Dimensional

Measuring the Costs of Index Reconstitution: A 10-Year Perspective

Kaitlin Hendrix, CFA
Asset Allocation Research Director and Vice President

Jerry Liu, PhD
Trading Research Director and Vice President

Trey Roberts, CFA
Senior Associate, Research

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KEY TAKEAWAYS

- Index-tracking funds seek to match an index's performance. This goal may lead to constraints and implementation costs that hurt returns.
- Our 10-year study identifies significant costs for index-tracking funds from demanding immediacy during index reconstitution events.
- A better investment approach would be a daily process that spreads turnover across all trading days, avoiding the costs of demanding immediacy and allowing for a consistent focus on stocks with higher expected returns.

Introduction

Funds that track indices have garnered attention and inflows in recent years, with assets in passive US equity mutual funds and exchange-traded funds (ETFs) surpassing assets in traditional actively managed rivals for the first time in 2019.[1] While index funds generally have low expense ratios, expense ratios are not the only costs borne by investors. These funds seek to match the performance of an index, and this objective may lead to constraints and implementation costs.

Indices generally undergo regular reconstitution events during which index providers add or delete securities following a predetermined set of rules. To maintain low tracking error vs. the index, index funds generally have to mirror these changes by purchasing and selling securities based on the revised index weights. This constraint can come at a cost. By ignoring information in market prices between reconstitution days, an index-tracking approach may lead to an inconsistent focus on a desired asset class as well as the inefficient pursuit of higher expected returns. For example, new cash flows between rebalancing dates are invested based on potentially stale information about company characteristics and expected returns as of the latest rebalancing date. A rigid index-tracking approach can also lead to inefficient execution of voluntary corporate actions. With respect to transaction costs, adhering to an index reconstitution schedule can result in relatively poor execution prices—buying higher and selling lower—which are in turn reflected in investors' returns. Herein, we focus on excess trading volume and price pressure associated with index reconstitution events, a prime example of the costs index fund managers face by giving up flexibility in an effort to minimize tracking error.

Evidence of an index reconstitution effect has been well documented in the literature. One of the earliest examples is Harris and Gurel (1986), who find strong price pressure around the S&P 500 index's reconstitution, particularly from 1978 to 1983. In September 1976, S&P began a notification service for subscribers that announced changes in the S&P 500 on the day of the change, typically after market close. Immediately after an addition is announced, prices increase by more than 3%. The increase is nearly fully reversed after two weeks. S&P's policy was changed in October 1989: Additions and deletions were to be announced one week in advance of the change, where possible, to facilitate index tracking.[2] Following that change, over the period 1990 through 1995, Lynch and Mendenhall (1997) find a similar abnormal return of over 3% relative to the market between announcement and rebalance, followed by a significant price reversal over the next two weeks. The authors also identify a spike in trading volume on rebalance day for S&P 500 additions and deletions.

1. Data from Morningstar. As of August 2019, the passive share of US equity open-end and ETF assets was 50.15% vs. 49.85% for active funds. "Morningstar Reports U.S. Mutual Fund and Exchange-Traded Fund Flows for August 2019," Morningstar, September 13, 2019.

2. For further discussion, see, for example: Messod D. Beneish and Robert E. Whaley, "An Anatomy of the 'S&P Game': The Effects of Changing the Rules," *Journal of Finance* 51, no. 5 (December 1996): 1909–1930.

Chakrabarti et al. (2005) study the index reconstitution effects globally, examining stocks added to or deleted from 29 countries that make up MSCI Standard Country Indices from 1998 through 2001. The authors identify a significant abnormal return of 3.4% to index additions relative to the market following announcement, with a further rise of 4.5% on the effective addition date. The performance declines somewhat over the following 10 days but remains positive. They find similar abnormal underperformance for index deletions following announcement, with a partial reversal. The authors also document a surge in abnormal trading volume on the day following index reconstitution. Chen et al. (2019) also study index reconstitution effects within the MSCI Standard Indices from 2000 through 2015. Consistent with earlier evidence, the authors find abnormal positive (negative) returns for stocks added to (deleted from) the index that is partially reversed, as well as excess trade volume on the day of reconstitution.

Index providers have responded to the price pressure by spreading trading over more days (e.g., S&P and CRSP indices generally rebalance quarterly, with CRSP starting to spread the rebalancing over five trading days each quarter in 2017), and by designing their asset class indices to share boundaries and have buffers so as to minimize net buys and sells across indices (e.g., Russell and CRSP).

Creating overlap among indices' constituents is, however, not a free lunch. Blurring of boundaries and spillovers have led to indices that focus less on the stated asset classes. Inadvertent style drift has meant investors are not getting the exposure they signed up for. For example, on average from 2010 through June 2023, roughly 25% of the Russell 2000 Index, positioned as a small cap index, was composed of the largest 1,000 stocks in the Russell 3000 Index. Similarly, the overlap between the Russell 1000 Value and Growth indices averaged about 300 companies over that period.

And transparency, once considered a reliable feature of indices, is no longer a given. While many think the S&P 500 is made up of the 500 largest stocks in the US, there are many other requirements for index inclusion, as determined by the Investment Committee of the S&P 500 index (see **Exhibit 3**). In fact, in 2023 the S&P 500 added 12 new stocks that had already been among the largest 500 US stocks for between seven and 97 months before their eventual addition to the index.

So has the index reconstitution effect changed as indices have become more blurred and less transparent? Recent claims contend that it might have disappeared or become less predictable as many market participants try to take advantage of this pattern, and index fund managers and index fund providers try to mitigate the costs associated with index rebalancing. For example, Petajisto (2011) computes an "index turnover cost" for the S&P 500 and Russell 2000 from 1990 through 2005. This reflects the lower bound of the cost incurred by a mechanical indexer compared to an index-neutral strategy, or a strategy that holds a portfolio with characteristics

