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Abstract

One of the most contentious debates in the literature on index revisions is whether the price effects are permanent or transitory. This paper sheds light on this debate by providing empirical insights into the interaction between information asymmetry risks, price patterns and trading volume behaviour around the revisions. Using data from the Nikkei 225 and liquidity as a proxy for information asymmetry, we find that price pressure effects for deleted (added) stocks with high (low) information asymmetry risks are substantially permanent (transitory), suggesting that the perceived higher information asymmetry risks for deleted stocks are priced. We further find that scheduled additions experience weaker price pressures that *fully* reverse within 15 days while non-scheduled additions experience stronger price pressures that, after 30 days, only *partially* reverse. Results overall highlight the important role an index's repertoire of rules can play in attenuating or exacerbating the persistence and magnitude of the price pressure effects around the revisions.

Key Words: Index rebalancing, Event study, Price pressure, Nikkei 225, Information asymmetry

JEL Classification: G12, G14

1. Introduction

Traditional asset pricing theories and the efficient markets hypothesis assume that the demand curves for stocks are flat. That is, in the absence of new information or change in fundamentals, investors can trade large quantities of a stock without impacting its price. On the other hand, the price pressure and imperfect substitute hypotheses argue that demand curves are downward sloping. However, while the price pressure hypothesis argues that short-term market frictions cause the demand curves to slope down temporarily but remain flat in the long term (leading to temporary price changes), the imperfect substitutes hypothesis holds the view that demand curves slope down over the long term (resulting in permanent price changes).

As we will discuss below, the literature on index effects has tended to discuss the observed price effects from the perspective of the price pressure hypothesis (Harris and Gurel, 1986), imperfect substitute hypothesis (Shleifer, 1986) and the information signaling hypothesis (Jain, 1987). The latter two predict, albeit inconveniently, that the inclusion or deletion of stocks from an index impacts their prices permanently. Also, little is discussed about what trading volume patterns around index rebalancing dates reveal about investors' motives. Trading volume, however, contains useful information about future price behaviour as it captures the interactions, as well as the motives for trade, between informed and uninformed agents.[2] As discussed in Wang (1994, p. 130), "informational trading and non-informational trading give rise to a very different dynamic relation between volume and returns". Specifically, price changes generated by

[2] See Easley, Engle, O'Hara and Wu (2005).

informational or speculative trades tend to persist while those generated by non-informational or portfolio rebalancing needs tend to reverse.

Similarly, Brunnermeier and Pedersen (2005) and Kappou et al. (2010) find that index-trackers carry out their portfolio-rebalancing trades very close to the effective date in order to minimize tracking error between the return on their portfolio and the benchmark index. Strategic investors on the other hand carry out their opportunistic information-based trades immediately after the announcement date, which would then imply that the best conceivable setting to identify and capture uninformed demand is by focusing on periods as close to the effective date as possible.[3] Our objective thus is to investigate how these patterns relate to the underlying trading motive characteristics and how, together, they influence return dynamics around index revision dates.

Further, most of the influential studies that test the downward sloping demand curve hypothesis in the context of index revisions use data on the S&P 500 (for example Shleifer, 1986; Harris and Gurel, 1986; Beneish and Whaley, 1996; Chen et al. 2004); all the above cited studies (except Harris and Gurel, 1986) find evidence of a permanent price effect when a stock is included in or removed from the S&P 500.[4] However, referencing the opaque rules (including but not limited to the secret candidate-replacement pool), several studies contend that revisions to the S&P 500 are not

[3] Although much of the literature supports the view that information traders trade close to announcement day while indexers trade close to effective day, we recognize that some mixing is – in principle – possible. For example rather than trade close to the announcement day, information traders may hide their trades by breaking them up and spreading them out over both announcement and effective periods. Similarly, indexers, rather than trade close to the effective day to minimize tracking error, may instead choose to trade close to the announcement date in order to generate profit from short-term price fluctuations or to reduce the cost of immediacy; doing so however may generate substantial tracking errors, as managers of index funds are typically evaluated on the basis of their tracking error (Lynch and Mendenhall, 1997).

[4] See Afego (2017) for a detailed review of the relevant theories that have been put forward to explain the index effect.

information-free events (for example Denis et al., 2003; Sui, 2003; Elliot et al., 2006; Patel and Welch, 2017). Furthermore, the Chairman of the S&P 500 Index Committee recently admitted that "the Index Committee have some discretion in selecting stocks or responding to market events",[5] which then raises the question about whether the permanent price effects documented in prior studies merely reflect the information-driven price adjustments or instead produce evidence that demand curve for stocks are downward sloping.

We respond to these concerns by identifying a setting where membership rules are transparent, mechanical and, thus, non-informative. In particular, we exploit the unique setting of Japan's Nikkei 225 index where the liquidity criteria for membership are predefined and computed from publicly available historical price and volume data. In this setting, revisions in principle provide no new insight on firms' fundamentals or future prospects, and so contain no material information. That notwithstanding, it would be a mistake to ignore the possibility that trades around the revision dates may be driven by motives other than portfolio rebalancing needs of index trackers. There are several reasons. The first is that since membership of the index is based mainly on liquidity rankings, exclusion from the index may hint at some hidden information about a firm's future prospects.[6] The second is that since the liquidity rankings are computed using publicly available historical data, revisions to the index may be perceived to provide a confirmation of information that consists of backward-looking *actual*, rather than *expected*, outcomes that are independently verifiable (Ball et al, 2012). On this view,

[5] https://www.indexologyblog.com/2014/08/07/inside-the-sp-500-an-active-committee/ (last accessed 7th April 2019)

[6] Baker and Stein (2004) for example demonstrate that firms whose shares are less liquid are more likely to be associated with higher debt levels.

announcements of revisions may be regarded by investors as a confirmatory piece of information regarding the liquidity and, in our submission, asymmetric information risks associated with a stock. Therefore, guided by Llorente, Michaely, Saar and Wang (2002), henceforth LMSW, we evaluate the potential effect of information asymmetry (proxied by liquidity) on the volume-return dynamics around the rebalancing dates. Specifically, we attempt to disentangle the information/liquidity hypotheses from the downward sloping demand curve by focusing on periods where the non-informational story predicts that index fund purchases and sales are motivated by necessity, as opposed to opportunistic information-based trading.[7]

Andres et al. (2014) assert that liquidity does a good, albeit imperfect, job as a proxy for information asymmetry. This, together with the liquidity-oriented nature of the rebalancings, motivates us to: (i) view revisions to the index as an indirect proxy for information asymmetry, and (ii) conjecture that added (deleted) stocks make up the portfolio of stocks with lower (higher) information asymmetry. Based on the LMSW model, price changes accompanied by high trading volume tend to exhibit strong reversals for stocks with low information asymmetry. However when information asymmetry is high, prices tend to exhibit weak reversals. From an empirical standpoint, examining the joint volume-price dynamics in the context of these theories is important as it can help provide clarity as to the conditions under which we can expect the rebalancing effects to be permanent or temporary. In addition, the analysis can provide insights not only on what trading volume patterns around the rebalancing dates reveal

[7] It is pertinent to note that the predictions of Wang (1994) and LMSW are similar to those of the price pressure hypothesis, except that Wang and LMSW explicitly assign an important role for trading volume and information asymmetry in distinguishing between price changes due to informational trades and those due to non-informational trades.

about investors' motives[8] but also about how much of the price effects may be due to stocks' liquidity/information asymmetry risks.

On another front, the efficient markets hypothesis predicts that only random and unexpected information can cause prices to change. Hence the degree to which the market predicts or anticipates revisions to an index can be expected to have an impact on the magnitude and persistence of the market reactions. From this perspective, scheduled rebalancing dates (as opposed to non-scheduled ones) can be used to obtain fairly precise estimates of announcement and effective dates in advance. Until now, we are unaware of any study of the unique dual policy of the Nikkei 225 index where some revisions are 'periodic' (scheduled) and others 'extraordinary' (non-scheduled). Scheduled revisions occur at clearly pre-specified calendar dates (early October each year), which implies that investors are more likely to form expectations and anticipate the changes. By contrast, non-scheduled revisions occur on an as-needed basis, at any time, implying that market participants are basically unaware of any upcoming changes to the index until when such changes are announced. Intuitively, we can expect that announcements of such non-scheduled revisions may cause a greater surprise and price reaction. This unique feature of the Nikkei 225 index thus allows us to directly test the possibility that the magnitude, speed and persistence of the price effects vary across the two regimes.

Consistent with the above predictions, we find that (deleted) stocks with high information asymmetry tend to exhibit weak reversals, whereas (added) stocks with low information asymmetry exhibit stronger reversals. We also find that non-scheduling

[8] See Karpoff (1987).

affects the magnitude as well as speed and degree of reversals of price effects. Specifically, scheduled additions experience weaker price pressures (6.7%) that *fully* reverse within 15 days. In contrast, non-scheduled additions experience stronger price pressures (10.7%) that, after 30 days, only *partially* reverse. Overall, the results suggest that non-scheduled rebalancing arrangements impose additional costs on index trackers as prices stray too far away from their efficient values, making it costlier for them to adjust their portfolios accordingly.

Our study makes a number of contributions to the literature. First, we extend the scope of research on the short-term index effect by incorporating information asymmetry risks as guided by LMSW's (2002) framework. Using liquidity as a proxy for information asymmetry, we find supportive evidence for the prediction that price changes accompanied by high trading volume tend to exhibit strong reversals for stocks with low information asymmetry risks, while price changes for stocks with high information asymmetry risks tend to exhibit weak reversals. Our finding that persistence of the rebalancing effects may be linked to stocks' information asymmetry risks provides some clarity to the long-running debate on whether the effects are permanent or transitory, and why.

Second, separating rebalancings into scheduled and non-scheduled, we find that the price pressures that cause prices to overshoot are substantially more pronounced for non-scheduled additions. These results have practical implications for index fund managers who trade very close to the effective day to minimize tracking error: when revisions are non-scheduled, it becomes substantially more costly to buy the shares of additions on the day they are included in the index. To the best of our knowledge this is the first attempt to provide direct evidence on the differential price impact between scheduled and non-scheduled revisions to a major index.

Third, the results, from a microstructure perspective, offer insight into how an index's repertoire of rules and policies can influence how long and to what magnitude prices might deviate from fundamental values following rebalancing. Also, by uncovering evidence that non-scheduling makes prices less efficient around the rebalancing dates, our study contributes to the wider literature on stock market efficiency.

The remainder of the paper is organized as follows. In section 2, we discuss the institutional framework, the assessment of liquidity and our underlying hypotheses. Section 3 discusses the data and test methodologies. Section 4 presents and discusses the empirical results. Section 5 concludes.

