Portfolio Optimization: A Comparative Analysis

Ossama Tchina - 3137796

Bocconi University

20598 – Finance with Big Data

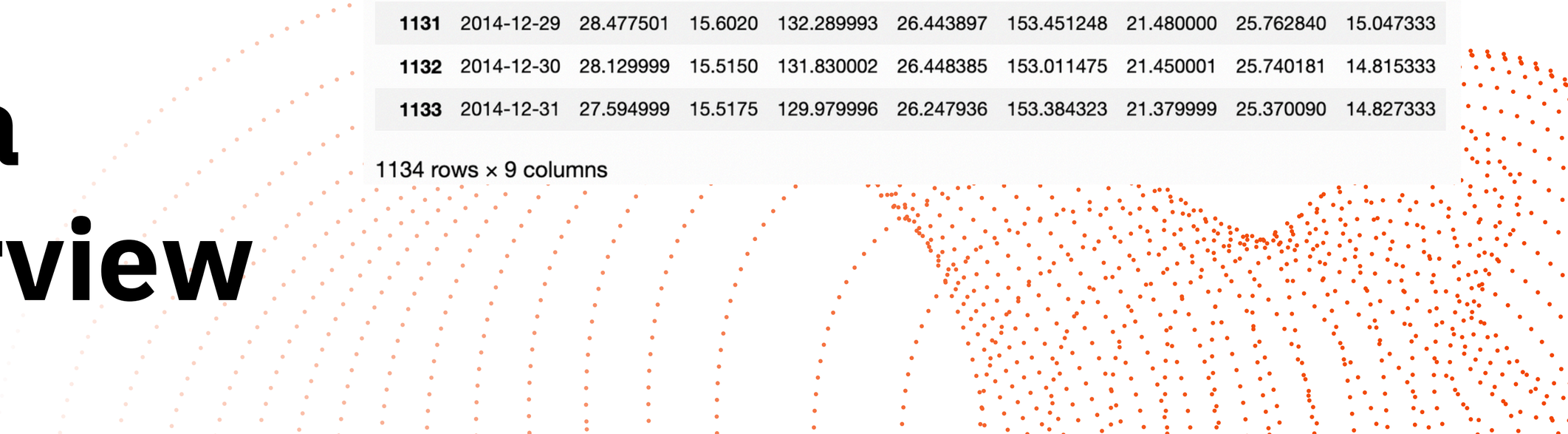
Table of contents

- yfinance package
- 8 stocks
- 2010-2015 vs 2015-2020

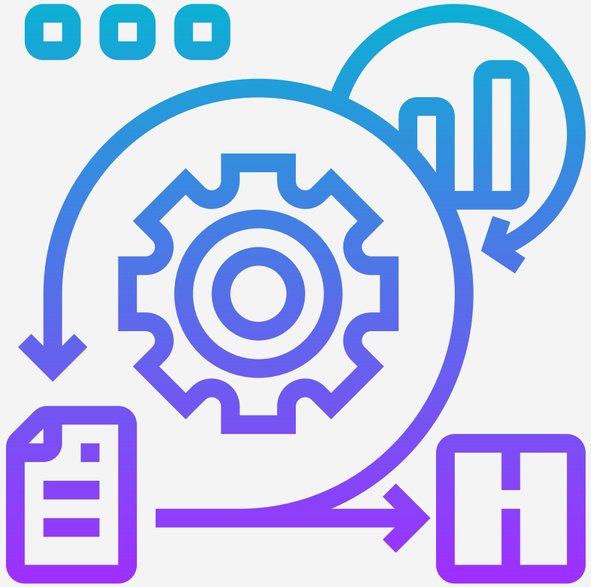
Data overview

Ticker	Date	AAPL	AMZN	BA	GOOG	IBM	MGM	T	TSLA
0	2010-07-01	8.874286	5.5480	62.259998	10.946221	117.179733	9.700000	18.383686	1.464000
1	2010-07-02	8.819286	5.4570	61.939999	10.872995	116.500954	9.480000	18.345921	1.280000
2	2010-07-06	8.879643	5.5030	61.360001	10.861040	118.030594	9.270000	18.436556	1.074000
3	2010-07-07	9.238214	5.6715	63.299999	11.212971	121.414917	9.900000	18.376133	1.053333
4	2010-07-08	9.217500	5.8110	64.730003	11.371377	122.342255	9.820000	18.557402	1.164000
...	...	...	...	...	...	...	...	...	...
1129	2014-12-24	28.002501	15.1515	131.240005	26.366112	154.703629	20.770000	25.649548	14.817333
1130	2014-12-26	28.497499	15.4545	131.630005	26.628391	155.200760	21.110001	25.808157	15.188000
1131	2014-12-29	28.477501	15.6020	132.289993	26.443897	153.451248	21.480000	25.762840	15.047333
1132	2014-12-30	28.129999	15.5150	131.830002	26.448385	153.011475	21.450001	25.740181	14.815333
1133	2014-12-31	27.594999	15.5175	129.979996	26.247936	153.384323	21.379999	25.370090	14.827333

