Predatory short-selling and covering around pre-announced deletions from index composition: Evidence from Nikkei 225 Index deletions

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Abstract

Focusing on pre-announced index deletions that induce liquidity needs on the part of index funds and using daily short selling data, we show that short sellers employ front-running strategies in which they sell stocks immediately after the announcements of deletions from index composition until the actual deletion day and buy back stocks thereafter. We find that, while short sellers can exploit profitable opportunities, their trading activities create temporary liquidity shortages and destabilize stock prices.

JEL Classification: G14; G19
Keywords: Short selling; Predatory trading; Front-run; Liquidity; Price reversal

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1 Introduction

Announcements of index deletions generate selling pressures for index funds and can lead to a short-term price depreciation and deviations of prices from fundamentals. As the announcement of index deletions are public information, sophisticated strategic investors might exploit the profitable opportunities by short-selling stocks that are delisted from the index before the large price declines and buy back the stocks when the prices begin reverting to fundamental values. Brunnermeier and Pedersen (2005) call such trading behavior predatory trading. While predatory trading is profitable for strategic investors, such trading could result in price destabilization. Stock prices sharply decline on the announcement day, continue declining until the actual deletions, and show a partial price reversal on the days following the deletion. In addition, predatory trading leads to illiquidity in the stock market when liquidity is most needed by index funds.

This paper explores how short sellers react to index deletions that could provoke temporal price depreciation by placing selling pressures on index funds and how the trading activities of short sellers are related to price dynamics and liquidity in the stock market. In general, the finance literature suggests that short sellers can be considered more rational, sophisticated, and informed (Miller, 1977; Diamond and Verrecchia, 1987). Empirical studies show that short sellers can predict future stock declines (Boehmer et al., 2008; Diether et al., 2009; Takahashi, 2010). Therefore, these empirical results are sufficient to justify our use of short sellers as strategic traders in the context of Brunnermeier and Pedersen (2005). In this study, we focus on deletions from the Nikkei 225 index over the time period from January 1998 to December 2010. We use these data because we can capture the trading behaviors of short sellers in the Japanese stock market on a daily basis during this period. Using these data, we examine the abnormal short selling

of stocks deleted from the Nikkei 225 around index revision announcements and actual deletions and investigate the effects of abnormal short selling and abnormal short covering on price and market liquidity during these intermediate days. In the analysis of price dynamics around index deletions, we examine price changes during the period from the announcement day to 60 days after the actual deletion day. This is because index fund trades are concentrated around actual deletion days (Green and Jame, 2011), and their depressing effects are limited to the short- or medium-term (Brunnermeier and Pedersen, 2005). Therefore, the analysis of long-term effects is beyond the scope of this study.[1]

In this study, we find that short sellers time their trades. Short sellers sell short aggressively from one to five days after the day the index deletion is announced. They aggressively cover their shorts from the index deletion day to one day after the deletion. During the period from the day index deletions are announced to the day they become effective, the stock prices of firms deleted from the index continue to decline. These results indicate that short sellers sell stocks at higher prices and buy them back at lower prices. Short sellers attempt to exploit profitable opportunities induced by index deletions. We also find that the trading behaviors of short sellers affect liquidity and stock prices in the stock market. Bid-ask spreads, which are measured by a proxy suggested by Corwin and Schultz (2012), widen during the period from the days deletions are announced to the actual deletion days. The tendency is stronger among stocks with higher abnormal short selling during the period. Finally, we find that stocks subject to higher short selling between the announcement day to the actual deletion day yield lower returns in the contemporaneous period and higher returns in the following three months after deletion. The empirical results suggest that short sellers can make profits by selling deleted stocks

[1]See Harris and Gurel (1986) and Blouin et al. (2000) on the long-term effects of index deletions and additions.

immediately after the announcement and beginning buy-backs of stocks on the actual deletion day. Moreover, the results indicate that trades by short sellers around index deletions destabilize stock prices. The evidence is consistent with the predatory trading in Brunnermeier and Pedersen (2005).

Our study is related to at least three streams in the finance literature. The first addresses the issue of short selling. In the finance literature, short sellers are generally considered informed traders. However, our empirical results show that short sellers contribute to price declines followed by long and slow reversals. This evidence is rarely shown in previous studies, which primarily find that short sellers can enhance market efficiency. We shed new light on the dark side of short selling, which tends to be criticized by most practitioners and regulators. To our knowledge, only Shkilko et al. (2012) highlight the dark side of short selling in a spirit similar to our study. However, our study is the first to test the theoretical predictions on predatory trading by focusing on deletions from a composite stock index.

