Impact of Changes in the Nasdaq 100 Index Membership

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Abstract

Purpose − The purpose of this study is to examine changes in stock returns, investor awareness, institutional ownership, and liquidity for companies added to and deleted from the Nasdaq 100 index, which offers at least four advantages over the S&P 500 index for analyzing the impact of stock index reconstitution.

Design/methodology/approach − This study differentiates between stocks added to the Nasdaq 100 index for the first time and repeated additions, as well as between stocks added at annual index revisions and stocks added irregularly throughout the year. The study uses the event study methodology to examine abnormal return and trading volume changes around the announcement and effective days of the index reconstitution from 1997 to 2015. It employs univariate tests to test for significant changes in investor awareness, institutional ownership, and liquidity. Multivariate regressions are used to perform a simultaneous analysis of competing factors.

Findings – This study finds asymmetric differences in changes in abnormal returns, investor awareness, and percentage of institutional shareholders between new additions on one hand and repeated additions and deletions on the other hand. Specifically, while new additions show a permanent stock price gain and significant increases in investor awareness and the percentage of institutional holdings, both repeated additions and new deletions exhibit temporary stock price changes, less pronounced changes in investor awareness, and no significant changes in the percentage of institutional holdings. Both new additions and repeated additions display significant improvements in liquidity, whereas only one out of five liquidity proxies consistently suggest a significant decline in liquidity for new deletions. Most important, changes in investor awareness and liquidity as well as arbitrage risk are significantly related to the observed cumulative abnormal returns around the Nasdaq 100 reconstitution for additions to the index.

Research limitations – Repeated irregular additions and repeated regular deletions are not analyzed in this study due to their small sample sizes.

Originality/value – This study provides comprehensive examination of market reactions to changes in the Nasdaq 100 index as well as highlights the importance of differentiating between new and repeated additions and considering all possible hypotheses for explaining abnormal returns. This study finds that three hypotheses (liquidity, investor awareness, and downward-sloping demand curve) simultaneously explain the observed abnormal returns. The understanding and predicting stock market reactions to changes in the Nasdaq 100 index membership can help both institutional and individual investors with designing profitable trading strategies.

Keywords Abnormal return · Event study · Index changes · Institutional ownership · Liquidity · Market makers · Nasdaq 100 index · Stock prices · Trading volume

Paper type Research paper

JEL Classification G12 · G14

1 Introduction

Researchers routinely observe a positive abnormal return for firms added to the S&P 500 index but disagree on reasons for this reaction and offer competing hypotheses. The possible presence of the signaling effect and other issues make it difficult to resolve this debate. To address this challenge, we examine stock returns, investor awareness, institutional ownership, arbitrage risk, and liquidity for companies that are added to and removed from the Nasdaq 100 index, which offers at least four advantages over the S&P 500 index for analyzing the impact of stock index membership.

First, announcements about addition to (deletion from) the S&P 500 index, which are difficult to predict, can convey a positive (negative) signal about future prospects of the firm. Conversely, changes to the Nasdaq 100 index are determined mainly by the market value ranking of stocks at regular annual reviews. As a result, announcements about the Nasdaq 100 index reconstitution do not send any new material information about the stocks added to or deleted from the index. This avoids the potentially confounding effect of the information signaling hypothesis and eliminates it as a possible explanation for the stock market reaction to index changes.

Second, changes to the S&P 500 index contain both NYSE- and Nasdaq-listed stocks. However, several studies (e.g., Elliott and Warr, 2003; Kappou, Brooks, and Ward, 2010; and Masulis and Shivakumar, 2002) report different price pattern around addition to the S&P 500 index for NYSE- versus Nasdaq-listed stocks. Marciniak (2012) finds a stronger reaction for addition to the S&P 400 index for Nasdaq-listed stocks than for NYSE-listed stocks as well. The analysis of changes to the Nasdaq 100 index, which consists of only Nasdaq-listed stocks, avoids these market microstructure issues that confound the studies of the S&P 500 index.

Third, Nasdaq-listed stocks tend to have lower visibility (e.g., Jain and Kim, 2006) and higher transactions costs (e.g., Bessembinder and Kaufman, 1997; Weston, 2000). Therefore, if index membership impacts stock's investor awareness and liquidity, these effects should be easier to detect by examining changes in the Nasdaq 100 index membership.

Fourth, most S&P 500 studies focus on additions or examine only small samples of deletions, because most S&P 500 deletions involve companies that reorganize, merge, or go bankrupt. In contrast, many companies that are removed from the Nasdaq 100 each year stay in business.

Unlike S&P 500 and other major large-cap stock indexes, such as Dow Jones Industrial Average (e.g., Polonchek and Krenbiel, 1994; Beneish and Gardner, 1995) and FTSE 100 (e.g., Mase, 2007; Fernandes and Mergulhão, 2015), Nasdaq 100 has received little attention in prior literature. To our knowledge, only one study examines changes to the Nasdaq 100 index (Yu, Webb, and Tandon, 2015). We provide a more comprehensive analysis by examining deletions from the index, differentiating between new and repeated additions (deletions), and studying changes in institutional ownership.

We find asymmetric responses in stock price, investor awareness, and percentage of institutional shareholdings between the firms added to the Nasdaq 100 index for the first time and repeated additions. However, both new and repeated additions show significant increases in the number of institutional shareholders and significant improvements in liquidity. Deletions from the Nasdaq 100 index experience a temporary stock price decline and do not show consistent evidence on the change in investor awareness and liquidity. One of the main findings of this study is that liquidity, investor awareness, and downward-sloping demand curve

hypotheses simultaneously explain the cumulative abnormal returns observed around addition to the Nasdaq 100 index.

2. Literature review

A large body of literature examines market reactions of stocks added to or removed from the S&P 500 index (e.g., Afego, 2017). However, researchers still disagree on both the duration and causes of a positive abnormal return associated with the announcement of new additions to the index. The five hypotheses most frequently mentioned in the literature are the price pressure hypothesis, investor awareness hypothesis, downward-sloping demand curve (or imperfect substitutes) hypothesis, liquidity hypothesis, and information signaling hypothesis.

Under the *price pressure hypothesis*, additions to (deletions from) the index experience only transitory stock price changes due to transitory increased demand (supply) from index funds. Specifically, the temporary price pressure created by index funds rebalancing their portfolios to incorporate index changes temporary pushes prices above (below) their equilibrium levels for additions (deletions). Supporting the price pressure hypothesis, Harris and Gurel (1986) and Elliott and Warr (2003) document a stock price reversal for firms added to the S&P 500 index.

The *investor awareness hypothesis* predicts a permanent stock price gain for additions and a temporary stock price decline for deletions due to changes in investor awareness associated with the index reconstitution. Based on the premise that investors invest only in those stocks of which they are aware (e.g., Merton 1987), this hypothesis explains a permanent stock price increase for index additions by the elevated awareness among investors. In contrast, because deletion from the index will not rapidly reduce the awareness of a stock, deleted stocks exhibit

only a transitory loss. Consistent with the investor awareness hypothesis, Chen, Noronha, and Singal (2004) observe a permanent stock price increase for additions to the S&P 500 index and a transitory stock price decrease for deletions. Zhou (2011) provides additional support for this hypothesis by reporting a temporary stock price increase for repeated additions as well as additions upgraded from the S&P 400, 600, or REIT indexes.

