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A comprehensive long-term analysis of S&P 500 index additions and deletions

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ABSTRACT

We investigate the long-term effects of S&P 500 index additions and deletions on a sample of stocks from 1962 to 2003 and find a significant long-term price increase for both added and deleted stocks, with deleted stocks outperforming added stocks. The long-term price increase for added stocks can be attributed to increases in institutional ownership, liquidity, and analyst coverage, and a decrease in the shadow cost in the long-term. However, while deletion has no significant effect on analyst coverage and shadow cost, we find a rebound in the institutional ownership and liquidity of deleted stocks. The difference in the long-term price increase of added and deleted stocks can be explained by analyst coverage and operating performance.

1. Introduction

The number of index-related financial assets has increased significantly in the past few decades. In the United States, the proportion of index fund assets to the total equity funds increased from 16% in 2001 to 33% in 2011.[3] The underlying assets of the S&P index component stocks, which are now worth about US$1.1 trillion, include investment products such as index funds, exchange traded funds, index futures, and index options. The composition of the constituent index stocks has an important effect on the value of these assets, and the stocks are continuously monitored by institutional investors. Accordingly, additions and deletions to the S&P index may have both short- and long-term effects on firm fundamentals. However, previous studies typically investigate the short-term price performance after index additions and deletions (e.g., Scholes, 1972; Harris and Gurel, 1986; Wurgler and Zhuravskaya, 2002). As a result, there is little research on the long-term effects of index additions and deletions on stocks.[4] In this study, we conduct a comprehensive analysis of the long-term performance of S&P 500 index stock additions and deletions. We examine the stock price performance and the operating performance of firms five years before and after index addition or deletion. We also analyze whether there are any long-term effects on the information quality and liquidity of the affected stocks, including changes in institutional ownership, liquidity, analyst coverage, and investor recognition.

There are a number of reasons why the long-term effects of addition or deletion on information quality and liquidity can be expected to influence permanent stock prices. Stocks added to the S&P 500 index are subject to greater scrutiny by investors and analysts, which helps to reduce information asymmetry (Denis et al., 2003). Furthermore, as the constituent stocks are chosen to be representative of the market, the addition of a stock to the index signals that the company is an industry leader, thereby resulting in greater investor recognition (Cai, 2008). As more investors become aware of the company, the shadow cost declines (Chen et al., 2004; Baran and King, 2012). An addition to the index may also improve the liquidity of a stock, which in turn would lower the liquidity premium required by investors. These factors signal either an

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[3] *Wall Street Journal*, February 20, 2012.

[4] The exception is Cai (2008), who examines the long-term effects of Russell 2000 index rebalancing on portfolio evaluation.

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increase in future operating cash flows or a reduction in the risk premium required by investors, both of which have long-term positive effects on stock prices.

For deleted stocks, the return required by investors may increase if there is a decline in analyst coverage, investor recognition, or liquidity. However, it remains unknown whether deletion will result in a decline in long-term operating performance.[5] While a firm may have been deleted for having poor prospects, it is possible for the firm to restructure so that its operating performance does not deteriorate in the long term.

We investigate the long-term effect of S&P 500 index addition and deletion on stocks from 1962 to 2003 and find a significant long-term price increase for both added and deleted stocks. It is interesting to note that the average abnormal return is higher for deleted stocks than for added stocks.[6] The long-term price increase for added stocks can be attributed to increases in institutional ownership, liquidity, and analyst coverage, and a decrease in the long-term shadow cost. The long-term effect for deleted stocks is a bit more complicated. While there is no significant effect on analyst coverage and shadow cost, there is a rebound in institutional ownership and liquidity after stock deletion. One interesting result is that the long-term operating performance declines for added stocks and increases slightly for deleted stocks subsequent to the year of stock addition or deletion (*year t*). This suggests that firms are added to the index during their peak performance stage and cannot sustain this performance in the long-run. In contrast, firms are deleted from the index during their worst performance stage but tend to recover somewhat in the long term, displaying a U-shaped pattern from year $t-5$ to year $t+5$. A cross-sectional regression analysis shows that the difference between the long-term returns of deleted stocks and added stocks can be explained by the difference in their operating performance.

The remainder of this paper is organized as follows. Section 2 reviews the literature on the effects of index composition changes. Section 3 describes the data. The results for long-term stock price performance are presented in Section 4, and those for operating performance in Section 5. Section 6 presents the evidence on the changes in information quality and liquidity after index revisions, and Section 7 introduces some regression analyses. We present our conclusions in Section 8.

2. Literature review

Previous studies have examined the effects of index composition changes on constituent stocks, with a focus on the addition of stocks to an index. There is a significant and well-documented stock price increase when a stock is added to an index, a finding for which several hypotheses have been advanced.

The first explanation is the downward-sloping demand hypothesis, which posits that when a stock is added to an index, there is additional demand from index-related users to hold the stock, which results in short-term upward price pressure. According to this hypothesis, the demand curve is downward sloping not only in the short run, but also in the long run (Scholes, 1972; Shleifer, 1986; Lynch and Mendenhall, 1997). Several studies provide consistent empirical evidence for stocks in the S&P 500 index (Harris and Gurel, 1986; Wurgler and Zhuravskaya, 2002), and the hypothesis is also supported by evidence from other US indices and markets, such as the Russell 2000 index (Biktimirov et al., 2004), the S&P Small Cap 600 index (Shankar and Miller, 2006), the TSE 300 index (Chung and Kryzanowski, 1998), the FTSE 100 index (Mase, 2007), and the ISE-100 and ISE-30 indices (Bildik and Gulay, 2008).

The second explanation is the liquidity effect hypothesis, which predicts that liquidity will improve (deteriorate) after a stock is added to (deleted from) an index (Chen et al., 2004). The amount of information on a stock increases upon its addition to an index due to greater attention from investors and greater coverage from analysts, the media, and other financial intermediaries. As a result, the information asymmetry declines and more liquidity becomes available. The concurrent decline in the liquidity premium causes a positive price movement. Furthermore, the presence of more investors trading the stock reduces the inventory cost component of liquidity, which results in a further positive price adjustment (Chen et al., 2004). Various studies provide empirical support for the liquidity effect hypothesis for the S&P 500 index (Hegde and McDermott, 2003; Becker-Blease and Paul, 2006), for the Dow Jones index (Beneish and Gardner, 1995), and for the TSE 300 index (Chung and Kryzanowski, 1998).

The third explanation is the investor recognition or 'shadow cost' hypothesis (Merton, 1987), which states that investors hold incompletely diversified portfolios in segmented markets. The return required by less than fully diversified investors is higher than that required in a full-information setting, with the difference between the two returns representing the shadow cost. When a stock is added to an index, this raises the awareness of investors, who will hold it to achieve diversification. The shadow cost of the stock thus falls, resulting in an increase in the stock price (Chen et al., 2004). Elliott et al. (2006) report that increased investor awareness explains the cross-section of abnormal announcement returns for stocks on the S&P 500 index.

The fourth explanation is the operating performance hypothesis, which states that stocks added to an index are more likely to have better prospects and to display improved operating performance. Furthermore, as institutional investors monitor the constituent stocks more closely, they will exert pressure on the firm to improve performance (Denis et al., 2003).

The addition of a stock to a major index signals that the firm is a leader in a leading industry. For example, Cai (2007) finds that the addition of a stock to the S&P 500 index conveys favorable information about the company or industry. Several studies (Denis et al., 2003; Elliott et al., 2006) look at changes in analyst earnings forecasts and realized earnings in the current year and in the fiscal year after a stock is added to the S&P 500 index, but do not find evidence of higher earnings. However, this may be because they examine the short-term operating performance.

