1.  (2.25 points)

An insurer uses five geographical Storm Zones (A, B, C, D, and E) in their rating plan. The insurer refines their rating plan using the following approach:

- Divide each Storm Zone into numerous geographical sectors.
- For each geographical sector and storm type, calculate the observed storm frequency as number of storms per year.
    - There are three storm types defined as Moderate, Strong, and Severe storms.

The insurer performs two credibility procedures to produce estimates of the respective storm frequencies in each sector. The first is a multi-dimensional credibility procedure and the second is a single-dimensional credibility procedure (utilizing only a single storm type).

a.  (1.5 points)

The multi-dimensional credibility results for a particular sector in Storm Zone C for Severe storms are given in the table below. The single-dimensional credibility factor is 0.30.

| Storm Type | Coefficient | Storm Zone Mean Frequency | Sector Mean Frequency |
|---|---|---|---|
| Intercept | not provided | | |
| Moderate | 0.05 | 5.30 | 7.10 |
| Strong | 0.12 | 1.40 | 2.40 |
| Severe | 0.20 | 0.73 | 0.69 |

Calculate the mean frequency estimate of Severe storms for each of the two credibility procedures.

b.  (0.75 point)

Fully explain why the single-dimensional credibility estimate in part a. above is lower than the multi-dimensional credibility estimate.

| QUESTION 1 | |
|---|---|
| **TOTAL POINT VALUE: 2.25** | **LEARNING OBJECTIVE: A2** |
| **SAMPLE ANSWERS** | |

**Part a:** 1.5 points

*Sample 1*
multi-dimensional:
   0.73 + 0.2 (0.69 – 0.73) + 0.12 (2.4 – 1.4) + 0.05 (7.1 – 5.3) = 0.932

single-dimensional:
   0.3 (0.69) + 0.7 (0.73) = 0.718

*Sample 2*
VH + b (VZ – VH) + c (WZ – WH) + d (XZ – XH)
severe cred-weighted estimate using multi-cred:
= .73 + .2 (.69 - .73) + .12 (2.4 – 1.4) + .05 (7.1 – 5.3)
= .932

using single dim cred:
.3 * .69 + (1 - .3) * .73
= .718

**Part b:** 0.75 point

*Sample 1*
   Single dimensional is lower because the sector's experience for severe claim frequency is lower than that of the storm zone. However, multi-dimensional credibility is based on the theory that claim frequency for different storm types are related. Since both the moderate & strong storm types have higher frequency experience in the sector compared to the zone, the multi dim credibility is higher than the single dim.

*Sample 2*
   Due to correlations with other storm types, strong and moderate, the sector freq. is greater than the zone freq., the multi-dim uses this info and calculates a higher est. than single cred., which does not use the correlation info.

*Sample 3*
   Weight is given to the relative mean frequency of the sector to the storm zone, and the mean frequencies of the sector for the other two storm types are much higher than the storm zone mean frequencies. This will increase the estimate using multi-dimensional credibility because it assumes high frequencies in other storm types are correlated positively with future frequency for severe storms.

**EXAMINER'S REPORT**

Candidates were expected to understand multi-dimensional credibility and how it differs from single-dimensional credibility, to apply the relevant formulas to calculate credibility-weighted estimates of a particular quantity, and to discuss the drivers of each estimate.

**Part a**

Candidates were expected to correctly calculate both the multi-dimensional and single-dimensional credibility estimates for severe storm frequency in a given sector within storm zone C.

Common mistakes included:
- Reversing the sector and the storm zone
- Applying the wrong "intercept" in the multi-dimensional calculation (0.69 instead of 0.73)
- Calculating relativities to another storm type – or to the total frequency – within the sector and the zone separately before applying the formulas
- Using 0.2 instead of 0.3 for the single-dimensional credibility to be assigned to severe storm types in the sector.

**Part b**

Candidates were expected to provide a detailed rationale for why the multi-dimensional credibility estimate was larger than the single-dimensional credibility estimate.

In order to get full credit, candidates needed to express three primary ideas:
- Storm types are correlated
- Moderate and strong storm types have higher frequency than severe storms
- Moderate and strong storm frequency in the sector is larger than the corresponding frequencies in the storm zone.

Common mistakes included:
- Listing only one reason; in particular, simply noting that severe storm frequencies are likely correlated with moderate and strong storm frequencies
- Omitting a comparison or contrast between the sector frequencies and the storm zone frequencies.