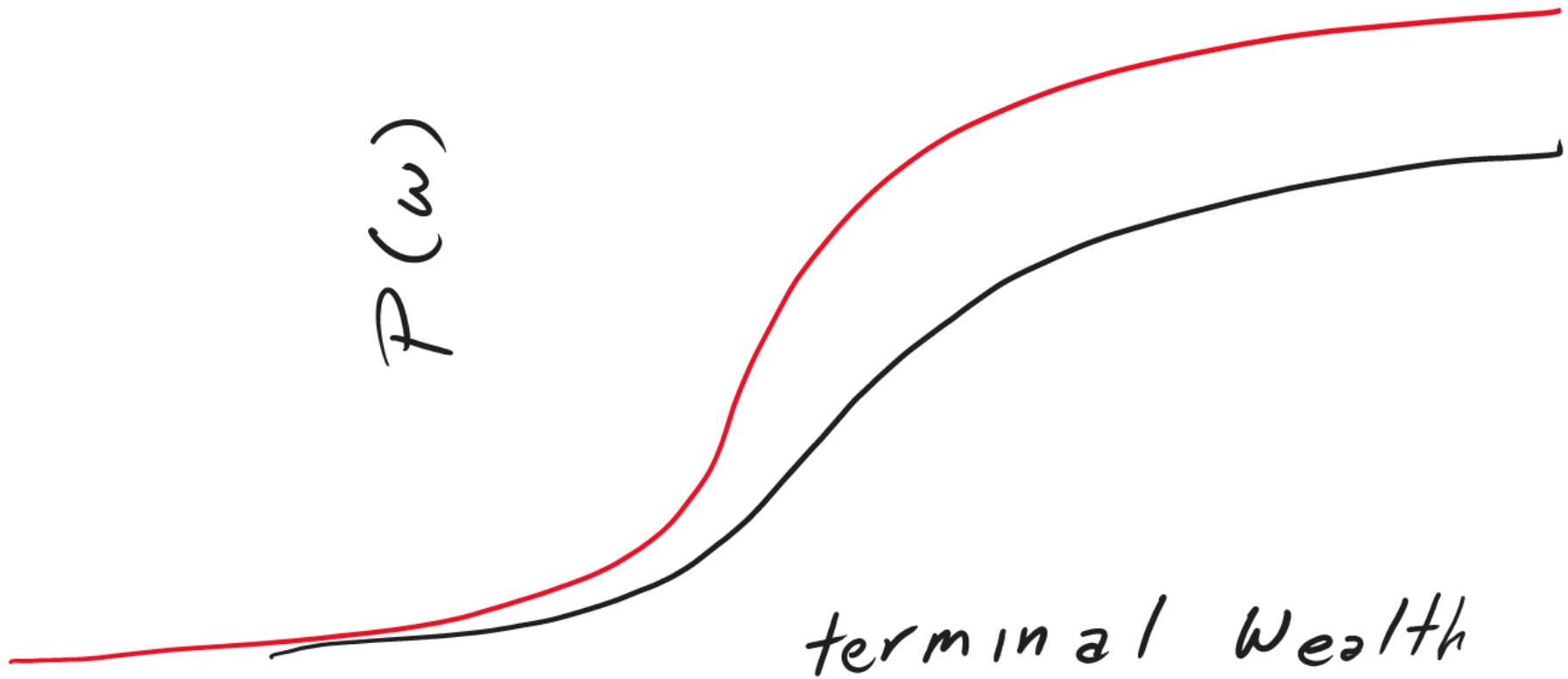# Beating Benchmarks with Equity Factors

Equity Factors for Multi-Asset Class Portfolios: a strategic asset allocation perspective. Stefano Cavaglia, Louis Scott, Ken Blay, Tarun Gupta. JAM 2022

Louis Scott
12 Sept 2022
Northfield London Conference 2022

Research background

- **Scott and Cavaglia (2017)** present a framework for evaluation of factors over long horizons

  - Explored equity factor overlays using Fama & French factors
  - Focused on equities as base asset
  - Focused on terminal wealth outcomes

Research background

- Blay et. al. (2020)

present a simulation-based multi-period portfolio selection framework

- Focused on long-horizon investing

- Focused on terminal wealth and decumulation outcomes

- Invesco commissions Cavaglia and Scott to expand 2017 research

- Explore multi-asset, multi-factor overlays

- Explore equities, bonds, and a 60/40 portfolio as base assets

- Explore terminal wealth and decumulation outcomes

- Invesco has factor expertise across multiple asset classes, use their data

- Cavaglia, Moroz and Scott (2021) confirm results in 21 countries.

Factor premia: a new old lens

Context: Recent experience and concerns

- Profound disappointment

- Expected returns versus actual returns

  - **Value and alternative risk premia crashed**

  - **Crowded markets, high transaction costs**

  - **Factor scepticism warranted**

Background

Historical Data Questions

- Long only factor returns: are they attainable?

    - DFA 37 years of replicating Fama and French within 15 bps

    - Institutional asset owners outperform asset class benchmarks
by 191 bps see Gerakos et. al. JF (2021)

- Long/Short implementation costs: are they prohibitive?

