Rebalancing: The Achilles' Heel of Conventional Indexing

By Rob Arnott, Chris Brightman, Vitali Kalesnik, and Lillian Wu

research affiliates™

RAFI Indices™
THE INDEX COMPANY OF RESEARCH AFFILIATES

Signatory of:
PRI Principles for Responsible Investment

The Genesis of Indexation

- The first index funds appeared in 1973.
  - Response to mounting evidence that a majority of active funds underperformed after fees.
  - Institutional product offered by Dean LeBaron and Bill Fouse.
  - Jack Bogle launched Vanguard 500 for retail investors.

The Genesis of Indexation

- The first index funds appeared in 1973.
- The Efficient Market Hypothesis and CAPM support indexing.
  - EMH assumes that current prices reflect all available information. Why bother picking stocks if you can't win?
    - › *If markets aren't efficient, a thoughtful investor can win.*
  - Capital asset pricing model (CAPM) demonstrates that the cap-weighted market portfolio can't be beat on a risk-adjusted basis.
    - › *Probably true, given some heroic – and false – assumptions.*
  - As these models gained popularity in academic circles.[1] Indexing was increasingly adopted as a portfolio management technique.
    - › *Other weighting schemes weren't even tried because cap-weight was "proven" to be correct.*

[1]The CAPM was developed independently by Jack Treynor (1961, 1962), William Sharpe (1964), John Lintner (1965a, b), and Jan Mossin (1966). Their work builds on the earlier work on diversification and modern portfolio theory done by Harry Markowitz. For their contribution to economic sciences, Sharpe and Markowitz received jointly with Merton Miller the 1990 Nobel Memorial Prize in Economics.

The Genesis of Indexation

- The first index funds appeared in 1973.
- The Efficient Market Hypothesis and CAPM support indexing.
- As indexing gained assets, performance that differed from the benchmark has been taken as evidence of sloppy implementation.
  - This led to an obsession with tracking error.
  - For many managers, tracking error trumps alpha, even to the point of shunning any quest for alpha, which is seen as folly.

The Genesis of Indexation

- The first index funds appeared in 1973.
- The Efficient Market Hypothesis and CAPM support indexing .
- As indexing gained assets, performance that differed from the benchmark has been taken as evidence of sloppy implementation.
- As indexers crowd their trading into the “effective date” for any index change, they move share prices… a lot.
  - Index providers began to provide a “grace period” in which these trading costs also impact index performance.
  - The trading costs became hidden.

The Genesis of Indexation

- The first index funds appeared in 1973.
- The Efficient Market Hypothesis and CAPM support indexing.
- As indexing gained assets, performance that differed from the benchmark has been taken as evidence of sloppy implementation.
- As indexers crowd their trading into the "effective date" for any index change, they move share prices… a lot.
- Any indexer who wants to beat the market, hence their peers, can do so with some surprisingly simple expedients.
  - Two Achilles' heels of indexing: *weighting and rebalancing.*
  - To win, we must accept modest tracking error, hence periods of modest underperformance.
  - Any indexer who pursues these expedients will occasionally need a bit of patience to win, as will their clients.

Sharpe's "Arithmetic of Active Management"

- Index funds own the market portfolio.
- Take them out of the market and what's left is the same portfolio.
  - This is collectively owned by active managers and individual investors.

Sharpe's "Arithmetic of Active Management"

- Index funds own the market portfolio.
- Take them out of the market and what's left is the same portfolio.
- So, index funds and active managers have the same gross performance.
  - Before fees and trading costs!!
  - Because indexers have lower fees and much lower turnover, the indexers therefore must win for the end customer.

Sharpe's "Arithmetic of Active Management"

- Index funds own the market portfolio.
- Take them out of the market and what's left is the same portfolio.
- So, index funds and active managers have the same performance.
- What's the empirical evidence?

Source: Research Affiliates, LLC, using data from Morningstar Direct. Performance measured from 1993–Dec 2017.

Sharpe's "Arithmetic of Active Management"

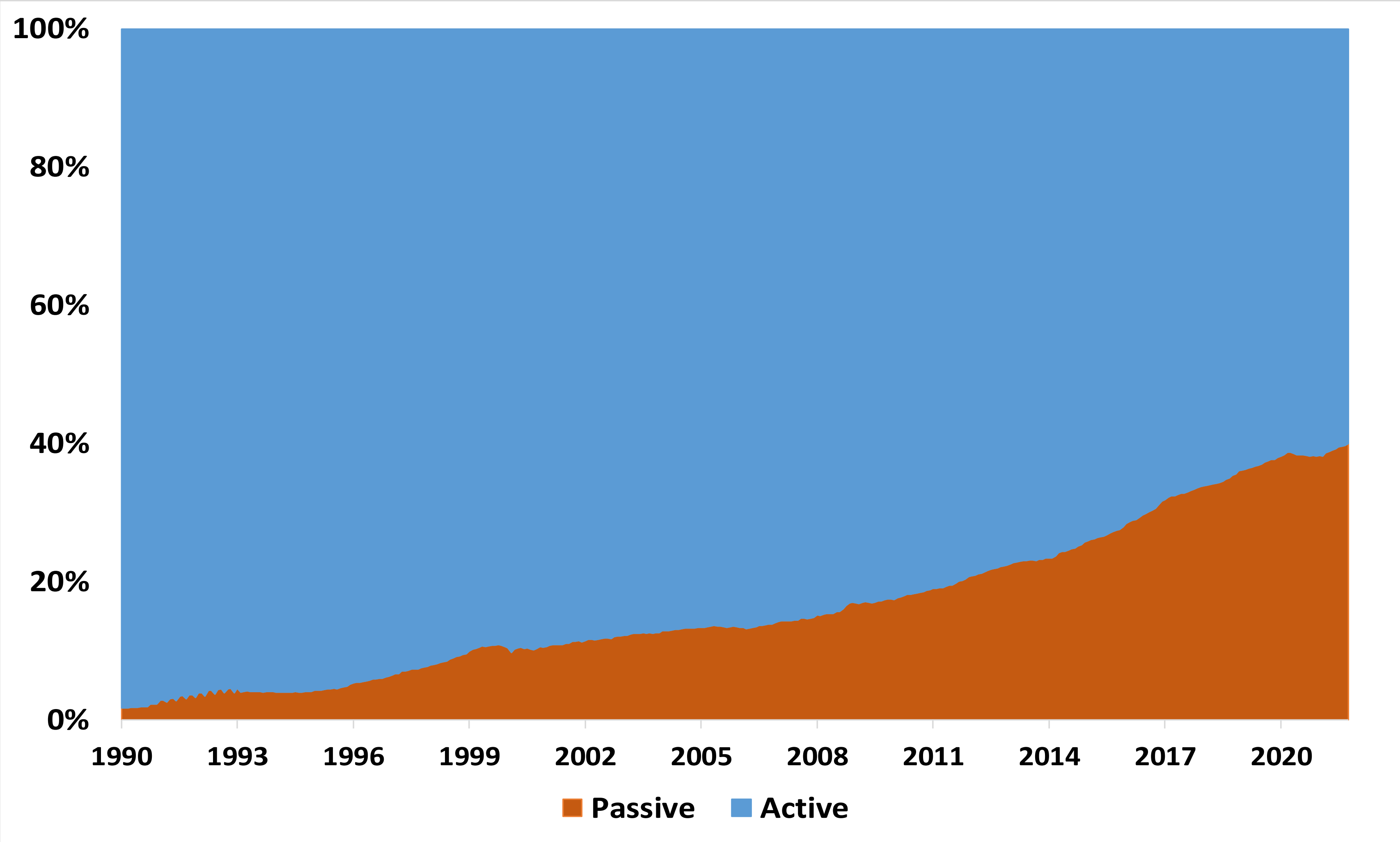
- Index funds own the market portfolio.
- Take them out of the market and what's left is the same portfolio.
- So, index funds and active managers have the same performance.
- What's the empirical evidence?

Fund Type	No. of Funds	(No. of ETFs)	Annualized Excess Return: Gross-of-Fees	Annualized Excess Return: Net-of-Fees
All Funds	4,254	(354)	-0.2%	-1.4%
Mutual Funds	3,900	(0)	-0.3%	-1.5%
ETFs	354	(354)	0.3%	-0.1%
Active	3,704	(31)	-0.3%	-1.6%
Passive	338	(151)	0.1%	-0.4%
Vanguard 500	1	(0)	0.1%	-0.1%
All Others	337	(151)	0.1%	-0.4%

- Before fees they match, after fees passive wins, ETFs beat funds.

Source: Research Affiliates, LLC, using data from Morningstar Direct. Performance measured from 1993–Dec 2017.

Extensive Passive Proliferation in the Last 30 Years



Source: Research Affiliates based on Morningstar data. The chart displays the share of index funds among US mutual funds classified by Morningstar active and index funds.

