An Overview of Recent Research on Implementable Factor Portfolios

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Questions to Answer

1. What is the best way to build a smart beta (factor) portfolio?
2. Should we neutralize sector and country active bets?
3. How much factor risk should we expect from a factor portfolio?

Our Guiding Principles

- Strong, theoretical underpinnings
- Avoid data mining and be aware of overfitting and over-complicating
- Implementation (Portfolio management and trading) critical. Investment rationale is negated when theoretical models can’t be implemented cost-efficiently
- Overall, take a pragmatic approach. Don’t overcomplicate for complexity’s sake; parsimony is always preferred.

A long time ago in a galaxy far, far away…

- The mean-variance framework (Markowitz [1959]) was the foundational model for portfolio construction
- Return maximizing investors sought sources of return that could improve return while reducing risk
- Stock pickers looked at qualitative aspects of individual companies while quantitative investors gravitated towards factors, e.g., security characteristics that were shown by the academics to be able to explain the cross-section of stock returns across broad universes
- This view of the world underlies Grinold and Kahn [1996]'s seminal framework for active quantitative portfolio management

But then a curious thing happened

- From the index part of the financial services industry, the idea of "alternatively weighted indexes" and "smart beta" arose in the 2000s
- Fundamental indexing (Arnott, Hsu, and Moore [2005]) was one of the first ideas that gained traction, particularly because it exhibited phenomenal performance in back-tests
- From there, a cottage industry exploded, including risk parity or equal risk contribution (weighting based on risk contribution) not to be confused with Risk Weighting (weighting based on risk), Equal Weighting (weighting based on the number of securities), Diversity Weighting, and many others
- Some methods such as Minimum Variance and Maximum Sharpe Ratio were at times incorrectly labeled as "new" weighting schemes when in fact they were variants of the original mean-variance paradigm

Rising to a Clash of the Titans

Using Mean-Variance Optimization to Create Factor Portfolios

Max $w'r - \lambda w'\Sigma w$

Traditional Markowitz framework maximized returns r

Max $w'X - \lambda w'\Sigma w$

Here we just replace returns r with factor exposures X

Which relates to pure factor portfolios

Factors from cross-sectional regressions al Barra/Axioma/Northfield:

$$f = (X'\Delta^{-1}X)^{-1}X'\Delta^{-1}r$$

The conditions for the “pure” factors to be equivalent to the solution to our optimization function are as follows:

- The factors must be orthogonal
- There is no long only constraint or any other constraints

Other Optimization-based Portfolio Construction Methods

Strategy	Objective	Assumptions for Mean-variance Optimality
Minimum Variance Portfolio	Min $\sigma_p^2 = w'\Omega\, w$	Expected returns are equal
Maximum Decorrelation Portfolio	Min $\sigma_p^2 = w'\Omega\, w$	Expected returns and volatilities are equal
Maximum Diversification Portfolio	Max $D_p = \frac{w'\sigma}{\sqrt{w'\Omega\, w}}$	Expected returns are proportional to volatilities
Risk-Parity Portfolio/Equal Risk Contribution	$\frac{\partial \sigma_p}{\partial w_i} w_i = \frac{\partial \sigma_p}{\partial w_j} w_j,$ $for \text{ any i}, j$	Expected returns are proportional to volatilities and correlations must be constant
Maximum Deconcentration	Maximizes 1/w′w	Expected returns and volatilities are equal; correlations are constant
Maximum Sharpe Ratio	Max $SR_p = \frac{w'r}{\sqrt{w'\Omega\, w}}$	No Assumptions needed; however expected returns must be specified, either as an additional input or assumed to be proportional to risk

Empirical Analysis

- Compare mean-variance factor approach against the others
- Factors: Value, Momentum, Low Size (Small Cap), Investments and Profitability—plus a sixth factor, Low Volatility. (The Low Volatility factor is defined as 60 month historical variance.)
- Universe: US Large cap (S&P 500 Index constituents)
- Period: January 1995 to December 2016
- Rebalancing Frequency: Monthly
- Risk Model: 3-factor PCA

Performance summary (USD Gross Returns, January 1995 to December 2016, Results using 3-factor PCA model, S&P 500 Universe)

	Maximum Divers-ification	Maximum Sharpe Ratio	Risk Parity/ ERC	Minimum Variance	Maximum Deconcen-tration	Maximum Decorre-lation	Mean-variance based Portfolio	Bmk (Cap Wtd)
Annualized Return	9.03%	9.81%	11.25%	9.65%	11.66%	8.57%	14.33%	9.58%
Annualized Volatility	12.40%	13.15%	14.03%	11.19%	16.84%	14.04%	16.27%	14.85%
Sharpe Ratio	0.73	0.75	0.80	0.86	0.69	0.61	0.88	0.64
Active Return	-0.55%	0.23%	1.67%	0.07%	2.08%	-1.01%	4.75%	0.00%
Tracking Error	9.62%	9.84%	5.49%	11.17%	5.73%	8.69%	9.81%	0.00%
Information Ratio	-0.06	0.02	0.30	0.01	0.36	-0.12	0.48	-
Best 12 Month Return	42.94%	49.98%	63.52%	36.27%	83.23%	48.60%	67.98%	53.52%
Worst 12 Month Return	-37.54%	-40.60%	-42.91%	-27.45%	-47.70%	-43.81%	-47.27%	-43.25%
Up Capture	0.66	0.71	0.93	0.58	1.12	0.77	1.04	1.00
Down Capture	0.62	0.64	0.84	0.46	1.03	0.79	0.83	1.00
Maximum Drawdown	-43.28%	-45.85%	-50.27%	-33.65%	-55.88%	-49.73%	-57.70%	-50.89%

