Welcome
We will begin promptly at 11 AM ET.
If you are unable to hear the speakers, please let us know in the chat box. You may enter your questions in the Q&A, we will address them at the end of the presentation.
You can find a copy of the recording of this webinar:
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www.caia.org/caia-infoseries
Financial Data Professional Institute

FDP Institute provides world class training and education to financial professionals to meet the accelerating needs of digital transformation in the industry.

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The FDP Institute

The FDP Charter

The FDP Institute offers a self-study program that provides financial data professionals an efficient path to learn the essential aspects of financial data science.

The FDP Study Guide is now accessible on our website at:
https://fdpinstitute.org/Candidate - Study - Guide

TOPICS COVERED INCLUDE:
1. Introduction to Data Science
2. Linear & Logistic Regression, Support Vector Machines, Regularization and Time Series
3. Decision Trees, Supervised Segmentation and Ensemble Methods
4. Classification, Clustering and Naïve Bayes
5. Neural Networks and Reinforcement Learning
7. Text Mining
8. Ethical & Privacy Issues
9. Fintech Applications

FDP EXAM Q4- 2023 IMPORTANT DATES:
Open Registration : June 1, 2023
FDP Exam Test Center Dates: October 9 - 22, 2023
Remote Proctor Testing Dates: October 23 & 23, 2023
How to Build Better Portfolios in Python Using Riskfolio - Lib

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Master of Finance & Software Engineer

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Portfolio Management & Quantitative Analysis Expert

Dr. Hossein Kazemi, CFA
Senior Advisor
CAIA Association & FDP Institute

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How asset managers build a Portfolio?

Asset managers have a wide universe of assets, asset classes and models to choose:

- Cash
  - Cash
  - T-bills, etc.
- Fixed Income
  - Gov. Bonds
  - Corp. Bonds, etc.
- Equities
  - Stocks
  - ETFs
- Commodities
  - Oil
  - Gold
  - Wheat, etc.
- Alternatives
  - Hedge Funds
  - Private Equity
  - Real State, etc.

How to combine them?

- 60 Equity / 40 Fixed Income
- 1/N Portfolio
- 100 - age in Equities
- Endowment model
- Portfolio Optimization
What is Portfolio Optimization?

Portfolio optimization is the process to select the best possible combination of asset according to a set of desired objectives and constraints using mathematical techniques.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversification, reduce of idiosyncratic risk.</td>
<td>Risk of over-diversification, too many assets increase cost of rebalancing.</td>
</tr>
<tr>
<td>Lead to more efficient portfolios in a risk return relationship.</td>
<td>More appropriate for frictionless markets and liquid assets.</td>
</tr>
<tr>
<td>Allows to build custom portfolios designed to meet investor needs.</td>
<td>Complex mathematical models. Some models are hard to implement and solve.</td>
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</tbody>
</table>
Riskfolio-Lib is a library for portfolio optimization in Python made in Peru. It is built on top of CVXPY and closely integrated with Pandas data structures. It allows users to solve two kinds of portfolio optimization models:

<table>
<thead>
<tr>
<th>Convex Portfolio Optimization</th>
<th>Machine Learning Portfolio Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk-Return Trade off</td>
<td>Hierarchical Risk Parity</td>
</tr>
<tr>
<td>Risk Parity Risk Budgeting Approach</td>
<td>Hierarchical Equal Risk Contribution</td>
</tr>
<tr>
<td>Risk Parity Least Squares Approach</td>
<td>Nested Clustered Optimization</td>
</tr>
<tr>
<td>Worst Case Optimization</td>
<td></td>
</tr>
</tbody>
</table>
Convex Portfolio Optimization