2. Institutional Background, Liquidity Assessment and Hypotheses

2.1 Some Background on the Nikkei 225

The Nikkei 225 is a stock price index composed of two hundred and twenty five (225) top-rated stocks Japanese companies listed on the First Section of the Tokyo Stock Exchange (TSE).[9] The index is price-weighted, denominated in Japanese Yen (JPY), and its constituents are selected on the basis of liquidity and sector balance. The index covers 6 major sectors, namely Technology, Financials, Consumer Goods, Materials,

[9] The TSE divides stocks into three different groups: the First Section (for large companies); the Second Section (for mid-sized companies); and the Mothers section (for high-growth startups). In order for a company to be listed in the First Section and eligible for the Nikkei 225 index, several requirements must be satisfied: number of shareholders must be at least 2,200; number of tradeable shares at least 4,000; market cap of tradeable shares at least JPY 2 billion; market cap at least JPY 4 billion and net assets at least JPY 1 billion (https://www.jpx.co.jp/english/equities/listing-on-tse/transfers/basic/01.html; last accessed 7th June 2019)

Capital Goods/Others, and Transportation and Utilities. It was launched in September 1950, making it the oldest stock index in Asia.

Nihon Keizai Shimbun (Nikkei Inc.), a leading Japanese media company, calculates and revises the composition of the index using strict, mostly mechanical, rules. The rules fall under two categories: periodic review and extraordinary replacement. Periodic review follows a predetermined calendar schedule where announcements of changes occur once a year, around middle of September and take effect at the beginning of October. Extraordinary replacements on the other hand are non-scheduled and can occur at any time in response to developments such as delistings or transfer to the Second Section of the TSE. Also, securities facing or involved in mergers, bankruptcy, corporate restructuring, or under supervision, investigation or monitoring may be dropped from the index under this framework. Replacements for such deleted stocks usually come from stocks with the highest liquidity within the sector not previously included in the index.[10]

2.2 Liquidity Assessment

The Nikkei 225 judges the liquidity of a stock according to two indicators: trading value and magnitude of price fluctuation by volume, the latter calculated as (high price/low price)/volume. The procedure of selecting liquid stocks comes in two phases. First is the so called "High Liquidity Group" comprising of top 450 liquid stocks of the First Section of the TSE. Second is another list of top 75 most liquid stocks also from the First Section of the TSE.

Assessment of liquidity ("High Liquidity Group")

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[10] For details, see https://indexes.nikkei.co.jp/nkave/archives/file/nikkei_stock_average_guidebook_en.pdf (last accessed on 3rd June 2019)

As mentioned above, highly liquid stocks from the TSE constitute part of the “High Liquidity Group” and the measures used to assess a stock’s liquidity are: (i) Trading value of the preceding 5 years, and (ii) Magnitude of price fluctuation by volume in the preceding 5 years. The top 450 most liquid stocks in terms of the above two measures constitute the “High Liquidity Group”.

Addition and Deletion due to Liquidity

Constituents are reviewed annually in accordance with the following rules: (i) Stocks in the “High Liquidity Group” ranked 75th or higher and not currently in the list of the constituents are added to the index, while (ii) those constituents not in the High Liquidity Group (ranked 451 or lower) are deleted from the index. Adding and deleting stocks based on these rules ensures that a list of 225 constituent stocks is maintained at all times.

2.3 Testable Hypotheses

2.3.1 Trading behaviour and its relation to information asymmetry and stock prices

Campbell, Grossman and Wang (1993) construct a rational expectation model of non-informational stock trading in which shifts in investors' risk aversion occur due to (non-informational) factors unrelated to stocks' fundamentals. Hence any subsequent reallocation of risk manifests itself in the form of (i) a rise in trading volume, and (ii) a rise in expected return to compensate those investors willing to bear the risk of holding the stock. Wang (1994) develops a more general stock trading model in which investors are heterogeneous both in their informational and private investment opportunities. The behaviour of trading volume, Wang argues, is closely linked to the underlying heterogeneity among investors. More specifically, Wang (1994) shows that information- (or speculation-) driven price changes are less likely to reverse, whereas non-information- (or liquidity-) driven trades lead to price changes that reverse. Furthermore LMSW, building on Wang's (1994) model, postulate that the degree of information asymmetry (proxied by market capitalization) affects the extent of price reversals. More specifically, they demonstrate that stocks with high information asymmetry risks tend to exhibit weak reversals or even continuation. Stocks with low information asymmetry risks on the other hand tend to exhibit strong reversals. We take this proposition to an index rebalancing setting and empirically examine its validity with respect to Nikkei 225 revisions. Specifically – and motivated by Andres et al.'s (2014) assertion that liquidity can proxy for information asymmetry – we view revisions to the Nikkei 225 as an indirect proxy for information asymmetry and thus implicitly assume that added (deleted) stocks make up the portfolio of stocks with low (high) asymmetric information risks. We make this assumption bearing in mind that changes to the index are based mainly on liquidity rankings of the top 450 stocks listed on the First Section of the TSE, in which case stocks in the index whose liquidity rankings fall become candidates for deletion and are replaced by stocks (usually from the same sector) whose liquidity rankings rise.

Thus following LSMW, we develop the following hypothesis concerning stock price behaviour around Nikkei 225 revisions and its relation to information asymmetry risks.

Hypothesis 1: For deleted stocks with high information asymmetry risks, the price pressure generated will exhibit *weak* reversals (or conversely *strong* persistence), whereas for added stocks with low information asymmetry risks, the price pressure will exhibit *strong* reversals (or conversely *weak* persistence).

Put differently, deleted stocks with higher information asymmetry risks should experience substantial permanent price impact while added stocks with low information asymmetry risks should experience temporary price impact. To test the hypothesis, we follow Mitchell, Pulvino and Stafford (2004) in employing an empirical strategy that captures the extent of price pressures and return reversals around index rebalancing dates. More details are provided in section 3.

2.3.2 Dual revisions and short-term rebalancing effects

A long running debate in the literature on index revisions is whether the price effects are persistent or transitory (Afego, 2017). Motivated by the need to address this controversy, we exploit the dual system of scheduled and non-scheduled announcements unique to the Nikkei 225 index. In doing so, we develop a set of hypothesis regarding stock price reaction to announcements of changes to the index. Rooted in the efficient market hypothesis is the idea that only unexpected (random) news can cause price changes. Thus if we consider that announcements of scheduled revisions are non-random and *not* unexpected, then we can expect that the price and volume response generated by announcements of non-scheduled revisions would be larger than that of scheduled revisions. In prior research, Okada et al (2006) and Liu (2006) investigate the market reaction to new additions to the Nikkei 225 index but do not distinguish between scheduled and non-scheduled additions. Unlike these studies, our paper examines this duality more closely and puts forth the following hypotheses concerning the market response to announcements of scheduled and non-scheduled additions on the Nikkei 225 index.

Hypothesis 2a: In a dual rebalancing regime, the market will have a stronger positive reaction to a non-scheduled addition than to a scheduled addition.

Next we consider the potential influence of this duality on the persistence of price pressure for additions.

Hypothesis 2b: The price pressure generated by non-scheduled additions will be substantially persistent while that of scheduled additions will be largely transitory.

Scheduled addition events allow market participants (particularly strategic traders) ample room to anticipate the changes and spread out their buying. Because the index revises its composition of stocks periodically, at the beginning of October, not only can strategic traders see *when* index funds will rebalance their portfolios but also they may be able to predict *which* stocks will be removed or added based on the index provider's established and publicly available revision rules. As a result, the traders can step in front of the trade by buying shares immediately after the announcements to gain a profit because they know a large number of shares would have to be bought by index funds soon. Thus with greater lead time, they can spread out and gradually build their positions in advance before selling for a profit on or near the effective date of the reconstitution. By spreading their purchases out over a long time, the run-up in price is more gradual, causing the overall price impact to be smaller and transitory.

Non-scheduled addition events on the other hand make it harder for strategic traders to anticipate the changes in advance. As a result, they have little lead time to build their positions or spread out their stock purchases, potentially resulting in a bigger, more persistent price impact than we would expect if their purchases were spread out over a longer time.

3. Data and Methodology

3.1 Primary data

The data consists of announcement and effective dates of changes to the composition of the Nikkei 225 index. Data on closing prices for additions and deletions from March 1970 to April 2015, as well as the market benchmark TOPIX, were extracted from the Nikkei Economic Electronic Database Systems (NEEDS). Table 1 provides some details on the frequency and distribution of announcements of index changes over the sample period. As shown in the table, deletions (Panel B) are much more clustered relative to additions (Panel A).

[Table 1 around here]

After screening for several contemporaneous events such as litigations, bankruptcy, stock split actions, mergers or takeover, shares repurchase programmes, as well as insufficient return data, we find confounding effects or insufficient return data for approximately 52% of additions and 74% for deletions, which is not very surprising considering that deleted firms tend to be more associated with contemporaneous events unrelated to the index change itself (Afego, 2017).

3.2 Descriptive statistics

Descriptive statistics for the sample of 77 additions and 42 deletions from the Nikkei 225 index are presented in Table 2. As shown, added stocks are generally pricier than deleted stocks. The mean (median) share price is 2,875 JPY (1,222 JPY) for additions compared to 249 JPY (203 JPY) for deletions. Also, the shares of additions have higher average trading volumes (1.3 million), compared with deletions (0.69 million). Note also that both samples experience extreme jumps in trading volume as seen in the maximum volumes of shares (8.7 million for additions and 8.8 million for deletions). With respect to performance, both added and deleted stocks appear to have similar levels of return performance prior to their joining or leaving the index. And, the interval between the announcement and effective dates appears to vary across the sample of event firms.

[Table 2 around here]

3.3 Methodology

Several alternative benchmarks can and have been used in modelling abnormal returns within the context of the standard event study methodology. These include the market model, the market-adjusted returns model and the mean-adjusted returns model.[11] As Campbell, Lo and McKinlay (1997) note, the main advantage of the market model lies in its potential to account for firm-specific sensitivities to market returns. The parameters of the market model we employ are calculated using a 250-day estimation window [-260, -11] prior to the event day. Motivated by prior studies which suggest that trading motives around the announcement and implementation dates of index rebalancing dates differ

[11] See Campbell, Lo and McKinlay (1997) for a detailed description of the alternative models.

considerably, we employ two separate event dates: the announcement date (AD) and effective date (ED).

