Actuarial Society of India

EXAMINATIONS

June 2005

ST3 –General Insurance

Indicative Solution

1. (i) Let us denote living area of the policyholder by B and the area of accident by A. The living area can be either Metro-city or other cities and towns. Similarly, the area of accident is denoted by M and C. Then, we are given that

P (A=M | B=M)= 0.8
P (A=C | B=M)= 0.2
P (A=M| B=C)= 0.3
P (A=C | B=C)= 0.7
P (B=M)= 0.75
P (B=C)= 0.25 [1]

Required probability is P (B=M | A=C)

Bayes' theorem can be stated as
P ($X=x_0$ | Y=y)= P ($X=x_0$) P (Y=y| $X=x_0$) / ∑ P (X=x) P (Y=y| X=x) [1]
Hence required probability,
P (B=M | A=C)= P (B=M) P (A=C|B=M) / (P (B=M) P (A=C|B=M)+ P (B=C) P (A=C|B=C))

= .75×.2 / (.75×.2+.25×.7) =.4615 [1]
Total [3]

1. (ii) (a)

- Assumptions of EBCT Model 1 may not hold good; in particular aggregate claim distributions under different group policy contracts may differ widely. [1]
- The variability within the "affected groups" (groups where credibility factor reduced) may have increased during the last policy year due to restructuring within such affected group or due to changes in factors influencing claim numbers or amounts, e.g. an increase in the proportion of hospitalization cases. As **E [s^2(è)]** increases, **Z** decreases. [1]
- Variability between different group policies may have decreased. This may be quite normal with increases in volumes within each group over the years. A decrease in **var[m(è)]** decreases **Z**. [1]
- Although the number of observations (i.e. number of policy years) have increased the NET effect could be a decrease in **Z**. For example, second policy year to third policy year, an increase of more than 50% in the value of **E [s^2(è)] / var[m(è)]** would produce such result. [1]

Total [4]

1. (ii) (b)

- EBCT Model 1 is not suitable. EBCT Model 2 or other robust model which aims to incorporate claims and premium volumes data would be considered and trial calculations carried out for different group sizes

with past data and likely future experience to examine suitability of model and refinements which might be needed. [1]

- Analysis of past experience, especially for the targeted new groups in the range 100 to 999, of claim numbers, mean claim amounts, variance within individual groups and variance between groups would be made. Also need to gather market data to the extent available for experience of all groups and in particular groups in the range 100 to 999. [1]
- If modification of experience rating system is to be done along with a review of premium rates for different types and sizes of groups, need to work on both together. Analysis of past experience stated above would have indicated the need for review, if any, of initial premium quotations on introduction of a new scheme for the first time. [1]
- Other aspects to be considered:
    - do we recognize past experience with a previous insurer? (most likely, yes)
    - problems of policyholders on transition from existing scheme to new scheme (they would prefer whichever is better)
    - changes required for IT systems, accounting and admin procedures
    - whether expenses of management are correctly recoverd?
    - How to absorb or cross-subsidise losses, if any from schemes with less than 100 group size?
    - Need to develop suitable communication to existing policyholders about proposed change [1/2 each, 3]

- Need to carry out some form of simple simulation on the expected profit for the portfolio as a whole over the next 3 to 5 years, particularly to bring out a worst case, best case and an expected average scenario. [1]

[Total 8]

Total for question 1: [15]

2 (i)
Claim A:
Retained under Surplus (30/40)×25=18.75
Retained after QS 0.7×18.75=13.125
Retained after XOL = 13.125

Claim B:
Retained under Surplus (30/125)×175=42
Retained after QS 0.7×42=29.4
Retained after XOL = 29.4

Claim C:
Retained under Surplus (30/80)×75=28.125

Retained after QS 0.7×28.125=19.6875
Retained after XOL = 19.6875

(Note: XOL limit too high for any of the 3 claims) [1 for each claim]

Total claim retained by direct insurer= 13.125+29.4+19.6875=62.2125

Limits for surplus treaty are: 1.2×35=42 and 1.5×35=52.5

Recovery from surplus reinsurer is 0.9×52.5=47.25 [1] Total [4]

