DSC5211C - QRM
Workshop9
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Group 09:

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1. TASK 1: Probabilistic constraints

A. Optimal policy for

1%

```
----     53 VARIABLE x.L  fraction of portfolio invested in asset i

aapl 0.197,    mcd  0.051,    qqq  0.455,    spy  0.296


----     53 VARIABLE e_return.L           =        0.020  expected return of th
                                                         e portfolio
            VARIABLE variance.L           =  3.261921E-4  variance of portfolio
            VARIABLE var.L                =       -0.042  value at risk
```

5%

```
----     53 VARIABLE x.L  fraction of portfolio invested in asset i

aapl 0.197,    mcd  0.051,    qqq  0.455,    spy  0.296


----     53 VARIABLE e_return.L           =        0.020  expected return of th
                                                         e portfolio
            VARIABLE variance.L           =  3.261921E-4  variance of portfolio
            VARIABLE var.L                =       -0.030  value at risk
```

10%

```
----     53 VARIABLE x.L  fraction of portfolio invested in asset i

aapl 0.197,    mcd  0.051,    qqq  0.455,    spy  0.296


----     53 VARIABLE e_return.L           =        0.020  expected return of th
                                                         e portfolio
            VARIABLE variance.L           =  3.261921E-4  variance of portfolio
            VARIABLE var.L                =       -0.023  value at risk
```

B) Risk neutral optimal policy only focuses on expected return. Risk averse policy seeks to decrease probability of a loss. The risk averse policy therefore focuses on a fixed probability of loss (β). By fixing β, the portfolio can be varied.

C) Decreasing target annual return will result in lower expected monthly return but also reduced risk (VAR). This is achieved through diversifying the portfolio. Increasing the target annual return results in higher expected monthly return but also increased risk (VAR). This results in focusing the entire portfolio in the single highest return stock (AAPL).

If we are to increase the target return to 1%, we would put all our funds to just APPL that gives the highest return. If we are to decrease the target return to 0.1%, we would put our funds across all other 4 stocks (MCD, QQQ, SPY, TLT) except APPL

Target 0.1

```
----     53 VARIABLE x.L  fraction of portfolio invested in asset i

aapl 1.000


----     53 VARIABLE e_return.L           =        0.029  expected return of th
                                                         e portfolio
            VARIABLE variance.L           =        0.002  variance of portfolio
            VARIABLE var.L                =       -0.184  value at risk
```

0.05

```
aapl 1.000


----     53 VARIABLE e_return.L           =        0.029  expected return of th
                                                         e portfolio
            VARIABLE variance.L           =        0.002  variance of portfolio
            VARIABLE var.L                =       -0.134  value at risk
```

0.025

```
aapl 0.429,    qqq  0.571


----     53 VARIABLE e_return.L            =        0.025  expected return of th
                                                           e portfolio
            VARIABLE variance.L            =  7.308163E-4  variance of portfolio
            VARIABLE var.L                 =       -0.063  value at risk
```

0.01

```
mcd 0.185,    qqq 0.183,    spy 0.588,    tlt 0.043


----     53 VARIABLE e_return.L            =        0.014  expected return of th
                                                           e portfolio
            VARIABLE variance.L            =  1.583893E-4  variance of portfolio
            VARIABLE var.L                 =       -0.026  value at risk
```

0.001

```
----     53 VARIABLE x.L  fraction of portfolio invested in asset i

mcd 0.185,    qqq 0.183,    spy 0.588,    tlt 0.043


----     53 VARIABLE e_return.L            =        0.014  expected return of th
                                                           e portfolio
            VARIABLE variance.L            =  1.583893E-4  variance of portfolio
            VARIABLE var.L                 =       -0.017  value at risk
```

2. TASK 2 – CV@R Optimization

A. Optimal policy

0.9

```
spy  0.481,    aapl 0.073,    mcd  0.176,    qqq  0.268,    tlt  0.001


----     82 VARIABLE e_return.L            =        0.016  expected return of th
                                                           e portfolio
            VARIABLE var.L                 =  -3.66099E-4  value at Risk
            VARIABLE cvar.L                =        0.005  conditional value at
                                                           risk
```