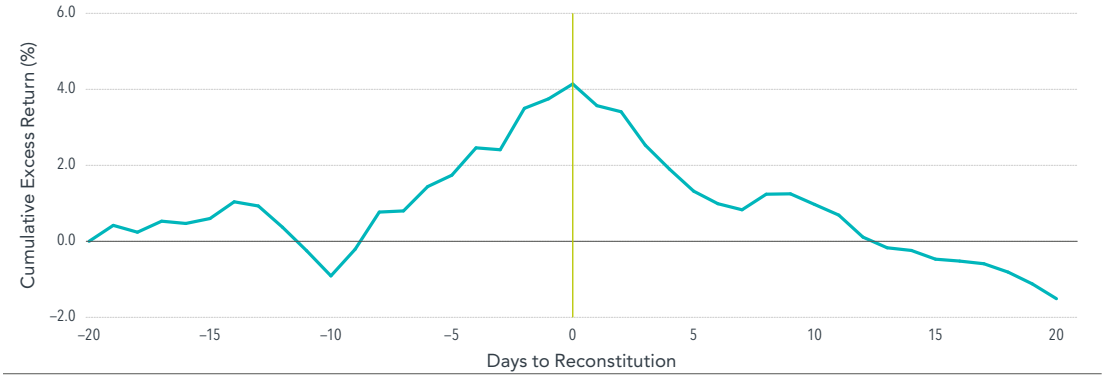
essentially identical to those of the index but not mechanically tied to holding the index all the time. He finds the lower bound cost peaks at 65–82 basis points (bps) for the S&P 500 and 232–463 bps for the Russell 2000, both in the year 2000, with the cost declining thereafter. More recently, Scari (2016) concludes the S&P 500 index inclusion effect has declined since the late 1990s. Bennet et al. (2020) focus on S&P 500 index reconstitution events from 1997 through 2017 and conclude that index inclusion has had a transitory positive effect but no long-term effect on stock prices in the first half of the period, yet in the second half of the period no transitory positive effect and a negative long-term effect. Greenwood and Sammon (2022) argue that the index reconstitution effect may have declined over time as market participants adapted to take advantage of predictable price movements for index additions and deletions, in part by creating arrangements where other institutions stand ready to supply liquidity to indexers.

This study provides an up-to-date and broad evaluation of the reconstitution effect. We measure the costs of index reconstitution from 2014 to 2023 for 10 US indices. In our analysis, we restrict adds and deletes to nonmigrating securities, i.e., stocks that are added to (or deleted from) an index and are not also deleted from (or added to) another index from the same index family on the same reconstitution date. By focusing on these "pure" additions and deletions, we are able to more cleanly identify the cost of demanding immediacy associated with tracking an index.

We find abnormally high trade volume on reconstitution dates for stocks added to or deleted from the indices. Furthermore, the spike in trade volume tends to be highly concentrated at the time of market close on reconstitution dates. Because the stock prices reflected in indices on the day of a rebalance are typically market-closing prices, this is consistent with index fund managers trying to execute their trades around market close to minimize tracking error.

Consistent with many prior studies, we find that index additions exhibit positive excess return patterns and deletions exhibit negative excess return patterns before reconstitutions, while both exhibit reversals after reconstitutions. In **Exhibit 1**, we show the average cumulative excess return of additions and deletions across the 10 indices, with the returns to deletions multiplied by –1 to present additions and deletions together. The average excess return to added/deleted securities is 4% over the 20 trading days leading up to reconstitution, with a reversal of –5.7% in the next month.

EXHIBIT 1: Average Cumulative Excess Return of Index Additions and Deletions in 20 Days around Reconstitution, *2014–2023*

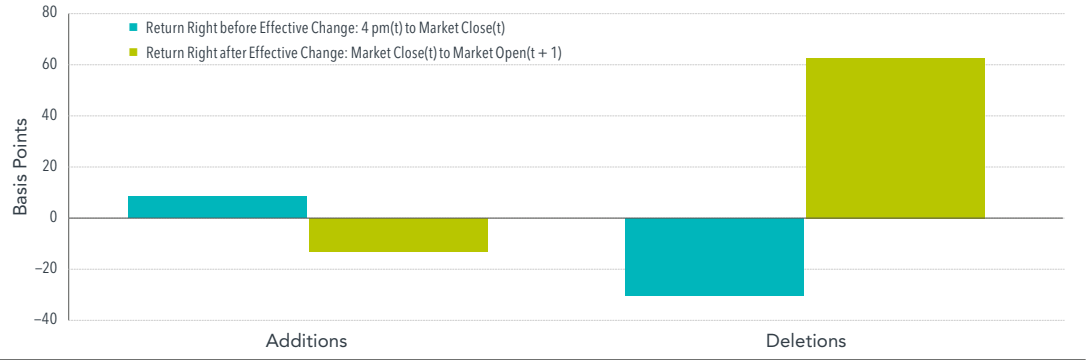


Past performance is no guarantee of future results.

Cumulative excess returns (CERs) are calculated as the cumulative sum of the daily excess returns for an individual security vs. its respective index from market close 20 trading days before reconstitution. Cumulative excess returns for deletions are multiplied by –1 before being averaged with cumulative excess returns of additions. Value-weighted average CERs are calculated by weighting the sets of CERs on a day by the securities' respective free-float market capitalizations as of the most recent month prior to reconstitution. Migrating events for S&P, Russell, and CRSP indices are excluded; see Appendix 1 for more information. Tesla's addition to the S&P 500 on December 18, 2020, is excluded. Indices are not available for direct investment; therefore their performance does not reflect the expenses associated with the management of an actual fund.

Using high-frequency-trading data from 2019 to 2023, we can zoom in on the price pressure right around market close. From the end of continuous trading at 4 pm to the closing auction, prices move up for adds and down for deletes as expected. This price pressure happens in a very short span of time: The typical span between the last trade and the closing auction is 10 seconds or less.[3] We also document a strong price reversal for those stocks by market open the following morning. **Exhibit 2** highlights these results by regressing the returns of all stocks on flags indicating if the stock was an index addition or deletion that day. Returns are measured from the last midpoint price of the continuous trading session on reconstitution day to the closing auction price (blue bars) and from that closing auction price to the market open price on the following day (lime-green bars). The price for additions on average goes up by 9 bps, relative to nonrebalanced stocks, in the roughly 10 seconds between 4 pm on reconstitution day and market close, and then reverses by a relative –13 bps by market open the next morning. This means that the index "buys" higher and the price falls immediately after the stock is added to the index. The opposite is true for deletions: On average, the price for deletions falls relative to nonrebalanced stocks by 30 bps from 4 pm to market close on reconstitution day, just before they are "sold" from the index, with a reversal of a relative 63 bps by market open the following day.

EXHIBIT 2: Price Pressure into Closing Auction on Index Reconstitution Days and Overnight Price Reversal after Index Reconstitution, *2019–2023*



Past performance is no guarantee of future results.

