Multi-Factor Design

Part 2: Keep a Handle on Trading Costs

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Webinar Series Outline

1. What Matters in Multi-Factor Investing?
   – Business case for multi-factor investing – academic framework
   – Critical review of evidence for popular factors
2. Ignored Risks of Factor Investing
3. Multifactor Design, Part 1 – Mixing vs. Integrating
4. Multifactor Design, Part 2 – Keep a Handle on Trading Costs
5. Issues in ESG Integration

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Multi-Factor Design

Part 2: Keep a Handle on Trading Costs

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Traditional Passive Index Funds Have Many Compelling Features

» In the beginning, index funds were derided as “un-American,” but in time investors came to appreciate these features

» Funds that track cap-weighted indices benefit from:

- High liquidity and capacity *
- Broad market participation *
- Low turnover and trading costs *
- Transparent portfolios
- Low fees
- A track record of beating active managers most of the time

* *Not so fast… as we will see!*

We Can Quantify the Cost of Buy High, Sell Low

- » Additions outperform the market and discretionary deletions lag the market between announcement date and effective date
- » This performance starts reversing about a week after the effective date

Relative to Market Performance of S&P 500 Additions and Discretionary Deletions, Oct 1989 - 2017

- » Deletions beat additions by over 20% in the year after an index change
- » Hidden costs of buy high, sell low are about $19B per year as of 2016

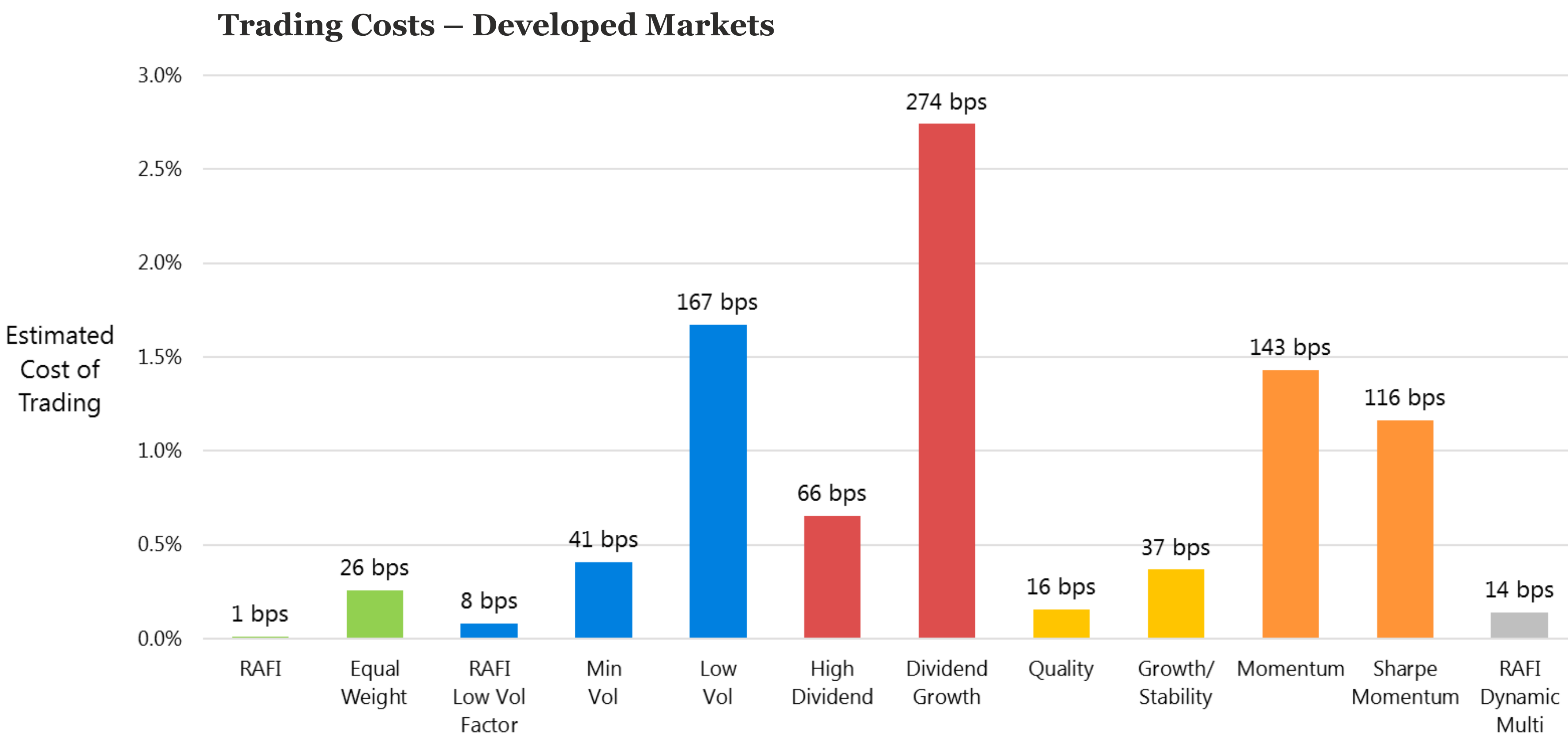
Source: Research Affiliates, LLC, using Siblis Research and CRSP.

