INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

15th May 2015
Subject ST8 - General Insurance: Pricing
Time allowed: Three hours (14.45* – 18.00 Hrs)
Total Marks: 100

INSTRUCTIONS TO THE CANDIDATES

1) *Please read the instructions on the front page of answer booklet and instructions to examinees sent along with hall ticket carefully and follow without exception*

2) ** You have 15 minutes at the start of the examination in which you are required to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have three hours to complete the paper.*

3) *You must not start writing your answers in the answer sheet until instructed to do so by the supervisor.*

4) *The answers are not expected to be any country or jurisdiction specific. However, if examples/illustrations are required for any answer, the country or jurisdiction from which they are drawn should be mentioned.*

5) *Attempt all questions, beginning your answer to each question on a separate sheet.*

6) *Mark allocations are shown in brackets.*

7) *Please check if you have received complete Question Paper and no page is missing. If so, kindly get new set of Question Paper from the Invigilator.*

AT THE END OF THE EXAMINATION

Please return your answer book and this question paper to the supervisor separately.

Q. 1)   Describe the features of fronting arrangements.   **[2]**

Q. 2)   Major automobile manufacturers in a country are launching new car models that feature driverless, or self-driving, technology after successful testing. The technology also features various elements such as park assist, collision avoidance system etc in many of these new products. The products are also expected to be well received by the consumers.

Briefly describe any four ways in which the insurance market would be impacted by this technology with respect to product coverage and pricing.   **[5]**

Q. 3)   You are an actuarial trainee and are trying to model the claim rates for motor insurance policies using generalized linear models (GLM). You have fitted following GLMs to a particular data set of 40 drivers. You have also calculated the scaled deviances given below:

Model	Linear predictor	Scaled deviance
X	$\eta_i = \alpha$	78.07
Y	$\eta_i = \begin{cases} \alpha \ for \ i = 1,2..,20 \\ \beta \ for \ i = 21,27,..40 \end{cases}$	71.24
Z	$\eta_i = \alpha_i$	51.11

i)   Explain briefly these models.   (1.5)

ii)   Assess whether or not the following statements are correct:

- Model Y is a significant improvement over Model X
- Model Z is a significant improvement over Model Y   (3.5)

[5]

Q. 4)   Describe the main characteristics of Director and Officers (D&O) insurance, with respect to the coverage, exclusions, perils covered, claim characteristics, exposure measure, rating factors etc.   **[6]**

Q. 5)   You are studying the claims severity trend for liability claims towards third party deaths that are covered by Motor insurance.

i)   Briefly explain how wage inflation and judicial inflation are the two key drivers of claims inflation.   (2)

ii)   What is the advantage in studying the trend of average settlement amount (including part payments in the past) per claim by Settlement Year?   (1)

iii)   State the problem in considering only the overall averages for trends by year without the effect of underlying variables.   (1)

iv)   Briefly outline the steps in using a GLM to identify only the component of judicial inflation trend in the past data.   (3)

[7]

Q. 6)   A general insurance company underwrites only a single class of business, commercial property insurance. The premium is determined by the underwriters by selecting an appropriate base rate for the building occupancy. This base rate is further adjusted depending on a number of other rating factors.

   i)   List the possible rating factors for commercial property, apart from building occupancy.   (4)

   The underwriters are reviewing the current base rates and also the adjustment factors. An insurance intermediary has a database of historical claims and sum insured values for all of its clients' properties that it can share for this review.

   ii)   List the data that the company would require from this database.   (4)
                                                                                                  [8]

Q. 7)   Claim counts follow Poisson (λ) distribution. Claim amounts follow Exponential (θ) distribution. Insurer charges 120% of expected loss as the premium to the customer.

   The insurer is purchasing Individual Excess of Loss reinsurance with retention level 'M'. Reinsurer charges 150% of its expected loss as reinsurance premium.

   Parameters λ and θ are assumed to be known. The insurer is trying to establish the optimal value of M. Assume zero expenses, zero acquisition charges, zero investment income etc.

   The objective is to select that value of M which minimizes E [exp {-(P-P_R-S_I)}] where:

   - P represents the total premium charged to the customers
   - P_R represents the total premium charged by the reinsurer
   - S_I represents the aggregate claims to the insurer, net of reinsurance

   i)   Briefly explain, using an example or otherwise, that the criterion being used by the insurer to deduce the optimal value of M indicates 'Risk Aversion' on the part of the insurer.   (2)

   ii)   Derive the value of M that minimizes E [exp {-(P-P_R-S_I)}].   (6)
                                                                                                  [8]

Q. 8)   **i)**   In a population of motorists, the number of claims X_i caused by policyholder i ($i = 1,..,n$) has a Poisson distribution, i.e., $X_i|\theta_i \sim$ Poisson (θ_i). However, the prior distribution $\pi(\Theta)$ is not known.