1134 rows × 9 columns



Methodology



Mean-variance optimization

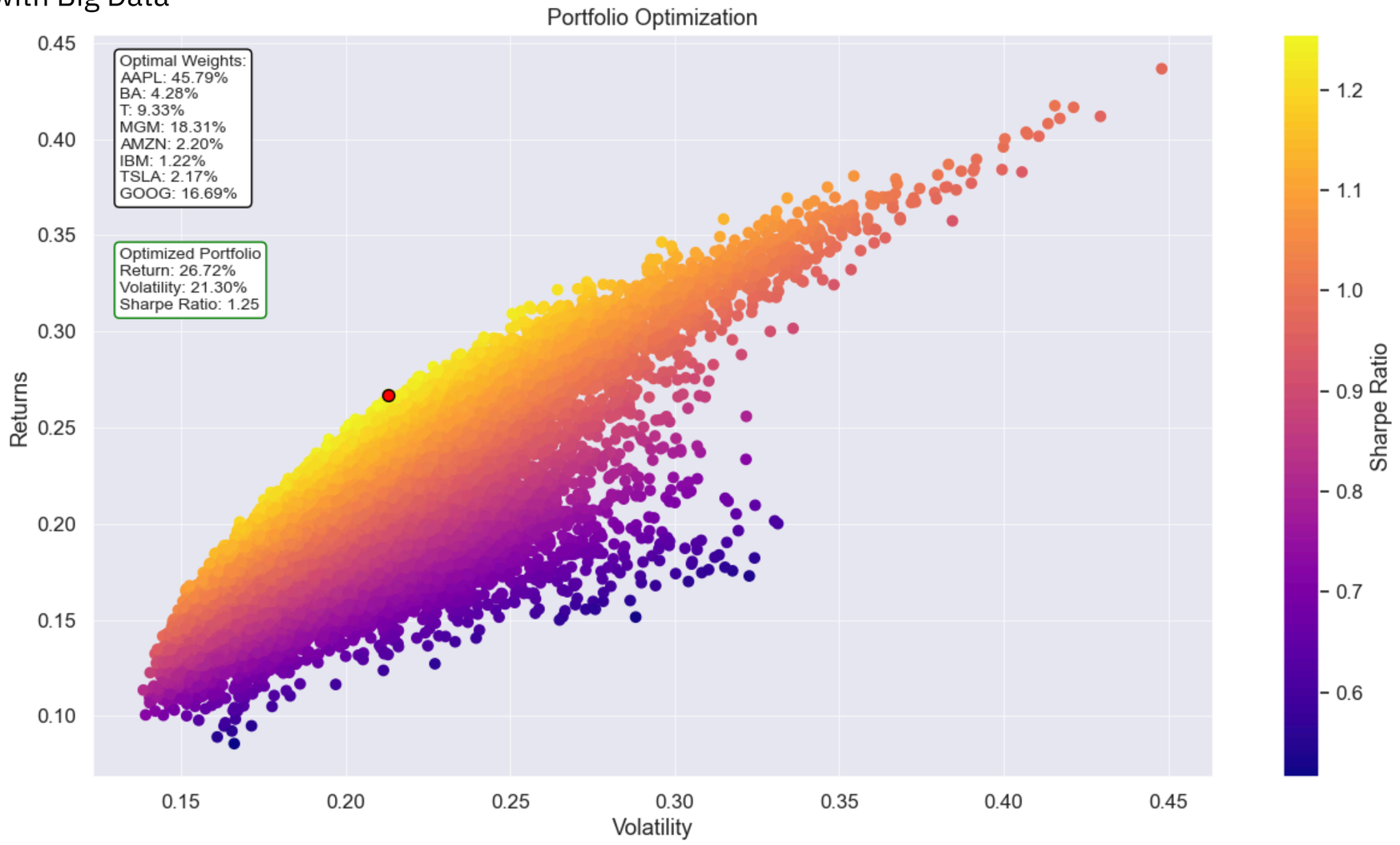
Black-Litterman model

Hierarchical Risk Parity optimization

Mean-variance optimization

- Computation of returns and volatilities of the stocks
- Determination of the covariances and correlations among all pairs of stocks in the portfolio
- Derivation of the expected returns and risks of several candidate portfolios
- Identifying the portfolio with the maximum risk-adjusted return