Comparison of Factor Exposures Across Approaches (S&P 500 Universe, 3-factor PCA model, Fama-French Factors Plus BAB, January 1995 to December 2016)

	Maximum Divers-ification	Maximum Sharpe Ratio	Risk Parity/ ERC	Minimum Variance	Maximum Deconcen-tration	Maximum Decorre-lation	Mean-variance based Portfolio
Intercept	0.02%	0.07%	0.03%	0.13%	0.02%	0.05%	0.24%
Market	0.70	0.72	0.91	0.59	1.06	0.76	0.92
SMB	0.02	0.06	0.16	-0.06	0.27	0.10	0.27
HML	0.05	0.07	0.07	-0.02	0.10	0.07	0.25
RMW	-0.03	0.00	0.10	-0.02	0.10	-0.10	0.06
CMA	0.24	0.25	0.17	0.32	0.13	0.10	0.17
WML	-0.04	-0.10	-0.11	-0.02	-0.17	-0.06	-0.09
BAB	0.15	0.15	0.10	0.18	0.05	0.08	0.08

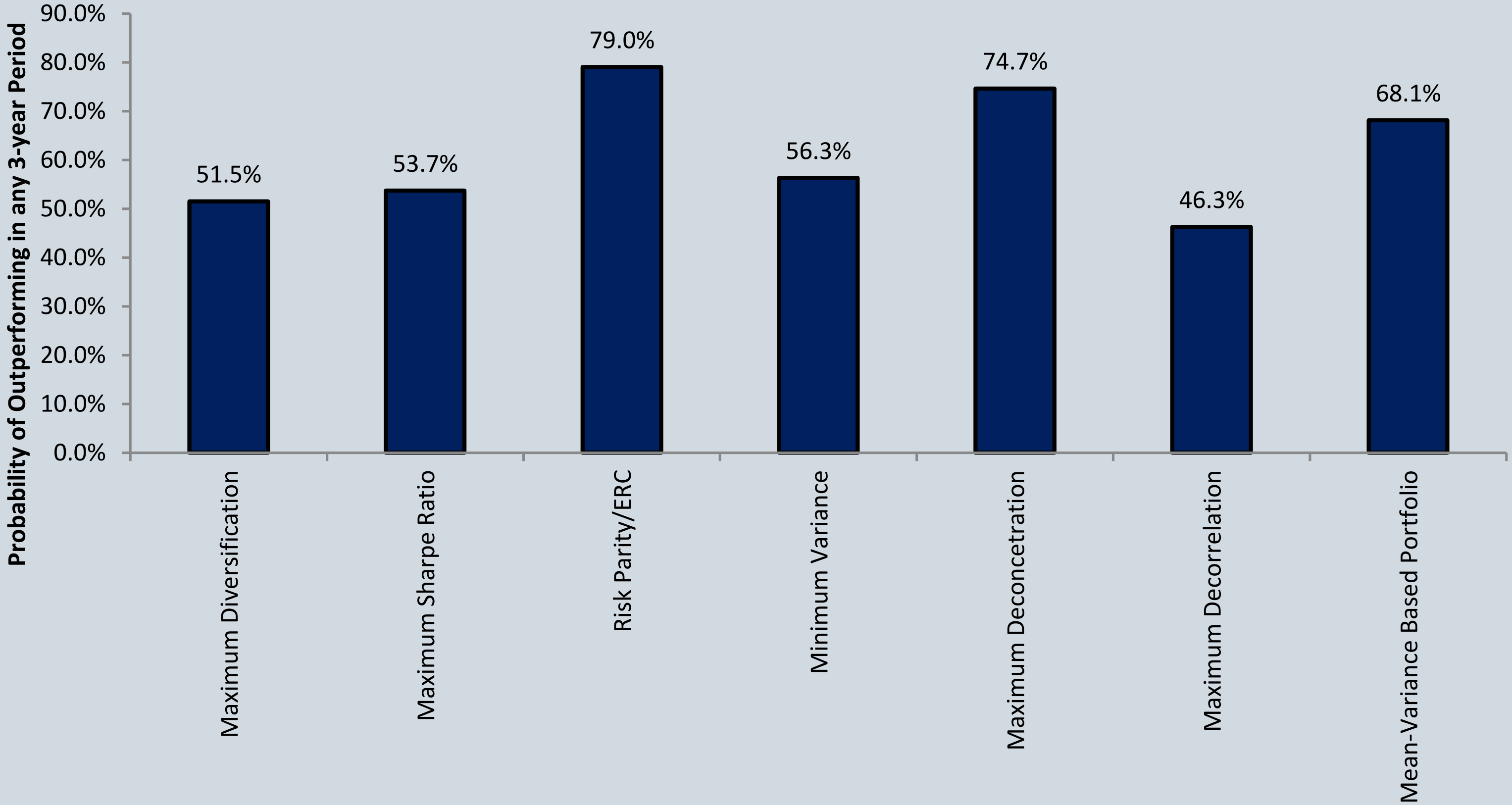
Statistically significant loadings adjusted for Newey-West are in blue

