

RMS® CCRA® Training Program

Uncertainty Measures Exercise #2

ANSWER KEY

You are a reinsurer who has been asked to assess the volatility of two catastrophe treaties that are being applied to Pacific Northwest (PNW) and California (CA) earthquake exposed commercial portfolios. You have already characterized the types of sources driving losses in both regions and you know that the average annual loss (AAL) is driven by events between the range of M6.5 and M7.5. In the PNW, however, there are also high severity low frequency events that impact the coast. These events contribute to loss farther out on the tail of the PNW portfolio exceedance probability (EP) curve.

Learning Objectives:

After completing this exercise you will be able to:

1. Assess and explain the differences in volatility for these two treaties.
2. Examine the pricing using your company's pricing guidelines.

Available Materials:

- Exercise 2 Uncertainty Measures.xls
- Post Import Summary report for each portfolio

Below is a summary of the exposure data and the two treaty terms

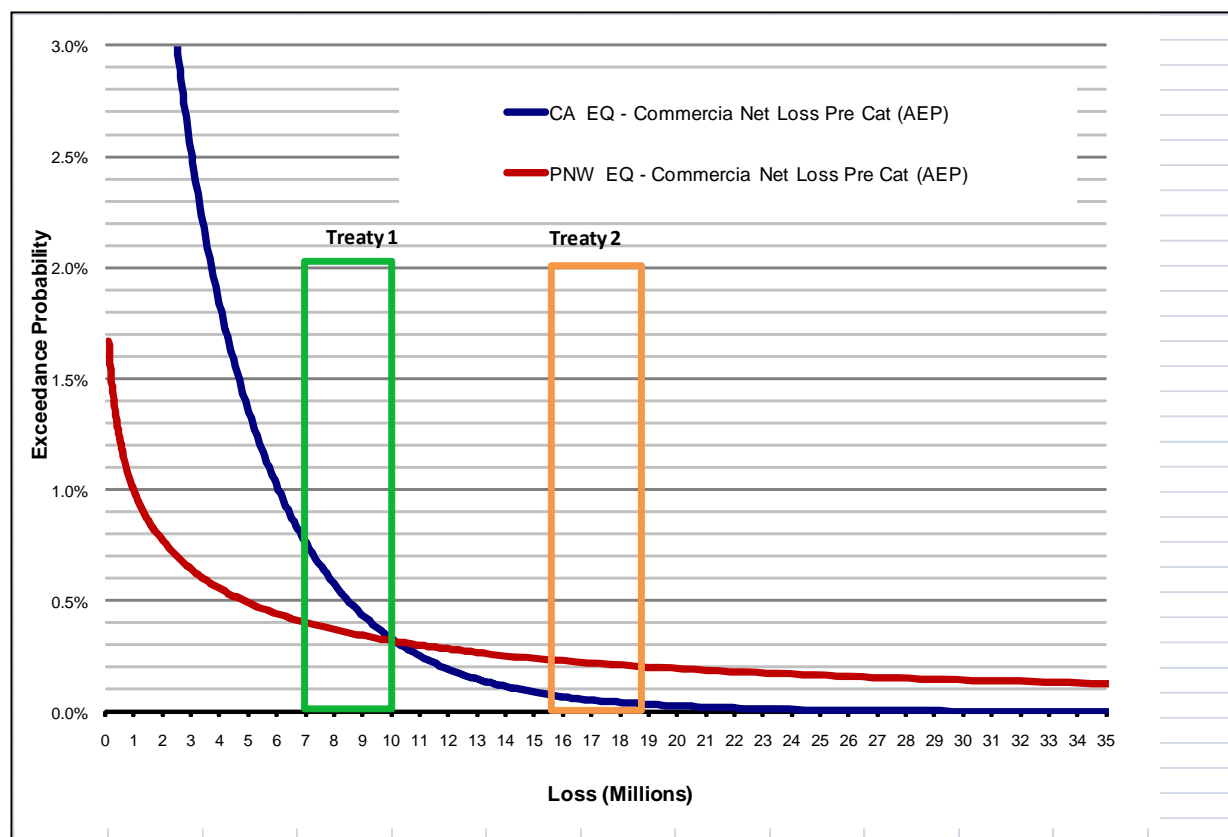
Exposure Data Summary:

	CA EQ Commercial Book	PNW EQ Commercial Book
# Accounts / Locations	81 accounts 320 locations	87 accounts 1,614 locations
Total Value	\$1,643,367,400	\$8,880,155,600
Geocoding Level as % of TIV	89.4% Street 5.9% ZIP Code 4.8% County	63.4% Street 36.6% ZIP Code
Line of Business	Commercial	Commercial
Primary Characteristics Modeled	Construction Occupancy Number of Stories (17% unknown; 76% 1-story) Year Built (80% unknown)	Construction Occupancy Number of Stories (99.8% known; 85% 1-story) Year Built (65% unknown)
Typical Deductibles or Attachment Points	Primary and excess policies Avg site deductible = 5% Various policy deductibles	Excess policies Avg site deductible = 3% Various policy deductibles

Treaty Terms:

Treaty	Occurrence Limit	Attachment Point	% Participation	Premium
1	\$3,000,000	\$7,000,000	100	\$20,000
2	\$3,000,000	\$15,000,000	100	\$10,000

Figure 1:



Part I

Take ten minutes to review the two portfolio AEP curve results in the figure above, and answer the following two questions:

- 1) At approximately what value and critical probability do the curves cross each other?

Answer: \$10,000,000 and 0.32 %

- 2) For each treaty, fill in the following table identifying which region (either California (CA), or Pacific Northwest (PNW)) you expect to have the highest pure premium by layer and the highest CV by layer.

	Region with Highest Pure Premium	Region with Highest CV
Treaty 1	CA	PNW
Treaty 2	PNW	CA

Table 2

Answer:

The results are based on the following observations:

Slope of EP curve where treaties apply – The steeper the slope, the lower the CV.

Area under the EP curve – The pure premium can be calculated as the area under the AEP curve. Assuming a close correlation between the area under the AEP and OEP curves, then relative comparisons can be made between the pure premiums for each treaty.

Probability of treaty inception – As a generalization, the higher the probability, the lower the treaty CV.

STOP! – Wait for class discussion.

As part of your initial assessment you now examine the exposure data for potential contributors to secondary uncertainty. The following resources are available to you:

- Post Import Summary Reports from RiskLink for both the CA EQ – Commercial and PNW EQ – Commercial portfolios.
- Information in the Exposure Summary table on page 1 of this exercise.

After ten minutes there will be a class review of your answers.

- 3) There are three sources of secondary uncertainty. Provide an example of two of these as contributors to portfolio volatility for both portfolios. In your answer, provide their percent contribution in terms of values, limits, or locations for each portfolio. Given your observations, for which region will each contributor be a greater driver of the portfolio volatility measure and why?

Answer:

Exposure data uncertainty:

- *For the Pacific NW portfolio, the geocoding resolution is only 63% high resolution, while the California portfolio has 89% at high resolution.*
- *For the California portfolio, 43% of the values have unknown construction, compared to 25% of the values with unknown construction for the Pacific NW portfolio. In addition, the California portfolio is using an ISO Fire construction scheme, which will contribute to the exposure data uncertainty in this book.*
- *It is difficult to say which portfolio is more affected by exposure data uncertainty as it depends on the impact of low-resolution geocoding information of the Pacific NW relative to the impact of unknown construction class information and the use of ISO Fire construction scheme in California.*

Hazard uncertainty:

- *The California book has a higher percentage of its TIV located in softer soil sites (60.3%) compared to the PNW (51.4%). Also, in the California book there is 46.5% of the TIV located in areas with moderate to very high liquefaction, while the majority of the PNW book (77.6%) is located in very low to low liquefaction areas. Thus, we should expect a greater contribution from hazard uncertainty in the California portfolio.*

Vulnerability uncertainty:

- *While there is no specific information in the post-import summary reports that allows us to quantify the contribution on vulnerability-related uncertainty on these portfolios, an example of vulnerability uncertainty is when two nominally identical structures experience the same severity of ground shaking in an earthquake, but exhibit different types and amounts of damage.*

STOP! – Wait for class discussion.