20598 – Finance with Big Data

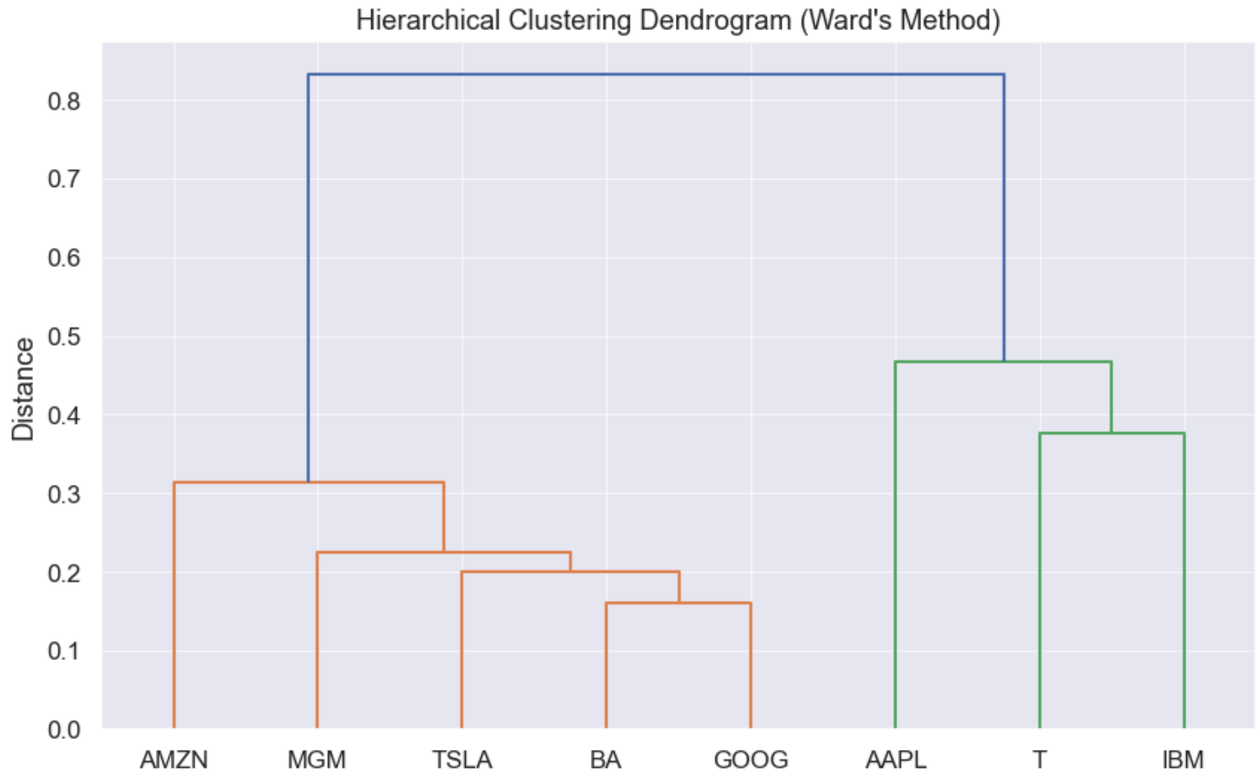


Black-Litterman model

- BL integrates market-implied returns (priors) with investor views, using a Bayesian framework to produce posterior expected returns.
- Investors can express views on specific assets (absolute) or relationships between assets (relative)
- Views and priors are weighted based on confidence (via Ω) and a tuning parameter τ, allowing for flexible portfolio adjustments.
- BL-generated posterior returns lead to more stable portfolios compared to mean-historical returns, reducing estimation risk.
- Outputs posterior returns and covariance matrix are used to calculate optimized portfolio weights.