Regression specification for the price pressure into closing auction is: $Ret_{LastMid,T}^{Auc,T} = a + b * Additions + c * Deletions + e_T$, *where* $Ret_{LastMid,T}^{Auc,T}$ *is the gross return (in bps) from last midpoint price of the continuous session on T to the closing auction price. Regression specification for the overnight reversal is:* $Ret_{Auc,T}^{Open,T+1} = a + b * Additions + c * Deletions + e_T$, *where* $Ret_{Auc,T}^{Open,T+1}$ *is the market-adjusted return (in bps) from closing auction price on T to open auction price on T + 1.* $Additions$ *is an indicator variable with 1 for index additions and 0 for other stocks.* $Deletions$ *is an indicator variable with 1 for index deletions and 0 for other stocks. Day fixed effects are included. The blue bars and lime-green bars represent the coefficient estimates for the* $Additions$ *and* $Deletions$ *indicator variables in the former and latter model, respectively. Samples includes all index addition and deletion events, as well as all other US stocks traded on the same index reconstitution days. Index migrations and events due to corporate actions are excluded. For CRSP indices, we include all five days of the transition period in the price pressure regression, but we only include the last day in the overnight reversal regression. Tesla's addition to the S&P 500 on December 18, 2020, is excluded. The regression models and results are in* ***Exhibit 12****. Indices are not available for direct investment; therefore their performance does not reflect the expenses associated with the management of an actual fund.*

3. Based on Dimensional's equity trades listed on NASDAQ and New York Stock Exchange from January 2023 through June 2024, as compiled by Dimensional.

Index Data

We examine the reconstitution events for 10 widely tracked US equity indices—the S&P 500 index, S&P MidCap 400 (S&P 400) index, S&P SmallCap 600 (S&P 600) index, Russell 1000 Growth Index, Russell 1000 Value Index, Russell 2000 Index, CRSP US Large Cap Growth Index, CRSP US Large Cap Value Index, CRSP US Mid Cap Index, and CRSP US Small Cap Index—from 2014 through 2023.[4] These indices are among the most widely tracked US asset class indices. **Exhibit 3** shows the total tracking assets as of December 31, 2023. The S&P 500 commands the most tracking assets, $6.9 trillion, followed by the S&P 400 index with $325 billion. The Russell 1000 Value Index has the fewest index-tracking assets, $87 billion. S&P data are reported by S&P and include assets in index funds as well as other index-tracking assets such as separately managed accounts or insurance products. CRSP data are provided by CRSP and reflect total linked assets in US mutual funds and ETFs. Estimates for Russell indices are obtained from Morningstar and are less comprehensive because they include assets in US 40 Act funds only. These figures should be considered a lower bound. For example, investors should also consider so-called "closet indexers" that closely follow indices and other financial instruments tied to indices, such as derivatives.

EXHIBIT 3: Assets Invested in Index-Tracking Funds, *as of December 31, 2023*

	S&P 500 Index	S&P 400 Index	S&P 600 Index	Russell 1000 Growth Index	Russell 1000 Value Index	Russell 2000 Index	CRSP US Large Cap Growth Index	CRSP US Large Cap Value Index	CRSP US Mid Cap Index	CRSP US Small Cap Index
Index-Tracking Assets (USD Billions)	6,850	325	147	137	87	121	201	156	158	134
Total Market Capitalization (USD Billions)	40,039	2,515	1,149	23,677	20,179	2,508	21,850	18,695	6,921	5,244
Percentage of Market Cap in Index Funds	17.1%	12.9%	12.8%	0.6%	0.4%	4.8%	0.9%	0.8%	2.3%	2.6%

Total assets indexed to S&P indices is from "S&P Dow Jones Indices Annual Survey of Assets." Total assets includes assets in index funds as well as other index-tracking assets such as separately managed accounts or insurance products. Total assets indexed to CRSP indices is from CRSP. Total assets reflect total linked assets in US mutual funds and ETFs. Total assets indexed to Russell indices are proxied by AUM of index-tracking funds, specifically US 40 Act funds, obtained from Morningstar. Percentage of market capitalization in index funds for each index is calculated as the index-tracking asset values divided by the total market capitalization of companies in the index.

4. CRSP data provided by CRSP, the Center for Research in Security Prices, University of Chicago. Frank Russell Company is the source and owner of the trademarks, service marks, and copyrights related to the Russell Indexes. S&P data copyright 2024 S&P Dow Jones Indices LLC, a division of S&P Global. All rights reserved. Indices are not available for direct investment; therefore their performance does not reflect the expenses associated with the management of an actual fund.

To understand the relative size of the assets in index funds, we also report the total market capitalization of companies in each index and the percentage of the market cap that is in index funds. As of December 31, 2023, 17% of the S&P 500 investment universe is covered by index-tracking assets. By comparison, less than 1% of the investment universe represented by the Russell 1000 Value Index is tracking the index.

The constituents of these indices are determined according to an index methodology and are changed periodically throughout the year based on index guidelines. A summary of the reconstitution methodologies for S&P indices, Russell indices, and CRSP indices is shown in Exhibit 4.

EXHIBIT 4: Summary of Reconstitution Guidelines

	S&P	Russell	CRSP
Indices Examined	S&P 500, S&P 400, and S&P 600 indices	Russell 2000, Russell 1000 Growth, and Russell 1000 Value indices	CRSP US Large Cap Growth, CRSP US Large Cap Value, CRSP US Mid Cap, CRSP US Small Cap indices
Rebalance Frequency	Quarterly and as needed	Annual	Quarterly
Effective Date(s)	Third Friday of March, June, September, and December; as needed as well	Fourth Friday in June	Prior to September 2017, effective date was third Friday of March, June, September, and December September 2017–present: quarterly transition beginning on Wednesday preceding third Friday of March, June, September, and December (20% of holdings changes made each day over 5-day period)
Guidelines for Index Membership	Subject to committee, requirements for US domicile, exchange listing, market cap, liquidity, financial viability, with some exceptions	Subject to index eligibility committee requirements to be a US company and regarding exchange listing, minimum share price, market cap, trading volume, trading gaps	Requirements around being classified as a US company, market cap, trading volume, trading gaps, suspended securities
Index Overlap	No overlap	Overlap between value/growth indices	Overlap between value/growth indices and between size indices
Announcement Date(s)	Typically five days before effective date	Membership eligibility determined on "rank day," typically 4–6 weeks prior to reconstitution; preliminary lists of constituents are published 2–5* weeks prior to reconstitution, with subsequent updates leading up to reconstitution	Two weeks prior to reconstitution

**FTSE Russell published preliminary constituent lists two weeks prior to reconstitution date from 2014 to 2018, three weeks prior from 2019 to 2022, and five weeks prior in 2023. S&P US indices methodology as of May 2024. Russell US indices methodology as of May 2024. CRSP US market indices methodology as of January 2024.*

To examine the extent to which abnormal trading volume and price pressure occur around index reconstitution events, we identify stocks that have been added to or deleted from the selected indices at a reconstitution event from 2014 through 2023. We identify additions and deletions primarily using index constituent data. We look at changes in constituents to identify potential additions and deletions, which we then review to exclude changes due to corporate actions; for example, if a stock is no longer a member of an index because it is acquired. S&P also issues press releases that we use to confirm the additions and deletions that we identify for those indices. For periods and indices during which we only have monthly data (such as for the CRSP indices), we determine the actual day of reconstitution using index reconstitution rules and news stories.

