Class 20: Asset Allocation

Financial Markets, Spring 2020, SAIF

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Outline

- Asset management takes into considerations:
  - Client risk tolerance.
  - Universe of assets and benchmark selection.
  - Passive vs. active; stock picking vs. asset allocation; tactical vs. strategic.
  - Marketing and performance evaluation.
- Mean-variance analysis as an asset management tool:
  - Optimal risk and return tradeoff.
  - Diversification and optimal portfolio weights.
  - The limitations of mean-variance analysis.
  - Black-Litterman asset allocation model.
- Influence of other finance theories in asset management:
  - Insight of the CAPM: alpha and beta.
  - Risk exposure and risk hedging.
  - Derivatives as hedging instruments.

Policy Portfolio, Harvard Management Company, 2002

	Min	Policy	Max	Benchmark
Domestic equities	10	15	25	80% S&P 500, 8% S&P 400, 12% Russell 2000
Foreign equities	5	10	15	93% EAFE, 7% MSCI Small Cap ex US ex EAFE
Emerging markets	2	5	8	80% MSCI EM Investable, 20% MSCI EM Inv + 5%
Private equities	8	13	18	Cambridge Associates Weighted Composite
Total	30	43	60	
Absolute return	8	12	16	20% equity composite, 20% LIBOR+5%, 60% funds of funds
High-yield	2	5	8	60% Sal. High-Yield/Bankrupt Weighted Composite, 40% EMBI+
Commodities	8	13	18	23% GSCI and 77% NCREIF Timberland Index
Real estate	6	10	14	50% CPI+6, 25% NCREIF, 25% REIT. Leverage adjusted
Total	25	40	50	
Domestic bonds	6	11	21	Lehman 5+ year Treasury Index
Foreign bonds	0	5	10	J.P. Morgan Non U.S.
Inflation-indexed	0	6	15	Salomon 5+ year TIPS
Cash	-10	-5	10	One-month LIBOR

Optimal Risk and Return Tradeoff

- Mean-Variance Investor:

$$\text{Utility} = \text{mean} - \frac{1}{2} \times \text{risk aversion} \times \text{variance}\,.$$

- Portfolio Weight:
  - Invest y in the risky portfolio R_t^M.
  - Leave $1-y$ in riskfree r_f.
  - Portfolio return: $R_t^y = y\,R_t^M + (1-y)\,r_f\,.$
- The Optimal Portfolio Weight:

$$y^* = \frac{\text{risk premium}}{\text{variance} \times \text{risk aversion}} = \frac{E(R_t^M) - r_f}{\text{var}(R_t^M)} \frac{1}{\text{risk aversion}}$$

Optimal Portfolio Weights for Two Risky and One Riskfree

- Portfolio Weights:
  - Invest in $\begin{pmatrix} R_t^1 \\ R_t^2 \end{pmatrix}$ with $w = \begin{pmatrix} w_1 \\ w_2 \end{pmatrix}$.
  - Portfolio return: $R_t^w = w_1 R_t^1 + w_2 R_t^2 + (1 - w_1 - w_2)\, r_f$.
- Risk Premium:

$$\text{risk premium} = \begin{pmatrix} E(R_t^1) \\ E(R_t^2) \end{pmatrix} - r_f = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} - r_f .$$

- Variance-Covariance:

$$\Sigma = \begin{pmatrix} \text{variance 1} & \text{covariance} \\ \text{covariance} & \text{variance 2} \end{pmatrix} = \begin{pmatrix} \sigma_1^2 & \sigma_1\sigma_2\rho \\ \sigma_1\sigma_2\rho & \sigma_2^2 \end{pmatrix}$$

- The Optimal Portfolio Weights:

$$w^* = \frac{1}{\text{risk aversion}} \times \Sigma^{-1} \times \text{risk premium}$$

The Optimal Risky Portfolio

- The Optimal Portfolio Weights:

$$w^* = \frac{1}{\text{risk aversion}} \times \Sigma^{-1} \times \text{risk premium}$$

- The Optimal Risky Portfolio Weights:

$$\frac{1}{\sum_{i=1}^{N}(w_i^*)} \begin{pmatrix} w_1^* \\ w_2^* \\ . \\ w_i^* \\ . \\ w_N^* \end{pmatrix}$$

.

- Investors with different risk aversion hold the same optimal risky portfolio, differing only on their relative weight on the risky portfolio.
- It is also the tangent portfolio, the portfolio with the highest Sharpe ratio.