Second, our study is related to the stock price effects associated with changes in index compositions. Previous studies show that index deletions (additions) press stock prices downward (upward) after the announcements and the price changes are partially reversed after the actual deletions (additions). Although researchers provide empirical evidence for the price effect associated with changes in index composition, why these price dynamics around deletions from an index occur remains unresolved. Our study notes that short sellers contribute to the price changes related to index deletions. To our knowledge, our study is the first to relate short selling activities to the price anomalies around changes in index composition.

Finally, our study is related to the literature on front-running behavior by sophisticated

investors. Previous studies demonstrate that trades based on liquidity needs can generate temporary but significant price pressures. Coval and Stafford (2007) show that distressed mutual funds are forced to sell stocks that they hold immediately and therefore cause temporal deviations in stock prices away from fundamental values. Coval and Stafford (2007) indicate that a front-running strategy based on liquidity induced sales by distressed mutual funds is profitable. Chen et al. (2008) find that hedge funds short stocks subject to liquidity- induced sales and the average returns of equity hedge funds are higher when a larger fraction of the mutual-fund sector is in distress. Chen et al. (2008) highlight the possibility that hedge funds take advantage of profitable opportunities due to liquidity induced sales by distressed mutual funds. We find that short sellers also employ front-running strategies based on liquidity induced sales by index funds around event days and short sellers exploit these profitable opportunities. We contribute to the literature by providing evidence for front-running behavior by short-sellers around index composition changes.

The remainder of the paper is organized as follows. Section 2 introduces the data sources and methodology. Section 3 examines the relationship between short selling and price declines and the relationship between price reversals and short covering. Section 4 concludes.

2 Data and methodology

2.1 Sample of index deletions

We hand-collected data on changes in the composition of the Nikkei 225 index that include the announcement dates and effective change dates, the data contain changes from January 1998 to the present. The data contain 116 deletions from January 1998 to December 2010. Daily stock returns and financial data are obtained from the Nikkei

NEEDS (FQ). From the original sample, 5 observations are deleted because we cannot obtain short-selling data. In addition, 65 of the remaining 111 observations are deleted due to mergers and acquisitions or delisting from the stock market. The remaining 46 observations (we call these observations the "clean sample") are used in our analysis.

2.2 Short-sell data

To gauge predatory short-selling in this study, we use data on the stocks borrowed from securities finance companies, which act as market makers in the stock lending markets. When investors borrow stocks from securities finance companies, there are restrictions on the stocks that can be sold short, the reimbursement terms, and the fees, all of which are determined by the stock exchange according to various standards, such as individual stock liquidity. Borrowing is processed after brokerage firms accept short-selling orders from investors. Lending stocks are borrowed from securities finance companies, while investors receive borrowed stocks from brokerage firms. In this paper, we use a dataset on daily stock borrowing and restitutions. The data are from the Japan Securities Finance Co., Ltd., which plays the most important market making role in the Japanese stock lending markets. The data cover all information on borrowings through brokerage firms, but they do not contain information on negotiation-based borrowings, which are primarily driven by institutional investors. The data provide the following information: date, identification code, number of shares in inventory, the number of shares that are newly lent and lent back, transaction price, and backwardation rate. The number of shares newly lent by the market maker refers to the number of shares short sellers borrow to sell short (defined as daily shorted shares), while the number of shares lent back to the market maker refers to the number of shares short sellers cover to liquidate short positions (defined as daily short covers). The data contain all available short-sale stocks on the Tokyo Stock Exchange

from December 1997 to December 2010. Summary statistics of our data are described in panels A and B of Table 1. Comparing the percentages of daily shorts and covers in the full sample to those in the clean sample, the two samples seem identical. However, when we compare trading volume of shorts and covers in the full sample to those in the clean sample, we observe high trading volume in the deleted sample. As firms deleted from the Nikkei 225 are more likely to be delisted from the stock market, the result indicates that investors more aggressively trade stocks that are expected to be delisted from the stock market in the near future.

2.3 Methodology

We use an event-study methodology with two event dates for each deletion: the announcement date of the deletion (AD) and the effective date of the deletion (CD). AR (abnormal return) and CAR (cumulative abnormal return) are defined as the daily returns of a firm minus its industry and market capitalization benchmark. First, each stock is assigned to one group according to its industry category (33 Nikkei industry codes). Subsequently, the stock is assigned to one of three market capitalization groups in each industry category. We employ the top three and the bottom three deciles based on firm market capitalization in each category as breakpoints to divide stocks into three groups. Industry and market capitalization benchmarks are calculated as value-weighted returns after excluding firms deleted from the Nikkei 225 index. AR and CAR around AD and CD are reported in Panel C of Table 1.