We exclude Tesla's addition to the S&P 500 index on December 18, 2020. At the time of its addition, Tesla became the sixth-largest company in the S&P 500, and on news of the announcement on November 16, Tesla's stock price jumped 8.2%, from $136.03 to $147.20. It continued to climb 70.3% over the next month to the day of its addition on December 18, compared to 2.3% for the S&P 500 index, an outperformance of 68 percentage points. By comparison, the 56 other nonmigrating additions to the S&P 500 index for 2014–2023 outperformed the S&P 500 by 11.66 percentage points, on average, in the month before their addition. Tesla's large market capitalization and outsize performance bump this average to 15.96% when included. Because of the unique circumstances whereby Tesla's addition was announced about one month in advance instead of the typical five days, we leave Tesla out of our analysis.[5]

Our sample includes a total of 3,488 additions and 2,517 deletions, which are categorized by index and year in **Exhibit 5**. The greatest number of additions and deletions occurs within the Russell 2000, which had 1,822 additions and 1,638 deletions. On average, 182 stocks are added and 164 are deleted at each reconstitution of the Russell 2000 Index. The S&P 500 index had the fewest total additions and deletions, 56 and 8, respectively, over the same period, and only one stock on average per event.

Stocks that fully migrate from one index to another index in the same family on the same day are excluded because such stocks can have conflicting trading pressure, making it difficult to disentangle one effect from another.[6] Similarly, we also drop stocks that partially migrate across indices, such as when a stock has its weight partially reduced from one index and simultaneously partially increased in another. By excluding migrating stocks, we are able to identify more cleanly the effect that index rebalancing has on stock volume and price.

5. See Kaitlin Hendrix and Mia Huang, "Tesla's Charge Reveals Weak Points of Indexing," *Insights* (blog), Dimensional Fund Advisors, January 2021.

6. This approach is discussed in Petajisto (2011).

EXHIBIT 5: Nonmigrating Index Additions and Deletions, *2014–2023*

	S&P 500 Index	S&P 400 Index	S&P 600 Index	Russell 1000 Growth Index	Russell 1000 Value Index	Russell 2000 Index	CRSP US Large Cap Growth Index	CRSP US Large Cap Value Index	CRSP US Mid Cap Index	CRSP US Small Cap Index
Additions										
2014	2	8	35	9	4	138	2	1	8	76
2015	7	10	45	12	11	118	3	2	16	86
2016	8	20	59	–	1	156	–	–	10	38
2017	9	21	51	6	8	165	–	–	14	42
2018	3	21	42	3	3	157	–	1	9	54
2019	4	24	51	8	5	167	1	–	14	28
2020	4	26	39	18	9	166	3	2	37	75
2021	4	24	30	20	14	224	9	8	17	121
2022	7	22	33	16	15	265	1	2	17	45
2023	8	47	39	9	9	266	–	–	22	19
Total	**56**	**223**	**424**	**101**	**79**	**1822**	**19**	**16**	**164**	**584**
Average by Event	1	1	1	11	8	182	2	1	4	15
Deletions										
2014	–	4	16	3	4	168	–	–	8	27
2015	–	6	16	1	–	148	–	–	8	55
2016	–	9	14	1	–	125	–	–	4	45
2017	–	4	14	1	1	105	–	–	3	36
2018	2	6	10	1	–	101	–	–	2	27
2019	2	7	24	2	2	116	–	–	11	59
2020	3	8	27	–	2	131	–	–	3	65
2021	1	3	15	1	1	287	1	–	12	16
2022	–	1	25	5	4	292	–	–	6	82
2023	–	2	69	3	6	165	–	–	3	80
Total	**8**	**50**	**230**	**18**	**20**	**1638**	**1**	**0**	**60**	**492**
Average by Event	1	1	2	2	3	164	1	0	2	12

Migrating events for S&P, Russell, and CRSP indices are excluded; see Appendix 1 for more information. Tesla's addition to the S&P 500 on December 18, 2020, is excluded.

The average index weight impacted by reconstitution events is presented in Panel A of Exhibit 6. Because some of these indices have multiple reconstitution events each year, Panel B presents average annual weights of additions and deletions across all the reconstitution events from 2014 through 2023. On average, the CRSP large value and growth indices had the lowest weight in nonmigrating adds and deletes, at 14 bps and 13 bps per year. The weight impacted by constituent changes is higher among small cap indices. The Russell 2000 Index has the highest impacted weight per rebalance, with 3.73% on average across nonmigrating stocks at each reconstitution. Because the average number of additions and deletions per event is one or two stocks for the S&P indices, the constituent weight changes at each reconstitution event are much lower than that per year. For the S&P 600 index, for example, the average weight change across nonmigrating stocks is 0.18% of index market capitalization per rebalance, compared to 6.53% per year. This is because the S&P indices have both regularly scheduled quarterly rebalances

and more numerous off schedule rebalances. For example, the S&P 600 averaged 37 unique reconstitution dates per year over the sample period, including four that were regularly scheduled and 33 that were off schedule on average.