Part II

To perform the questions in Part II of this exercise, RiskLink's post analysis treaty editing (PATE) capabilities have been run to add the two treaties with the terms shown in Table 1 to the analysis results.

Now view the *Treaty Losses* tab in the MS Excel file *Exercise 2 Uncertainty Measures.xls*. You will note the summary statistics for both Treaty 1 and Treaty 2 listed for each of the portfolios separately (PNW Commercial and CA Commercial), and for the group of both portfolios results (Combined Commercial).

In groups of two or three, answer the following questions from the reinsurer perspective:

- 1) Compare the probability of activation for each treaty/region with the pure premium and coefficient of variation. What trends do you see and why? Were your observations in Part I correct?

Answer:

The larger the probability of treaty activation, the larger the pure premium and the smaller the coefficient of variation. At higher attachments, treaties are covering the portion of the EP curve where low frequency/high severity losses dominate and thus increasing the loss uncertainty. In addition, the California portfolio experiences fewer high severity/low frequency events compared to the PNW, thus the uncertainty around modeled loss is much greater for Treaty 2 in California.

- 2) Based on the amount of capital at hand, and the average expected return for the company, the risk load multiplier is assumed to be 25%. Expenses are assumed to be 20% of the pure premium. Thus the below formula is used for pricing these treaties:

$$\text{Price} = 1.2 \text{ PP} + 0.25\sigma$$

Using the results from this formula for each treaty in each region (shown in row titled *1.2*Pure Premium + .25*σ* on the Treaty Losses tab for each portfolio), do you think the premium being charged for each treaty for each portfolio is reasonable? Why or why not?

Answer:

See values in row titled: **(1.2*Pure Premium + .25* σ)** in table at the end of this document. The price for both treaties is not adequate using this pricing formula for either portfolio.

- 3) Let's assume you wish the price of the treaties to be set to cover annual treaty losses 99.6% of the time. What treaty AEP return period does this correspond to? Reviewing these return period losses, do you think the current Treaty 1 premium is sufficient? Why or why not?

Answer:

The 250 year return period. The modeled 250-year return period losses for Treaty 1 are \$66,122 and \$2,050,935 for the PNW and CA portfolios, respectively. Using this metric alone for treaty pricing would make the current Treaty 1 pricing inadequate for both the Pacific Northwest and California portfolios.

- 4) Given your high exposure to risk in Treaty 1 for the California portfolio, you have decided to focus on changing the treaty terms and pricing. Choose a new treaty attachment point and/or a new occurrence limit to **reduce** the overall treaty volatility. *Note: There is no single correct answer.*

- a) What attachment point and limit did you set?

Answer:

There is no single correct answer to this exercise.

As an example, if you lower the occurrence limit to \$1,000,000 and keep the attachment point the same, then the Net CV will be reduced to 12.24. In general, if you lower the occurrence limit, then this should lower the overall treaty volatility, since more is known about risk response to higher frequency, lower magnitude events.

- b) How would you expect this change will impact the standard deviation and coefficient of variation?

Answer:

There is no single correct answer to this exercise. Answer depends on answer to a) above.