Sensitivity to Time Periods

	Maximum Divers-ification	Maximum Sharpe Ratio	Risk Parity/ ERC	Minimum Variance	Maximum Deconcen-tration	Maximum Decorre-lation	Mean-variance based Factor Portfolio	Bmk (Cap Wtd)
Annualized Return								
1995-1999	13.6%	14.4%	17.0%	12.8%	19.1%	14.9%	17.6%	26.7%
2000-2004	9.4%	11.0%	10.3%	8.9%	9.6%	8.2%	14.9%	-1.7%
2005-2009	1.1%	1.3%	1.6%	2.4%	2.2%	-0.4%	-0.9%	0.2%
2010-2016	11.5%	12.1%	15.2%	13.4%	15.1%	11.1%	23.6%	13.8%
Annualized Excess Return								
1995-1999	-13.1%	-12.3%	-9.7%	-13.9%	-7.6%	-11.8%	-9.0%	
2000-2004	11.1%	12.7%	11.9%	10.6%	11.3%	9.9%	16.6%	
2005-2009	0.9%	1.1%	1.4%	2.2%	1.9%	-0.6%	-1.1%	
2010-2016	-2.3%	-1.7%	1.5%	-0.4%	1.4%	-2.6%	9.8%	
Tracking Error								
1995-1999	9.9%	10.7%	6.1%	10.8%	5.5%	9.7%	10.2%	
2000-2004	11.8%	11.7%	7.6%	12.9%	7.2%	9.1%	11.4%	
2005-2009	7.3%	6.9%	3.1%	9.0%	6.2%	7.1%	8.6%	
2010-2016	8.5%	8.9%	3.0%	11.0%	2.9%	8.1%	8.2%	
Information Ratio								
1995-1999	-1.32	-1.15	-1.57	-1.28	-1.38	-1.21	-0.89	
2000-2004	0.94	1.08	1.57	0.82	1.57	1.08	1.46	
2005-2009	0.12	0.16	0.44	0.24	0.31	-0.09	-0.13	
2010-2016	-0.27	-0.19	0.48	-0.03	0.46	-0.33	1.20	

USD Gross Returns, January 1995 to December 2016, Results using 3-factor PCA model, S&P 500 Universe

Probability of Outperforming the Benchmark in Any Three Year Period



USD Gross Returns, January 1995 to December 2016, Results using 3-factor PCA model, S&P 500 Universe

Similar Past Studies

- Chow, Hsu, Kalesnik, and Little (2011]
  - Argues that optimization-based methods do not provide meaningful diversification improvement over non-optimized portfolios
  - Do not use factors as “alpha source” in objective function
- Qian, Alonso, and Barnes [2015]
  - Analyze “naïve beta”: equally weighted, minimum variance, maximum diversification, and risk parity
  - Argue that while all 4 outperform market cap weighting, Risk parity is the best, as it is least sensitive to risk inputs
  - Do not use factors as “alpha source” in objective function

Questions?

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One question that comes up…

- Pure factor portfolios have zero exposure to all other factors, including countries and sectors
- But countries and sectors often exhibit Value, Momentum, Quality, etc. traits
- So what should we do about country and sector active bets? Neutralize them completely? Constrain them at some level?

Fama-French portfolios are NOT country/industry neutral

- Securities are first sorted on size (market capitalization) and split into two groups, small and big.
- They are also sorted into three book-to-market groups—low, middle, and high.
- Fama and French construct six portfolios from the intersection of the two size and three book-to-market groups.
- Small Cap "SMB" portfolio (small minus big) = difference between the average returns for the three small-stock portfolios minus the average returns to the three big-stock portfolios
- Resulting portfolios are generally market and beta neutral but they are NOT neutralized for sector or country effects.
- These effects can be quite large; for instance, as of December 2018, the Fama-French Global Size portfolio significantly overweights Financials, Japan, and underweights the US

Prior Studies

Evidence against neutralizing Momentum for industry bets: Moskowitz and Grinblatt [1999]

Mixed evidence against neutralizing Low Volatility for industry bets: Asness, Frazzini, and Pedersen [2014]

Evidence for sector neutralizing factors generally: Aguet, Amenc, and Goltz [2018]

Three Exercises

Exercise #1:

Rank each country in the MSCI World Index for each factor using Fama-French definitions for Value, Size, Operating Profitability, Asset Growth and Momentum.

Calculate returns to long portfolio of the highest ranked countries/sectors and a short portfolio of the lowest ranked countries/sectors (equally weighted).

