FINTECH 545 FINAL

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Problem1

#a
This is the log return. I dropped all nan values.

```
              Price1     Price2     Price3
Date
2023-04-13   0.018993   0.003195  -0.000451
2023-04-14   0.002168   0.007144   0.002393
2023-04-15  -0.006809  -0.002536  -0.000854
2023-04-16  -0.003761  -0.004983  -0.002282
2023-04-19  -0.001601  -0.005461  -0.001421
2023-04-20   0.002864   0.000578   0.001313
2023-04-21  -0.001993   0.003972  -0.000706
2023-04-24   0.003410   0.005293  -0.000427
2023-04-25   0.006229   0.003376   0.000830
2023-04-26  -0.006950  -0.005061  -0.000667
2023-04-27   0.009240   0.004083   0.001317
2023-04-28   0.008836  -0.002461  -0.000957
```

#b
Pairwise Covariance Matrix:
```
 [[0.09000000000000001, 0.11616778283337, 0.01289133815358598],
[0.11616778283337, 0.09000000000000001, 0.015150806409572592],
[0.01289133815358598, 0.015150806409572592, 0.09]]
```

#c
It is not PSD.

#d
Fixed Matrix:
```
 [[0.09       0.08998502 0.01228759]
 [0.08998502 0.09       0.01391191]
 [0.01228759 0.01391191 0.09       ]]
```

Problem 2
#a
The call price is: 6.801866322511721
#b
The delta of the call is: 0.5084801613020203
#c
The gamma of the call is: 0.023104378660025782
#d
The vega of the call option is: 28.309901459443246
#e
Rho of the call option is: -3.6872810452777642
#f
VaR at 5% is: 60.461567591870654
#g
ES at 5% is: 79.06241228618667
#h
This is similar to a covered call

Problem 3
#a
[0.37140965 0.34794704 0.2806433]
#b
[0.352 0.3394 0.3086]
#c
As we can see, the maximum Sharpe ratio portfolio is [0.37, 0.35, 0.28], and the risk parity portfolio is [0.35, 0.34, 0.31]. There is difference but the difference is small. Also, their ER, SDand SR is similar too. This is because the correlation matrixes are equal, so the risk parity portfolio is the max Sharpe ratio portfolio. The little difference is perhaps because of digital accuracy.

This is the correlation matrix I am talking about:
[[1.   0.88 0.88]
 [0.88 1.   0.88]
 [0.88 0.88 1.]]

These are ER, SD, SR values:

ER Optimal: 0.14115218197083818
SD Optimal: 0.18035036046673555
SR Optimal: 0.5331410578942137

ER RP: 0.14148229019665012
SD RP: 0.18095388639326654
SR RP: 0.5331871678454336

Problem 4
#a
new weights for each period:
[[0.43226518 0.15549249 0.41224233]
 [0.44480495 0.15171745 0.4034776]
 [0.45716808 0.16549373 0.37733819]
 [0.46624717 0.16555259 0.36820024]
 [0.47921907 0.15739076 0.36339018]
 [0.46930371 0.16718065 0.36351564]
 [0.46969817 0.16270907 0.36759276]
 [0.42953883 0.17382824 0.39663293]
 [0.4201786 0.16851823 0.41130318]
 [0.40786885 0.16518321 0.42694794]
 [0.43319934 0.16759738 0.39920328]
 [0.41514963 0.15558505 0.42926532]
 [0.44915144 0.15009118 0.40075737]
 [0.45214956 0.15247169 0.39537876]
 [0.44972802 0.16321312 0.38705886]
 [0.43479535 0.15645844 0.40874621]
 [0.42310482 0.17341374 0.40348145]
 [0.4336153 0.17309293 0.39329177]
 [0.45661383 0.17155924 0.37182694]
 [0.43953408 0.16967044 0.39079548]]

#b

	Asset1	Asset2	Asset3	Portfolio	Value
1	−0.012221	0.024968	−0.035901	−0.023153	Return Attribution

#c

	Asset1	Asset2	Asset3	Portfolio	Value
2	0.012564	0.000161	0.021275	0.033999	Vol Attribution

Problem5
#a
Price1:
VaR: 0.04891275687040775
ES: 0.10489991622767447

Price2:
VaR: 0.09871574198213295
ES: 0.19094033270882227

Price3:
VaR: 0.09403475703427944
ES: 0.1933242642515971

Price4:
VaR: 0.07867808610927796
ES: 0.14823893554428932

```
#b
Price1 and Price2:
VaR:  0.1265274558131182
ES:  0.2515723412821313

Price3 and Price4:
VaR:  0.14317437418844747
ES:  0.27835547661766824

#c
Price1, Price2, Price3 and Price4:
VaR:  0.2228997256864318
ES:  0.402755071498205
```