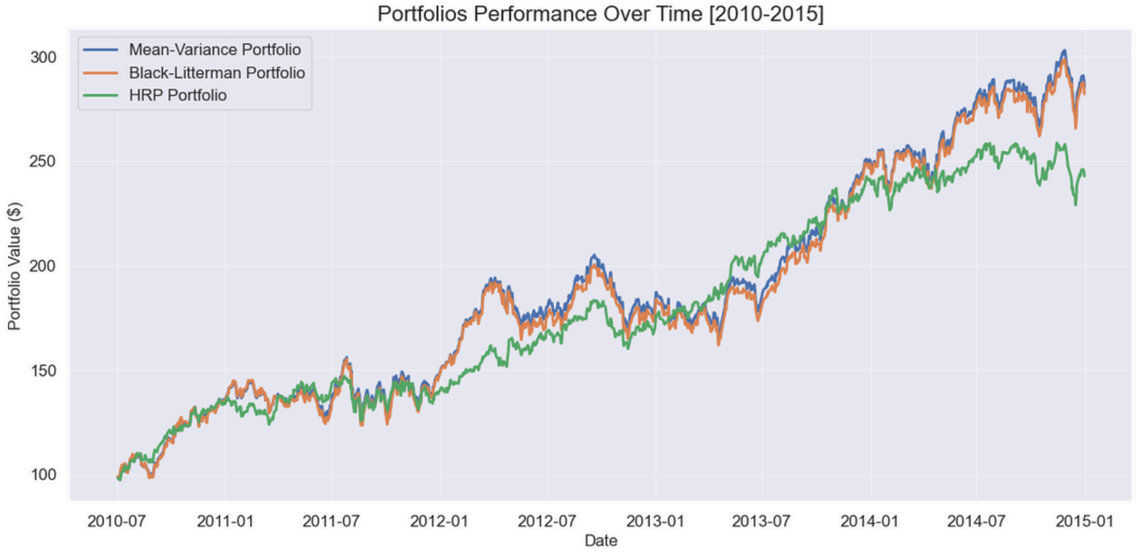
Hierarchical Risk Parity optimization

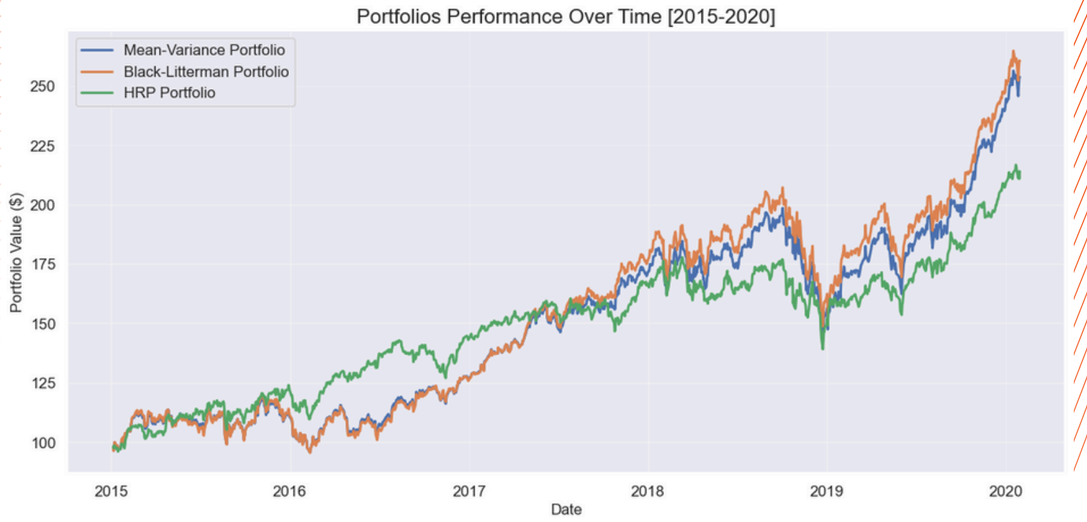
1. Formation of clusters
2. Quasidiagonalization
3. Recursive Bisection