We compute the abnormal return of each event firm at day *t* as its return in excess of the market portfolio return. We use the Tokyo Stock Price Index (TOPIX), which comprises of over 1600 companies listed on the TSE, as proxy for the market return. Using the TOPIX minimizes the impact of Nikkei 225 additions and deletions on our measure of market portfolio returns. Average abnormal return (AAR) at day *t* is the average of the abnormal returns of all new additions or deletions, at day *t*:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AAR_{it,} \qquad (1)$$

where *N* represents the number of all new additions or deletions. Cumulative average abnormal return (CAAR) is then computed by summing the AARs over the multi-period intervals say from day *t-n* to day *t*:

$$CAAR_{t-n,t} = \sum_{t-n}^{t} \frac{1}{N}\sum_{i=1}^{N} AAR_{it.} \qquad (2)$$

Because the variance of returns in the event window almost always exceeds the variance in the estimation window (Harrington and Shrider, 2007; Kothari and Warner, 2007), failure to correct for the increased variability over the two windows tends to bias the standard deviation downwards, thereby overstating the abnormal return estimates. To account for this potential bias, we employ the standardized cross-sectional test statistic proposed by Boehmer et al. (1991) to assess the significance of the event window returns. For robustness, we also employ the time series t-statistic which implicitly accounts for the potential cross-sectional correlation in the sample data. The Boehmer et al. (1991) test statistic is given by:

$$t_B = \frac{\overline{SAR}\sqrt{n}}{S}, \tag{3}$$

where $\overline{SAR}$ is the average standardized abnormal return for all sample firms, and

$$S^2 = \frac{1}{n-1}\sum_{i=1}^{n}(SAR_i - \overline{SAR})^2. \tag{4}$$

The abnormal volume (AV) estimation methodology, defined within the framework of the market model, follows the one used in Campbell and Wasley (1996) and Biktimirov and Li (2014). The significance of the abnormal volume is assessed using the rank test statistic of Corrado (1989) which has been shown to have substantially higher power in detecting daily abnormal trading volume relative to other test statistics (Campbell and Wasley, 1996). For robustness, we also use the time series test statistic of Brown and Warner (1985).

Price pressure is measured as trade-induced abnormal returns over a set period within the event window but *before* the event day. Reversals on the other hand are measured as abnormal returns over a period within the event window but *past* the event day. To measure price pressure and reversals, we follow Mitchell, Pulvino and Stafford (2004) and compute CAARs over the period [*ED-5, peak (trough) day*]. The *peak* (*trough*) day is defined as the day within the 21-day event window when prices are at their highest (lowest). To measure reversals, we use CAARs over the period [*peak (trough) day+1,* *ED+t*] where *t* captures the duration of price pressure or speed of post-event reversal, and takes the value 5, 10, 15, 20, 25, 30, and *peak (trough) day+1* is defined as one day after the *peak* (*trough*) day.

4. Analysis of Results

We begin by first assessing the general patterns of price and volume adjustment in the period around the announcement-day (AD) and effective-day (ED) of the index revisions. Second, we test whether our conjecture (that Nikkei 225 changes with higher information asymmetry risks exhibit weaker return reversals) is consistent with Wang's (1994) and LMSW's (2002) predictions (that a stock's price response to volume shocks is associated with the degree of information asymmetry associated with the stock). Third, we test whether there is a differential market response to unscheduled rebalancings relative to scheduled rebalancings.

4.1 Price adjustments around the event windows

Prior research suggests that short-window event studies can produce poor estimates of wealth effects (Mitchell, Pulvino, Stafford, 2004). An expanded window thus allows us to determine for example if the observed abnormal returns persist or quickly reverse. Table 3 reports the AARs and CAARs over a 21-day [-10, 10] announcement window. On the announcement day (AD 0), both additions and deletions generate positive AARs of 0.59% and 0.09% respectively. On the day after the announcement day (AD+1) however, we observe statistically significant positive and negative reaction for additions (3.97%) and deletions (-12.39%) respectively. This is expected because *Nihon Keizai*

Shimbun announces the changes after the close of trading on AD 0, hence the noticeable price reactions on AD+1.

[Table 3 around here]

Note that the CAARs for both samples are generally positive prior to the announcement day. On AD+1 however the CAARs for deletions decline more sharply than the CAARs for additions increase. In all, although Table 3 shows that additions and deletions experience similar levels of abnormal trading volume of 120% and 107% respectively on AD+1 (also see Figures 1 and 2),[12] the magnitude of the price impact around the announcement day is substantially larger for deletions than for additions.

[Figure 1 around here]

As regards the effective period, Table 4 shows that the CAARs turn significantly negative (positive) for deletions (additions) on ED-5 (ED-6), indicative of intense selling (buying) pressure by index funds in the days leading to the effective date.

Figures 1 and 2 are graphical plots depicting the behaviour of prices and trading volume respectively around the index rebalancing dates.

[Figure 2 around here]

Notice the disproportionate price impact (CAARs) of 10.75% and -19.86% on ED-1 for additions and deletions respectively. Notice also in Figure 2 the disproportionate volume reactions of additions (170%) relative to deletions (259%).

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[12] Similar announcement-day increases in abnormal trading volume can be seen around revisions of the FTSE Small Cap index (131% and 103% for additions and deletions respectively) documented in Biktimirov and Li (2014).

[Table 4 around here]

4.2 Trading behaviour and its relation to information asymmetry and stock prices

At first glance, the results in the previous section suggest that price pressure is more of an issue for deletions. However recall from Table 2 that, measured by trading volume, added stocks are on average twice as liquid as deleted stocks. As such, one interpretation is that the larger magnitude of the price impact for deleted stocks may be associated with their lower liquidity (see Ambrose, Cai and Helwege, 2009; Green and Jame, 2011; Hendershott and Menkveld, 2014). Put differently, the price impact for deletions possibly may contain both information and price pressure effects whereas added stocks are affected mainly by price pressure. Systematic tests of the LMSW model should shed more light on this phenomenon.

Implicit in the predictions of LMSW is the idea that price pressures are temporary. That is, price pressures on newly added or deleted stocks will subsequently reverse. To be consistent with this prediction, we expect the degree of reversals to be stronger (weaker) for the more (less) liquid sample of added (deleted) stocks, post change. To test this proposition, we first measure the price pressure effects induced by index trackers' demand for immediacy as they seek to buy (sell) stocks entering (exiting) the index. We then estimate the degree of reversals that follow the initial price effects.

As stated at the outset, index-tracking investors, as opposed to opportunistic information-based traders, tend to carry out their portfolio-rebalancing trades very close to the effective date to minimize tracking error. To disentangle the effects due to price pressure from those due to information effects – and thus capture the attendant uninformed demand shocks – we focus on periods around the effective date. This way, not only are we able to provide as clean a test as possible of the downward sloping demand curve hypothesis but also we are able to evaluate the potential role of trading activity and information asymmetry risks around the effective rebalancing dates based on the interpretations of LMSW.

Table 5 presents the results of our analyses to test Hypothesis 1. Panel A of the table reports the results for additions. For this sample, the price pressure effect from ED-5 through to ED-1 (the peak day) is 8.98%. By ED+5, prices partially reverse to -6.6%. The reversals become stronger on ED+15 (-8.03%), and basically complete by ED+25.

[Table 5 around here]

The complete reversals observed from around 25 days after the effective date suggest that additions to the Nikkei 225 are information-neutral events. That is, the observed price effects are a result of the temporary impact of demand for immediacy by indexers and merely reflect compensation to dealers/liquidity providers, consistent with the notion that demand curve for stocks slope down temporarily but remain flat in the long-term. Furthermore considering that added stocks are on the average more than twice as liquid as deleted stocks, and using liquidity as a proxy for information asymmetry, the results in Panel A are consistent with our conjecture (hypothesis 1) that, for stocks with low information asymmetry risks, price changes accompanied by high trading volume exhibit strong reversals.

Panel B of Table 5 reports the CAARs for deletions. We observe that the price pressure effect of -23.29% is accompanied by only a partial reversal of 14.57% and 16.64% in the subsequent 20 and 30 trading days, respectively. The results, consistent with our conjecture, suggest that the perceived higher information asymmetry risks of Nikkei 225 deletions are priced.

4.3 Other Possible Alternative Explanations

In general when investors with an urgent need to sell a given stock arrive to the market, the stock price must temporarily fall below its equilibrium value to induce dealers to provide immediacy, and later, after the investors that are demanding immediacy leave the market and new ones arrive, prices revert back to their equilibrium levels (same logic applies to purchases). However, since changes to the Nikkei 225 index are based on stocks' liquidity rankings computed using publicly available historical data, announcements of the changes, particularly deletions, may be viewed by investors as a confirmatory piece of information regarding a stock's liquidity deterioration and, by extension, higher asymmetric information risks, which may then be priced.

Still, it is worthwhile to note the possibility of inventory effects as an alternative explanation of the results for deletions.[13] Managers of index funds are typically evaluated on the basis of their tracking error (i.e., the difference between fund's return and the return on the index over any period (Lynch and Mendenhall, 1997)). As a result, it is important they sell the deleted securities on the day they are removed from the index. Dealers who act as market makers must be compensated for the inventory-

[13] The effect of inventory on prices is well documented in the microstructure literature. For a detailed review see Madhavan (2000).

carrying risks that they bear when they agree to immediately buy these securities which they otherwise would not trade. This sale by index funds releases a *substantial* fraction of the firm's security into circulation resulting in an increase in dealers' inventory levels, which in turn causes the market clearing price of the security to decline. To summarize, the inventory view implies that index rebalancers cause fluctuations in dealers' inventory levels, which in turn may significantly impact security prices.

Although this consideration may be important in other contexts, it is of limited use in explaining the observed permanent price declines for Nikkei 225 deletions, for the following reason: Nikkei 225 has a low indexation level, meaning it is a lightly tracked index. Some perspective is needed. As at June 2014, USD 57 billion was invested in Nikkei 225 mutual funds and ETFs. At about the same time the aggregate market cap of the index's constituents was about USD 4.49 trillion, implying that these funds had a 1.3% ownership stake in the index as a whole.[14] Over the same period, the S&P 500 index (with a market cap of USD 17.64 trillion) had about USD 2.2 trillion in investment funds *directly* benchmarked to it, which implies that indexers had a 12.5% ownership stake in it, and if we include other *non-directly* linked assets (totaling about USD 7.8 trillion), the ownership stake would be in the region of 44%.[15]

The indexers' ownership stake provides a measure of the magnitude of demand or supply shocks that would occur when a stock is included or eliminated from each index. So while the magnitude of shifts in inventory levels can be large for a heavily tracked

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[14] https://indexes.nikkei.co.jp/nkave/archives/file/profile_of_nikkei225_en.pdf (last accessed on 3rd June 2019)
[15] https://www.prnewswire.com/news-releases/sp-500-benchmarked-assets-reach-78-trillion-305-trillion-invested-in-products-indexed-to-sp-dji-indices-300094228.html (last accessed 4th June 2019); https://www.seeitmarket.com/stocks-driving-large-cap-outperformance-16063/ (last accessed 4th June 2019)

index say the S&P 500, the potential shifts to market makers' inventory levels, and the subsequent impact on prices, would be substantially smaller for the relatively lightly tracked Nikkei 225, all else equal. Thus, it is not hard to see why inventory effects are at most a small part of the complete story and therefore not very likely to explain the observed big, long-lasting price impact (although they might explain some part of it).