    - Frazzini et.al. (2018): trading costs are manageable

    - Survey of investment bank products

        - Management + implementation: 60bps (average)

        - Net return/Gross return: 65% (average)

        - Are current factor returns anomalous?

- Were bond returns anomalous in the 1990s and this year?

Research: What does the theory tell us? (the old lens)

The typical multifactor-efficient portfolio of the ICAPM combines an MVE portfolio with hedging portfolios that mimic uncertainty about consumption-investment state variables.

> - Eugene Fama Multifactor Portfolio Efficiency and Multifactor Asset Pricing
> Journal of Financial and Quantitative Analysis 1996

A typical investor then picks a point which gives him the best possible portfolio, trading off mean, variance, and recession sensitivity that is available. Investors want to hold multifactor efficient, rather than mean-variance efficient portfolios.

> -John Cochrane Portfolio Advice in a Multi-factor World
> Federal Reserve Bank of Chicago Economic Perspectives 1999

Background

Research: What does the theory tell us? (the old lens)

Implications of the theory

- **Aspiring retirees solve a multi-period portfolio problem**

- **Factors are portfolio construction instruments:**

   - To support attaining wealth accumulation/decumulation goals

   - To tailor the journey to attain those goals by accounting for investor risk aversion

- **The correlation of factors with the base (mean-variance efficient) portfolio matters**

   - This may be linked to economic conditions

Background

Our work: The new lens

- **Examine how factor can support accumulation decumulation goals**

    - Apply simulation analysis to review range of possible outcomes

    - Evaluate the benefits of factors accounting for risk aversion

- Examine the importance of factors in a total portfolio context

    - Apply a factor overlay to reduce the risk of a reference asset

    - Fill the risk budget and obtain a more efficient portfolio

- Examine the performance of factors through economic regimes

    - Construct all-weather factor completion portfolios

Background

Key questions

- To what extent does the overlay enhance an investor's ability to attain her his wealth accumulation (or retirement income) goal?

- Is the journey over time to attaining the desired goal smoother or more turbulent due to the factor overlay?

- Does the short side matter?

- How do factor premia interact with different underlying base assets?

- How sensitive are the results to alternative views about the future persistence of the historical returns of the factor premia?

Research

Methods

- Using historical returns for the period from Jan 1997 through March 2020

- We produce 10,000 20-year block bootstrap simulations of various base assets with two different implementations of factor premia composite overlays

- Base assets: Equities, bonds, and 60/40

- Implementations: 200/100 and 130/30

- We assume overlay exposure are adjusted to drifting base asset exposures monthly

The Factors

- **EM: Earnings momentum** a portfolio that seeks to capture the outperformance of stocks whose earnings growth performance exceeds sector or market averages

- **PM: Price momentum** a portfolio of stocks whose historical share price performance exceeds sector or market averages

- **V: Value** portfolio a portfolio of stocks perceived to be inexpensive relative to sector or market averages based primarily on various financial ratios such as price-to-cashflow or price-to-earnings

- **Q: Quality** a portfolio of stocks that demonstrate a stronger balance sheet (e.g., lower levels of debt, higher profit margins) relative to sector or market averages

- **LV: Low volatility** a portfolio that seeks to capture the higher risk-adjusted returns of low volatility stocks

- **ALL Equal-weighted composite** of the five equity premium portfolios (EM, PM, V, Q, and MV).

Data

Results

We produce outcome distributions and certainty equivalents for:

- Terminal wealth

- Maximum drawdowns

- Coverage ratios

Coverage ratio of Kritzman and Estrada (2018) define as:

Coverage Ratio:
$$C_t = \frac{Y_t}{L}$$

where:

    Y = the number of years of withdrawals sustained by a strategy, both during and after the retirement period

    L = the length of the retirement period considered

We implement 30 years of withdrawals with a 4% real spending rate

Tables

Results historical data correlations

| | Form | Volatility (%) | Correlations | | | | | | | | | Serial Correlation |
			Equities	Bonds	Comm.	EM L/S	PM L/S	V L/S	Q L/S	LV L/S	ALL L/S	
Equities	L	15.32	1.00									-
Bonds	L	6.38	0.10	1.00								-
Commodities	L	22.92	0.39	0.13	1.00							-
EM	L/S	6.12	-0.37	0.07	-0.03	1.00						0.19
PM	L/S	8.21	-0.44	0.05	-0.12	0.83	1.00					0.21
V	L/S	4.54	-0.67	0.03	-0.32	0.39	0.45	1.00				0.34
Q	L/S	6.61	-0.01	0.06	0.09	-0.35	-0.38	0.26	1.00			0.40
LV	L/S	5.40	-0.19	0.25	-0.03	0.21	0.24	0.27	0.15	1.00		0.06
EW	L/S	3.70	-0.54	0.14	-0.12	0.73	0.76	0.75	0.18	0.59	1.00	0.19

