



Master in Actuarial Science
Loss Reserving
17-06-2014
Time allowed: 2 hours

Instructions:

1. This paper contains **5** questions and comprises **8** pages including the title page and **3** 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 have been asked to estimate the ultimate claim cost of a portfolio of long-tailed insurance that has been running for four years only. The company has given you its premiums and paid claims.

Company Statistics

Accident year	Premium M€	Paid claims M€
2010	63	5
2011	99	11
2012	155	12
2013	178	5

A quick glance convinces you that the company's statistics alone are useless for estimating the ultimate claims, given the long-tailed nature of the business.

Fortunately you have access to seven years of industry statistics, shown below.

Industry Statistics

		Accumulated paid claims by Development year (M€)						
Accident year	Premium M€	0	1	2	3	4	5	6
2006	2 329	33	139	265	464	661	847	949
2007	2 495	39	163	319	503	709	869	
2008	2 649	60	186	368	574	813		
2009	2 674	65	193	348	514			
2010	2 584	31	129	256				
2011	2 561	42	164					
2012	2 526	30						
Sum	17 817	300	974	1 556	2 055	2 183	1 716	949

1. Estimating a payment pattern from the Industry Statistics

- Estimate year-on-year development factors δ_e^* for $e = 1, \dots, 6$. [10 marks]
- Assume that claims paid until development year 6 make up only 2/3 (66.7%) of ultimate claim cost. Calculate the development factor that applies to the development from development year 6 to ultimate. For simplicity you may denote it by δ_7^* .

[10 marks]

- c. Transform the set of estimated development factors $\delta_1^*, \dots, \delta_7^*$ into a payment pattern π_0^*, \dots, π_7^* , where π_e^* denotes the expected proportion of ultimate claim payments, that will be made in development year e . [10 marks]
- d. Collect the results of a-c above in this table.

	Specify formula	0	1	...	6	7 to ultimate
δ_e^*						
Δ_e^*		Preprinted answer sheet available				
$\pi_{\leq e}^*$						
π_e^*						

The meaning of the symbols is:

- δ_e^* Year-on-year development factor,
 Δ_e^* Accumulated development factor,
 $\pi_{\leq e}^*$ Accumulated payment proportion (current-to-ultimate),
 π_e^* Incremental payment proportion (payment year to ultimate).

Please display your results as ratios with four decimals (x.xxxx) or as percentages with two decimals (x.xx%). [5 marks]

- e. Estimate the ultimate claim cost of the Industry Portfolio using the Chain ladder method (CL). Display your results in the table below. [10 marks]

Accident year j	Premium	Paid claims	$\pi_{\leq 2012-j}^*$	Estimated claim rate (CL)	Estimated Outstanding claim cost (CL)	Estimated Ultimate claim cost (CL)
Specify formula						
2006						
2007		Preprinted answer sheet available				
...						
2011						
2012						
Total				(average)		

- f. Use the Cape Cod (CC) method to calculate the average claim rate. [10 marks]

2. Estimating the claim cost of the company

Now you get to the task that you actually were asked to do:
to estimate the ultimate claim cost of the company portfolio.

- a. Estimate the ultimate claim cost of the Company Portfolio using Benktander's method. Display your results in the table below.

Accident year j	Premium	Paid claims	$\pi_{\leq 2013}^*$	Estimated claim rate			Estimated claim cost (Benktander)		
				Chain ladder	Average	Benktander	Outstanding	Ultimate	Ultimate claim rate
Specify formula									
2010			Preprinted answer sheet available						
...									
2013									
Total				(average)					

[25 marks]

- b. The company is convinced that its own portfolio is more profitable than the industry portfolio. Just taking the numbers at face value, and leaving aside all doubts about the paucity of the company data or the relevance of the industry's payment pattern, do your results support or contradict the company's assertion?

[10 marks]

- c. A board member says to you "I've never heard of this Ben Thunder. Every actuary I know uses the chain ladder. Why aren't you using it?"

Explain why, in your opinion, using the Chain ladder method for the Company Portfolio would not be a very good idea. Use the actual numbers you have, to illustrate your point.

[15 marks]

3. Explaining mechanisms of claim development.

Use as context that the insurance generating the numbers above is for occupational injury and diseases, often called "Workers' Compensation insurance".

- a. Explain the meaning of the acronym RBNS, and give three possible reasons why the assessed cost of a reported claim can change before it is settled.

[10 marks]

- b. Explain the meaning of the acronym IBNR, and give three possible reasons why claim notification can be delayed. [10 marks]
- c. Explain thoroughly the meaning of the acronym CBNI. [10 marks]
- d. In what sense are claims IBNR similar to claims CBNI? [10 marks]

In a-c above, *explaining* the meaning of an acronym means more than just spelling it out in words.

4. Generalised Linear Models

Modelling of claim development and outstanding claim prediction can be cast into the mould of Generalised Linear Models (GLM).

- a. What link function would you use? [5 marks]
- b. Give three examples of sensible covariate structures. [15 marks]
- c. What probability distribution would you use and why? [10 marks]
- d. Given parameter estimates, how do you calculate predictions? [5 marks]

Please specify precisely the meaning of any symbols you use. It is not sufficient to write up a formula without telling what its symbols express.

5. Bühlmann-Straub model

- a. Describe briefly the assumptions of the Bühlmann-Straub model for claim amounts and explain the meaning of its parameters β , φ and λ . [15 marks]
- b. Explain under what conditions the chain ladder method can be derived from the Bühlmann-Straub model. [5 marks]

THE END

Name: _____

Preprinted answer sheet for Question 1d

		Development year e							
	Specify formula	0	1	2	3	4	5	6	7 to ultimate
δ_e^*									
Δ_e^*									
$\pi_{\leq e}^*$									
π_e^*									

Name: _____

Preprinted answer sheet for Question 1e

Accident year	Premium	Paid claims	$\pi_{\leq e}^*$	Estimated claim rate (CL)	Estimated Outstanding claim cost (CL)	Estimated Ultimate claim cost (CL)
Specify formula						
2006						
2007						
2008						
2009						
2010						
2011						
2012						
Total						

Name: _____

Preprinted answer sheet for Question 2a

				Estimated claim rate			Estimated claim cost (Benktander)		
Accident year	Premium	Paid claims	$\pi_{\leq e}^*$	Chain ladder	Average	Benktander	Outstanding	Ultimate	Ultimate claim rate
Specify formula									
2010									
2011									
2012									
2013									
Total									