Clearly, there are several fundamental reasons to expect a permanent, long-term price effect from the addition of a stock to an index. Although there are fewer grounds on which to predict the effects of a deletion from an index, the driving factors for added stocks should work in the opposite direction for deleted stocks. In the next section, we provide empirical evidence for both added and deleted stocks.

3. Data

3.1. Sample construction

We analyze the changes in the constituent stocks underlying the S&P 500 index from July 1962 to December 2003. The data from July 1962 to December 2000, which are also used by Chen et al. (2004), can be downloaded from the *Journal of Finance* website.[7] The data on effective dates between 2001 and 2003 are

[5] The criteria for inclusion in the S&P 500 index include market capitalization, liquidity, domicile, public float, sector classification, financial viability, and treatment of IPOs. A stock can be deleted from the index if the company is involved in a merger, acquisition, or significant restructuring, or if it substantially violates one or more of the addition criteria (Standard and Poor's, 2011).

[6] It should be noted that the sample size differs between the added and deleted stocks. The number of deleted stocks is smaller than the number of added stocks because many stocks were deleted due to mergers, spinoffs, and other corporate finance events. Trading in such stocks ceased within a few days of their deletion.

[7] http://www.afajof.org/supplements.asp.

collected from CRSP, and the data on announcement dates are from the S&P 500 Index Focus Monthly Review and the ProQuest database. We collect information on the stock returns, trading volume, number of shares outstanding, and market capitalizations from the CRSP database, and related accounting data from the Compustat database. Institutional ownership data are obtained from the Thomson Financial Institutional database, the analyst forecasts are taken from IBES, and the Fama–French three-factor data are downloaded from Kenneth French's website.[8]

Over the study period, the number of constituent stock changes per year in the S&P 500 index ranges from 8 to 60. Fig. 1 plots the number of changes to the S&P 500 index between 1962 and 2003. Altogether, 937 stocks were added to or deleted from the S&P 500 index so that, on average, 22 stocks were added to the index and 22 deleted, every year.

Following Chen et al. (2004), we exclude stocks that were added due to a merger or takeover (54), spinoff (37), or change in share type (10), or for which there are insufficient data (48). Seven hundred eighty-eight added stocks are included in the sample.

In terms of deleted stocks, we first exclude 436 stocks for which trading stopped within two days of deletion, as according to Chen et al. (2004) these stocks are most likely merger targets. Of the remaining stocks, we exclude those that were deleted due to a final merger offer that had been or was likely to be accepted by stockholders (161); spinoffs (27); divestiture, bankruptcy, or liquidation (25); buyout, suspension, or delisting from the NYSE (8); LBO or MBO (5); treatment as a foreign firm (7), and other reasons such as a change in share type (24). Two hundred forty-four deleted stocks are included in the final sample, which is roughly a quarter of the 937 total changes. This sample is consistent with that used by Chen et al. (2004), who find that about three quarters of stock deletions from the index are involuntary and due to merger, bankruptcy, or other forms of major restructuring.

3.2. Deleted stock sample

According to Chen et al. (2004), stocks are involuntarily deleted from the index either because the firm is no longer representative of its industry, or the industry is no longer representative of the economy. We check the universe of stocks (937 added and deleted stocks). We check the numbers of stocks added to or deleted from the same industry (added–deleted) from 1962 to 2003 year by year, and then in four sub-periods. There is strong evidence that over time greater numbers of manufacturing industry stocks (SIC codes 2 and 3) are replaced by stocks in the finance, insurance, real estate, and services industries (SIC codes 6 and 7) in the S&P 500 index. For example, for SIC code 2 stocks, the number of added stocks minus deleted stocks is −8, −10, −25, and −25 in 1962–1971, 1972–1981, 1982–1991, and 1992–2003, respectively. For stocks in SIC code 7, the number of added stocks minus deleted stocks is 3, 4, 10, and 23 in 1962–1971, 1972–1981, 1982–1991, and 1992–2003, respectively.

We further check some two-digit sub-industries such as stone, clay, glass, and concrete products (SIC code 32), railroad transportation (SIC code 40), security and commodity brokers, dealers, exchanges, and services (SIC code 62), and health services (SIC code 80). We find there are more deleted stocks than added stocks in some of the older industries (SIC 32 and 40), while the result is reversed for some of the newer industries (SIC 62 and 80). Therefore, stock deletion appears to be related to poor industry prospects.

For the remaining 244 deleted firms in the 1995–2003 period, we find two common reasons for being deleted from the S&P 500. One reason is that the firms are no longer "considered leading companies in leading industries". Again, this is related to the firms' poor prospects. Another common reason is that the firm switches to the S&P SmallCap 600 Index, which occurs after a company declines in market capitalization due to a significant drop in its stock price.

[8] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

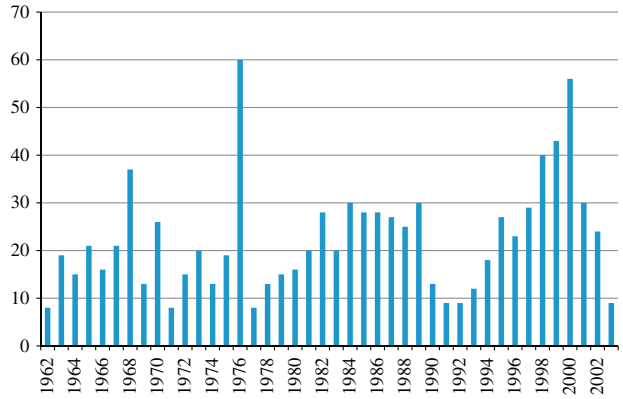

Fig. 1. Number of constituent stock changes. The data extend those used by Chen et al. (2004). The data for before 2001 are from the website of the *Journal of Finance*. The method of Chen et al. is used to collect the data for the period from January 2001 to December 2003.

Table 1
Summary statistics for the sample stocks.

	Firm Size	*RET_P1Y*	*RET_P5Y*	*M/B*
Panel A: Additions				
Mean	2890	0.39	3.78	3.3
Median	951	0.21	1.49	2.16
S.D.	5808	0.77	10.87	3.53
P10	104	−0.22	0.12	0.86
P90	7112	1.12	7.5	6.76
Panel B: Deletions				
Mean	322	−0.05	0.01	1.34
Median	128	−0.01	−0.14	0.86
S.D.	527	0.4	0.84	2.85
P10	17	−0.61	−0.8	0.35
P90	905	0.39	0.9	1.84

This table reports the summary statistics for sample firms added to or deleted from the S&P 500 index between July 1962 and December 2003. *Firm Size* is the closing price at the end of month $t-1$ times the number of shares outstanding in millions of dollars. *RET_P1Y* is the cumulative raw return from month $t-12$ to $t-1$. *RET_P5Y* is the cumulative raw return from month $t-60$ to $t-1$. *M/B* is the market-to-book ratio at month $t-1$. The sample comprises 788 added stocks and 244 deleted stocks.

3.3. Summary statistics

Table 1 presents the characteristics of the sample stocks. *Firm Size* (in millions of dollars) is calculated at the end of the previous month by multiplying the closing monthly stock price by the number of shares outstanding. *RET_P1Y* is the cumulative raw return in the previous year. *RET_P5Y* is the cumulative raw return over the previous five years. *M/B* is the market-to-book ratio in the previous month.