Results

Results: historical conditional returns

	Form	Hedged	Conditional Returns (%)							Regime Returns (%)			
			Full Sample	Equities > 0	Equities < 0	Bonds > 0	Bonds < 0	Comm > 0	Comm < 0	Contraction	Expansion	Recovery	Slowdown
Equities	L	–	0,58	3,23	-3,74	0,96	0,10	1,57	-0,56	-1,64	0,53	1,26	1,00
Bonds	L	–	0,37	0,38	0,35	1,61	-1,25	0,50	0,22	0,81	-0,08	0,28	0,61
Commodities	L	–	-0,08	1,32	-2,37	0,77	-1,20	4,60	-5,54	-2,90	0,63	-0,11	0,24
EM	L/S	U	0,70	0,31	1,34	0,81	0,56	0,80	0,59	0,85	0,87	-0,10	0,87
EM	L/S	H	0,77	0,78	0,75	0,80	0,74	0,88	0,65	0,59	0,95	0,09	0,97
EM	L	H	0,69	0,64	0,77	0,71	0,67	0,62	0,77	0,30	0,85	0,90	0,61
EM	S	H	0,08	0,14	-0,02	0,09	0,07	0,25	-0,12	0,29	0,10	-0,81	0,37
PM	L/S	U	0,67	0,08	1,62	0,66	0,68	0,66	0,68	0,99	0,69	0,06	0,81
PM	L/S	H	0,78	0,84	0,68	0,71	0,87	0,93	0,60	0,53	0,82	0,35	0,99
PM	L	H	0,64	0,62	0,66	0,63	0,65	0,58	0,71	0,21	0,74	1,04	0,52
PM	S	H	0,14	0,22	0,01	0,08	0,22	0,35	-0,11	0,33	0,08	-0,69	0,47
V	L/S	U	0,56	0,03	1,42	0,59	0,51	0,33	0,82	1,11	0,35	0,22	0,68
V	L/S	H	0,64	0,65	0,63	0,66	0,61	0,67	0,61	0,68	0,47	0,44	0,83
V	L	H	0,57	0,52	0,65	0,58	0,55	0,45	0,70	0,25	0,54	1,08	0,47
V	S	H	0,07	0,13	-0,02	0,08	0,06	0,22	-0,10	0,43	-0,07	-0,64	0,36
Q	L/S	U	0,70	0,54	0,96	0,87	0,48	0,61	0,81	0,46	0,46	1,46	0,64
Q	L/S	H	0,69	0,55	0,93	0,78	0,58	0,48	0,94	0,46	0,46	1,48	0,62
Q	L	H	0,62	0,50	0,82	0,68	0,55	0,38	0,90	0,19	0,60	1,65	0,35
Q	S	H	0,07	0,05	0,11	0,10	0,04	0,10	0,04	0,27	-0,14	-0,18	0,27
LV	L/S	U	0,35	0,14	0,71	0,60	0,03	0,28	0,44	0,23	0,17	0,37	0,52
LV	L/S	H	0,32	0,30	0,34	0,31	0,32	0,27	0,38	-0,07	0,23	0,41	0,46
LV	L	H	0,50	0,48	0,54	0,49	0,52	0,42	0,59	-0,02	0,41	0,49	0,73
LV	S	H	-0,18	-0,18	-0,20	-0,17	-0,20	-0,16	-0,22	-0,05	-0,18	-0,08	-0,27
ALL	L/S	U	0,60	0,22	1,21	0,71	0,45	0,54	0,67	0,73	0,51	0,40	0,70
ALL	L/S	H	0,64	0,62	0,67	0,65	0,62	0,64	0,63	0,44	0,59	0,55	0,78
ALL	L	H	0,60	0,55	0,69	0,62	0,59	0,49	0,73	0,18	0,63	1,03	0,54
ALL	S	H	0,04	0,07	-0,02	0,03	0,04	0,15	-0,10	0,25	-0,04	-0,48	0,24

Results: historical conditional returns

	Form	Hedged	Conditional Returns (%)							Regime Returns (%)			
			Full Sample	Equities > 0	Equities < 0	Bonds > 0	Bonds < 0	Comm > 0	Comm < 0	Contraction	Expansion	Recovery	Slowdown
Equities	L	-	0.58	3.23	-3.74	0.96	0.10	1.57	-0.56	-1.64	0.53	1.26	1.00
Bonds	L	-	0.37	0.38	0.35	1.61	-1.25	0.50	0.22	0.81	-0.08	0.28	0.61
Commodities	L	-	-0.08	1.32	-2.37	0.77	-1.20	4.60	-5.54	-2.90	0.63	-0.11	0.24
PM	L/S	U	0.67	0.08	1.62	0.66	0.68	0.66	0.68	0.99	0.69	0.06	0.81
PM	L/S	H	0.78	0.84	0.68	0.71	0.87	0.93	0.60	0.53	0.82	0.35	0.99
PM	L	H	0.64	0.62	0.66	0.63	0.65	0.58	0.71	0.21	0.74	1.04	0.52
PM	S	H	0.14	0.22	0.01	0.08	0.22	0.35	-0.11	0.33	0.08	-0.69	0.47
V	L/S	U	0.56	0.03	1.42	0.59	0.51	0.33	0.82	1.11	0.35	0.22	0.68
V	L/S	H	0.64	0.65	0.63	0.66	0.61	0.67	0.61	0.68	0.47	0.44	0.83
V	L	H	0.57	0.52	0.65	0.58	0.55	0.45	0.70	0.25	0.54	1.08	0.47
V	S	H	0.07	0.13	-0.02	0.08	0.06	0.22	-0.10	0.43	-0.07	-0.64	0.36