4.4 Dual rebalancing regimes and short-term effects

As earlier mentioned, the Nikkei 225 index is reconstituted based on a dual policy of scheduled and non-scheduled announcements of revisions. Scheduled revisions to the index follow a pre-determined calendar schedule in the sense that they occur annually at the beginning of October, whereas non-scheduled revisions occur on an as-needed basis such that announcements of the changes can occur at any time.

In this section, we examine whether there is a differential impact between the two regimes. Specifically, we expect a muted market response for scheduled additions since their inclusion occur at a pre-determined calendar time and are thus more easily anticipated: the anticipation effect should attenuate the price pressure effect caused by demand for immediacy. On the other hand, we expect a stronger market reaction for the non-scheduled additions since the announcements would appear to be largely unanticipated. In this scenario, even though liquidity is still the main determinant of membership, the low probability of anticipation of the announcements should trigger a stronger market response. Hypothesis 2a is examined by comparing the AARs and CAARs of non-scheduled additions with that of scheduled additions. The results are presented in Table 6.

[Table 6 around here]

As Table 6 indicates, announcements of additions are accompanied by significant positive price reactions for both groups. The market reaction to the announcements is significantly positive on AD+1. However, consistent with hypothesis 2a, the AARs are larger for non-scheduled additions (4.07%) relative to scheduled additions (3.84%). More crucially the observed positive AAR on AD+2 is larger and statistically significant for non-scheduled additions (2.51%, t-stat = 3.90) but not for scheduled additions (0.05%, t-stat = 1.37), confirming our expectation of a stronger response for the non-scheduled group. The differential market response between the two groups is also reflected in the magnitudes of the CAARs: the difference in CAARs between the two groups is positive throughout the 21-day announcement widow and significantly so on six of those days. The stronger impact can be attributed to the 'surprise' factor associated with non-scheduled announcements.

[Figure 3 around here]

We illustrate further the disproportionate price and volume effects between both regimes using a time plot of the observed abnormal effects (see Figures 3 and 4). For scheduled additions, the price impact of 8.13% around the announcement period is similar in magnitude to the 8.83% observed around the effective period. For non-scheduled additions however, the difference between the two periods is relatively large (14.71% compared with 12.20%). Also we can observe from Figure 4 that the trading volume intensity for non-scheduled additions around the announcement date (AD) is almost twice that of scheduled additions.

[Figure 4 around here]

We then assess whether the CAARs for additions in the two groups are impacted differently over various holding periods within several windows, namely the pre-announcement period ([-10, -1] and [-5, -1]), the period immediately around the announcement day ([-1, 1]), the post-announcement period ([1, 10] and [1, 30]) and the full event window ([-10, 30]). Table 7 presents the results. Again, we observe consistently larger positive price impact for the non-scheduled group (Panel B) over all event windows except [1, 10]. Also the CAARs are all statistically significant for the non-scheduled group but not for the scheduled group (Panel A). The difference in CAAR (Panel C) between the two groups is positive albeit insignificant in all cases except [1, 5]. Notwithstanding the weak statistical significance, the results offer reasonable support to our conjecture (Hypothesis 2a).

[Table 7 around here]

As for hypothesis 2b, we estimate the observed price pressure effects and the associated reversals for the two groups. The results, presented in Table 8, show that non-scheduled additions experience stronger price pressure effects (10.69%) than scheduled additions (6.7%). Also, whereas scheduled revisions completely reverse within 10 to 15 days, non-scheduled additions only partially reverse even after 30 days.

[Table 8 around here]

Despite the similarities in abnormal trading volume estimates around ED-1 for both groups (see Figure 4), non-scheduled additions continue to trade at elevated levels 30 days post-inclusion. Figure 5 illustrates this point more clearly.

[Figure 5 around here]

On the whole, the results are supportive of Hypothesis 2b. The substantially larger magnitudes of price pressure for the non-scheduled group, in addition, imply that index funds keen on minimizing tracking error are forced to pay far above the efficient price for newly added stocks. That is, when index changes are non-scheduled, the costs of immediacy (to indexers) are larger. From a market efficiency viewpoint, this suggests that non-scheduling disturbs price efficiency around the rebalancing dates.

It would be desirable to make the same discrimination for deleted stocks. Unfortunately this is not feasible because a sizable number of deletion events on the Nikkei 225 that occur as part of non-scheduled revisions involve firms facing or tangled in bankruptcy, litigation/investigation, mergers, formation of holding companies or subsidiaries, and other forms of corporate restructuring. Therefore including these stocks in our analyses would complicate any meaningful attempt to clearly distinguish the effects attributable to the deletion event itself from that of the news of bankruptcy, litigation, merger or share repurchase, and hence compromise our objective of providing as 'clean' a sample of deletions as possible.[16]

4.5 Additional tests

As additional tests, we also look at the implications of Wang's (1994) and LMSW's (2002) predictions on return dynamics around the announcement window. Specifically, we perform the same tests as we did for Hypothesis 1 but for the announcement window when trades are likely to be driven by opportunistic/speculative information-

[16] With the exception of the 25 non-scheduled deletions that occurred in April 2000, virtually all deleted stocks that qualified for inclusion in our final sample occurred as part of scheduled deletions.

based motives, as opposed to uninformed liquidity motives. Brunnermeier and Pedersen (2005) and Kappou et al. (2010) show that unlike uninformed liquidity investors, informed strategic (or speculative) investors tend to trade immediately after the announcement of index reshuffles. Takahashi and Xu (2016) document further evidence of such predatory behaviour by strategic investors immediately around the announcement dates for the Nikkei 225 index. Based on the interpretations of Wang (1994), if the announcement-window price pressures are due mainly to speculation-driven trading, we expect to see very weak reversals in prices going forward. Results of these tests are reported in Table 9.

[Table 9 around here]

It can be seen in Table 9 that price pressures for additions, measured from AD-5 to AD+5, are 9.66% (Panel A) while the subsequent reversals measured from AD+6 to AD+*t* (where *t*=30) are -4.48%, implying that less than half the magnitude of the announcement price pressure reverses over the subsequent 30 days. For deletions (Panel B), the price pressures generated by trades around the announcement day are much larger (-20.72%). But, as with additions, only about half of these reverse. Note however that none of the reversal returns for deletions are statistically significant. Overall, this set of results are consistent with the predictions of Wang (1994) and LMSW (2002) that when speculative trading by informed/strategic investors is dominant, prices tend to exhibit weak reversals.

4.6 Robustness checks

In our tests we measure price pressure as CAAR [ED-5, peak (trough) day]. Needless to say, our choice of ED-5 is arbitrary. For this reason we examine what happens if we extend the length to ED-10, that is, the time horizon over which demand shocks that induce price pressure are computed.

[Table 10 around here]

Table 10 shows that extending the length to ED-10 increases the magnitude of the price impact for additions (Panel A) from 8.98% to 10.65%. Still, however, the results do not vary much as the subsequent reversals are largely complete by ED+30. For deletions (Panel B), even though the magnitude of the price pressure contracts from -23.29% to -19.68%, the results are similar to those reported in our main tests, in that the reversals remain incomplete over the subsequent 30 days. We also perform similar tests for the dual rebalancing samples of additions, as well as for Wang's (1994) predictions that price pressures induced by speculative trades tend to display weak reversals.

As shown in Table 11 the results for the dual rebalancing regimes show a similar pattern of price pressure for scheduled additions, the only difference being that prices now fully reverse within 20 days, as opposed to within 15 days. The results are also similar for non-scheduled additions in the sense that the reversals are weak even after 30 days.

[Table 11 around here]

Using the same alternative price pressure measure (AD-10), Table 12 reports the results for Wang's (1994) predictions. Again the results are complementary to that shown in Table 9, and are supportive of the hypothesis that speculation-driven trades around the announcement of Nikkei 225 revisions lead to price changes that do not largely reverse.

[Table 12 around here]

Furthermore, given that the length of the estimation window used may affect the abnormal return or trading volume estimates, we repeat the computations by employing a 100-day estimation window [-110, -11]. The statistical significance, magnitude and persistence of the price and trading volume effects found remain robust to changes in the estimation window settings.[17]

5. Summary and Concluding Remarks

Previous empirical studies of price pressure effects around index revisions suffer from information effects. This is especially the case of the S&P 500 where decisions regarding membership are made on a case-by-case basis using unclear rules, which gives the index committee an “active” role in managing the composition of the index. We address this concern by examining a setting – the Nikkei 225 index – where stocks are simply added or removed using mostly mechanical rules that are all public information, thus providing a ‘clean’ test of the downward sloping demand curve hypothesis in the absence of material information.

Given that the revisions are based on liquidity rankings, we further examine the potential influence of asymmetric information risks (proxied by liquidity) on return dynamics around the revisions. Specifically, we take to an index rebalancing setting the

[17] The results obtained using these alternative specifications are not reported here due to limitation of space but are available upon request.

predictions of Wang (1994) and LMSW (2002) that stocks with higher asymmetric information risks tend to be associated with weaker return reversals (or conversely stronger return persistence). We show the validity of these predictions in the context of index composition changes. Specifically, the complete price reversals observed 25 to 30 days after the effective date suggest that additions to the Nikkei 225 contain no information effects, that is, the observed price pressure are a result of the temporary impact of trading and merely reflect compensation to liquidity providers, consistent with the notion that in the absence of new information demand curves for stocks (may slope down temporarily but overall) are flat. By contrast, deletions appear to be informative. The price impact has a permanent component, which we interpret as reflecting the price adjustment for the perceived high asymmetric information risks. This finding not only supports the theoretical framework of LSMW (2002) but also corroborates the view that block trades will have a permanent price effect if they reveal information (Barclay and Dunbar, 1996).

We also find evidence that suggests that stocks that are added on a non-scheduled basis exhibit greater sensitivity to market frictions which cause prices to overshoot and, as a result, impose additional costs on index funds. From a microstructure perspective, our analysis of the dual rebalancing regime of the Nikkei 225 highlights the important role an index's repertoire of rules can play in attenuating or exacerbating market frictions around rebalancing dates.

We perform additional checks by examining price dynamics around announcement dates, when the likelihood of opportunistic speculative trading is high. Our empirical findings provide ample support for the predictions of Wang (1994) and LMSW (2002) that when speculative trading by informed strategic investors is strong, prices tend to exhibit weak reversals.

The results, nevertheless, should be interpreted with caution and a number of limitations should be borne in mind. First, we rely upon past research to develop our hypothesis regarding trading behaviour and its relationship to asymmetric information and return dynamics around the revisions. As a proxy for asymmetric information, we use liquidity as defined by the Nikkei 225 index governing body, whereas the motivating paper uses market capitalization. Examining other proxies for asymmetric information derived from the microstructure literature will therefore be vital for future research. Second, although our findings are robust to alternative definitions of price pressure and estimation window settings, they should be considered with the caveat that our objective of providing as clean a test as possible implies that a relatively small number of stocks qualified for inclusion in the analyses.

