Fintech545 Final

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Question 1

- Using the data in “problem1.csv”
  a. Calculate Log Returns (2pts)
  b. Calculate Pairwise Covariance (4pt)
  c. Is this Matrix PSD? If not, fix it with the “near_psd” method (2pt) d. Discuss when you might see data like this in the real world. (2pt)

Question 1(a) Answer

```
The log returns are as the following:
              Price1    Price2    Price3
Date
2023-04-13  0.014389 -0.001276  0.012089
2023-04-14  0.000350  0.018212 -0.018281
2023-04-15       NaN -0.027514 -0.004008
2023-04-16       NaN  0.015923       NaN
2023-04-17  0.019789  0.041891       NaN
2023-04-18  0.011155 -0.008922 -0.001463
2023-04-19 -0.016460 -0.053688 -0.012862
2023-04-20 -0.001548  0.039996  0.030623
2023-04-21 -0.003592       NaN       NaN
2023-04-22  0.004768       NaN       NaN
2023-04-23       NaN       NaN -0.033571
2023-04-24       NaN       NaN  0.017242
2023-04-25  0.010076  0.004917  0.025432
2023-04-26  0.001086 -0.007237 -0.023922
2023-04-27 -0.006507 -0.023310  0.028445
2023-04-28 -0.005505  0.053597 -0.027276
2023-04-29  0.002584 -0.053102  0.016422
2023-04-30  0.005423  0.035326  0.004032
2023-05-01 -0.015111 -0.022887 -0.021360
```

Question 1(b) Answer

```
Pairwise correlation matrix:

          Price1    Price2    Price3
Price1  1.000000  0.293073 -0.206321
Price2  0.293073  1.000000 -0.049936
Price3 -0.206321 -0.049936  1.000000
```

Question 1(c) Answer

```python
# Question 1(c)
def is_psd(matrix, tol=1e-7):
    return np.all(np.linalg.eigvals(matrix) >= -tol)

#print comfirm result
print(is_psd(correlation_matrix))
print('This matrix is PSD from the test above.')
```

```
True
This matrix is PSD from the test above.
```

Question 1(d) Answer

- Missing values are very common in finance. Not all markets are open at the same time on the same days.
- A holiday in one market is not necessarily a holiday in another, even in the same country.
- If we only use the days on which all markets are open, the data is very limited and we will lose a
- large portion of the data. Finding the matching rows for each pair is a good way, although we do not
- garentee that the matrix is PSD.

Question 2

1. “problem2.csv” contains data about a call option. Time to maturity is given in days. Assume 255 days in a year.
    1. Calculate the call price (1pt)
    2. Calculate Delta (1pt)
    3. Calculate Gamma (1pt)
    4. Calculate Vega (1pt)
    5. Calculate Rho (1pt)
2. Assume you are long 1 share of underlying and are short 1 call option. Using Monte Carlo assuming a Normal distribution of arithmetic returns where the implied volatility is the annual volatility and 0 mean
    1. Calculate VaR at 5% (2pt)
    2. Calculate ES at 5% (2pt)
    3. This portfolio’s payoff structure most closely resembles what? (1pt)

Question 2(a) Answer

- Call price is: 5.114843950375857

Question 2(b) Answer

- Delta is: 0.5501626934623628

Question 2(c) Answer

- Gamma is: 0.03220793839235446

Question 2(d) Answer

- Vega is: 21.14591993424314

Question 2(e) Answer

- Rho is: 15.978424540858985

Question 3

1. Data in “problem2_cov.csv” is the covariance for 3 assets. “problem3_ER.csv” is the expected return for each asset as well as the risk free rate.
    1. Calculate the Maximum Sharpe Ratio Portfolio (4pt)
    2. Calculate the Risk Parity Portfolio (4pt)
    3. Compare the differences between the portfolio and explain why. (2pt)

Questin 3(a) Answer

The most efficient portfolio consists of:

	weights(%)
A	34.55
B	34.87
C	30.59

The Portfolio's Sharpe Ratio is: 0.5566581406854578

Question 3(b) Answer

- [[0.34576234 0.34806117 0.30617649]]
- The above matrix is the corresponding weight for AssetA, B and C for risk parity portfolio.