Matrix Operations

Some useful tips for matrix operation in *Excel*:

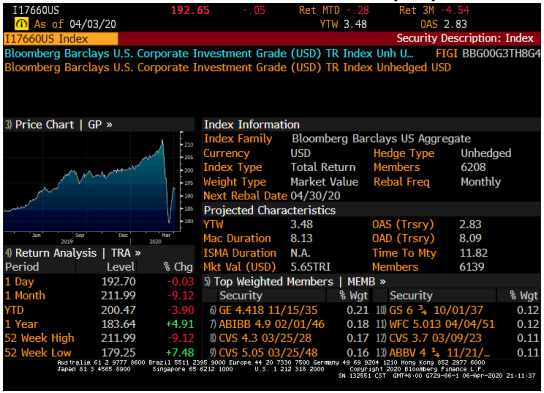
- the command for summation is still "+"
- the command for multiplication is "mmult"
- the command for inverse, say Σ^{-1}, is "minverse"

Some useful tips for matrix operation in *Matlab*:

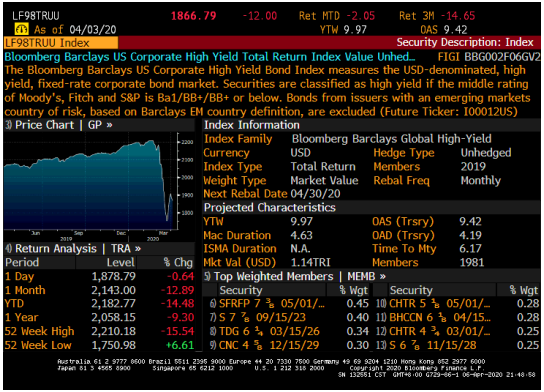
- the command for summation is still "+"
- the command for multiplication is still "$*$"
- the command for inverse, say Σ^{-1}, is "inv(Σ)"

US Corporate Bonds, IG and HY

Investment Grade (IG)

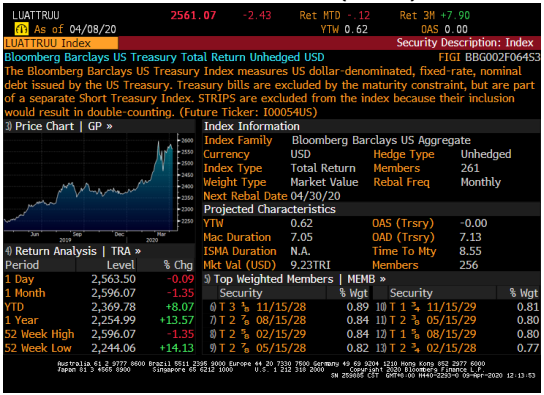


High Yield (HY)



US Bond and Equity, UST and SPX

US Treasury (UST)



S&P 500 Index (SPX)

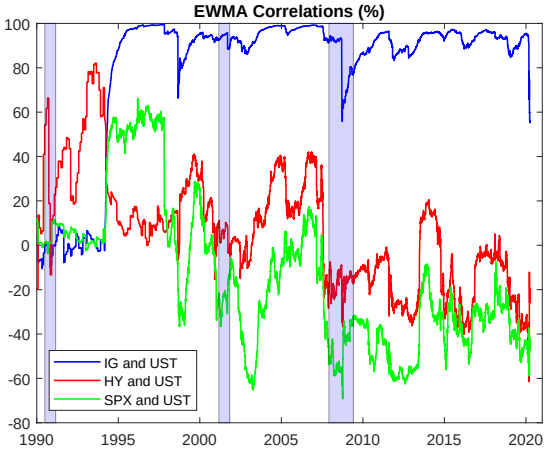
SPX, US Credits, UST, and Chinese Stocks

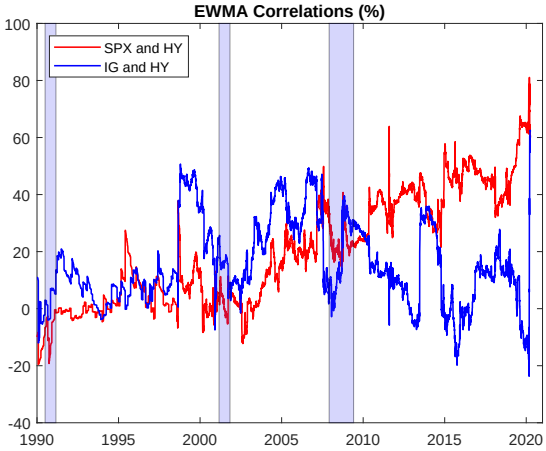
	US				CN			
	SPX	IG	HY	UST	CN	LG	Med	SM
	Monthly Returns 1993-2018							
μ	0.81	0.54	0.74	0.46	1.16	0.99	1.41	2.02
	[3.51]	[5.83]	[4.69]	[5.90]	[1.85]	[1.65]	[2.00]	[2.60]
σ	4.10	1.65	2.79	1.36	11.05	10.56	12.49	13.74
	Monthly Returns 2000-2018							
μ	0.49	0.50	0.66	0.41	0.86	0.80	1.02	1.43
	[1.75]	[4.60]	[3.24]	[4.54]	[1.60]	[1.52]	[1.61]	[2.08]
σ	4.20	1.65	3.08	1.35	8.16	7.96	9.60	10.42
	Monthly Returns 2010-2018							
μ	0.99	0.40	0.61	0.24	0.28	0.21	0.40	0.99
	[2.89]	[3.43]	[3.48]	[2.43]	[0.44]	[0.34]	[0.48]	[1.07]
σ	3.57	1.21	1.83	1.03	6.59	6.38	8.60	9.59