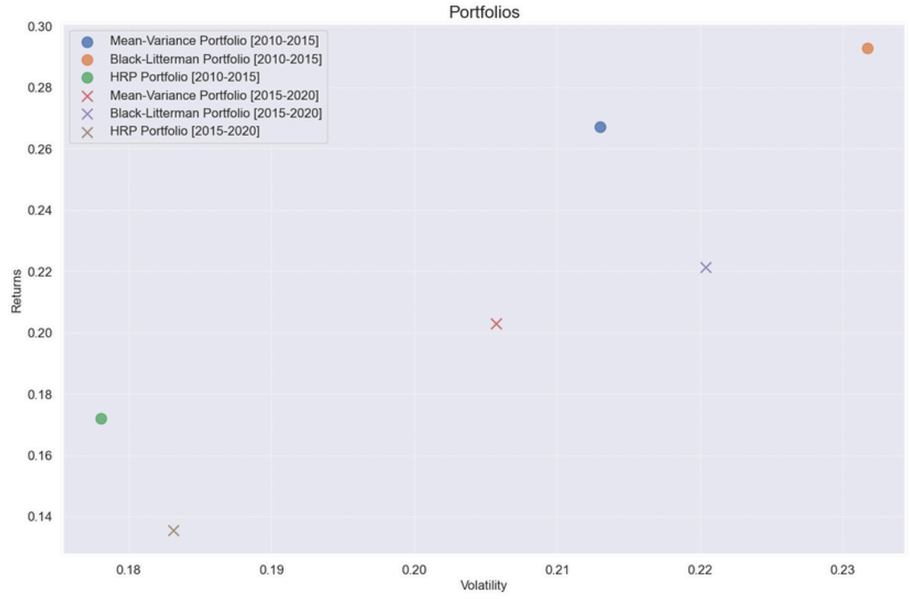


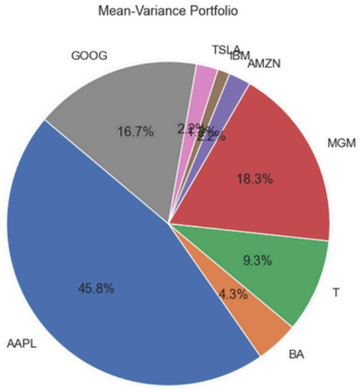
Data analysis and results

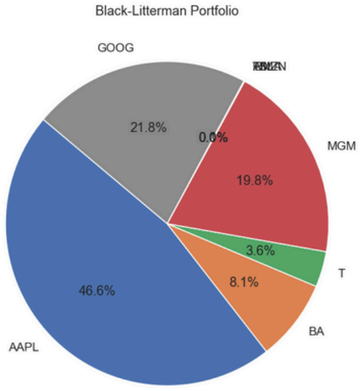
20598 – Finance with Big Data

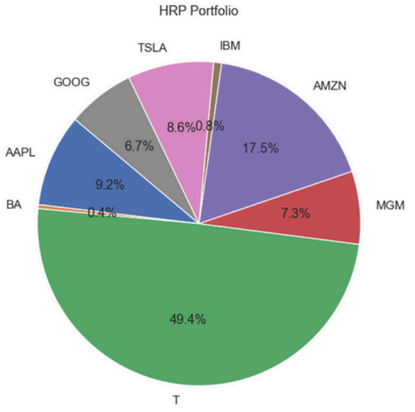










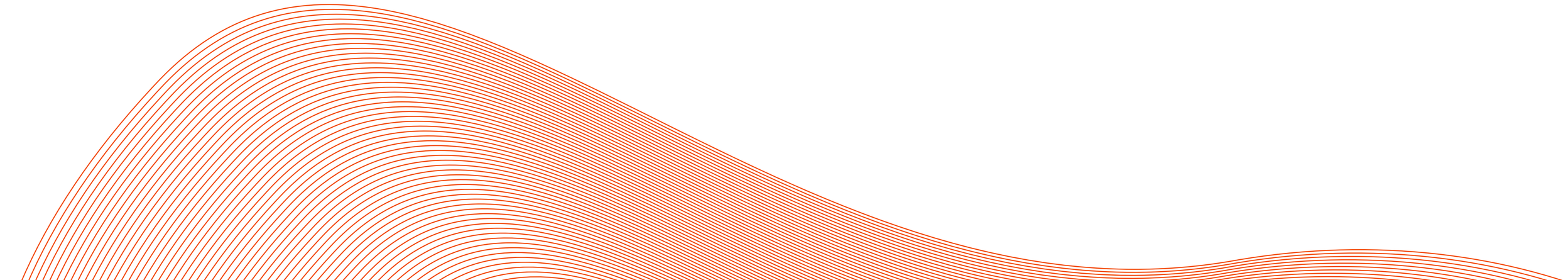


2010-2015

	Return	Volatility	Sharpe Ratio
Mean-Variance Portfolio	0.267208	0.205732	1.298815
Black-Litterman Portfolio	0.292804	0.212228	1.379667
HRP Portfolio	0.172024	0.183135	0.939325

2015-2020

	Return	Volatility	Sharpe Ratio
Mean-Variance Portfolio	0.203065	0.205732	0.987038
Black-Litterman Portfolio	0.221380	0.212228	1.043123
HRP Portfolio	0.135488	0.183135	0.739826



Thank you!