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Table 1: Nikkei 225 Index constituent changes, 1970 - 2015

Period	Total no. of index changes in original sample	No. of changes retained in final sample	No. of changes by periodic review (scheduled)	No. of changes by extraordinary replacement (nonscheduled)
Panel A: Additions				
1970 – 1990	22	–	–	–
1991 – 2000	58	37	12	25
2001 – 2015	80	40	21	19
Total	160	77	33	44
Panel B: Deletions				
1970 – 1990	22	–	–	–
1991 – 2000	58	25	–	25
2001 – 2015	80	17	17	–
Total	160	42	17	25

Table 2: Firm characteristics and descriptive statistics

	Mean	Median	Min.	Max.	25th Percentile	75th Percentile
Panel A: Additions						
Share price (yen)	2,875	1,222	156	15,932	640	3,411
Trading volume ('thousands)	1,321	629	23	8,721	365	1,420
Returns (%)	-0.031	0.005	-6.34	1.73	-0.36	0.37
Ann to Eff interval (trading days)	8	5	1	18	5	13
Panel B: Deletions						
Share price (yen)	249	203	21	10,459	134	328
Trading volume ('thousands)	691	395	8	8,870	275	728
Returns (%)	-0.028	-0.143	-3.48	5.34	-0.98	0.76
Ann to Eff interval (trading days)	20	25	11	25	17	25

Note: *Ann* and *Eff* refer to announcement day and effective day, respectively

Table 3: Announcement window AARs and CAARs

Ann. Day	Additions (AAR)	Deletions (AAR)	Additions (CAAR)	Deletions (CAAR)
-10	0.0012	-0.0026	0.0012	-0.0026
	(1.17)	(-0.79)	(1.17)	(-0.79)
-9	0.0021	0.0216	0.0033	0.0190
	(0.26)	(3.07)***	(1.01)	(2.22)**
-8	0.0041	-0.0023	0.0075	0.0167
	(1.47)	(-0.55)	(1.48)	(2.02)**
-7	0.0059	0.0086	0.0133	0.0253
	(2.21)**	(2.59)***	(2.34)**	(3.04)***
-6	0.0024	0.0111	0.0157	0.0353
	(0.89)	(2.38)**	(2.63)***	(3.55)***
-5	0.0002	-0.0101	0.0159	0.0252
	(-0.37)	(-2.42)	(2.36)**	(2.67)***
-4	0.0014	0.0042	0.0173	0.0292
	(0.62)	(1.04)	(2.5)**	(2.70)***
-3	0.0032	0.0003	0.0205	0.0296
	(0.81)	(0.15)	(2.55)**	(2.26)**
-2	0.0021	0.0134	0.0225	0.0426
	(0.72)	(3.62)***	(2.61)***	(2.95)***
-1	0.0041	0.0083	0.0266	0.0508
	(1.29)	(1.60)	(2.84)***	(2.94)***
0	0.0059	0.0009	0.0325	0.0518
	(2.62)***	(0.01)	(3.38)***	(2.92)***
+1	0.0397	-0.1239	0.0722	-0.0721
	(7.48)***	(-10.39)***	(7.53)***	(-6.81)***
+2	0.0163	-0.0489	0.0884	-0.1210
	(3.99)***	(-4.69)	(8.94)***	(-10.89)***
+3	0.0107	0.0091	0.0992	-0.1120
	(2.07)**	(1.011)	(8.33)***	(-8.73)***
+4	-0.0061	-0.0364	0.0931	-0.1483
	(-1.86)*	(-4.28)***	(7.63)***	(-10.56)***
+5	0.0201	-0.0262	0.1132	-0.1745
	(2.70)***	(-2.17)**	(8.27)***	(-8.76)***
+6	-0.0183	0.0259	0.0949	-0.1486
	(-3.50)***	(2.22)**	(7.81)***	(-9.08)***
+7	0.0003	0.0009	0.0952	-0.1477
	(0.34)	(-0.21)	(7.64)***	(-8.38)***
+8	-0.0107	0.0064	0.0845	-0.1413
	(-0.87)	(-0.06)	(6.42)***	(-7.17)***
+9	-0.0057	0.0011	0.0788	-0.1403
	(-1.60)	(0.40)	(5.63)***	(-6.61)***
+10	0.0039	0.0454	0.0827	-0.0949
	(0.64)	(0.44)	(5.99)***	(-2.98)***

Note: This table reports the average abnormal returns (AARs) and cumulative average abnormal returns (CAARs) over the 21-day announcement change window (-10; 10) for additions and deletions. *t*-values (Boehmer et al. (1991)) are provided in parentheses. Superscripts ***, ** and * denote statistical significance for the abnormal return estimates at the 1%, 5%, and 10% level, respectively.

Table 4: Effective window AARs and CAARs

Eff. Day	Additions (AAR)	Deletions (AAR)	Additions (CAAR)	Deletions (CAAR)
-10	0.016	0.003	0.016	0.003
	(0.58)	(0.86)	(0.58)	(0.86)
-9	0.0047	0.0056	0.0063	0.0086
	(1.51)	(0.59)	(1.62)	(1.07)
-8	0.0026	0.0145	0.0089	0.0231
	(0.99)	(2.20)	(1.90)	(2.15)**
-7	0.004	0.0078	0.0128	0.0309
	(0.74)	(0.74)	(1.87)	(1.96)**
-6	0.0038	0.0053	0.0167	0.0362
	(1.86)*	(0.47)	(2.50)**	(1.85)*
-5	0.018	-0.0992	0.0346	-0.063
	(3.63)***	(-5.76)***	(4.36)***	(-5.07)***
-4	0.0192	-0.0615	0.0538	-0.1245
	(4.62)***	(-7.40)***	(5.76)***	(-8.80)***
-3	0.0122	0.0032	0.066	-0.1213
	(2.33)**	(0.04)	(6.37)***	(-9.23)***
-2	0.004	-0.0319	0.070	-0.1532
	(1.85)*	(-3.54)***	(6.91)***	(-9.14)***
-1	0.0375	-0.0435	0.1075	-0.1968
	(4.61)***	(-4.05)***	(7.59)***	(-8.72)***
0	-0.0463	0.0834	0.0612	-0.1133
	(-6.61)***	(1.82)*	(4.95)***	(-3.48)***
+1	-0.007	-0.0122	0.0542	-0.1255
	(-1.75)*	(-2.23)**	(4.63)***	(-4.01)***
+2	-0.0039	-0.0053	0.0503	-0.1309
	(-1.74)*	(0.28)	(4.11)***	(-4.14)***
+3	0.0015	-0.0162	0.0518	-0.1471
	(0.69)	(-1.99)**	(4.05)***	(-4.49)***
+4	-0.0024	0.0079	0.0494	-0.1392
	(-0.82)	(1.59)	(3.52)**	(-4.13)***
+5	-0.0068	0.0094	0.0426	-0.1297
	(-2.49)**	(2.06)**	(2.97)***	(-4.00)***
+6	0.0029	0.0148	0.0455	-0.115
	(1.07)	(2.70)***	(3.23)***	(-3.71)***
+7	-0.0051	0.0187	0.0404	-0.0963
	(-2.08)**	(3.28)***	(2.84)***	(-3.43)***
+8	0.0007	-0.0011	0.0411	-0.0974
	(0.12)	(-0.41)	(2.91)***	(-3.53)***
+9	0.0047	-0.0016	0.0458	-0.099
	(1.33)	(0.04)	(3.21)**	(-3.55)***
+10	-0.0079	-0.0003	0.0378	-0.0992
	(-2.77)***	(0.06)	(2.66)***	(-3.49)

Note: This table reports the average abnormal returns (AARs) and cumulative average abnormal returns (CAARs) over the 21-day effective change window (-10; 10) for additions and deletions. *t*-values (Boehmer et al. (1991)) are provided in parentheses. Superscripts ***, ** and * denote statistical significance for the abnormal return estimates at the 1%, 5%, and 10% level, respectively.

Table 5: Price pressure around effective date (uninformed demand)

	Price Pressure	Price Reversal [t=5]	Price Reversal [t=10]	Price Reversal [t=15]	Price Reversal [t=20]	Price Reversal [t=25]	Price Reversal [t=30]
Panel A: Additions							
CAAR	0.0898	-0.066	-0.0707	-0.0803	-0.0758	-0.0893	-0.0984
t-stat	6.73***	-6.66***	-5.81***	-5.91***	-2.57**	-2.93***	-3.21***
Peak day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1
Panel B: Deletions							
CAAR	-0.2329	0.067	0.0975	0.1319	0.1457	0.1361	0.1664
t-stat	-8.41***	1.87*	3.02***	4.06***	3.49***	3.05***	3.67***
Trough day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1

Note: This table reports the cumulative average abnormal returns (CAARs) that measure price pressures triggered by mainly uninformed trades. To measure price pressure, CAARs over the period [ED-5, peak (trough) day] are used. The peak (trough) day is defined as the day within the 21-day effective window when prices are at their highest (lowest). To measure reversals, CAARs over the period [peak (trough) day+1, ED+*t*] are used. *t* captures the duration of price pressure or speed of mean reversion after the event date, and takes the value 5, 10, 15, 20, 25, 30. *Peak* (trough) day+1 is defined as one day after the peak (trough) day. Panel A presents results for additions while Panel B presents results for deletions. Superscripts ***, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 6: Announcement AARs and CAARs for scheduled and non-scheduled additions

