THEORY OF FINANCE

Solution Sheet on Problem Set 1

Return Calculations, Portfolio Choice and Mean-Variance Frontier

Deadline: 19.10.2021

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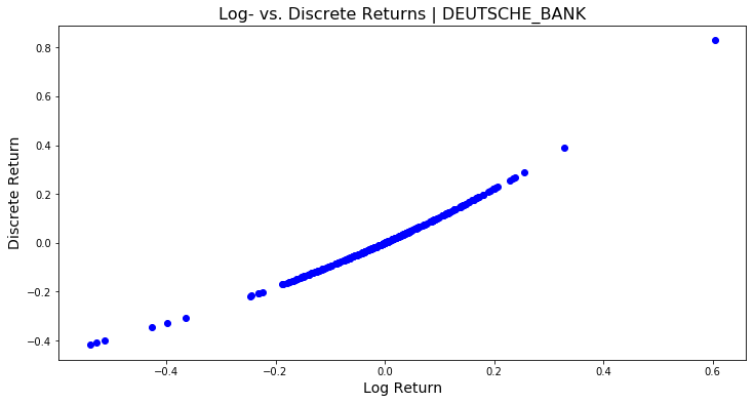
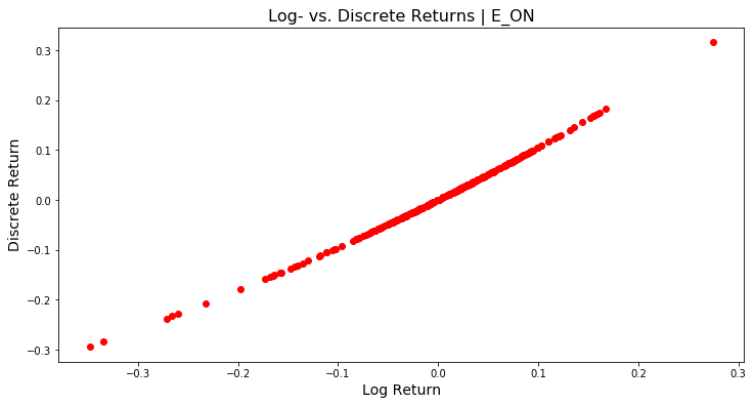
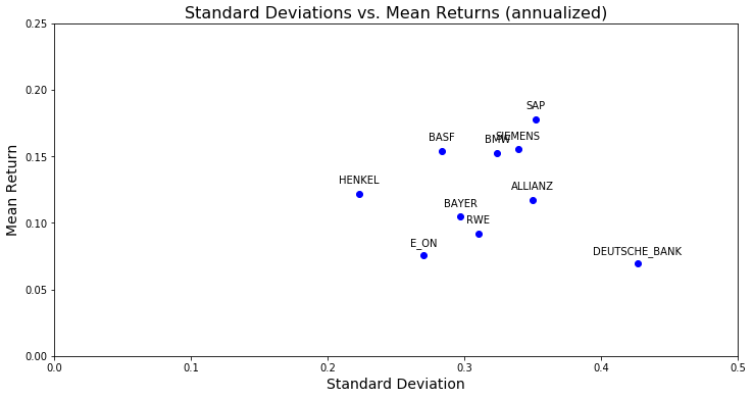
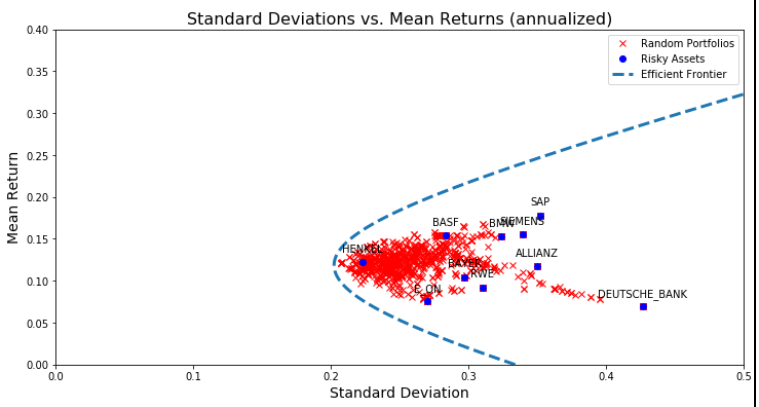
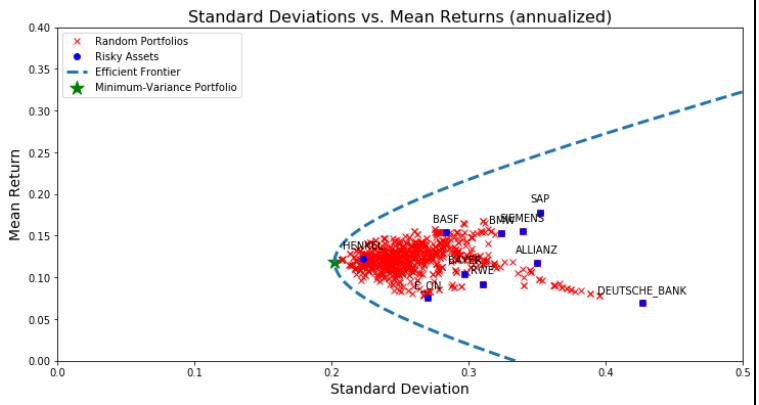
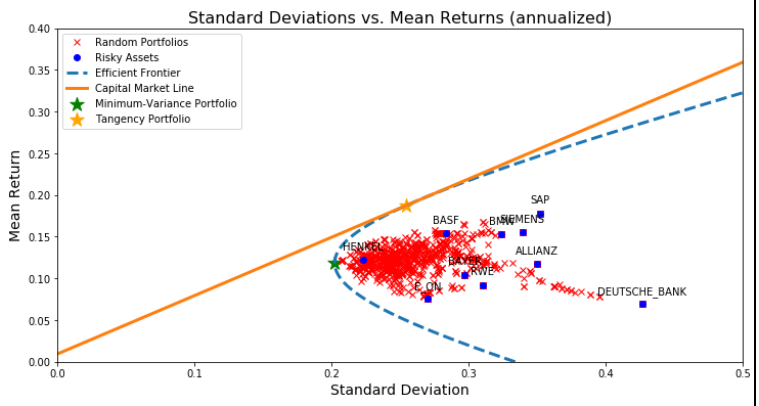
Task		Points Earned
1. Return Comparison a) Discrete vs. Log-Returns: mean, st.dev. and annualized (6 points)	See return variations in code section “Problem 1 – Return Comparison – a)”	
b) Discrete vs. Log-Returns: Plot and interpretation (8 points)	  Given we are using log returns which have a normalizing effect on the data there is barely any difference noticeable. However, it can be clearly seen that there is an upwards curvature which is because discrete returns are always larger than the corresponding log return.	
c) Usage of return type (6 points)	Usually, the discrete return is used for calculating the return of a portfolio (i.e. multiple assets) and when choosing the different weights of assets in a portfolio. Log returns are used when returns are aggregated across time and when comparing investment horizons for the same asset.	

