



Master in Actuarial Science
Loss Reserving
24-06-2015
Time allowed: 2 hours

Instructions:

1. This paper contains **7** questions and comprises **9** pages including the title page and **5** preprinted answer sheets.
2. Enter all requested details on the cover sheet.
3. You must not start writing your answers until instructed to do so.
4. Number the pages of the paper where you are going to write your answers.
5. Attempt all questions.
6. Begin your answer to each question on a new page.
7. Marks are shown in brackets. Total marks: 200.
8. Show calculations where appropriate.
9. An approved calculator may be used.
10. Mobile phones and smartphones may not be used during the examination.
11. Preprinted answer sheets are available for some of the tables required.

You are the actuary of a general insurance company and have been asked to analyse the claim cost of its liability insurance portfolio. This is the data you receive from the company:

Accident year	Earned premium
2009	336
2010	414
2011	500
2012	536
2013	558
2014	635

Cumulative paid claims

	Development year					
Accident year	0	1	2	3	4	5
2009	N/A	N/A	150	180	211	223
2010	N/A	96	169	218	242	
2011	16	77	144	204		
2012	15	90	158			
2013	11	80				
2014	16					

1. Do you consider the portfolio to be short-tailed or not? Given your answer, what prediction methods would you recommend or not recommend? [5 marks]
2. Convert the triangle of cumulative paid claims to incremental paid claims. [15 marks]
3. Estimating the payment pattern.
 - a. Estimate delay-specific claim rates, as in the Bornhuetter-Ferguson method. [15 marks]
 - b. A little bird has told you that you can expect some 10% of an accident year's total claims to be paid after more than five years' delay. You may assume that the remaining 10% will be paid in development year 6. Calculate a claim rate for delay 6 that amounts to 10% of the total. [10 marks]
 - c. Calculate the sum of the delay-specific claims rates. [5 marks]
 - d. Calculate a payment pattern for development years 0-6. [10 marks]
 - e. What other information could you ask of the company, to help you to assess the proportion of payments to expect after development year 5? [5 marks]

Calculate your answers with three decimals.

In exercises 2-3, take care to avoid mistakes that could result from the fact that some payment information is missing.

4. Claim predictions

- a. Predict the outstanding claim cost, the ultimate claim cost and the ultimate claim rate of each accident year, using the Bornhuetter-Ferguson prediction method. [15 marks]
- b. Predict the timing of future payments of each accident year, using the estimated payment pattern. [20 marks]
- c. Predict the remaining outstanding claims at the start and the end of each future payment year. [15 marks]

Calculate your answers with three decimals.

5. Outstanding claim provision according to Solvency II

Assume an interest rate of 3%.

The “best estimate”

- a. Calculate the discounted value of the predicted outstanding claims.
You can assume that payments are made at the end of each payment year.
You do not need to specify the best estimate by accident year, just in total. [15 marks]

The “risk margin”

- b. Assume that on 1st January of 2015-2020, the solvency capital requirement (SCR) is 50% of the outstanding claims that you predicted in exercise 3.c.
The upfront cost of providing capital for one year is 6%. Calculate the risk margin as the total discounted cost of providing solvency capital for the years 2015-2020. You do not need to specify the risk margin by accident year. [20 marks]

Calculate your answers with three decimals.

6. Modelling by GLM

- a. Specify the GLM(s) that will reproduce the predictions of the Bornhuetter-Ferguson method. A GLM is fully specified by its covariate structure, its link function and its probability distribution. [15 marks]

The Bornhuetter-Ferguson method may be derived by assuming that the expected claim rate is the same for all accident years. That may not always be a realistic assumption. For instance, if you study the ultimate claim rates in 4.a, you see that mature years have higher-than-average ultimate claim rates. You can easily see that premiums have increased at a faster rate than claims. This indicates that the Bornhuetter-Ferguson method was not the best choice.

At the other end of the modelling spectrum one has the chain ladder method, which may be derived by assuming that each accident year's ultimate claim rate is unique. Some would say that using the chain ladder method amounts to ignoring valuable information.

As a compromise between the extreme assumptions, you could assume that the expected claim rates for accident years 2009-2014 follow a trend function, and try to estimate the trend.

- b. Specify a GLM that will allow you to estimate the payment pattern and an exponential trend in the accident year claim rates. [20 marks]

Hint: We have seen how to model a calendar year trend. Just make the necessary change in the quantitative variable.

7. Mention briefly some other methods that you can use to learn from the claim experience, when accident years' claim rates are similar but not identical. You get additional marks for a description of their properties. [15 marks]

THE END

Name: _____

Answer sheet for Question 2

Incremental paid claims	Development year					
Accident year	0	1	2	3	4	5
2009						
2010						
2011						
2012						
2013						
2014						

Name: _____

Answer sheet for Question 3a-d

		Development year e							
	Specify formula	0	1	2	3	4	5	6	Total
Delay-specific claim rates θ_e^*		3a	3a	3a	3a	3a	3a	3b	3c
Incremental payment proportions π_e^*									
Cumulative payment proportions $\pi_{\leq e}^*$									

Name: _____

Answer sheet for Question 4a

Accident year j	Earned premium	Cumulative Payments to date	pi(cum.)	Theta	Outstanding payments (prediction)	Ultimate payments (prediction)	Ultimate claim rate (prediction)
Specify formula	p_j	$X_{j, \leq 2014-j}$	$\pi_{\leq 2014-j}^*$	θ^*			
2009							
2010							
2011							
2012							
2013							
2014							
Total							

Name: _____

Answer sheet for Question 4b and 4c

	Payment year						
Accident year	2015	2016	2017	2018	2019	2020	Total
2009							
2010							
2011							
2012							
2013							
2014							
Total payments during payment year (prediction)							
Outstanding payments at start of payment year							
Outstanding payments at end of payment year							

Name: _____

Answer sheet for Question 5a and 5b

	Payment year						Total
	2015	2016	2017	2018	2019	2020	
Predicted payments at 31 st December of the payment year							
Discount factor at 31st December 2014							
Discounted value of predicted payments at 31st December 2014							"Best estimate"
Outstanding payments on 1st January of the payment year							
Solvency capital required during the year							
Upfront cost of solvency capital provided during the year							
Discount factor at 31st December 2014							
Discounted value of cost of capital at 31st December 2014							"Risk margin"