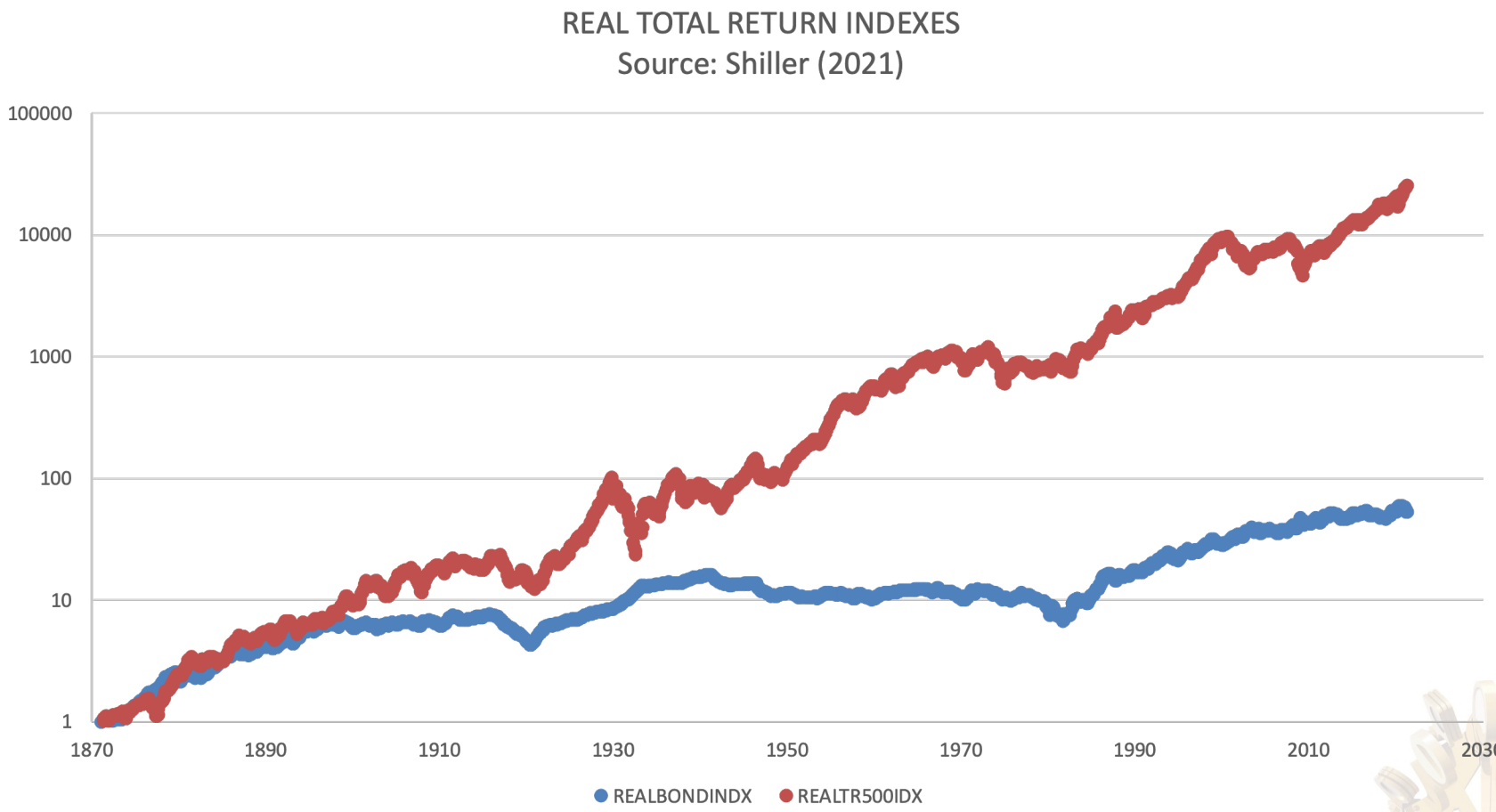
Jarrod Wilcox

DEVELOPING PRACTICAL INVESTMENT RESILIENCE

JULY 20, 2021

RESOURCE: GITHUB.COM/JARRODWILCOX/RESILIENCE_LAB.

DIFFERENT RETURN CHARACTERISTICS AT DIFFERENT SCALES



WHY STUDY RESILIENT INVESTING?

- What we face:
  - Markets are never at more than momentary equilibrium.
  - Returns are not i.i.d. Parameters are uncertain.
  - Investors differ more widely than we assume.
  - Continuous time finance is an heroic assumption.
- Market disruptions awaken us to our deeper need for better asset allocation methods.

