



Subject: Statistical and Risk
Modelling - 2

Chapter: Unit-4

Category: Practice Question

The table below shows the incremental claims paid on a portfolio of insurance policies together with an extract from an index of prices. Claims are fully paid by the end of development year 3.

Development Year						
Accident Year	0	1	2	3	Year	Price index (mid year)
2006	103	32	29	13	2006	100
2007	88	21	16		2007	104
2008	110	35			2008	109
2009	132				2009	111

Calculate the reserve for unpaid claims using the inflation-adjusted chain ladder approach, assuming that future claims inflation will be 3 % pa.

Answer: 134.7

2. CT6 April 2012 Q8

The table below shows claims paid on a portfolio of general insurance policies. You may assume that claims are fully run off after three years.

Development year				
Underlying year	0	1	2	3
2008	450	312	117	41
2009	503	389	162	
2010	611	438		
2011	555			

Past claims inflation has been 5% pa. However, it is expected that future claims inflation will be 10% pa.

Use the inflation adjusted chain ladder method to calculate the outstanding claims on the portfolio.

Answer: 959.56

3. CT6 September 2012 Q7

The table below shows claims paid on a portfolio of general insurance policies. Claims from this portfolio are fully run off after 3 years.

Underwriting year	Development Year			
	0	1	2	3
2008	85	42	30	7
2009	103	65	25	
2010	93	47		
2011	111			

Estimate the outstanding claims using the basic chain ladder approach.

Answer: 144.08

4. CT6 September 2013 Q6

The tables below show cumulative data for the number of claims and the total claim amounts arising from a portfolio of insurance policies.

	Claim Numbers Development Year				Total Claim Amounts Development Years		
	0	1	2		0	1	2
2010	87	132	151	2010	43,290	87,430	126,310
2011	117	156		2011	68,900	125,290	
2012	99			2012	74,250		

Claims are fully run off after two development years.

Estimate the outstanding claims using the average cost per claim method with grossing up factors.

Answer: 186,592

5. CT6 April 2014 Q9

The table below sets out incremental claims data for a portfolio of insurance policies.

	Development year		
Accident year	0	1	2
2011	1,403	535	142
2012	1,718	811	
2013	1,912		

Past and projected future inflation is given by the following index (measured to the mid-point of the relevant year).

Year	Index
2011	100
2012	107
2013	110
2014	113
2015	117

Estimate the outstanding claims using the inflation-adjusted chain ladder technique.[9]

Answer: 1182.02

6. CT6 April 2015 Q2

The table below shows cumulative claim amounts incurred on a portfolio of insurance policies.

Accident Year	Development Year			
	0	1	2	3
2011	1,509	1,969	2,106	2,207
2012	1,542	2,186	2,985	
2013	1,734	1,924		
2014	1,773			

Annual premiums written in 2014 were 4,013 and the ultimate loss ratio has been estimated as 93,5%. Claims can be assumed to be fully run off by the end of development year 3.

Estimate the total claims arising from policies written in 2014 only, using the Bornhuetter-Ferguson method.

Answer: 3225.01

7. CT6 April 2016 Q5

(i) Explain why insurance companies make use of run-off triangles.

(ii) The run-off triangle below shows incremental claims incurred on a portfolio of general insurance policies.

Policy Year	Development Year			
	0	1	2	3
2011	4,657	3,440	931	572
2012	6,089	5,275	1,381	
2013	5,623	4,799		
2014	7,224			

Calculate the outstanding claims reserve for this portfolio using the basic chain ladder method.

Answer: 11,250

8. CT6 September 2016 Q8

The table below shows incremental claim amounts paid on a portfolio of general insurance policies, where claims are assumed to fully run off after three years.

<i>Underwriting Year</i>	<i>Development Year</i>			
	<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>
2012	504	286	110	35
2013	621	302	120	
2014	685	340		
2015	801			

Past and projected future inflation is given by the following index (measured to the mid-point of the relevant year).