What Are Trading Costs?

- Explicit trading costs – how much strategy lags the index
  - Easy to observe
  - Usually insignificant for skilled implementers

- Implicit trading costs – trading costs imbedded in the index performance due to impact on stock price from index-related trades
  - Not directly observable
  - Usually quite significant while hidden in the index performance
  - Grows with the amount of assets tracking the index

Poor Index Design Can Lead to High Costs



https://interactive.researchaffiliates.com/smart-beta.html

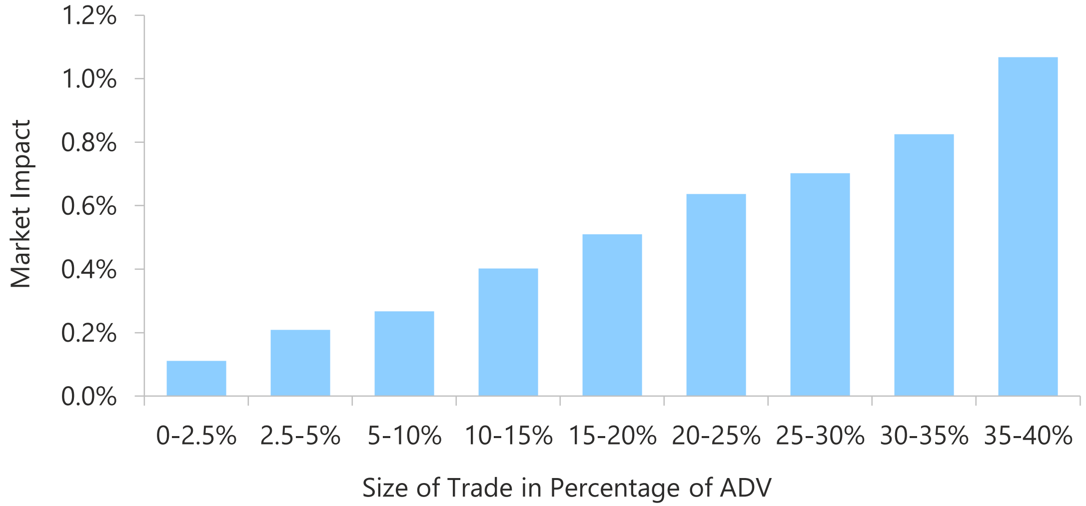
Source: Research Affiliates, LLC, using data from CRSP/Compustat and Datascope/Worldstream as of 9/30/2018. Annualized trading costs are estimated as the market impact of transactions, assuming $10B in AUM. For descriptions of the strategies shown, please see https://interactive.researchaffiliates.com/smart-beta.html. Strategy returns and characteristics are simulated. Please see important information at the end of this presentation regarding simulated data.