2. (ii) (a)
Motor: Total loss/ damage to vehicle, death of or injury to self/ occupants
Property: Damage- wide range
Marine: Damage under hull insurance, loss of/ damage to cargo
Health and PA: Sickness consequent to event, loss of/ injury to limbs
Rural/ Other: Loss of/ damage to fishing boats, equipment. Death of insured
1 each, [5]

(ii) (b) x)

- Reinsurer appears to have obviously increased his premium loading factor î substantially. In theory, retention of entire risk under such circumstances will maximize the value of the adjustment coefficient. [1]
- Although, not renewing the CAT cover increases expected profit, any internal reserves set up would reduce the expected profit. [1]
- The insurer is quite possibly, a medium sized company with a reasonably good solvency position. However, future business plans / volumes need evaluation in the light of recent experience and possible steps for wider dispersion of location of risks to be considered. [1]
- In particular, large property risks and concentrations in areas identified as highly risk prone to Tsunami or other catastrophes to be avoided/ minimized. Also, rural/ other risks covering fishermen and occupations specific to coastal areas to be minimized. [1]
- Setting up internal reserves is hopefully a temporary measure. For, as business volumes grow higher and higher, internal reserves required would also increase. Then, it may not be possible to maintain the security/profit trade-off in the long run. Whenever reinsurance rates ease, decision could be reviewed. [1]

Total [5]

y)

- Estimate expected CAT losses for current/ future business volumes using current experience. For this, consider exposure by post-codes particularly risky on Tsunami and other catastrophes. Some increases in current claim amounts/ sums insured but recurrence of event with similar magnitude in the next 3 years less likely. [2]

- Estimate **U** (initial surplus) using a hypothetical but relevant theoretical distribution of CAT risk. [1]
- Compare with outgo on reinsurance using new rates quoted by reinsurer. [1]
- Consider possibility and degree of increase in premium loading factor (direct insurer's) over next few years and set off any gains in security by this against **U.** [1]
- No increase in adjustment coefficient; increase, if at all. Marginal reduction in profit, if not maintain profit position. [1]
- Tax relief, if any and interest to be earned on internal reserves to be taken in to account in the calculations. [1]
- 2 or 3 alternatives indicating implied security level and profitability position may need to be presented to the Board. [1]

Total [7]
Total for question [21]

3. (i) (a)
UPR= $GP\times(1-AC)\times(1-t^2/n^2)$
Where GP is the gross premium instalment under the policy
AC is the acquisition costs as a proportion of GP
t is the number of days elapsed since inception of risk as on the date of valuation
n is the number of days from due date of instalment premium to the end of the policy period [2]
The formula will be applied to each instalment of premium separately and UPR under any policy will be the sum of amounts so calculated for each instalment premium already received as on date of valuation. [1]
Reasons:

- Incidence of risk is not uniform and generally higher towards the end of the period of cover. [1]
- Policy conditions such as those on extension of cover period, termination of policy and adjustment of sum insured do not seem to place any burden on insurer and hence no adjustment for UPR. [1]
- Equality of instalments of premium might pose some burden but possibly the first instalment would allow for any srain caused on this score. [1]

Total [6]
Note for marking: Any other suitable formula may be accepted.
(b)

- Ideally, under every policy, changes (increases and decreases) in value of work for exposure to risk, need to be notified by policyholder in order to provide for correct UPR. Most/ many policyholders may not fulfill this, even if appropriate provision is there in the policy. [1]
- Changes in risk incidence under individual policies would almost certainly not correspond to value brought by formula. However, steps to see that errors become compensatory in direction and that the overall UPR is good enough, have to be taken by continuous review of formula *vis a vis* actual position by possibly inspections either at claim stage or as a random process. [1]

- Some projects might be particularly exposed to weather related risks. The formula does not provide for effects of such seasonality. An exercise once in, say, every three years may be carried out to identify nature of projects affected and the degree to which such exposure arises, so as to modify the formula by use of a differently decreasing progression. [1]
- Policies can be marked in the computer system as falling under one of, say, 3 or 4 types of projects and different mathematical formula used for each type. [1]

3 (ii)