Table of RiskLink 11.0 results:

			PNW Commercial		CA Commercial		Combined Commercial	
Statistics			Cat 1 3x7 (USD) Treaty Loss	Cat 2 3x15 (USD) Treaty Loss	Cat 1 3x7 (USD) Treaty Loss	Cat 2 3x15 (USD) Treaty Loss	Cat 1 3x7 (USD) Treaty Loss	Cat 2 3x15 (USD) Treaty Loss
Pure Premium			10,727.14	6,792.24	14,532.81	1,671.44	25,349.73	8,408.47
Standard Deviation			175,693.44	141,178.38	193,020.58	66,215.11	269,299.40	156,121.08
Coefficient of Variation			16.3784	20.79	13.2817	39.62	10.6234	18.5671
Rate On Line			0.67%	0.33%	0.67%	0.33%	0.67%	0.33%
Pure Premium/Limit			0.36%	0.23%	0.48%	0.06%	0.85%	0.28%
(Pure Premium + 1.5*s) /Limit			9.14%	7.29%	10.14%	3.37%	14.31%	8.09%
Premium/Pure Premium			1.8644	1.4723	1.3762	5.9829	0.789	1.1893
Prob. 100% Loss Ratio			0.40%	0.24%	0.72%	0.08%	1.29%	0.39%
Probability of Layer Activation			0.40%	0.24%	0.72%	0.08%	1.11%	0.33%
Probability of Layer Exhaustion			0.32%	0.21%	0.31%	0.04%	0.63%	0.25%
Probability of Exhausting All Reinstatements			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Premium			20,000.00	10,000.00	20,000.00	10,000.00	20,000.00	10,000.00
Pure Premium/Premium			53.64%	67.92%	72.66%	16.71%	126.75%	84.08%
Net Pure Premium			10,688.96	6,776.94	14,462.78	1,670.51	25,146.46	8,385.83
Net Standard Deviation			174,770.28	140,705.91	191,696.13	66,162.32	266,203.36	155,510.37
Net Coefficient of Variation			16.3505	20.7624	13.25	39.61	10.59	18.54
(Net Pure Premium + 1.5*s) /Limit			9.09%	7.26%	10.07%	3.36%	14.15%	8.06%
(1.2*Pure Premium + .25*s)			56,795.93	43,445.28	65,694.52	18,559.96	97,744.53	49,120.43
Risk load pricing/premium			2.8397964	4.3445283	3.28472585	1.85599565	4.8872263	4.9120434
Critical Prob.			Return Period					
0.01%	10,000	3,000,000.00	3,000,216.94	3,000,000.00	3,000,154.01	3,000,275.28	3,000,113.286	
0.02%	5,000	3,000,000.00	3,000,206.15	3,000,000.00	3,000,098.71	3,000,215.23	3,000,007.85	
0.10%	1,000	3,000,000.00	3,000,119.90	3,000,000.00	0.00	2,999,971.27	2,999,921.19	
0.20%	500	3,000,000.00	3,000,012.09	3,000,000.00	0.00	2,999,890.74	2,999,812.86	
0.40%	250	66,121.76	0.00	2,050,935.24	0.00	2,999,535.04	434.93	
0.50%	200	0.00	0.00	1,283,187.20	0.00	2,987,852.05	3.12	

Portfolio AEP Results:

		PNW EQ - Commercial (USD) Net Loss Pre Cat AEP	CA EQ - Commercial (USD) Net Loss Pre Cat AEP	Combined Commercial (USD) Net Loss Pre Cat AEP	PNW EQ - Commercial (USD) Net Loss Post Cat AEP	CA EQ - Commercial (USD) Net Loss Post Cat AEP	Combined Commercial (USD Net Loss Post Cat AEP
Critical Prob.							
0.20%	500 Return Period	19,263,191.34	11,848,079.63	22,516,369.05	13,152,893.43	9,063,692.21	17,951,072.00
0.40%	250 Return Period	7,098,386.12	9,310,526.04	13,470,672.40	6,998,231.82	7,042,037.83	10,918,222.67
	Pure Premium	196,970.77	247,732.44	444,703.22	179,112.46	231,114.83	411,471.65
	Standard Deviation	4,584,601.37	1,200,011.34	4,898,078.12	4,363,952.47	1,032,746.51	4,625,620.18
	Coefficient of Variation	23.2755	4.844	11.0143	24.3643	4.4685	11.2416