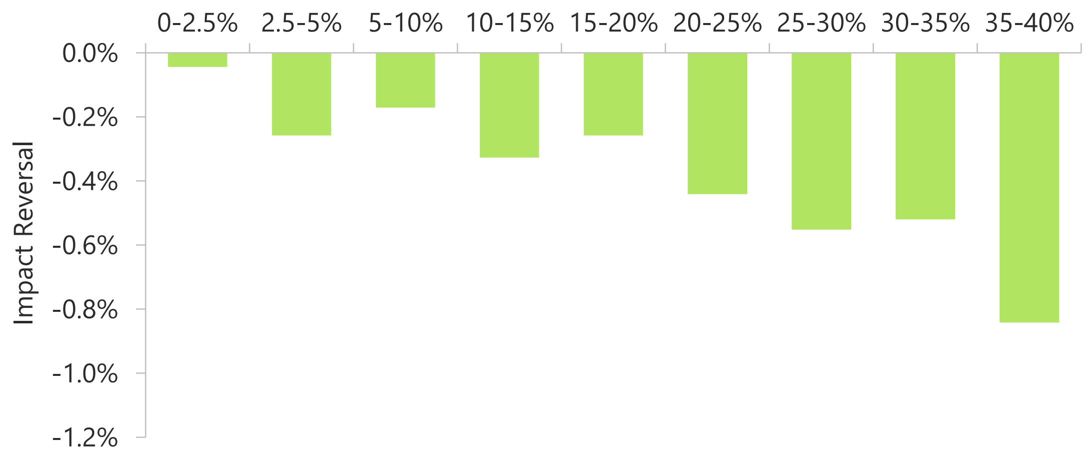
What Should Investors Pay Attention To?

» Assumptions

- » Trading costs arise from temporary price impact created from buying/selling securities
- » Price impact is proportional to percentage of ADV bought/sold
- » Volume on rebalance days are assumed to be equal to ADV
- » Maximum impact per trade is capped at 2%