Traditional Passive Index Funds Have Many Compelling 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*

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

Traditional Passive Index Funds Have Many Compelling Features

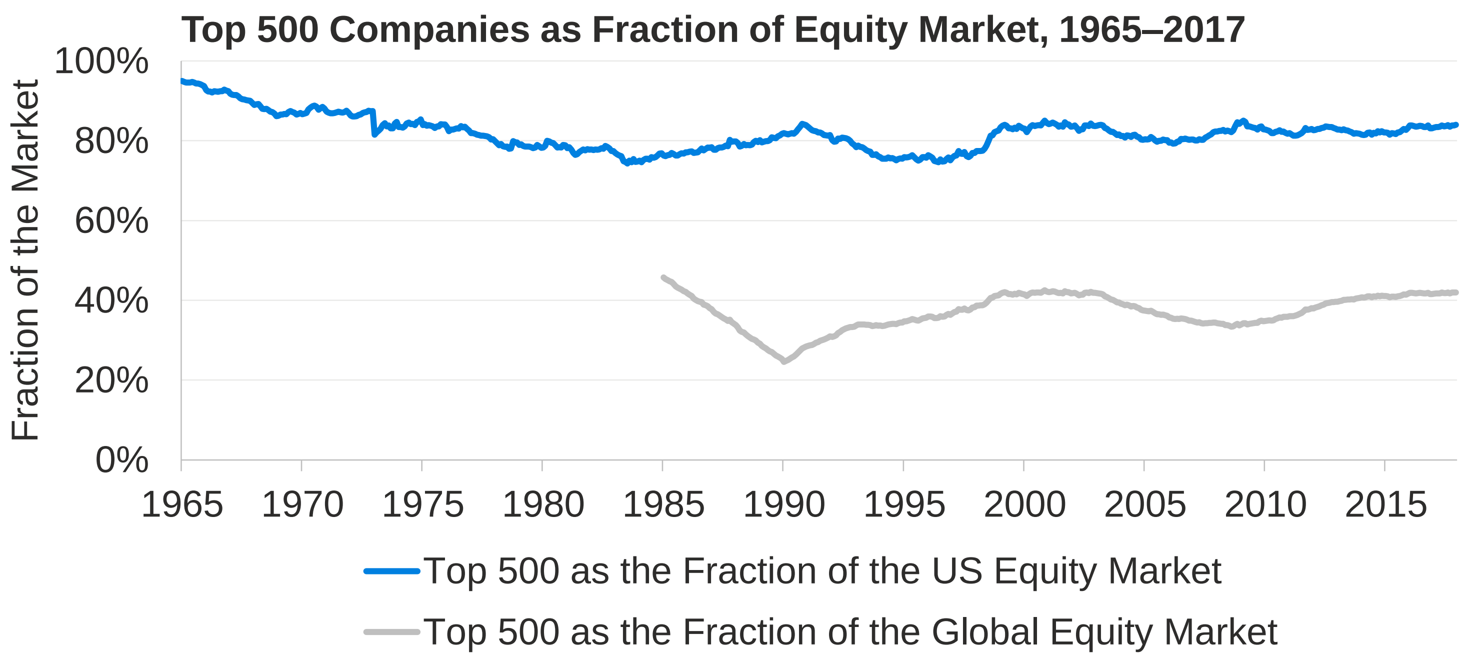
- Funds that track cap-weighted indices benefit from:
  - High liquidity and capacity*
  - Broad market participation*
  - Low turnover and trading costs*
  - Transparent portfolios
  - Low fees
  - A track record of beating active managers *most of the time*

*Not so fast … as we will see!

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

Are Markets Truly Efficient?

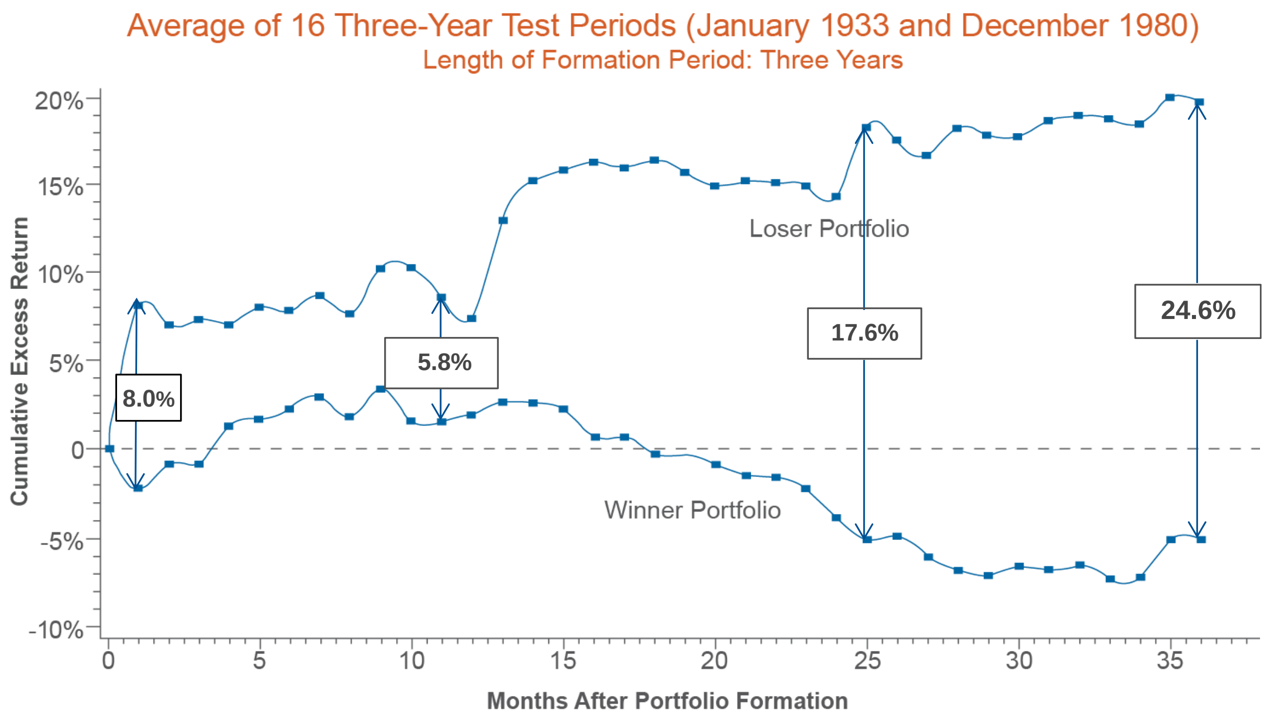
- The modern investor has many opportunities outside the largest 500 US stocks. What is the true market portfolio?
  - Smaller companies, foreign firms, non-equity asset classes, human capital, and even state-run entitlements are all theoretically part of the market.



Source: Research Affiliates, LLC, based on data from CRSP and Datastream.

But… Stock Returns May Not Be a Random Walk

- De Bondt and Thaler (1985) show that stock returns exhibit a strong pattern of reversion to the mean.



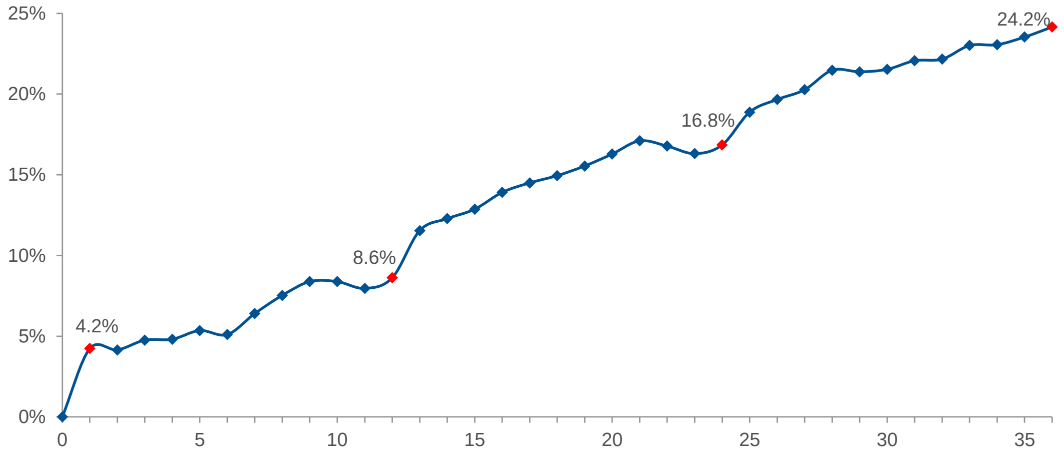
- Their work shows limited statistical significance and seasonality… the big gains are in months 1, 13, and 25. What gives?

Source: Research Affiliates LLC, based on De Bondt and Thaler (1985).

But… Stock Returns May Not Be a Random Walk

- De Bondt and Thaler (1985) show that stock returns exhibit a strong pattern of reversion to the mean.
- Their work shows limited statistical significance and seasonality… the big gains are in months 1, 13, and 25. What gives?
- They used 16 non-overlapping three calendar year samples, all starting in January… What if we use rolling 36-month spans?

Average Relative Returns, Rolling Three-Year Period, Jan 1930–Jan 2014



- Over the long run, losers beat winners… relentlessly.

Source: Research Affiliates LLC, based on De Bondt and Thaler (1985).

The “Top Dogs” Are Constantly Changing!

Since 1980, a decade-by-decade analysis shows that typically only 2 of the top 10 companies in the market remain among the largest companies 10 years later.

10 Largest Market Capitalization Stocks in the World at the Beginning of Each Year

2021	2010	2000*	1990	1980
Apple	PetroChina	Microsoft	Nippon T&T	IBM
Microsoft	Exxon Mobil	General Electric	Bank of Tokyo-Mitsubishi	AT&T
Amazon	Microsoft	NTT DoCoMo	Industrial Bank of Japan	Exxon
Alphabet	ICBC	Cisco	Sumitomo Mitsui	Standard Oil
Facebook	Wal-Mart	Wal-Mart	Toyota	Schlumberger
Tencent	China Construction Bank	Intel	Fuji Bank	Shell
Tesla	BHP Billiton	Nippon T&T	Dai-Ichi Kangyo Bank	Mobil
Alibaba	HSBC	Exxon Mobil	IBM	Atlantic Richfield
TSMC	Petrobras	Lucent	UFJ Bank	General Electric
Berkshire Hathaway	Apple	Deutsche Telekom	Exxon	Eastman Kodak

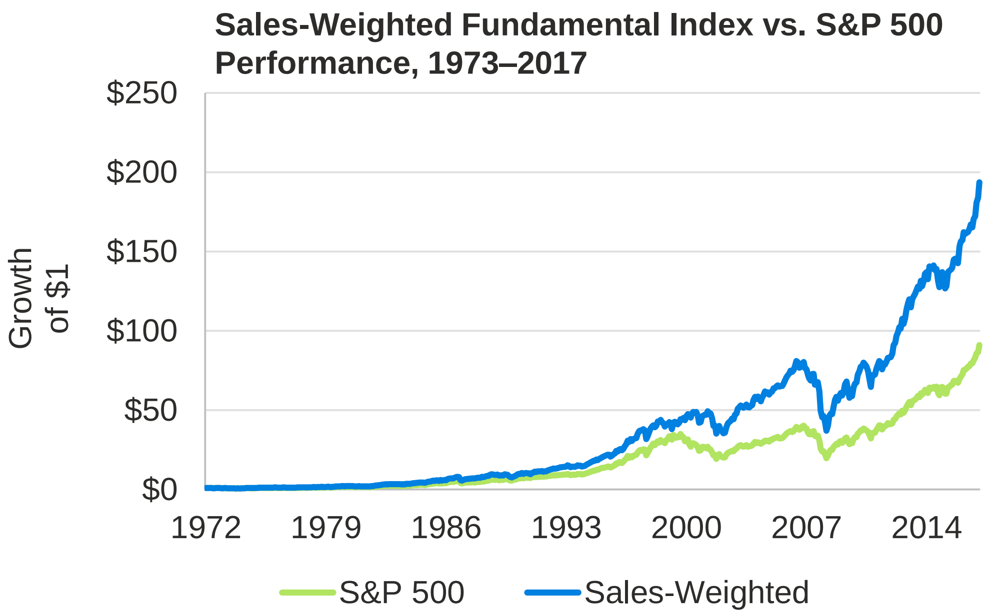
Legend: New Addition | Drops Next Period | Flip-Flop: New Then Drops

US | Europe | Emerging Markets | Japan & Australia

*Year 2000 represents holdings as of March, three months late.
Source: Research Affiliates, LLC, using data from Financial Times, Wikipedia, and Gavekal Research. Rankings shown represent beginning-of-year rankings.

