STK_MAT 3700

12th October 2023
Mandatory Assignment
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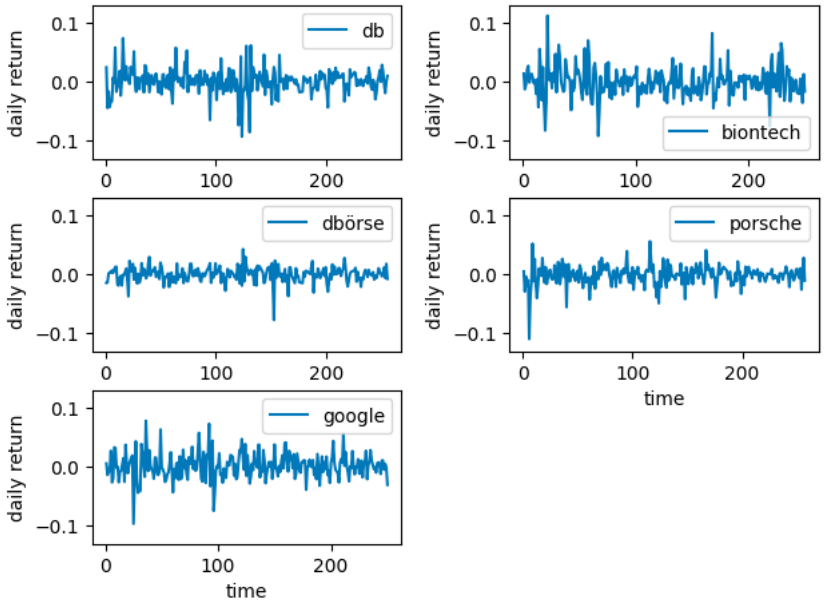
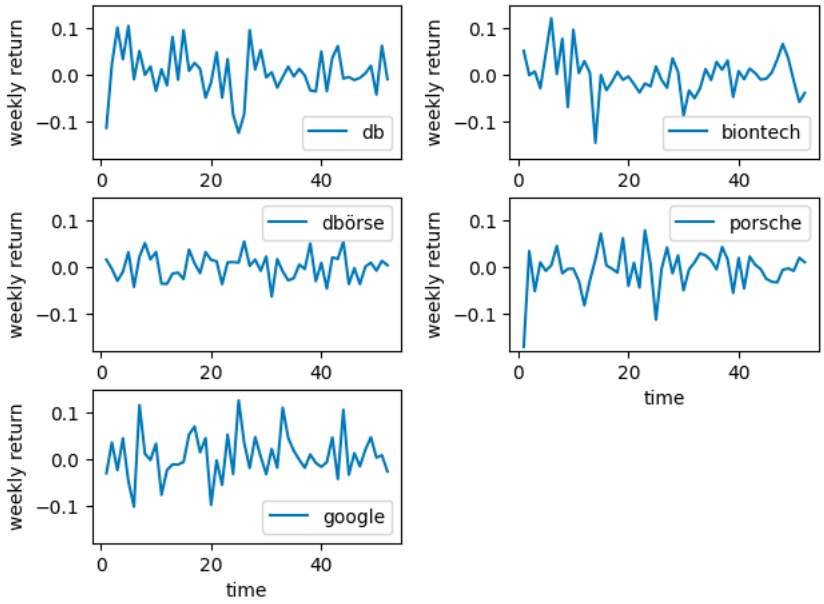
I did only print the outputs here, when it was explicitely written to do so. You find all the results in the provided code.

Exercise 1a

I chose to evaluate the data of the past year and evaluated the following companies: Deutsche Bank, Biontech, Deutsche Börse, Porsche, Google.





