and singles are available in two different formats: physical (vinyl records and CDs) and digital (downloads).

You are an actuarial student working for a consultancy in Actuaria. The Actuarian Recorded Music Industry (ARMI) has approached your boss, a qualified actuary, and asked whether it is possible to construct a model which projects numbers of sales and sales revenue for the different formats for each year up to and including 2021. In particular it is interested in understanding when revenue from the sale of downloads might overtake that from physical sales.

In order to perform these projections and analysis, ARMI has provided you with its data on the numbers of albums and singles sold in each of the two formats (physical and digital) in the calendar years 2007 to 2012 inclusive.

ARMI has also pointed out that there was an unusual situation in 2012 which may need to be taken into account in the sales projections. One particular album, by a band called Yodelle, accounted for a very high proportion of the overall sales. The album ("Twenty-Twelve") was launched at the start of March 2012. In its first twelve months of availability, it had sold a total of 7 million copies across the two formats. The relevant sales of this album are included in the data provided.

Numbers of sales

Your boss has suggested three possible approaches by which the numbers of sales could be projected. She has asked you to construct a model projecting future model sales and revenue.

For each of the four classes of data (physical singles, physical albums, digital singles, digital albums), you first need to calculate the % change (year on year) of sales numbers for each of the past years for which this is possible. This % year on year change is defined as the *additional* increase (or decrease) rather than as the ratio of values. So for example, the % change from 100 to 105 should be expressed as 5% rather than 105%.

Each class should then be projected forward assuming that:

Approach 1: the future year on year % change is constant, and at the same level as it was from 2011 to 2012.

Approach 2: the future year on year % change is constant, and at the same level as the arithmetic mean of the year on year % changes over the 2007–2012 data period.

Approach 3: the future year on year % change varies, in line with patterns in the historic % changes. More specifically, if $\{x_i\}$ represents the set of historic % changes from year $i - 1$ to year i (for $i = 2008$ to 2012), then you first need to calculate the second order % changes in the form of ratios x_i / x_{i-1}. Your boss has suggested that you then take the arithmetic mean of these ratios and assume that the second order % changes stay at this level in future. This will enable you to produce the first order % changes (i.e. the x_i for $i > 2012$) and hence to project the future sales numbers.

Your boss has asked you to produce projections of the numbers of sales for each of the four data classes using each of these three approaches in turn. She wishes you to do this in the first instance ignoring any potential adjustment for the Yodelle album.

Although she feels that it is useful to present the client with the projections from each of the three approaches, having performed some high level preliminary analysis she has decided that the most appropriate method is Approach 3 for all classes other than physical albums, for which Approach 1 appears to be preferable. She would like you to use your projections to demonstrate that this decision is appropriate, and then to use these specified approaches for the rest of your analysis.

Before starting to consider the amounts of sales revenue, your boss has asked you to repeat the projections of sales numbers using the specified approaches (i.e. Approach 3, other than Approach 1 for physical albums). However, this time she wants you to remove the Yodelle album from the data provided, in order to understand the potential impact of this possible distortion.

Sales revenue

ARMI has also provided the following data on the prices of albums and singles in each format (figures in Actuarian dollars $):

- Physical singles cost an average of $3.00 each in 2007, but this had fallen to $2.40 in 2012.

- Physical albums cost an average of $10.00 each in 2007, but this had fallen to $8.00 in 2012.

- Digital singles cost an average of $1.00 each in 2007, but this had fallen to $0.80 in 2012.

- Digital albums cost an average of $10.00 each in 2007, but this had fallen to $7.00 in 2012.

Annual inflation in Actuaria in the period 2007 to 2012 was broadly zero.

Your boss has asked you to use your projections of sales numbers and the above price information to estimate future annual sales revenues to 2021 for each of the four classes. She wishes you to assume that the reduction in prices continues at the same annual rate throughout the projection period.

She then wishes you to use these revenue projections to determine the year in which annual revenue from digital sales is first expected to exceed that from physical sales.

She wishes you to perform the above sales revenue projections and analysis both ignoring and allowing for the Yodelle adjustment.

Unfortunately, your boss is out of the office visiting a client and cannot be contacted for the next three hours. She would like the above calculations finished ready for her return.

Data

Numbers of sales in millions

Year	2007	2008	2009	2010	2011	2012
Physical:						
Singles	14.6	8.4	4.8	3.0	2.1	1.6
Albums	137.5	131.6	123.2	112.7	98.7	84.5
Digital:						
Singles	52.5	79.5	113.4	145.5	166.7	176.5
Albums	2.8	6.2	10.3	16.1	21.0	26.1

Source: Actuarian Recorded Music Industry (ARMI)

END OF PAPER

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