Asset Allocation Project

Two Risky-Assets Case

1. Efficient Frontier Without Riskless Asset

Figure A below shows the efficient frontier of two risky individual assets - Treasury Bonds and S&P 500 (stock), the Maximum Variance Portfolio (MVP) and Maximum Sharpe Ratio Portfolio (MSRP) are also annotated in the graph. On the efficient frontier, every combination offers the highest excess return for a given level of risk.

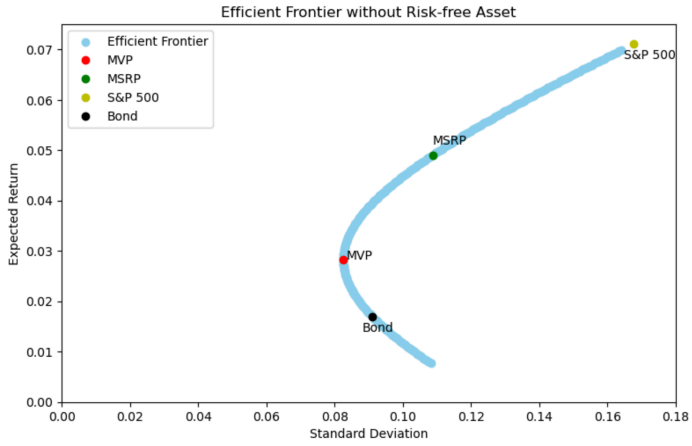

Figure A

2. Efficient Frontier With Riskless Asset

Figure B below shows the new efficient frontier after adding a risk-free asset (Treasury Bill). The introduction of the risk-free asset provides opportunities to obtain a higher return at a given level of risk by leveraging risk-free assets. Portfolio L is an example of leveraging.

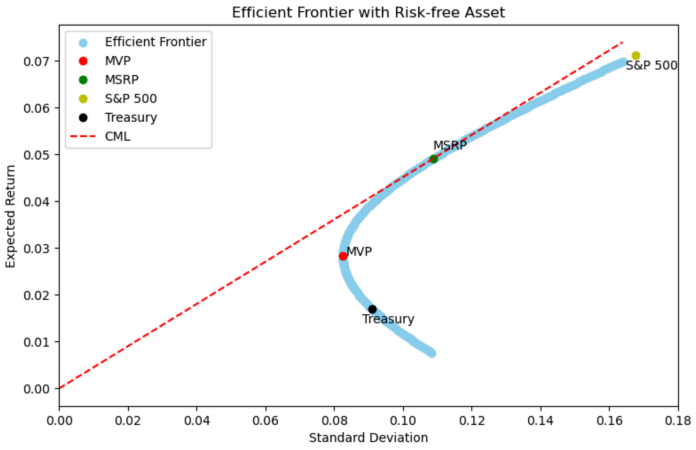

Figure B

3. Portfolio L: Leveraged Portfolio

Portfolio L represents an efficient portfolio on the new efficient frontier with a higher standard deviation than MSRP and a 25% leverage. **Figure C** below shows the position of Portfolio L. **Table A** summarizes the weights in stocks, bonds and the risk-free asset, and the expected return and standard deviation of Portfolio L.