<i>Year</i>	<i>Index</i>
2012	100
2013	103
2014	105
2015	106
2016	105
2017	107
2018	110

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Estimate the outstanding claims reserve using the inflation-adjusted chain ladder technique.

Answer: 827.0

9. CT6 April 2017 Q8

(i) Write down the general form of a statistical model for a claims run-off triangle, defining all terms used.

The table below shows the cumulative incurred claim amounts on a portfolio of insurance policies.

<i>Underwriting Year</i>	<i>Development Year</i>		
	<i>0</i>	<i>1</i>	<i>2</i>
2014	3,215	6,847	10,078
2015	2,986	7,123	
2016	4,167		

Claims are assumed to fully run off after Development Year 2. The estimated loss ratio of both 2015 and 2016 is 91% and the respective premium income in each year is:

Premium Income

2014	11,365
2015	12,012
2016	12,867

The total of claim amounts paid to date is 21,186 from policies written in 2014 to 2016.

(ii) Calculate the outstanding claim reserve for this portfolio using the Bornheutter-Ferguson method.

Answer: 11864

10. CT6 October 2017 Q5

The table below shows the cost of claims settled per calendar year for a set of car insurance policies, with figures in €000s.

<i>Accident Year</i>	<i>Development Year</i>		
	<i>0</i>	<i>1</i>	<i>2</i>
2014	5,419	908	239
2015	6,234	1,088	
2016	7,719		

The corresponding number of settled claims is as follows:

<i>Accident Year</i>	<i>Development Year</i>		
	<i>0</i>	<i>1</i>	<i>2</i>
2014	760	98	37
2015	819	93	
2016	881		

(i) Calculate the outstanding claims reserve for this portfolio, using the average cost per claim method with grossing up factors.

(ii) State four key assumptions made in part (i).

Answer: 1,938k



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11. CT6 April 2018 Q4

The table below shows the cumulative incurred claims by year for a portfolio of general insurance policies, with all figures in £m. Claims paid to date total 13.5. The ultimate loss ratio is expected to be in line with the 2013 accident year, and claims are assumed to be fully developed by the end of Development Year 3.

<i>Accident Year</i>	<i>Development Year</i>				<i>Earned Premiums</i>
	<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	
2013	3.01	3.38	3.85	4.00	4.32
2014	3.30	3.67	4.15		4.41
2015	3.32	3.86			4.55
2016	3.74				4.68

Calculate the total reserve required to meet the outstanding claims, using the Bornheutter-Ferguson method.

Answer: 4.13m

12. CT6 September 2018 Q5

The cumulative claim amounts incurred on a portfolio of motor insurance policies are as follows:

<i>Accident Year</i>	<i>Development Year</i>			
	<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>
2014	3,907	5,606	6,061	6,145
2015	4,831	7,319	7,470	
2016	6,042	8,282		
2017	7,061			

The cumulative number of reported claims are as follows

<i>Accident Year</i>	<i>Development Year</i>			
	<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>
2014	435	469	528	534
2015	485	525	541	
2016	509	558		
2017	544			

- (i) Estimate the ultimate number of claims, for each accident year, using the chain-ladder technique.
- (ii) Estimate the ultimate average incurred cost per claim, for each accident year, using the grossing-up method.
- (iii) Calculate the total reserve required, using the results from (i) and (ii), assuming that claims paid to date are 19,544.

Answer: (iii) 13,775

15. CM2A September 2019 Q9

- (i) Write down the general form of a statistical model for a claims run-off triangle, defining all terms used.

The table below shows the cumulative incurred claims on a portfolio of insurance policies.

<i>Accident Year</i>	<i>Development Year</i>		
	<i>1</i>	<i>2</i>	<i>3</i>
2016	130	180	190
2017	140	185	
2018	150		

The company decides to apply the Bornhuetter-Ferguson method to calculate the reserves, with the assumption that the Ultimate Loss Ratio is 80%.