Risk-Return Trade Off

<table>
<thead>
<tr>
<th>Minimize $\phi_0(x)$</th>
<th>$\sum_{i=1}^{N} \left( \frac{x_i (\Sigma x)_i}{x^T \Sigma x} - b_i \right)^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject to $Ax \geq B$, $\mu^T x \geq \bar{\mu}$</td>
<td>Subject to $Ax \geq B$</td>
</tr>
<tr>
<td>$\phi_i(x) \leq \bar{\phi}_i$, $i = 1, \ldots, m$</td>
<td>$1^T x = 1$, $x \geq 0$</td>
</tr>
</tbody>
</table>

Risk Parity Least Squares

<table>
<thead>
<tr>
<th>Maximize $\mu^T x$</th>
<th>Maximize $\min \mu x - \lambda \max \mu^T x$</th>
</tr>
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<td>$\Sigma \in U\Sigma$</td>
</tr>
</tbody>
</table>

Worst Case Optimization

<table>
<thead>
<tr>
<th>Minimize $x^T \Sigma x$</th>
<th>Maximize $\min \mu x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject to $Ax \geq b$</td>
<td>Subject to $Ax \geq b$</td>
</tr>
</tbody>
</table>

Robust Variance Minimization

Utility Maximization

<table>
<thead>
<tr>
<th>Maximize $\mu^T x$</th>
<th>Maximize $\min \mu x - \lambda \max x^T \Sigma x$</th>
</tr>
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</table>
Convex Portfolio Optimization

It is the traditional approach for portfolio optimization. Using convex optimization techniques, we can create portfolios that meets investor’s needs like:

- Minimize the risk of a portfolio.
- Create constraints on asset classes.
- Create tracking error constraints.
- Create long-short portfolios.
- Constraints on risk measures, among other investor’s needs.
Machine Learning Portfolio Optimization

Hierarchical Risk Parity

Hierarchical Equal Risk Contribution

Nested Clustered Optimization
More Riskfolio-Lib Features

Efficient Frontier Mean-Standard Deviation

Efficient Frontier Mean-CVaR
More Riskfolio-Lib Features

Risk Parity - Equal Risk Contribution

Portfolio Return’s Histogram

Risk Parity - Equal Risk Contribution per Asset Class

Assets Cluster’s Network
Riskfolio-Lib Links

- Source code is available in https://github.com/dcajasn/Riskfolio-Lib
- Documentation is available in https://riskfolio-lib.readthedocs.io/
- Examples are available in https://riskfolio-lib.readthedocs.io/en/latest/examples.html
- Pypi page for installation is available in https://pypi.org/project/Riskfolio-Lib/
- Support this project (Donations):
  - https://github.com/sponsors/dcajasn
  - https://ko-fi.com/riskfolio
Mean Risk Optimization

1. Downloading the data:

```python
import numpy as np
import pandas as pd
import yfinance as yf
import warnings

warnings.filterwarnings("ignore")
pd.options.display.float_format = '{:.4f}'.format

# Date range
start = '2016-01-01'
end = '2019-12-30'

# Tickers of assets
assets = ['JCI', 'TGT', 'OMESA', 'CMH', 'HO', 'APA', 'MNC', 'JPM',
          'ZION', 'PSA', 'BAX', 'BMY', 'LVV', 'PCAR', 'TXT', 'TMO',
          'DE', 'MSFT', 'HPQ', 'SEE', 'VZ', 'CNP', 'NI', 'T', 'BA']
assets.sort()

# Downloading data
data = yf.download(assets, start=start, end=end)
data = data.iloc[:, ('Adj Close', slice(None))]
data.columns = assets
```
Selected Questions

• About advanced mathematical portfolio construction models beyond mean-variance theory under ESG context.

• How stable the most recent Machine Learning allocation optimization methods are, compare to more traditional ones?

• How would you account for tail risk in portfolio optimization programs?

• What is your favorite feature?
Selected Questions

- Does speaker have any experience in integrating Riskfolio-lib with another open-source data aggregation tool OpenBB?
- What is the necessary programming background to build portfolios?
- Recommended mathematics to study?
- Highlight practical differences between RlVaR, EVaR, CVaR and cases where each one should be over the others?
Thanks

Dany Cajas - April 2023
Q & A

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