To put the impacted index weight in perspective for the large cap value and growth indices, consider that the average annual turnover of the top 10 largest large cap value funds in Morningstar was 24% in 2023. This is over twice the average annual index weight for all additions and deletions for the Russell 1000 Value and CRSP US Large Cap Value indices. The difference is more stark for growth indices: The average annual turnover of the top 10 largest large cap growth funds was 41% in 2023. By comparison, the average annual index weight in additions and deletions for the CRSP US Large Cap Growth Index was 5% over the last 10 years.[7]

EXHIBIT 6: Average Index Weights (%) of Additions and Deletions, *2014–2023*

	S&P 500 Index	S&P 400 Index	S&P 600 Index	Russell 1000 Growth Index	Russell 1000 Value Index	Russell 2000 Index	CRSP US Large Cap Growth Index	CRSP US Large Cap Value Index	CRSP US Mid Cap Index	CRSP US Small Cap Index
Panel A: Average Index Weight by Reconstitution Event										
Nonmigrating Additions and Deletions	0.11	0.37	0.18	0.56	0.48	3.73	0.07	0.06	1.40	0.44
All Additions and Deletions	0.10	0.60	0.46	8.87	10.27	14.17	1.29	1.17	2.29	1.56
Panel B: Average Index Weight by Calendar Year										
Nonmigrating Additions and Deletions	0.61	5.98	6.53	0.56	0.48	3.73	0.14	0.13	5.45	1.78
All Additions and Deletions	1.30	20.19	19.52	8.87	10.27	14.17	5.03	4.69	9.17	6.23

Index weights are calculated at each reconstitution event as the sum of index weights of both additions and deletions. In Panel B, the index weights are then aggregated across all reconstitution events during a calendar year. Average index weight by reconstitution event includes regularly scheduled events and off-schedule events. See Appendix 1 for more information on migrating events definition. Tesla's addition to the S&P 500 on December 18, 2020, is excluded.

7. Data include largest funds by AUM as of May 31, 2024 categorized as large cap growth or large cap value funds by Morningstar. Limited to funds with value or growth benchmarks.

Trading Volume around Reconstitution Day

To quantify the extent to which index reconstitution events are associated with abnormal trading volume, we compare average trading volume in additions and deletions on reconstitution days with trading volume in the same stock on days before and after the reconstitution day. Throughout, the reconstitution day for the CRSP indices, which rebalance 20% a day over a five-day period, is set as the third day in the period, when over 50% of updates have been made. Exhibit 7 presents the average volume for rebalanced stocks on reconstitution day *t*, reported as a multiple of the stocks' volume on day *t minus 20*. If trading volume on reconstitution day is abnormally high for a rebalanced stock, it would lead to an increase in its ratio of volume traded on event day relative to nonevent days. Indeed, averaging the volume ratios by index across all events over the period, we find a large spike in the trading volume multiple on reconstitution day in stocks added to or deleted from each index, ranging from 3 times for the CRSP US Mid Cap Index to over 27 times for the S&P 500 index.[8]

EXHIBIT 7: Average Trading Volume Multiples for Index Additions and Deletions on Reconstitution Day vs. 20 Days Prior, *2014–2023*

Index	Multiple
S&P 500	27.3
S&P 400	20.4
S&P 600	26.1
Russell 1000 Growth	6.4
Russell 1000 Value	7.5
Russell 2000	21.3
CRSP US Large Cap Growth	6.8
CRSP US Large Cap Value	12.6
CRSP US Mid Cap	3.0
CRSP US Small Cap	6.3
Average	**13.8**

The security-level trade volume multiple is based on the ratio of observed daily volume levels over the event horizon relative to the observed daily volume 20 trading days prior to the reconstitution date. The value-weighted average trading volume multiple is calculated by weighting the set of trading volume multiples on a day by the securities' respective free-float market capitalizations, which are month-end values from the most recent month prior to reconstitution dates. Migrating events for S&P, Russell, and CRSP indices are excluded; see Appendix 1 for more information. Tesla's addition to the S&P 500 on December 18, 2020, is excluded.

These spikes in trading volume are robust to excluding triple-witching days, which are days when stock index futures, stock index options, and stock options all expire.

8. Average trading volume multiples and price pressure presented throughout this paper are value-weighted using market capitalization at month-end before index reconstitution. Results are robust to alternative weighting approaches, including equal weighting.

Trading Volume around Market Close on Reconstitution Day

To minimize tracking error, index managers are incentivized not only to trade the same securities in the same direction on the same day as dictated by the index rebalancing rules but also to execute rebalance trades at the closing price, which is used to compute the daily return of an index. It is therefore natural to expect higher-than-normal trading volume in index additions and deletions around the time of the market close.

To examine this, we compare the intraday trading volume over 15-minute intervals on the reconstitution date to the average volume levels within the same 15-minute intervals in the same stock over the previous 30 calendar days, or about 20 trading days. The sample period for this analysis is the past five years, 2019–2023, due to data availability. **Exhibit 8** shows that the heightened trade activity for index additions and deletions is concentrated on reconstitution day from 4pm to 4:15pm, during which the closing auction takes place. Abnormal trading volume ranges from about 10x to 120x on rebalance day compared to the prior one month.

For the S&P indices, the S&P 600 exhibits the greatest volume increase, at around 112x trading volume from 4 to 4:15pm on reconstitution day in rebalanced stocks compared to trading volume in the same stocks during the same 15-minute window averaged over the prior month.

The greatest volume pressure occurs for the Russell 2000 Index, with 119 times volume on rebalance day compared to the prior month.

For the CRSP indices, which add/delete stocks 20% a day over a five-day period, we show relative 4–4:15pm volume separately on each day in the five-day rebalance window. The abnormal volume is the greatest on day three. This day occurs on the third Friday of the quarter-end month (the day when S&P indices also typically rebalance), which is a triple-witching day. As mentioned above, triple-witching days are when stock market index futures, stock market index options, and stock options all expire. These derivative expirations generally lead to higher trading volume in the underlying stocks, so it is plausible that the jump in volume is driven by the volume related to triple witching. But the fact that we see a consistent 20x jump in 4–4:15pm volume for most CRSP adds and deletes on the other four days of the rebalancing schedule suggests that the rebalance does cause an abnormal trading volume at the end of the day for the adds and deletes. For the S&P indices, the exclusion of triple-witching days does not materially impact the results.

