Past Exam Problems

1. **2000 Exam 9 - Q32 (3 points)**

   Based on Bailey and Simon's "An Actuarial Note on the Credibility of Experience of a Single Private Passenger Car" and the table below, answer the following.

Merit Rating	Earned Car Years	Earned Premium at Present B Rates	Number of Claims Incurred	Claim Frequency per $1,000 of Premium	Relative Claim Frequency
Private Passenger Automobile Liability - Non-Farmers Class 3 - Business Use					
A	247,424	$25,846,000	31,964	1.237	0.920
X	15,868	$1,783,000	2,695	1.511	1.123
Y	20,369	$2,281,000	3,546	1.555	1.156
B	37,666	$4,129,000	7,565	1.832	1.362
Total	321,327	$34,039,000	45,770	1.345	1.000

   where: Class A - Three or more years claim free
   Class X - Two years claim free
   Class Y - One year claim free
   Class B - Zero years claim free

   (a) (1.5 points)

   Calculate the credibilities for a single private passenger car for one or more years, two or more years, and three or more years claim-free. Show all work.

   (b) (0.5 point)

   Briefly describe the relationship that Bailey and Simon expect between the three credibilities from part (a).

   (c) (1 point)

   Do the credibilities in part (a) follow the relationship described in part (b)? Briefly explain why or why not.

2. **2001 Exam 9 - Q2 revised (1 point)**

According to Bailey and Simon's "An Actuarial Note on the Credibility of Experience of a Single Private Passenger Car," which of the following is <u>false</u>?

(a) The experience for one car for one year has significant and measurable credibility for experience rating.

(b) Credibility for experience rating depends on the variation of individual hazards within the class.

(c) In a highly refined private passenger rating classification system that reflects inherent hazard, there would not be much accuracy in an individual risk merit rating plan.

(d) In experience rating, an increase in the volume of data in the experience period increases the reliability of the indication in proportion to the square root of the volume.

3. **2001 Exam 9 - Q22 (2.5 points)**

Use Bailey and Simon's "An Actuarial Note on the Credibility of Experience of a Single Private Passenger Car," and Hazam's discussion to answer the following questions.

(a) (1.5 points)

Using the information below, calculate the credibility for 1-year and 2-year claim-free periods for Class 1. Show all work.

	Number of Years Claim Free	Earned Premium at Present Rates	Number of Claims Incurred	Earned Car Years
Class 1	2 or more	$5,000,000	7,000	15,000
	1	$7,000,000	10,000	12,250
	0	$1,000,000	2,000	400
	Total	$13,000,000	19,000	27,650

(b) (0.5 point)

What exposure base do the authors use? Explain why.

(c) (0.5 point)

According to Hazam, what two conditions must be met to use the exposure base described in part (b)?

4. ***Good problem*** **2002 Exam 9 - Q47 (2 points)**

    (a) (1.5 points)

    Given the following data, calculate the credibilities for 1-year and 2-year claim free periods.

    A represents 3 or more years since the most recent accident.
    X represents 2 years since the most recent accident.
    Y represents 1 year since the most recent accident.
    B represents 0 years since the most recent accident.

	Earned Car Years	Earned Premium at Present Class B Rates	Number of Claims
A	50,000	$5,500,000	5,000
X	6,500	$682,500	1,000
Y	5,000	$535,000	850
B	4,500	$490,500	900
TOTAL	66,000	$7,208,000	7,750

    (b) (0.5 point)

    Give two possible reasons that the 2-year credibility is less than 2 times the 1-year credibility.

5. **2003 Exam 9 - Q2 (1 point)**

    Which of the following statements is <u>false</u> for private passenger auto experience rating?

    (a) Credibility assigned to an individual risk within a highly refined classification rating plan would be higher than the credibility assigned in a less refined rating plan.

    (b) Credibility for experience rating depends on the amount of variation individual hazard within the class.

    (c) Credibility for experience rating is significant and measurable when based on data from one car for one year.