Results: terminal wealth distributions

200/100 factor premia overlay

	Equities Base	Terminal Wealth ($) - Expected Return: Historical						Terminal Wealth ($) - Expected Return: 50% of historical					
		Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile 0.05	0.71	3.09	2.69	3.06	2.95	2.54	3.07	1.37	1.24	1.50	1.34	1.31	1.45
0.25	1.56	7.30	6.55	6.48	6.82	5.73	6.87	3.26	3.03	3.20	3.11	2.97	3.26
0.50	2.63	12.87	11.81	10.70	12.09	9.79	11.61	5.75	5.48	5.29	5.51	5.09	5.52
0.75	4.39	22.56	20.85	17.42	20.96	16.29	19.44	10.10	9.68	8.62	9.58	8.47	9.26
CE	1.91	8.77	7.83	7.98	8.35	6.97	8.37	3.91	3.62	3.94	3.80	3.61	3.97

	Bonds Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile 0.05	1.75	6.41	5.08	6.16	5.17	5.82	6.87	2.86	2.35	3.04	2.35	3.02	3.26
0.25	2.01	8.78	7.60	7.65	7.69	7.11	8.44	3.92	3.52	3.78	3.50	3.69	4.01
0.50	2.21	10.86	10.00	8.98	10.07	8.17	9.73	4.85	4.64	4.44	4.60	4.25	4.63
0.75	2.43	13.31	12.92	10.47	13.24	9.30	11.17	5.95	5.99	5.18	6.05	4.83	5.31
CE	2.19	10.26	9.09	8.74	9.31	7.97	9.51	4.58	4.21	4.32	4.24	4.14	4.52

	60/40 Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile 0.05	1.26	5.19	4.40	5.20	4.77	4.40	5.28	2.31	2.03	2.56	2.17	2.28	2.51
0.25	1.95	8.94	7.92	7.97	8.16	7.13	8.54	3.99	3.67	3.94	3.72	3.70	4.06
0.50	2.61	12.89	11.69	10.61	11.98	9.69	11.56	5.76	5.42	5.24	5.47	5.03	5.50
0.75	3.50	18.30	17.24	14.07	17.45	13.09	15.58	8.19	8.01	6.96	7.97	6.81	7.42
CE	2.36	10.97	9.77	9.65	10.18	8.62	10.30	4.90	4.53	4.77	4.64	4.47	4.90

Results

Results: terminal wealth distributions

200/100 factor premia overlay

Terminal Wealth ($) - Expected Return: Historical							
	60/40 Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile							
0.05	1.26	5.19	4.40	5.20	4.77	4.40	5.28
0.25	1.95	8.94	7.92	7.97	8.16	7.13	8.54
0.50	2.61	12.89	11.69	10.61	11.98	9.69	11.56
0.75	3.50	18.30	17.24	14.07	17.45	13.09	15.58
CE	2.36	10.97	9.77	9.65	10.18	8.62	10.30

Terminal Wealth ($) - Expected Return: 50% of historical							
		Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile							
0.05	1.26	2.31	2.03	2.56	2.17	2.28	2.51
0.25	1.95	3.99	3.67	3.94	3.72	3.70	4.06
0.50	2.61	5.76	5.42	5.24	5.47	5.03	5.50
0.75	3.50	8.19	8.01	6.96	7.97	6.81	7.42
CE	2.36	4.90	4.53	4.77	4.64	4.47	4.90

Results

Results: Max Drawdown distributions

200/100 factor premia overlay

Percentile	Equities Base	Value at Drawdown ($) - Expected Return: Historical						Value at Drawdown ($) - Expected Return: 50% of historical					
		Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
0.05	0.29	0.40	0.38	0.46	0.40	0.41	0.43	0.34	0.31	0.40	0.33	0.35	0.37
0.25	0.45	0.54	0.52	0.59	0.54	0.55	0.57	0.49	0.47	0.54	0.49	0.50	0.51
0.50	0.55	0.62	0.61	0.66	0.62	0.63	0.64	0.58	0.56	0.62	0.58	0.59	0.60
0.75	0.64	0.68	0.67	0.72	0.68	0.69	0.70	0.65	0.64	0.69	0.65	0.67	0.67
CE	0.49	0.58	0.56	0.63	0.58	0.59	0.61	0.53	0.51	0.58	0.53	0.55	0.56