Ann. Day	Non-scheduled (AAR)	Scheduled (AAR)	Non-scheduled (CAAR)	Scheduled (CAAR)	Diff. (CAAR)
-10	0.0023	-0.0002	0.0023	-0.0002	0.0025
	(0.97)	(0.65)	(0.97)	(0.65)	
-9	0.0043	-0.0007	0.0066	-0.0009	0.0075
	(0.81)	(-0.66)	(1.21)	(-0.06)	
-8	0.0061	0.0015	0.0126	0.0006	0.012
	(1.42)	(0.55)	(1.55)	(0.25)	
-7	0.0082	0.0027	0.0209	0.0033	0.0176
	(2.11)**	(0.82)	(2.40)	(0.60)	
-6	0.005	-0.0011	0.0258	0.0022	0.0236**
	(1.43)	(-0.12)	(2.91)***	(0.48)	
-5	0.0005	-0.0002	0.0263	0.0020	0.0243**
	(-0.11)	(-0.53)	(2.80)***	(0.23)	
-4	-0.003	0.0072	0.0233	0.0092	0.0141
	(-0.83)	(1.80)	(2.41)	(1.00)	
-3	0.0054	0.0002	0.0287	0.0094	0.0193
	(1.27)	(-0.12)	(3.01)***	(0.70)	
-2	-0.0009	0.006	0.0278	0.0155	0.0123
	(-0.27)	(1.22)	(2.49)***	(1.19)	
-1	0.0053	0.0024	0.0332	0.0179	0.0153
	(1.14)	(0.61)	(2.55)**	(1.37)	
0	0.0083	0.0027	0.0415	0.0205	0.021
	(2.53)	(0.88)	(3.14)***	(1.51)	
+1	0.0407	0.0384	0.0822	0.0589	0.0233
	(5.73)***	(4.95)***	(6.02)***	(4.51)***	
+2	0.0251	0.0045	0.1072	0.0634	0.0438**
	(3.90)***	(1.37)	(8.01)***	(4.63)***	
+3	0.0051	0.0182	0.1123	0.0816	0.0307
	(0.68)	(2.03)**	(8.00)***	(4.34)***	
+4	-0.0036	-0.0094	0.1087	0.0722	0.0365
	(-0.57)	(-2.24)	(6.88)***	(4.01)***	
+5	0.0384	-0.0043	0.1471	0.0679	0.0792**
	(3.46)***	(-1.37)	(7.69)***	(4.00)***	
+6	-0.0312	-0.001	0.1159	0.0669	0.049**
	(-3.58)***	(-0.73)	(7.11)***	(3.93)***	
+7	-0.0029	0.0047	0.1130	0.0716	0.0414**
	(-0.32)	(0.84)	(6.94)***	(3.90)***	
+8	-0.0243	0.0075	0.0887	0.0790	0.0097
	(-1.80)*	(1.99)	(5.03)***	(3.95)***	
+9	-0.0021	-0.0106	0.0866	0.0685	0.0181
	(-0.56)	(-2.09)	(4.57)***	(3.29)***	
+10	0.0022	0.0061	0.0888	0.0746	0.0142
	(-0.05)	(1.02)	(4.65)***	(3.74)***	

Note: This table reports the AARs and CAARs over the 21-day announcement window for the scheduled group and non-scheduled group of additions, as well as the difference in CAARs between the two groups. *t*-values (Boehmer et al. (1991)) are provided in parentheses. Superscripts ***, ** and * denote statistical significance for the abnormal return estimates at the 1%, 5%, and 10% level, respectively.

Table 7: Multi-period announcement CAARs for scheduled and non-scheduled additions

Event Window	[-10, -1]	[-5, -1]	[-1, 1]	[1, 5]	[1, 10]	[1, 30]	[-10, 30]
Panel A: Scheduled Additions							
CAAR	0.0189	0.0149	0.0457	0.0480	0.0549	0.0189	0.0409
Pos:Neg	21:12	20:13	27:06	27:06	27:06	19:14	21:12
t-stat	1.52	1.53	5.71***	3.57***	3.26***	0.70	1.38
Panel B: Non-scheduled Additions							
CAAR	0.0324	0.067	0.0548	0.1044	0.0444	0.0480	0.0887
Pos:Neg	29:15	27:17	38:06	34:10	31:13	28:16	29:15
t-stat	2.46***	0.71***	6.54***	4.86***	2.35**	2.18**	3.54***
Panel C: Difference(B-A)							
CAAR	0.0135	0.0521	0.0091	0.0564	-0.0105	0.0291	0.0478
t-stat	0.69	0.70	0.74	2.07**	-0.33	0.77	1.10

Note: This table reports the announcement window cumulative average abnormal returns (CAARs) over multi-period holding periods for the scheduled group and non-scheduled group of additions, as well as the difference in CAARs between the two groups. Superscripts ***, ** and * denote statistical significance for the abnormal return estimates at the 1%, 5%, and 10% level, respectively.

Table 8: Price pressure around effective date (uninformed demand)

	Price Pressure	Price Reversal [t=5]	Price Reversal [t=10]	Price Reversal [t=15]	Price Reversal [t=20]	Price Reversal [t=25]	Price Reversal [t=30]
Panel A: Scheduled Additions							
CAAR	0.067	-0.0594	-0.0612	-0.077	-0.1043	-0.1238	-0.1221
t-stat	4.08***	-4.71***	-4.14***	-4.04***	-2.07**	-2.28**	-2.32**
Peak day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1
Panel B: Non-scheduled Additions							
CAAR	0.1069	-0.0709	-0.0778	-0.0828	-0.0544	-0.0634	-0.0806
t-stat	5.32***	-4.68***	-4.06***	-4.30***	-2.31**	-2.96***	-3.76***
Peak day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1

Note: This table reports the cumulative average abnormal returns (CAARs) that measure price pressures triggered by mainly uninformed trades. To measure price pressure, CAARs over the period [ED-5, peak day] are used. The peak day is defined as the day within the 21-day effective window when prices are at their highest. To measure reversals, CAARs over the period [peakday+1, ED+*t*] are used. *t* captures the duration of price pressure or speed of mean reversion after the event date, and takes the value 5, 10, 15, 20, 25, 30. Peakday+1 is defined as one day after the peak day. Panel A presents results for scheduled additions while Panel B presents results for non-scheduled additions. Superscripts ***, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 9: Price pressure around announcement date (speculative demand)

	Price Pressure	Price Reversal [t=8]	Price Reversal [t=10]	Price Reversal [t=15]	Price Reversal [t=20]	Price Reversal [t=25]	Price Reversal [t=30]
Panel A: Additions							
CAAR	0.0966	-0.0287	-0.0314	-0.0314	-0.0397	-0.0321	-0.0448
t-stat	7.42***	-2.36**	-2.73***	-2.32**	-2.73***	-1.99**	-2.72***
Peak day	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5
Panel B: Deletions							
CAAR	-0.2072	0.0297	0.0782	0.0815	0.0995	0.1117	0.1165
t-stat	-9.13***	1.35	0.89	0.62	1.21	1.31	1.32
Trough day	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5

Note: This table reports the cumulative average abnormal returns (CAARs) that measure price pressures triggered by mainly speculative trades. To measure price pressure, CAARs over the period [AD-5, peak (trough) day] are used. The peak (trough) day is defined as the day within the 21-day announcement window when prices are at their highest (lowest). To measure reversals, CAARs over the period [peak (trough) day+1, AD+*t*] are used. *t* captures the duration of price pressure or speed of mean reversion after the event date, and takes the value 5, 10, 15, 20, 25, 30. *Peak* (trough) day+1 is defined as one day after the peak (trough) day. Panel A presents results for additions while Panel B presents results for deletions. Superscripts ***, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 10: Price pressure around effective date (uninformed demand)

	Price Pressure (from ED-10)	Price Reversal [t=5]	Price Reversal [t=10]	Price Reversal [t=15]	Price Reversal [t=20]	Price Reversal [t=25]	Price Reversal [t=30]
Panel A: Additions							
CAAR	0.1065	-0.066	-0.0707	-0.0803	-0.0758	-0.0893	-0.0984
t-stat	7.45***	-6.66***	-5.81***	-5.91***	-2.57**	-2.93***	-3.21***
Peak day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1
Panel B: Deletions							
CAAR	-0.1968	0.067	0.0975	0.1319	0.1457	0.1361	0.1664
t-stat	-8.72***	1.87*	3.02***	4.06***	3.49***	3.05***	3.67***
Trough day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1

Note: This table reports the cumulative average abnormal returns (CAARs) that measure price pressures triggered by mainly uninformed trades. To measure price pressure, CAARs over the period [ED-10, peak (trough) day] are used. The peak (trough) day is defined as the day within the 21-day effective window when prices are at their highest (lowest). To measure reversals, CAARs over the period [peak (trough) day+1, ED+*t*] are used. *t* captures the duration of price pressure or speed of mean reversion after the event date, and takes the value 5, 10, 15, 20, 25, 30. *Peak* (trough) day+1 is defined as one day after the peak (trough) day. Panel A presents results for additions while Panel B presents results for deletions. Superscripts ***, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 11: Price pressure around effective date (uninformed demand)

	Price Pressure (from ED-10)	Price Reversal [t=5]	Price Reversal [t=10]	Price Reversal [t=15]	Price Reversal [t=20]	Price Reversal [t=25]	Price Reversal [t=30]
Panel A: Scheduled Additions							
CAAR	0.088	-0.0594	-0.0612	-0.077	-0.1043	-0.1238	-0.1221
t-stat	4.65***	-4.71***	-4.14***	-4.04***	-2.07**	-2.28**	-2.32**
Peak day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1
Panel B: Non-scheduled Additions							
CAAR	0.1203	-0.0709	-0.0778	-0.0828	-0.0544	-0.0634	-0.0806
t-stat	5.77***	-4.68***	-4.06***	-4.30***	-2.31**	-2.96***	-3.76***
Peak day	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1	ED-1

Note: This table reports the cumulative average abnormal returns (CAARs) that measure price pressures triggered by mainly uninformed trades. To measure price pressure, CAARs over the period [ED-10, peak day] are used. The peak day is defined as the day within the 21-day effective window when prices are at their highest. To measure reversals, CAARs over the period [peakday+1, ED+*t*] are used. *t* captures the duration of price pressure or speed of mean reversion after the event date, and takes the value 5, 10, 15, 20, 25, 30. Peakday+1 is defined as one day after the peak day. Panel A presents results for scheduled additions while Panel B presents results for non-scheduled additions. Superscripts ***, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 12: Price pressure around announcement date (speculative demand)

	Price Pressure (from AD-10)	Price Reversal [t=8]	Price Reversal [t=10]	Price Reversal [t=15]	Price Reversal [t=20]	Price Reversal [t=25]	Price Reversal [t=30]
Panel A: Additions							
CAAR	0.113	-0.0287	-0.0314	-0.0314	-0.0397	-0.0321	-0.0448
t-stat	8.57***	-2.36**	-2.73***	-2.32**	-2.73***	-1.99**	-2.72***
Peak day	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5
Panel B: Deletions							
CAAR	-0.166	0.0297	0.0782	0.0815	0.0995	0.1117	0.1165
t-stat	-8.58***	1.35	0.89	0.62	1.21	1.31	1.32
Trough day	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5	AD+5

Note: This table reports the cumulative average abnormal returns (CAARs) that measure price pressures triggered by mainly speculative trades. To measure price pressure, CAARs over the period [AD-10, peak (trough) day] are used. The peak (trough) day is defined as the day within the 21-day announcement window when prices are at their highest (lowest). To measure reversals, CAARs over the period [peak (trough) day+1, AD+*t*] are used. *t* captures the duration of price pressure or speed of mean reversion after the event date, and takes the value 5, 10, 15, 20, 25, 30. *Peak* (trough) day+1 is defined as one day after the peak (trough) day. Panel A presents results for additions while Panel B presents results for deletions. Superscripts ***, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