    (d) Credibility within a highly refined private passenger classification rating system would be larger where a wide range of hazard is encompassed within a classification.

6. **2003 Exam 9 - Q22 (3 points)**

   You are given the following data:

Class	Years since last accident	Actual Earned Premium at Present B Rates	Earned Car Years	Number of Claims
A	3+	375,000	2,500	200
X	2	15,000	100	12
Y	1	22,500	150	20
B	0	37,500	250	38

   Assume that the same rate is charged to all insureds within a class, and there have been no rate changes in or since the experience period.

   (a) (1 point)

      What is the credibility of 3 or more accident-free years of experience?

   (b) (1 point)

      What is the credibility of 1 or more accident-free years of experience?

   (c) (1 point)

      Give two possible reasons why the answer in part (a) is not 3 times the answer in part (b).

7. **2004 Exam 9 - Q2 revised (1 point)**

   Given the following information:

Class	Number of Years Since Most Recent Accident	Earned Car Years	Earned Premium at Present B Rates	Number of Claims
A	3 or more	10,000	$1,000,000	1,000
X	2	7,000	$770,000	1,155
Y	1	5,000	$625,000	1,250
B	0	2,000	$400,000	1,000
Total		24,000	$2,795,000	4,405

   Calculate the credibility of one or more accident-free years of experience.

8. ***Good problem*** **2005 Exam 9 - Q3 (3 points)**

   (a) (2 points)

   Given the following information:

   > N = the number of drivers in the population
   > m = the mean claim frequency of all drivers
   > Mod = the credibility weighted modification factors for risks with one or more claims
   >   in the past year

   Derive the formula for the credibility assigned to the experience of drivers with one or more claims in the past year.

   Assume that claim frequency follows a Poisson distribution.

   (b) (1 point)

   If there is a switch from a less refined class plan to a highly refined class plan, describe the likely change in the credibility assigned to an individual risk.

9. **2006 Exam 9 - Q2 (4 points)**

   (a) (3 points)

   Given the following information about an automobile insurance portfolio:

Group	Number of Accident-Free Years	Earned Premium at Present Group D Rates	Number of Claims Incurred
A	3	$25,000,000	40,000
B	2	$8,000,000	15,000
C	1	$13,000,000	25,000
D	0	$8,000,000	30,000

   Calculate the credibility of a single car for each of the following: one-year, two-year, and three-year accident-free periods.

   (b) (1 point)

   In performing the analysis in part (a) above, would using car years instead of earned premium as an exposure base be more preferable? Explain why or why not.

10. ***Good problem*** **2007 Exam 9 - Q2 (3.5 points)**

   (a) (2 points)

   The following data were compiled from the ABC automobile insurance portfolio:

Group	Number of Accident-Free Years	Earned Premium at Present Group D Rates	Number of Claims Incurred
A	3 or more	$100,000,000	120,000
B	2	$10,000,000	25,000
C	1	$17,000,000	44,000
D	0	$10,000,000	36,000

   Calculate the credibility of a single car for each of the following ranges of accident-free years:

     i 1 or more

     ii 2 or more

     iii 3 or more

   (b) (1 point)

   The following table provides the single car credibility for the XYZ automobile insurance portfolio:

Accident-Free Years	Single Car Credibility
1 or More	0.14
2 or More	0.10
3 or More	0.06

   Discuss two conclusions that can be drawn from the different credibility results of the ABC and XYZ portfolios.

   (c) (0.5 point)

   Explain why analysis of the two portfolios with different classification plans could assign different values to the credibility of the experience of a single car.

11. ***Good problem*** 2008 Exam 9 - Q5 (2 points)

A liability insurer collects the following data for a particular class of private passenger auto risks:

Accident-Free Years	Earned Exposures	Incurred Losses($)
2 or more	2,500	1,000,000
1	500	500,000
0	1,000	2,500,000
Total	4,000	4,000,000

Assume the following:

- The base rate is $1,250 per exposure.
- An experience rating factor is the only factor applied to the base rate.