Percentile	Bonds Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
0.05	0.92	0.82	0.72	0.94	0.78	0.92	0.93	0.78	0.68	0.91	0.73	0.90	0.90
0.25	0.94	0.87	0.80	0.96	0.85	0.94	0.95	0.84	0.77	0.93	0.81	0.93	0.93
0.50	0.95	0.89	0.83	0.96	0.87	0.95	0.95	0.87	0.81	0.95	0.84	0.94	0.94
0.75	0.96	0.92	0.88	0.97	0.89	0.96	0.96	0.89	0.86	0.95	0.87	0.95	0.95
CE	0.95	0.88	0.83	0.96	0.86	0.95	0.95	0.86	0.80	0.94	0.83	0.94	0.94

Percentile	60/40 Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
0.05	0.58	0.64	0.61	0.73	0.62	0.67	0.69	0.58	0.54	0.68	0.56	0.62	0.63
0.25	0.70	0.73	0.71	0.80	0.72	0.76	0.77	0.69	0.66	0.76	0.67	0.72	0.73
0.50	0.76	0.78	0.76	0.83	0.77	0.80	0.81	0.75	0.73	0.81	0.73	0.78	0.79
0.75	0.80	0.82	0.80	0.86	0.80	0.83	0.84	0.80	0.77	0.84	0.78	0.82	0.82
CE	0.73	0.76	0.74	0.82	0.75	0.79	0.79	0.73	0.70	0.79	0.71	0.76	0.76

Results

Results: Max Drawdown distributions

200/100 factor premia overlay

Value at Drawdown ($) - Expected Return: Historical							
	Equities Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile 0,05	0,29	0,40	0,38	0,46	0,40	0,41	0,43
0.25	0.45	0.54	0.52	0.59	0.54	0.55	0.57
0.50	0.55	0.62	0.61	0.66	0.62	0.63	0.64
0,75	0,64	0,68	0,67	0,72	0,68	0,69	0,70
CE	0.49	0.58	0.56	0.63	0.58	0.59	0.61

Value at Drawdown ($) - Expected Return: 50% of historical							
	Equities Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile 0,05	0,29	0,34	0,31	0,40	0,33	0,35	0,37
0.25	0.45	0.49	0.47	0.54	0.49	0.50	0.51
0.50	0.55	0.58	0.56	0.62	0.58	0.59	0.60
0,75	0,64	0,65	0,64	0,69	0,65	0,67	0,67
CE	0.49	0.53	0.51	0.58	0.53	0.55	0.56

Results

Results:Volatility of base assets and factor overlays

	Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Equties	15.3%	16.3%	17.0%	15.7%	16.7%	16.1%	15.6%
Bonds	6.4%	8.5%	9.7%	7.2%	9.2%	8.2%	7.1%
60/40	9.8%	11.3%	12.2%	10.3%	11.8%	11.0%	10.2%

Results: Certainty Equivalents

	Certainty Equivalent ($)			
	(A) BASE	(B) ALL	(C) Base + ALL	Portfolio benefit of premia C – (A + B)
Equities	0.91	1.07	2.97	0.99
Bond	1.19	1.07	3.52	1.26
60/40	1.36	1.07	3.90	1.46

Results: Certainty Equivalents in Detail

Equities Base Asset		Certainty Equivalent ($)					
		Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Rebalance Frequency	1 month	10.6	9.4	9.6	10.0	8.3	10.1
	3 month	10.8	9.6	9.8	10.3	8.4	10.3
	6 month	10.9	9.7	10.0	10.5	8.5	10.5
	12 month	11.1	9.8	10.1	10.7	8.6	10.7

Bonds Base Asset		Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Rebalance Frequency	1 month	12.6	11.0	10.6	11.3	9.6	11.6
	3 month	12.6	11.1	10.6	11.4	9.6	11.6
	6 month	12.7	11.1	10.6	11.5	9.6	11.7
	12 month	13.7	12.1	12.0	12.8	10.5	12.9

60/40 Base Asset		Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Rebalance Frequency	1 month	13.5	11.9	11.8	12.5	10.4	12.6
	3 month	13.6	12.1	11.9	12.6	10.5	12.8
	6 month	13.6	12.1	11.9	12.7	10.5	12.9
	12 month	13.7	12.1	12.0	12.8	10.5	12.9

Results

Results: Coverage ratios

Coverage Ratio – Expected Return: Historical / 50% of historical

Equities Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
0.05 → 0.55	2.82	2.11	2.77	3.80	2.16	3.02	0.82	0.74	0.94	1.08	0.84	0.96
0.25 → 0.88	8.61	7.06	7.21	10.90	6.07	8.39	2.35	2.08	2.34	3.04	2.16	2.54
0.50 → 1.43	18.46	15.18	13.65	22.00	12.00	16.48	4.97	4.36	4.37	6.16	4.17	4.90
0.75 → 2.54	37.80	31.58	25.18	41.78	22.99	31.32	10.32	9.13	8.04	11.78	7.97	9.42
CE → 1.23	9.16	7.44	8.43	12.18	6.92	9.47	2.90	2.58	2.95	3.67	2.72	3.14