Table 1 demonstrates that the firms being added to the S&P 500 index are much larger than those being deleted. The average firm size for added stocks is US$2,890 million, compared to US$322 million for deleted stocks. The added stocks perform significantly better before index revision, with average cumulative returns of 39%

in the previous one-year period and 378% in the previous five-year period. In comparison, the average cumulative returns for the deleted stocks are −5% and 1%, respectively. The added stocks have higher market-to-book ratios (3.3) than the deleted stocks (1.34), suggesting that added stocks are more likely to be growth stocks.

4. Long-term stock performance

4.1. Buy and hold raw returns and stock market index adjusted returns

We now examine the long-term stock price performance of the added and deleted stocks after index revision. Table 2 reports the three- and five-year raw returns and the market adjusted cumulative returns. We use the CRSP Value Weighted index (including dividends) as the benchmark for calculating the market adjusted returns.

Table 2 shows that both added and deleted stocks have positive raw returns in the three- and five-year post-event periods. The average cumulative raw returns of added stocks are 40% over the three-year period and 75% over the five-year period. Rather surprisingly, the average cumulative returns of deleted stocks are even larger, at 68% and 107% in the three- and five-year periods, respectively. Although the short-term price pressure for added stocks is well documented, this is not the focus of this study. Nevertheless, we can still infer the short-term price pressure based on return performance over the [1,36]- and [0, 36]-month periods, as the difference between the two event windows represents the effect of short-term price pressure. The difference is 4% for added stocks and −7% for deleted stocks, which is consistent with the previous evidence on short-term price pressure. For example, Harris and Gurel (1986) find that there is an immediate price increase of more than 3% after the announcement of the addition of a stock to the S&P 500 index, although the increase is almost fully reversed after two weeks. Some studies, such as that of Lynch and Mendenhall (1997), also provide evidence that is consistent with the short-term price pressure effect, although they also find that a portion of the increase remains permanent and cannot be explained by price pressure.

Table 2 shows that both added and deleted stocks outperform the market (CRSP Value-Weighted index) in the long-run. Over a five-year period, added stocks outperform the market by 11% (with a *t*-value of 2.17), whereas deleted stocks outperform the market by 54% (with a *t*-value of 4.92).[9] The difference in returns between the added and deleted stocks is 28% over the three-year period (with a *t*-value of 3.22) and 32% over the five-year period (with a *t*-value of 2.62). These results are consistent with those of Cai (2008), who investigates the long-term effect of Russell 2000 index rebalancing.

One concern is that because some deleted stocks are simply delisted from the exchange, survivorship bias may explain why the returns for the deleted stocks that remain listed are higher than those for added stocks after index composition changes. To address this issue, we check the reasons for the delisting of added and deleted stocks over the subsequent five years. The results are reported in Table 3. Following Shumway (1997), we classify the reasons for delisting as merger, exchange, liquidation, or performance. Of the 99 added stocks that were subsequently delisted, 86 are due to mergers, 5 are due to migration to another exchange, and 8 are due to performance. Of the 55 deleted stocks that were delisted, 30 are due to mergers, 3 due to exchanges, 3 due to liquidation, and 19 due to performance. The inclusion of the delisting returns in our sample, which is calculated by comparing a value after delisting against the price on the security's last trading date, does not materially affect the results in Table 2.[10]

Table 2
Market adjusted buy-and-hold long-term returns.

	Post-event months		
	[0,36]	[1,36]	[1,60]
Raw returns (additions)	0.44	0.40	0.75
Raw (additions) – CRSP	0.09**	0.06	0.11**
t-Value	2.22	1.59	2.17
Raw returns (deletions)	0.61	0.68	1.07
Raw (deletions) – CRSP	0.32***	0.41***	0.54***
t-Value	3.83	4.40	4.92
Raw ret (deletions) – raw ret (additions)	0.17*	0.28***	0.32***
t-Value	1.90	3.22	2.62

This table reports the mean market-adjusted returns of stocks added to or deleted from the S&P 500 index between July 1962 and December 2003. The sample comprises 788 added stocks and 244 deleted stocks. CRSP denotes the CRSP value-weighted index return (with dividends).
* Significance at the 10% level of confidence.
** Significance at the 5% level of confidence.
*** Significance at the 1% level of confidence.

Table 3
Delisting time.

Reasons for delisting	Post-event period (months)					
	[1,12]	[13,24]	[25,36]	[37,48]	[49,60]	Total
Panel A: Additions						
Merger	11	21	21	19	14	86
Exchange	3			2		5
Liquidation						0
Δ Exchange						0
Performance			2	1	5	8
Total	14	21	23	22	19	99
Panel B: Deletions						
Merger	7	6	6	5	6	30
Exchange		2		1		3
Liquidation		2		1		3
Δ Exchange						0
Performance	7	6	1	2	3	19
Total	14	16	7	8	9	55

This table reports the reasons for and timing of the delisting of added and deleted stocks from the stock exchange and the categories of reasons for delisting. Following Shumway (1997), we treat Merger, Exchange, Liquidation, and Δ Exchange as non-negative news and Performance as negative news. The number reported is the number of stocks delisted for that particular period and particular reason.
The sample period runs from July 1962 to December 2003. The sample comprises 788 added stocks and 244 deleted stocks at month *t*.

4.2. Calendar-time abnormal returns

In addition to the standard event study, we also employ the calendar time approach to measure the abnormal returns associated with index additions and deletions. An advantage of this approach is that the variance in the portfolio automatically takes into account the cross-sectional correlation among the individual stocks that comprise the portfolio. In addition, the calendar-time event portfolio approach represents an implementable investment strategy (Desai et al., 2002). We form equal- and value-weighted portfolios of added and deleted stocks in the event months and

[9] We also check whether added and deleted stocks outperform the Dow Jones Industrial Average index (DJIA), and the S&P 500 index. The results are stronger. For example, added stocks outperform the DJIA by 19% over a [1,36] event period and by 38% over a [1,60] event period. Deleted stocks outperform the DJIA by 57% over a [1,36] event period and by 87% over a [1,60] event period.

[10] Some firms were added to and deleted from the S&P 500 index on the same dates, and thus their returns may not be independent of each other. Following Kolari and Pynnonen (2010), we use the scaled CAR to obtain the *t*-values to check the level of significance. Although not reported, the results are robust and are available on request.

Table 4
Calendar-time abnormal long-run returns.

	Intercept	$R_m - R_f$	*SMB*	*HML*	*MOM*	R^2
Panel A: Value-weighted						
Additions	0.004***	1.208***	0.167***	−0.011	−0.151***	0.32
t-Value	6.14	76.92	8.32	−0.48	−9.92	
Deletions	0.006***	1.004***	0.772***	0.655***	−0.355***	0.17
t-Value	3.41	22.49	15.04	10.66	−9.13	
Panel B: Equal-weighted						
Additions	0.002***	1.251***	0.22***	0.089***	−0.229***	0.34
t-Value	3.48	80.62	11.08	3.75	−15.26	
Deletions	0.004**	1.051***	0.839***	0.711***	−0.357***	0.19
t-Value	1.99	23.75	16.47	11.66	−9.25	

This table presents the monthly abnormal returns of stocks added to or deleted from the S&P 500 index.
The sample period is from July 1962 to December 2003. The sample comprises 788 added stocks and 244 deleted stocks. The factors are available from French's website.
** Significance at the 5% level of confidence.
*** Significance at the 1% level of confidence.

investigate the portfolio performance in the following five years. We then regress the excess returns of the portfolios against the Fama–French three factors and Carhart's momentum factor. The excess return is computed as follows:

$$R_{pt}^{AorD} - R_{ft} = \alpha + \beta_m(R_{mt} - R_{ft}) + \beta_s SMB_t + \beta_h HML_t + \beta_m MOM_t + \varepsilon_t \quad (1)$$

where R_{pt} is a portfolio's return for month t, with A and D in the superscript indicating added and deleted stocks, respectively; R_{ft} is the risk-free interest rate; $(R_{mt} - R_{ft})$ is the market excess return; SMB_t is the difference in the returns of portfolios of small and large cap stocks; HML_t is the difference between the returns of portfolios of high and low book-to-market ratio stocks; and MOM_t is the highest monthly portfolio return minus the lowest monthly portfolio return over the previous 2- to 12-month period. The expected value of the intercept α, which measures the monthly abnormal return, is zero under a null hypothesis of no abnormal performance.

