5. (2.5 points)

An actuary estimated the loss cost for workers compensation insurance using a multi-dimensional credibility method.

Given the following:

- There were 2 classes in Hazard Group X.
- There were no major or minor permanent partial losses.
- Premium information was not available.
- Holdout sample of odd years was used as a proxy of the true mean.

Claim Count by Injury Type for Hazard Group X

	Even Year 1			Even Year 2		
Class	Fatal (F)	Permanent Total (PT)	Temporary Total (TT)	Fatal (F)	Permanent Total (PT)	Temporary Total (TT)
Class 1	2	10	1,000	1	12	1,000
Class 2	3	10	1,000	2	13	1,000
Total	5	20	2,000	3	25	2,000

Optimal Weights for Estimation of Permanent Total Injury Ratio

Fatal	Permanent Total
0.2	0.3

a. (1 point)

Determine the ratio of permanent total injury to temporary total injury for Class 2 using a multi-dimensional credibility method.

b. (1 point)

Fully describe the steps involved in performing a quintile test to evaluate the actuary's work.

c. (0.5 point)

Briefly describe one shortcoming of the individual class sum of squared errors test and briefly describe why the quintiles test is a better way to evaluate the actuary's work.

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QUESTION 5

Total Point Value: 2.50 **Learning Objective: A2a, A2c**

Sample Answers

Part a: 1.00 points

Sample 1

$$E[w_2] = E[W] + b_w (V_2\text{-}E[V]) + c_w (W_2\text{-}E[W])$$

$$= \frac{20+25}{2000+2000} + 0.2\left(\frac{3+2}{1000+1000} - \frac{5+3}{2000+2000} \right) + 0.3\left(\frac{10+13}{1000+1000} - \frac{20+25}{2000+2000} \right)$$

Component 1 Component 2 Component 3

$$= 0.011425$$

Part b: 1.00 points

Sample 1

Given a class, group into quintiles by predicted class frequency. Compute the sum of squared errors compared to the holdout sample value for the following 3 predictions: credibility procedure, raw data, hazard group relativity. If the credibility procedure is effective, it should have the lowest sum of squared errors of the three.

Sample 2

Derive ratios for all classes using credibility procedure. Rank all classes from smallest to largest by credibility relativity. Group into quintiles and calculate relativity of quintile ratio to the hazard group ratio for credibility estimate, new estimate, and holdout estimate. Calculate SSE for credibility, raw, and hazard group vs the hold out estimates. Method with the lowest SSE is best approach.

Part c: 0.50 points

Sample 1

There is too much noise in the individual test. Grouping into quintiles diversifies away the class specific variation allowing one to see the effect of the credibility procedure.

Sample 2

Each class is relatively small compared to the hazard group and results can be volatile from class to class, grouping into quintile allows for a more credible evaluation of the results.

Examiners Report

Part a:

Generally, candidate responses fell into one of four categories:

1) Those who followed the prescribed methodology exactly and arrived at the correct final answer.
2) Those who used only one of the two years provided and followed the methodology correctly.
3) Those who used the weights in the problem to arrive at a reasonable estimate but didn't follow the methodology.
4) Those who did not successfully attempt the problem.

Those in group 1 received full credit. Those in groups 2 and 3 received various degrees of partial credit depending upon how far along they were with the calculations. Those in group 4 received minimal partial credit.

Part b:

Most candidates attempted to describe the quintiles test as it applies to the calculation of the multidimensional credibility weighted relativities.

To receive full credit, the candidate should have at the minimum provided the following:

- Sort the credibility weighted relativities.
- Group the classes into quintiles based upon the sorted relativities with similar number of TT claims.
- Calculate the relativities for the three basic methods (credibility, raw, hazard group) by quintile. (This can be shown with formulas of SSE)
- Calculate the SSE for each method against the holdout data relativities, and choose method with lowest SSE.

Partial credit was given for addressing each of these steps in the quintiles test.

Some candidates addressed the quintiles test as it relates to other applications (e.g. experience mods, excess ratios). Some partial credit was given in this case.

Some candidates pointed out that there were only two classes in part a of the problem, so a quintiles test could not be performed. However, part b asked the candidate to describe how such a test would be performed. It did not ask them to calculate it from the data given in part a.

Part c:

Some candidates only addressed the shortcomings of the SSE test, but failed to address why the quintiles test was better. Some candidates only addressed the shortcomings of the quintiles test, but failed to address why the SSE test was better. In both of these cases partial credit was awarded.