Bonds Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
0,05 → 0.84	5.10	3.44	4.48	4.80	4.28	5.71	1.52	1.14	1.60	1.47	1.64	1.86
0.25 → 0.94	7.92	6.01	6.17	8.29	5.61	7.58	2.27	1.87	2.11	2.41	2.09	2.40
0.50 → 1.03	10.55	8.74	7.64	11.90	6.80	9.24	2.98	2.64	2.56	3.43	2.49	2.89
0,75 → 1,13	13.91	12.42	9.55	17.57	8.20	11.24	3.87	3.70	3.16	5.01	2.97	3.49
CE → 1.03	9.52	7.36	7.28	10.26	6.52	8.84	2.73	2.31	2.48	3.03	2.41	2.79

60/40 Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
0,05 → 0,74	5.09	3.85	5.08	6.27	4.13	5.68	1.46	1.18	1.72	1.82	1.53	1.79
0.25 → 1.03	10.26	8.15	8.52	12.17	7.29	9.99	2.85	2.41	2.80	3.44	2.62	3.07
0.50 → 1.36	16.43	13.51	12.07	19.10	10.68	14.63	4.51	3.96	3.94	5.40	3.78	4.45
0,75 → 1.82	25.93	22.25	16.99	29.51	15.44	20,98	7.14	6.48	5.50	8.32	5.43	6.38
CE → 1.28	12.59	9.97	10.48	15.18	8.99	12.32	3.56	3.06	3.46	4.33	3.25	3.80

Results

Terminal wealth distribution details

Equities

	Percentile	Equities Base	Long/Short Terminal Wealth ($) Expected Return: Historical						Long Terminal Wealth ($) Expected Return: Historical						Short Terminal Wealth ($) Expected Return: Historical					
			Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile	0.05	0.7	3.1	2.7	3.1	3.0	2.5	3.1	2.5	2.2	2.1	2.3	2.1	2.3	0.7	0.8	0.8	0.8	0.7	0.8
	0.25	1.6	7.3	6.6	6.5	6.8	5.7	6.9	6.3	5.4	5.0	5.7	5.0	5.5	1.6	1.7	1.8	1.7	1.6	1.7
	0.50	2.6	12.9	11.8	10.7	12.1	9.8	11.6	11.5	9.8	8.8	10.5	9.0	10.0	2.8	3.0	3.0	2.9	2.7	2.9
	0.75	4.4	22.6	20.9	17.4	21.0	16.3	19.4	20.5	17.5	15.3	19.3	15.9	17.6	4.8	5.2	5.0	4.7	4.5	4.9
	CE	1.9	8.8	7.8	8.0	8.3	7.0	8.4	7.5	6.4	6.0	6.8	6.0	6.6	2.0	2.1	2.2	2.1	2.0	2.1
	Vol	15.3	16.3	17.0	15.7	16.7	16.1	15.6	16.1	16.2	16.0	16.8	16.3	16.0	16.8	17.0	16.5	16.4	15.4	16.1

Bonds

	Percentile	Bonds Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile	0.05	1.7	6.4	5.1	6.2	5.2	5.8	6.9	5.9	5.1	4.7	4.6	4.8	5.2	1.2	1.2	1.4	1.3	1.4	1.4
	0.25	2.0	8.8	7.6	7.6	7.7	7.1	8.4	7.9	6.7	6.1	6.8	6.3	6.9	1.8	1.9	2.0	1.9	1.8	1.9
	0.50	2.2	10.9	10.0	9.0	10.1	8.2	9.7	9.6	8.2	7.4	8.9	7.6	8.3	2.4	2.6	2.5	2.4	2.3	2.4
	0.75	2.4	13.3	12.9	10.5	13.2	9.3	11.2	11.7	10.1	8.9	11.7	9.1	10.1	3.1	3.4	3.3	3.0	2.8	3.1
	CE	2.2	10.3	9.1	8.7	9.3	8.0	9.5	9.2	7.9	7.1	8.2	7.3	8.0	2.2	2.3	2.4	2.2	2.2	2.3
	Vol	6.4	8.5	9.7	7.2	9.2	8.2	7.1	8.1	8.2	7.9	9.4	8.4	7.8	9.4	9.8	8.9	8.7	6.5	8.1

60/40

	Percentile	60/40 Base	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL	Base + EM	Base + PM	Base + V	Base + Q	Base + LV	Base + ALL
Percentile	0.05	1.3	5.2	4.4	5.2	4.8	4.4	5.3	4.3	3.7	3.6	3.8	3.6	3.9	1.1	1.2	1.4	1.3	1.2	1.3
	0.25	2.0	8.9	7.9	8.0	8.2	7.1	8.5	7.8	6.7	6.1	6.9	6.2	6.8	1.9	2.1	2.2	2.0	2.0	2.1
	0.50	2.6	12.9	11.7	10.6	12.0	9.7	11.6	11.5	9.9	8.7	10.4	9.0	9.9	2.8	3.0	3.0	2.8	2.7	2.9
	0.75	3.5	18.3	17.2	14.1	17.4	13.1	15.6	16.6	14.2	12.4	16.0	12.9	14.3	4.0	4.4	4.2	3.9	3.7	4.0
	CE	2.4	11.0	9.8	9.6	10.2	8.6	10.3	9.6	8.2	7.5	8.6	7.6	8.4	2.4	2.6	2.7	2.5	2.4	2.5
	Vol	9.8	11.3	12.2	10.3	11.8	11.0	10.2	11.0	11.1	10.9	12.0	11.2	10.8	12.0	12.3	11.6	11.4	9.9	11.0

