Fintech (545) **Spring2024**, 1–8

Project Week 05: Advanced VaR and Expected Shortfall

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1 PROBLEM 1

Please see the repo. The *RiskManagement* folder contains all files for tests:

`Cov` – Covariance estimation techniques.
`NonPSD` – Non-PSD fixes for correlation matrices.
`Sim` – Simulation Methods.
`VaR` – VaR calculation methods (all discussed).
`ES` – ES calculation.

1.1 Missing covariance calculations

Two common way yo calculate:

(i) Only use the days on which all markets are open;
(ii) Use pairwise calculations. Find the matching rows for each pair, and build the covariance matrix piece by piece.

1.1.1 Skip missing rows-covariance

	x1	x2	x3	x4	x5
x1	2.148513	-1.389470	-0.516466	-0.129327	-1.056814
x2	-1.389470	1.035342	0.339993	0.193888	0.626876
x3	-0.516466	0.339993	0.942388	0.947887	0.051788
x4	-0.129327	0.193888	0.947887	1.113436	-0.204731
x5	-1.056814	0.626876	0.051788	-0.204731	0.592027

1.1.2 Skip missing rows-correlation

	x1	x2	x3	x4	x5
x1	1.000000	-0.931618	-0.362959	-0.083616	-0.937042
x2	-0.931618	1.000000	0.344202	0.180583	0.800698
x3	-0.362959	0.344202	1.000000	0.925357	0.069333
x4	-0.083616	0.180583	0.925357	1.000000	-0.252163
x5	-0.937042	0.800698	0.069333	-0.252163	1.000000

1.1.3 Pairwise-covariance

	x1	x2	x3	x4	x5
x1	1.173986	-0.629631	-0.278932	-0.081448	-0.735140
x2	-0.629631	1.318197	0.018090	0.446047	0.139309
x3	-0.278932	0.018090	0.918102	0.360836	0.258613
x4	-0.081448	0.446047	0.360836	0.894764	-0.235190
x5	-0.735140	0.139309	0.258613	-0.235190	0.522607

1.1.4 Pairwise-correlation

	x1	x2	x3	x4	x5
x1	1.000000	-0.483199	-0.241787	-0.067767	-0.714761
x2	-0.483199	1.000000	0.015446	0.405660	0.178286
x3	-0.241787	0.015446	1.000000	0.488250	0.336248
x4	-0.067767	0.405660	0.488250	1.000000	-0.322136
x5	-0.714761	0.178286	0.336248	-0.322136	1.000000

1.2 EW covariance

$$w_{t-i} = (1-\lambda)\lambda^{i-1} \tag{1}$$

$$\widehat{w_{t-i}} = \frac{w_{t-i}}{\sum_{j=i}^{n} w_{t-j}} \tag{2}$$

$$\widehat{cov(x,y)} = \sum_{i=1}^{n} \widehat{w_{t-i}}(x_{t-i} - \bar{x})(y_{t-i} - \bar{y}) \tag{3}$$

1.2.1 EW covariance λ=0.97

	x1	x2	x3	x4	x5
x1	0.855911	0.127559	0.186929	0.081415	0.052412
x2	0.127559	1.08735	0.032715	0.112515	-0.432729
x3	0.186929	0.032715	0.744771	0.131065	0.065806
x4	0.081415	0.112515	0.131065	0.86881	0.113836
x5	0.052412	-0.432729	0.065806	0.113836	1.13918

1.2.2 EW correlation λ=0.94

	x1	x2	x3	x4	x5
x1	1.0	0.109711	0.218511	0.116902	0.059677
x2	0.109711	1.0	-0.046716	0.191773	-0.444896
x3	0.218511	-0.046716	1.0	0.184148	0.089927
x4	0.116902	0.191773	0.184148	1.0	0.122028
x5	0.059677	-0.444896	0.089927	0.122028	1.0