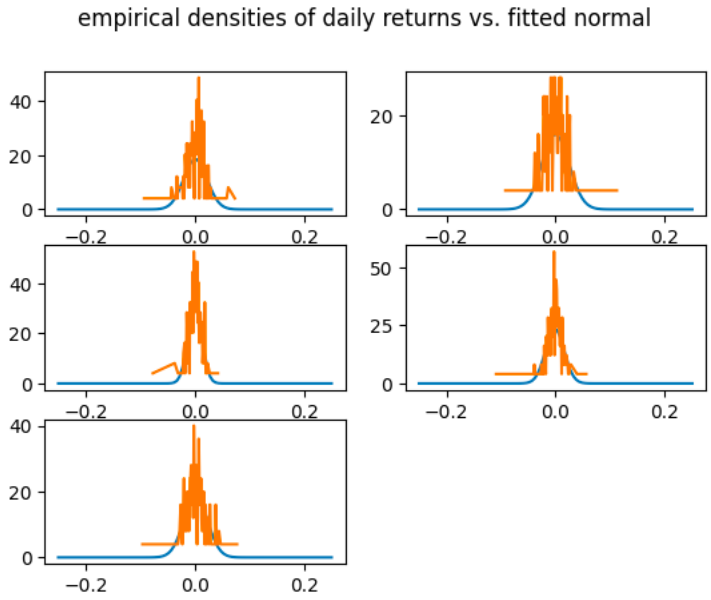
Exercise 1b

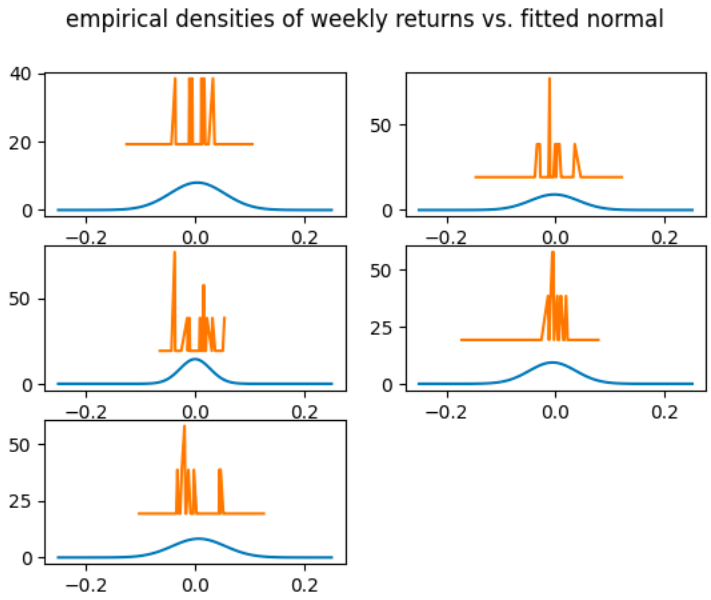
db_daily_mean: 0.0007702932370513637

db_weekly_mean: 0.004339099753338295
biontech_daily_mean: -0.000352979434944665
biontech_weekly_mean: -0.002254000204807188
porsche_daily_mean: -0.0015397334518382772
porsche_weekly_mean: -0.005766768506563269
dbörse_daily_mean: -0.00010191563226261088
dbörse_weekly_mean: 0.0003808141656413158
google_daily_mean: 0.0007702932370513637
google_weekly_mean: 0.0007702932370513637
db_daily_vol: 0.021474053388312056
db_weekly_vol: 0.04970409213566631
biontech_daily_vol: 0.02506202373140432
biontech_weekly_vol: 0.04385937736704859
porsche_daily_vol: 0.016888909081598263
porsche_weekly_vol: 0.04275574495374037
dbörse_daily_vol: 0.012628215177437474
dbörse_weekly_vol: 0.027629501206997847
google_daily_vol: 0.021474053388312056
google_weekly_vol: 0.021474053388312056

Exercise 1c

Order: Deutsche Bank, Biontech, Deutsche Börse, Porsche, Google





While for the densities of the daily returns, the assumption seems reasonable, the weekly returns have heavier tails than estimated by the normal distribution. Regarding Biontech and Porsche this becomes the most obvious.