A Thought Experiment

- The Fortune 500 – the largest companies by sales – introduced in 1954.
- The S&P 500 – 500 of the largest companies by market cap – in 1957.
- What if Fortune had introduced the Fortune 500 *index* in 1954?
  - It would naturally have been weighted by sales, not market cap!
- What if index funds were introduced in 1973?
  - They would naturally have tracked the Fortune 500, not the S&P!



Source: Research Affiliates, LLC, based on data from Compustat, CRSP, and S&P official website.

What Is Overlooked About Index Funds?

The trading of index funds – <u>and they do trade</u> – is very, very expensive.

They buy high and sell low!

Their largest holdings are the most expensive.

Each of these problems is an opportunity, too!

Broad Market Indices Were Not Designed to Be Investment Strategies

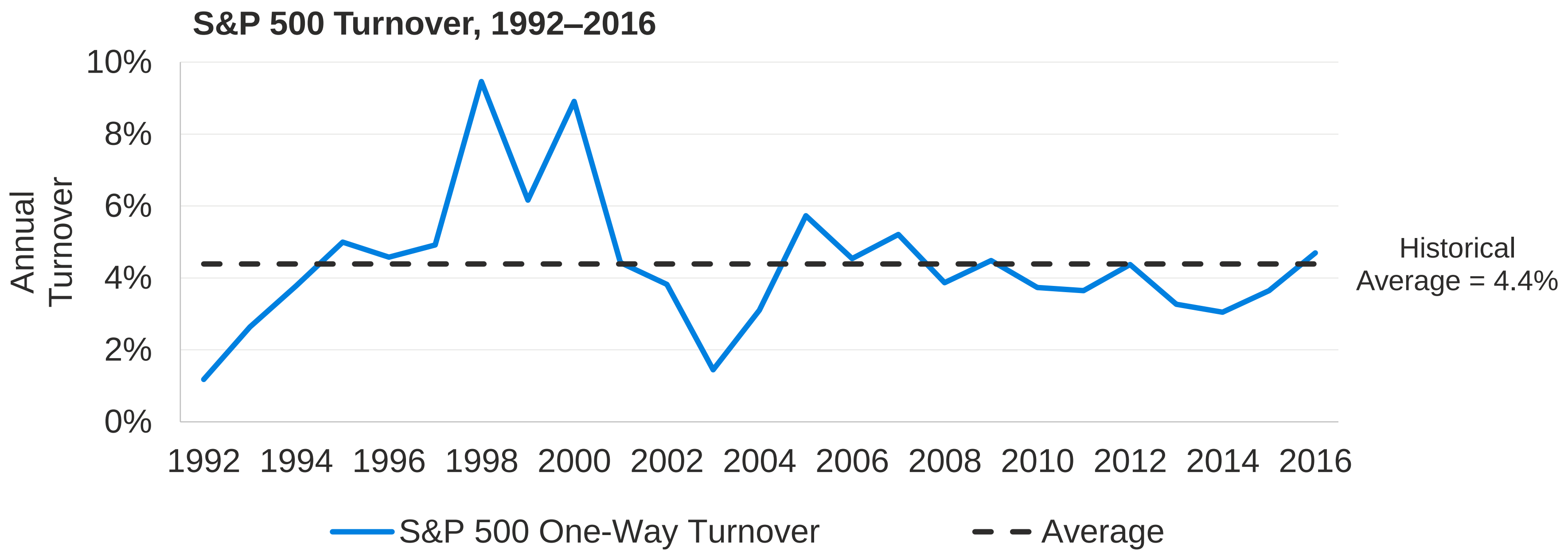
What Was the Original Purpose of Indices?

- Broad market indices were not originally intended to be used as investment strategies.
- They were created with one simple purpose—to measure the performance of the broad stock market.
- Today the largest mutual funds and ETFs are all index funds tracking cap-weighted broad market indices.

Fund Type	Total Net Assets (USD Million)
Vanguard TSM Index	$1,260,000
Vanguard 500 Index	$750,410
SPDR S&P 500 ETF	$374,030
iShares:Core S&P 500	$294,950
Vanguard Instl Index	$287,800

Source: Lipper Performance Report as of February 2018.

Cap-Weighted Index Funds Trade *Significantly*!



- S&P 500 historical average one-way turnover is 4.4%, multiplied by $4.2 trillion of assets tracking the index, means that roughly $185 billion worth of stocks are being sold (and bought) every year!
- Costs are incurred between the date when a change is announced and the effective date, so the funds won't underperform the index.

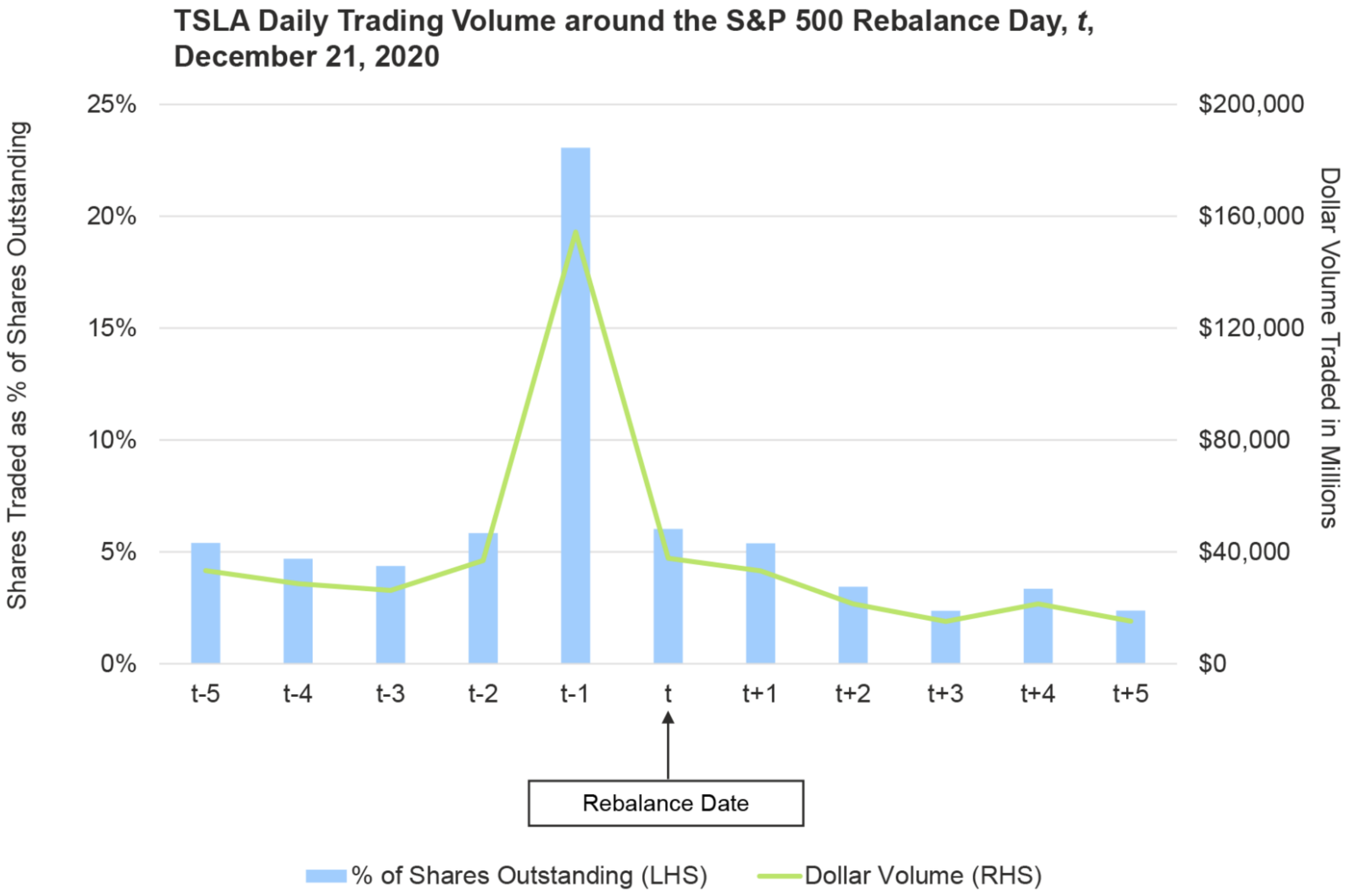
Source: Research Affiliates, LLC, using data from Standard & Poors.

S&P 500 History

- The S&P 500 was launched in 1957.
- Before October 1, 1989, changes to the index were implemented on the day of announcement.
  - Various studies from the late 1980s support evidence of a “reconstitution effect” generally attributed to the effects of temporary price pressures.
- Since October 1989, S&P began <u>*pre-announcing*</u> index changes.
  - There is now a grace period of between a week to nearly a month between the announcement date and the effective day.
  - Trading costs “disappear.”
- Busted!! Collusion to hide the true cost of index funds?!? Maybe.
  - Note: I’m not suggesting nefarious intent. I am pointing out that all trading costs are now hidden.