1.2.3 EW cov w/EW var(λ=0.94) EW correlation(λ=0.97)

	x1	x2	x3	x4	x5
x1	0.855911	0.10584	0.174461	0.100809	0.058928
x2	0.10584	1.08735	-0.04204	0.186396	-0.495153
x3	0.174461	-0.04204	0.744771	0.148129	0.082832
x4	0.100809	0.186396	0.148129	0.86881	0.121399
x5	0.058928	-0.495153	0.082832	0.121399	1.13918

1.3 Non-psd matrices

$$\Lambda = diag(\lambda_i) \tag{4}$$

$$CS = \Lambda S \tag{5}$$

$$\lambda_i' = max(\lambda_i, 0) \tag{6}$$

$$t_i = [\sum_{j=1}^{n} s_{i,j}^2 \lambda_j']^{-1} \tag{7}$$

$$T = diag(t_i) \tag{8}$$

$$B = \sqrt{T} S \sqrt{\Lambda'} \tag{9}$$

$$BB^T = \hat{C} \approx C \tag{10}$$

1.3.1 Near_psd covariance

	x1	x2	x3	x4	x5
x1	1.173986	-0.617989	-0.284559	-0.065152	-0.688287
x2	-0.617989	1.318197	0.017092	0.445696	0.139176
x3	-0.284559	0.017092	0.918102	0.354147	0.246056
x4	-0.065152	0.445696	0.354147	0.894764	-0.218717
x5	-0.688287	0.139176	0.246056	-0.218717	0.522607

1.3.2 Near_psd Correlation

	x1	x2	x3	x4	x5
x1	1.000000	-0.483199	-0.241787	-0.067767	-0.714761
x2	-0.483199	1.000000	0.015446	0.405660	0.178286
x3	-0.241787	0.015446	1.000000	0.488250	0.336248
x4	-0.067767	0.405660	0.488250	1.000000	-0.322136
x5	-0.714761	0.178286	0.336248	-0.322136	1.000000

1.3.3 Higham covariance

	x1	x2	x3	x4	x5
x1	1.173986	-0.623870	-0.294335	-0.057677	-0.693888
x2	-0.623870	1.318197	0.016449	0.448579	0.143703
x3	-0.294335	0.016449	0.918102	0.354067	0.246866
x4	-0.057677	0.448579	0.354067	0.894764	-0.217062
x5	-0.693888	0.143703	0.246866	-0.217062	0.522607

1.3.4 Higham correlation

	x1	x2	x3	x4	x5
x1	1.000000	-0.483199	-0.241787	-0.067767	-0.714761
x2	-0.483199	1.000000	0.015446	0.405660	0.178286
x3	-0.241787	0.015446	1.000000	0.488250	0.336248
x4	-0.067767	0.405660	0.488250	1.000000	-0.322136
x5	-0.714761	0.178286	0.336248	-0.322136	1.000000

1.4 Cholesky factorization

(i) Column j , start on the diagonal element

(ii) Subtract the sum of the squares of the values on the root matrix for row j from the value on the input matrix on the diagonal.

(iii) Update the root matrix at position (j, j) with the square root of 2

(iv) Moving down the column, row i

(a) Calculate the dot product of sub matrix vector $[i, 1 : (j-1)]$ and $[j, 1 : (j-1)]$

(b) Subtract a. from the (i, j) element of the input matrix.

(c) Divide b. by the j diagonal element of the root matrix

(d) Store that value in element (i, j) of the root matrix.