The regression results are reported in Table 4. Panel A reports the results based on the value-weighted portfolio returns. For added stocks, α is 0.4% and significant at the 1% confidence level. For deleted stocks, α is 0.6% and also significant at the 1% level. Thus, both added and deleted stocks outperform the benchmark in the five-year period after the index change. In terms of factor loadings, the coefficient on the *SMB* factor for added stocks is 0.167 (with a *t*-value of 8.32) and is smaller than the coefficient for deleted stocks (0.772, with a *t*-value of 15.04). This is consistent with Table 1, which shows that deleted stocks are much smaller than added stocks. The coefficient on the *HML* factor is positively significant for deleted stocks (0.655, with a *t*-value of 10.66) but insignificant for added stocks. The finding that added stocks do not load on the *HML* factor indicates that such stocks are healthier firms with little distress risk. It is interesting to note that the coefficients on the momentum factor (*MOM*) are significantly negative for both added and deleted stocks, suggesting that added and deleted companies do not ride on market momentum.

Panel B of Table 4 reports the results for the equal-weighted portfolios, which are similar to those reported in Panel A. The intercepts (α) are 0.2% (with a *t*-value of 3.48) and 0.4% (with a *t*-value of 1.99) for added and deleted stocks, respectively. The coefficients on the factor loadings are similar to those in Panel A, with the exception that the coefficient of *HML* for added stocks is significantly positive. The deleted stocks, again, have higher factor loadings on *SMB* and *HML*, and the coefficients on *MOM* remain significantly negative for both the added and deleted stocks.

Overall, the evidence complements existing research on index additions in showing not only a short-term price appreciation for stocks added to the index, but also the persistence of this price increase in the subsequent five-year period. However, contrary to conventional wisdom, it may not be wise for investors to sell deleted stocks that move to the S&P Small Cap 600 Index or are no longer the leading companies in their industries, as these stocks also outperform the market in the long run.

5. Changes in operating performance

As stocks that are added to and deleted from the S&P 500 index experience abnormal returns in the long run, the evidence clearly cannot be explained by the downward-sloping demand curve. Rather, the evidence suggests the influence of changes to company fundamentals. In this section, we examine whether there are any noticeable changes in the operating performance of companies added to or deleted from an index.

We follow Loughran and Ritter (1997) and examine several operating efficiency measures. The first is *Profit Margin*, which is defined as net income divided by sales. The second is *ROA*, which is defined as net income over total assets. The third is *OIBD/Assets*, which is operating income divided by total assets, with operating income defined as the operating income before depreciation, amortization, and taxes, plus interest income. The fourth is *(C&RD)/Assets*, which is capital and R&D expenditure as a proportion of total assets. The fifth is *M/B*, or the firm's market-to-book ratio.

We classify the companies into industry sectors based on the two-digit SIC codes. The five operating efficiency measures are adjusted by the respective industry averages in the corresponding year. We then compare the measures from year $t-5$ to year $t+5$, with t being the year of index addition or deletion.

Table 5 reports the operating performance over the 10-year period for added and deleted stocks. Panel A presents the results for added stocks. The adjusted operating measures are all positive in the 10-year period, and the added stocks all record a better performance than that of their industry peers. The performance is especially good just before addition to the index. For example, the adjusted values of *OBID/Assets* are 3.58% and 3.44% in years $t-1$ and t, respectively, but decline to 2.92% and 2.60% in years $t+1$ and $t+2$, respectively. This is not surprising, because the S&P 500 index is likely to choose better performing companies for its constituent stocks. Compared with industry peers, these companies continue to perform well in terms of operating results as much as five years after addition to the index. Panel B presents the results for deleted stocks. In contrast to the results for added stocks, the adjusted operating measures for deleted stocks are mostly negative in the 10-year period, indicating that companies that are deleted from the S&P 500 index are poor performers in the industry both before and after deletion from the index.

Panel C of Table 5 reports the results of the Wilcoxon test for the differences in operating measures in year $t-5$ vs. year t and in year t vs. year $t+5$ for added and deleted stocks. For added stocks, all of the operating measures except for *C&RD/Assets* increase from year $t-5$ to year t and then decrease from year t to year $t+5$, although they are still above the industry average. For deleted stocks, all five operating measures decrease from year $t-5$ to year t. In the post-deletion period, there is evidence of improvement in operating performance. For example, *ROA* and the *M/B* ratio increase at the 5% significance level, and the profit margin increases at the 10% significance level. Overall, Panel C shows that the operating performance of deleted stocks generally displays a U-shape from year $t-5$ to year $t+5$.[11]

[11] For a robustness check, we conduct further tests for two different samples: a sample restricted to firms that appear from years t to $t+5$; and a second sample restricted to firms that appear from years $t-5$ to $t+5$. The results are similar to those reported in Table 5. We also conduct similar robustness checks for Tables 6 to 8 and find similar results to those already reported.

Table 5
Changes in industry-adjusted operating performance.

Year	Obs	*OIBD/Assets*	*C&RD/Assets*	*Profit Margin*	*ROA*	*M/B*
Panel A: Additions						
−5	515	0.0251	0.0156	0.0188	0.0122	0.5
−4	565	0.0253	0.0151	0.0187	0.0148	0.6
−3	604	0.0313	0.0131	0.0193	0.0161	0.71
−2	636	0.0301	0.0094	0.0213	0.0172	0.74
−1	656	0.0358	0.0096	0.0244	0.0196	0.85
0	662	0.0344	0.0086	0.0222	0.016	0.74
1	644	0.0292	0.0098	0.0198	0.014	0.57
2	629	0.026	0.0108	0.0172	0.0109	0.5
3	612	0.0245	0.0062	0.0194	0.0127	0.4
4	593	0.0212	0.0028	0.0175	0.0128	0.34
5	568	0.0188	0.002	0.0181	0.0105	0.28
Panel B: Deletions						
−5	155	−0.0093	−0.0009	−0.0005	−0.0056	−0.11
−4	159	−0.0067	−0.0036	−0.002	−0.0047	−0.17
−3	162	−0.0062	−0.0051	−0.0041	−0.0067	−0.18
−2	165	−0.0154	−0.0055	−0.0097	−0.0104	−0.2
−1	167	−0.0144	−0.0074	−0.0111	−0.0125	−0.22
0	165	−0.015	−0.0092	−0.0109	−0.0122	−0.2
1	150	−0.0098	−0.0057	−0.0071	−0.0065	−0.15
2	144	−0.0049	−0.0101	−0.0091	−0.0087	−0.16
3	143	−0.0025	−0.0122	0.0006	−0.0023	−0.09
4	133	−0.0086	0	−0.0052	−0.0021	−0.08
5	127	−0.0121	−0.0059	−0.0044	−0.0024	−0.07
Panel C: Significance of difference						
Additions						
$t-5$ vs. t		2.07**	−2.27**	1.81*	1.81*	2.18**
t vs. $t+5$		−4.41***	−2.43**	−2.75***	−3.63***	−7.54***
Deletions						
$t-5$ vs. t		−1.79*	−2.29**	−3.05***	−3.12***	−1.89*
t vs. $t+5$		1.07	0.79	1.76*	2.44**	2.00**