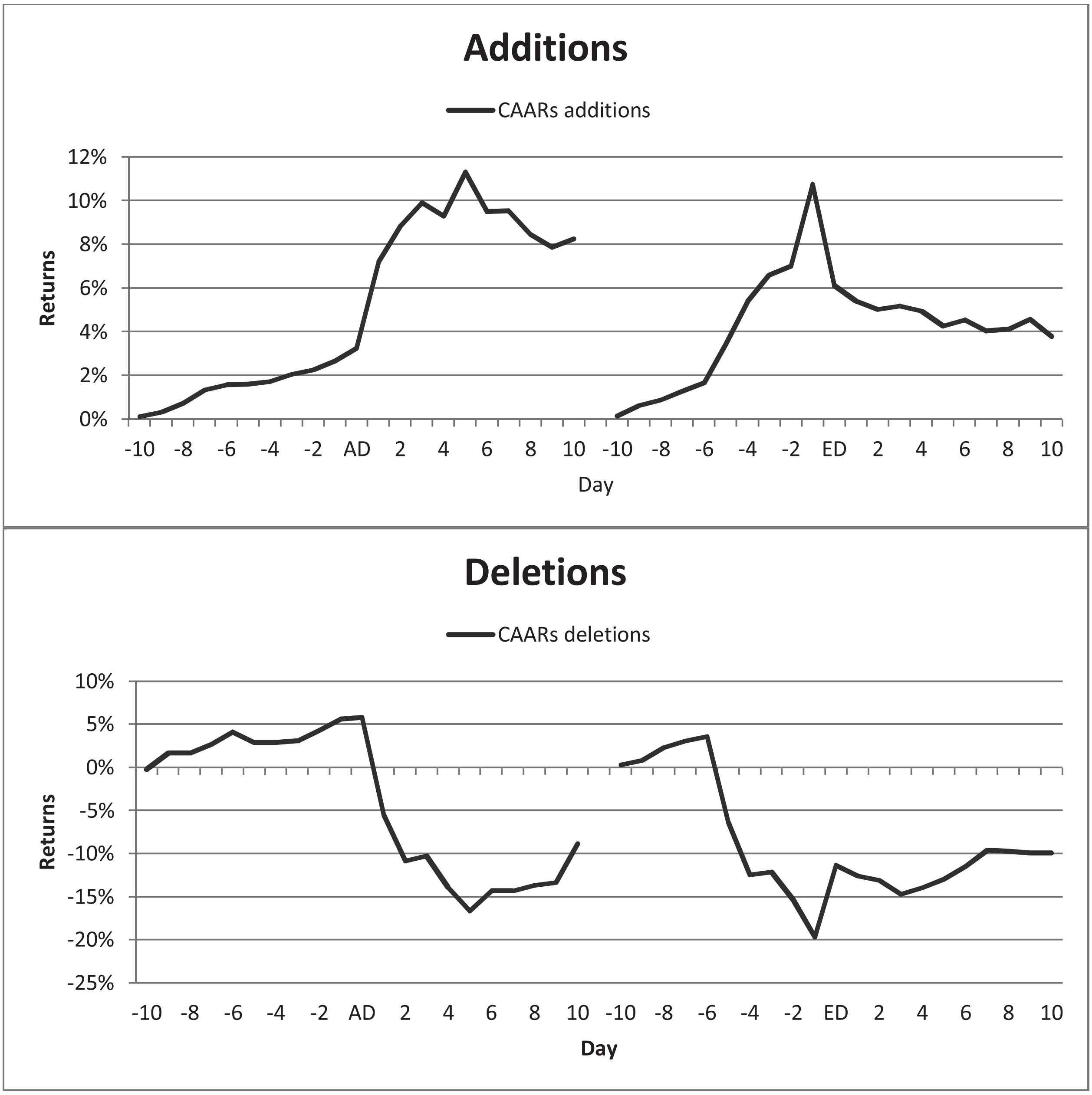


Figure 1: Time plot of returns for Additions (top pane) and Deletions (bottom pane)

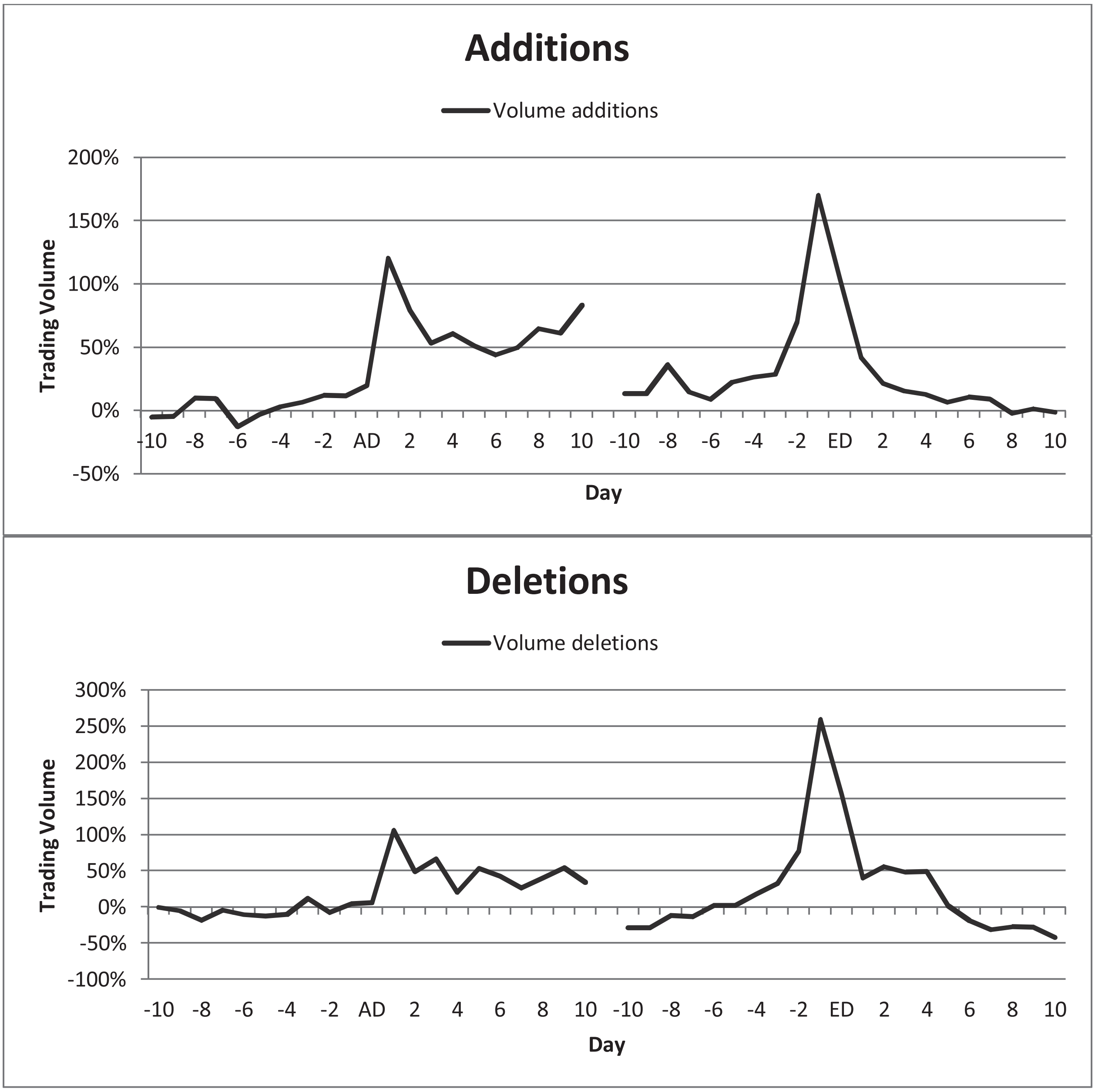
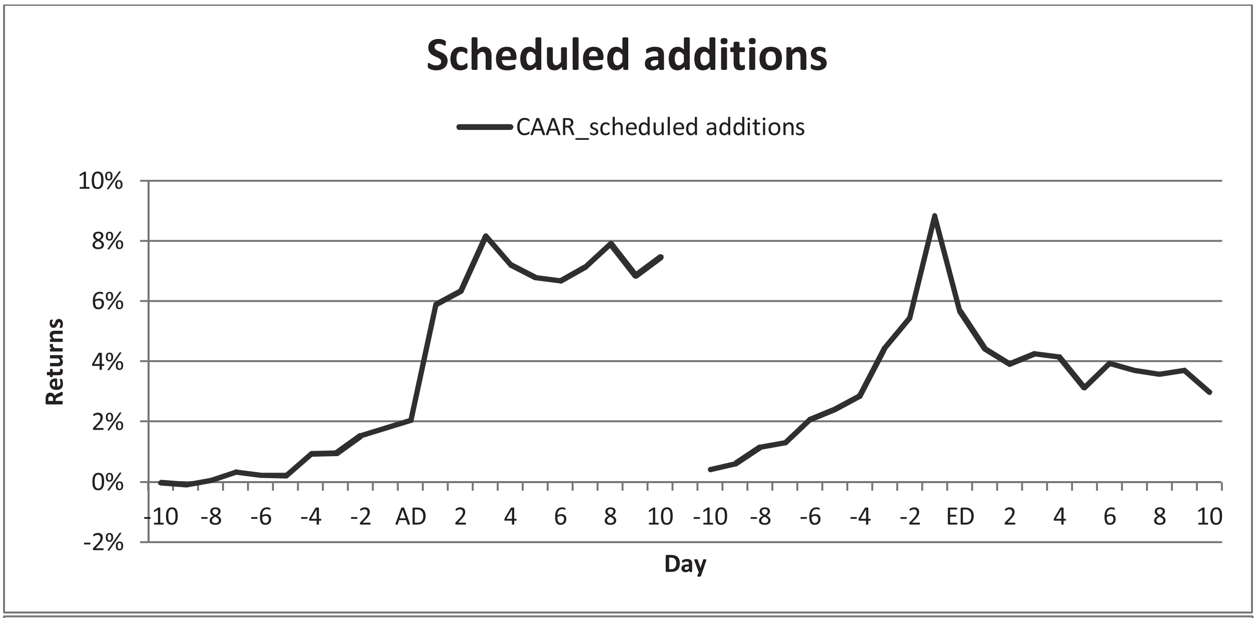


Figure 2: Time plot of trading volume for Additions (top pane) and Deletions (bottom pane)