Average Market Impact vs. Trade Size



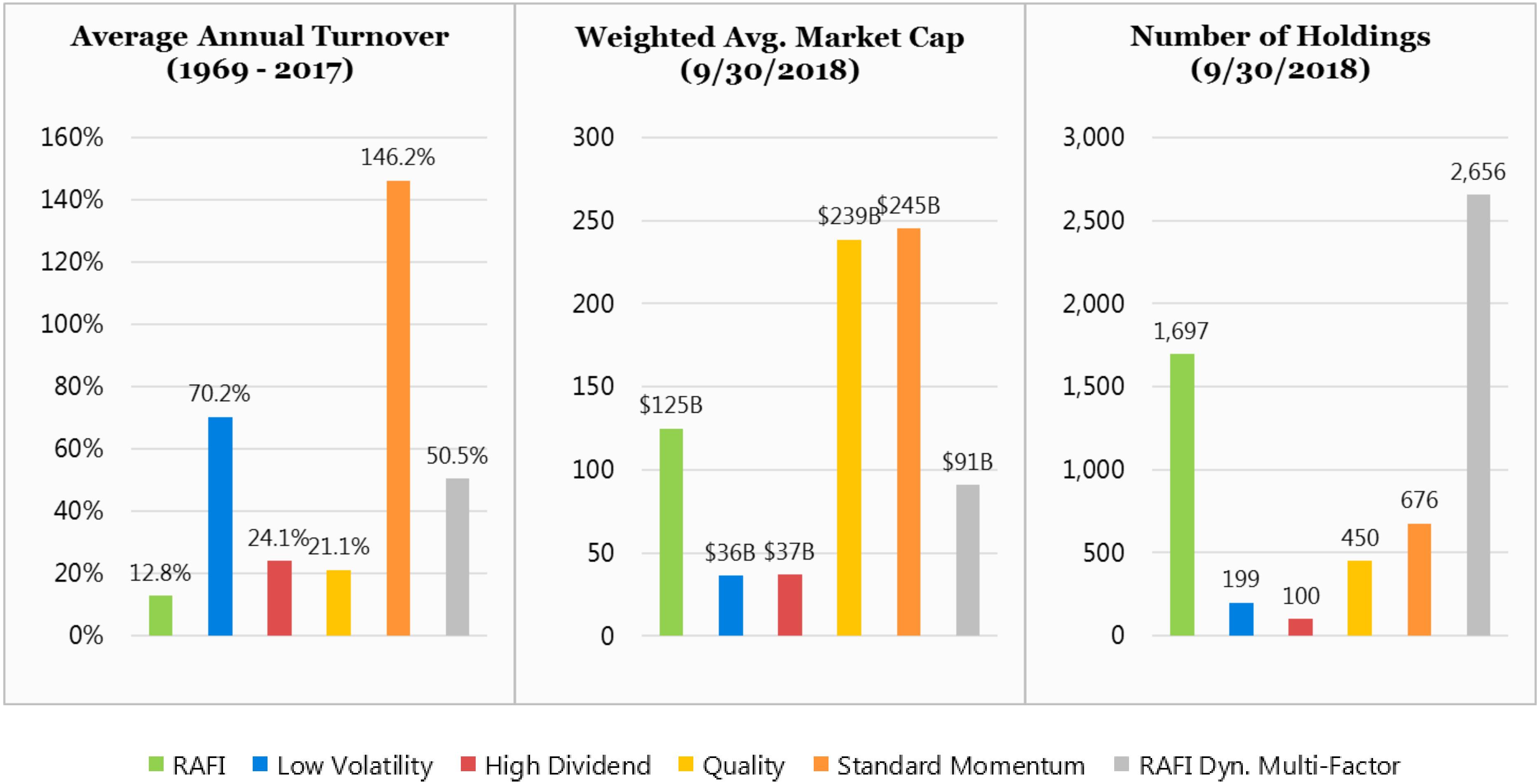


Average Impact Reversal vs. Trade Size

Source: Research Affiliates, LLC. Measured for 25,000 trades for all geographies from the period 2010–2013 using the FTSE RAFI™ Index Series. Average Impact Reversal vs. Trade Size is measured for the three trading days following index reconstitution.

Alternative Sanity Check

Characteristics That Affect Trading Costs – Developed Markets



Source: Research Affiliates, LLC, based on data from CRSP/Compustat. For descriptions of the strategies shown, please see https://interactive.researchaffiliates.com/smart-beta.html. Strategy returns and characteristics are simulated. Please see important information at the end of this presentation regarding simulated data.

Thoughtful Implementation

Differences of Weighting Schemes

Performance of Factor Strategies – Developed Markets

Strategy	Weighting Methodology	Value Added	Trading Cost	Turnover	Tracking Error
Value	**Fundamental**	**2.68%**	**0.29%**	**32%**	**6.83%**
	Equal Weight	2.35%	0.57%	37%	6.14%
	Equal Risk	2.40%	0.52%	35%	6.46%
	Max Decorrelation	2.54%	0.71%	41%	5.91%
	Market Cap	1.70%	0.24%	29%	5.49%
Quality	**Fundamental**	**2.27%**	**0.75%**	**47%**	**5.27%**
	Equal Weight	2.20%	1.19%	55%	4.31%
	Equal Risk	2.28%	1.20%	53%	4.95%
	Max Decorrelation	1.81%	1.41%	57%	4.63%
	Market Cap	0.61%	0.70%	46%	3.88%
Low Volatility	**Fundamental**	**1.68%**	**0.75%**	**42%**	**7.86%**
	Equal Weight	2.65%	1.24%	47%	7.60%
	Equal Risk	2.58%	1.11%	43%	8.27%
	Max Decorrelation	2.43%	1.48%	52%	7.90%
	Market Cap	1.17%	0.58%	42%	6.80%

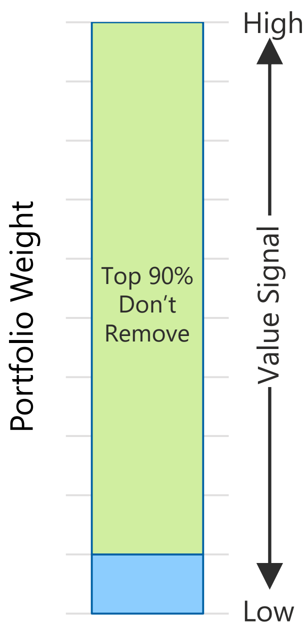
Strategy	Weighting Methodology	Value Added	Trading Cost	Turnover	Tracking Error
Momentum	**Fundamental**	**1.68%**	**4.91%**	**189%**	**7.02%**
	Equal Weight	1.93%	5.28%	173%	8.77%
	Equal Risk	1.35%	5.77%	182%	7.61%
	Max Decorrelation	1.75%	6.19%	188%	7.66%
	Market Cap	1.29%	3.59%	160%	8.07%
Size	**Fundamental**	**2.60%**	**0.27%**	**28%**	**6.24%**
	Equal Weight	0.95%	0.28%	29%	4.56%
	Equal Risk	1.51%	0.26%	27%	5.15%
	Max Decorrelation	1.34%	0.39%	35%	4.85%
	Market Cap	0.83%	0.19%	23%	3.75%
5-Factor	**Fundamental**	**2.52%**	**0.18%**	**54%**	**5.01%**
	Equal Weight	1.82%	0.25%	50%	4.17%
	Equal Risk	1.98%	0.24%	49%	4.93%
	Max Decorrelation	1.96%	0.31%	56%	4.44%
	Market Cap	1.25%	0.14%	49%	2.49%