This table reports the industry-adjusted average values of operating performance before and after a stock is added to or deleted from the S&P 500 index. *Profit Margin* is defined as net income divided by sales. *ROA* is defined as net income over total assets. *OIBD/Assets* is operating income divided by total assets, where operating income is defined as operating income before depreciation, amortization, and taxes, plus interest income. (*C&RD*)/*Assets* is capital and R&D expenditure as a proportion of total assets. *M/B* is the firm's market-to-book ratio. Panels A and B report the operating performance for added and deleted stocks, respectively, between fiscal years $t-5$ and $t+5$. Panel C reports the t-values for the differences in the means. The sample period is from July 1962 to December 2003. The data are taken from the CRSP and Compustat databases.

* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

6. Information quality and liquidity

As we have shown, both added and deleted stocks outperform the benchmark in terms of stock price and long-term performance. However, as Table 5 demonstrates, although added stocks perform better than their industry peers in terms of operating results, the same cannot be said of deleted stocks. Thus, the stock price performance of added and deleted stocks clearly cannot be wholly attributed to operating performance. We further investigate the relationship between stock price performance and operating performance later. In this section, we examine the changes in information quality and liquidity for added and deleted stocks after index revisions. Information quality is measured by institutional ownership, investor recognition, and analyst coverage while liquidity is measured by turnover and Amihud illiquidity, as described in the subsections that follow.

6.1. Institutional ownership

Many institutional investors adopt investment strategies that are tied to the S&P 500 index. In addition to passive funds such as index and exchange-traded funds, many actively managed funds adopt the S&P 500 index as the benchmark to beat. Consequently, the announcement by Standard and Poor's of changes to the component stocks of the index affects the holdings of institutional investors. We expect the institutional ownership of a company to increase when it is added to the S&P 500 index, and to decrease when it is deleted. We create two proxies for institutional ownership: *IO_NO* and *IO_RATIO*. *IO_NO* is the number of institutions holding the stock and *IO_RATIO* is the proportion of the stock that is held by institutions, which is calculated by the total number of shares held by institutions divided by the number of shares outstanding. Because ownership data is only available from 1980 onward and we need to investigate ownership five years before and after index changes, we can only analyze the changes in institutional ownership from 1985 to 2003.

Table 6 reports the results. For added stocks, both of the institutional ownership proxies increase significantly from year $t-5$ to year $t-1$, indicating that institutional investors increase their holdings in these companies before they are added to the index. The proportion of institutional ownership (*IO_RATIO*) increases from 0.52 in year $t-5$ to 0.59 in year $t-1$, and the number of institutional investors (*IO_NO*) increases from 105 in year $t-5$ to 176 in year $t-1$. This is probably because the added stocks gain recognition before addition to the index for outperforming the market in terms of stock price and operating performance. In the year of addition to the index, the two institutional ownership proxies further increase. *IO_NO*, in particular, increases from 176 in year $t-1$ to 228 in year t. There is no noticeable change in institutional ownership for deleted stocks before deletion from the index, but

Table 6
Changes in institutional ownership and the shadow cost.

Year	Obs (IO)	*IO_RATIO*	*IO_NO*	Obs (shadow costs)	Shadow costs
Panel A: Additions					
−5	182	0.52	105	368	12.321
−4	204	0.55	118	385	9.307
−3	245	0.56	129	422	12.715
−2	281	0.57	148	453	10.094
−1	310	0.59	176	513	8.949
0	342	0.61	228	535	5.395
1	358	0.59	240	538	4.41
2	376	0.59	244	540	3.726
3	370	0.59	256	550	3.199
4	379	0.6	260	537	2.912
5	386	0.61	269	533	3.15
Panel B: Deletions					
−5	69	0.55	127	81	0.267
−4	70	0.55	128	80	0.448
−3	72	0.54	129	84	0.375
−2	74	0.55	131	89	0.395
−1	75	0.55	125	104	0.459
0	74	0.48	88	143	0.375
1	70	0.48	75	137	0.353
2	63	0.53	84	137	0.397
3	64	0.55	101	146	0.392
4	64	0.59	114	139	0.407
5	62	0.6	118	133	0.424
Panel C: Significance of difference					
Additions					
$t-5$ vs. t		9.28***	24.96***		−2.75***
t vs. $t+5$		4.84***	9.96***		−3.47***
Deletions					
$t-5$ vs. t		−1.69*	−5.51***		4.14***
t vs. $t+5$		4.85***	2.83***		1.18

This table reports the institutional ownership and shadow cost of stocks five years before and five years after their addition to or deletion from the S&P 500 index from 1985 to 2003. *IO_NO* is the number of institutions holding the stock and *IO_RATIO* is the proportion of the stock held by institutions, which is defined as the total number of shares held by institutions divided by the number of shares outstanding. The shadow cost ($\times 10^9$) is defined as:

$$ShadowCost_t = \frac{ResidualStandardDev_t}{S\&P500MarketCap_0} \times \frac{FirmSize_0}{NumberofShareholders_t}$$

where $FirmSize_0$ (the market value of equity) and $S\&P500MarketCap_0$ are measured on the announcement dates of index changes. $ResidualStandardDev_t$ is the standard deviation of the difference between a firm's return and the S&P 500 total return from year $t-5$ to year t before the index change announcement or from year t to $t+5$ after the effective day for the post-period. The data are taken from the CRSP and Compustat databases. The t-values for the differences in the means are reported.

* Significance at the 10% level.

*** Significance at the 1% level.

immediately after deletion the institutional ownership decreases dramatically, with *IO_RATIO* decreasing from 0.55 in year $t-1$ to 0.48 in year t and *IO_NO* decreasing from 125 in year $t-1$ to 88 in year t.

Consistent with previous studies, we find that institutions increase their holdings of stocks that are added to the S&P 500 index and decrease their holdings of stocks that are deleted from the index. However, the effect seems to be confined to the year of addition or deletion. For added stocks, although *IO_NO* increases from 228 in year t to 269 in year $t+5$, *IO_RATIO* remains fairly stable in the post-addition period. For deleted stocks, we find that institutional ownership rebounds somewhat, with *IO_RATIO* increasing from 0.48 in year $t+1$ to 0.60 in year $t+5$, and *IO_NO* increasing from 88 in year $t+1$ to 118 in year $t+5$. This shows that the decline in institutional ownership for deleted stocks appears to be temporary.

Although not reported, we classify mutual funds as either index-related or non-index-related, and find a significant increase in *IO_RATIO* for added stocks and a significant decrease for deleted stocks among index-related funds from quarter $t-1$ to t. These results are available on request.

