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:

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

- 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:

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

## 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:  $R^w = w_1 R^1 + w_2 R^2 + (1 - w_1 - w_2) r_2$ .

• Portfolio return:  $R_t^w = w_1 R_t^1 + w_2 R_t^2 + (1 - w_1 - w_2) r_f$ .

• Risk Premium:

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:

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

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# The Optimal Risky Portfolio

• The Optimal Portfolio Weights:

$$w^* = rac{1}{ ext{risk aversion}} imes \Sigma^{-1} imes ext{risk premium}$$

• The Optimal Risky Portfolio Weights:

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

- 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.

#### Some useful tips for matrix operation in Excel:

- $\bullet$  the command for summation is still "+"
- the command for multiplication is "mmult"
- $\bullet$  the command for inverse, say  $\Sigma^{-1},$  is "minverse"

#### Some useful tips for matrix operation in Matlab:

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

## US Corporate Bonds, IG and HY

#### Investment Grade (IG)

I17660US		192.0	5505	Ret MTD -	.28 Re	t 3M -4.54	
🕧 As of 04/0	03/20			YTW 3	. 48	0AS 2.83	
I17660US Index					Sec	urity Description	n: Index
<b>Bloomberg Barcl</b>	lays U.S. Cor	porate I	nvestment Grade	(USD) TR Ir	ndex Unh U	FIGI BBG00	G3TH8G4
Bloomberg Barcl	lays U.S. Cor	porate I	nvestment Grade	(USD) TR Ir	ndex Unhedg	jed USD	
-							
3) Price Chart   (	GP »		Index Informat	ion			
		A Ena	Index Family	Bloomberg	Barclays US	Aggregate	
	- M	205	Currency	USD	Hedge 1	Type Unhed	ged
A	a man	- 200	Index Type	Total Return	n Member	s 6208	
/ V	~~	- 195	Weight Type	Market Valu	ie – Rebal F	req Month	y
		- 190	Next Rebal Date	04/30/20			
man		- 185	<b>Projected Chara</b>	cteristics			
		V 103	YTW	3.48	OAS (Tr	sry) 2.83	
Jun 5ep 2019	Even 21	Mar 120	Mac Duration	8.13	OAD (Tr	sry) 8.09	
4) Return Analysi	is   TRA »		ISMA Duration	N.A.	Time To	Mty 11.82	
Period	Level	% Chg	Mkt Val (USD)	5.65TRI	Member	s 6139	
1 Day	192.70		5) Top Weighted	Members   N	MEMB »		
1 Month	211.99		Security	8	Wgt Secu	irity	% Wgt
YTD	200.47		6) GE 4.418 11/	15/35 0	0.21 10) GS 6	3, 10/01/37	0.12
1 Year	183.64	+4.91	7) ABIBB 4.9 02	2/01/46 0	0.18 11) WFC	5.013 04/04/51	0.12
52 Week High	211.99		8) CVS 4.3 03/2	5/28 0	0.17 12) CVS	3.7 03/09/23	0.11
52 Week Low	179.25	+7.48	9) CVS 5.05 03/	25/48 0	0.16 13) ABB	/ 4 ¼ 11/21/	0.11
Australia Japan 81	x 61 2 9777 0500 Br 3 4565 8900 5	azil 5511 23 Singapore 65	95 9000 Europe 44 20 73. 6212 1000 U.S. 1 2	10 7500 Germany 49 12 318 2000	69 9204 1210 Hom Copyright 2020 B1	s Kons 852 2977 6000 comberg Finance L.F.	
				SN :	132551 CST GMT+8	00 6729-66-1 05-Apr-2	020 21:11:37