The other three hypotheses predict permanent stock price changes for both additions and deletions. The *downward-sloping demand curve (or imperfect substitutes) hypothesis*, proposed by Shleifer (1986), assumes that stocks do not have perfect substitutes and, therefore, their long-run demand curve slopes downward. As a result, increased demand from index funds leads to a permanent stock price gain for additions. On the other hand, decreased demand from index funds results in a permanent stock price loss for deletions. Wurgler and Zhuravskaya (2002) provide supporting evidence for this hypothesis by observing a larger stock price gain on addition to the S&P 500 index for stocks with no close substitutes.

Based on the Amihud and Mendelson's (1986) argument that improvement in stock liquidity is positively associated with firm value, the *liquidity hypothesis* predicts a permanent increase (decrease) in value for added (deleted) stocks. Consistent with the liquidity hypothesis, Hegde and McDermott (2003) find significant increases (decreases) in liquidity for additions to (deletions from) the S&P 500 index.

According to the *information signaling hypothesis* (e.g., Jain 1987) announcements about S&P 500 index reconstitution send positive (negative) news about the future prospects of additions (deletions). Supporting this hypothesis, Denis, McConnell, Ovtchinnikov, and Yu (2003) report significant improvements in analysts' earnings per share forecasts and significant increases in realized earnings for companies added to the S&P 500 index. As another support for

the information signaling hypothesis, Cai (2007) observes a significantly positive price reaction for the industry and size matched firms of the companies added to the S&P 500 index.

3. Sample selection

Launched in January 1985, the Nasdaq 100 index is a value-weighted index that consists of 100 largest domestic and international nonfinancial firms listed on the Nasdaq stock market. The Nasdaq 100 index is widely followed by finance professionals, and is the basis of the PowerShares QQQ exchange traded fund. In addition, options, futures, and structured products based on the Nasdaq 100 index and PowerShares QQQ trade on various exchanges.

In 1993 the index adopted an annual membership revision process, which occurs each December. Occasional changes also happen throughout a year to replace companies that merged, went bankrupt, or switched to NYSE. To determine what stocks should be added to or deleted from the Nasdaq 100 index at annual reviews, Nasdaq ranks all eligible stocks based on their market values. A stock is kept in the index if it is ranked in the top 100 stocks. A stock also remains in the Nasdaq 100 index, if it is ranked between top 101 and 125 stocks, but was ranked within top 100 stocks in the previous annual revision. Stocks that do not meet the eligibility criteria are replaced with non-index stocks that have the largest market capitalization.

To compute the market capitalization of a stock, Nasdaq uses a closing price on the last trading day of October and the number of shares outstanding from a public SEC document available on EDGAR as of the end of November.[1] Thus, investors can predict potential index changes before an actual public announcement about Nasdaq 100 index changes is issued in early December. Therefore, we consider three announcement days: AD_1 is the first trading day in

[1] For more information, refer to "Nasdaq announces the annual re-ranking of the Nasdaq-100 Index. (December 11, 2009). *Globe Newswire*. and "Annual changes to Nasdaq-100 Index. (December 11, 2000). *Business Wire*.

November (the first day after the closing price is known), AD_2 is the last trading day in November (when the number of shares outstanding is determined), and AD_3 is the first trading day after the announcement is released after the market close on the previous day. Index changes become effective after the market close on the third Friday of December. We define the effective day (ED) as the last trading day before an index change becomes effective. Irregular index changes, which happen on unscheduled dates throughout a year, have only one announcement day (AD) – the day of the actual announcement. Similar to annual index changes, ED is defined as the last trading day before an index change becomes effective.

As the Lexis-Nexis database contains announcement and effective dates for Nasdaq 100 index changes starting from 1997, the sample period runs from 1997 to 2015. We identify 166 regular additions and 166 regular deletions that occurred at Nasdaq 100 annual reviews and 91 irregular additions that occurred throughout the year. This initial sample is reduced to a final, clean sample of 165 regular additions, 158 regular deletions, and 70 irregular additions after an application of the following screens. The first screen removed 5 companies (1 regular addition and 4 regular deletions) that had less than 100 trading days in the 180-trading day post-event estimation period running from ED+61 to ED+240. The second screen removed 4 regular deletions that were acquired or went bankrupt. The third screen removed 19 irregular additions that do not have at least one trading day between AD and ED, and 2 irregular additions that entered the index due to corporate events: merger with a member of the Nasdaq 100 index (VeriSign Inc.) and replacement of one class of the common stock in the index with another class (Comcast Corp.).

In the final sample, we also differentiate between the stocks added to (deleted from) the index for the first time and the ones added (deleted) for the second time. We do not analyze

repeated regular deletions and repeated irregular additions due to their small sample sizes of 17 stocks and 8 stocks, respectively.

Taken together, we examine the following four groups:

1. New regular additions consist of 128 stocks added to the Nasdaq 100 index for the first time at annual revisions.

2. Repeated regular additions consist of 37 added to the Nasdaq 100 index for the second time at annual revisions.

3. New regular deletions consist of 141 stocks removed from the Nasdaq 100 index for the first time at annual revisions.

4. New irregular additions consist of 62 stocks added to the Nasdaq 100 index for the first time on unscheduled dates throughout the year.

4. Analyses

4.1 Abnormal returns

To examine returns behavior in the period surrounding changes to the Nasdaq 100 index, we use Fama-French three-factor model (1993)[2] and a 180-trading day post-event estimation period running from day ED+61 to day ED+240.[3] The daily returns of the Nasdaq Composite index collected from CRSP are used as a proxy for the market return. To estimate the significance of abnormal returns, we use a parametric *t*-test and two non-parametric tests: a sign test (Corrado and Zivney, 1992; Cowan, 1992) and a rank test (Corrado, 1989).

[2] By adjusting for the size and value risk factors, the Fama and French's three-factor model produces more conservative estimates of abnormal returns (Afego, 2017).

[3] The use of a pre-event estimation period may lead to biased results, because stocks added to (deleted) from the Nasdaq 100 index usually experience superior (inferior) performance before entering (exiting) the index.

Table 1 presents abnormal returns for stocks added to or deleted from the Nasdaq 100 index at annual revisions. As shown in Panel A, new additions experience a positive cumulative abnormal return of 9.38% in the 30-day period prior to AD_1, which is significant at the 1% level under three tests. This gain is consistent with a significant pre-announcement run-up in prices for additions to other large-cap indexes, such as the UK's FTSE 100 (e.g., Mase 2007) and German DAX (e.g., Mama, Mueller, and Pape (2017), that use market capitalization to determine new index members. New additions also show significant positive abnormal returns on ED–1 and ED. Not presented here to save space, trading volume analysis documents the largest abnormal trading volume on ED for both additions and deletions. This observation is consistent with the trading behavior of index fund managers who delay their trades until the effective day to minimize tracking error. Kappou et al. (2010) and Geppert, Ivanov, and Karels (2011) observe similar trading behavior for index funds that follow the S&P 500 index.

Most important, stock price gains for additions do not show any sign of reversal, as a cumulative abnormal of 16.24% remains significant in the period from AD_1–30 to ED+60 at least at the 1% level under all three tests.