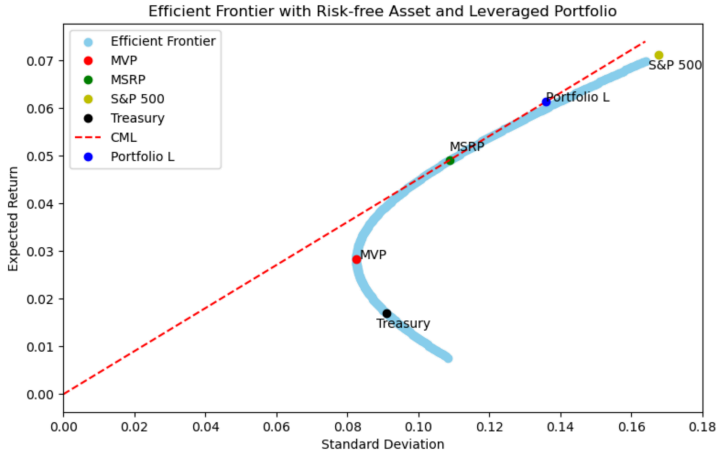

Figure C

4. Portfolio U: Unleveraged Portfolio

Portfolio U represents a portfolio with nearly the same standard deviation as Portfolio L but without leverage. **Figure D** below shows the position of Portfolio U in comparison to Portfolio L. **Table A** summarizes the weights in stocks, bonds and the risk-free asset, the expected return, standard deviation and sharpe ratio of Portfolio L and Portfolio U.

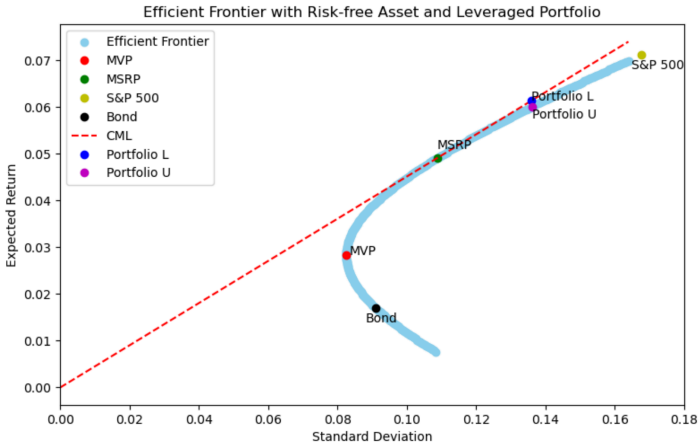

Figure D

Portfolio	Stock Weight	Bond Weight	Risk-Free Weight	Mean Return	Standard Deviation	Sharpe Ratio
L (Levered)	0.740723	0.509277	-0.25	0.061340	0.135956	0.451171
U (Unlevered)	0.795748	0.204252	0.00	0.060098	0.136215	0.441201

Table A

Comparing Portfolio L and U, leveraging in the risk-free asset slightly increases the portfolio's expected return and Sharpe ratio. Leverage in the risk-free asset allows more allocation to the risky asset (bonds) compared to Portfolio U.

Three Risky-Assets Case

1. Efficient Frontier Without Riskless Asset

Figure E shows the efficient frontier, the MVP, and the MSRP when adding a third risky asset (Real Estate)

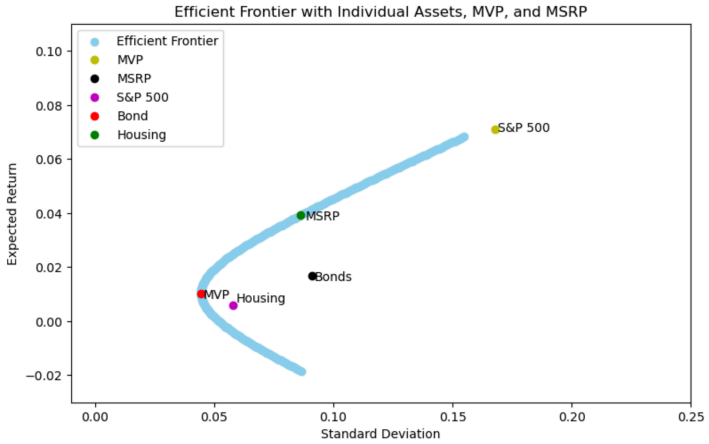

Figure E

Table B summarizes the MVP and MSRP portfolio weights, means, standard deviations, and Sharpe ratios.

	Portfolio	Weights	Return	Volatility	Sharpe Ratio
0	MVP	[0.012, 0.315, 0.673]	0.010	0.045	0.231
1	MSRP	[0.453, 0.346, 0.201]	0.039	0.086	0.455

Table B

2. Portfolio Without Riskless Asset With Target Mean Return Of 10%

Figure F shows the position of a portfolio with three risky assets and a target mean return of 10%.