Source: Research Affiliates, LLC, using data from CRSP/Compustat and Datascope/Worldstream from 4/1985-11/2018. Strategies shown are long-only strategies for developed market region. Strategies are created using the most common academic definition (e.g. price-to-book is used to create the value factor). Value added is shown prior to trading costs. The data published herein are simulated. Please see important information at the end of this presentation regarding simulated data.

Thoughtful Design to Control Transaction Costs

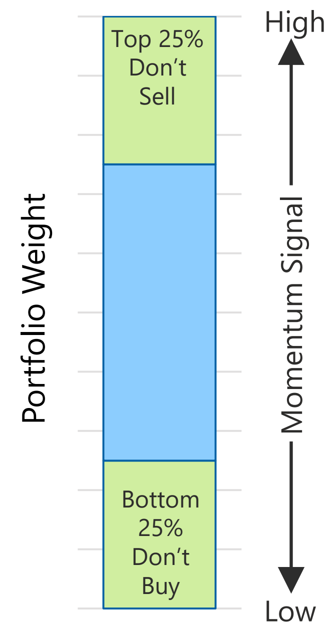
Example: Value Factor Index

Turnover Control



1. Rank existing portfolio by value signal (RAFI/Cap).
2. Replace bottom 10% of portfolio with new constituents.

Momentum Filtering

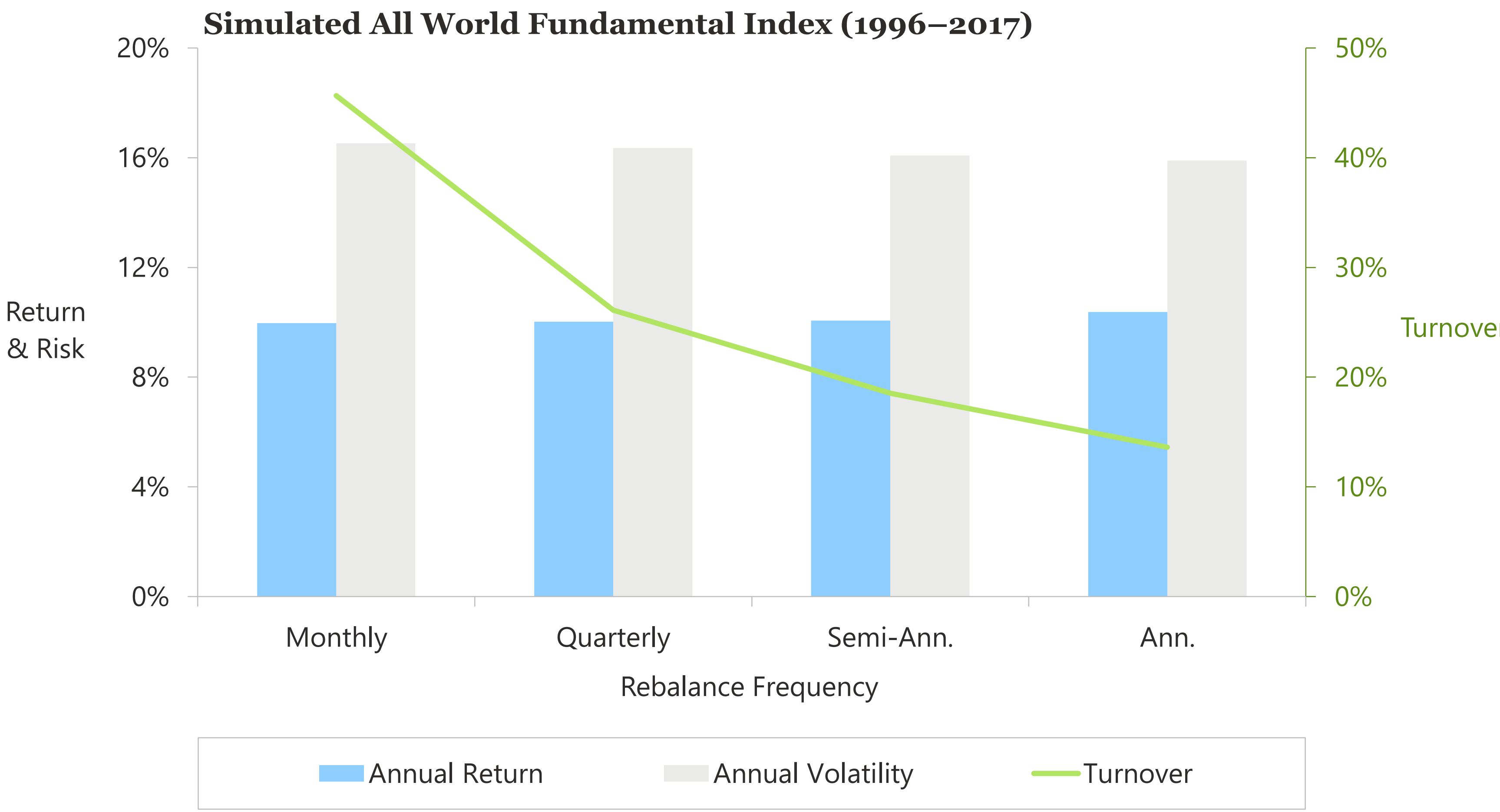


1. With new names added, rank Value Factor Index by momentum.
2. Do not sell high-momentum stocks while they're soaring.