Positive return spread -> we do not want to neutralize country bets

Some Evidence for Neutralizing Value and Size, and Profitability

Returns to Top Five and Bottom Five Countries Ranked Using Factor Characteristics (Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions)

	Portfolio of Top Five Countries (EW)	Portfolio of Bottom Five Countries (EW)	Spread (Top minus Bottom)
Book to Market (Value)	3.3%	7.3%	-4.0%
Size (Small)	3.7%	5.7%	-1.9%
Operating Profitability	3.9%	7.5%	-3.5%
Asset Growth (Low)	6.9%	1.6%	5.3%
Momentum	10.9%	-1.4%	12.3%
Volatility (Low)	6.6%	2.9%	3.7%

Some Evidence for Neutralizing Value and Size

Returns to Top Five and Bottom Five Sectors Ranked Using Factor Characteristics (Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions)

	Portfolio of Top Five Sectors (EW)	Portfolio of Bottom Five Sectors (EW)	Spread (Top minus Bottom)
Book to Market (Value)	5.4%	9.0%	-3.6%
Size (Small)	6.3%	7.8%	-1.5%
Operating Profitability	8.0%	6.1%	1.9%
Asset Growth (Low)	8.2%	6.1%	2.1%
Momentum	8.8%	5.2%	3.7%
Volatility (Low)	7.2%	6.5%	0.7%

Three Exercises

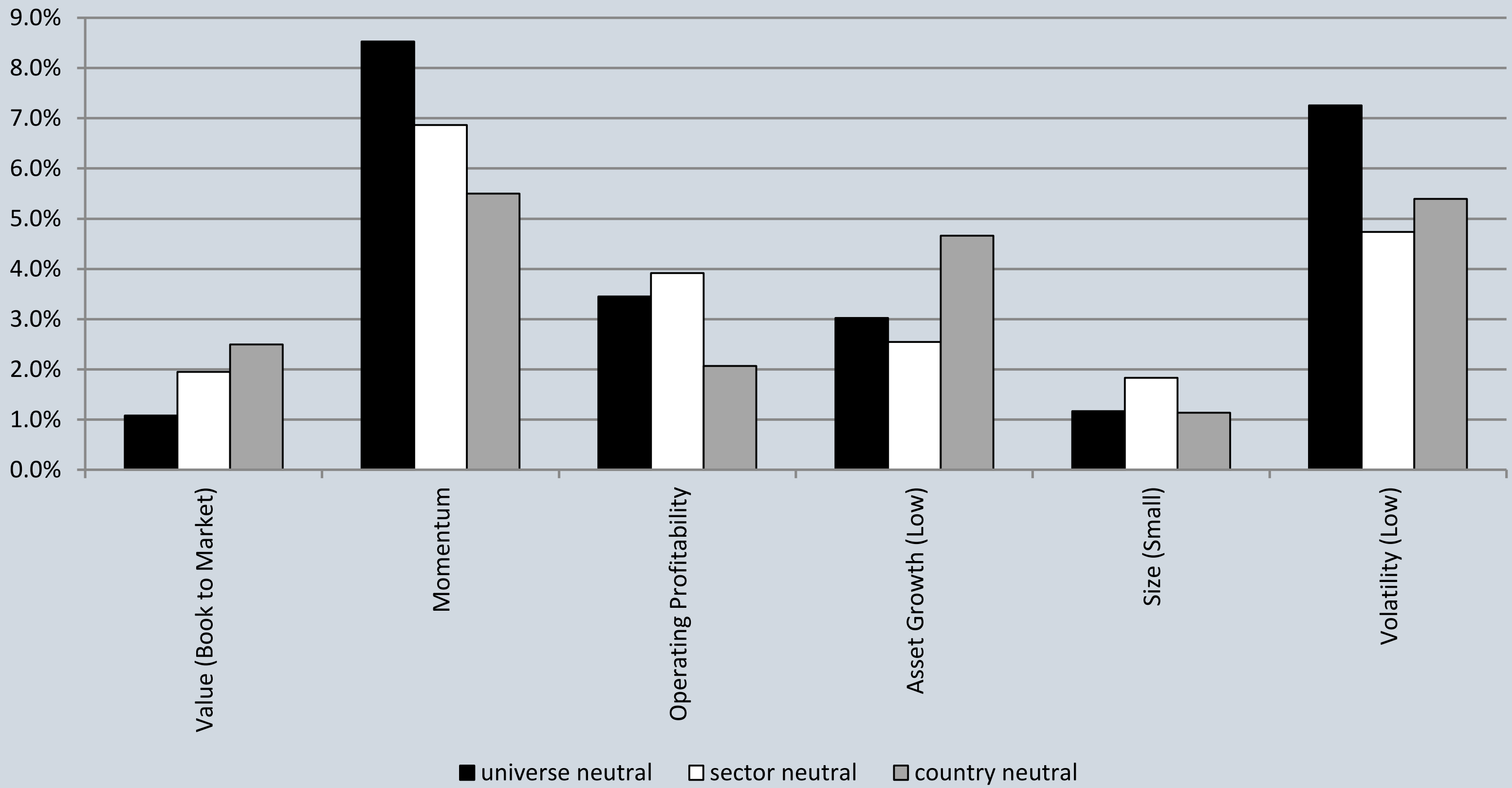
Exercise #2: We sort MSCI World securities into quintiles based on their factor characteristics. When we do the sorting, we normalize the raw factor characteristics in different ways. We evaluate three variants:

1. Universe neutral: Factor scores for each security are normalized relative to the whole universe
2. Sector neutral: Factor scores for each security are normalized relative to their sector average
3. Country neutral: Factor scores for each security are normalized relative to their country average

Positive quintile spread = premium coming from the factor

The more positive the quintile spread, the better

More Evidence for Neutralizing Value, but not the other factors



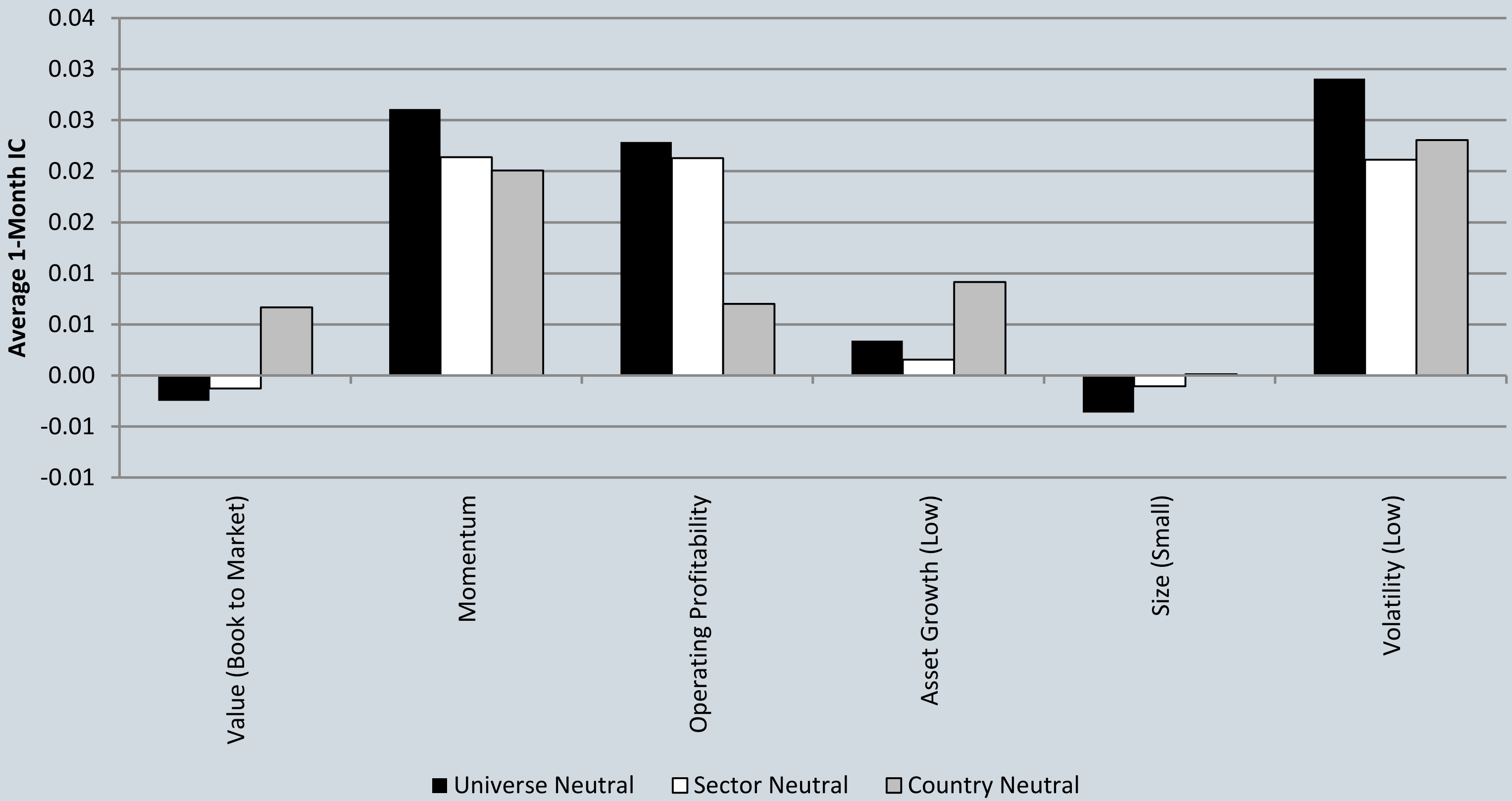
Quintile Spread Returns to Factor Portfolios Neutralized with Different Methods (Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions)

Three Exercises

Exercise #3:

- Use the same scores as before
- Calculate the Information Coefficient (cross-sectional correlation with security returns in the following month)
- Repeat this for every month and take the average over all months
- Uses the same information as before but results are no longer dependent on arbitrary sorting
- The more positive the IC for the neutral versions, the stronger the case for neutralizing

Results largely consistent with previous exercise



Average Information Coefficients for Scores Neutralized with Different Methods (Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions)

Empirical Analysis within a Rules Based Portfolio Construction framework

Rules-based portfolio construction: Security weight is $1 + z \; if \; z > 0$ and $\frac{1}{1-z} \; if \; z \leq 0$ where z is the security score