#### High Yield (HY)

LF98TRUU		1866.		Ret MTD -2.0	5 Ret 3M -14	. 65
🚯 As of 🗘	1/03/20			YTW 9.97	0AS 9.4	42
LF98TRUU Ind	ex				Security Des	cription: Index
Bloomberg Ba	rclays US Cor	porate Hig	h Yield Total Re	eturn Index Value	e Unhed FIG	BBG002F06GV2
The Bloomber	g Barclays US	Corporate	e High Yield Bon	d Index measure	es the USD-denor	ninated, high
yield, fixed-ra	ite corporate	bond marl	ket. Securities a	re classified as	high yield if the	middle rating
of Moody's, Fi	tch and S&P i	s Ba1/BB+	/BB+ or below.	Bonds from issu	iers with an eme	rging markets
country of risl	k, based on B	arclays EM	country definit	tion, are exclude	d (Future Ticker:	I00012US)
3) Price Chart	GP »		Index Informat	ion		
		- 2200	Index Family	Bloomberg Bar	clays Global High	n-Yield
		M	Currency	USD	Hedge Type	Unhedged
		1100	Index Type	Total Return	Members	2019
		- 2000	Weight Type	Market Value	Rebal Freq	Monthly
		A = 1990	Next Rebal Date	04/30/20		
		1000	<b>Projected Chara</b>	acteristics		
		1	YTW	9.97	OAS (Trsry)	9.42
3an 2019	p tec	Nar 020	Mac Duration	4.63	OAD (Trsry)	4.19
<ol> <li>Return Analy</li> </ol>	ysis   TRA »		ISMA Duration	N.A.	Time To Mty	6.17
Period	Level	% Chg	Mkt Val (USD)	1.14TRI	Members	1981
1 Day	1,878.79		5) Top Weighted	Members   MEM	B »	
1 Month	2,143.00		Security	% Wgt	Security	% Wgt
YTD	2,182.77		6) SFRFP 7 3 (	05/01/ 0.45	10) CHTR 5 1/8 05	/01/ 0.28
1 Year	2,058.15		7) S 7 % 09/15	5/23 0.40	11) BHCCN 6 1 <sub>B</sub> (	04/15 0.28
52 Week High	2,210.18		8) TDG 6 4 03	/15/26 0.34	12) CHTR 4 🔧 03	/01/ 0.25
52 Week Low	1,750.98	+6.61	9) CNC 4 58 12,	/15/29 0.30	13) S 6 7 11/15	/28 0.25

Australia 61 2 9777 0600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Nons Kong 052 2977 6000 Japan 81 3 4585 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Comprehensive Standards Transce L.F.

