

Practical Portfolio Optimization



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What is Optimization?



∞ Informal definition:

- ∞ Given a criteria for measuring quality of solutions, find the best solution
- ∞ Example: travelling salesman problem

∞ Formal definition:

(S, f)

- ∞ S is the set of all possible solutions
 - ∞ f is a function that maps every candidate solution in S to a number
- Task: to find a solution x in S such that $f(x)$ is maximal or minimal

Objectives in investment



- ⌘ To maximize return
- ⌘ To minimize risk
- ⌘ This is a 2-objectives optimization problem
 - ⌘ High risk → high return

What is a portfolio



- ⌘ A portfolio is a bag of assets of different weights
- ⌘ E.g. 40% in HSBC, 25% on BP, 35% on cash

Why invest in a portfolio?



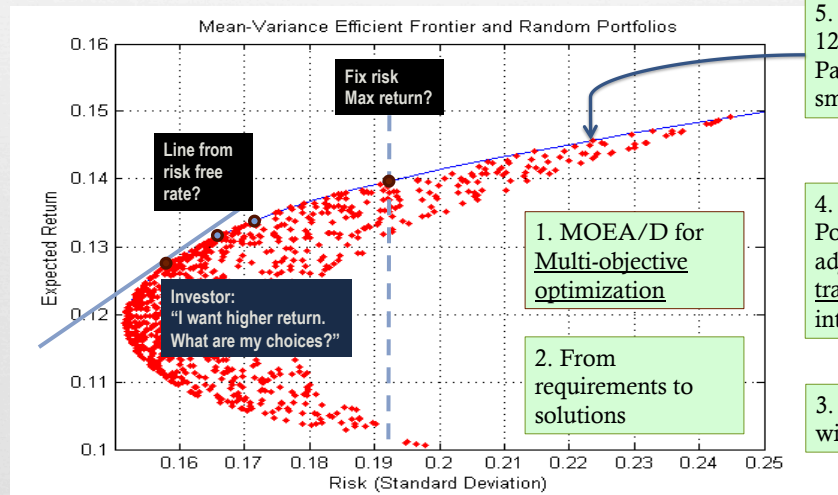
- ⌘ The aim is to reduce risk without sacrificing too much return
- ⌘ Assumption: not all asset prices do not change together
- ⌘ Losses in one asset may be compensated by gains in another asset
- ⌘ Therefore, diversification reduces risks

Markowitz Model



- ⌘ Given a set of assets (a_1, a_2, \dots, a_n) with weights (w_1, w_2, \dots, w_n)
- ⌘ Expected Return = $\sum_{i,n} w_i r_i$
- ⌘ Expected Risk = $\sum_{i,n} \sum_{j,n} w_i w_j \sigma_i \sigma_j \rho_{ij}$
- ⌘ $\rho_{ij} = 1$ for $i = j$; $\rho_{ij} = \sum_{i,n} \sum_{j,n} w_i w_j \sigma_{ij}$ otherwise

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5. One cannot buy 12.45 shares, so the Pareto Front is not smooth!

4. Dynamic Portfolio adjustment: taking transaction costs into consideration

3. Modelling risk with VaR, CVaR, ...

1. MOEA/D for Multi-objective optimization

2. From requirements to solutions

Collaborators



- ⌘ Prof Qingfu Zhang, Univ. of Essex, UK & City University, Hong Kong
 - ⌘ Multi-objective optimization: MOEA/D
- ⌘ Dr Amadeo Alentorn, Head of Research / Fund Manager at Old Mutual Global Investors, UK
 - ⌘ Algorithmic portfolio optimization
- ⌘ Dr Hamid Jalalian, University of Essex, UK
 - ⌘ Noisy Multi-objective optimization
- ⌘ Dr Rong Qu, Nottingham University, UK
 - ⌘ Modelling risk with CVaR, Hyperheuristics

Exercise



- ⌘ Data is provided for a portfolio optimization problem
- ⌘ Follow the links from the assignments in 2011-12:
 - ⌘ <http://www.brasil.net/teaching/CFE/2011-2012.html>