Trading Spikes Up on The Rebalancing Days

- The S&P 500 was launched in 1957.



Source: Research Affiliates, LLC, based on data from Bloomberg.

Classifying Index Additions and Deletions

- Using data from Siblis Research, we constructed a sample of S&P 500 historical component changes.
- Additions and deletions were classified in two ways:
  - Non-discretionary: change due to merger, spin-off, or acquisition.
  - Discretionary: change chosen by the committee.
    - 90% of additions and 39% of deletions were *discretionary.*

Date Range	Discretionary Additions	Non-Discretionary Additions	Total Additions	Discretionary Deletions	Non-Discretionary Deletions	Total Deletions
Mar 1970–Oct 1989	417	26	443	165	278	443
Oct 1989–Jun 2021	663	90	753	299	452	751
Mar 1970–Jun 2021	1080	116	1196	464	730	1194

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

How Index Funds Buy High and Sell Low

Cap-Weighting Causes Valuation Headwinds

- In the year prior to a constituent change, additions outperform discretionary deletions by nearly 65%!

Days Before Announcement	Additions	Discretionary Deletions	Non-Discretionary Deletions	Additions minus Discretionary Deletions
252 (1 year)	41.48%	-29.11%	21.29%	**70.59%**
126 (6 months)	16.35%	-18.81%	14.96%	**35.16%**
63 (1 quarter)	6.13%	-12.79%	5.74%	**18.91%**
21 (1 month)	2.13%	-6.42%	1.18%	**8.55%**
5 (1 week)	0.94%	-4.38%	-0.91%	**5.32%**
3	0.56%	-3.17%	-0.83%	**3.73%**
1	0.16%	-2.21%	-0.46%	**2.37%**

- Additions also trade at 3.5x to 6.5x higher valuations than deletions.

Type	Count	P/B	P/E	P/CF	P/S	P/D	Average
Additions	753	1.55	1.83	2.11	2.21	1.91	**1.92**
Deletions	751	0.58	0.74	0.62	0.52	0.67	**0.62**
Discretionary	299	0.42	0.53	0.45	0.34	0.50	**0.45**
Non-Discretionary	452	0.92	1.09	1.01	0.99	1.00	**1.00**
Additions Relative to Discretionary Deletions		**3.72**	**3.45**	**4.72**	**6.54**	**3.80**	**4.30**

- Buying high and selling low, indeed! So, are they worth the premium?

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

Additions Outperform After the Announcement of an Index Change but *Quickly* Fall Behind Deletions

- During "grace period," additions beat discretionary deletions by 8.7%

Relative Performance, 2010–Dec 2017

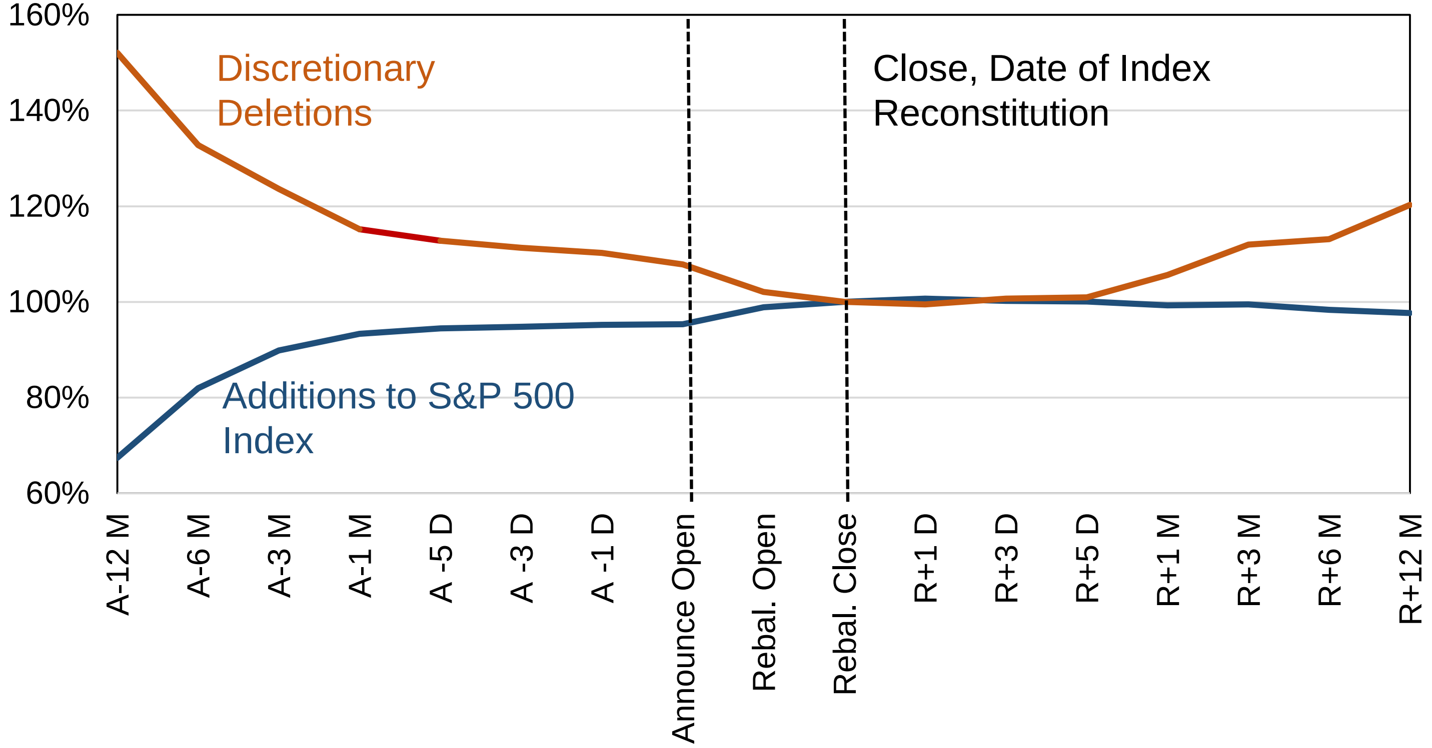
Cumulative from Announcement to Rebalancing Date	Additions	Discretionary Deletions	Non-Discretionary Deletions	Additions minus Discretionary Deletions
Exclusive of rebalancing date	3.69%	-5.31%	-0.19%	**8.99%**
Inclusive of rebalancing date	4.89%	-7.25%	-0.73%	**12.14%**

Days after Rebalancing	Additions	Discretionary Deletions	Non-Discretionary Deletions	Additions minus Discretionary Deletions
1	0.66%	-0.56%	—	**1.21%**
3	0.18%	0.70%	—	**-0.52%**
5 (1 week)	0.05%	0.94%	—	**-0.90%**
21 (1 month)	-0.70%	5.65%	—	**-6.35%**
63 (1 quarter)	-0.56%	12.00%	—	**-12.56%**
126 (6 months)	-1.68%	13.12%	—	**-14.80%**
252 (1 year)	-2.36%	20.26%	—	**-22.63%**

- Within a week, the average discretionary deletion is outpacing the average addition.

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 reverses about a week after the effective date.



- Deletions beat additions by over 20% in the year after an index change.

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

Can We Fix Indexing's Buy-High, Sell-Low Travails?

RACWI Methodology

1. Determine Relative Size of Companies in the Starting Universe Using Fundamental Measures	2. Security Selection
Fundamental size is the equally weighted average of the following four fundamental measures: • Adjusted Sales • Adjusted Cash Flow • Dividends + Buybacks • Book Value + Intangibles	• Create six regions: United States, Japan, United Kingdom, Europe ex UK, Other Developed, Emerging Markets. • Top 86% by cumulative fundamental weight constitutes large & mid company portfolios.
3. Weighting	**4. Rebalance**
• Combine the six large/mid regions by fundamental weight to create global exposure • Within each region weight securities by float-adjusted market capitalization weight.	• Portfolio is reconstituted annually on the third Friday of March.

For illustrative purposes only.
Adjusted Sales – Company sales multiplied by company equity to assets ratio averaged over the past five years.
Adjusted Cash Flow – Company operating cash flow averaged over the past five years plus company R&D expenses averaged over the past five years.
Dividends + Buybacks - Average dividends paid and share buybacks over the past five years
Book Value + Intangibles – Most recent company book value plus research capital, with research capital defined as the accumulation of depreciated R&D expenses over the past six years.

Traditional Cap-Weight Benchmarks Buy High and Sell Low

RACWI Global (2711 Names)			Standard Cap-Weight (3541 Names)
Large Fundamentals/ Small Cap-Weight			Large Cap-Weight/ Small Fundamentals

Top Holdings

RACWI Weight		Cap-Weight
4.39%	Apple	3.95%
3.94%	Microsoft	3.62%
2.63%	Alphabet	2.37%
2.28%	Amazon	2.07%

Largest in RACWI and Not Generic Cap

0.03%	Cenovus Energy	0.0%
0.03%	Diamondback Energy	0.0%
0.03%	Textron	0.0%
0.03%	Universal Music Group	0.0%

Largest in Generic Cap and not RACWI

0.0%	Shopify	0.22%
0.0%	ServiceNow	0.18%
0.0%	Sea Ltd.	0.18%
0.0%	Moderna	0.12%

For illustrative purposes only.
Note: RACWI Weights for the RACWI Global Index as of 12/31/2021. Standard Cap-Weight benchmark is a cap-weighted index created from the same global universe selected and weighted by cap-weight as of 12/31/2021.

Traditional Cap-Weight Benchmarks Buy High and Sell Low

RACWI US (486 Names)				S&P 500 (500 Names)
	RACWI Weight	**Top Holdings (9/30/2021)**	**Cap-Weight**	
Large Fundamentals/ Small Cap-Weight	6.44%	Apple	6.08%	Large Cap-Weight/ Small Fundamentals
	6.08%	Microsoft	5.80%	
	4.48%	Alphabet	4.26%	
	4.13%	Amazon	3.92%	

	Largest in RACWI and Not S&P	
0.23%	Blackstone	0.0%
0.02%	Uber	0.0%
0.02%	Waste Connections	0.0%
0.01%	Dell	0.0%

	Largest US Stocks* in S&P and Not RACWI	
0.0%	Moderna	0.23%
0.0%	ServiceNow	0.08%
0.0%	Autodesk	0.13%
0.0%	IDEXX	0.01%

* S&P 500 contains eight stocks that are no longer domiciled in the US.