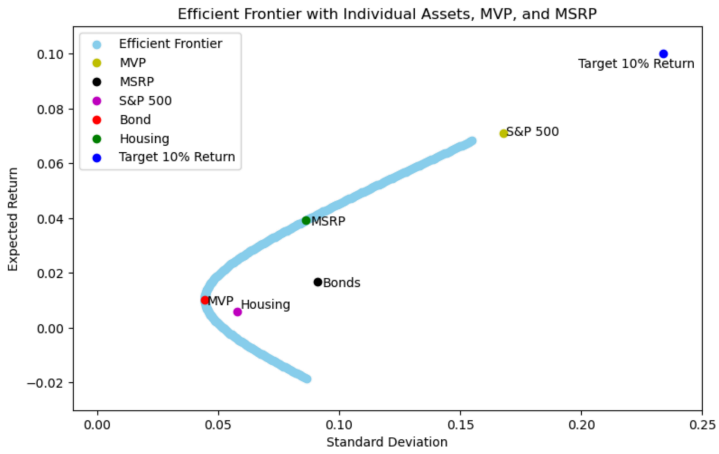

Figure F

Table C summarizes the portfolio weights of each asset.

Asset	Weights
Stock	1.374382
Bonds	0.411974
Housing	-0.786356

Table C

3. Efficient Frontier With Riskless Asset

Figure G shows the new efficient frontier after adding the risk-free asset.

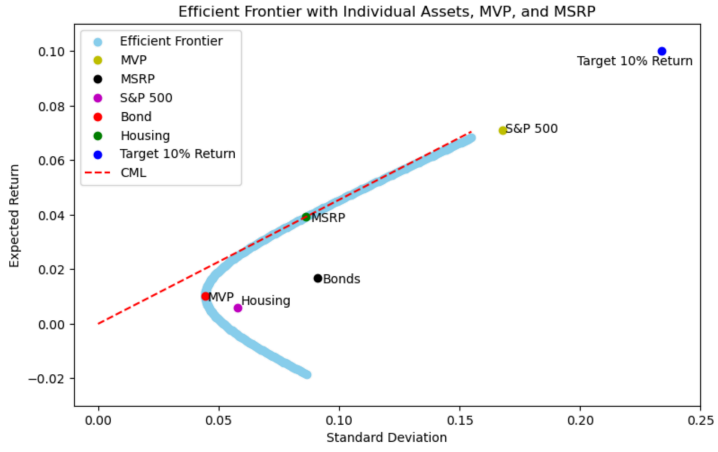

Figure G

4. Changes From Two-Risky-Asset Case To Three-Risky-Asset Case

Figure H shows the efficient frontiers of 2 risky assets, of 3 risky assets, of 2 risky assets with risk-free assets, and of 3 risky assets with risk-free assets. The MVPs and MSRPs in both cases are annotated.

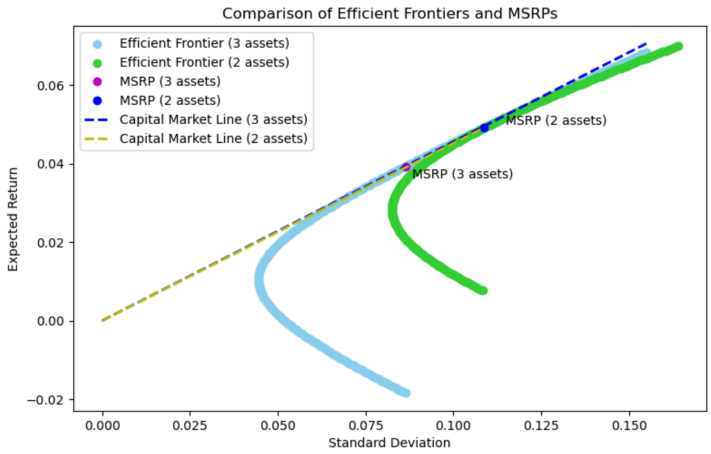

Figure H

Adding another risky asset shifts the efficient frontier to the left and makes the portfolio more diversified. The addition of a new asset introduces more combinations of portfolio weights, resulting in a broader set of possible risk-return trade-offs.