Introduction to Financial Engineering

Final Assignment

(1) **portfolio optimization**:

a) **diversification**: Choose financial stock indices (at least 7) for different markets or sectors. Time interval 20 years, monthly data. When necessary, convert all values in one domestic currency (e.g. USD).

b) **estimate**: expected yearly returns and covariance matrix with a rolling window of 10 years (in annual steps).

c) **efficient frontier**: show in one or more figures the 11 different efficient frontiers (one for each rolling window) and explain in your report the diversification benefit.

d) **Tobin separation**: repeat the assignment c), now including a risk-free rate of 1%. What are the consequences for the portfolio management in such a world?

e) **asset allocation**: choose a constant required return and calculate the optimal asset allocation for the case of the Tobin separation efficient frontier in the different years. How high is the portfolio turnover on average each year?

f) **backtest**: conduct a backtest (ex-post) for the optimized portfolio (with annual re-balancing, see point e). Calculate the average return and the standard deviation for your ex-post portfolio out of sample? (i.e. your portfolio is created by calculating the mean and covariance in-sample to find your optimal portfolio, BUT then you hold your portfolio for one year out-of-sample and calculate the return you have had during this period. Then you repeat the same process again and again for each period.)

g) **beta**: use a broad stock index to test, whether our portfolio is in line with the CAPM prediction:

$$\bar{R}_P = R_F + (\bar{R}_M - R_F)\beta_P$$

Has your portfolio created "alpha"? Is the "alpha" significant? (see Jensen's alpha)

h) **Black-Litterman (BL)**: How would the asset allocation and your backtest change if you use the model implied expected returns of the Black-Litterman approach?

i) **timing**: calculate the *Treynor-Mazuy* measure and give an interpretation to these results (portfolio returns without BL)

(2) **bonds**:

a) Use five different "real" bonds and calculate for these bonds the yield to maturity, duration and convexity.

b) Calculate the duration and convexity of a portfolio of these bonds, if EUR 100.000,-- is invested in each of them

c) Estimate the potential decline in the market value of your portfolio, if the yield increases by 150 basis points.

Write a **report**: Describe your data and the corresponding source, the techniques, and give an interpretation to the results (i.e. show us what you have done and learnt). Submit on campus net a pdf report and a zip file with all the Matlab code. Please remember to include all of your group members when you submit your report on Campus Net.