3. Do not buy low-momentum stocks while they're in free fall.
4. Rebalance the middle 50% back to fundamental weights.

Characteristics	Without Turnover Control & Momentum Trade Filtering	With Turnover Control	With Turnover Control & Momentum Trade Filtering
Annual One-Way Turnover	36.9%	26.0%	20.0%
Estimated Transaction Costs	19bps	11bps	9bps

Source: Research Affiliates, LLC, using data from Worldscope, and Datastream. Turnover and transaction costs are estimated for the period 5/1987– 9/2016 for RAFI Value Factor US Index. Estimated transaction costs assume $5B in AUM. The index data published herein are simulated. Please see important information at the end of this presentation regarding simulated data.

Is Your Strategy Rebalancing Too Often?



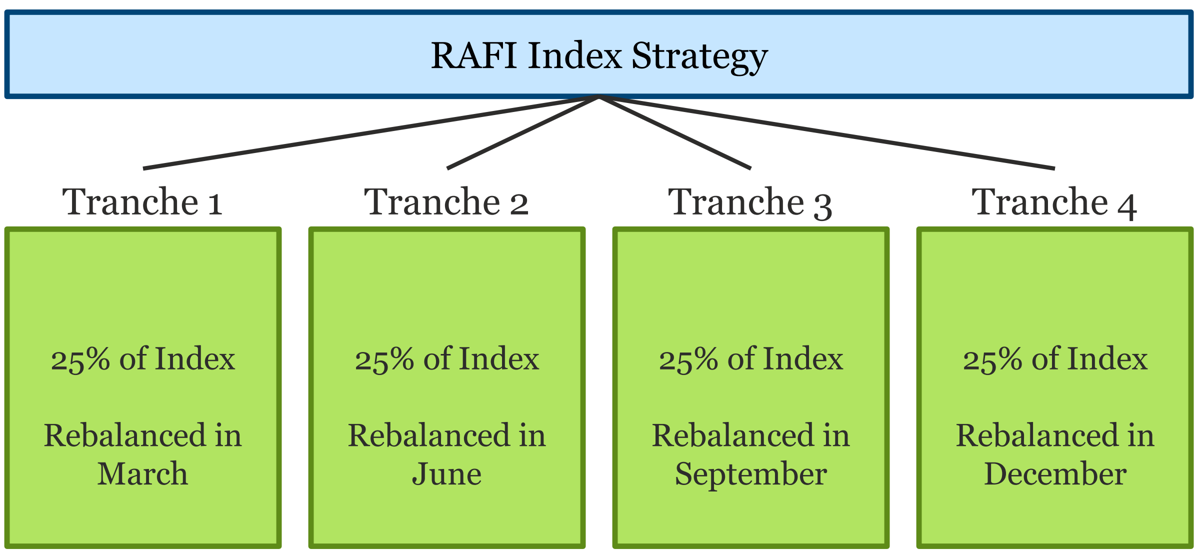
Frequent rebalancing increases costs without improving returns or lowering volatility!