Results

Completion versus Max Sharpe portfolio

Portfolio		Portfolio Weights (%)					Volatility (%)		
		EM	PM	V	Q	LV	Base	Overlay	Portfolio
Max. Sharpe Factors	Unconstrained	0.0	24.0	76.0	0.0	0.0	-	3.3	-
	Constrained	21.7	10.0	17.8	30.0	20.5	-	3.4	-
Equities Base	Unconstrained	0.0	24.0	76.0	0.0	0.0	15.3	4.7	12.6
	Constrained	20.0	30.0	30.0	10.0	10.0	15.3	4.4	13.3
Bonds Base	Unconstrained	32.2	0.0	36.9	30.9	0.0	6.4	3.5	7.6
	Constrained	20.0	10.0	30.0	30.0	10.0	6.4	3.5	7.6
60/40 Base	Unconstrained	0.0	16.1	83.9	0.0	0.0	9.8	4.6	7.7
	Constrained	16.3	30.0	30.0	13.7	10.0	9.8	4.2	8.4

Future work extends these results to real world optimal constructs.

Cavaglia et al. Portable Beta and Total Portfolio Management, FAJ June 2022.

Results

Summation

- To what extent does the overlay enhance an investor's ability to attain her his wealth accumulation (or retirement income) goal?

- Is the journey over time to attaining the desired goal smoother or more turbulent due to the factor overlay?

- Does the short side matter?

- How sensitive are the results to alternative views about the future persistence of the historical returns of the factor premia?

- How do factor premia interact with different underlying base assets?
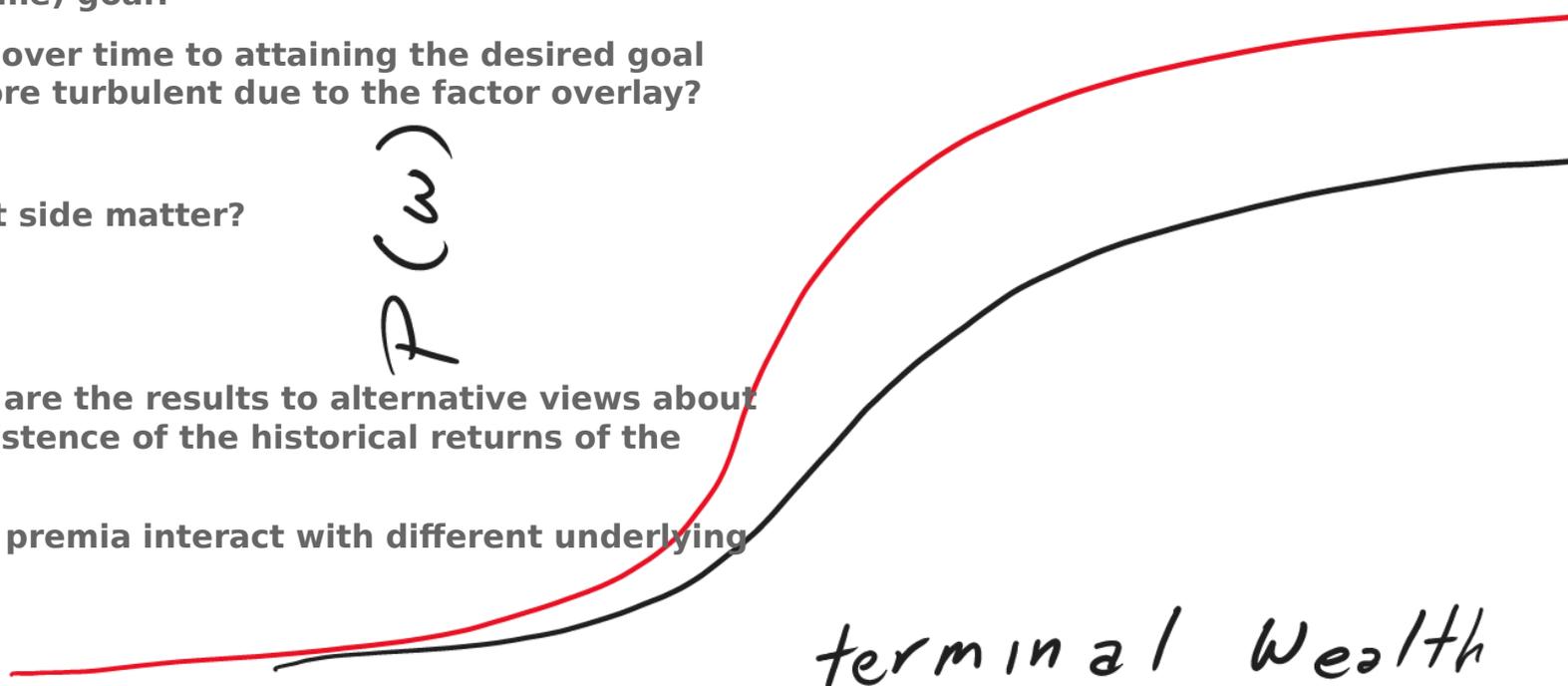
References

Blay, Kenneth, Anish Gosh, Steven Kusiak, Harry Markowitz, Nicholas Savoulides, and Qi. Zheng. 2020. Multiperiod Portfolio Selection: A Practical Simulation-Based Framework. Journal of Investment Management 18 (4): 94–129.