Our results thus complement the existing reported findings. For example, Pruitt and Wei (1989) find that institutional ownership increases for added stocks, but decreases for deleted stocks using data from before and after S&P 500 index revisions from 1973 to 1986. Hegde and McDermott (2003) find that institutional ownership increases following S&P 500 index addition for NYSE stocks in the 1993–1998 period. However, these studies focus on the quarter immediately after index revisions. Our study extends the post-event period to five years and shows that the percentage of institutional ownership does not increase for added stocks after the year of index addition, and does not decline for deleted stocks in the long-term.

6.2. Shadow costs

As noted, another explanation for the short-term price reaction of stocks added to and deleted from the S&P 500 index is the investor awareness hypothesis (Chen et al., 2004). According to this hypothesis, investor awareness affects the degree of diversification among investors, because if some investors know only a subset of stocks and hold only those stocks of which they are aware, then they will be inadequately diversified and demand a premium known as a shadow cost for the non-systematic risk that they bear. When a stock is added to the S&P 500 index and investors are alerted to its existence, the required rate of return on that stock

should fall due to a reduction in the nonsystematic portfolio risk. We investigate the shadow cost over a long event window from year $t-5$ to $t+5$. Following Chen et al. (2004), we compute the shadow cost (multiplied by 10^9) as

$$ShadowCost_t = \frac{ResidualStandardDev_t}{S\&P500MarketCap_0} \times \frac{FirmSize_0}{NumberofShareholders_t} \quad (2)$$

$FirmSize_0$ (the market value of equity) and $S\&P500MarketCap_0$ are measured on the announcement date of an index change; $ResidualStandardDev_t$ is the standard deviation of the difference between a firm's return and the S&P 500 total return from year $t-5$ to year t before the index change announcement and from year t to $t+5$ after the effective day for the post announcement period; and $NumberofShareholders_t$ is the number of shareholders before the index change announcement.

The results for the changes in shadow cost are also reported in Table 6. For added stocks, the shadow cost decreases significantly, dropping from 12.321 in year $t-5$ to 8.949 in year $t-1$, 5.395 in year t, and 3.15 in year $t+5$. Panel C shows that the decreases in shadow cost from year $t-5$ to t and from year t to $t+5$ are significant for added stocks. For deleted stocks, the shadow cost increases slightly from year $t-5$ to t and remains at that level thereafter. The average shadow cost is 0.267, 0.459, 0.375, and 0.424 in years $t-5$, $t-1$, t, and $t+5$, respectively. Panel C shows that the change in shadow cost is significant from year $t-5$ to t, but insignificant from t to $t+5$.

Our results for the long-term changes in the shadow cost are consistent with those of existing studies. For example, Baran and King (2012) find that the shadow cost is reduced for stocks added to the S&P 500 index, but not for stocks that are deleted from the index. Elliott et al. (2006) find that the shadow cost of added stocks is reduced based on a sample of S&P 500 constituent stocks. Our results demonstrate that the effect of addition to the index on the shadow costs continues over the five-year period, although the effect does not extend as long for deleted stocks. This is because although investor awareness of added stocks increases over time, investors will not be any less aware of deleted stocks once they are removed from the index.

6.3. Analyst coverage and forecasts

Index revisions also have a long-term effect on analyst activity. Financial analysts are important providers of information about listed companies. When there are more analysts covering a company, the speed of information diffusion is faster, which leads to more efficient stock prices. We examine two measures of analyst activity, coverage (*COVERAGE*) and dispersion (*DISPERSION*), where *COVERAGE* is the number of analysts following a stock and *DISPERSION* is the standard deviation of the analysts' annual earnings per share (EPS) forecasts for the fiscal year divided by their average EPS forecast. We expect *COVERAGE* to increase for a stock after it is added to an index and to decrease after the stock is deleted. The *DISPERSION* of deleted stocks should be higher than that of added stocks due to greater uncertainty.

Table 7 reports the analyst coverage and dispersion of analyst earnings forecasts five years before and five years after stocks are added to or deleted from the S&P 500. Consistent with our predictions, for added stocks, *COVERAGE* increases from year $t-5$ to year t and further increases thereafter, with values of 10.2, 14.2, 15.9, and 16.2 in years $t-5$, t, $t+2$, and $t+5$, respectively. In contrast, for deleted stocks, *COVERAGE* decreases from year $t-5$ to year t and but does not decreases thereafter, with values of 10.4, 7.1, 5.3, and 6 in years $t-5$, t, $t+2$, and $t+5$, respectively.

Table 7
Changes in analyst coverage and the dispersion of earnings forecasts.

Year	Obs	Coverage	Dispersion
Panel A: Additions			
−5	340	10.2	0.0789
−4	381	10.2	0.1098
−3	412	11.2	0.0801
−2	452	12	0.128
−1	474	13.2	0.1233
0	538	14.2	0.0803
1	556	15.3	0.0818
2	559	15.9	0.1561
3	554	16.1	0.1685
4	547	16.3	0.1352
5	534	16.2	0.1406
Panel B: Deletions			
−5	81	10.4	0.1626
−4	82	10.3	0.2762
−3	82	9.9	0.1978
−2	80	9.8	0.2874
−1	80	9.6	0.3781
0	100	7.1	0.3103
1	104	5.6	0.4836
2	106	5.3	0.3723
3	107	5.7	0.2342
4	109	5.7	0.2242
5	101	6	0.2851
Panel C: Significance of difference			
Additions			
$t-5$ vs. t		17.75***	−2.03**
t vs. $t+5$		9.27***	3.58***
Deletions			
$t-5$ vs. t		−2.95***	3.28***
t vs. $t+5$		0.02	1.24

Analyst coverage and the dispersion of analyst earnings forecasts are plotted for five years before and five years after stocks are added to or deleted from the S&P 500 index from 1979 to 2003. *Coverage* is the number of analysts following a stock. *Dispersion* is the standard deviation of analysts' earnings per share forecasts divided by their average earnings per share forecast. The data is obtained from the IBES database. The *t*-values for the differences in the means are reported.
** Significance at the 5% level.
*** Significance at the 1% level.

DISPERSION for deleted stocks is consistently higher than for added stocks. Over time, *DISPERSION* for added stocks is quite stable from year $t-5$ to t, which means that in general the uncertainty of analyst forecasts does not change much. However, we do find an increase in *DISPERSION* after year $t+2$. For deleted stocks, there is an upward trend in *DISPERSION* from year $t-5$ to year t. After that, *DISPERSION* decreases significantly and remains at a lower level from year $t+3$ to year $t+5$.

Our results are consistent with those of previous studies on analyst coverage around index revisions. For example, Elliott et al. (2006) find that for stocks added to the S&P 500 index between 1993 and 2000, the analyst coverage increased by 11%. Our results provide strong evidence that the analyst coverage of added stocks increases significantly even over the five-year period, whereas the analyst coverage of deleted stocks does not decrease sharply.

6.4. Liquidity

We also investigate the long-term effect of index revisions on liquidity. Three liquidity proxies are constructed. The first is turnover ratio (*TURNOVER*), which is trading volume divided by the number of shares outstanding. The second is the market-adjusted turnover ratio (*ADJTURNOVER*), which is *TURNOVER* divided by an adjustment factor (*ADJFACTOR*). *ADJFACTOR* is the monthly CRSP turnover ratio, for which we set January 1950 as the base month

Table 8
Changes in liquidity.