(v) Repeat for the next column.

	x1	x2	x3	x4	x5
x1	1.083506	0.000000	0.000000	0.000000	0.000000e+00
x2	-0.570360	0.996437	0.000000	0.000000	0.000000e+00
x3	-0.262628	-0.133175	0.911807	0.000000	0.000000e+00
x4	-0.060130	0.412871	0.431384	0.731160	0.000000e+00
x5	-0.635240	-0.223938	0.054179	-0.256892	1.053671e-08

1.5 Normal simulation

$$x = F^{-1}(random\ uniform) \tag{11}$$

1.5.1 PD input

	x1	x2	x3	x4	x5
x1	0.085367	0.087933	0.042383	0.009032	0.003874
x2	0.087933	0.160844	0.058218	0.012410	0.005335
x3	0.042383	0.058218	0.037386	0.005975	0.002566
x4	0.009032	0.012410	0.005975	0.001695	0.000548
x5	0.003874	0.005335	0.002566	0.000548	0.000314

1.5.2 PSD input

	x1	x2	x3	x4	x5
x1	0.085474	0.117461	0.042377	0.008987	0.003869
x2	0.117461	0.161419	0.058236	0.012350	0.005317
x3	0.042377	0.058236	0.037285	0.005926	0.002564
x4	0.008987	0.012350	0.005926	0.001679	0.000543
x5	0.003869	0.005317	0.002564	0.000543	0.000314

1.5.3 NonPSD input, near_psd fix

	x1	x2	x3	x4	x5
x1	0.085318	0.008679	0.037962	0.008066	0.003476
x2	0.008679	0.160988	0.052052	0.011104	0.004768
x3	0.037962	0.052052	0.037545	0.006033	0.002593
x4	0.008066	0.011104	0.006033	0.001699	0.000553
x5	0.003476	0.004768	0.002593	0.000553	0.000315

1.5.4 NonPSD input Higham fix

	x1	x2	x3	x4	x5
x1	0.084845	0.013741	0.039073	0.008274	0.003577
x2	0.013741	0.160394	0.053686	0.011398	0.004918
x3	0.039073	0.053686	0.037571	0.006248	0.002700
x4	0.008274	0.011398	0.006248	0.001692	0.000572
x5	0.003577	0.004918	0.002700	0.000572	0.000315

1.5.5 PSD Input - PCA simulation

	x1	x2	x3	x4	x5
x1	0.085344	0.117282	0.042516	0.009038	0.003896
x2	0.117282	0.161173	0.058427	0.012420	0.005355
x3	0.042516	0.058427	0.037562	0.006046	0.002595
x4	0.009038	0.012420	0.006046	0.001103	0.000474
x5	0.003896	0.005355	0.002595	0.000474	0.000204

1.6 Returns

1.6.1 Arithmetic returns

$$P_t = P_{t-1}(1 + r_t) \tag{12}$$

1.6.2 Fit normal distribution

Date	SPY	AAPL	MSFT	AMZN	NVDA
2022-09-02	-0.010544	-0.013611	-0.016667	-0.002425	-0.020808
2022-09-06	-0.003773	-0.008215	-0.010974	-0.010980	-0.013336
2022-09-07	0.017965	0.009254	0.019111	0.026723	0.018795
2022-09-08	0.006536	-0.009618	0.001666	0.002626	0.020126
2022-09-09	0.015535	0.018840	0.022977	0.026575	0.028377
...	...	...	...	...	...
2023-09-18	0.000586	0.016913	-0.003513	-0.002920	0.001503
2023-09-19	-0.002074	0.006181	-0.001246	-0.016788	-0.010144
2023-09-20	-0.009193	-0.019992	-0.023977	-0.017002	-0.029435
2023-09-21	-0.016528	-0.008889	-0.003866	-0.044053	-0.028931
2023-09-22	-0.002249	0.004945	-0.007887	-0.001624	0.014457

