



**Instituto Superior de Economia e Gestão**

UNIVERSIDADE TÉCNICA DE LISBOA

DESDE 1911

Master in Actuarial Science

Loss Reserving

28-06-2013

Time allowed: 2 hours

Instructions:

1. This paper contains **5** questions and comprises **4** pages including the title page.
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.

The following table shows cumulative paid claims for accident years 2008-2012 at 31.12.2012.

Cumulative claim payments					
	Development year				
Accident year	0	1	2	3	4
2008	112	168	178	180	182
2009	116	180	190	192	
2010	140	228	246		
2011	156	262			
2012	170				

The exposure is shown in the next table.

Accident year	Exposure
2008	244
2009	252
2010	296
2011	306
2012	334

### 1. Preparation

- a. Organise the incremental paid claims in a development triangle. [5 marks]

### 2. Bornhuetter-Ferguson method

In what follows, claim ratio means claims divided by exposure. You may assume that no claims will be paid with more than 4 years' delay.

- a. Estimate the delay-specific claim ratios for delays 0 to 4. [10 marks]
- b. Estimate the overall claim ratio per accident year (all delays). [10 marks]
- c. Estimate the payment pattern expressed in percent of ultimate cost. [10 marks]
- d. Estimate the outstanding claim payments for each accident year. [10 marks]
- e. Calculate the estimated ultimate claim cost and the estimated ultimate claim ratio of each accident year. [10 marks]

3. Bühlmann-Straub model

- a. Describe briefly the assumptions of the Bühlmann-Straub model for claim amounts and explain the meaning of the parameters  $\beta$ ,  $\varphi$  and  $\lambda$ . [15 marks]

The optimal credibility estimator of the random claim level of accident year  $j$  has the form  $\bar{b}_j = \zeta_j \hat{b}_j + (1 - \zeta_j) \beta$ , where  $\hat{b}_j$  is the chain ladder estimator,  $\beta$  is the prior mean, and  $\zeta_j$  is the optimal credibility factor.

- b. Specify the formula for the optimal credibility factor  $\zeta_j$ . [10 marks]
- c. Explain in what way the Bornhuetter-Ferguson method and the chain ladder method can be seen as limiting cases of the Bühlmann-Straub credibility method. [10 marks]

Now assume that the following parameter values have been estimated:

$\beta$ (beta)	0.83
$\varphi$ (phi)	0,3
$\lambda$ (lambda)	0.004

- d. Use these parameter values and the payment pattern from problem 2 to complete the following table. Please specify the formula that you use in each column.

Accident year	Exposure	Claims paid	$\pi_{\leq J-j}$	$\hat{b}_j$	$\beta$	$\zeta_j$	$\bar{b}_j$	Outstanding	Ultimate	Claims ratio
2008	244	182								
2009	252	192								
2010	296	246								
2011	306	262								
2012	334	170								
Total	1 432	1 052								

[20 marks]

4. Generalised linear models

A generalized linear model (GLM) is fully specified by the following three choices:  
The link function, the covariate structure and the probability distribution.

- a. Specify the link function that will provide multiplicative means. [10 marks]
- b. Specify a covariate structure that will allow you to estimate a multiplicative model that has development year effects and an inflation rate acting on calendar years. It is sufficient to write down the formula, no matrix is required. [20 marks]

5. Stages in the life of a claim

- a. Explain the meaning of the acronyms RBNS, IBNR and CBNI. Please do not just translate the abbreviations, but explain what it means for a claim to be “RBNS”, “IBNR” or “CBNI” on a specific valuation date. [10 marks]
- b. Suggest a few pieces of information that could be useful in modeling the development and estimating the ultimate cost of claims that are RBNS. [10 marks]
- c. Suggest what information could be used to model the arrival and estimate the ultimate cost of claims that are (still) IBNR. [10 marks]
- d. Explain the meaning of this assertion:  
“Statistically, CBNI claims behave in the same way as IBNR claims.” [15 marks]
- e. Explain the meaning of this assertion:  
“Know your RBNS, then IBNR/CBNI come by themselves (well, almost).” [15 marks]