Exercise 2a

```
To verify the results, I checked that the diagonals equal the squared
vol from 1)

  cov3
  [[ 2.47049678e-03 -7.01158123e-05 -1.28490239e-04]
   [-7.01158123e-05  1.92364498e-03  8.20789355e-05]
   [-1.28490239e-04  8.20789355e-05  7.63389337e-04]]
  cov4
  [[ 2.47049678e-03 -7.01158123e-05 -1.28490239e-04 -1.97663336e-04]
   [-7.01158123e-05  1.92364498e-03  8.20789355e-05 -1.06013278e-04]
   [-1.28490239e-04  8.20789355e-05  7.63389337e-04  4.44353077e-04]
   [-1.97663336e-04 -1.06013278e-04  4.44353077e-04  2.34718608e-03]]
  cov5
  [[ 2.47049678e-03 -7.01158123e-05 -1.28490239e-04 -1.97663336e-04
     1.04344448e-03]
   [-7.01158123e-05  1.92364498e-03  8.20789355e-05 -1.06013278e-04
    -3.02192053e-04]
   [-1.28490239e-04  8.20789355e-05  7.63389337e-04  4.44353077e-04
     1.76438578e-04]
   [-1.97663336e-04 -1.06013278e-04  4.44353077e-04  2.34718608e-03
     4.47586359e-04]
   [ 1.04344448e-03 -3.02192053e-04  1.76438578e-04  4.47586359e-04
     1.82805373e-03]]
```

Exercise 2b

```
# The variance of the minum variance portfolio has to (not strictly)
decline in the number of assets n. This is because larger n increases
the set of possible portfolios and includes all possible portfolios
from n-1. Hence due to monotonicity the minimal variance is decreasing
in n.
```

Exercise 2c

```
# By the same argument as above follows that the efficient frontier
curve with n assets must be equal or strictly higher than the
corresponding curve with n-1 assets. For any given volatility the
efficient frontier portfolio's return with n assets has to be equal or
higher than the corresponding one with n-1 assets.
```

Exercise 2d

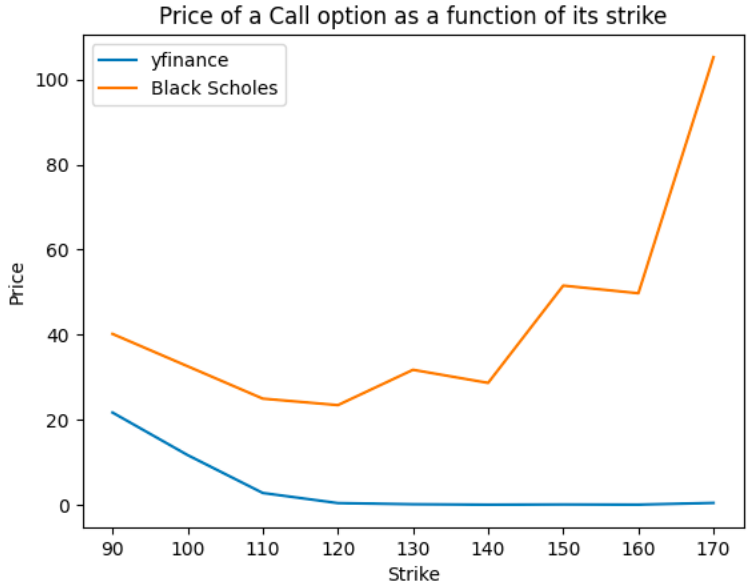
```
# The risk can be anywhere between larger or equal zero (portfolio only
consisting of risk free investment). Risk larger than the maximal
volatility of the assets can be achieved by negative positions. The
expected return can be anywhere above the risk free interest rate r0,
since infinetely high risk implies infinitely high expected return.
```

Exercise 3a

```
# As the risk free interest rate I chose the current deposit rate given
by the EZB, since the central bank is in charge of stabilizing and
assuring financial stability.
```

Exercise 3b

Note: As a sanity check I fixed the volatility and then plotted; the BS curve was declining as it should.



Exercise 3c
I didn’t manage to implement a method to find the zero of the function.