- Company in 5th year; claims not fully run off- basic CL not suitable? [1/2]
- Differences in claim data between statistical file and accounts file [1/2]
- Inflation lower than 5% in previous years from which data drawn for basic CL? [1/2]
- Change in business mix: evidence in question. Private car and other (possibly commercial vehicles) give rise to higher amounts and frequency? [1]
- Half-yearly reviews and improvements for case estimates reflect real picture, especially social/ legal environment better than basic CL? [1/2]
- Large/ CAT claims in latest development year not fully reflected in paid claims data? [1/2]
- Liability not yet developed/ paid reflected better in IBNR? [1/2]
- Company's case procedure quicker in detecting new information and worsening cases? [1/2]
- Business growth cause of lower quality of business and higher average claim amount- not reflected in basic CL? [1/2]
- How does basic CL data account for allocated costs ? [1/2]
- How is impact of reinsurance allowed in basic CL? [1/2]

Total [6]

4 (i)

Measure of exposure: Sum insured; may not be feasible to verify other measures such as weight of cargo [1]

Risk factors: (Factors which have a bearing on risk)

- Nature of cargo
- Mode of transport (road, rail, air, inland water, sea)
- Transporter's reputation
- Distance involved in transport
- Packaging standards
- Size/ volume of cargo [1]

Rating factors: (Factors used for premium rating)

- Nature of cargo
- Mode of transport
- Sum Insured
- Distance for transport [1]

Underwriting: Depends on rating factors. Proposal form seeks information relating to risk factors such as about transporter, packaging, etc. Where replies are deemed as not standard, premium rate may be increased or risk rejected. For high value cargo, inspections may be carried out. [2]

Exclusions: Terrorism, nuclear risks and cargo involving legally prohibited activities. [1]

(ii)

Answer given in tabular form below:

Benefit reference in question	Response of policyholder	Advantage to insurer	Disadvantage to insurer
A	May be seen as value addition	Helps increase market share	Cost of arrangements compared to extra premium may not be good. Implications of any legal responsibilities arising.
B	May be seen as value addition but could be low take up rate	Helps increase market share. Additional premium useful to cover costs	Fixing maximum on indemnity levels difficult. Deductible placed, if any, may not be liked by policyholder. Definition of personal belongings a problem?
C	May be seen as value addition. Combined frequency of accident + theft high enough, say 30%. Good take up rate?	Helps increase market share. Help higher renewal rate. Good additional premium	Cost of hire car subject to inflation. Control on expected period of use of hire car difficult. Customers' dissatisfaction on type/ individual status of hire car provided.

½ mark for each point. Max [9]

5. Fixed costs and net reinsurance costs are not available separately for private car and other vehicles.

Fixed costs may be apportioned based on numbers of vehicles. So, for private cars fixed costs are: 113474×(15065÷277905)= 6151.33 [1/2]

Net reinsurance costs are 7125, i.e. 7125÷356300= 2% of gross written premiums
This proportion can be used for private car also. [1/2]
There is no universal method of using information on SD of claim amount. One way is to aim for 55% of cases to be within the range for the charge and hence load for 12.6%* of the SD. (* derived from normal distribution). [1]
(Note: Aim at a high confidence level and be sure to get rejected in the market.)
Pure risk cost-current= (mean+.126×SD) ×claim frequency= (15000+.126×17000) ×0.375= 6428.25 [1/2]
Pure risk cost with claim inflation for half year= $5142.6\times1.03^{½}\times1.09^{½}$= 6811.22

Acquisition costs for private car are 20000÷127800= 15.65% of premiums

Assumed profit loading= 3% of premiums. [1/2]

Required premium= $(6811.22+(6151330\div15065)\times1.06^{½}))\div(1-.1565-.02-.03)$ = 9113.55
[2]

Check: The premium rate collected on existing number of vehicles of 15065 would give about 7.5% more GWP than what is being received. [1]
Max. [6]

6. 2004 claims paid for travel are 7 months of claims because of 3 months delay in start date plus 2 months for payment. Similarly for pet care 4 months of claims.
Paid claims are:
Travel (7÷12)×.65×40=15.167
Pet care (4÷12)×.8×11=2.933 [1]

Outstanding reported claims are 1 months claims
Travel (1÷12)×.65×40=2.167
Pet care (1÷12)×.8×11=0.733 [1]
IBNR claims are also 1 months claims due to 1 month reporting delay [1]

For 2004, claims incurred= claims paid+outstanding reported+IBNR
For 2005, claims incurred= claims paid-outstanding reported 2004-IBNR 2004
[1]
We now have the following:

Item	Travel	Pet care
Written premium	40	11
Earned premium 2004	30	5.5
UPR 2004	10	5.5
Earned premium 2005=UPR 2004	10	5.5
Total incurred claims	26	8.8
2004 incurred claims	19.5	4.4
2005 incurred claims	6.5	4.4

DAC at 20% of UPR	2	1.1

[2]

Profit and Loss accounts (Travel+ Pet care)

Item	2004	2005
Earned premiums	35.5	15.5
Incurred claims	(23.9)	(10.9)
Expenses=commission + other	(12.2)	(1.0)
Increase in DAC	3.1	(3.1)
Investment income	1.7	2.0
Premium taxes	(2.55)	0
Profit	1.65	2.5
Tax on profit	.165	.25
Net profit	1.485	2.25

[2]

Assets at 31.12.04

Assets at 1.1.2004	10
+Premiums	51
-paid claims	18.1
-expenses paid	12.2
+Investment income	1.7
-Tax paid	2.715
Assets at 31.12.2004	29.685

[1]

Balance sheet at 31.12.2004

Assets	29.685	Liabilities	
DAC	3.1	UPR	15.5
Total	32.785	O/S	2.9
		IBNR	2.9
		SH	10.0
		SH increase	1.485
		Total	32.785

[1]

7. (i)

- For each class, matching of term of assets to term of liabilities to the extent feasible. For example Motor would be short(1 year or less) to medium (1 to 5years). Liability would be long (5 or more but much of it < 10years). Property and Health is mainly short term. Overall term decided by overall mean term, if match by class difficult due to small volumes in some class. [1]
- Liability figures may include solvency margin applicable to class. Free assets in excess of solvency margin would be absorbed partly in certain set up costs and

balance to be invested to maximize investment return, but within regulatory limits. [1]

- Claim inflation different for each class, e.g. would be high in liability and low in property. Liability figures to allow for such inflation. [1]
- For each class, any mismatch between assets and liabilities to be considered as additional requirement of solvency margin for class and invested for class specific asset type and term. [1]
- Fluctuations in interest rates affect values of government securities also, unless allowed to be valued as held to redemption. To reduce impact of volatility in values, best management of investments with regard to timing of purchases and sales is necessary. [1]

Total [5]

(ii) A stochastic model is to be used so as to study variability of outcome on key aspects of business such as volumes and market rank, solvency and profit. [1/2]

The model could be oriented as a profit testing model or as a tactical level model, depending on purpose. [1/2]

Profit testing would involve claim costs split by nature, cause, etc. NB, renewal, lapse rates, acquisition costs, claim handling expenses, admin. Expenses, sales incentives, sales costs and external factors. [1]

Tactical level model may deal with evaluation of a project such as timing of next stage of computerization, effect on total and unit production costs, etc. [1]

There would be a stochastic scenario generator with, say, 5 cmponents.

- Interest rate: Short term rates, term structure, general inflation, change in inflation by class of business and stock returns [1]
- Non- catastrophe losses: Mean frequency, SD of frequency, mean claim amount of individual claim, SD of claim amount, cumulative change in claim frequency and cumulative change in claim amount [1]
- Catastrophe losses: Mean number of CAT losses, variance and total loss per event (gross of reinsurance) [1]
- Underwriting cycles: Time lag effect of pricing decisions, trends and short term variations, market values of assets and market ranking transition rates to reflect strength of competition. [1]
- Payment patterns: Data by accident year and development year. [1]

In respect of each sub model, the model and the parameters for the stochastic process would be monitored, reviewed and revised as needed, once in a year. [1]

Financial issues concerned with profit measures:

- Decisions on reserving bases and hidden margins have an impact on profit. Consistency in approach from year to year and conformity with published overall accounting policies of company needed.
- Development projects such as recruitment and training, introduction of new IT systems, movement to new premises, etc. have to be evaluated on a reasonable and realistic approach.

- Investment returns and capital appreciation have to be evaluated on a basis seen as acceptable by public and shareholders.
- Each region/ profit center would have its own peculiarities on business mix, productivity level, expense rates, etc. Any uniform measure should be perceived as objective.

1 for each point. Max [3]

Total [12] Up to 2 bonus marks extra for a correct flow chart/ diagram.