For illustrative purposes only.
Note: RACWI Weights for the RACWI Global Index as of 9/30/2021. Standard Cap-Weight benchmark is a cap-weighted index created from the same global universe selected and weighted by cap-weight as of 9/30/2021.

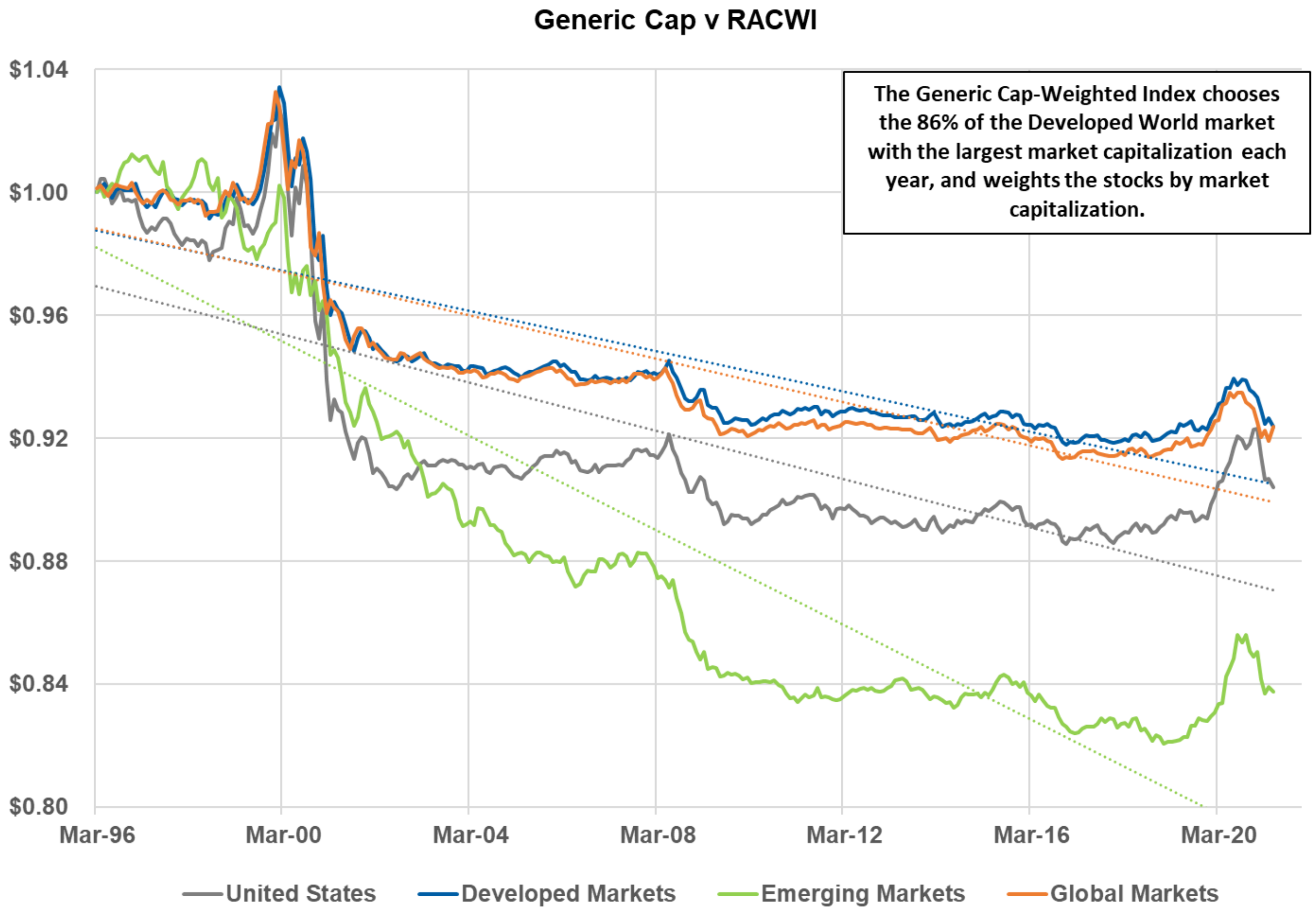
Simulation Results

	Excess Return	Tracking Error	I.R.	Turnover (Select by Cap)	Turnover (Select by RAFI)
RACWI US Large	0.27%	1.04%	0.26	5.6%	4.7%
RACWI Developed	0.40%	0.90%	0.44	6.2%	5.1%
RACWI Emerging Markets	0.63%	1.19%	0.53	11.9%	10.1%
RACWI Global Markets	0.34%	0.99%	0.34	6.3%	5.1%

- Selecting by RAFI and weighting by Cap consistently outperforms
- Minimal tracking error
- Slight reduction in turnover

The data published herein is simulated. Please see disclosures for important information regarding simulated data.
Simulation selects the top 86% by Market Capitalization or RAFI Fundamentals then weights by Market Capitalization. US history begins on 4/30/1962–6/30/2021. Developed History begins on 4/30/1984–6/30/2021. Emerging Markets History begins on 4/30/1996–6/30/2021. Global History begins on 4/30/1996–6/30/2021.
Source: RAFI Indices, LLC, based on data from Worldscope and Datastream.

How Much Do Cap-Weighted Indices Forfeit Relative to RACWI?



For illustrative purposes only.
The data published herein are simulated. Please see important information at the end of this presentation regarding simulated data.
Source: Research Affiliates, LLC, based on data from Worldscope and Datastream.

Index Characteristics & Returns

Characteristics

As of 6/30/2021	P/E	P/B	P/S	Dividend Yield	Mkt. Cap ($B USD)	Active Weight	One-Way Turnover	Capacity ($B)	Market Impact Costs (bps)
RACWI Global	25.9	2.8	2.0	1.7%	360	32.4%	5.2%	755	0.7
Cap-Weight Global	27.5	3.1	2.3	1.6%	336		6.4%	608	0.8

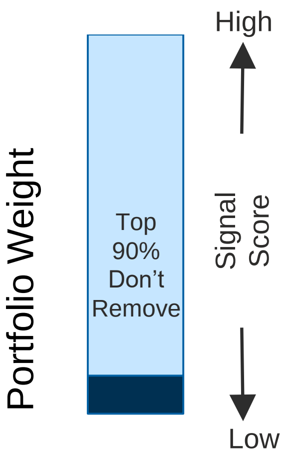
Performance

6/30/2021	1-Year	3-Year	5-Year	10-Year	Since 4/1996	Standard Deviation (4/1996)	Sharpe Ratio (4/1996)	Tracking Error (4/1996)	Information Ratio (4/1996)
RACWI Global	40.42%	14.51%	14.89%	10.32%	8.50%	15.35%	0.42	0.99%	0.34
Cap-Weight Global	39.24%	14.81%	14.99%	10.31%	8.16%	15.56%	0.39		

Source: Research Affiliates, LLC, based on data from Worldscope/Datastream. One-way turnover represents average annual turnover for the years 3/1996–3/2021. Capacity measure assumes 50bps of implementation costs due to trading while market impact cost assumes $10B of AUM in the strategy. Please see disclosures for important information regarding simulated data. Cap-Weight Global represents a simulated global market cap index.

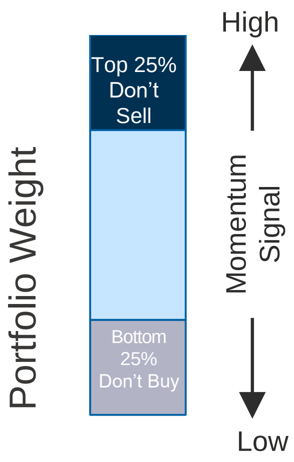
Thoughtful Implementation Can Mitigate Costs

Turnover Control



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

Momentum Filtering



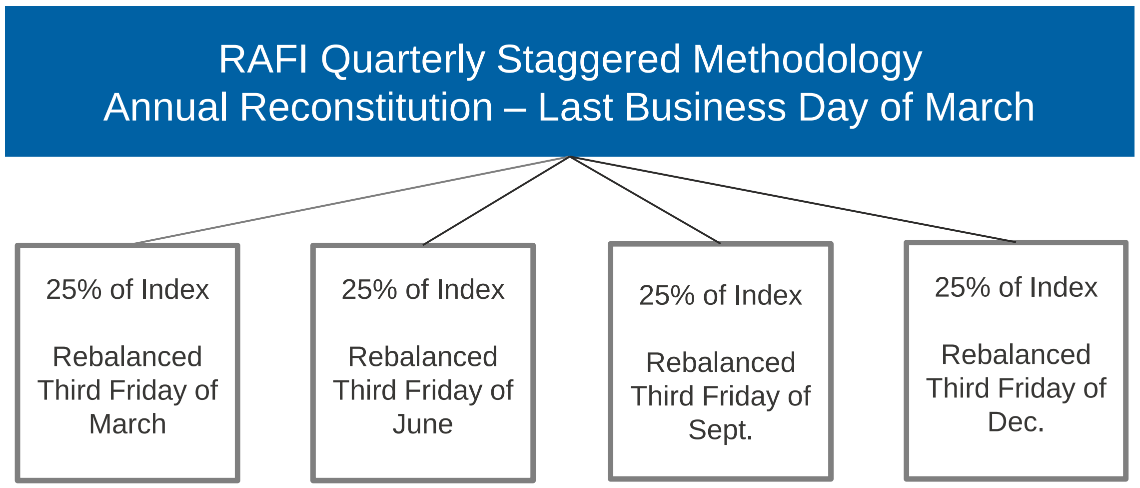
1. With new names added, rank index by momentum.
2. Do not sell high-momentum stocks while they're soaring.
3. Do not buy low-momentum stocks while they're in free-fall.
4. Rebalance the middle 50% back to fundamental weights.

