3. (1.75 points)

The table below shows property claim frequency by year for the last five years. Assume that claim frequencies are Poisson distributed with a mean of 1.5.

Year	Exposures	Frequency
2011	118	1.5
2010	132	1.7
2009	121	1.3
2008	109	1.6
2007	97	1.3

The critical value for the relevant chi-squared distribution is 9.49.

a. (1.25 points)

Calculate the chi-squared test statistic for whether the claim frequency is shifting over time. Interpret the result.

b. (0.5 point)

Describe a second method for testing whether the claim frequency is shifting over time.

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Question 3:

Model Solution 1

a.

Year	Actual	Expected	$(A-E)^2 / E$
2011	118 x 1.5 = 177	118 x 1.5 = 177	0.00
2010	224.4	198	3.52
2009	157.3	181.5	3.23
2008	174.4	163.5	0.73
2007	126.1	145.5	2.59

$$\chi^2 = \sum \frac{(A-E)^2}{E}$$
$$= 10.06 > 9.49$$
$$\Rightarrow \text{Reject } H_0 \text{ and conclude parameter shift}$$

b. Correlation Test: Calculate the correlation between pairs of data for all years, group the correlations by number of years apart between data. If correlations decrease when the number of years apart increases, the claim frequency is shifting.

Model Solution 2

a.

$$\chi^2 = \sum \frac{w_i(O-E)^2}{E}$$
$$= 118\frac{(1.5-1.5)^2}{1.5} + 132\frac{(1.7-1.5)^2}{1.5} + 121\frac{(1.3-1.5)^2}{1.5} + 109\frac{(1.6-1.5)^2}{1.5} + 97\frac{(1.3-1.5)^2}{1.5}$$
$$= 10.06$$

Since the observed χ^2 value is greater than the test statistic of 9.49, we can conclude that the claim frequency is shifting over time.

b. Correlation of Years Test
Create pairs of average frequency values, each separated by *t* years.
Calculate correlation of values at each value of *t*.
If correlation decreases for larger *t*'s, then we conclude frequency is shifting over time.

Examiner's Comments:

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Part a:

For full credit, a candidate had to correctly state and calculate the chi-squared test statistic, as well as correctly interpret this result relative to the given critical value and draw the correct conclusion regarding the parameter shift.

The most common error was not including exposures in the calculation of the chi-squared statistic. Other common errors included incorrectly stating the formula, or using an expected frequency other than the 1.5 given in the problem.

Part b:

Most candidates used the correlation of years test from Mahler, but other solutions were considered if they were well-described and justified.

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