GOING BACK TO EXPECTED UTILITY

- A single period decision…
- Responding to multiple future time points,
- Multiple return probability regimes,
- And investors with widely different needs.

Investor's Probability of Consequent Utility Need		Investment Return Probability Distributions		Trial Allocation
		Pa1 Outcome	X	Utility a1
Pa	{	Pa2 Outcome	X	Utility a2
		Pa3 Outcome	X	Utility a3
		Pb1 Outcome	X	Utility b1
Pb	{	Pb2 Outcome	X	Utility b2
		Pb3 Outcome	X	Utility b3
		Pz1 Outcome	X	Utility z1
Pz	{	Pz2 Outcome	X	Utility z2
		Pz2 Outcome	X	Utility z3
		Expected Utility		

STUDY UNIVERSE, 18 YEARS

ID	NAME	CLUSTER
EFA	iShares MSCI EAFE ETF	C11111
EZU	iShares MSCI Eurozone ETF	C11111
EST_EEM	iShares MSCI Emerging Markets ETF	C11112
EWJ	iShares MSCI Japan ETF	C1112
IWR	iShares Russell Mid-Cap ETF	C11211111
IWS	iShares Russell Mid-Cap Value ETF	C11211111
IWP	iShares Russell Mid-Cap Growth ETF	C11211112
SPY	SPDR S&P 500 ETF Trust	C1121112
XLK	Technology Select Sector SPDR Fund	C112112
XLE	Energy Select Sector SPDR Fund	C11212
VWEHX	Vanguard High-Yield Corporate Fund	C1122
IYR	iShares U.S. Real Estate ETF	C1122
XLP	Consumer Staples Select Sector SPDR Fund	C1211
DIA	SPDR Dow Jones Industrial Average ETF Trust	C1212
XLY	Consumer Discretionary Select Sector SPDR Fund	C1212
IBB	iShares Nasdaq Biotechnology ETF	C122
XLV	Health Care Select Sector SPDR Fund	C122
IEF	iShares 7-10 Year Treasury Bond ETF	C21111
VFITX	Vanguard Intermediate-Term Treasury Fund	C21111
VFIIX	Vanguard GNMA Fund Investor Shares	C21112
VUSTX	Vanguard Long-Term Treasury Fund	C21121
TLT	iShares 20+ Year Treasury Bond ETF	C21121
VWESX	Vanguard Long-Term Investment-Grade Fund	C21122
EST_GLD	SPDR Gold Shares	C212
VWSTX	Vanguard Short-Term Tax-Exempt Fund	C2211
VWAHX	Vanguard High-Yield Tax-Exempt Fund	C2212
VWLTX	Vanguard Long-Term Tax-Exempt Fund	C2212
LQD	iShares iBoxx $ Investment Grade Corporate Bond ETF	C222

THE SIMPLEST BAYESIAN POSTERIOR

(real returns would have been an improvement)

	N	MEAN	STD DEV
VFINX (stocks)	540	0.99%	4.49%
VWESX (bonds)	540	0.53%	2.52%
VWSTX (cash)	540	0.39%	0.32%
PGOLD (gold)	276	-0.01%	5.10%

Let N be the number of observations, and V their variance, with subscripts *h* signifying the prior history and *o* signifying the new observations.

$P_h = N_h / V_h$, $P_o = N_o / V_o$ (the precisions)

$W_h = P_h / (P_h + P_o)$, $W_o = 1 - W_h$ (the weights)

For a conjugate normal with known variance approximation, the shrinkage mean M_S is calculated as: $M_S = W_h M_h + W_o M_o$

A Little Utility Math

- Mean-variance: $MV = \mu - L\,\sigma^2/2$
  - Ensemble statistics μ, σ^2
- Rubinstein utility: $GLUM=\ln(1+Lr)$
  - Each outcome portfolio return r has a well-defined utility
- Let $Q = L\sigma / (1+L\mu)$, then:
- Expected $GLUM = \ln(1+L\mu) - Q^2/2 + SQ^3/3 - KQ^4/4 + \ldots$
- Limit $\Delta t \rightarrow 0$ of Expected GLUM = L (MV)

WHERE IS SIMPLEST TAIL RISK?

A. Return Distribution Skew and Kurtosis
B. Utility Function
C. Risk Aversion

In this case:

Utility = ln(1+Lr)

L is risk aversion
r is investment return

The rightmost 3 columns represent change in utility from skewness and kurtosis.