[Table 1 about here]

Unlike new additions, repeated additions show neither a significant pre-announcement price run-up nor a significant cumulative abnormal return for the period from AD_1–30 to ED+60. They experience significant gains of 1.34% and 0.90% only on AD_1–1 and AD_3–1, respectively. This difference in stock price reaction between new additions and repeated additions is similar to the one documented by Zhou (2011) in the context of the S&P 500 index changes. Specifically,

Zhou observes a larger and permanent stock price reaction for new additions versus smaller and temporary stock price reaction for repeated additions. Zhou explains this difference by a significant increase in investor awareness for new additions and insignificant changes in investor awareness for repeated additions.

Turning to the new deletions group presented in Panel B, a significant negative cumulative abnormal return of 4.94% is observed in the 30-day period prior to AD_1. New deletions also lose an abnormal 1.16% and 1.24% on AD_3–1 and AD_3, respectively. In contrast to the permanent stock price gains for new additions, however, these losses are completely reversed over subsequent periods. Specifically, deletions show a significant positive cumulative abnormal return of 8.08% from ED+1 to ED+60, and, as a result, a cumulative abnormal return from AD_1–30 to ED+60 is not statistically significant. Taken together, permanent stock price gains for new additions as well as transitory stock price changes for repeated additions and new deletions provide support for the investor awareness hypothesis.

Table 2 shows abnormal returns for stocks added to the Nasdaq 100 index for the first time on unscheduled dates throughout the year. Although the announcement dates of irregular index changes are not fully predictable, similar to new regular additions, irregular additions also show a significant price run-up of 9.83% in the 30-day period prior to AD, which is significant at the 1% level under three tests. As expected, their largest one-day gain of 2.55% happens on AD. These gains are permanent, as a cumulative abnormal return of 8.91% from day AD–30 to ED+60, which is significant at least at the 5% level under three tests, does not suggest a price reversion. Taken together, the stock price behavior of new irregular additions is similar to the one of new regular additions. Actually, this pattern of similarity extends to other analyses performed in this paper. Therefore, to save space and to avoid any potential bias associated with the not fully anticipated

nature of irregular additions, we focus only on the regular additions and deletions, which happen at the annual index reconstitutions, in our subsequent discussion.

[Table 2 about here]

4.2 Investor awareness

According to the investor awareness hypothesis, a permanent stock price gain for new additions, as well as transitory stock price changes for repeated additions and deletions, can be explained by changes in investor awareness. Specifically, whereas awareness about a stock is expected to increase after addition to a major stock index, awareness does not increase as strongly when a stock is added to the index for the second time or does not decline as rapidly when a stock is deleted from the index. To test these predictions, following Elliott, Van Ness, Walker, and Warr (2006) and Zhou (2011) we analyze changes in three proxies for investor awareness: the number of shareholders, Merton's shadow cost, and the number of analysts following a stock. The sample sizes for each proxy vary depending on data availability.

4.2.1 Number of shareholders

As awareness of a stock increases, more investors become shareholders and the firm's value rises. Consistent with this explanation, Chen et al. (2004), Elliott et al. (2006), and Zhou (2011) report a significant increase in the number of shareholders for companies added to the S&P 500 index. To examine changes in the total number of shareholders, we follow Chen et al. (2004), Elliott et al. (2006), and Zhou (2011) by collecting from Standard and Poor's COMPUSTAT the number of shareholders as close as possile before AD_3 and at least nine

months after ED and then test for significant differences. If data from COMPUSTAT are not available, we use companies' 10-K filings with the Securities and Exchange Commission.

Table 3 reports changes in the number of shareholders around the annual Nasdaq 100 index reconstitution. As predicted by the investor awareness hypothesis, new additions show the largest average increase of 12,823 in the number of shareholders, which is significant under three tests. In contrast, the average increases of 2,240 shareholders and 317 shareholders for repeated additions and new deletions, respectively, are not significant according to the *t*-test. Although non-parametric tests suggest declines in the median number of shareholders for these two groups, the magnitudes of these declines in both absolute and percentage terms are considerably smaller than a median increase in the number of shareholders for new additions. Taken together, consistent with the investor awareness hypothesis, repeated additions and new deletions experience less pronounced changes in the number of shareholders.

[Table 3 about here]

4.2.2 Merton's shadow cost

Merton's shadow cost is frequently used to examine changes in investor awareness. For example, several studies find a positive relation between Merton's shadow cost and abnormal returns associated with visibility-enhancing events, such as NYSE listing (Kadlec and McConnell, 1994), global equity issues (Chaplinsky and Ramchand, 2000), and seasoned equity issues (Autore and Kovacs, 2014). Consistent with the investor awareness hypothesis, Chen et al. (2004), Elliott et al. (2006), and Zhou (2011) find a significant increase in shadow costs for companies added to the S&P 500 index. To analyze changes in Merton's shadow cost around the

Nasdaq 100 index reconstitution, we use procedures similar to those in Kadlec and McConnell (1994), Chen et al. (2004), Elliott et al. (2006), and Zhou (2011):

$$Shadow\ Cost = \frac{Residual\ Standard\ Deviaion}{Nasdaq\ 100\ Market\ Cap} \times \frac{Firm\ Size}{Number\ of\ Shareholders}, \quad (1)$$

where the pre-event (post-event) residual standard deviation is calculated as the standard deviation of the difference between the firm's return and the Nasdaq 100 index total return in the 252-trading day period before AD_3 (after ED). Firm size, which is defined as the market value of equity, and the Nasdaq 100 Market Cap are measured on AD_3. We obtain the number of shares outstanding from CRSP and the Nasdaq 100 Market Cap from Bloomberg.

As shown in Table 4, both non-parametric tests indicate a significant decline in Merton's shadow cost for new additions at least at the 7% level. Only the Wilcoxon signed-rank test suggests a significant decrease in shadow cost for new deletions. Repeated additions do not exhibit significant changes. As a comparison, Zhou (2011) also do not find significant changes in shadow cost for repeated additions to the S&P 500 index. Taken together, consistent with the predictions of the investor awareness hypothesis, the observed results suggest a decline in Merton's shadow cost for new additions and no significant changes for both repeated additions and new deletions.

[Table 4 about here]

4.2.3 Number of analysts

The literature proposes that the number of analysts following a company can affect investor recognition of its stock. For example, Cliff and Denis (2004) and Autore and Kovacs (2014) suggest that greater analyst coverage can lead to greater investor awareness in the context

of IPO and seasoned equity offerings, respectively. Elliott et al. (2006), and Zhou (2011) report a significant increase in analyst following for companies added to the S&P 500 index. Moreover, supporting the investor awareness hypothesis as a possible explanation for temporary price changes for repeated additions, Zhou (2011) does not find a significant change in the number of analysts for that group of stocks.

To examine changes in the analyst following around the Nasdaq 100 index reconstitution, we compute the average number of analysts in two fiscal quarters prior to the fiscal quarter of the announcement day AD_3 from the IBES summary files. We compute the same averages in two fiscal quarters following the fiscal quarter of the effective day. We then test for significant differences. As presented in Table 5, new additions experience a significant average increase of 1.67 analysts, whereas new deletions show a significant average decline of 1.47 analysts following the Nasdaq 100 index reconstitution. Consistent with the investor awareness hypothesis, repeated additions do not show significant changes in the number of analysts.

[Table 5 about here]

By way of comparison, Yu et al. (2015) document a similar increase of 1.80 analysts for regular, year-end additions in the six months after the Nasdaq 100 index change announcement from the six months before in the 1994–2009 period. For the S&P 500 index reconstitutions, Zhou (2011) reports a significant increase of 0.72 analysts for pure additions and a significant decrease of 2.94 analysts for pure deletions.