0.95

```
spy  0.491,    aapl 0.066,    mcd  0.176,    qqq  0.257,    tlt  0.009


----     82 VARIABLE e_return.L           =        0.016  expected return of th
                                                          e portfolio
            VARIABLE var.L                =        0.004  value at Risk
            VARIABLE cvar.L               =        0.009  conditional value at
                                                          risk
```

Beta = 0.99 s = 10000

```
spy  0.501,    aapl 0.057,    mcd  0.193,    qqq  0.233,    tlt  0.016


----     82 VARIABLE e_return.L           =        0.015  expected return of th
                                                          e portfolio
            VARIABLE var.L                =        0.012  value at Risk
            VARIABLE cvar.L               =        0.016  conditional value at
                                                          risk
```

As beta increases, the portfolio reduces AAPL stock and increase proportion of SPY. The portfolio expected monthly return remains stable but the CVAR increases

B) Increasing the number of scenarios will result in the VAR remaining the same but CVAR increasing. This is because the CVAR is focused on the outliers. As the number of scenarios increases, there is increasing chance of larger outliers.

Beta = 0.99 and scenario = 1000

```
spy  0.522,    aapl 0.035,    mcd  0.166,    qqq  0.243,    tlt  0.035


----     82 VARIABLE e_return.L           =        0.015  expected return of th
                                                          e portfolio
            VARIABLE var.L                =        0.012  value at Risk
            VARIABLE cvar.L               =        0.015  conditional value at
                                                          risk
```

Beta = 0.99 and scenario = 100

```
spy 0.600,    mcd 0.143,    qqq 0.240,    tlt 0.017


----     82 VARIABLE e_return.L           =        0.014  expected return of th
                                                         e portfolio
            VARIABLE var.L                =        0.012  value at Risk
            VARIABLE cvar.L               =        0.012  conditional value at
                                                         risk
```

C) As SPY represents a market index, you would typically expect the majority of stocks to be correlated with the market. As such, the correlation matrix will be adjusted so that the SPY correlation is always +'ve.

ORIGINAL Corr

```
Parameters ro(i)  correlation matrix between spy and the other securities
      /aapl     0.270
      mcd      -0.337
      qqq      -0.123
      spy       1.000
      tlt       0.090/;
```

Once correlation matrix has been adjusted to show positive correlation between SPY and the other stocks, the solution shows increased apportionment to the index funds (SPY and QQQ) as these typically have lower variance than individual stocks.

```
Parameters ro(i)  correlation matrix between spy and the other securities
      /aapl     0.270
      mcd       0.337
      qqq       0.123
      spy       1.000
      tlt       0.090/;
```

```
spy  0.475,    aapl 0.087,    mcd  0.081,    qqq  0.327,    tlt  0.030


----     82 VARIABLE e_return.L           =        0.017  expected return of th
                                                          e portfolio
            VARIABLE var.L                =        0.010  value at Risk
            VARIABLE cvar.L               =        0.017  conditional value at
                                                          risk
```

When the correlation changed as below (all 0.001 vs. SPY) , the SPY proportion is still around 45%, but the remaining AAPL, MCD and QQQ are more equally distributed. TLT has negative return, therefore, the proportion is immaterial.

```
Parameters ro(i)  correlation matrix between spy and the other securities
      /aapl    0.001
      mcd      0.001
      qqq      0.001
      spy      1.000
      tlt      0.001/;
```

```
----     82 VARIABLE x.L  fraction of portfolio invested in asset i

spy  0.455,    aapl 0.118,    mcd  0.123,    qqq  0.273,    tlt  0.031


----     82 VARIABLE e_return.L           =        0.017  expected return of th
                                                          e portfolio
            VARIABLE var.L                =        0.006  value at Risk
            VARIABLE cvar.L               =        0.012  conditional value at
                                                          risk
```