	MONTHLY RETURN					TAIL RISK BY RISK AVERSION		
ID	MEAN	SMEAN	STD DEV	SKEW	KURT	L:2	L:4	L:8
EFA	0.73%	0.93%	4.97%	-0.54	4.8	0.000	-0.003	-0.032
EZU	0.76%	0.95%	6.23%	-0.38	4.6	0.000	-0.006	-0.066
EST_EEM	1.06%	1.00%	6.28%	-0.34	4.3	0.000	-0.005	-0.062
EWJ	0.63%	0.89%	4.57%	-0.32	3.5	0.000	-0.001	-0.017
IWR	1.07%	1.01%	4.85%	-0.81	6.7	0.000	-0.004	-0.040
IWS	0.99%	0.99%	4.96%	-0.98	8.0	0.000	-0.005	-0.053
IWP	1.16%	1.03%	4.93%	-0.65	5.8	0.000	-0.003	-0.036
SPY	0.93%	0.97%	4.16%	-0.56	4.8	0.000	-0.002	-0.017
XLK	1.26%	1.06%	4.90%	-0.36	3.4	0.000	-0.002	-0.020
XLE	0.75%	0.96%	7.31%	-0.16	7.6	-0.001	-0.013	-0.178
VWEHX	0.57%	0.74%	2.29%	-1.82	16.3	0.000	-0.001	-0.007
IYR	0.93%	0.98%	6.20%	-0.61	9.5	-0.001	-0.011	-0.127
XLP	0.82%	0.92%	3.26%	-0.61	4.1	0.000	-0.001	-0.007
DIA	0.89%	0.96%	4.00%	-0.56	4.6	0.000	-0.001	-0.014
XLY	1.16%	1.03%	5.07%	-0.10	4.9	0.000	-0.002	-0.026
IBB	1.26%	1.04%	5.92%	-0.21	3.7	0.000	-0.003	-0.040
XLV	0.90%	0.96%	3.84%	-0.31	3.7	0.000	-0.001	-0.009
IEF	0.42%	0.48%	1.82%	0.25	4.3	0.000	0.000	0.000
VFITX	0.24%	0.36%	1.37%	-0.44	5.9	0.000	0.000	0.000
VFIIX	0.29%	0.34%	0.81%	-0.38	6.5	0.000	0.000	0.000
VUSTX	0.43%	0.51%	3.34%	0.36	4.1	0.000	0.000	-0.002
TLT	0.61%	0.54%	3.77%	0.46	4.9	0.000	0.000	-0.004
VWESX	0.55%	0.53%	2.78%	0.07	5.3	0.000	0.000	-0.002
EST_GLD	0.88%	0.40%	4.92%	-0.02	3.2	0.000	-0.001	-0.015
VWSTX	0.14%	0.28%	0.22%	0.37	6.8	0.000	0.000	0.000
VWAHX	0.42%	0.47%	1.45%	-1.06	7.2	0.000	0.000	-0.001
VWLTX	0.38%	0.44%	1.39%	-0.92	6.0	0.000	0.000	-0.001
LQD	0.49%	0.52%	2.13%	0.08	11.9	0.000	0.000	-0.002

CLUSTERS TO IDENTIFY STRUCTURE

- Top-Down Hierarchical Clusters, McQuitty & Clark 1968.
- Identify Structure-Based Modeling Potential.