We also apply the event-study methodology to variables related to short selling and trading volume. AS, AC, and ANS are abnormal standardized daily short selling, abnormal standardized daily short covering, and abnormal standardized net short, respectively. Net shorts are defined as shares shorted daily divided by shares outstanding minus

daily short covers. Abnormal shorted shares (short covers) are defined as daily shorted shares (short covers) divided by shares outstanding (standardized shorts) minus normal standardized shorted shares (short covers) over the $(-125, -6)$ window preceding the announcement day. Abnormal daily net shorts are calculated as daily shorted net shorts minus normal net shorts over the $(-125, -6)$ window preceding the announcement day.

Employing the event-study methodology, we calculate the abnormal non-shorted turnover ratio (ANST). The non-shorted turnover ratio (NST) is defined as trading shares minus the average shares of shorts and covers divided by those outstanding. As in the calculation of abnormal short selling/covering, we define the average of NSTs over the $(-125, -6)$ window preceding the announcement day as the normal standardized non-shorted turnover ratio. ANST is defined as NST minus the normal standardized NST. We adopt the stock liquidity measure proposed in Corwin and Schultz (2012), in which the stock liquidity estimates are calculated using daily high and low prices. We label this liquidity measure the high-low liquidity measure. We employ this liquidity measure to allow us to calculate accurate liquidity measures in the form of the liquidity measures computed from high-frequency intraday transaction level data. To capture abnormal levels of stock liquidity, we compare stock liquidity during the event time to those during the $(-125, -6)$ window preceding the announcement day. The difference is defined as the abnormal bid-ask spread (labeled the "abnormal HLspread").

3 Empirical results

3.1 Predatory short selling

Figure 1 and Table 2 provide an illustration of abnormal short selling (AS, ANS), adjusted abnormal returns, and adjusted cumulative abnormal return around the announcement day for the clean sample. Cross-sectional standard deviations are used in the statistical

tests. The results confirm the expectation of predating trading theory. Short sellers sell until the index change, and this leads to a contemporaneous large price decline. The sharp price decline is accompanied by large increase in short selling. Until one day prior to the announcement, mean (median) abnormal standardized short selling is negative or insignificant. Meanwhile, mean (median) abnormal short selling becomes remarkably large soon after the announcement. Mean abnormal short selling and median abnormal short selling each peak at 0.717 percent of outstanding shares, which is accompanied by a large price decline.[2]

Figure 1 and the third and fourth columns in Table 2 provide a similar illustration for the tendencies of abnormal net short selling around the announcement day. Similarly, mean (median) abnormal net short selling peaks on the fifth day after the announcement (AD+5) generating price declines and abnormal net short selling is minimized on day AD+6 with slow price rebounds. As illustrated in Figure 1, abnormal net short selling peaks on the fifth day after the deletion announcement, at which point the stock price approaches its minimum. Soon after the peak, abnormal net short selling becomes significantly negative and then sharply declines as the price rebounds. These empirical results are consistent with the theoretical prediction that short sellers cover their short positions when stock prices bottom out. Mean and median abnormal standardized net short selling are not significantly different from zero after AD+8.

Shkilko et al. (2012) show that 5-minute interval short selling intensifies substantially after returns have declined for a period of time and reaches its peak approximately half way through the price decline stage. Subsequently, after the peak, abnormal short sell-

[2]Although Brunnermeier and Pedersen (2005) theorize that predatory traders sell at a constant velocity until the deletion day, in our study abnormal short selling varies across intermediate days (at most 17 business days). We surmise that early predatory short selling induces short selling until the day prior to the deletion.

ing decreases slightly and picks up again, as the price approaches its intraday minimum. Following reversals, abnormal short selling becomes significantly negative. Their results suggest that short sellers are rather skillful in timing intraday price movements. In addition, Shkilko et al. (2012) show that although extreme reversals are often associated with corporate and macroeconomic news announcements, a sizable share of extreme reversals may be caused by undocumented events such as the liquidity-related activities of large institutions. Our study shed new light on instances of pre-announced deletions from a composite index, when index funds are most likely to rebalance their portfolios on the effective day.