   Find the credibility factor that should be assigned to one year of experience for a policyholder. Use Bühlmann - Straub Formula with estimates for $E[Var(\Theta)]$ and $Var[\mu(\Theta)]$ based on the sample mean and sample variance from the sample data of number of claims by policyholder. The sample mean was observed to be 0.2 and sample variance to be 0.25. Use the following equation to find the estimate for $Var[\mu(\Theta)]$: $Var(X_i) = Var[\mu(\Theta)] + E[Var(\Theta)]$ (4)

    ii) Name any one advantage and one disadvantage of various choices of Complement of Credibility in pricing the primary insurance layer for a particular class of risk of a liability product: (4)

        a) Loss Cost of a larger group that includes the class
        b) Loss Costs of a related large risk class
        c) Existing Rates adjusted for frequency and severity trends
        d) Competitor's rates for this class of risk

        [8]

Q. 9) A general insurance Company X coinsures one risk with Company Y. It has a sum insured of 75 Crore but an expected maximum loss (EML) of 2.5 Crore. Company X accepts 40% of this risk and Company Y 60%.

Company X reinsures 5% of every risk under a quota share treaty with Company R1. It is agreed that Company X will not write business for which its gross share of the EML exceeds 1.25 Cr.

Company X also has a three line surplus treaty with companies R2 and R3, each taking 50%, which operates after the quota share, and is based on Company R1 taking 5% of Company X's gross business. The surplus treaty has a maximum EML retention of 25 Lakhs.

A single large claim gives rise to a loss of 3.75 Crores.

    i) Calculate the amount of the claim which Company X will pay, net of all reinsurance recoveries due. State any assumptions you make.   (5)

    ii) Explain how your answer to (i) would differ if, immediately prior to this claim, Companies Y and R2 were declared insolvent.   (4)

        [9]

Q. 10) An Insurer that writes Private Car Insurance for Own Damage is now providing the customers an option of selecting one of a fixed set of amounts as voluntary deductible.

This insurer charges the premium for Own Damage cover on the basis of a variety of rating factors. This insurer is also introducing No Claim Bonus for customers with claims-free experience. Customers are offered a reduction in their premiums subject to claims-free experience in the previous policies. The extent of discount varies by the duration of claims-free period before the renewing policy.

For customers eligible for No Claim Bonus (NCB), the insurer is also offering the choice of an add-on called 'NCB Protection'. Under this feature, No Claim Bonus for the future policies is unaffected if there is exactly one claim during the current policy period. If there are two or more claims under the current policy, no bonus is offered at renewal.

    i) What are the main advantages to the insurer and the customer with the option of the voluntary deductible?   (2)

ii) For the purpose of practicality and ease of implementation of premium reduction due to voluntary deductible, the insurer is considering one of the following two options only:

- A fixed percentage on premium before deductible, with discount percentage varying by the amount of voluntary deductible but same for all models
- A fixed amount of premium, with the discount amount varying by the amount of voluntary deductible but same for all models

Which of these two options is more appropriate and why?   (2)

iii) List the advantages to insurer and customer due to No Claim Bonus system.   (3)

iv) Briefly explain how the NCB system relates to credibility theory.   (2)

v) List the two items that have to be considered in the estimation of cost to the insurer due to NCB Protection. Also list one challenge, for each of these two items, with respect to their estimation.   (4)

[13]

Q. 11) i) Briefly explain the following in the context of Generalized Linear Models (GLM):

a) Near-Aliasing   (2)

b) Grouping of various levels of a factor   (2)

c) Parameter smoothing   (2)

ii) A Generalized Linear Model (GLM) is fitted to the hypothetical data given below. The responses are assumed to be independent and to follow normal distribution with common variance σ^2. The log-link function is used in the model.

Sr. No.	Variable X_1	Variable X_2	Response Variable Y
1	0	0	1000
2	0	1	800
3	1	0	2000
4	1	1	1400

Show that the estimates given below for the parameters below maximize the likelihood:

$\hat{\beta}_0 = 6.944656$, $\hat{\beta}_1 = 0.64635$ and $\hat{\beta}_2 = -0.32745$ where:

- β_0 *is the intercept parameter,*
- β_1 *is the parameter on Variable X_1 and*
- β_2 *is the parameter on Variable X_2*   (8)

[14]

Q. 12) A general insurance company is in the process of pricing an insurance policy for the property portfolio of a large commercial entity. The company has decided to price the layer based on the experience of this risk. The coverage is 25 Crore excess of 2,500,000 per loss. The company has insured the risk for many years, in which time the coverage has always remained the same.

   i) List down the various components of risk premium and office premium   (3)

   ii) Describe the various adjustments that are required to be made to the base data for pricing the policy and comment on appropriateness of using open and closed claims data for pricing the policy.   (8)

   iii) Suggest how the claims data might be adjusted for pricing the following policy options.   (4)

        a) Increasing the excess
        b) Lowering the excess
        c) Lowering the limit
        d) Increasing the limit   **[15]**

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