1.6.3 Log returns

$$P_t = P_{t-1}e^{r_t} \tag{13}$$

1.6.4 Fit normal distribution

Date	SPY	AAPL	MSFT	AMZN	NVDA
2022-09-02	-0.010600	-0.013705	-0.016807	-0.002428	-0.021027
2022-09-06	-0.003780	-0.008249	-0.011035	-0.011040	-0.013426
2022-09-07	0.017806	0.009211	0.018931	0.026372	0.018621
2022-09-08	0.006515	-0.009664	0.001665	0.002623	0.019926
2022-09-09	0.015416	0.018664	0.022717	0.026228	0.027982
...	...	...	...	...	...
2023-09-18	0.000586	0.016772	-0.003519	-0.002925	0.001502
2023-09-19	-0.002076	0.006162	-0.001247	-0.016931	-0.010196
2023-09-20	-0.009236	-0.020195	-0.024269	-0.017148	-0.029877
2023-09-21	-0.016666	-0.008929	-0.003873	-0.045053	-0.029357
2023-09-22	-0.002251	0.004932	-0.007918	-0.001625	0.014354

1.7 Fit

1.7.1 Fit normal distribution

mu	sigma
0.046026	0.046545

1.7.2 Fit t distribution

$$ll = \frac{n}{2}ln(\sigma^2 2\pi) - \frac{1}{2\sigma^2}\sum_{i=1}^{n}(x_i - \mu)^2 \tag{14}$$

mu	sigma	nu
0.04594	0.045443	6.336867

1.7.3 Fit t regression

mu	5.951481e-07
sigma	0.048548
nu	4.598303
Alpha	0.042633
B1	0.97501
B2	2.041187
B3	3.154751

1.8 VaR and ES

$$VaR_\alpha(x) = -F_x^{-1}(\alpha) \tag{15}$$

$$ES_\alpha(X) = -\frac{1}{\alpha}\int_{-\infty}^{-VaR(X)} xf(x)dx \tag{16}$$

1.8.1 VaR normal distribution

VaR Absolute	VaR Diff from Mean
0.030535	0.07656

1.8.2 VaR t distribution

VaR Absolute	VaR Diff from Mean
0.04153	0.08747

1.8.3 VaR simulation

VaR Absolute	VaR Diff from Mean
0.041848	0.087703

1.8.4 ES normal distribution

ES Absolute	ES Diff from Mean
0.049984	0.09601

1.8.5 ES t distribution

ES Absolute	ES Diff from Mean
0.075232	0.121172

1.8.6 ES Simulation

ES Absolute	ES Diff from Mean
0.076033	0.122302

1.9 Risk with copula

$$C_R(X) = \Phi_R(\Phi^{-1}(F_1(x_1)), \Phi^{-1}(F_2(x_2)), \ldots, \Phi^{-1}(F_n(x_n))) \quad (17)$$

Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
A	93.986214	117.630036	0.046993	0.058815
B	108.399648	152.062133	0.036133	0.050687
Total	153.620537	201.552029	0.030724	0.04031

2 PROBLEM 2

The VaRs of Noraml distribution and MLE fitted T distribution are more different from each other than ESes of these two distribubtions. It is because the fat tail of t distribution results of a similar ES but smaller VaR.

Meanwhile, according to historic simulation, the VaR and ES are similar to the fitted t distribution. It shows us that the actual rates of return fit in t distribution better.

2.1 a

Using a normal distribution with an exponentially weighted variance (lambda=0.97):

VaR Absolute	VaR Diff from Mean
0.091169	0.09029

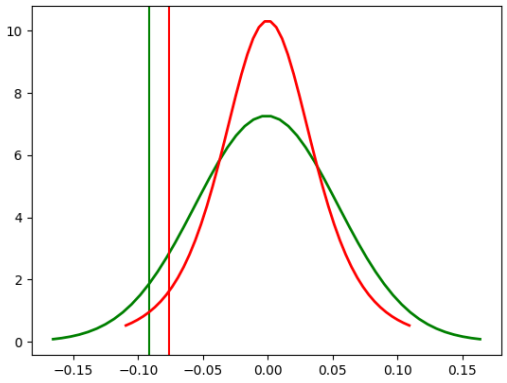

Figure 1. Normal and T Distribubtions.