To summarize, the three proxies show that investor awareness increases significantly for companies added to the Nasdaq 100 index for the first time. Consistent with the investor

awareness hypothesis, repeated additions do not exhibit significant changes in investor awareness. For new deletions, only a decline in the number of analysts is significant under three tests, while the other two proxies either do not show significant changes (Shadow cost) or the magnitude of a change (Number of shareholders) is considerably smaller than the one for new additions.

4.3 Institutional ownership

Institutional investors tend to be more informed and most likely are aware of a company before it is added to the index. Nevertheless, to shed a light on the behavior of institutional investors around the Nasdaq 100 index reconstitution, in this section we examine if the number of institutional investors and the percentage of shares owned by institutional shareholders change for firms added to and removed from the index. The understanding of whether institutional ownership changes significantly is important, because, at least two hypotheses, price pressure and downward-sloping demand curve, explicitly explain stock price reactions around index reconstitutions by trading of institutional investors. Specifically, the price pressure hypothesis predicts temporary stock price changes for index additions and deletions by index funds trading around the reconstitution day, while the downward-sloping demand curve predicts the permanent stock price changes by the change in the demand for stocks created by index funds.

S&P 500 reconstitution studies find a significant increase (decrease) in institutional ownership for companies added to (deleted from) the index (e.g., Pruitt and Wei, 1989; Chen et al., 2004; Chan, Kot, Tang, 2013). Similar results are reported for reconstitutions of other indexes, such as S&P 600 (e.g., Shankar and Miller 2006) and FTSE SmallCap (e.g., Biktimirov and Li, 2014). To examine changes in institutional ownership around the Nasdaq 100 index

reconstitution, we follow the method used by Biktimirov, Cowan, and Jordan (2004) and Shankar and Miller (2006). We manually collect data on the number of institutional shareholders, the number of shares they hold, and the total number of shares outstanding for two months before (October and November) and two months after (January and February)[4] the effective day from S&P's *Security Owner's Stock Guide*. We drop firms where data are not available for all four months leaving the final sample of 108 new additions, 32 repeated additions, and 149 new deletions. We compute the mean (median) difference in both the number of institutional shareholders and the percentage of institutional shareholding[5] before and after the Nasdaq 100 index change. We then test for significant differences.

Table 6 presents some descriptive statistics for the institutional shareholdings and tests for differences in the mean (median) between the pre- and post-event periods. As shown in Panel A, both new and repeated additions experience significant increases in the number of institutional shareholders. The average number of institutions grows by 38.10 and 51.55 for new and repeated additions, respectively. In contrast, new deletions experience a significant decline of 16.11 institutional shareholders.

[Table 6 about here]

Panel B of Table 6 highlights a noticeable difference in changes in the percentage of institutional shareholders between new additions on one hand and repeated additions and new deletions on the other hand. Specifically, while new additions show a significant increase in the

[4] Because additions announced in 1997 had ED on January 6, 1998, institutional ownership data for February and March were used for the post-event period for these stocks.
[5] In cases of three firms when the percentage of institutional shareholding exceeds 100%, we limit it to 100%.

percentage of institutional holdings, both repeated additions and new deletions do not exhibit significant changes. This difference in percentage of institutional holding may explain a difference in cumulative abnormal returns between the groups observed in Table 1. Namely, a significant increase in the percentage of institutional shareholders may explain a permanent stock price gain for new additions, whereas the lack of significant changes in the percentage of institutional shareholders may explain temporary stock price reactions for repeated additions and new deletions.

Thus, the permanent stock price gain for new additions on one hand and temporary stock price reactions for repeated additions and new deletions can be attributed not only to differences in changes in investor awareness, but also to differences in changes in institutional ownership, which is consistent with the downward-sloping demand curve hypothesis. Note that the downward-sloping demand curve hypothesis predicts permanent price changes for both additions and deletions on the assumption that both additions and deletions experience significant changes in institutional ownership. The asymmetrical change in institutional ownership observed for changes to the Nasdaq 100 index predicts the asymmetrical stock price response as well.

4.4 Arbitrage risk

As an additional test of predictions of the downward-sloping demand curve hypothesis, we compute a correlation between the measure of arbitrage risk (*A1*) suggested by Wurgler and Zhuravskaya (2002) and the cumulative abnormal return around the Nasdaq 100 index changes. *A1* is the variance of the error term from a regression of the stock's excess return on the market's excess return over a $[AD_1-365, AD_1-20]$ calendar day window. Due to the predictable nature of annual changes to the Nasdaq 100 index, as shown in Table 1, additions to and deletions from

the index begin experiencing abnormal returns before the announcement day. Therefore, the cumulative abnormal stock return starts 30 days prior to AD_1 and runs for 60 days after ED.

Wurgler and Zhuravskaya (2002) propose that a stock with a high *A1* does not have close substitutes available and, therefore, is more difficult to arbitrage. According to the downward-sloping demand curve hypothesis, stocks with high *A1* should experience a stronger stock price reaction associated with addition to or deletion from an index. Thus, if arbitrage risk is at least partially responsible for the abnormal return around Nasdaq 100 index changes, we should observe a correlation between *A1* and abnormal returns.

Table 7 presents correlations between *A1* and the cumulative abnormal return from AD_1– 30 to ED+60 for the three groups. Consistent with the downward-sloping demand curve hypothesis, new additions have a positive correction of 0.25, which is significant at the 1% level. An insignificant correlation between A1 and CAR (AD_1– 30, ED+60) for repeated additions is consistent with the downward-sloping demand curve hypothesis as well, because repeated additions experience neither significant changes in the percentage of institutional ownership nor permanent stock price changes around the Nasdaq 100 index reconstitution.

[Table 7 about here]

For the new deletions group, Table 7 reports a positive correlation of 0.17, which is significant at the 4% level. This result is somewhat unexpected given that deletions do not exhibit a significant change in the percentage of institutional ownership or a permanent change in stock price.

4.5 Liquidity

The previous sections provide evidence that new additions experience larger changes in investor awareness and the percentage of institutional ownership compared to repeated additions and new deletions. In this section, we compare changes in liquidity between these groups. Studies on the S&P 500 index changes document a significant increase in stock liquidity for companies added to (e.g., Erwin and Miller, 1998; and Becker-Blease and Paul, 2006) and removed (e.g., Hedge and McDermott, 2003) from the S&P 500 index. Moreover, by examining bid-ask spreads and trading volume, Yu et al. (2017) conclude that liquidity improves for companies added to the Nasdaq 100 index as well.

As each liquidity measure reflects a different side of liquidity, we use five measures for stock liquidity: relative spread, dollar volume, illiquidity ratio, zero return ratio, and number of market makers.

Relative spread is the difference between the daily closing ask and bid prices divided by the mid-point of closing ask and bid prices.

Dollar volume is the natural logarithm of daily trading volume in dollars.

The illiquidity ratio is the average of the daily ratio of absolute stock return to its daily trading volume in dollars. Amihud (2002) proposes the illiquidity ratio to capture price impact. The illiquidity ratio is expected to be larger for more liquid stocks.

The zero return ratio is the ratio of the number of zero return days to the total number of trading days. Lesmond, Ogden, and Trzcinka (1999) propose this measure as a proxy for transaction costs.