		Value			Momentum			Low Volatility		
	MSCI World	C-N	S-N	U-N	C-N	S-N	U-N	C-N	S-N	U-N
Return (%)	6.24%	8.20%	8.20%	7.81%	8.70%	8.79%	9.07%	8.69%	9.00%	9.66%
Risk (%)	15.10%	19.4%	19.0%	19.6%	15.9%	15.4%	16.4%	11.1%	12.4%	11.2%
Sharpe Ratio	0.41	0.42	0.43	0.40	0.55	0.57	0.55	0.78	0.73	0.86
Excess Return (%)		1.96%	1.96%	1.57%	2.46%	2.55%	2.83%	2.45%	2.76%	3.42%
Tracking Error (%)		8.9%	9.2%	9.8%	7.1%	6.0%	7.6%	8.1%	6.0%	8.1%
Information Ratio		0.22	0.21	0.16	0.35	0.43	0.37	0.30	0.46	0.42
Factor Exposure		1.39	1.35	1.42	1.04	1.08	1.19	0.98	0.94	1.12
Factor Exposure/TE		0.16	0.15	0.15	0.15	0.18	0.16	0.12	0.16	0.14
Turnover (Ann. 1-way)		64%	65%	56%	194%	189%	183%	44%	44%	37%

Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions, Gross USD Returns)

Empirical Analysis within a Rules Based Portfolio Construction framework (cont.)

Rules-based portfolio construction: Security weight is $1 + z \; if \; z > 0$ and $\frac{1}{1-z} \; if \; z \leq 0$ where z is the security score

		Size			Operating Profitability			Asset Growth		
	MSCI World	C-N	S-N	U-N	C-N	S-N	U-N	C-N	S-N	U-N
Return (%)	6.24%	7.39%	7.54%	7.32%	7.91%	8.38%	8.33%	8.64%	7.39%	7.51%
Risk (%)	15.10%	17.9%	17.6%	17.8%	16.9%	17.7%	18.0%	17.1%	17.5%	17.8%
Sharpe Ratio	0.41	0.41	0.43	0.41	0.47	0.47	0.46	0.50	0.42	0.42
Excess Return (%)		1.15%	1.30%	1.09%	1.67%	2.14%	2.09%	2.40%	1.15%	1.27%
Tracking Error (%)		7.2%	7.5%	7.7%	5.8%	6.0%	6.6%	6.8%	7.8%	8.2%
Information Ratio		0.16	0.17	0.14	0.29	0.36	0.32	0.35	0.15	0.16
Factor Exposure		1.92	1.97	1.97	0.55	0.96	1.11	1.17	1.30	1.31
Factor Exposure/TE		0.27	0.26	0.25	0.09	0.16	0.17	0.17	0.17	0.16
Turnover (Ann. 1-way)		44%	42%	40%	55%	49%	42%	64%	69%	64%

Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions, Gross USD Returns)

Empirical Analysis within the Mean-Variance Portfolio Construction framework

Use optimization framework from earlier but this time using Axioma optimizer and risk model (Worldwide Medium Term) and add the following constraints: ex ante Tracking error <= 3%, Turnover <= 10% two way monthly (20% for Momentum), Active security level weight <= +/-2%

		Value			Momentum			Low Volatility		
	MSCI World	C-N	S-N	U-N	C-N	S-N	U-N	C-N	S-N	U-N
Return (%)	6.2%	6.7%	7.4%	6.9%	9.8%	9.4%	9.2%	7.5%	7.4%	7.4%
Risk (%)	15.1%	16.1%	16.4%	16.2%	15.5%	15.4%	15.5%	13.2%	13.4%	13.4%
Sharpe Ratio	0.41	0.41	0.45	0.43	0.63	0.61	0.59	0.56	0.55	0.56
Excess Return (%)		0.45%	1.15%	0.67%	3.53%	3.18%	2.92%	1.21%	1.12%	1.19%
Tracking Error (%)		4.19%	4.24%	4.18%	4.72%	4.45%	4.63%	4.52%	3.82%	4.31%
Information Ratio		0.11	0.27	0.16	0.75	0.72	0.63	0.27	0.29	0.28
Factor Exposure		1.62	1.56	1.68	1.14	1.14	1.18	1.28	1.30	1.40
Factor Exposure/TE		0.39	0.37	0.40	0.24	0.26	0.26	0.28	0.34	0.32
Turnover (Ann. 1-way)		61%	61%	61%	120%	120%	120%	60%	60%	60%

Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions, Unconstrained versions (U-N) employ +/- 10% bounds, Gross USD Returns

Empirical Analysis within the Mean-Variance Portfolio Construction framework (cont.)