ES Absolute	ES Diff from Mean
0.114107	0.113227

2.2 b

Using a MLE fitted T distribution:

VaR Absolute	VaR Diff from Mean
0.076476	0.076382

ES Absolute	ES Diff from Mean
0.113218	0.113124

2.3 c

Using a Historic Simulation:

VaR Absolute	VaR Diff from Mean
0.075862	0.074978

ES Absolute	ES Diff from Mean
0.115348	0.114465

3 PROBLEM 3

Portfolio A				
Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
AAPL	319.698063	416.240591	0.036591	0.047640
TSLA	144.570012	185.999312	0.069733	0.089716
JPM	266.225789	352.636092	0.029624	0.039239
HD	254.182058	352.304489	0.029834	0.041351
BAC	245.647852	339.168018	0.032904	0.045432
XOM	530.235927	707.483313	0.033121	0.044193
AVGO	374.986735	488.656299	0.036800	0.047955
PEP	184.993798	264.543730	0.018784	0.026861
TMO	319.018509	428.953169	0.032984	0.044351
CMCSA	222.062681	306.735728	0.030202	0.041718
META	339.330533	506.297343	0.057794	0.086232
ACN	273.060130	361.911907	0.033020	0.043764
INTC	203.644752	281.630728	0.040799	0.056423
PYPL	251.168632	336.906464	0.056191	0.075372
MRK	248.017316	358.905660	0.018894	0.027342
T	172.099777	255.900433	0.024653	0.036657
LOW	285.078973	381.228807	0.032533	0.043505
NEE	259.714247	373.378850	0.029294	0.042115
AMD	385.249791	517.603896	0.062566	0.084060
INTU	399.195650	499.290847	0.050056	0.062607
MS	316.140563	420.103977	0.031611	0.042006
AMAT	349.989001	439.690695	0.050251	0.063130
CVS	212.519125	312.481375	0.024837	0.036519
GS	284.255683	387.969460	0.028609	0.039048
BA	431.454904	626.215750	0.045228	0.065644
SBUX	368.818026	562.108832	0.034778	0.053004
GE	266.993670	376.933769	0.034070	0.048099
ISRG	343.946419	483.908816	0.042684	0.060054
MU	310.367712	398.839973	0.050071	0.064344
NOW	491.131379	652.715399	0.055793	0.074149
ADP	264.819745	362.460903	0.026880	0.036790
PNC	236.088215	313.393204	0.032303	0.042881
ADI	374.815613	491.005973	0.035586	0.046617
SYK	326.317617	447.041014	0.032483	0.044501
TJX	364.807050	507.934442	0.032037	0.044606
Total	7981.422654	10459.412470	0.026609	0.034871

Portfolio A Last Week Assignment		
Stock	VaR95	VaR95_Pct
AAPL	270.010557	0.030904
TSLA	168.958152	0.081496
JPM	171.401475	0.019072
HD	239.432324	0.028103
BAC	158.983279	0.021296
XOM	455.951196	0.028481
AVGO	288.304919	0.028293
PEP	146.827016	0.014909
TMO	275.359045	0.028470
CMCSA	212.213731	0.028862
META	536.555760	0.091385
ACN	242.161698	0.029283
INTC	207.901920	0.041652
PYPL	181.978391	0.040712
MRK	278.124370	0.021188
T	194.701450	0.027890
LOW	261.146125	0.029801
NEE	289.913855	0.032701
AMD	403.870920	0.065590
INTU	358.802784	0.044991
MS	233.322810	0.023330
AMAT	350.387110	0.050308
CVS	187.660233	0.021932
GS	251.980096	0.025361
BA	282.136042	0.029575
SBUX	258.463953	0.024372
GE	239.292266	0.030535
ISRG	293.095926	0.036374
MU	269.500572	0.043478
NOW	395.980341	0.044984
ADP	262.023761	0.026596
PNC	220.585414	0.030182
ADI	281.460097	0.026723
SYK	424.992070	0.042306
TJX	211.029931	0.018532
Total	5670.202920	0.018904