Corr (%)	SPX	IG	HY	UST	CN
	Monthly Returns 1993-2018				
SPX	100				
IG	25	100			
HY	61	54	100		
UST	-17	69	-7	100	
CN	16	9	14	-4	100
	Monthly Returns 2000-2018				
SPX	100				
IG	19	100			
HY	63	53	100		
UST	-33	59	-19	100	
CN	26	14	21	-9	100
	Monthly Returns 2010-2018				
SPX	100				
IG	9	100			
HY	72	51	100		
UST	-46	67	-17	100	
CN	41	4	30	-27	100

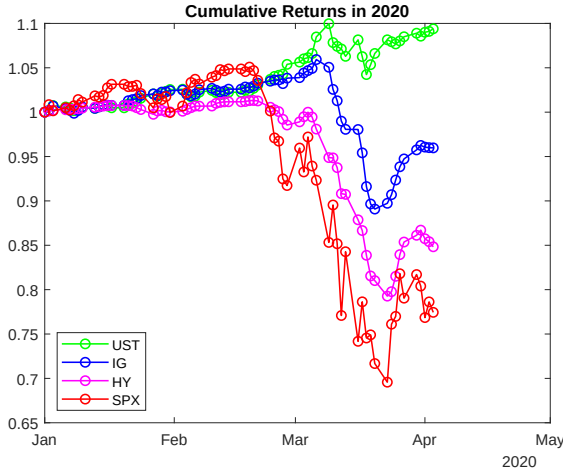
Cumulative Returns of SPX, IG, and HY

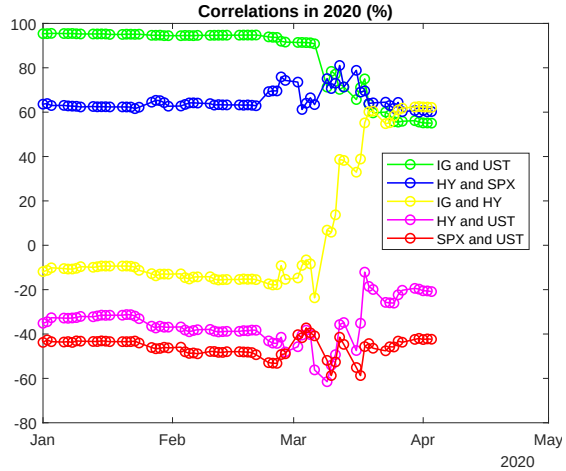
Daily Return Correlations: Treasury, SPX and Credit





UST, SPX, and Credit in 2020





Optimal Portfolio Weights

since	1993	2000	2010
SPX	100.0	100.0	100.0
Sharpe	0.15	0.08	0.26
CN	100.0	100.0	100.0
Sharpe	0.09	0.09	0.03
UST	100.0	100.0	100.0
Sharpe	0.18	0.20	0.19
HY	100.0	100.0	100.0
Sharpe	0.19	0.17	0.31
IG	100.0	100.0	100.0
Sharpe	0.21	0.22	0.29

since	1993	2000	2010
SPX	85.4	63.2	119.2
CN	14.6	36.8	-19.2
Sharpe	0.16	0.11	0.28
SPX	17.1	4.9	27.2
CN	3.7	4.7	-4.8
IG	79.2	90.4	77.6
Sharpe	0.24	0.23	0.38
SPX	14.1	-22.1	22.3
CN	7.2	13.4	-8.9
HY	78.7	108.7	86.5
Sharpe	0.20	0.18	0.32
SPX	20.6	15.1	26.2
CN	2.9	3.9	-1.6
UST	76.6	80.9	75.4
Sharpe	0.27	0.26	0.44

since	1993	2000	2010
SPX	9.1	4.3	16.0
IG	-55.3	-33.3	-40.6
HY	39.0	33.4	28.5
UST	107.3	95.5	96.2
Sharpe	0.30	0.30	0.46
SPX	9.8	4.5	18.9
HY	23.2	23.6	12.3
UST	66.9	72.0	68.8
Sharpe	0.29	0.29	0.44
SPX	22.2	17.5	24.7
UST	77.8	82.5	75.3
Sharpe	0.26	0.25	0.44
SPX	17.0	-17.7	15.4
HY	83.0	117.7	84.6
Sharpe	0.20	0.17	0.31

Main Takeaways