3.2 Predatory short covering

Brunnermeier and Pedersen (2005) predict that predatory traders will buy back shares beginning on the deletion day. Figure 2 and Table 3 display the abnormal short covering pattern, abnormal net short selling pattern and price dynamics relative to the deletion day for the clean sample. During the period from five days prior to the effective date to two days prior, abnormal short covers reported in the first column in Table 3 are significant and positive. However, the large positive abnormal net short selling reported in the third column in Table 3 occurs on the day prior to deletion, suggesting that the largest short selling offsets significant positive short covering. Short covering intensifies on the deletion day and reaches a peak of 1.293 percent in terms of the mean (0.975 percent in terms of the median). The price, however, only slightly rebounds as shown in Figure 2. This suggests that such covering orders might be offset by selling orders by index funds on the other side. We examine this possibility in the next subsection by analyzing non-shorted trading. On day (CD+1), short sellers continue to buy back significant amounts of shares. From day (CD+2), abnormal short covering is unremarkable, as is abnormal net short

selling. Compared to short selling after the announcement, short covering appears to be concentrated in the two days [CD, CD+1] the deletion. The results might reflect that predatory short sellers begin buying back shares shorted earlier when most index funds begin unloading sizable positions.

Consistent with an emphasis on minimizing tracking error, Green and Jame (2011) provide evidence that index funds' trading concentrates on the effective date. However, they also observe a gradual increase in net trading of added stocks from day (CD-5) to day (CD-1) and a gradual decline from day (CD+1) through day (CD+5). Their findings suggest that some index funds trade around the effective date in an attempt to mitigate transaction costs.[3] On the whole, minimizing tracking error seems to be a higher priority for index funds than mitigating transaction costs. Therefore, the front-running model in Brunnermeier and Pedersen (2005) is suitable.

It is unclear if when predators short sell more during intermediate days they then subsequently buy back more of a deleted stock following the deletion day, as predicted in Brunnermieier and Pedersen (2005).[4] To dissect this issue, we group all sample firms into three tertiles (15 : 16 : 15) by abnormal short selling behavior and then examine the subsequent top-minus-bottom abnormal short covering difference by employing Welch's t-tests. Table 4 presents the findings on abnormal short selling during the intermediate days and abnormal short covering beginning on the deletion day by tertile. Panel A displays statistics on the three tertiles grouped by abnormal short selling behavior during the period from the announcement day to one day after the announcement. As shown in the second column in Table 4, while the abnormal sort covering of the top tertile during

[3]Earlier trading before the effective date might induce earlier short coverings. If some index funds sell shares of a deleted stock, multiple predators have incentives to begin covering earlier, as theorized in Brunnermeier and Pedersen (2005)

[4]The maximum amount that predators can short from the announcement day to the deletion day depends on the market structure and the constraints on short selling.

the period from the effective day to the day after deletion represents 1.312 percent of outstanding shares, the bottom tertile's abnormal covering represents 0.473 percent. The difference between the top and the bottom tertiles' abnormal short covering is significantly positive at the 1 percent significance level. The right two columns show that the top-minus-bottom tertile abnormal net short selling is significantly negative during the period from the effective day to one day after deletion and during the period from the effective day to five days after deletion, respectively. The results are similar when we employ other grouping methods, which are reported in panels B, C, and D. The results reveal a positive relationship between the degrees of short selling and subsequent short covering. To our knowledge, we are the first study to empirically confirm how predators time price depreciations around index deletions.

3.3 Non-shorted trading

Lynch and Mendenhall (1997) find that the fraction of shares traded on the day prior to the effective date is more than three times as great as that on the announcement date, which also exhibits large trading volume relative to the pre-announcement period. In Chen, et al. (2004), the median announcement day's turnover is 249 percent higher than a normal day's trading volume turnover adjusted for the market average and turnover is 15 times higher than normal on the effective date. Brunnermieier and Pedersen (2005) argue that high observed trading volume on the day prior to deletion indicates that many of the index funds were already trading prior to this date. Using the non-shorted turnover ratio, defined as trading shares minus shares shorted divided by shares outstanding, we examine whether the abnormal non-shorted turnover ratio increases around the effective dates of index deletions.

Table 5 reports the abnormal non-shorted turnover ratio around the announcement and

effective days of deletions. While the rows labeled "$[AD-5, AD-1]$" and "$[CD-5, CD-1]$" report the abnormal non-shorted turnover ratio during the period from five days to one day prior to the event day, the rows labeled "$[AD, AD+5]$" and "$[CD, CD+5]$" report the abnormal non-shorted turnover ratio during five days after the event day. The abnormal non-shorted turnover ratios are presented in the first column. The abnormal non-shorted turnover ratio exhibits an insignificant value before the announcement. It exhibits a significantly positive value after the announcement. As shown in the following rows, the non-shorted turnover ratio presents statistically significant and positive values before and after the effective dates of index deletions. These results indicate that non-shorted trading increases after the announcement of index deletions and is more prominent during the period from the announcement day to the day of the index deletion becomes effective. The results are consistent with the predictions of Brunnermieier and Pedersen (2005). In addition, the second and third columns in Table 5 report Spearman correlations with abnormal short selling and abnormal net short selling. The table shows that non-shorted trading is positively related to short-selling during the period from the announcement day to the effective day. The results indicate that short selling provokes trading that results in substantial price depreciation. In addition, we observe abnormally high levels of non-shorted trading even after the dates that index deletions become effective. Furthermore, as seen in the second and third columns in Table 5, non-shorted trading shows a statistically insignificant Spearman correlation with net short selling. That is, we observe a high level of non-shorted trading that is unrelated to short selling after the effective day.