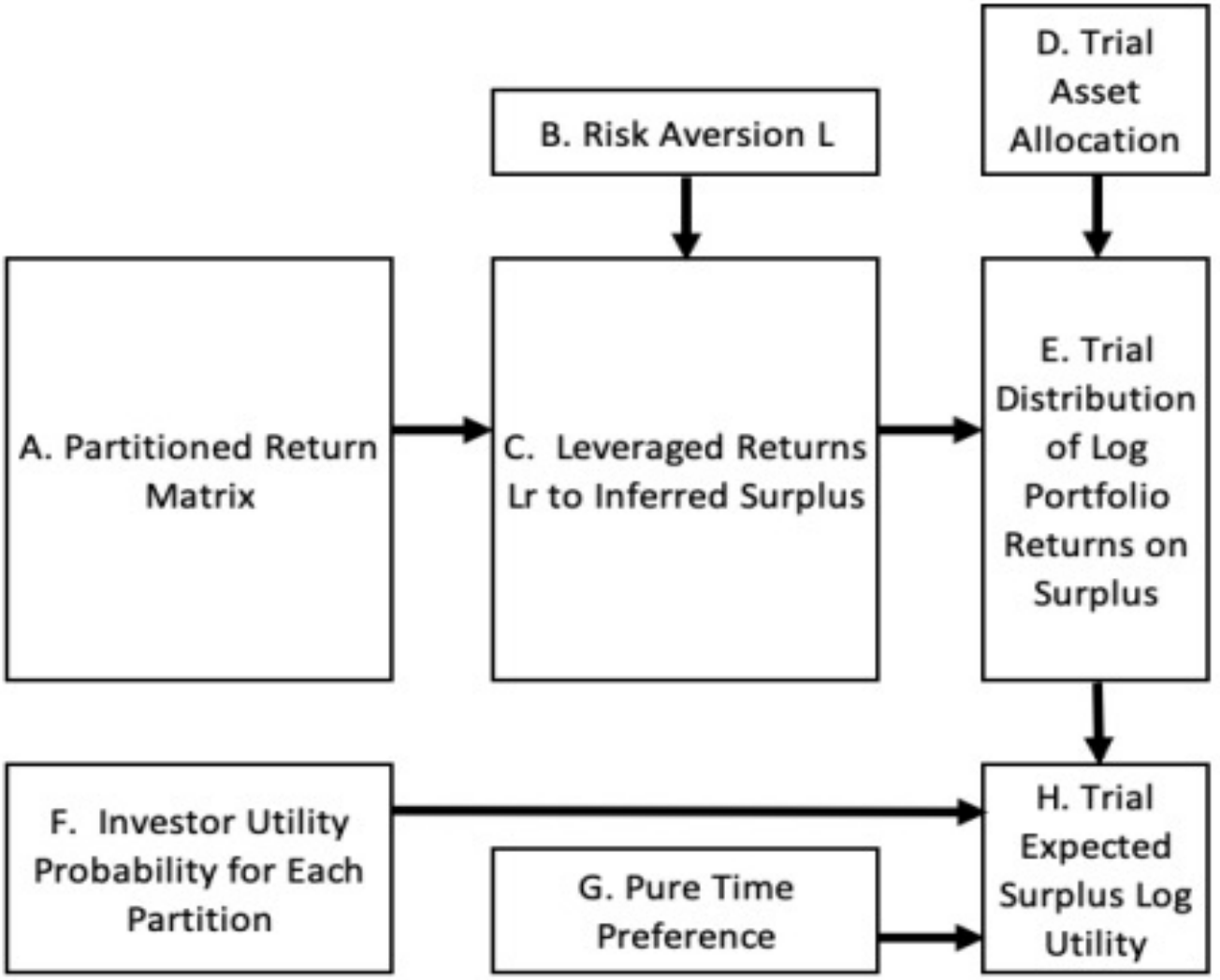
HISTORY 1-MONTH		CRISIS		6-MONTH	
ID	CLUSTER	ID	CLUSTER	ID	CLUSTER
EFA	C11111	EFA	C1111111	EFA	C111111
EZU	C11111	EZU	C1111111	EZU	C111111
EST_EEM	C11112	EWJ	C1111112	EST_EEM	C111112
EWJ	C1112	XLP	C1111121	EWJ	C11112
IWR	C11211111	SPY	C1111122	XLE	C1112
IWS	C11211111	DIA	C1111122	IWR	C11211
IWP	C11211112	IWS	C1111211	IWS	C11211
SPY	C1121112	IWR	C1111211	IWP	C11212
XLK	C112112	XLY	C1111212	VWEHX	C1122
XLE	C11212	IYR	C111122	IYR	C1122
VWEHX	C1122	XLE	C11121	XLP	C1211
IYR	C1122	IWP	C1112211	XLY	C121211
XLP	C1211	XLK	C1112211	SPY	C121212
DIA	C1212	EST_EEM	C1112212	DIA	C121212
XLY	C1212	VWEHX	C111222	XLK	C12122
IBB	C122	XLV	C112	IBB	C122
XLV	C122	IBB	C112	XLV	C122
IEF	C21111	VWAHX	C12	IEF	C21111
VFITX	C21111	VWLTX	C12	TLT	C21112
VFIIX	C21112	IEF	C21111	VUSTX	C21112
VUSTX	C21121	VUSTX	C21112	VFIIX	C2112
TLT	C21121	TLT	C21112	VFITX	C2112
VWESX	C21122	VFIIX	C2112	EST_GLD	C212
EST_GLD	C212	VFITX	C2112	VWSTX	C212
VWSTX	C2211	VWESX	C212	VWAHX	C221
VWAHX	C2212	EST_GLD	C212	VWLTX	C221
VWLTX	C2212	LQD	C22	LQD	C222
LQD	C222	VWSTX	C22	VWESX	C222

THE INVESTOR JOINS THE DECISION TREE

(But how should valuation probabilities be set?)