Use optimization framework from earlier but this time using Axioma optimizer and risk model (Worldwide Medium Term) and add the following constraints: ex ante Tracking error <= 3%, Turnover <= 10% two way monthly (20% for Momentum), Active security level weight <= +/-2%

		Size			Operating Profitability			Asset Growth		
	MSCI World	C-N	S-N	U-N	C-N	S-N	U-N	C-N	S-N	U-N
Return (%)	6.2%	7.7%	8.4%	8.2%	8.5%	8.2%	8.0%	7.3%	8.3%	8.0%
Risk (%)	15.1%	15.8%	15.8%	15.9%	16.0%	16.0%	16.0%	15.7%	15.7%	15.7%
Sharpe Ratio	0.41	0.49	0.53	0.51	0.53	0.52	0.50	0.47	0.53	0.51
Excess Return (%)		1.44%	2.21%	1.93%	2.30%	2.00%	1.71%	1.04%	2.08%	1.79%
Tracking Error (%)		4.20%	3.89%	4.07%	3.91%	3.65%	3.93%	3.65%	3.53%	3.57%
Information Ratio		0.34	0.57	0.47	0.59	0.55	0.43	0.28	0.59	0.50
Factor Exposure		2.06	2.13	2.18	1.35	1.44	1.53	1.32	1.33	1.39
Factor Exposure/TE		0.49	0.55	0.54	0.35	0.39	0.39	0.36	0.38	0.39
Turnover (Ann. 1-way)		73%	71%	72%	60%	60%	60%	60%	61%	60%

Universe = MSCI World Index constituents, December 31, 1996 to December 31, 2018, Fama-French definitions, Unconstrained versions (U-N) employ +/- 10% bounds, Gross USD Returns

To Neutralize or not?

- In simple empirical exercises, the case for sector/country neutralization is stronger for Value and Size but weak for the other factors
- However, everything is muddied when evaluated within a portfolio construction framework, particularly an optimized framework. Depending on the volatility of the sectors/countries and the correlation structure between them, neutralizing the active weights may or may not reduce risk.
- Value and Size benefit only from sector neutralizing, and some of the other factors benefit from sector and/or country neutralizing
- Not shown here but other tests we have conducted with different constraints indicate there is an "optimal" constraint for each factor somewhere between +/-3% and +/-7% for a medium (5%ish) TE portfolio. However, we want to be wary of data mining…

Questions?

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The Factor-to-Specific Ratio for Factor Portfolios

What is a reasonable level investors might expect for long-short vs long-only factor portfolios and how much deviation is normal?

Are there any limitations with this metric and is a higher ratio necessarily always better?

The Factor-to-Specific Ratio for Factor Portfolios

The risk of any equity portfolios can be decomposed ex ante into factor risk versus specific risk:

$\sigma^2 = h'(XFX' + D)h$ or $\sigma^2 = \underbrace{h'(XFX')h}_{factor} + \underbrace{h'Dh}_{specific}$

where

h = s x 1 vector of portfolio weights (or active weights if active variance) where s is the number of securities

X = s x N exposure matrix of securities to factors where N is the number of factors

F = N x N covariance matrix for factors

D= s x s diagonal specific variance matrix

Empirical Analysis

- Factor: Value as defined by Axioma => Book-to-Price
- Risk model: Axioma USE4 model
- Period: December 1997 to December 2017
- Rebalancing frequency: Annual
- We start with the following set of a base case set of simulations:
  - Long-short factor mimicking portfolio using optimization (Russell 3000 Index universe, 1% tracking error)
  - Long-only factor portfolio using optimization (Russell 3000 Index universe, 1% tracking error)
- The optimization is similar to before where we maximize the portfolio's factor exposure subject to a max TE constraint, and long only constraint. Here we add a soft constraint that all other Axioma factor exposures must be zero.

Even a long-short factor mimicking portfolio does not have 100% factor risk

Long-Short Factor mimicking portfolios using optimization: Security weights are found by solving a general mean-variance optimization problem that maximizes exposure to the target factor and maintains zero exposure to all other factors with minimum portfolio risk.
Long-only factor portfolios using optimization: Security weights are found using the same optimization as the Long-Short portfolio, only a Long-Only constraint is added

	Average Active Ex ante Factor-to-Total Variance Ratio	Tracking Error (Benchmark = Russell 3000)	Active Factor Exposure (Targeted Factor)
Long-Short Factor Mimicking Portfolio	78%	1.0%	0.5
Long-Only Factor Portfolio	61%	1.0%	0.4

Base Case Simulations for Value Factor (December 1997 to December 2017, Value Factor Defined as Axioma USE4 Value, Annually Rebalanced, Estimation Universe = Axioma USE4 Universe, Investable Universe = Russell 3000 Constituents, Target Tracking Error = 1%)

The higher the tracking error, the lower the factor risk in a long-only portfolio

	Average Active Ex ante Factor-to-Total Variance Ratio	Tracking Error (Benchmark = Russell 3000)	Active Factor Exposure (Targeted Factor)
Tracking Error = 1% (Base Case)			
Long-Short Factor Mimicking Portfolio	78%	1.0%	0.5
Long-Only Factor Portfolio	61%	1.0%	0.4
Tracking Error = 2%			
Long-Short Factor Mimicking Portfolio	80%	2.0%	1.0
Long-Only Factor Portfolio	46%	2.0%	0.7
Tracking Error = 3%			
Long-Short Factor Mimicking Portfolio	80%	3.0%	1.5
Long-Only Factor Portfolio	33%	3.0%	0.8

Simulations for Value Factor for Varying Levels of Tracking Error (December 1997 to December 2017, Value Factor Defined as Axioma USE4 Value, Annually Rebalanced, Estimation Universe = Axioma USE4 Universe, Investable Universe = Russell 3000 Constituents)