Portfolio B				
Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
MSFT	309.845851	407.942765	0.035617	0.046893
GOOGL	15.799451	20.858871	0.041573	0.054886
NVDA	548.155913	689.431394	0.064580	0.081224
JNJ	173.107609	234.898658	0.017876	0.024256
PG	185.883789	261.379272	0.021529	0.030273
MA	311.053107	433.059747	0.031101	0.043300
DIS	271.828486	356.814327	0.037320	0.048988
ADBE	318.163408	443.039109	0.042330	0.058945
KO	181.735878	262.965155	0.018701	0.027059
NFLX	420.348453	604.140063	0.057979	0.083330
COST	286.367993	443.954943	0.028601	0.044340
WFC	280.135348	396.796852	0.034040	0.048216
WMT	222.570164	352.213018	0.022793	0.036069
LLY	367.021876	494.510093	0.026191	0.035288
NKE	345.758894	485.404591	0.041616	0.058424
LIN	305.364841	407.725357	0.029619	0.039548
UNP	230.433758	301.038762	0.027712	0.036203
UPS	268.992829	352.641648	0.029714	0.038954
MDT	208.376372	277.544772	0.026798	0.035694
ORCL	295.961427	409.654119	0.029701	0.041110
RTX	284.344303	386.235042	0.026660	0.036213
AMGN	201.527595	298.709888	0.019528	0.028945
CAT	345.192876	519.445121	0.031855	0.047936
AMT	270.979461	361.061721	0.031481	0.041947
COP	535.800794	721.281554	0.042017	0.056563
AXP	386.773879	530.446428	0.035938	0.049288
SPGI	265.479849	353.437037	0.030418	0.040496
BKNG	519.528291	687.304829	0.042652	0.056426
ZTS	252.692326	337.249029	0.032069	0.042800
MDLZ	194.483187	266.189134	0.020579	0.028166
GILD	270.291529	418.931992	0.022573	0.034986
GM	308.434223	395.055132	0.045176	0.057864
Total	6614.900632	8723.025281	0.022470	0.029631

Portfolio B Last Week Assignment		
Stock	VaR95	VaR95_Pct
MSFT	319.154553	0.036687
GOOGL	21.446967	0.056433
NVDA	516.717370	0.060876
JNJ	165.865367	0.017128
PG	136.346437	0.015792
MA	198.231465	0.019820
DIS	236.775781	0.032507
ADBE	256.770890	0.034162
KO	144.881568	0.014908
NFLX	295.429098	0.040749
COST	265.698454	0.026536
WFC	173.484149	0.021080
WMT	165.298780	0.016928
LLY	326.082410	0.023269
NKE	239.776895	0.028860
LIN	279.485834	0.027109
UNP	217.914542	0.026207
UPS	265.081575	0.029282
MDT	218.443462	0.028093
ORCL	201.805005	0.020252
RTX	218.174372	0.020456
AMGN	182.906996	0.017724
CAT	270.047710	0.024921
AMT	223.840394	0.026005
COP	502.107152	0.039375
AXP	435.461777	0.040462
SPGI	222.509694	0.025495
BKNG	287.272641	0.023584
ZTS	211.445854	0.026834
MDLZ	168.622654	0.017842
GILD	299.956267	0.025050
GM	314.625817	0.046083
Total	4494.598411	0.015268