Year	Obs	*TURNOVER*	*ADJTURNOVER*	*ILLIQUIDITY*
Panel A: Additions				
−5	521	0.4926	0.093	0.156
−4	559	0.5537	0.0892	0.1137
−3	603	0.5967	0.088	0.0913
−2	638	0.6435	0.0823	0.0749
−1	667	0.6719	0.08	0.0656
0	693	0.7319	0.081	0.0572
1	696	0.7679	0.0777	0.0514
2	683	0.7608	0.072	0.0585
3	667	0.774	0.0691	0.0586
4	648	0.7679	0.0666	0.0542
5	629	0.7825	0.0657	0.0542
Panel B: Deletions				
−5	210	0.425	0.092	0.288
−4	212	0.4249	0.0897	0.2633
−3	216	0.4103	0.0895	0.2831
−2	216	0.4341	0.0854	0.3686
−1	218	0.4256	0.083	0.432
0	220	0.4523	0.0788	0.4809
1	220	0.4657	0.0803	0.5477
2	207	0.4717	0.0796	0.5363
3	191	0.4826	0.0751	0.4578
4	183	0.5182	0.0768	0.4565
5	172	0.5544	0.0776	0.3569
Panel C: Significance of difference				
Additions				
$t-5$ vs. t		9.52***	−6.36***	−11.33***
t vs. $t+5$		4.16***	−7.41***	−2.14**
Deletions				
$t-5$ vs. t		1.92*	−2.63***	3.47***
t vs. $t+5$		5.44***	0.28	−2.08**

This table reports the liquidity of stocks five years before and five years after they are added to or deleted from the S&P 500 index from 1962 to 2003. *TURNOVER* is the trading volume divided by the number of shares outstanding. *ADJTURNOVER* is *TURNOVER* divided by an adjustment factor *ADJFACTOR*. *ADJFACTOR* is an index based on the CRSP turnover in January 1950 as the base month. *ILLIQUIDITY* represents Amihud (2002)'s illiquidity measure. The data are taken from the CRSP and Compustat databases. The *t*-values for the differences in the means are reported.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

with a value of 1. The third is the Amihud illiquidity ratio (*ILLIQUIDITY*), which is calculated according to Amihud (2002) as follows:

$$ILLIQUIDITY_{it} = \frac{1}{D_{im}} \sum_{t=1}^{D_{im}} \frac{|R_{imd}|}{VOLD_{imd}} \quad (3)$$

where D_{im} is the number of days for which data is available for stock i in month m, R_{imd} is the return on stock i on day d of month t, and $VOLD_{imd}$ is the respective daily volume in dollars.

Table 8 reports the results. *TURNOVER* increases for both added and deleted stocks before the index revision, with values of 0.4926 and 0.7319 for added stocks at years $t-5$ and t and values of 0.4250 and 0.4523 for deleted stocks at years $t-5$ and t, respectively. Panel C shows that the difference between *TURNOVER* at year $t-5$ and year t is statistically significant for both added and deleted stocks. In the post-event period, there is a further increase in *TURNOVER* for added stocks, with values of 0.7679 and 0.7825 at years $t+1$ and $t+5$, respectively. For deleted stocks, *TURNOVER* does not decrease, but rather increases in the long run, with values of 0.4657 and 0.5544 at years t and year $t+5$, respectively.

Notably, market turnover has generally increased over the past four decades, and we thus look at *ADJTURNOVER*, as it is independent of market trends. Relative to the market, *ADJTURNOVER* declines for both added and deleted stocks in the pre-event period, indicating that newly added stocks are liquid before being added to the S&P 500. In contrast, *ADJTURNOVER* for deleted stocks does not decrease after their removal from the index. The values of *ADJTURNOVER* at year $t-5$ and year t are 0.0930 and 0.0810 for added stocks and 0.0920 and 0.0788 for deleted stocks, respectively. Panel C shows that the difference in *ADJTURNOVER* between year $t-5$ and year t is statistically significant for both added and deleted stocks. In the post-event period, there is a further decline of *ADJTURNOVER* for added stocks, but not for deleted stocks. The corresponding figures are 0.0777 and 0.0657 for added stocks and 0.0803 and 0.0776 for deleted stocks at year $t+1$ and year $t+5$, respectively.

ILLIQUIDITY, or the Amihud illiquidity measure, of added stocks decreases from year $t-5$ to year t and further decreases from year t to $t+5$. The corresponding values of *ILLIQUIDITY* are 0.1560, 0.0572, and 0.0542 at years $t-5$, t and $t+5$, respectively. These findings are consistent with those for *TURNOVER*, which increases not only in the pre-event period, but also in the post-event period. Conversely, *ILLIQUIDITY* for deleted stocks increases from year $t-5$ to year t, but decreases from year t to year $t+5$. The corresponding values of *ILLIQUIDITY* are 0.2880, 0.4809, and 0.3569 at years $t-5$, t, and $t+5$, respectively. This is inconsistent with the evidence on *TURNOVER*, which improves in the pre-event period. Panel C confirms that the changes from year $t-5$ to t and from t to $t+5$ are statistically significant for both added and deleted stocks.

To summarize, there are changes in liquidity in the long run after index additions and deletions. For added stocks, the liquidity increases before index addition, and then increases further after addition. For deleted stocks, the changes in liquidity in terms of *TURNOVER* and *ILLIQUIDITY* are mixed before index deletion, but some improvement is shown in both measures in the post-event period.

The evidence on liquidity changes for added stocks is consistent with that from previous studies. For example, Becker-Blease and Paul (2006) find that the liquidity of stocks added to the S&P 500 index increases in the long run. Baran and King (2012) find that the liquidity of added stocks improves for S&P 500 index revisions, whereas the liquidity of deleted stocks declines. We find that the liquidity of deleted stocks also improves from year t to year $t+5$.

7. Regression analysis

We now perform the regression analyses by combining all the variables relating to operating performance, information quality, and liquidity. For the sake of simplicity, we only use $\Delta Illiquidity$ as the liquidity measure and ΔROA as the operating performance measure in the regression analyses. We define five variables to capture the changes in information quality and liquidity over the five-year post-event period: change in institutional ownership (ΔIO_RATIO), change in analyst coverage ($\Delta Coverage$), change in shadow cost ($\Delta ShadowCost$), change in Amihud illiquidity ($\Delta Illiquidity$), and change in return on assets (ΔROA), where the changes are measured from year t to year $t+5$.

The dependent variable is the market adjusted buy-and-hold return (*ADJCRET*) over the 5-year period from Table 2.[12] We estimate the following regression for added and deleted stocks. A dummy variable for deletion stocks is added so we can investigate whether there is any difference in long-run stock returns between deleted and added stocks after the explanatory variables are controlled. The dummy variable is equal to 1 for deleted stocks and 0 for added stocks. The variables are Winsorized at the 5% level and the *t*-values are adjusted by the Rogers standard errors clustered by firm and year (Petersen, 2009).

[12] We also use the raw cumulated returns over the five-year period and find that the results are similar to those reported in Table 9. These results are available on request.