(a) (1 point)

Calculate the credibility of an exposure that is accident-free for 1 or more years.

(b) (1 point)

Calculate the premium for an exposure that is accident-free for 2 or more years.

12. ***Good problem*** 2009 Exam 9 - Q4 (3.5 points)

The following information can be used to calculate the credibility assigned to the experience of a single private passenger car.

Group	Last Accident	Earned Car Years	Premium at Present B Rates	Number of Claims
A	3 or more	650,000	400,000,000	50,000
X	2	230,000	150,000,000	20,000
Y	1	100,000	75,000,000	12,000
B	0	M	45,000,000	18,000
Total		980,000 + M	670,000,000	100,000

Assume claim counts follow a Poisson distribution.

(a) (2.5 points)

Calculate M, the earned car years for Group B, given that the credibility for an insured that has had no claim-free years is equal to 0.167.

(b) (1 point)

Calculate the credibility for the group of risks that have been claim-free for two or more years.

13. **2010 Exam 9 - Q5 (1 point)**

    An insurance company has a private passenger auto book of business with the following claims experience:

Group	Number of Accident-Free Years	Earned Premium at Present Group D Rates	Number of Claims Incurred
A	3 or more	60,000,000	45,000
B	2	15,000,000	15,000
C	1	20,000,000	29,300
D	0	5,000,000	18,700
		100,000,000	108,000

    Calculate the credibility of a single car for a driver with one or more accident-free years.

14. ***Good problem* 2011 Exam 8 - Q1 (3 points)**

    An insurance company is using a merit rating plan for drivers in two states. State X has the following claims experience:

Group	Number of Accident-Free Years	Earned Premium at Present Group D rates	Number of Claims Incurred
A	3 or more	$500,000	240
B	2	$150,000	125
C	1	$200,000	190
D	None	$300,000	300
Total		$1,150,000	855

    State Y has the following relative claim frequencies for accident-free experience:

Number of Accident-Free Years	Relative Claim Frequencies to Total
3 or more	0.70
2 or more	0.77
1 or more	0.84

    Assuming that no new risks enter or leave either state, use relative credibility to explain which state has more variation in an individual insured's probability of an accident.

15. ***Good problem* 2012 Exam 8 - Q6 (2.5 points)**

An insurance company has a private passenger auto book of business with the following claims experience:

Territory	Years Since Last Accident	Earned Premium at Present Rates for Two Years Since Last Accident	Earned Car Years	Number of Claims	Incurred Loss
1	0	$15,000,000	15,000	5,000	$9,000,000
1	1	$125,000,000	125,000	41,000	$75,000,000
1	2+	$230,000,000	230,000	76,000	$138,000,000
2	0	$25,000,000	25,000	7,000	$16,000,000
2	1	$310,000,000	300,000	84,000	$187,000,000
2	2+	$550,000,000	535,000	147,000	$328,000,000
3	0	$10,000,000	10,000	4,000	$7,000,000
3	1	$80,000,000	100,000	35,000	$43,000,000
3	2+	$160,000,000	170,000	60,000	$100,000,000

Choose an appropriate exposure base for calculating credibility. Justify the selection.

16. ***Good problem*** **2014 Exam 8 - Q5 (2.5 points)**

The following data shows the experience of a merit rating plan for a specific state.

Number of Accident-Free Years	Earned Car Years	Earned Premium ($000)	Number of Incurred Claims
3 or More	250,000	250,000	1,200
2	300,000	100,000	625
1	25,000	100,000	750
0	12,000	150,000	1,500
Total	587,000	600,000	4,075

The base rate is $1,000 per exposure. No other rating variables are applicable.

(a) (0.5 point)

The typical exposure base used to develop the merit rating plan is earned premium. Briefly discuss two assumptions in selecting this exposure base.

(b) (1.5 points)

Calculate the ratio of credibility for an exposure with two or more years accident-free experience to one or more years accident-free experience.