Impact of Portfolio Construction Techniques – RAFI Multi-Factor Developed

Characteristics	Without Turnover Control, Momentum Trade Filtering, & QSR	Without Turnover Control & Momentum Trade Filtering	Without Momentum Trade Filtering	With All Features
Annual One-Way Turnover	58.3%	54.2%	42.8%	41.1%
Estimated Transaction Costs	10 bps	8 bps	7 bps	6 bps

For illustrative purposes only.
Source: Research Affiliates, LLC, using data from Worldscope and Datastream. Returns are calculated over the period 4/1992 – 12/2018. Turnover is estimated for the period 6/1992 – 9/2018. 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.

Quarterly Staggered Rebalancing (QSR)



- Sub-index weights rebalanced to new weights once a year
- Minimizes single, annual entry point risk
- Increases capacity

For illustrative purposes only.

Summary

- Arguments in favor of traditional passive index funds seem compelling on the surface, but indexers have their own **avoidable** travails.
  - Stocks added to the cap-weighted indices are routinely priced at a substantial premium to market valuation multiples, while discretionary deletions are routinely deep-discount value stocks.
  - The notion that index funds have near-zero trading costs is wrong.
    - *The dirty little secret: The transaction cost is still there; it is just hidden from plain view because the index is changed after the index funds are done with their trading.*

Summary

- Arguments in favor of traditional passive index funds seem compelling on the surface, but indexers have their own **avoidable** travails.
- There is abundant evidence that the addition or removal of a stock from a major index can have a significant impact on the stock's short-term performance.
  - Additions generally outperform deletions in the days prior to the effective date, but performance reverses thereafter, to a remarkable extent!

Summary

- Arguments in favor of traditional passive index funds seem compelling on the surface, but indexers have their own **avoidable** travails.
- There is abundant evidence that the addition or removal of a stock from a major index can have a significant impact on the stock's short-term performance.
- Today, index funds compete with each other over fee differences of one or two basis points while ignoring the elephant in the room: the avoidable buy-high, sell-low dynamic of the traditional indices loses investors tens of basis points in performance.

Summary

- Arguments in favor of traditional passive index funds seem compelling on the surface, but indexers have their own **avoidable** travails.
- There is abundant evidence that the addition or removal of a stock from a major index can have a significant impact on the stock's short-term performance.
- Today, index funds compete with each other over fee differences of one or two basis points while ignoring the elephant in the room: the avoidable buy-high, sell-low dynamic of the traditional indices loses investors tens of basis points in performance.
- Index funds can beat their peers by:
  - Trading well after a change is made, to allow for the likely mean reversion.
  - Engaging in "banding," deferring trades that are within a wide range of the approximate market cap cutoff.
  - Cutting exposure to the "top dogs."
    - *And these are just three of the easiest ways to add a modest reliable alpha.*
- I predict that not one of the major indexers will do any of these. They worry too much about tracking error, which has nothing to do with growing client wealth.

Q&A

Appendix: How Do the Largest Holdings of Index Funds Impact Performance?

“Top Dogs” Vanish Because They *Underperform*!

- The global top dog outpaced the global cap-weighted stock market only 5% of the time in the last 30 years.
- It delivered an annual shortfall of 10.5% per year, roughly equivalent to losing 2/3 of its value!

Performance of Largest Market Cap Stocks, 1982-2011

Type of Top Dog	Horizon	Relative Return vs. Sector, Avg Across Countries	Frequency of Win vs. Sector, Avg Across Countries
Average largest stocks in each sector across G-8 countries	1 Year	-5.3%	44%
	5 Years	-4.8%	39%
	10 Years	-5.1%	34%

	Horizon	Relative Return vs. Developed World	Frequency of Win vs. Developed World
Largest market cap stock in Developed World	1 Year	-12.5%	33%
	5 Years	-11.2%	15%
	10 Years	-10.5%	5%

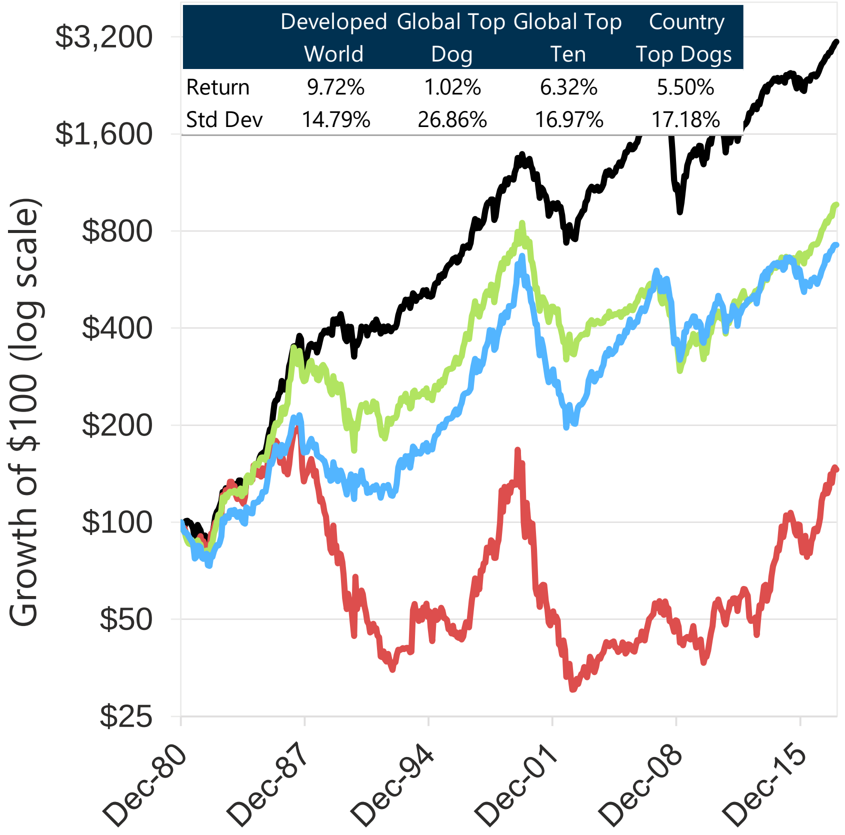
Source: “The winner’s curse: Too Big to Succeed?” by Arnott and Wu, 2012.

How Do "Top Dogs" Impact Index Performance?

- Do I want to own a portfolio in which my largest holding has a 95% likelihood of underperforming over the next 10 years? ***No!***
- We compared the performance of five different portfolios:
  - Developed World Portfolio, Cap-Weighted ("World").
  - World, excluding the single largest market-cap stock in the world.
  - World, excluding the 10 largest market-cap stocks in the world.
  - World, excluding the largest market-cap stock in each country.

Portfolios of “Top Dogs” Underperform the Market

Performance of Top Dog Portfolios



	Developed World	Global Top Dog	Global Top Ten	Country Top Dogs
Return	9.72%	1.02%	6.32%	5.50%
Std Dev	14.79%	26.86%	16.97%	17.18%

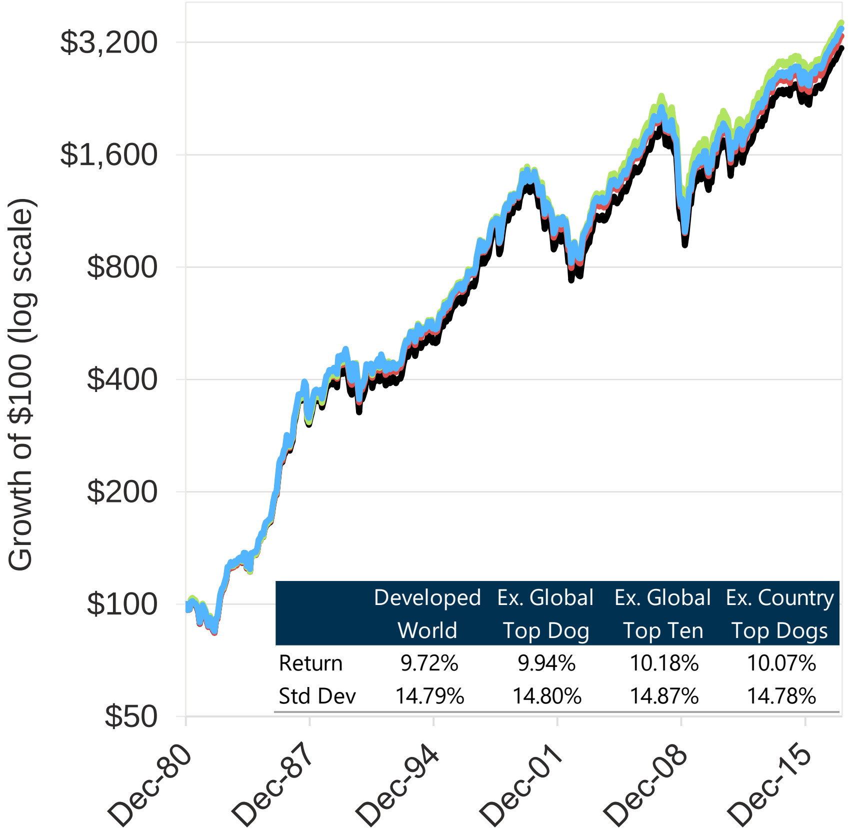
Performance Relative to Dev. World

	Global Top Dog	Global Top Ten	Country Top Dogs
Value Added	-8.70%	-3.40%	-4.22%
Avg of World Index	2.15%	11.27%	7.92%
Tracking Error	22.38%	8.99%	8.34%
Information Ratio	-38.85%	-37.78%	-50.54%

Source: Research Affiliates based on Data from Worldscope and Datastream. Data from 1980-2017.

