

# FinTech 545 - Week 5

Renjie Wang

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1. For problem 1, I have created a Library for risk management, which contains **covariance\_estimation.py**, **non\_psd\_fixes.py**, **simulation.py**, **var.py**, **es.py** and **copula.py**. They conduct Covariance estimation techniques, Non-PSD fixes for correlation matrices, Simulation Methods, VaR calculation methods, ES calculation respectively.

In **Week05.ipynb**, I tested the functionality of these risk management methods, showing that my resultant output was close to the answer to a few decimal places. Test result 9.1 is very close, indicating that I passed the test as well.

## Testout result:

Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
A	94.460376	118.289371	0.047230	0.059145
B	107.880427	151.218174	0.035960	0.050406
Total	152.565684	199.704532	0.030513	0.039941

## My result:

Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
A	93.98826	117.199357	0.046994	0.0586
B	108.812034	152.088099	0.036271	0.050696
Total	152.863228	200.235847	0.030573	0.040047

2. By applying the library created before, answers could be obtained easily.
  - a. Using a normal distribution with an exponentially weighted variance (lambda=0.97)

The VaR result is as follows:

VaR Absolute	VaR Diff from Mean
0.091169	0.09029

The ES result is as follows:

ES Absolute	ES Diff from Mean
0.114107	0.113227

#### **b. Using an MLE fitted T distribution**

The VaR result is as follows:

VaR Absolute	VaR Diff from Mean
0.076476	0.076382

The ES result is as follows:

ES Absolute	ES Diff from Mean
0.113218	0.113124

#### **c. Using a Historic Simulation**

The VaR and ES results are as follows:

VaR Absolute	VaR Diff from Mean	ES Absolute	ES Diff from Mean
0.075862	0.074978	0.115348	0.114465

The VaR for the normal distribution with exponentially weighted variance (0.091169) is higher than that for the MLE-fitted t-distribution (0.076476) and the historical simulation (0.075862), which are similar to each other. This can be attributed to the fact that the t-distribution and historical simulation can capture the heavier tails present in the data, suggesting more extreme losses are possible than the normal distribution would predict. Hence, they indicate a lower VaR, reflecting a more cautious estimate of risk under normal market conditions.

The ES for the normal distribution with exponentially weighted variance (0.114107) is between that of the MLE-fitted t-distribution (0.113218) and the historical simulation (0.115348). While ES is a measure of the average loss in the tail beyond the VaR threshold, the slightly higher ES in the historical simulation indicates that the observed losses in the tail are larger on average than what the normal and t-distributions would suggest. This is because the historical simulation directly uses historical returns data, which may include extreme loss events.

In summary, the differences in VaR and ES across these methods arise due to their differing sensitivity to tail risk. The normal distribution assumes a symmetrical distribution of risk, while the t-distribution and historical simulation allow for more realistic, asymmetrical risk profiles with potentially heavier tails. This results in lower VaR estimates for the latter methods, as they predict a greater likelihood of extreme losses, which also influences the ES calculations.

3. Still using the repository from the risk management library, we can easily obtain the answers for the VaR and ES of portfolios A, B, C, and total.

**Portfolio A:**

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
0	AAPL	322.00	415.70	0.036854	0.047579
1	TSLA	143.58	181.98	0.069258	0.08778
2	JPM	269.62	354.05	0.030001	0.039396
...					
33	SYK	334.53	463.23	0.033301	0.046113
34	TJX	383.68	523.75	0.033694	0.045995
Portfolio A		8113.20	10632.04	0.027049	0.035446

**Portfolio B:**

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
1	MSFT	331.84	436.50	0.038145	0.050176
2	GOOGL	16.11	21.76	0.042385	0.057249
3	NVDA	569.26	709.02	0.067066	0.083531
...					
30	GILD	292.84	440.49	0.024456	0.036786
31	GM	317.43	405.11	0.046493	0.059336
Portfolio B		6970.14	9244.93	0.023677	0.031404

**Portfolio C:**

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
1	AMZN	20.08	25.46	0.051103	0.064798
2	GOOG	16.12	20.25	0.042205	0.053027
3	BRK-B	225.78	282.97	0.023707	0.029713
...					
31	LMT	344.43	440.51	0.027136	0.034707
32	TFC	238.70	301.58	0.033425	0.042229
Portfolio C		5986.85	7523.28	0.02217	0.02786

**Total Portfolio:**

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
1	AAPL	317.55	412.72	0.036345	0.047238
2	TSLA	142.46	178.72	0.068717	0.086205
3	JPM	269.52	365.18	0.02999	0.040635
...					
98	LMT	343.58	426.46	0.02707	0.033599
99	TFC	236.92	298.77	0.033175	0.041835
Total		20541.05	26617.81	0.023764	0.030794

I cannot compare the result of this question to that of Week04, since a different dataset is used in this particular question.