EXHIBIT 8: Average Intraday Trading Volume Multiples for Index Additions and Deletions from 4 to 4:15pm on Reconstitution Day vs. 4 to 4:15pm 20 Days Prior, *2019–2023*

	Trading Multiple				
Index	*t*–2	*t*–1	Reconstitution Day	*t* +1	*t*+2
S&P 500			108.6		
S&P 400			82.7		
S&P 600			111.9		
Russell 1000 Growth			41.1		
Russell 1000 Value			42.0		
Russell 2000			118.8		
CRSP US Large Cap Growth	22.0	21.9	114.0	21.2	21.2
CRSP US Large Cap Value	20.5	18.4	104.4	18.9	19.2
CRSP US Mid Cap	5.1	5.0	12.3	4.8	5.1
CRSP US Small Cap	18.1	17.4	64.8	17.6	17.6
Average			**80.1**		

Data are from January 2019 through December 2023. The security-day-level intraday volume multiple is based on the ratio of observed intraday volume levels on the index reconstitution date relative to the observed equal-weighted average intraday volume over the 30-calendar-day period prior to the reconstitution date. The value-weighted average intraday volume multiples are then calculated across all securities and reconstitution days for each index, using securities' respective free-float market capitalizations, which are month-end values from the most recent month before reconstitution date. Migrating events for S&P, Russell, and CRSP indices are excluded; see Appendix 1 for more information. Tesla's addition to the S&P 500 on December 18, 2020, is excluded.

Price Pressure

How does the abnormal trading volume shown in the previous sections impact the prices of rebalanced stocks? Because most index providers announce changes to index membership before the reconstitution day, it is reasonable to expect security prices to incorporate expectations of the future trading activity. The S&P indices typically announce changes to index constituents five days prior to the effective date, whereas Russell announces its ranking of stocks by market capitalization one to two months before the effective date. On the Russell ranking date, market participants can infer the composition of Russell indices with a high degree of accuracy.

If a stock is being added to an index, the stock sees increased demand from index-tracking funds that must add the position to their holdings. As a result, there is likely to be positive pressure on the price of index additions. The inverse is true for stocks that are deleted. Note that this price pressure does not have to happen all on the day of reconstitution. Prices are forward-looking and are likely to adjust over the days between the announcement and reconstitution as market participants get a better idea of the buy and sell flow that is likely to happen on the rebalancing day.

We estimate this price impact by calculating the average cumulative return to added or deleted stocks in excess of the return to the corresponding index starting one month before reconstitution day. The results, illustrated in **Exhibit 9**, confirm the intuition: We find that, on average, additions outperform their respective index, while deletions underperform in the days leading up to the reconstitution. The pattern tends to reverse immediately following reconstitution. Returns are plotted from 20 trading days before the effective date of reconstitution to 20 days after, with the lime-green lines marking the effective date. The cumulative excess return for each stock on day t is the sum of the excess returns of the stock from day $t - 20$ to day t. The cumulative excess returns of deletions are multiplied by –1 to show additions and deletions together. For each index, we form a value-weighted average cumulative excess return, with weights proportional to the market capitalizations of the adds and deletes as of the month-end before the index reconstitution.

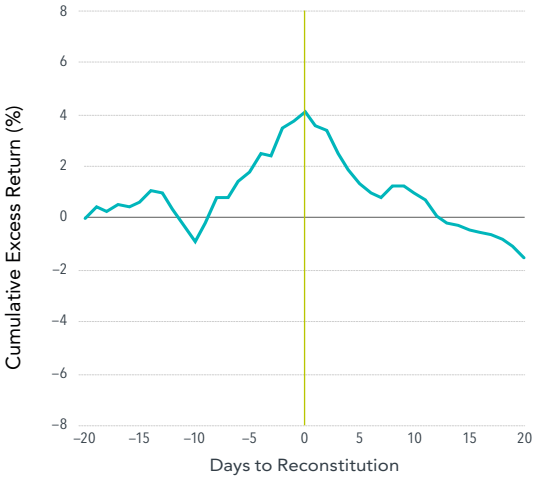
In **Panel A**, we show the equally weighted average of cumulative excess return for all 10 indices together over the past 10 years. The cumulative excess return of additions and deletions is 4%, on average, over the 20 trading days leading up to reconstitution. The pattern unwinds in the next month, with the excess return being –5.7% on average in the 20 trading days following reconstitution.

To highlight the difference in behavior between additions and deletions, **Panel B** plots the excess returns separately for the two groups. As expected, adds rise in price relative to the index before rebalancing, while deletes fall in price. After reconstitution, both adds and deletes experience price reversals, with the effect being greater for adds on average.

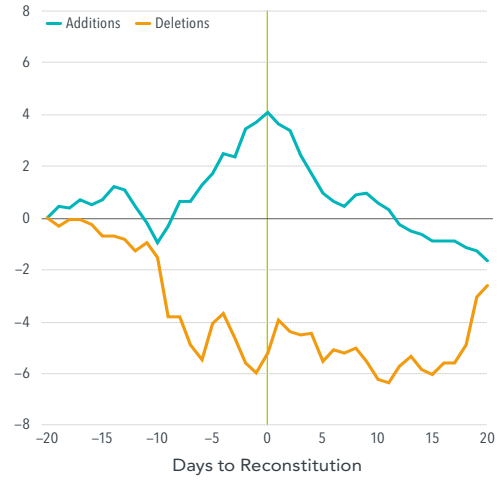
Panels C shows the cumulative price pressure from *t*–20 to reconstitution day and from reconstitution day to *t*+20 for the S&P, Russell, and CRSP indices. The observed pattern is the strongest for the S&P indices, which is not surprising given its magnitude of tracking assets compared to other indices.

EXHIBIT 9: Average Cumulative Excess Return of Additions and Deletions (%), *January 2014–December 2023*

Panel A: Average of All Indices



Panel B: Average of All Indices by Additions and Deletions



Panel C: S&P, Russell, and CRSP Indices

Index	*t*–20 to *t*	*t* to *t*+20
S&P 500	11.7	–1.6
S&P 400	4.6	–0.8
S&P 600	8.7	–0.5
Russell 1000 Growth	2.2	–3.0
Russell 1000 Value	3.1	–1.8
Russell 2000	–1.1	–3.1
CRSP US Large Cap Growth	7.0	–20.2
CRSP US Large Cap Value	2.0	–20.4
CRSP US Mid Cap	0.4	–1.8
CRSP US Small Cap	2.8	–3.3
Average	**4.1**	**–5.7**

Past performance is no guarantee of future results.

Excluding the CRSP US Large Cap Growth Index and the CRSP US Large Cap Value Index, the average cumulative excess return from t–20 to t is 4.0% and from t to t+20 is –2.0%. Cumulative excess returns (CERs) are calculated as the cumulative sum of the daily excess returns for an individual security vs. its respective index from market close 20 trading days before reconstitution. Cumulative excess returns for deletions are multiplied by –1 before being averaged with cumulative excess returns of additions. Value-weighted average CERs are calculated by weighting the sets of CERs on a day by the securities' respective free-float market capitalizations as of the most recent month prior to reconstitution. Migrating events for S&P, Russell, and CRSP indices are excluded; see Appendix 1 for more information. Tesla's addition to the S&P 500 on December 18, 2020, is excluded. Indices are not available for direct investment; therefore their performance does not reflect the expenses associated with the management of an actual fund.