The more misaligned the risk estimation universe is from the investable/strategy universe, the lower the factor risk

	Average Active Ex ante Factor-to-Total Variance Ratio	Tracking Error (Benchmark = Russell 3000 or Russell 1000, or S&P 500 respectively)	Active Factor Exposure (Targeted Factor)
Limited Misalignment (Base Case, Investable Universe = Russell 3000)			
Long-Short Factor Mimicking Portfolio	78%	1.0%	0.5
Long-Only Factor Portfolio	61%	1.0%	0.4
Larger Misalignment (Base Case, Investable Universe = Russell 1000)			
Long-Short Factor Mimicking Portfolio	59%	1.0%	0.4
Long-Only Factor Portfolio	46%	1.0%	0.4
Larger Misalignment (Base Case, Investable Universe = S&P 500)			
Long-Short Factor Mimicking Portfolio	38%	1.0%	0.3
Long-Only Factor Portfolio	28%	1.0%	0.3

Impact of Universe Misalignment--Simulations for Value Factor (December 1997 to December 2017, Value Factor Defined as Axioma USE4 Value, Annually Rebalanced, Estimation Universe = Axioma USE4 Universe, Investable Universe = Russell 3000 Constituents, Tracking Error = 1%)

Misalignment between “alpha” (the factor definition used for Value) and the risk model definition of Value affects factor risk

	Average Active Ex ante Factor-to-Total Variance Ratio	Tracking Error (Benchmark = Russell 3000)	Active Factor Exposure (Targeted Factor)
No Misalignment (Base Case)			
Long-Short Factor Mimicking Portfolio	78%	1.0%	0.5
Long-Only Factor Portfolio	61%	1.0%	0.4
Misaligned (Alpha as Equal Weighted Average of Value and Sales to Price)			
Long-Short Factor Mimicking Portfolio	10%	1.0%	1.0
Long-Only Factor Portfolio	32%	1.0%	0.4

Impact of Factor Definition Misalignment— Simulations for Value Factor (December 1997 to December 2017, Value “Alpha” Factor Defined as a Blend of Book-to-Price and Sales-to-Price, Annually Rebalanced, Estimation Universe = Axioma USE4 Universe, Investable Universe = Russell 3000 Constituents, Tracking Error = 1%)

Is a Higher ratio always better?

	Average Active Ex ante Factor-to-Total Variance Ratio	Tracking Error (Benchmark = Russell 3000)	Active Factor Exposure (Targeted Factor)
Long-Short Factor Mimicking Portfolio	78%	1.0%	0.5
Long-Only Factor Portfolio	61%	1.0%	0.4
Long-Only Simple Quintile Factor Portfolio	95%	13.5%	1.9

A long-only simple quintile portfolio has 95% of variance coming from factors!

Which means we should look at other measures

	Average Active Ex ante Factor-to-Total Variance Ratio	Tracking Error (Benchmark = Russell 3000)	Active Factor Exposure (Targeted Factor)	Exposure per unit of TE (Targeted Factor)	Percent of variance contribution (Targeted Factor)	Factor Efficiency Ratio
Long-Short Factor Mimicking Portfolio	78%	1.0%	0.5	51	91%	43
Long-Only Factor Portfolio	61%	1.0%	0.4	44	71%	30
Long-Only Simple Quintile Factor Portfolio	95%	13.5%	1.9	17	10%	0.4

Comparison of Portfolios with Additional Criteria—Value Factor (December 1997 to December 2017, Value Factor Defined as Axioma USE4 Value, Annually Rebalanced, Estimation Universe = Axioma USE4 Universe, Investable Universe = Russell 3000 Constituents)

In Summary

- Even pure long-short factor mimicking portfolios do not have 100% of risk coming from factors
- More importantly, factor-to-total variance ratios are misleading in that they do not reflect how much risk and return comes from the targeted factors versus the non-targeted factors
- Other metrics such as exposure per unit of TE, percent of variance contribution, and the factor efficiency ratio are needed to understand how much exposure the portfolio has to the targeted factor and how much risk comes from the latter

Questions about Factor Portfolios, some (sort of) answered, some not…

- What is the best way to combine factors—bottom up vs top down?
- How should we weight factors? Can we time factors?
- How should we calibrate constraints--concentration, exposure, country/sector/holdings constraints, investability constraints?
- How big a problem is misalignment between factors in the “alpha” term and in the risk model, and how to correct?
- Best way to do factor attribution, how to interpret?
- And of course, do factors still work? When will Value bounce back, if ever?

Questions?

THANK YOU!

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For More Information

“Clash of the Titans: Factor Portfolios vs Alternative Weighting Schemes”, Journal of Portfolio Management QES Issue 2019, Jennifer Bender, Thomas Blackburn, and Xiaole Sun

“Country and Sector Bets: Should They Be Neutralized in Global Factor Portfolios?” Journal of Index Investing 2019, Jennifer Bender, Rehan Mohamed, and Xiaole Sun

“A Closer Look at the Factor-to-Specific Risk Ratio in Factor Portfolios” Journal of Portfolio Management, forthcoming, Jennifer Bender and Xiaole Sun