

FinTech 545 Homework Week 05

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1. I created a Risk Management Library named RMLib. My directory looks like this

```
./
├── RMLib
│   ├── copula.py
│   ├── covar.py
│   ├── expected_shortfall.py
│   ├── fit_model.py
│   ├── non_psd.py
│   ├── returns.py
│   ├── simulation.py
│   └── value_at_risk.py
├── test.py
└── data
    └── all test inout csv files
```

Here are the function names:

1. Covariance & Correlation:

Cor
CorToCov
Cov
CovToCor
ewCorr
ewCovCor
ewCovar
ewVar

6. VaR Calculation:

VaR_MLE_t
VaR_historic
VaR_norm_df
VaR_normal_distribution
VaR_simulation
VaR_t_df
VaR_t_distribution
Var_normal_distribution_EW

2. Non-PSD Fixes:

CorToCov
CovToCor
chol_psd
higham_nearestPSDCor
higham_nearestPSDCov
nearPSDCor
nearPSDCov
proj_spd

7. Expected Shortfall Calculation:

ES_historic
ES_norm_df
ES_normal_distribution
ES_normal_distribution_EW
ES_simulation
ES_t_df
ES_t_distribution

3. Simulation Methods:

simNormal
simPca

4. Return Calculation:

return_w_method

5. Parametric Models:

MLE_t
fit_general_t
fit_normal
fit_regression_t

8. Copula:

aggRisk
copula_risk

The testing code `test.py` tests the functionality of my RM Library by taking input files, and compare my output against output files. My results are nearly identical to the output files, although I have to increase the tolerance for simulation questions.

Here is the console output for the testing.

testout_1.1	True	
testout_1.2	True	
testout_1.3	True	
testout_1.4	True	
testout_2.1	True	
testout_2.2	True	
testout_2.3	True	test6_1 True
testout_3.1	True	test6_2 True
testout_3.2	True	testout7_1 True
testout_3.3	True	testout7_2 True
testout_3.4	True	testout7_3 True
testout_4.1	True	testout8_1 True
testout_5.1	True	testout8_2 True
testout_5.2	True	testout8_3 True
testout_5.3	True	testout8_4 True
testout_5.4	True	testout8_5 True
testout_5.5	True	testout8_6 True

The output for 9-1 is close to the test result. Because of the nature of simulation, I cannot directly compare that. Here is the result

	Stock		VaR95	ES95		VaR95_Pct	ES95_Pct
0	A		90.926824	114.99930096398587		0.0454634117865793	0.0575
1	B		111.053792	154.983021443826		0.03701793068047219	0.051661
2	Total	157.9970594204113		197.50845226074037		0.031599	0.039502

2. The VaR and ES result is:

Question 2:

```
VaR EW Normal w/ Lambda = 0.97
  VaR Absolute  VaR Diff from Mean
0      0.091169      0.09029
VaR general T | MLE T
  VaR Absolute  VaR Diff from Mean
0      0.076476      0.076382
VaR Historic
  VaR Absolute  VaR Diff from Mean
0      0.078245      0.077278
ES EW Normal w/ Lambda = 0.97
  ES Absolute  ES Diff from Mean
0      0.113349      0.113227
ES general T | MLE T
  ES Absolute  ES Diff from Mean
0      0.113218      0.113124
ES Historic
  ES Absolute  ES Diff from Mean
0      0.112664      0.111968
```

The VaR under exponentially weighted normal is greater than both VaR fitted by MLE T distribution and historical VaR, which suggests that the recent returns are more volatile than past data, because EW puts a higher weight on recent data. The expected shortfall for these 3 models are very close to each other.

The absolute VaR/ES is very close to the VaR/ES difference from mean. This implies that the average return is close to zero.

3. The 95% value at risk and expected shortfall under Copula is:

Portfolio A:

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
35	Total	8340.049895614682	10448.56663757482	0.027805	0.034834

Portfolio B:

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
32	Total	6818.447134423607	8552.413868649955	0.023162	0.029052

Portfolio C:

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
32	Total	5754.165059662527	7233.337351563172	0.021308	0.026786

Total:

	Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
99	Total	22150.18831328848	27793.5175065322	0.025626	0.032154

Compared to last week's functions using the same dataset (and I also changed EW covariance to covariance to match the process of this week's copula):

Arithmetic Return:

For Portfolio A, the 95% VaR is: \$7946.138

For Portfolio B, the 95% VaR is: \$6674.0675

For Portfolio C, the 95% VaR is: \$5635.3731

For Portfolio Total, the 95% VaR is: \$19978.9998

We can see that the portfolio C's VaRs are very similar, because both model are built upon normal assumption for portfolio C. Last week's VaR of A and B are smaller than copula derived VaR, which could be explained by different model assumption.