Question 3(c) Answer

```
ER optimal: [[0.12098371]]
ER RP: [[0.12097494]]
SD optimal: [[0.1364917]]
SD RP: [[0.1364841]]
SR optimal: [[0.55669111]]
SR RP: [[0.55665782]]
```

The weights are very similar to each other, and it's almost identical with just a little difference.
We can see that from the above ER, SD, and SR analysis that these three numbers for optimal portfolio and for risk parity portfolio are very similar and very close to each other. This can also explain why the weights for two portfolios are very close to each other.

Question 4

1. Data in “problem4_returns.csv” is a series of returns for 3 assets. “problem4_startWeight.csv” is the starting weights of a portfolio of these assets as of the first day in the return series.
    1. Calculate the new weights for the start of each time period (2pt)
    2. Calculate the ex-post return attribution of the portfolio on each asset (4pt)
    3. Calculate the ex-post risk attribution of the portfolio on each asset (2pt)

Question 4(a) Answer

The new weights for each time period is as the following:

	0	1	2	Date
0	0.340701	0.276936	0.382363	2023-04-12
1	0.342880	0.264561	0.392559	2023-04-13
2	0.345686	0.245843	0.408471	2023-04-14
3	0.345938	0.256509	0.397553	2023-04-15
4	0.336285	0.248698	0.415018	2023-04-16
5	0.327108	0.247798	0.425094	2023-04-17
6	0.315249	0.245591	0.439161	2023-04-18
7	0.313195	0.224855	0.461951	2023-04-19
8	0.302968	0.236569	0.460463	2023-04-20
9	0.289797	0.247324	0.462879	2023-04-21
10	0.299361	0.239763	0.460876	2023-04-22
11	0.279797	0.225325	0.494878	2023-04-23
12	0.281712	0.231770	0.486518	2023-04-24
13	0.277160	0.255895	0.466945	2023-04-25
14	0.265720	0.255861	0.478419	2023-04-26
15	0.260515	0.264125	0.475360	2023-04-27
16	0.245631	0.278970	0.475399	2023-04-28
17	0.220813	0.302848	0.476339	2023-04-29
18	0.211770	0.303685	0.484546	2023-04-30
19	0.203401	0.302536	0.494063	2023-05-01

Question 4(b)&(c) Answer

Return Attribution and risk Attribution for each asset are in the following table:

	Value	Asset1	Asset2	Asset3	Portfolio
0	TotalReturn	-0.281192	0.356570	0.581352	0.221873
1	Return Attribution	-0.086871	0.087059	0.221685	0.221873
2	Vol Attribution	0.009658	0.004309	0.016932	0.030898

Question 5

1. Input prices in “problem5.csv” are for a portfolio. You hold 1 share of each asset. Using arithmetic returns, fit a generalized T distribution to each asset return series. Using a Gaussian Copula:
    1. Calculate VaR (5%) for each asset (3pt)
    2. Calculate VaR (5%) for a portfolio of Asset 1 &2 and a portfolio of Asset 3&4 (4pt)
    3. Calculate VaR (5%) for a portfolio of all 4 assets. (3pt)

Question 5(a) Answer

```
Portfolio Asset1 VaR 5%: 0.040606269104216 61
Portfolio Asset2 VaR 5%: 0.060685296702743585
Portfolio Asset3 VaR 5%: 0.0538184428363877
Portfolio Asset4 VaR 5%: 0.044899987915400175
```

Question 5(b) Answer

```
Portfolio Asset1&2 VaR 5%: 0.08256019979373264
Portfolio Asset3&4 VaR 5%: 0.08618808770157216
```

Question 5(c) Answer

- Portfolio Total all 4 assets VaR 5%: 0.13797841918773202