Source: Research Affiliates, LLC, based on data from CRSP/CompuStat. Return and Volatility figures are annualized. Turnover figures are one-way. Strategy shown is simulated using FTSE RAFI methodology. Please see important information at the end of this presentation regarding simulated data.

The Balancing Act of Staggered Rebalancing

- Annual rebalancing often leads to larger trade sizes vs. more frequent rebalancing — increasing costs!
- Instead, the strategy can be separated into four tranches where:
  - Fundamental weights are recalculated annually, but implemented quarterly
  - Sub-index weights are rebalanced to new weights once a year
  - Entry point risk is decreased versus single, annual rebalance
  - Costs decrease and capacity increases

Quarterly Staggered Rebalance (QSR) Portfolio



For illustrative purposes only.

The Trade-Off in Multi-Factor

Theoretical Factor Returns Are Robust

Strategy	Absolute Performance			Relative Performance		
	Return	Volatility	SR	Value-Add	TE	IR
Market	11.01%	15.5%	0.40	--	--	--
Value	13.50%	18.5%	0.47	2.49%	9.49%	0.26
Low Beta	13.23%	12.3%	0.69	2.22%	8.71%	0.25
Profitability	11.29%	14.9%	0.44	0.28%	3.23%	0.09
Investment	13.56%	15.3%	0.57	2.55%	5.08%	0.50
Momentum	12.65%	17.2%	0.46	1.64%	6.46%	0.25

Source: Li and Shim, "Trade-Off in Multi-Factor Smart Beta Investing: Factor Premium and Implementation Cost," *Journal of Portfolio Management* (Forthcoming). The index data published herein are simulated for the US market from 1973-2017. Please see important information at the end of this presentation regarding simulated data.

Trading Costs Are Material

Strategy	Number of Stocks	WAMC ($B)	Turnover	Trading Cost (at $1B)	Trading Cost (at $5B)	Trading Cost (at $10B)	Capacity ($B)
Market	3,154	148.7	4.6%	0.00%	0.01%	0.02%	248.6
Value	154	136.4	46.0%	0.06%	0.30%	0.60%	8.0
Low Beta	277	37.9	57.8%	0.18%	0.89%	1.78%	3.0
Profitability	320	189.2	16.7%	0.02%	0.10%	0.20%	24.4
Investment	201	89.4	67.3%	0.13%	0.66%	1.32%	3.7
Momentum	258	112.4	160.4%	**0.28%**	**1.38%**	**2.77%**	1.9

Source: Li and Shim, "Trade-Off in Multi-Factor Smart Beta Investing: Factor Premium and Implementation Cost," *Journal of Portfolio Management* (Forthcoming). The index data published herein are simulated for the US market from 1973-2017. Please see important information at the end of this presentation regarding simulated data.

The Consequences of Cherry-Picking Factors

Strategy	Absolute Performance						Relative Performance					
	Return	Vol	Sharpe Ratio	After-Cost Sharpe Ratio			Value-Add	TE	IR	After-Cost IR		
				(at $1B)	(at $5B)	(at $10B)				(at $1B)	(at $5B)	(at $10B)
Market	11.01%	15.5%	0.40	0.40	0.40	0.40	--	--	--	--	--	--
4 Factors	13.10%	14.3%	0.58	0.58	0.57	0.56	2.10%	4.29%	0.49	0.48	0.45	0.42
4 Factors + Mom	13.09%	14.6%	0.57	0.57	0.56	0.55	2.08%	3.46%	0.60	0.59	0.56	0.52

» The benefits of harder-to-implement factors can be captured by combining them with easier-to-implement ones

Source: Li and Shim, "Trade-Off in Multi-Factor Smart Beta Investing: Factor Premium and Implementation Cost," *Journal of Portfolio Management* (Forthcoming). The index data published herein are simulated for the US market from 1973-2017. Please see important information at the end of this presentation regarding simulated data.

Conclusion and Further Reading

» Poor index design can lead to high trading costs for investors

» Thoughtful implementation can mitigate costs
  - Using weighting schemes that promote liquidity
  - Employing turnover control mechanisms
  - Staggering rebalancing

» A well-constructed multi-factor approach can help investors capture the benefits of harder-to-implement factors without the associated costs

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