Claims are assumed to be fully run off by development year 3. The earned premium for 2018 is 300 and the paid claims for 2018 are 100.

- (ii) Calculate the reserve in respect of the accident year 2018.

Answer: (ii) 121.8

16. CM2A September 2020 Q5

The run-off triangle below shows cumulative claims incurred on a portfolio of general insurance policies.

<i>Accident year</i>	<i>Development year</i>		
	<i>0</i>	<i>1</i>	<i>2</i>
2017	2,440	3,294	3,788
2018	2,065	2,849	
2019	2,158		

Past and projected future inflation is given by the following index (measured at the midpoint of the relevant year).

<i>Year</i>	<i>Index</i>
2017	100
2018	105
2019	109
2020	116
2021	123

Calculate the outstanding claims using the inflation adjusted chain ladder method.

Answer: 1689.99

17. CM2A April 2021 Q4

(i) Explain the similarities and differences between the basic chain ladder method and the inflation-adjusted chain ladder method for calculating run-off triangles. [3]

(ii) Discuss when it may be more appropriate to use the inflation-adjusted chain ladder method than the basic chain ladder method.

(iii) Discuss possible reasons why neither method may be appropriate for calculating run-off triangles.

18. CM2A April 2022 Q2

(i) Define the term 'loss ratio' as used in the Bornhuetter–Ferguson method for estimating outstanding claim amounts.

The run-off triangle below shows cumulative claims incurred on a portfolio of insurance policies.

<i>Accident year</i>	<i>Development year</i>		
	<i>0</i>	<i>1</i>	<i>2</i>
2017	864	1,011	1,072
2018	798	915	
2019	820		

Annual premiums written for accident year 2019 were 1,520 and the ultimate loss ratio is assumed to be 92.5%. Claims can be assumed to be fully run off by the end of development year 2.

(ii) Calculate the total claims arising from accidents in 2019, using the Bornhuetter–Ferguson method.

1 year later, an unexpected event has resulted in higher claims than expected. The run-off triangle is now as shown below.

<i>Accident year</i>	<i>Development year</i>		
	<i>0</i>	<i>1</i>	<i>2</i>
2018	798	915	1,320
2019	820	1,412	
2020	1,016		

(iii) Calculate the revised total claims arising from accidents in 2019, using the Bornhuetter–Ferguson method.

(iv) Discuss the implications of your answer to part (iii) for the insurance company.

Answer: (ii) 1081.68, (iii) 1843.37

19. CM2A September 2022 Q7

The run-off triangle below shows the cumulative claims incurred on a portfolio of general insurance policies.

<i>Accident year</i>	<i>Development year</i>			
	<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>
2018	1355	1876	2140	2288
2019	1456	2007	2232	
2020	1412	1986		
2021	1347			

The claims inflation over the 12 months up to the middle of the given year is as follows:

<i>Year</i>	<i>Rate (%)</i>
2019	2.00
2020	1.80
2021	2.40

It is estimated that corresponding claims inflation rates for future years will be as follows:

<i>Year</i>	<i>Rate (%)</i>
2022	2.80
2023	2.60
2024	1.90

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(i) Calculate the outstanding claims, using the inflation-adjusted chain ladder method.

(ii) Explain how you could validate whether the method in part (i) is appropriate for modelling this portfolio.

Following a review, the insurer has decided to reduce the number of staff working on claim settlement.

(iii) Discuss, without performing further calculations, how you may adapt your calculations in part (i) to reflect this change.

The law requires the insurer to hold a reserve higher than the expected future claims to allow for possible adverse experience. The required reserve is $1.75 \times$ the present value of expected claims. Claims are assumed to be paid halfway through each year.

(iv) Calculate the required reserve using the following discount rates: (a) 3% p.a. (b) 4% p.a.

Answer: (i) 1,480.68, (iv)a) 2,518.75, b) 2,495.69



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