Number of market makers is the average number of market makers for a stock. The literature suggests that Nasdaq market makers play an important role in providing liquidity,

especially in times of large volume shocks or high volatility (e.g., Li, McCormick, and Zhao, 2005; Rahman, Krishnamurti, and Lee, 2005).

We calculate the average for the first four liquidity measures over a 180-day period before AD_3 and after ED and then test for significant differences.[6] Similar to Chen et al. (2004) and Becker-Blease and Paul (2010), we compute post-event liquidity starting 61 days after the effective day to avoid any confounding effects introduced by index fund and arbitrage trading. Thus, the pre-event period runs from AD_3–210 to AD_3–31 and the post-event period lasts from ED+61 to ED+240 for all groups. The pre-event and post-event values for the number of market makers are computed as the average of two months (September and October) prior to the month of AD_1 and the average of two months (January and February) after the month of ED, respectively. To test the difference between the pre-event and post-event levels for each measure, we use a parametric paired *t*-test and two non-parametric tests: sign and Wilcoxon signed rank sum tests.

Table 8 shows some descriptive statistics for the liquidity measures and tests for differences in the mean (median) between the pre- and post-event periods. Both new additions (Panel A) and repeated additions (Panel B) experience improvements in liquidity following their inclusion in the Nasdaq 100 index. They show significant decreases in the relative spread, illiquidity ratio, and zero return ratio (for new additions only). Their dollar volume and number of market makers show increases, which are significant at the 0.01% level under all tests.

[Table 8 about here]

[6] As robustness checks, we also used 90-day and 270-day periods. The results are qualitatively unchanged.

In contrast, changes in liquidity proxies suggest decline in liquidity for new deletions (Panel C). Specifically, new deletions experience significant increases in the illiquidity ratio and the zero return ratio as well as a decrease in trading volume, which is significant at the 0.01% level under all tests.

Taken together, the results of the liquidity analysis suggest improvements in liquidity for both the stocks added for the first time to the Nasdaq 100 index and the stocks added for the second time. Conversely, liquidity worsens for stocks removed from the index.

4.6. Regression Analysis

In previous sections, the univariate tests that document significant changes in investor awareness, institutional ownership, and liquidity do not control for the effects of competing factors. Therefore, in this section we perform the multivariate regression analysis to examine if any factors are significantly related to cumulative abnormal returns around Nasdaq 100 index changes in the presence of other competing explanations.

The dependent variable is the cumulative abnormal return from AD_1-30 to ED+60. Independent variables consist of changes in five liquidity proxies, changes in three investor awareness proxies and a dummy variable for repeated additions (deletions), changes in two measures of institutional ownership and the measure of arbitrage risk (*A1*). The firm size, which is computed as the stock's market value (*MV*) on day $AD_3–30$, is used as the control variable.

We run a separate set of regressions for additions and deletions. To allow for different proxies of liquidity, Table 9 presents five regressions for stocks added to the Nasdaq 100 index. Three proxies for liquidity, relative spread, dollar volume, and illiquidity ratio are significant at the 1% level and have expected signs. A positive coefficient for changes in dollar volume as well

as negative coefficients for changes in relative spread and illiquidity ratio indicate that improvements in liquidity are associated with larger positive cumulative abnormal returns around index changes. The lack of significance for the change in zero return ratio is somewhat expected given that only two tests suggest significant changes in zero return ratio for new additions at least at the 8% level (see Table 8, Panel A) and neither of three tests show significant changes for repeated additions (see Table 8, Panel B). Although a coefficient for the change in the number of market makers is significant, its negative sign is not consistent with the liquidity hypothesis.

[Table 9 about here]

Turning to proxies for investor awareness, coefficients for reentry dummy and the change in shadow costs and are significant in four regressions at least at the 4% and 8% levels, respectively. As predicted by the investor awareness hypothesis, the coefficients have a negative sign.

The only coefficient that is significant in all regressions is the coefficient for the *A1* variable. Providing support for the downward-sloping demand curve hypothesis, its positive sign suggests that stocks without close substitutes tend to have larger cumulative abnormal returns.

The regression analysis for the new deletions group does not produce strong significant results.[7] Only one variable, change in the number of common shareholders, show any level of significance. However, it is significant only in two regressions out of five and only at the 10% level. The lack of significant coefficients in regression models for new deletions may be

[7] To save space, these results are not presented here, but are available upon request.

attributed to the less pronounced reactions to Nasdaq 100 index reconstitutions compared to new additions. As reported in earlier sections, new deletions experience neither permanent stock price changes nor significant changes in the percentage of institutional ownership. They also exhibit much smaller change in the number of shareholders and less pronounced changes in liquidity.

5. Discussion

The results of this study clearly show that changes in the Nasdaq 100 index reconstitution represent a significant event for affected companies. Among different groups of stocks examined in this study, new regular additions to the Nasdaq 100 index experience the strongest reaction. They show a permanent stock price gain, significant increases in investor awareness (supported by all three proxies), significant increases in institutional ownership as reflected in both the number of institutional shareholders and the percentage of institutional shareholdings, and significant improvements in liquidity (supported by all five proxies). In contrast, repeated regular additions show only a temporary stock price gain, no significant changes in investor awareness, and no significant increases in the percentage of institutional shareholdings. However, similar to new additions, they experience an increase in the number of institutional shareholders and significant improvements in liquidity.

The most important, in the multivariate regression models for additions, three proxies for liquidity changes (Δ Relative spread, Δ Dollar volume, Δ Illiquidity ratio), two proxies for investor awareness (Reentry dummy and Δ Shadow cost), and a proxy for the arbitrage risk (*A1*) remain significant. We consider this result to be one of the main findings of this study: liquidity, investor awareness, and arbitrage risk show significant relation with cumulative abnormal returns around the Nasdaq 100 index changes even in the presence of other competing factors. Thus,

univariate tests and multivariate regression analysis suggest that three hypotheses (liquidity, investor awareness, and downward-sloping demand curve) simultaneously explain the observed abnormal returns.

The deletions group show a less pronounced reaction. They experience a temporary stock price decline and a significant decline in the number of institutional shareholders. Among three proxies for investor awareness, only a decrease in the number of analysts is significant under three test statistics, and among five proxies for liquidity, only a decline in dollar volume is significant under three test statistics. Given the absence of consistently significant results of the univariate tests, it is not surprising to observe the lack of significant coefficients in the multivariate regression analysis. Taken together, deletion from the Nasdaq 100 index does not seem to have a significant permanent impact on the affected stocks.

6. Conclusion

Prior studies provide mixed results on the market reaction to changes to the S&P 500 index and offer competing explanations. We examine changes in stock price, investor awareness, institutional ownership, and liquidity around changes in the Nasdaq 100 index membership.

The firms added to the Nasdaq 100 Index for the first time and repeated additions show significant increases in the number of institutional shareholders and significant improvements in liquidity. However, they show asymmetric responses in stock price, investor awareness, and percentage of institutional shareholdings. One of the main findings of this study is that liquidity, investor awareness, and downward-sloping demand curve hypotheses simultaneously explain the cumulative abnormal returns observed around the Nasdaq 100 index changes.