Blitz, David, Joop Huij, Simon Lansdorp, and Pim van Vliet. 2014. Factor Investing: Long-Only versus Long-Short. SSRN Working Paper. https://dx.doi.org/https://doi.org/10.2139/ssrn.2417221

Briere, Marie, Charles-Albert Lehalle, Tamara Nefedova, and Amine Raboun. 2020. Stock Market Liquidity and the Trading Costs of Asset Pricing Anomalies. SSRN Working Paper. http://dx.doi. org/https://doi.org/10.2139/ssrn.3380239

Cavaglia, Stefano, Louis Scott, Kenneth Blay, and Vincent De Martel. 2021a. Momentum, Value, and Carry Commodity Factors for Multi-Asset Portfolios. In Market Momentum: Theory and Practice, ed. Stephen Satchell and Andrew Grant, 359–386. New York: Wiley.

Cavaglia, Stefano, Vadim Moroz, and Louis Scott. 2021b. Exploiting the Countercyclical Properties of Momentum and other Factor Premia – a Cross Country Perspective. In Market Momentum: Theory and Practice, ed. Stephen Satchell and Andrew Grant, 198–217. New York: Wiley.

Cochrane, John. 1999. Portfolio Advice in a Multifactor World. Federal Reserve Bank of Chicago Economic Perspectives 23: 59–78.

Conine, Thomas, Michael McDonald, and Mauri Tamarkin. 2016 Estimation of Relative Risk Aversion across Time SSRN. Working Paper. http://dx.doi.org/https://doi.org/10.2139/ssrn.3045931

Cuthbertson, Keith, Simon Hayley, Nick Motson, and Dirk Nitzche. 2016. Diversification Returns, Rebalancing Returns and Volatility Pumping. Caas Business School Working Paper. http://dx.doi org/https://doi.org/10.2139/ssrn.2311240

Das, Sanjiv, Daniel Ostrov, Anand Radhakrishnan, and Deep Srivastav. 2019a. Dynamic Portfolio Allocation in Goals-Based Wealth Management. Santa Clara University Working Paper. http:// dx.doi.org/https://doi.org/10.2139/ssrn. 3211951

References

Das, Sanjiv, Daniel Ostrov, Anand Radhakrishnan, and Deep Srivastav. 2019b. A New Approach to Goals Based Wealth Management. Santa Clara University Working Paper. http://dx.doi.org/https:// doi.org/10.2139/ssrn.3117765

De Longis, Alessio. 2019. Dynamic Asset Allocation Through the Business Cycle: A Macro Regime Approach, Invesco Investment Solutions Manuscript.

De Longis, Alessio, and Dianne Ellis. 2019. Market Sentiment and the Business Cycle: Identifying Macro Regimes Through Investor Risk Appetite. Invesco Investment Solutions Manuscript

Erb, Claude, and Campbell Harvey. 2006. The Strategic and Tactical Value of Equity Futures. Financial Analyst Journal 62 (2): 69–97.

Estrada, Javier and Mark Kritzman. 2018. Evaluating Retirement Strategies: A Utility Based Approach, SSRN Working Paper. http:// dx.doi.org/https://doi.org/10.2139/ssrn.3135125

Fama, Eugene. 1996. Multifactor Efficiency and Multifactor Asset Pricing. Journal of Financial and Quantitative Analysis 31 (4): 441–465.

Polk, Christopher, Mo. Haghbin, and Alessio De Longis. 2020. Time- Series Variation in Factor Premia: The Influence of the Business Cycle. The Journal of Investment Management 18 (1): 218–242.

Politis, D.N. and Joseph P. Romano. 1992. A Circular Block Resampling Procedure for Stationary Data. in Exploring the Limits of Bootstrap, edited by R. LePage and L. Billard, 263-270. New York: John Wiley and Sons.

Politis, D.N. 2003. The Impact of Bootstrap Methods on Time Series Analysis. Statistical Science 18 (2): 219–230.

Raymond, Donald. 2009. Integrating Goals, Structure, and Decision- Making at Canada Pension Plan Investment Board, SSRN Working Paper 1131414.

Scott, Louis, and Stefano Cavaglia. 2017. A Wealth Management Perspective on Factor Premia and the Value of Downside Protection. Journal of Portfolio Management, Spring 2017: 1–9.

Warren, Geoffrey. 2019. Choosing and Using Utility Functions in Forming Portfolios. Financial Analysts Journal 75 (3): 39–69.

Wilcox, Jarrod, Jeffrey Horvitz, and Dan DiBartolomeo. 2006. Investment Management for Taxable Private Investors. The Research Foundation of the CFA

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