Problem1:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **closed\_form\_greeks** |  | **finite\_diff\_greeks** |  | **Diff** |
| Delta of the call option is | 0.083 | Delta of the call option is | 0.083 | 0 |
| Delta of the put option is | -0.917 | Delta of the put option is | -0.917 | 0 |
| Gamma of the call option is | 0.017 | Gamma of the call option is | 0.017 | 0 |
| Gamma of the put option is | 0.017 | Gamma of the put option is | 0.017 | 0 |
| Vega of the call option is | 6.939 | Vega of the call option is | 6.904 | 0.00504 |
| Vega of the put option is | 6.939 | Vega of the put option is | 6.904 | 0.00504 |
| Theta of the call option is | -8.127 | Theta of the call option is | -8.098 | 0.00357 |
| Theta of the put option is | -1.941 | Theta of the put option is | -1.913 | 0.01443 |
| Rho of the call option is | -0.03 | Rho of the call option is | -0.03 | 0 |
| Rho of the put option is | -1.243 | Rho of the put option is | -1.243 | 0 |
| Carry Rho of the call option is | 1.133 | Carry Rho of the call option is | 1.131 | 0.00177 |
| Carry Rho of the put option is | -12.515 | Carry Rho of the put option is | -12.516 | -8E-05 |

A table with numbers and text

Description automatically generated

Problem 2:   
PS：The simulation test may cause ES to be calculated as NA due to random reasons, please run it a few more times

Normal assumption:

A screenshot of a computer screen

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Delta assumption:

A screenshot of a computer

Description automatically generated

Last week:  
A black screen with white text

Description automatically generated

The preceding observations highlight a consistency between the outcomes of the previous week and those originating from the normal assumption. However, the results stemming from the delta normal assumption markedly surpass those arising from the other two hypotheses.

Problem 3:

Annual Return:

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The covariance matrix:A screen shot of a computer

Description automatically generated  
The super-efficient portfolio is  
A screen shot of a computer

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