Table 9
Regression analysis.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Panel A: 1962–2003							
Int	0.9428	0.8116	−0.0893	0.9453	0.9939	0.4657	0.2458
	1.56	1.31	−0.11	1.56	1.33	1.39	0.85
Dummy	0.2915***	0.2043	0.4681***	0.2825***	0.3541**	0.3950***	0.4334
	2.80	0.96	3.00	2.65	2.25	3.05	1.53
ΔIO_Ratio		1.1871***					−0.2613
		3.28					−0.47
ΔCoverage			0.0585***				0.0484***
			8.40				4.67
ΔIlliquidity				−0.0191**			0.0953
				−2.17			1.49
ΔShadowCost					−0.0020		−0.0022
					−0.52		−0.59
ΔROA						0.2499	1.5644***
						1.62	2.85
Adj R^2	0.08	0.03	0.16	0.08	0.03	0.07	0.12
Obs	880	341	535	854	541	716	270
Panel B: 1985–2003							
Int	0.2575	0.2410	0.2575	0.2575	0.2579	0.2362	0.2448
	0.79	0.71	0.84	0.79	0.79	0.76	0.83
Dummy	0.4524*	0.3911	0.5639**	0.4807*	0.4498*	0.2433	0.4455
	1.79	1.55	2.32	1.84	1.78	0.89	1.63
ΔIO_Ratio		0.5850					−0.1908
		1.10					−0.35
ΔCoverage			0.0499***				0.0460***
			5.52				4.73
ΔIlliquidity				0.1051			0.0993
				1.59			1.63
ΔShadowCost					0.0006		−0.0017
					0.17		−0.47
ΔROA						1.9290***	1.5122***
						3.11	2.81
Adj R^2	0.00	0.00	0.11	0.00	0.00	0.05	0.12
Obs	270	270	270	270	270	270	270

This table reports the following univariate and multivariate regression results:
$ADJCRET_i = \alpha_0 + \alpha_1 * Dummy + \beta_1 \Delta IO\_Ratio_i + \beta_2 \Delta Coverage_i + \beta_3 \Delta Illiquidity_i + \beta_4 \Delta ShadowCost_i + \beta_5 \Delta ROA_i + \varepsilon$
ADJCRET is the market adjusted buy-and-hold 5-year return on a stock that is added to or deleted from the S&P 500 index. *Dummy* is a dummy variable for deleted stocks (1 for deleted stocks and 0 for added stocks). *ΔIO_Ratio* is defined as IO_RATIO_{t+5} minus IO_RATIO_t. *ΔCoverage* is defined as $Coverage_{t+5}$ minus $Coverage_t$ scaled by $Coverage_t$. *ΔIlliquidity* is defined as $ILLIQUIDITY_{t+5}$ minus $ILLIQUIDITY_t$. *ΔShadowCost* is defined as $ShodowCost_{t+5}$ minus $ShadowCost_t$. *ΔROA* is defined as ROA_{t+5} minus ROA_t. The variables are Winsorized at 5% and the *t*-values are adjusted by the Rogers standard errors clustered by firm plus year dummies.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

$$ADJCRET_i = \alpha_0 + \alpha_1 * Dummy + \beta_1 \Delta IO\_Ratio_i + \beta_2 \Delta Coverage_i + \beta_3 \Delta Illiquidity_i + \beta_4 \Delta ShadowCost_i + \beta_5 \Delta ROA_i + \varepsilon \quad (4)$$

Table 9 reports the regression results. As some of the variables are obtained from CRSP and Compustat and others from the Thomson Financial Institutional database and IBES, the starting period for the variables is not the same. For example, the institutional ownership data start from 1985, whereas the analyst coverage data start from 1979. Thus, Panel A reports the results based on all the available data and Panel B reports the results after 1985, for which we have data for all the variables. We present seven regression models. Model 1 includes only the dummy variable. For Models 2–6, we add one of the five variables as an explanatory variable: *ΔIO_RATIO*, *ΔCoverage*, *ΔShadowCost*, *ΔIlliquidity*, and *ΔROA*. Model 7 combines the dummy and the five variables to investigate the joint explanation.

We first discuss the results in Panel A. Model 1 shows that there is a significant difference of ADJCRET between deleted stocks and added stocks. The dummy coefficient is 0.2915 with a *t*-value of 2.80. Model 2 shows that post-event returns are positively related to *ΔIO_Ratio*. The coefficient of *ΔIO_Ratio* is 1.871 with a *t*-value of 3.28. However, the dummy becomes insignificant in Model 2, which means that changes of institutional ownership help to explain the difference in long-run stock returns between deleted stocks and added stocks. Model 3 includes *ΔCoverage* as an independent variable. The coefficient of *ΔCoverage* is 0.0585 with a *t*-value of 8.40, which shows that changes in analyst coverage are positively related to long-run stock returns. Model 4 includes *ΔIlliquidity* as an independent variable. The coefficient of *ΔIlliquidity* is −0.0191 with a *t*-value of 2.17, suggesting that post-event long-run returns are negatively related to *ΔIlliquidity*. However, the statistically significant dummy coefficients in Models 3 and 4 mean that *ΔCoverage* and *ΔIlliquidity* cannot adequately explain the difference in returns between deleted stocks and added stocks.

In Models 5 and 6, we add *ΔShadowCost* and *ΔROA* as independent variables in the regression and the coefficients are not significant. The dummy coefficients in Models 5 and 6 are statistically significant. In Model 7 we combine all five variables in a multivariate regression. The results show that the coefficients of *ΔCoverage* and *ΔROA* are statistically significant and the dummy variable is no longer significant. In an unreported regression, we exclude *ΔIO_Ratio* as it only starts from 1985, and the results are the same as those in Model 7. Panel A shows that *ΔCoverage* has the best explanatory power, with the largest *t*-value for the coefficient

and the highest adjusted-R^2. However, the results in Model 7 may not be directly comparable with those in Models 1–6 because of the different sample sizes.

Panel B of Table 9 provides a direct comparison of each variable restricted to the same sample firms. The results are slightly different from those reported in Panel A. In Model 1, the dummy coefficient remains significant, although at a marginal 10% level. In Models 2–6, the coefficients of ΔIO_Ratio, $\Delta Illiquidity$, and $\Delta ShadowCost$ are not significant, while the coefficients of $\Delta Coverage$ and ΔROA are statistically significant. Furthermore, when ΔROA is included in Model 6, the dummy coefficient is no longer significant. Therefore, operating performance can explain the difference between the long-term returns of deleted stocks and added stocks. The results in Model 7 are similar to those reported in Panel A, indicating that the coefficients of $\Delta Coverage$ and ΔROA are significant in the multivariate regressions.[13]

Overall, the results in Table 9 suggest that the difference between the long-term returns of deleted stocks and added stocks can be explained by analyst coverage and operating performance. Therefore, it seems that investors do not expect the performance of deleted stocks to rebound after deletion and that the stocks' long-term price performance can be explained by the firms' post-deletion improvement in operating performance.

8. Conclusion

We investigate the long-term effects of S&P 500 index constituent stock additions and deletions between 1962 and 2003 and find a significant price increase for added stocks in the short run and in the five-year period after addition. Nevertheless, although there is an initial price decline for deleted stocks after their deletion from the index, stocks deleted from the S&P 500 index due to a lack of industry representation or because of a transfer to the S&P Small Cap 600 index outperform the market in the long run.

We consider changes in information quality and liquidity after index revision as possible explanatory factors. For added stocks, there are increases in institutional ownership and liquidity, a decline in shadow cost, and a long-term increase in analyst coverage. For deleted stocks, there is a decline in analyst coverage, an increase in liquidity, but no significant long-term effects on institutional ownership and shadow cost. The results of our regression analyses show that the difference in the long-term returns of added and deleted stocks can be explained by analyst coverage and operating performance. These results show that the price effects associated with index addition and deletion are not simply due to changes in short-term demand, but rather reflect the long-term effects of changes in analyst coverage and operating performance.

To the best of our knowledge, this study is the first to provide a comprehensive analysis of the long-term performance of stocks added to or deleted from the S&P 500 index, and to provide evidence linking stock price performance to firm fundamentals. The finding that a subset of deleted stocks outperforms the market in the long run has important implications for long-term buy-and-hold investors.

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