## US Bond and Equity, UST and SPX

#### US Treasury (UST)

LUATTRUU		2561.			Ret MT	TD12	Ret	3H +7.90	
As of 04	/08/20					W 0.62		0AS 0.00	
LUATTRUU Inde	ex						Secu	rity Description	: Index
Bloomberg Bar	rclays US Trea	asury Tota	al Retur	n Unhedg	ed USD			FIGI BBG00	2F064S3
The Bloomberg	g Barclays US	Treasury	Index	measures	s US dolla	ar-deno	minated,	fixed-rate, nor	ninal
debt issued by	the US Treas	sury. Trea	sury bil	lls are ex	cluded b	y the m	naturity co	onstraint, but a	re part
of a separate	Short Treasur	y Index. S	STRIPS	are exclu	uded fron	n the in	idex becau	se their inclus	sion
would result in	i double-coun	ting. (Fut	ure Ticl	ker: 1000	54US)				
3) Price Chart	GP »		Index	Informat	ion				
		2600	Index	Family	Bloomb	erg Bar	clays US /	Aggregate	
		2550	Curren	cy	USD		Hedge Ty	pe Unhedg	jed
		1 2500	Index '	Гуре	Total Re	eturn	Members	261	
MA	A M	2400	Weight	Туре	Market \	Value	Rebal Fre	q Monthl	у
	a manage	-2350	Next R	ebal Date	04/30/2	20			
and and a		- 2309	Project	ted Chara	acteristic	s			
~~~~		- 2250			0.62		OAS (Trsr	y) -0.00	
Jun 540	Dec 2	Har 920	Mac Du	ration	7.05		OAD (Trsi	y) 7.13	
4) Return Analy	sis   TRA »		ISMA D	uration	N.A.		Time To I	Mty 8.55	
Period	Level	% Chg	Mkt Va	l (USD)	9.23TRI		Members	256	
1 Day	2,563.50		5) Top \	weighted	Members	S   MEMI	8 »		
1 Month	2,596.07		Sec	urity		% Wgt	Securi	ty	🛛 🗞 Wgt
YTD	2,369.78	+8.07	6) T 3	<sup>1</sup> <sub>b</sub> 11/15	5/28	0.89	10) T 1 🐴	11/15/29	0.81
1 Year	2,254.99	+13.57	7) T 2	<sup>7</sup> <sub>8</sub> 08/15	5/28	0.84	11) T 2 🖥	05/15/29	0.80
52 Week High	2,596.07		8) T 2	<sup>5</sup> ₀ 02/15	5/29	0.84	12) T 1 🖥	08/15/29	0.80
52 Week Low	2,244.06	+14.13	9) T 2	<sup>2</sup> β 05/15	5/28	0.82	13) T 2 🍡	02/15/28	0.77
Austral Japan	lia 61 2 9777 8500 E 81 3 4555 8900	Brazil 5511 235 Singapore 65	95 9000 Eur 6212 1000	ope 44 20 73 U.S. 1 2	30 7500 Germa 12 318 2000	ny 49 69 90 Copyr:	204 1210 Hong H ight 2020 Bloot	tong 852 2977 6000 mberg Finance L.P.	

#### S&P 500 Index (SPX)

SPX C	2749.98 r d 0 2685	+90.57 .00 H 2760	.75 L 2663.	2694.35/3 30 Prev 2	2961.71 2749.98	8	-		
SPX Index					Page	1/2 Se	curity Dese	cription:	Index
1) Profile 🛛 🕖	Characteristic	cs							
S&P 500 Index							FIGI	BBG000	H4FSM0
The S&P 5000	is widely re	garded as th	ne best single	e gauge of l	arge-c	ap U.S.	equities a	nd serv	es as
the foundation	for a wide	range of inv	estment proc	lucts. The ir	ndex in	icludes .	500 leadin	g compa	anies
and captures a	pproximatel	ly 80% cover	age of availa	able market	: capita	lization			
3) Price Chart	GP »			Index Info	rmatio	n			
				Volume		800	.53MLN (04	4/08/20	)
			M	Index Mark	cet Cap	N.A.			
m			1, , 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	Divisor		N.A.			
			1 M	Trading Ho	urs	21:	30 - 04:15		
			V	Currency		USD			
April May 1 Ann 1 Al	Aug Sup Den 2010	No. of Concession, Name	101	Composite	Vol	3.3	3BLN	5) SPX	NOLC
Period	Level	% Change	Net Change	6 Members	I MEM	IB » 505	1481	24	→ <b>0</b>
Year to Date	3230.78	-14.88	-480.80	7) Groups	GWGT	» 158			
52 Week Ago	2878.20	-4.45	-128.22	8 Movers	MOV ×	<b>,</b>			
52 Week High	3393.52	(02/19/20)		Leaders		% Chg	Lagger	S	🗞 Chg
52 Week Low	2191.86	(03/23/20)		9) APA	UN	+16.26	13) CARR	UN	-6.49
4) Financial Ana	alysis   FA »			10) WELL	UN	+16.19	14) ODFL	UW	-3.04
P/E	18.09	Ex-Dividend	-0.35	11) TDG	UN	+14.60	15) KR	UN	-2.64
Positive P/E	17.81	F12 Div Yld	2.20	12) ADS	UN	+14.45	16) K	UN	-1.74
Aus that	in 61_2_9777_8500	Brazil 5511_2395	9000 Europe 44 20	7330 7500_6erman	1y 49_69 9	204 1210 Ho	ng Kong 852 293	77 6000	

65 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Coewright 2020 Bloomberg Finance L.P. SN 259005 CST GMT+0.00 H+40-2293-0 03-0pr-2020 12:51:33

## SPX, US Credits, UST, and Chinese Stocks

	US						С	N	
	SPX	IG	ΗY	UST		CN	LG	Med	SM
	Monthly Returns 1993-2018								
$\mu$	0.81 [3.51]	0.54 [5.83]	0.74 [4.69]	0.46 [5.90]		1.16 [1.85]	0.99 [1.65]	1.41 [2.00]	2.02 [2.60]
$\sigma$	4.10	1.65	2.79	1.36		11.05	10.56	12.49	13.74
	Monthly Returns 2000-2018								
$\mu$	0.49 [1.75]	0.50 [4.60]	0.66 [3.24]	0.41 [4.54]		0.86 [1.60]	0.80 [1.52]	$1.02 \\ [1.61]$	1.43 [2.08]
$\sigma$	4.20	1.65	3.08	1.35		8.16	7.96	9.60	10.42
			Month	ıly Returi	ns	2010-20	18		
$\mu$	0.99 [2.89]	0.40 [3.43]	0.61 [3.48]	0.24 [2.43]		0.28 [0.44]	0.21 [0.34]	0.40 [0.48]	0.99 [1.07]
$\sigma$	3.57	1.21	1.83	1.03		6.59	6.38	8.60	9.59

Corr (%)	SPX	IG	ΗY	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		
Mc	nthly R	leturns	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



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#### Daily Return Correlations: Treasury, SPX and Credit



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#### 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
ΗY	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
ΗY	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
ΗY	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
ΗY	83.0	117.7	84.6
Sharpe	0.20	0.17	0.31

#### Main Takeaways