Intraday Price Pressure

Similar to volume pressure, price pressure is concentrated around market close on effective reconstitution date. As shown in column 4 of **Exhibit 10**, the average trading volume of index additions and deletions in the closing auction on effective reconstitution date is 8–300 times higher than the median closing auction volume over the previous month for the same securities. Again, this result is robust to excluding triple-witching dates.

This comes with a cost. In Exhibit 10, we measure this cost in two ways: 1) the increase/decrease in price for an add/delete between 4 pm and closing auction (price pressure into market close) and 2) the decrease/increase in price for an add/delete between closing auction and next day's market open (overnight reversal). The market closing price is set by the closing auction, which clears submitted orders to maximize executed volume in a single trade, just after regular trading hours end at 4 pm. For the overnight reversal, we adjust the price movement for the overall market movement; we don't adjust the return from 4 pm to closing auction because the time is so short. We multiply returns to deletions by –1 to show additions and deletions together. We examine the five years from January 2019 through December 2023, the period for which we have high-frequency-trading data for all stocks in global equity markets.

For additions, the average price pressure in column 5 indicates the stock price has gone up from 4 pm to market close, meaning the index "buys" higher. The opposite is true for deletions. The price moved in an unfavorable direction for those buying additions and selling deletions for nine of 10 indices, and stayed about flat for the 10th (CRSP US Large Cap Growth Index), with costs as high as 10 bps (CRSP US Small Cap Index) and 14.7 bps (CRSP US Large Cap Value Index). For CRSP indices, the cost is greatest on day three of the five-day rebalance window, when the transition amount crosses the 50% mark.

By market open on the day following reconstitution, the average price pressure in column 6 indicates that the stock price has fallen, relative to the market, after index additions and increased following deletions. The estimated overnight reversal exceeds 15 bps for eight of the 10 indices and exceeds 40 bps for six of the 10, up to a cost of 97 bps for the Russell 1000 Value.

For the S&P 500, assuming about $42 billion in turnover of index-tracking assets per year due to index additions and deletions (61 bps index weight change per year on average times $6.9 trillion in index-tracking assets), then a cost of 54 bps between market close on reconstitution day and market open the next day is equivalent to $226 million per year in aggregate to index trackers.

Across all 10 indices, the average cost of rebalancing at market close on reconstitution day instead of market open the next day is 40 bps. And as we showed earlier, the cost increases with time: On average, prices move adversely for additions and deletions by 5.7% in the 20 days following reconstitution.

EXHIBIT 10: Trading Cost around Market Close on Effective Reconstitution Date, *January 2019–December 2023*

Index	Number of Adds/Deletes	Number of Days per Add/Delete	Average Closing Auction Volume as a Percentage of Daily Volume	Average Excess Closing Auction Volume vs. Previous 30 Days	Average Price Pressure into Market Close (bps)	Average Overnight Reversal (bps)
	(1)	(2)	(3)	(4)	(5)	(6)
S&P 500	30	1	45.6%	14,138%	4.1	−54.1
S&P 400	134	1	50.2%	10,326%	3.2	−42.3
S&P 600	327	1	53.6%	15,248%	7.3	−59.2
Russell 1000 Growth	81	1	52.0%	7,063%	1.8	−54.2
Russell 1000 Value	66	1	56.6%	6,614%	4.4	−97.0
Russell 2000	2,123	1	62.3%	29,336%	6.2	−3.4
CRSP US Large Cap Growth	25	5	29.0%	4,035%	−0.2	−17.9
CRSP US Large Cap Value	15	5	34.1%	5,036%	14.7	−47.8
CRSP US Mid Cap	145	5	30.7%	782%	0.7	−18.3
CRSP US Small Cap	643	5	31.5%	4,101%	10.0	−1.0
Equal-Weighted Average	–	–	–	–	5.3	−39.5

Data are from 2019 to 2023. Nondiscretionary additions and deletions (M&A, relist, spun-off, etc.) are excluded. Migrating events for S&P, Russell, and CRSP indices are excluded; see Appendix 1 for more information. Tesla's addition to the S&P 500 on December 18, 2020, is excluded. Average excessive closing auction volume is volume on reconstitution day as a percentage of median closing auction volume over the previous 30 calendar days for the same securities. Price pressure into market close is calculated as gross return from 4 pm to market close price on reconstitution day. Overnight reversal is calculated as gross return from market close on reconstitution day to market open the following day adjusted by market return, where the market return is calculated as the market-capitalization-weighted average return of all stocks traded in the US. Returns to deletions are multiplied by –1. All statistics are aggregated across stocks for an index and across reconstitution days using weighted averages, where the weights are the stocks' free-float market cap as of the previous month-end.

Is the adverse price pressure in the minutes around market close on reconstitution day statistically reliable? In **Exhibit 11**, we regress the return of additions or deletions from the last midpoint price of the continuous trading session on reconstitution day to the closing auction price (column 1) and from that closing auction price to the market open price on the following day (column 2) on flags indicating if a stock is added or deleted that day. The regressions include all US stocks with trading data on that day, not just the index changes. This allows us to have more power when testing the statistical reliability of the abnormal addition and deletion returns. We cluster standard errors by date and stock.

For index additions, there is a positive return of 9 bps, relative to all nonrebalanced stocks, from the last midpoint price of the continuous session on index reconstitution day to closing auction price on the same day. This pattern reverses in the next morning's open: Additions fall by a relative 13 bps by the next morning's open. This means that if an index fund buys an addition at the closing auction price on a reconstitution day, the fund pays a relative 9 bps more on average to buy the stock than if buying at the end of the day's continuous session. And after the fund pays up, the price of the stock falls by a relative 13 bps, on average, by the following morning.

The reverse pattern is true for deletions. On average, there is a negative return of 30 bps relative to nonrebalanced stocks leading up to market close on reconstitution day, meaning an index fund will on average sell lower, which reverses by market open the following day with an average positive relative return of 63 bps.

To confirm that the reversal is not due to the bid-ask bounce, in columns 3 and 4, we adjust the closing auction price by adding (subtracting) half the bid-ask spread for trades made below (above) the 4 pm midpoint price. The patterns remain the same.