(c) (0.5 point)

Calculate the premium for an exposure that is accident free for two or more years.

17. ***Good problem*** **2015 Exam 8 - Q1 (2.5 points)**

An actuary is evaluating a merit rating plan for private passenger cars. Given the following:

Number of Accident-Free Years	Earned Car Years	Number of Claims Incurred
2 or More	500,000	20,000
1	200,000	15,000
0	100,000	9,000
Total	800,000	44,000

- Frequency varies by territory.
- State law prohibits reflecting territory differences in rating.
- Annual claims for an individual driver follow a Poisson distribution.
- Claim cost distributions are similar across all drivers.

(a) (0.5 point)

Identify one potential issue with the exposure base used. Briefly explain whether or not earned premium would be a better choice for the exposure base.

(b) (1 point)

Calculate the credibility of one driver with one or more year's accident-free experience.

(c) (1 point)

Calculate the credibility of one driver with 0 Accident-Free years.

18. **2016 Exam 8 - Q1 (2.75 points)**

A group of insureds have different expected claim frequencies. The number of insureds claim-free for the past t years is as follows:

Expected Claim Frequency	t=0	t=1	t=2	t=3
0.05	50,000	47,500	45,000	44,000
0.10	50,000	45,000	43,000	36,000
0.20	25,000	20,500	16,500	14,000
Total	125,000	113,000	104,500	94,000

Determine whether the variation of an individual insured's chance for an accident changes over time.

19. ***Good problem* 2017 Exam 8 - Q3 (1.5 points)**

The following data shows the experience of a merit rating plan for private passenger vehicles. The merit rating plan uses multiple rating variables, including territory.

Number of Accident-Free Years	Earned Car Years (000s)	Earned Premium ($000s)	Number of Incurred Claims
5 or More	250	500,000	15,000
3 and 4	100	90,000	13,500
1 and 2	80	60,000	8,000
0	70	50,000	10,500
Total	500	700,000	47,000

Territory	Frequency	Average Premium
A	0.05	1,500
B	0.10	2,000
C	0.15	1,250

(a) (0.75 point)

Recommend and justify an exposure base for this merit rating plan.

(b) (0.75 point)

Calculate the relative credibility of an exposure that has been three or more years accident-free using the exposure base from part (a) above.

20. **2018 Exam 8 - Q3 (2.75 points)**

An insurance company has a private passenger auto book of business with the following claims experience:

Group	Number of Accident-Free Years	Earned Premiums	Current Merit Rating Factor	Number of Claims Incurred
A	3 or more	216,000,000	0.60	25,000
X	2	135,000,000	0.75	18,000
Y	1	63,750,000	0.85	20,000
B	0	200,000,000	1.00	C
Total		614,750,000		63,000 + C

- Claim counts follow a Poisson distribution with parameter $\lambda = 0.05$.
- The credibility for the new policy period for an insured that has had no claim-free years is equal to 0.038.

(a) (1.5 points)

Calculate C, the number of claims incurred for Group B.

(b) (0.75 point)

Calculate the merit rating factor for an exposure that is accident-free for two or more years for the new policy period.

(c) (0.5 point)

Briefly explain two circumstances under which using earned premium as the exposure base would not correct for maldistribution.

21. ***Good problem*** **2019 Exam 8 - Q3 revised (1.75 points)**

An insurance company has a private passenger auto book of business with an experience modification factor in its rating plan.

Given the following:

- Annual claims for an individual driver follow a negative binomial distribution with r = 10.
- The expected claim frequency for the entire book of business is 0.101.
- The credibility for the group of risks that have had at least one accident in the last year is 0.02.

For the negative binomial distribution:

- $f(x) = \binom{x+r-1}{x}(1-p)^r p^x$

- $E[X] = \frac{pr}{1-p}$

(a) (1.25 points)

Calculate the experience modification factor for a policy that has had at least one accident in the last year.

(b) (0.5 point)

Describe why a class with a higher volume of claims and more exposures may have less credibility than a class with fewer claims and exposures.