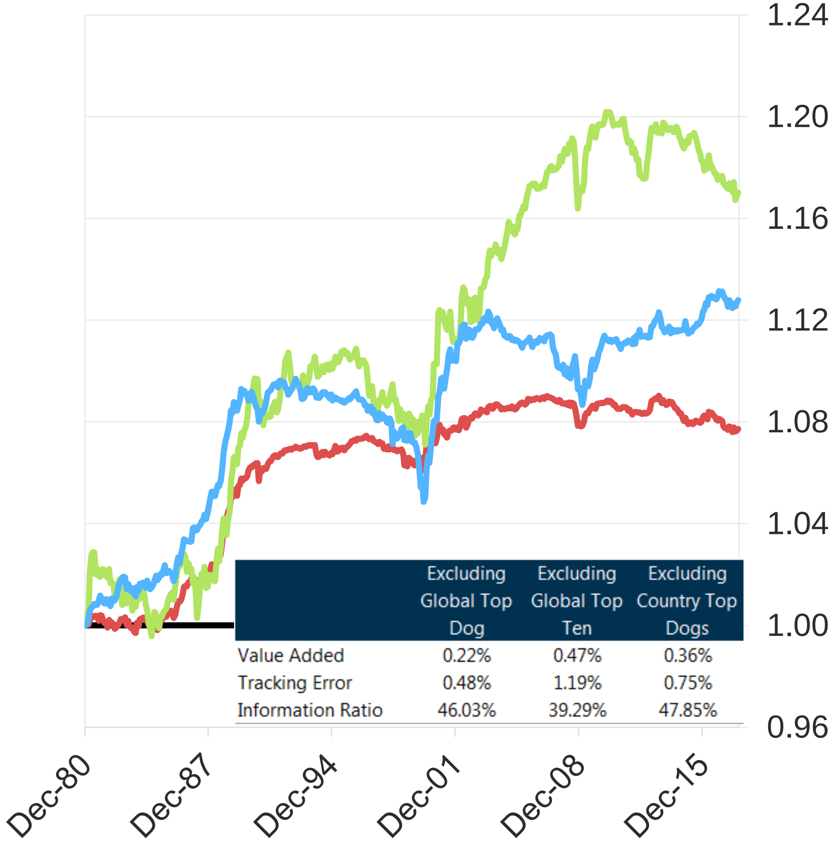
Performance Improves With Each Exclusion…
But Investors Must Be Willing to Accept Higher TE

Performance of ex. Top Dog Portfolios



	Developed World	Ex. Global Top Dog	Ex. Global Top Ten	Ex. Country Top Dogs
Return	9.72%	9.94%	10.18%	10.07%
Std Dev	14.79%	14.80%	14.87%	14.78%

Performance Relative to Dev. World



	Excluding Global Top Dog	Excluding Global Top Ten	Excluding Country Top Dogs
Value Added	0.22%	0.47%	0.36%
Tracking Error	0.48%	1.19%	0.75%
Information Ratio	46.03%	39.29%	47.85%

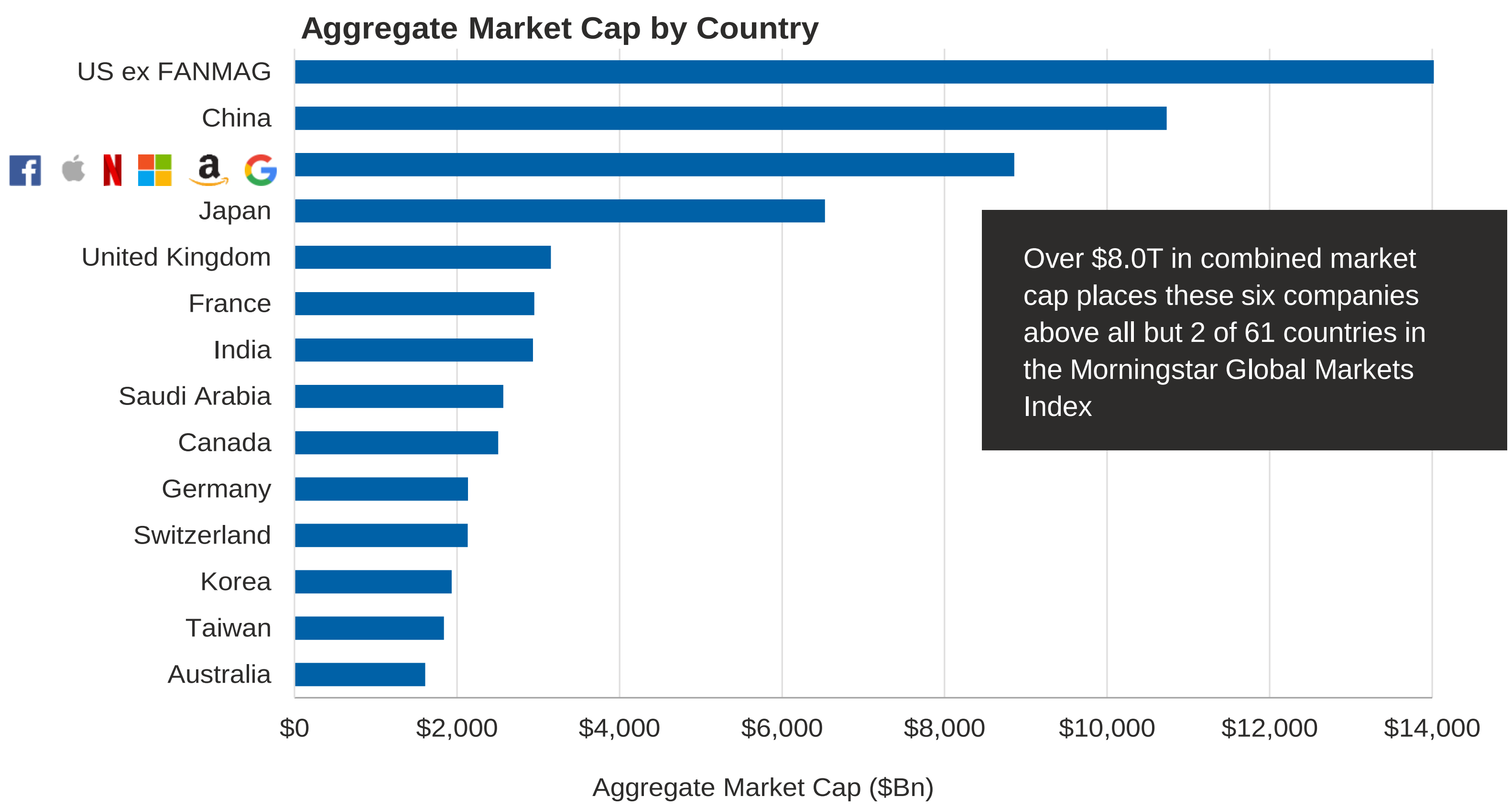
Developed World
World ex Global Top Dog
World ex Global Top Ten
World ex Country Top Dogs

Source: Research Affiliates based on Data from Worldscope and Datastream. Data from 1980-2017.

research affiliates

RAFI Indices™

How Expensive are FANMAG (Facebook, Apple, Netflix, Microsoft, Amazon, & Google)?

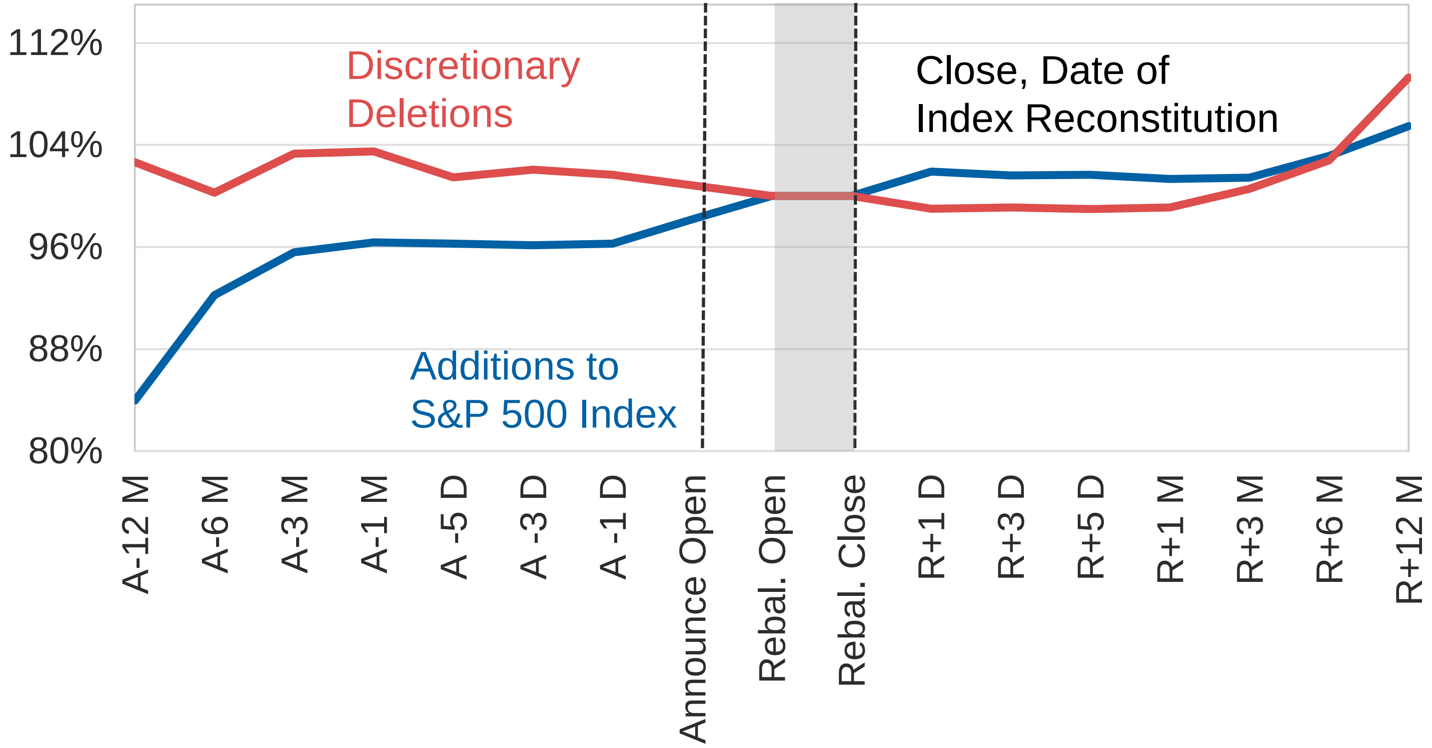


Source: Research Affiliates, LLC, based on data from FactSet as of 9/30/2021. Market cap for sectors represents the sum of the market caps for their constituents in the Russell 1000 Index. Market caps for Facebook, Apple, Netflix, Microsoft, Amazon, & Google are excluded from the Technology sector.