The impact on the firms removed from the Nasdaq 100 index is less pronounced. They experience a temporary stock price decline and do not show consistent evidence on the change in investor awareness and liquidity. Moreover, any possible changes in investor awareness and liquidity are not related to the cumulative abnormal returns around the Nasdaq 100 index changes.

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Table 1. Cumulative average abnormal returns (CARs) for stocks added to or deleted from the Nasdaq 100 index at annual reconstitutions.

Panel A

	New Additions (N = 128)				Repeated Additions (N = 37)			
Period	CARs	*t* test	Sign test	Rank test	CARs	*t* test	Sign test	Rank test
AD_1–30, AD_1–1	9.38%	4.95**	4.88**	3.64**	3.58%	1.95*	0.66	0.46
AD_1–1	0.14%	0.40	0.99	0.29	1.34%	4.00**	1.65	2.17*
AD_1	0.68%	1.96	1.17	2.00	0.29%	0.86	1.65	1.12
AD_1+1	–0.45%	–1.31	–0.24	–0.73	–0.08%	–0.25	1.32	0.39
AD_1+1, AD_2–1	–0.64%	–0.43	0.11	–0.46	–0.01%	–0.01	0.01	–0.48
AD_2–1	–0.01%	–0.02	–0.24	0.20	–0.22%	–0.67	–0.65	–0.68
AD_2	0.74%	2.15*	0.99	1.15	0.46%	1.36	0.66	1.38
AD_2+1	0.63%	1.82	2.59**	1.01	–0.10%	–0.29	–0.32	–0.38
AD_2+1, AD_3–1	3.19%	2.98**	2.59**	3.01**	0.96%	0.96	0.34	1.37
AD_3–1	0.54%	1.56	3.29**	3.12**	0.90%	2.69**	2.97**	3.22**
AD_3	0.02%	0.06	–1.30	–0.47	0.41%	1.22	1.65	1.62
AD_3+1	–0.15%	–0.44	–1.30	–1.00	–0.55%	–1.65	–1.31	–1.12
AD_3+1, ED–1	0.85%	1.41	1.17	–0.93	–0.01%	–0.01	–0.32	–1.10
ED–1	0.78%	2.25*	3.12**	2.03*	0.25%	0.74	1.32	1.30
ED	1.09%	3.16**	2.94**	2.11*	–0.43%	–1.28	0.66	–0.39
ED+1	0.42%	1.23	0.64	0.62	0.15%	0.44	1.32	0.46
ED+1, ED+20	–1.87%	–1.20	–1.66	–1.59	0.40%	0.27	0.34	–0.30
ED+1, ED+40	0.71%	0.32	0.29	–0.43	–1.39%	–0.65	–0.32	–1.16
ED+1, ED+60	1.96%	0.73	1.53	–0.37	–0.62%	–0.24	0.01	–0.24
AD_1–30, ED+20	13.45%	4.22**	3.65**	2.22*	5.65%	1.84	1.98	0.73
AD_1–30, ED+40	16.03%	4.52**	3.47**	2.33*	3.86%	1.13	0.99	0.29
AD_1–30, ED+60	16.24%	4.54**	3.82**	2.48**	4.62%	1.24	0.01	0.73

Table 1 continues

Table 1 (*continued*)

Panel B

	New Deletions (N = 141)			
Period	CARs	*t* test	Sign test	Rank test
AD_1–30, AD_1–1	–4.94%	–2.25*	–2.24*	–3.68**
AD_1–1	0.60%	1.50	1.30	0.94
AD_1	1.85%	4.61**	2.99**	2.96**
AD_1+1	–0.18%	–0.46	–1.22	–0.61
AD_1+1, AD_2–1	3.90%	2.27*	2.15*	1.23
AD_2–1	0.26%	0.65	–0.55	–0.63
AD_2	0.27%	0.68	1.81	1.16
AD_2+1	–0.67%	–1.68	–0.21	–0.89
AD_2+1, AD_3–1	–1.59%	–1.28	–2.07	–1.24
AD_3–1	–1.16%	–2.90**	–3.92**	–3.49**
AD_3	–1.24%	–3.10**	–3.92**	–3.95**
AD_3+1	0.26%	0.65	1.30	0.96
AD_3+1, ED–1	0.23%	0.33	0.63	0.70
ED–1	–0.56%	–1.39	–2.24*	–2.17*
ED	0.88%	2.19*	–0.04	0.44
ED+1	–0.04%	–0.11	1.14	0.68
ED+1, ED+20	4.27%	2.38*	4.17**	2.49*
ED+1, ED+40	5.98%	2.36*	3.67**	1.76
ED+1, ED+60	8.08%	2.60**	3.67**	1.87
AD_1–30, ED+20	3.61%	0.98	0.80	–0.59
AD_1–30, ED+40	5.33%	1.30	2.82**	–0.51
AD_1–30, ED+60	7.43%	1.66	3.33**	–0.94

Notes: Abnormal returns are estimated using Fama and French's (1993) three-factor model and a 180-trading day post-event estimation period that runs from ED+61 to ED+240. The Nasdaq Composite index serves as a proxy for the return on the market portfolio. AD_1 is the first trading day in November (the first day after the closing price is known), AD_2 is the last trading day in November (when the number of shares outstanding is determined), and AD_3 is the first trading day after the announcement is released after the market close on the previous day, and ED is the effective day (the last trading day before an index change becomes effective).

** and * indicate statistical significance at the 1% and 5% level, respectively, using a two-tail test.

Table 2. Cumulative average abnormal returns (CARs) for stocks added to the Nasdaq 100 index throughout the year for the first time (new irregular additions).

Period	CARs	*t* test	Sign test	Rank test
AD–30, AD–1	9.83%	3.96**	3.92**	3.08**
AD–1	0.55%	1.22	1.89	1.99*
AD	2.55%	5.64**	4.17**	4.84**
AD+1	–0.75%	–1.66	–2.33*	–1.96*
AD+1, ED–1	–0.48%	–0.70	–1.11	0.60
ED–1	–0.14%	–0.31	0.74	–0.32
ED	0.53%	1.16	0.61	1.43
ED+1	–1.25%	–2.77**	–2.18*	–3.70**
ED+1, ED+20	–0.96%	–0.48	–1.67	–1.51
ED+1, ED+40	–3.12%	–1.09	–2.69**	–1.76
ED+1, ED+60	–1.79%	–0.51	0.36	–0.91
AD–30, ED+20	11.51%	3.46**	0.61	0.96
AD–30, ED+40	9.36%	2.40*	1.38	1.76
AD–30, ED+60	10.68%	2.43*	1.89	1.81

Notes: Abnormal returns are estimated using Fama and French's (1993) three-factor model and a 180-trading day post-event estimation period that runs from ED+61 to ED+240. The Nasdaq Composite index CRSP serves as a proxy for the return on the market portfolio. AD is the announcement day and ED is the effective day (the last trading day before an index change becomes effective).
** and * indicate statistical significance at the 1% and 5% level, respectively, using a two-tail test.

Table 3. Changes in the number of shareholders for stocks added to or deleted from the Nasdaq 100 index at annual reconstitutions.