d) Investment value (6 points)	At end the of July 2021 the investment would be worth EUR 980.76.	
2. Diversification Effect a) Diversification using two stocks (6 points)	When looking purely for diversification (regardless of any implies on return) the idea is to reduce the portfolio variance. Given the portfolio variance is defined by $$\mathrm{Var}(\mathrm{R_P}) = \omega_1^2\sigma_{11} + \omega_2^2\,\sigma_{22} + 2\omega_1\,2\omega_2\,\sigma_{12}$$ the diversification benefit increases with decreasing correlation of the two assets. Therefore, to get the highest diversification benefit an investor should choose stocks SAP and E_ON as they have the lowest correlation out of the 10 stocks. The worst diversification benefit is achieved by only investing in a single stock (as correlation = 1). However, given two stocks need to be picked, the worst diversification effect is achieved with investing into RWE and E_ON given they have the highest correlation.	
b) Diversification and portfolio volatility (12 points)		
c) Visualization and interpretation of b) (12 points)		
3. Mean-Variance Frontier a) Mean-Volatility Plot (8 points)		

b) Efficient Frontier (10 points)		
c) Minimum Variance Portfolio (10 points)	See minimum-variance portfolio in code section “Problem 3 – Mean-Variance Frontier and Portfolio Choice – c)” 	
d) Tangency Portfolio (10 points)	See tangency portfolio in code section “Problem 3 – Mean-Variance Frontier and Portfolio Choice – d)” 	
e) Portfolio Choice (6 points)	Optimal allocation for portfolio in ETF and risk-free asset: Weight in ETF: 36.84% Weight in risk-free asset: 63.16%	