RISK ANALYTICS PROJECT 2

OPERATIONAL RISK

Simulate Loss Distribution to Determine Operational Risk Using the AMA Approach

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Topic: Simulate loss distribution to determine operational risk capital using the AMA approach:

1. Loss Frequency: Poisson distribution with parameter 2
2. Loss Severity: Normal Loga distribution with parameter 70+a, 20+a

Simulation 500 value of loss distribution, calculate VaR (99%).

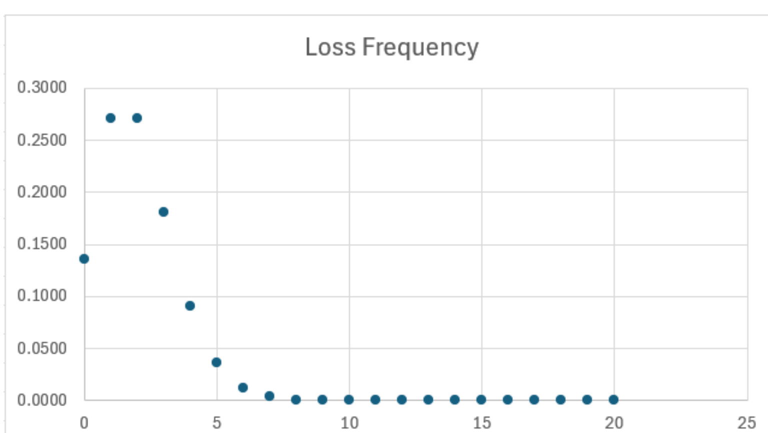
Monte Carlo Simulation

1. **Step 1**: Sample from the Poisson distribution to determine the number of loss events in a year.

   A Poisson distribution is often assumed for loss frequency. This is a distribution of the number of events in a certain time if the events occur at a certain rate and are independent of each other. If the expected number of losses in a year is the probability of n losses during the year given by the Poisson distribution is:

$$\frac{e^{-\lambda}\lambda^{n}}{n!}$$

   In this step, I create a table with 3 columns.
   - The first column is the number of loss events with value from 0 – 20.
   - The second column is probability of n losses during the year given by the Poisson distribution with $\lambda = 2$. Use Excel formula to calculate probabilities: ***POISSON.DIST(x, mean, cumulative)***

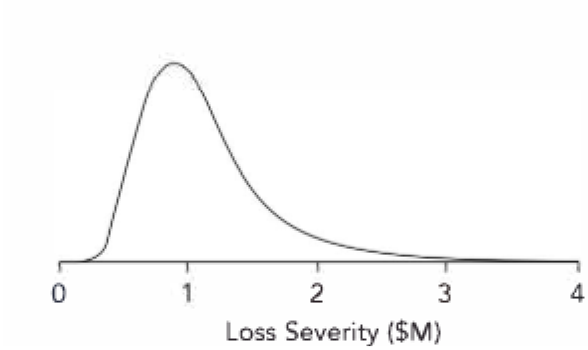


- The third column is cumulative probability of losses.

No of loss events	Probability	Cumulative
0	0.1353	0.1353
1	0.2707	0.4060
2	0.2707	0.6767
3	0.1804	0.8571
4	0.0902	0.9473
5	0.0361	0.9834
6	0.0120	0.9955
7	0.0034	0.9989
8	0.0009	0.9998
9	0.0002	1.0000
10	0.0000	1.0000
11	0.0000	1.0000
12	0.0000	1.0000
13	0.0000	1.0000
14	0.0000	1.0000
15	0.0000	1.0000
16	0.0000	1.0000
17	0.0000	1.0000
18	0.0000	1.0000
19	0.0000	1.0000
20	0.0000	1.0000

- In Monte Carlo simulation table, create a column **Random,** use excel formula **RAND** to sample the percentile of the Poisson distribution as a random number between zero and one. Use **MATCH** function to determine number of losses.

2. **Step 2**: Sample n times from the lognormal distribution of the loss size for each n loss events.
   - Loss severity is often fitted to a lognormal distribution.



- From mean and standard deviation of the loss size are estimated to be 70, 20, respectively. Under the lognormal assumption, the mean of logarithm of the loss size is:

$$m = \ln\left(\frac{\mu}{\sqrt{1+w}}\right)$$

  And the variance of the logarithm of the loss size is:

$$s^2 = \ln(1+w)$$

  Where $w = (\sigma/u)^2$

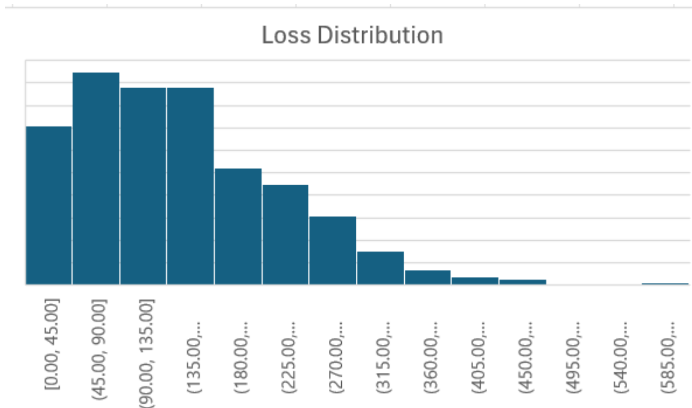
  We have: $\boldsymbol{w} = 0.0816$; $\boldsymbol{m} = 4.209$, $\boldsymbol{s} = 0.28$

- Use inverse function of lognormal to determine loss for each n loss events and simulate 500 times: **LOGNORM.INV (probability, mean, standard deviation)**

  Where:
  - probability is estimated by random value between 0 and 1.
  - mean is $\boldsymbol{m}$.
  - standard deviation is ***s*.**

Trial	Random	Frequency	1	2	3	4	5	6	7	8	9	10
1	0.060341598	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.416972969	2	52.93	58.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.956699264	5	86.90	92.29	69.02	38.88	71.79	0.00	0.00	0.00	0.00	0.00
4	0.669488762	2	60.76	46.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.432260685	2	74.66	83.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.80946021	3	88.25	94.66	64.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.70232825	3	61.63	69.27	88.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.645741015	2	54.68	62.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.631446916	2	74.27	95.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.604887817	2	86.31	89.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.704822711	3	54.13	93.34	78.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.629551434	2	77.23	105.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.713392291	3	66.49	71.36	61.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.089705254	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.993031555	6	94.17	55.80	71.67	107.11	102.31	60.71	0.00	0.00	0.00	0.00
16	0.73785073	3	65.26	102.09	96.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.872610045	4	36.72	91.68	65.17	76.30	0.00	0.00	0.00	0.00	0.00	0.00
18	0.437717948	2	63.89	99.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.474579047	2	32.61	50.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.322110024	1	57.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3. **Step 3**: Sum the n loss sizes to determine the total loss.



4. **Step 4:** Repeat steps 1 to 3 many times.
5. **Step 5:** Calculate the Value at Risk with confidence level 99% by **PERCENTILE.INC (array, k)**
    - Array is total loss column.
    - k is confidence level.

Simulation	500
Percentile	0.99
VAR	417.2922551