Group	Period	Mean (Median)	Mean (Median) difference	*t* test (*p*-value)	Sign test (*p*-value)	Wilcoxon signed-rank test (*p*-value)
New Additions (*N* = 109)	Pre-event	18,861 (758)	12,823 (65)	1.90 (0.06)	12.00 (0.03)	1249.00 (0.00)
	Post-event	31,684 (1,247)				
Repeated Additions (*N* = 33)	Pre-event	5,497 (826)	2,240 (–36)	1.56 (0.13)	–6.50 (0.04)	–94.50 (0.09)
	Post-event	7,736 (797)				
New Deletions (*N* = 134)	Pre-event	14,597 (1,574)	317 (–28)	0.30 (0.77)	–19.00 (0.00)	–908.50 (0.04)
	Post-event	14,914 (1,596)				

Notes: The pre-event number of shareholders is obtained as close as possible prior to AD_3 (the first trading day after the announcement is released after the market close on the previous day). The post-event number of shareholders is obtained at least nine months after the effective day. Two-tailed *p*-values are in parentheses.

Table 4. Changes in Merton's shadow cost[a] for stocks added to or deleted from the Nasdaq 100 index at annual reconstitutions.

Group	Period	Mean (Median)	Mean (Median) difference	*t* test (*p*-value)	Sign test (*p*-value)	Wilcoxon signed-rank test (*p*-value)
New Additions (*N* = 80)	Pre-event	0.5452 (0.0904)	0.0540 (–0.0010)	0.22 (0.82)	–11.00 (0.02)	–381.00 (0.07)
	Post-event	0.5990 (0.0691)				
Repeated Additions (*N* = 32)	Pre-event	0.1069 (0.0766)	–0.0098 (–0.0031)	–1.04 (0.31)	–5.00 (0.11)	–70.00 (0.20)
	Post-event	0.0971 (0.0614)				
New Deletions (*N* = 102)	Pre-event	0.1043 (0.0244)	0.0840 (–0.0001)	0.92 (0.36)	–7.00 (0.20)	–741.50 (0.01)
	Post-event	0.1880 (0.0237)				

Notes: Merton's shadow cost is computed as

$$Shadow\ Cost = \frac{Residual\ Standard\ Deviaion}{Nasdaq\ 100\ Market\ Cap} \times \frac{Firm\ Size}{Number\ of\ Shareholders}$$

The pre-event (post-event) residual standard deviation is calculated as the standard deviation of the difference between the firm's return and the Nasdaq 100 index total return in the 252-trading day period before AD_3 (after ED). The pre-event number of shareholders is obtained as close as possible prior to AD_3. The post-event number of shareholders is obtained at least nine months after ED. Firm size, measured as the market value of equity, and the Nasdaq 100 market cap are measured on AD_3. AD_3 is the first trading day after the announcement is released after the market close on the previous day, and ED is the effective day (the last trading day before an index change becomes effective). Two-tailed *p*-values are in parentheses.

[a] Units are 10^{-3}

Table 5. Changes in the number of analysts' following for stocks added to or deleted from the Nasdaq 100 index at annual reconstitutions.

Group	Period	Mean (Median)	Mean (Median) difference	*t* test (*p*-value)	Sign test (*p*-value)	Wilcoxon signed-rank test (*p*-value)
New Additions (*N* = 123)	Pre-event	12.67 (12.00)	1.67 (1.50)	5.40 (0.00)	24.50 (0.00)	1642.00 (0.00)
	Post-event	14.34 (14.00)				
Repeated Additions (*N* = 36)	Pre-event	14.99 (15.00)	0.64 (0.50)	1.66 (0.11)	5.00* (0.09)	69.50 (0.11)
	Post-event	15.63 (15.75)				
New Deletions (*N* = 138)	Pre-event	13.84 (13.00)	–1.47 (–1.00)	–5.04 (0.00)	–25.50 (0.00)	–1930.50 (0.00)
	Post-event	12.37 (12.00)				

Notes: The pre-event (post-event) number of analysts is computed as the average number of analysts in two fiscal quarters prior to (after) the fiscal quarter of the announcement day AD_3 (effective day ED). AD_3 is the first trading day after the announcement is released after the market close on the previous day, and ED is the effective day (the last trading day before an index change becomes effective). Two-tailed *p*-values are in parentheses.

Table 6. Changes in institutional shareholdings for stocks added to or deleted from the Nasdaq 100 index at annual reconstitutions.

Panel A: Number of institutional shareholders

Group	Period	Mean (Median)	Mean (Median) difference	*t* test (*p*-value)	Sign test (*p*-value)	Wilcoxon signed-rank test (*p*-value)
New Additions (*N* = 110)	Pre-event	509.35 (484.50)	38.10 (31.25)	6.24 (0.00)	40.00 (0.00)	2331.50 (0.00)
	Post-event	547.45 (521.25)				
Repeated Additions (*N* = 33)	Pre-event	667.86 (676.50)	51.55 (45.00)	5.56 (0.00)	12.50 (0.00)	265.50 (0.00)
	Post-event	719.41 (723.50)				
New Deletions (*N* = 131)	Pre-event	468.03 (439.00)	–16.11 (–14.50)	–3.75 (0.00)	–26.50 (0.00)	–2259.50 (0.00)
	Post-event	451.92 (424.50)				
Panel B: Percentage of institutional shareholdings						
New Additions (*N* = 107)	Pre-event	67.66 (75.90)	1.80 (0.92)	3.37 (0.00)	16.00 (0.00)	1086.50 (0.00)
	Post-event	69.44 (76.40)				
Repeated Additions (*N* = 32)	Pre-event	74.00 (81.35)	1.12 (0.87)	1.40 (0.17)	4.00 (0.22)	66.00 (0.22)
	Post-event	75.12 (80.37)				
New Deletions (*N* = 126)	Pre-event	62.50 (67.63)	–0.17 (0.14)	–0.38 (0.70)	6.50 (0.28)	73.50 (0.85)
	Post-event	62.33 (66.94)				

Notes: Pre-event values show institutional ownership in the two months before (October and November) the effective day, whereas post-event values present institutional ownership in two months after (January and February) the effective day. Two-tailed *p*-values are in parentheses.

Table 7. Correlations between a proxy for arbitrage risk *A1* and the cumulative abnormal return from AD_1– 30 to ED+60 for stocks added to or deleted from the Nasdaq 100 index at annual reconstitutions.

Group	*Correlation* (*p*-value)
New additions (*N* = 128)	0.25 (0.00)
Repeated additions (*N* = 37)	0.17 (0.31)
New deletions (*N* = 141)	0.18 (0.04)

Notes: A proxy for arbitrage risk *A1* is defined as the variance of the error term from a regression of the stock's excess return on the market's excess return over a [AD_3−365, AD_3−20] calendar day window. The cumulative abnormal return from AD_1– 30 to ED+60 is estimated by using Fama and French's (1993) three-factor model and a 180-trading day post-event estimation period that runs from ED+61 to ED+240. The Nasdaq Composite Index is used as a proxy for the market return. AD_1 is the first trading day in November (the first day after the closing price is known), AD_3 is the first trading day after the announcement is released after the market close on the previous day, and ED is the effective day. Two-tailed *p*-values are in parentheses.

Table 8. Changes in liquidity for stocks added to or deleted from the Nasdaq 100 index at annual reconstitutions.