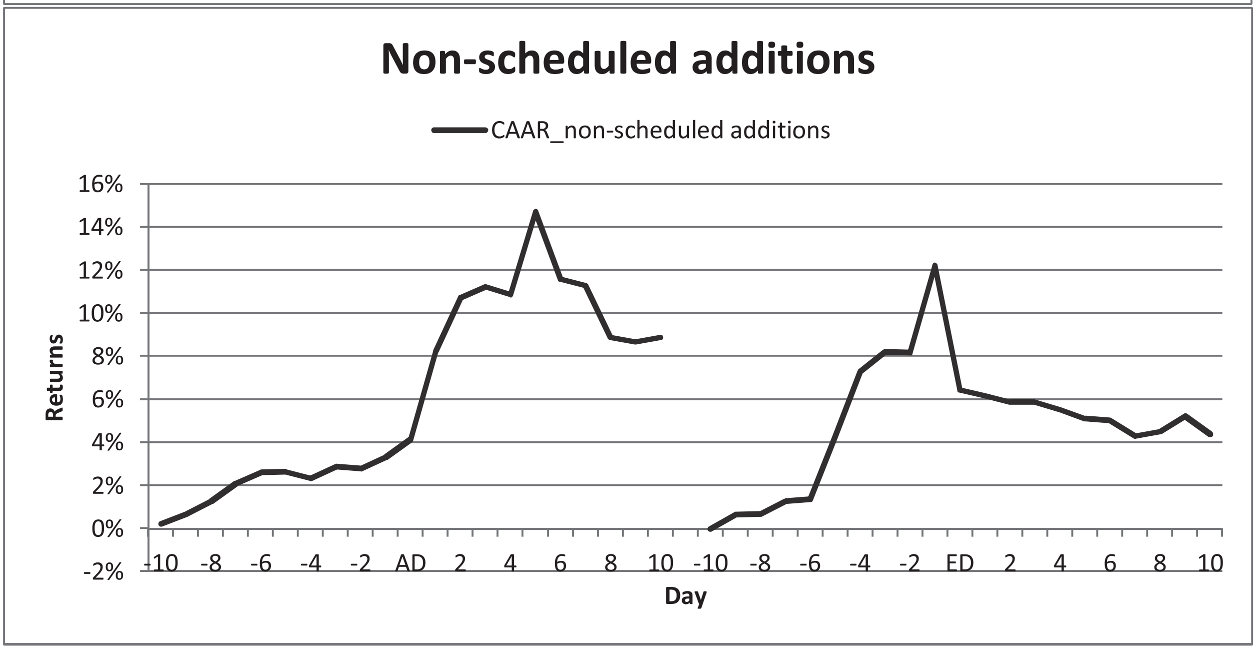
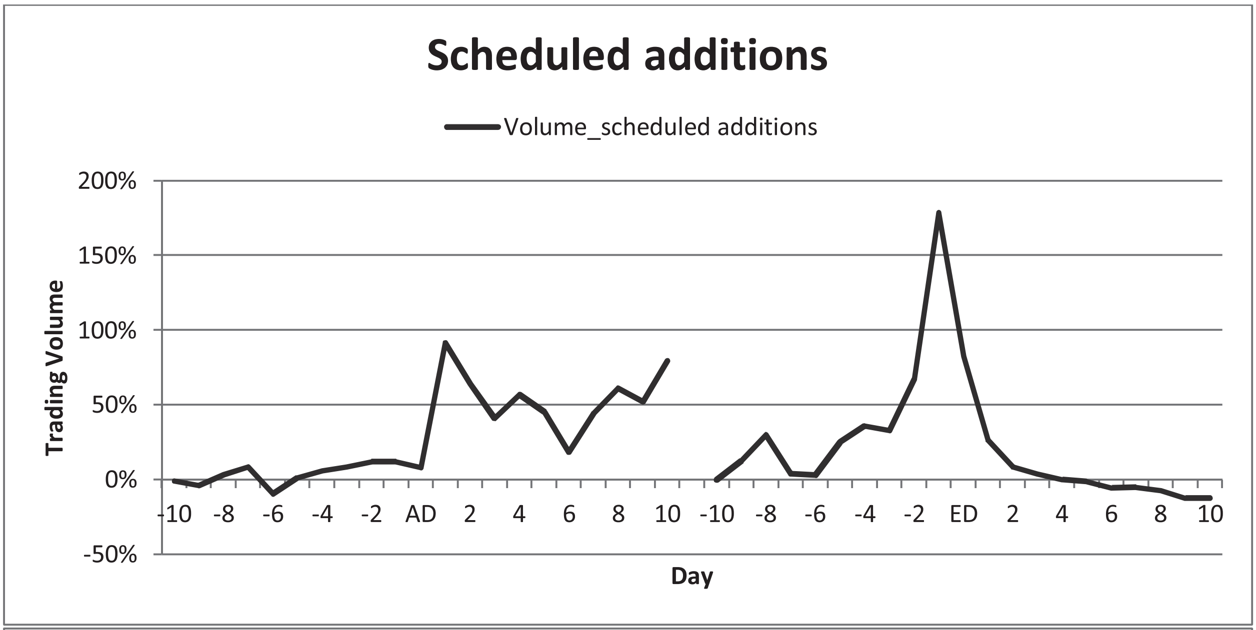


Figure 3: Time plot of returns for Scheduled (top pane) and Non-scheduled Additions (bottom pane)



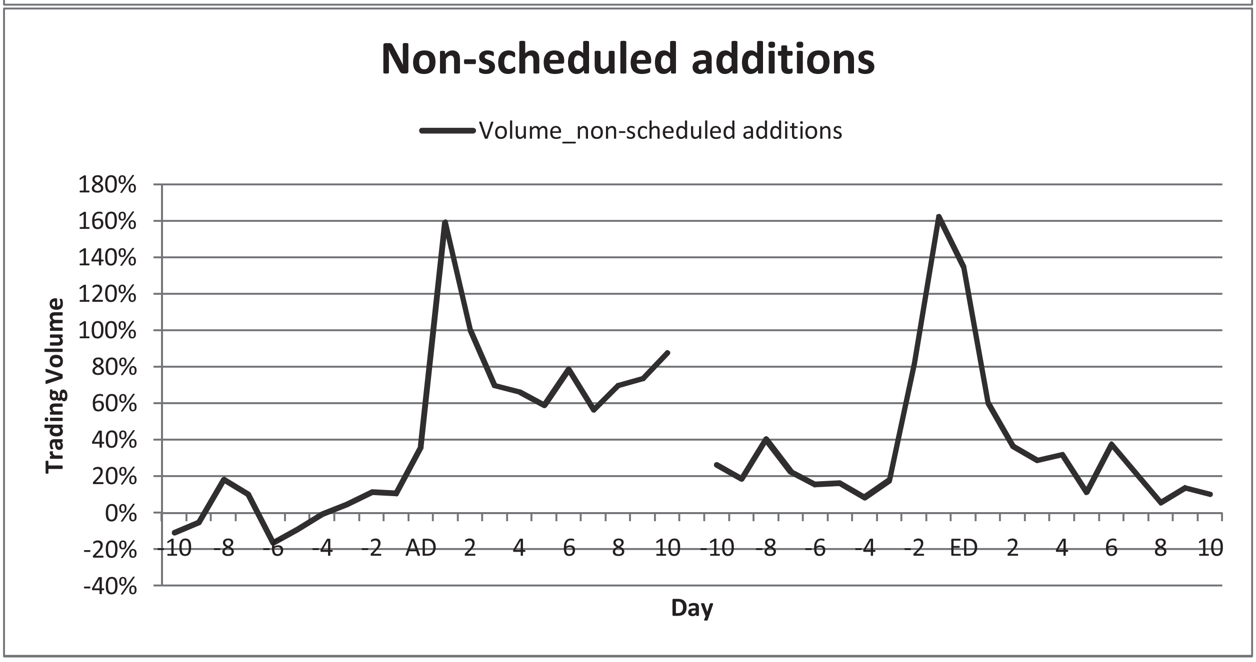


Figure 4: Time plot of trading volume for Scheduled (top pane) and Non-scheduled Additions (bottom pane)

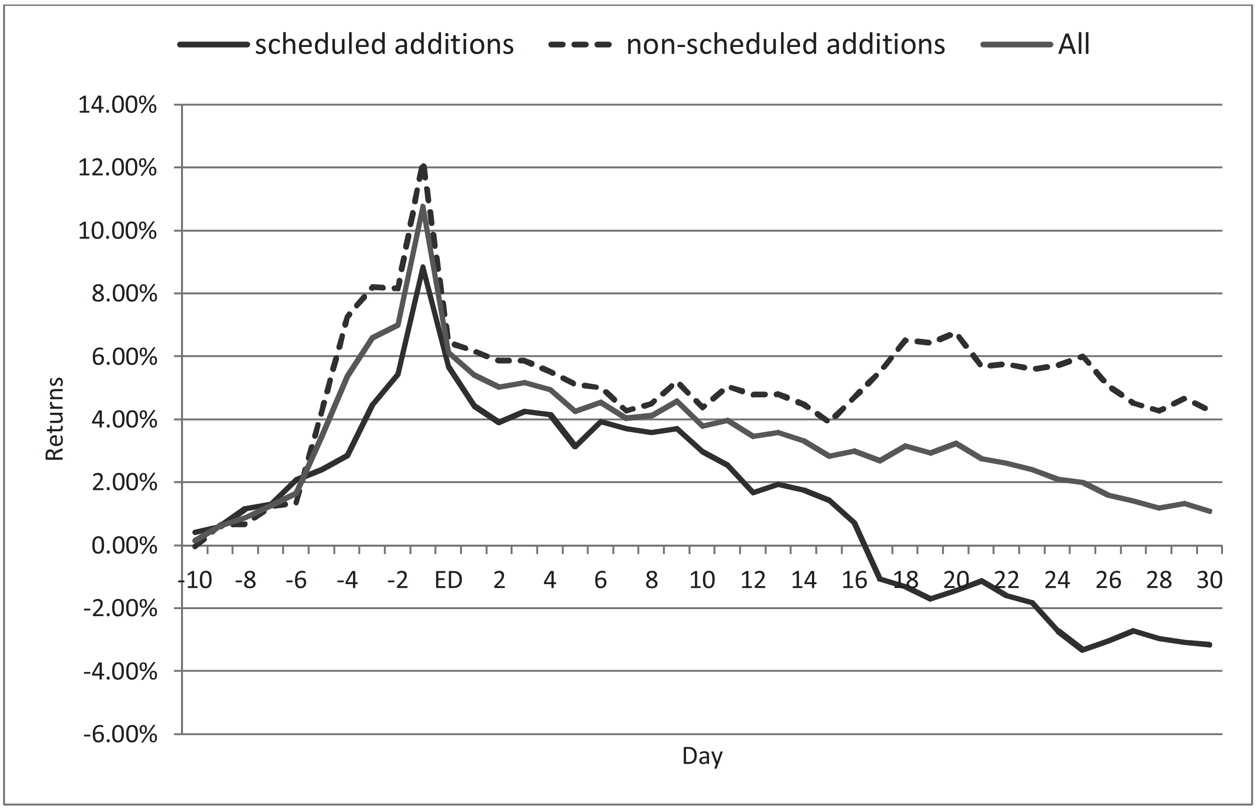


Figure 5: Time plot of price behaviour around effective date

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Number	Author	Title	Date
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Number	Author	Title	Date
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Number	Author	Title	Date
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Number	Author	Title	Date
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