Portfolio C				
Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
AMZN	20.473750	25.577295	0.052101	0.065089
GOOG	16.310975	20.363706	0.042717	0.053330
BRK-B	221.569452	277.276247	0.023266	0.029115
UNH	269.963319	338.371570	0.025263	0.031665
V	319.682724	400.526543	0.029657	0.037156
PFE	219.128403	274.407367	0.027780	0.034788
CSCO	230.068002	289.767645	0.030205	0.038042
CVX	439.263160	554.820276	0.033434	0.042229
ABBV	258.275600	324.730030	0.023471	0.029511
ABT	232.330038	292.221251	0.027213	0.034228
CRM	369.687648	463.684562	0.048382	0.060683
VZ	183.277373	228.952076	0.024488	0.030591
QCOM	327.571583	409.337219	0.047350	0.059169
MCD	211.737873	265.700229	0.020829	0.026137
DHR	311.447695	390.659674	0.034881	0.043753
TXN	290.507511	366.334270	0.030743	0.038768
PM	256.036859	322.004111	0.025873	0.032539
HON	228.346451	286.869086	0.024917	0.031304
BMY	222.840190	282.295123	0.020110	0.025476
SCHW	318.119828	398.607864	0.038071	0.047704
C	264.511055	330.885797	0.035282	0.044136
BLK	327.128943	410.766792	0.038075	0.047810
IBM	239.948119	301.347981	0.023920	0.030041
PLD	303.709204	381.556804	0.035939	0.045151
TGT	380.770649	477.161099	0.048303	0.060530
DE	398.313898	499.887792	0.036157	0.045377
MMM	195.945632	242.994583	0.030984	0.038424
F	248.166519	309.616932	0.049260	0.061457
LRCX	380.106359	478.650759	0.052666	0.066320
MO	241.603104	302.994826	0.026471	0.033198
LMT	332.050272	419.222113	0.026161	0.033029
TFC	245.061281	306.773110	0.034315	0.042956
Total	5836.170844	7305.161503	0.021612	0.027052

Portfolio C Last Week Assignment		
Stock	VaR95	VaR95_Pct
AMZN	20.776392	0.052872
GOOG	21.607140	0.056587
BRK-B	160.161346	0.016817
UNH	281.948145	0.026385
V	195.328527	0.018120
PFE	176.146508	0.022331
CSCO	154.391514	0.020269
CVX	413.803141	0.031496
ABBV	215.063268	0.019544
ABT	165.487422	0.019384
CRM	288.218340	0.037720
VZ	151.481647	0.020240
QCOM	293.244106	0.042388
MCD	187.077750	0.018403
DHR	257.237142	0.028810
TXN	286.166539	0.030284
PM	167.238085	0.016900
HON	210.862650	0.023010
BMY	256.032990	0.023106
SCHW	268.294681	0.032108
C	163.496750	0.021808
BLK	222.615297	0.025911
IBM	201.490529	0.020086
PLD	242.743774	0.028725
TGT	234.930417	0.029802
DE	288.140574	0.026156
MMM	218.610141	0.034568
F	240.400370	0.047718
LRCX	335.635340	0.046504
MO	214.874684	0.023543
LMT	225.268270	0.017748
TFC	186.071900	0.026055
Total	3786.589011	0.014022

Portfolio Total with Copula				
Stock	VaR95	ES95	VaR95_Pct	ES95_Pct
AAPL	317.995155	414.868591	0.036396	0.047483
TSLA	145.110614	185.365150	0.069994	0.089410
JPM	263.040835	351.331424	0.029269	0.039094
HD	258.148103	357.101958	0.030300	0.041914
BAC	245.307208	343.078750	0.032859	0.045955
...	...	...	...	...
LRCX	387.070708	487.204190	0.053631	0.067505
MO	240.784458	302.411692	0.026382	0.033134
LMT	332.034271	420.935903	0.026160	0.033164
TFC	240.896016	301.967208	0.033732	0.042283
Total	20090.879755	26079.340183	0.023243	0.030171

Portfolio Total Last Week Assignment		
Stock	VaR95	VaR95_Pct
AAPL	270.010557	0.030904
TSLA	168.958152	0.081496
JPM	171.401475	0.019072
HD	239.432324	0.028103
BAC	158.983279	0.021296
...	...	...
LRCX	335.635340	0.046504
MO	214.874684	0.023543
LMT	225.268270	0.017748
TFC	186.071900	0.026055
Total	13577.075419	0.015707