This Pattern Was Much Weaker Before 1989!

- Note the very different scale. The moves are far smaller than after 1989.

Relative to Market Performance of S&P 500 Additions and Discretionary Deletions, 1970–Oct 1989



- Perhaps before 1989 there was less pressure from index fund managers and customers to include glamour stocks, and the index was created to minimize buy-high, sell-low impacts.

Thank you

THE INDEX COMPANY OF RESEARCH AFFILIATES

researchaffiliates.com

rafi.com

Follow Us For More Insights

@RA_Insights

@Research-Affiliates

Important Information

By accepting this document, you agree to keep its contents confidential. You also agree not to disclose the contents of this document to third parties without the prior written permission of Research Affiliates, LLC (“RA”), RAFI Indices, LLC (“RAFI”), or their affiliated entities.

The material contained in this document is for informational purposes only. This material is not intended as an offer or solicitation for the purchase or sale of any security or financial instrument, nor is it advice or a recommendation to enter into any transaction. The information contained herein may be opinions, which are subject to change, at any time, and should not be construed as financial or investment advice on any subject matter.

Past performance is not indicative of future results. Performance of a product may change significantly over time and yield materially different results in the future. Certain performance information presented represents simulated performance or performance based on combined simulated index data (pre-index launch) and live index data (post-index launch). Hypothetical investor accounts depicted are not representative of actual client accounts. Indexes are unmanaged and cannot be invested in directly. Past simulated performance is no guarantee of future performance and does not represent actual performance of an investment product based on an index. No allowance has been made for trading costs, management fees, or other costs associated with asset management, as the information provided relates only to the index itself. Actual investment results will differ. As such, the simulated data may have under-or over-compensated for the impact, if any, of certain market factors. Simulated returns may not reflect the impact that material economic and market factors might have had on the advisor's decision making if the advisor were actually managing clients' money. Simulated data is subject to the fact that it is designed with the benefit of hindsight. Simulated returns carry the risk that actual performance is not as depicted due to inaccurate predictive modeling. Simulated returns cannot predict how an investment strategy will perform in the future. Simulated returns should not be considered indicative of the skill of the advisor. Investors may experience loss of all or some of their investment. With the exception of the data on Research Affiliates Fundamental Index, all other information and data are generally based on information and data from third party sources.

RA, RAFI, their affiliates, agents, and each of their respective officers, directors, employees, agents, representatives and licensors (collectively “Research Affiliates”) do not make any warranties, express or implied, to anyone regarding the information provided herein, including, without limitation, any warranties with respect to the timeliness, sequence, accuracy, completeness, currentness, merchantability, quality or fitness for a particular purpose or any warranties as to the results to be obtained by any third-party in connection with the use of the information. Nothing contained in this material is intended to constitute legal, tax, securities or investment advice, nor an opinion regarding the appropriateness of any investment, nor a solicitation of any type. The general information contained in this material should not be acted upon without obtaining specific legal, tax and investment advice from a licensed professional. Investors should be aware of the risks associated with data sources and quantitative processes used to create the content contained herein or the investment management process. Errors may exist in data acquired from third party vendors, the construction or coding of indices or model portfolios, and the construction of the spreadsheets, results or information provided. Research Affiliates takes reasonable steps to eliminate or mitigate errors, and to identify data and process errors so as to minimize the potential impact of such errors; however, Research Affiliates cannot guarantee that such errors will not occur.

Use of this material is conditioned upon, and evidence of, the user’s full release of Research Affiliates from any liability or responsibility to any third party for any loss or damage, direct, indirect or consequential, arising from or related to (i) any inaccuracy or incompleteness in, errors or omissions in the provided information or (ii) any decision made or action taken by any third party in reliance upon this information. Research Affiliates shall not be liable to anyone for loss of business revenues, lost profits or any indirect, consequential, special or similar damages whatsoever, whether in contract, tort or otherwise, even if advised of the possibility of such damages.

The trademarks Fundamental Index™, RAFI™, Research Affiliates Equity™, RAE™, and the Research Affiliates™ trademark and corporate name and all related logos are the exclusive intellectual property of RA and, in some cases, are registered trademarks in the U.S. and other countries.

Research Affiliates, LLC

Frank Russell Company is the source and owner of the Russell index data contained or reflected in this material and copyrights related thereto. Frank Russell Company and RA have entered into a strategic alliance with respect to the Russell RAFI Indexes. The Russell RAFI Indexes are calculated by Russell in conjunction with RA. All intellectual property rights in the Russell RAFI Indexes (the “Index”) vest in Russell and RA. Neither Russell nor RA nor their licensors accept any liability for any errors or omissions in the Index and/or Index ratings or underlying data. No further distribution of Russell Data is permitted without Russell’s express written consent. Russell® is a trademark of Frank Russell Company. RA is the owner of the trademarks, service marks, patents and copyrights related to the Fundamental Index and the Fundamental Index methodology. The presentation may contain confidential information and unauthorized use, disclosure, copying, dissemination, or redistribution is strictly prohibited. Frank Russell Company is not responsible for the formatting or configuration of this material or for any inaccuracy in Research Affiliates’ presentation thereof.

The FTSE Research Affiliates Fundamental Indexes are calculated by FTSE International Limited (“FTSE”) in conjunction with RA. All rights and interests in the FTSE Research Affiliates Fundamental Indexes vest in FTSE. All rights in and to the RA fundamental weighting methodology used in the calculation of the FTSE Research Affiliates Fundamental Indexes vest in RA. All rights in the FTSE indices and/or FTSE ratings (together the “FTSE Data”) vest in FTSE and/or its licensors. Except to the extent disallowed by applicable law, neither FTSE nor RA nor their licensors shall be liable (including in negligence) for any loss arising out of use of the FTSE Research Affiliates Fundamental Indexes, the FTSE Data or underlying data by any person. “FTSE™” is a trademark of the London Stock Exchange Plc and is used by FTSE under license. FTSE is not an investment adviser and makes no representation regarding the advisability of investing in any security. Inclusion of a security in an index is not a recommendation to buy, sell or hold such security. No further distribution of FTSE Data is permitted without FTSE’s express written consent.

Copyright MSCI. All Rights Reserved. Without prior written permission of MSCI, this information and any other MSCI intellectual property may only be used for your internal use, may not be reproduced or redisseminated in any form and may not be used to create any financial instruments or products or any indices. This information is provided on an “as is” basis, and the user of this information assumes the entire risk of any use made of this information. Neither MSCI nor any third party involved in or related to the computing or compiling of the data makes any express or implied warranties, representations or guarantees concerning the MSCI index-related data, and in no event will MSCI or any third party have any liability for any direct, indirect, special, punitive, consequential or any other damages (including lost profits) relating to any use of this information. All MSCI returns information provided under license through MSCI. Any expected returns forecasted herein may be calculated by RA using data provided by MSCI Inc. No funds or securities relating to those expected returns forecasted herein are sponsored, endorsed or promoted by MSCI Inc., and MSCI bears no liability with respect to any such funds or securities.

RA is an investment adviser registered under the Investment Advisers Act of 1940 with the U.S. Securities and Exchange Commission (SEC). Our registration as an investment adviser does not imply a certain level of skill or training. RA does not provide investment advice outside of Australia, the United States, Canada and Ireland. RA does not offer or sell any securities, commodities or derivative instruments or products. Any such business may only be conducted through registered or licensed entities and individuals permitted to do so within the respective jurisdiction and only in conjunction with legally required disclosure documents and subject to all legally required regulatory filings. RA is not a broker-dealer and does not effect transactions in securities.

Notice to wholesale clients in Australia:

RA is exempt from the requirement to hold an Australian financial services license by operation of ASIC Class Order 03/1100: US SEC regulated financial service providers.

RAFI Indices, LLC

Any applicable financial instruments referenced herein are not sponsored, promoted, sold or supported in any other manner by RAFI or Solactive AG (“Solactive”). With respect to any RAFI index referenced herein (the “Index”), neither RAFI nor Solactive offer any express or implicit guarantee or assurance either with regard to the results of using the Index and/or Index trademark referenced herein, or the Index price at any time or in any other respect. The Index is calculated and published by RAFI and Solactive, which use their best efforts to ensure that the Index is calculated correctly. Irrespective of their obligations toward any licensee, neither RAFI nor Solactive has any obligation to point out errors in the Index to third parties, including but not limited to licensees, investors and/or financial intermediaries of the financial instrument. Neither publication of the Index nor the licensing of the Index or Index trademark for the purpose of use in connection with the financial instrument constitutes a recommendation by RAFI or Solactive to invest capital in said financial instrument nor does it in any way represent an assurance or opinion of RAFI or Solactive with regard to any investment in the financial instrument.

RAFI is a wholly owned subsidiary of Research Affiliates Global Holdings, LLC and does not offer or provide investment advice or offer or sell any securities, commodities or derivative instruments or products. Any such business may only be conducted through registered or licensed entities and individuals permitted to do so within the respective jurisdiction and only in conjunction with legally required disclosure documents and subject to all legally required regulatory filings.
The RAFI trademark is used under license by RAFI. The RAFI Indices, LLC corporate name and all related logos are the exclusive intellectual property of RAFI.

Various features of the Fundamental Index™ methodology, including an accounting data-based non-capitalization data processing system and method for creating and weighting an index of securities, are protected by various patents, and patent-pending intellectual property of RA. (See all applicable US Patents, Patent Publications, Patent Pending intellectual property and protected trademarks located at https://www.researchaffiliates.com/en_us/about-us/legal.html, which are fully incorporated herein.) Any use of these trademarks, logos, patented or patent pending methodologies without the prior written permission of RA is expressly prohibited. RA reserves the right to take any and all necessary action to preserve all of its rights, title, and interest in and to these marks, patents or pending patents.

It is not RAFI’s intent to provide investment advice and accordingly, we will not receive any fees or other compensation directly from you for the provision of investment advice (as opposed to other services) in connection with any transaction, unless contracted for or permissioned to do so. Without an express written objection from you, we will deem that these acknowledgments and representations apply.