Liquidity Measure	Period	Mean (Median)	Mean (Median) difference	*t* test (*p*-value)	Sign test (*p*-value)	Wilcoxon signed-rank test (*p*-value)
Panel A: New Additions *(N = 128)*						
Relative Spread	Pre-event	0.0019 (0.0012)	–0.0006	–3.83	–34.00	–2283.00
	Post-event	0.0014 (0.0008)	(–0.0003)	(0.00)	(0.00)	(0.00)
Dollar Volume	Pre-event	17.7262 (17.7018)	0.4270	5.03	30.00	2224.00
	Post-event	18.1533 (18.1517)	(0.3265)	(0.00)	(0.00)	(0.00)
Illiquidity Ratio[a]	Pre-event	0.0008 (0.0004)	–0.0002	–2.11	–25.00	–1673.00
	Post-event	0.0006 (0.0003)	(–0.0001)	(0.04)	(0.00)	(0.00)
Zero Return Ratio	Pre-event	0.0141 (0.0056)	–0.0038	–2.42	–6.00	–472.50
	Post-event	0.0103 (0.0056)	(0.0000)	(0.02)	(0.26)	(0.08)
Market Makers	Pre-event	45.10 (46.00)	3.99	11.91	46.50	3413.00
	Post-event	49.10 (48.50)	(3.50)	(0.00)	(0.00)	(0.00)
Panel B: Repeated Additions *(N = 37)*						
Relative Spread	Pre-event	0.0009 (0.0006)	–0.0004	–4.47	–15.50	–304.50
	Post-event	0.0005 (0.0004)	(–0.0002)	(0.00)	(0.00)	(0.00)
Dollar Volume	Pre-event	17.9365 (18.1028)	0.3648	5.18	13.50	279.50
	Post-event	18.3012 (18.3026)	(0.2894)	(0.00)	(0.00)	(0.00)
Illiquidity Ratio[a]	Pre-event	0.0004 (0.0002)	–0.0002	–3.73	–13.50	–294.50
	Post-event	0.0002 (0.0002)	(–0.0001)	(0.00)	(0.00)	(0.00)
Zero Return Ratio	Pre-event	0.0093 (0.0056)	–0.0009	–0.66	–1.50	–23.00
	Post-event	0.0084 (0.0056)	(0.0000)	(0.52)	(0.69)	(0.54)
Market Makers	Pre-event	57.42 (57.50)	1.65	2.82	9.00	171.50
	Post-event	59.07 (59.00)	(1.00)	(0.00)	(0.00)	(0.00)

Table 8 continues

Table 8 (*continued*)

Panel C: New Deletions *(N = 141)*

Liquidity measure	Period	Mean (Median)	Mean (Median) difference	*t* test (*p*-value)	Sign test (*p*-value)	Wilcoxon signed-rank test (*p*-value)
Relative Spread	Pre-event	0.0028 (0.0020)	0.0009 (0.0000)	2.84 (0.01)	–1.50 (0.87)	292.50 (0.55)
	Post-event	0.0037 (0.0013)				
Dollar Volume	Pre-event	17.2722 (17.2726)	–0.3783 (–0.2734)	–5.99 (0.00)	–30.50 (0.00)	–2658.50 (0.00)
	Post-event	16.8939 (17.0146)				
Illiquidity Ratio[a]	Pre-event	0.0015 (0.0009)	0.0033 (0.0001)	3.14 (0.00)	9.50 (0.13)	1679.50 (0.00)
	Post-event	0.0049 (0.0009)				
Zero Return Ratio	Pre-event	0.0247 (0.0167)	0.0037 (0.0000)	1.82 (0.07)	7.50 (0.20)	832.00 (0.02)
	Post-event	0.0284 (0.0167)				
Market Makers	Pre-event	55.78 (57.00)	0.53 (0.00)	2.02 (0.04)	6.50 (0.29)	884.50 (0.03)
	Post-event	56.31 (56.50)				

Notes: Relative spread is the average of the difference between the daily closing ask and bid prices divided by the mid-point of closing ask and bid prices. Dollar volume is the average of the natural logarithm of daily trading volume in dollars. ILLIQ, illiquidity ratio, is the average of the daily ratio of absolute stock return to its daily trading volume in dollars. Zero return ratio is the ratio of the number of zero return days to the total number of trading days. Market makers is the average number of market makers for a stock. Except Market makers, pre-event values for each liquidity proxy are computed over a 180-day period that ends at AD_3–31, where AD_3 is the first trading day after the announcement is released after the market close on the previous day. Post-event values are computed over a 180-day period that starts at ED+61, where ED is the effective day (the last trading day before an index change becomes effective). The pre-event and post-event values for the number of market makers are computed as the average of two months (September and October) prior to the month of AD_1 and the average of two months (January and February) after the month of ED, respectively. Two-tailed *p*-values are in parentheses.

[a] Units are 10^{-6}.

Table 9. Regressions on CAR (AD_1– 30, ED+60) for stocks added to the Nasdaq 100 index at annual reconstitutions.

	(1)	(2)	(3)	(4)	(5)
Constant	0.02	–0.08	0.01	0.06	0.16*
	(0.82)	(0.26)	(0.84)	(0.46)	(0.05)
Liquidity					
Δ Relative spread	–134.40				
	(0.00)				
Δ Dollar volume		0.36			
		(0.00)			
Δ Illiquidity Ratio			–218.72		
			(0.00)		
Δ Zero return ratio				–1.24	
				(0.76)	
Δ Number of market makers					–0.03
					(0.00)
Investor awareness					
Reentry dummy	–0.18	–0.17	–0.17	–0.13	–0.18
	(0.04)	(0.04)	(0.04)	(0.15)	(0.04)
Δ Number of common shareholders	0.00	0.00	0.00	0.00	0.00
	(0.42)	(0.98)	(0.33)	(0.31)	(0.20)
Δ Shadow cost	–35.85	–48.89	–41.25	–35.46	–37.09
	(0.08)	(0.01)	(0.03)	(0.11)	(0.07)
Δ Number of analysts	0.02	0.02	0.01	0.02	0.02
	(0.24)	(0.16)	(0.38)	(0.17)	(0.17)
Downward-sloping demand curve					
Δ Number of institutional shareholders	–0.00	–0.00	–0.00	–0.00	–0.00
	(0.80)	(0.23)	(0.84)	(0.48)	(0.57)
Δ Percentage of shares held by institutions	0.14	0.55	0.04	0.81	0.77
	(0.87)	(0.50)	(0.96)	(0.40)	(0.40)
A1	122.87	169.91	143.88	83.06	107.26
	(0.00)	(0.00)	(0.00)	(0.06)	(0.01)
Control variable					
Market value	0.00	0.00	0.00	0.00	–0.00
	(0.80)	(0.40)	(0.87)	(0.85)	(0.82)
N	96	96	96	96	96
Adj. R^2 (%)	19.80	33.61	24.80	10.87	19.58

Notes: The dependent variable is the cumulative abnormal return from AD_1– 30 to ED+60 estimated by using Fama and French's (1993) three-factor model and a 180-trading day post-event estimation period that runs from ED+61 to ED+240. The Nasdaq Composite Index is used as a proxy for the market return. AD_1 is the first trading day in November (the first day after the closing price is known) and ED is the effective day. Relative spread, Dollar volume, ILLIQ, Zero return ratio, and Number of market makers are defined in Table 7. The reentry dummy equals 1 if a stock is added to the index for the second time, and zero otherwise.*A1* is the variance of the error term from a regression of the stock's excess return on the market's excess return over a [AD_1−365, AD_1−20] calendar day window. Market value is the stock's market value on AD_3–30. Two-tailed *p*-values are in parentheses.