	Date	EFA	IEF		VALUATION PROBABILITY	LOG TIME DISCOUNT
History Fragment	Sep-20	-1.84%	0.40%	…		
	Oct-20	-3.35%	-1.31%	…		
	Nov-20	14.47%	0.40%	…	54%	-0.0025
	…	…	…	…		
Crisis Fragment	Jul-07	-0.63%	2.26%	…		
	Aug-07	5.32%	0.08%	…		
	Sep-07	4.25%	1.10%	…	6%	-0.0025
	…	…	…	…		
6 Month Fragment	Sep-20	22.19%	1.29%	…		
	Oct-20	11.39%	-0.38%	…		
	Nov-20	20.72%	-0.38%	…	40%	-0.0148
	…	…	…	…		

SEARCH FOR BEST ALLOCATION



DISRUPTION CREATES MORE HIGH MOMENT THREAT

- Mixing pdf's increases tail risk.
- This improves the benefit of Rubinstein utility.

0.8 MONTHLY HISTORY, 0.2 CRISIS

MEAN-VARIANCE ALLOCATION

	L:1	L:2	L:4	L:8	L:16
Utility:	0.0049	0.0105	0.0196	0.0345	NaN
Allocation Weights:					
IEF	0	0	0	41%	49%
VWSTX	0	0	0	0	5%
VWEHX	0	0	14%	21%	23%
XLP	38%	67%	51%	28%	16%
VWAHX	0	0	0	0	1%
IBB	57%	33%	18%	9%	4%
TLT	0	0	17%	0	0
XLK	6%	0	1%	1%	2%

EXPECTED SURPLUS GROWTH ALLOCATION

	L:1	L:2	L:4	L:8	L:16
Utility:	0.0049	0.0108	0.0206	0.0371	0.0599
Allocation Weights:					
IEF	0	0	43%	61%	32%
VWSTX	0	0	0	0	9%
VWEHX	0	0	0	12%	5%
XLP	33%	39%	30%	15%	8%
VFIIX	0	0	0	0	36%
IBB	67%	38%	22%	12%	8%
VWLTX	0	0	0	0	2%
TLT	0	16%	0	0	0
EST_GLD	0	8%	5%	0	0
Utility Difference:	0.0000	0.0003	0.0010	0.0026	+Inf

WHICH PORTFOLIO WOULD YOU CHOOSE TODAY?

- Base your answer just on holdings.
- If the investor has said she will have little turnover?
- Does the utility comparison tell you anything?

HISTORY, 1-MONTH AHEAD

MEAN-VARIANCE ALLOCATION

	L:1	L:2	L:4	L:8	L:16
Utility:	0.007	0.0147	0.0269	0.0413	NaN
Allocation Weights:					
IEF	0	0	0	1%	44%
EWJ	0	0	1%	2%	2%
VWEHX	0	0	0	28%	26%
XLP	0	34%	44%	29%	15%
IBB	22%	12%	4%	1%	0
XLV	0	11%	19%	12%	6%
TLT	0	0	10%	19%	0
DIA	0	0	0	0	3%
XLK	79%	43%	23%	10%	5%

0.4 MONTHLY HISTORY, 0.2 CRISIS, 0.4 6-MONTH AHEAD

EXPECTED SURPLUS GROWTH ALLOCATION

	L:1	L:2	L:4	L:8	L:16
Utility:	0.0175	0.0381	0.0702	0.1186	0.1863
Allocation Weights:					
IEF	0	0	0	50%	63%
VWSTX	0	0	0	0	4%
VWEHX	0	0	0	3%	4%
XLP	66%	85%	66%	37%	17%
IBB	7%	10%	11%	8%	7%
TLT	0	0	22%	0	0
XLK	27%	4%	2%	3%	5%
Utility Delta?:	0.011	0.023	0.043	0.077	+Inf

RESILIENT INVESTORS CAN

- Trigger better tail-risk review with:
  - Return mean shrinkage to make history usable,
  - Quantify return higher moment threats to surplus,
  - Cluster analysis to reveal structure change and outliers.
- Manage tail risk better using return matrices, Rubinstein utility, and scenarios.
- Reflect future trends, reversals and drift vs noise with multiple time point evaluations.