EXHIBIT 11: Price Pressure into Closing Auction on Reconstitution Days and Overnight Price Reversal after Reconstitution, *2019–2023*

	Closing Auction	Overnight Reversal	Closing Auction, Adjusted	Overnight Reversal, Adjusted
	(1)	(2)	(3)	(4)
Additions	8.504***	−12.940**	6.887***	−11.914*
	(2.930)	(5.736)	(1.926)	(6.293)
Deletions	−30.186***	62.682***	−20.879***	46.825***
	(8.984)	(17.347)	(6.085)	(13.32)
Observations	847,266	846,424	847,140	843,119
Adjusted R^2	0.023	0.002	0.004	0.002

Regression specification for model (1) is: $Ret^{Auc}_{LastMid} = a + b * Additions + c * Deletions + e_T$, *where* $Ret^{Auc}_{LastMid}$ *is the gross return (in bps) from last midpoint price of the continuous session on T to the closing auction price. Regression specification model (2) is:* $Ret^{Open,T+1}_{Auc,T} = a + b * Additions + c * Deletions + e_T$, *where* $Ret^{Open,T+1}_{Auc,T}$ *is the market-adjusted return (in bps) from closing auction price on T to open auction price on T + 1. In models (3) and (4), returns are adjusted by adding (subtracting) half of the bid-ask spread into closing auction price for trades made below (above) last midpoint price to eliminate the effect of bid-ask spread bounce.*[9] $Additions$ *is an indicator variable with 1 for index additions and 0 for other stocks.* $Deletions$ *is an indicator variable with 1 for index deletions and 0 for other stocks. Standard errors are double-clustered by stock and date and reported in parentheses. Day fixed effects are included. Samples includes all index addition and deletion events as well as all other US stocks traded on the same index reconstitution days. Index migrations and events due to corporate actions are excluded. For CRSP indices in models (1) and (3), we include the events over all days during the five-day transition period. For CRSP indices in models (2) and (4), we only include the events on the last day of the five-day transition period. Tesla's addition to the S&P 500 on December 18, 2020, is excluded.* $*p < 0.1$; $**p < 0.05$; $***p < 0.01$

Investor Implications

An index-tracking approach generally lacks flexibility, which can leave returns on the table. To maintain low tracking error, index fund managers must rebalance when indices rebalance, demanding immediacy and unusually large volumes in trade execution on specific dates and at specific times. Using data on 10 widely tracked US indices from 2014 through 2023, we find that trade volume may be over 25 times higher on the reconstitution date than its prior 20-day average, with a spike of over 100 times near the market close. Demanding such unusually large trade volume can result in price pressure.

Since market prices are forward-looking and index rebalances are announced before the reconstitution date and often anticipated before the announcement date, an approach that is constrained to rebalance on the same day as an index may suffer from price pressure well ahead of the reconstitution date. Indeed, we find that stocks added to an index tend to go up in price prior to rebalance, while deletions tend to go down. This price pressure generally unwinds following a reconstitution. Across the 10 US indices examined, nonmigrating index additions outperformed and index deletions underperformed their respective indices by 4.1%, on average, in the month leading up to index reconstitution. This price pressure reverses by 5.7% in the 20 trading days following reconstitution, on average.

9. Similar to Bogousslavsky and Muravyev (2023).

Seeking to minimize tracking error by buying additions and selling deletions in the market close on reconstitution day further detracts from performance, compared to buying at the end of regular trading on reconstitution day or waiting until market open the next morning. The price for additions on average goes up by 9 bps, relative to nonrebalanced stocks, in the roughly 10 seconds between 4 pm on reconstitution day and market close, and then reverses by a relative –13 bps by market open the next morning. On average the price for deletions falls relative to nonrebalanced stocks by 30 bps in the 10-second span from 4 pm to market close on reconstitution day, with a reversal of a relative 63 bps by market open the following day.

The patterns are not limited to complete additions and deletions; in unreported results, we also see a spike in trading volume and price pressure for stocks that experience an index share change.

While some of these costs can be mitigated by trading on a different date or spreading trading over a few days, an even better approach would be a daily process that consistently focuses on stocks with higher expected returns and spreads turnover across all trading days in the year, with flexibility across stocks and quantities. Such an approach allows investors to avoid the cost of demanding immediacy from the market. A daily investment process also allows for the incorporation of short-term information about expected returns that is relevant over days or months, such as momentum and information from securities lending fees. Such short-term information about differences in expected returns cannot be incorporated effectively if an index is rebalanced only once or twice per year. Overall, a daily process that uses real-time market information can enhance investment outcomes by maintaining continuous and accurate exposure to securities with higher expected returns while also spreading turnover through time and continuously balancing tradeoffs between premiums, costs, and diversification.

Appendix 1: Migrating Additions and Deletions Definitions

S&P	Russell	CRSP
S&P 500: Additions (deletions) that are deleted from (added to) the S&P 400 or S&P 600 indices **S&P 400**: Additions (deletions) that are deleted from (added to) the S&P 500 or S&P 600 indices **S&P 600**: Additions (deletions) that are deleted from (added to) the S&P 400 or S&P 500 indices	**Russell 2000**: Additions (deletions) that are deleted from (added to) the Russell 1000 Growth or Russell 1000 Value indices **Russell 1000 Growth:** Additions (deletions) that are deleted from (added to) the Russell 2000 or Russell 1000 Value indices (or weight adjusted in Russell 1000 Value Index) **Russell 1000 Value**: Additions (deletions) that are deleted from (added to) the Russell 2000 or Russell 1000 Growth indices (or weight adjusted in Russell 1000 Growth Index)	**CRSP US Large Cap Growth**: Additions (deletions) that are deleted from (added to) the CRSP US Small Cap or CRSP US Large Cap Value indices (or weights adjusted in either index) **CRSP US Large Cap Value**: Additions (deletions) that are deleted from (added to) the CRSP US Small Cap or CRSP US Large Cap Growth indices (or weights adjusted in either index) **CRSP US Mid Cap**: Additions (deletions) that are deleted from (added to) the CRSP US Small Cap Index (or weight adjusted in the CRSP US Small Cap Index) **CRSP US Small Cap**: Additions (deletions) that are deleted from (added to) the CRSP US Large Cap Growth, CRSP US Large Cap Value, or CRSP US Mid Cap indices (or weights adjusted in either index)

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