We find that non-shorted trading also increases after the announcement, as reported in Lynch and Mendenhall (1997). However, non-shorted trading does not always accompany

short selling. Non-shorted trading remains prominent after the dates that index deletions become effective, when short selling weakens. The empirical evidence indicates that traders other than short sellers trade shares continuously after the announcement. We infer that index funds strategically split their trades in stocks deleted from the index to minimize trading costs. Green and Jame (2011) empirically confirm this inference, finding that index funds begin rebalancing their portfolios at the announcement of composition changes and do not fully establish their positions until weeks after the effective date.

3.4 Liquidity

Index funds need to sell shares of a deleted stock; predatory traders also sell shares. In addition, short sellers engage in predatory short selling and withdraw liquidity instead of providing it. Thus, the market is illiquid when liquidity is needed most, as predicted in Madrigal (1996) and Brunnermerier and Pederson (2005). Consistent with their theoretical predictions, Avramov et al. (2006) confirm that the large short-run price reversals occur in illiquid stocks. Shkilko et al. (2012) also find lower liquidity and higher trading costs during the price decline stage, indicated by widened quoted and effective spreads. In their study, liquidity returns to levels comparable with those observed during control periods after prices begin reverting.[5]

In this study, we examine abnormal high-low spreads on event days. Table 6 shows that the average abnormal high-low spread is -1.064 percent and is statistically insignificant during the five days prior to the announcement. It becomes a statistically significant 6.917 percent at the 1 percent level during the six days following the announcement. Similarly, Table 6 also contains results on abnormal high-low spreads after the announcement day. Table 6 shows that the average abnormal high-low spread is 8.870 percent

[5]However, they show that quoted and effective spreads are statistically indistinguishable from those observed during control events, specifically price declines that are not followed by reversals.

and is statistically significant during the five days prior to deletion. It decreases to 1.621 percent during the six days following deletion. The second and third columns of Table 6 report Spearman correlations between high-low spreads and abnormal short sales (AS and ANS). The Spearman correlation between the high-low spread and AS (ANS) during the five days prior to deletion is 0.504 (0.544), statistically significant at the 1 percent level, but the correlation decreases to 0.123 (0.178) after deletion. That is, abnormally high spreads are strongly associated with the levels of short-selling.

Overall, the results confirm that the market is illiquid when short selling is aggressive. The high-low spread widens it is positively correlated with abnormal short selling, as the price approaches around the bottom for the period observed. When index funds begin selling and the price approaches the bottom, The high-low spread decreases rapidly, and the correlation between the high-low spread and short selling is no longer statistically significant. After the price begins reverting, the high-low spread returns to the level prior to the announcement. Considering the increase in non-shorted trading during the period after the announcement documented in the previous subsection, the above results suggest that abnormal short selling and index funds' strategic selling may reduce market liquidity.

Brunnermeier and Pedersen (2005) theorize that a trader can buy (sell) at the highest intensity without incurring the cost associated with a temporary price impact. As mentioned above, abnormal short covering concentrates on the deletion day. This suggests that when index funds begin liquidating their positions and predators begin covering their short positions simultaneously, the maximum intensity increases and the high-low spread decreases. As a result, the price only rebounds by 2.387 percent on the deletion day, and the abnormal return is -0.420 percent (non-significant) regardless of the significantly

heavy short covering. Figure 2 and Table 3 reveal a slow price reversal from the the day deletions become effective relative to the rapid price decline after the announcement. This suggests that the change in market liquidity around deletion leads to changes in trading intensities and slow price reversal.

3.5 Predatory short selling and price reversal

Thus far, we have not considered the effect of abnormal short selling on the magnitudes of price declines or its influence on subsequent price reversals. To shed additional light on this issue, Table 7 displays the cumulative abnormal returns after sorting the data into three tertiles using the abnormal short selling measures.

In Panel A of Table 7, we group stocks into tertiles based on cumulative abnormal short selling during the period from the announcement day to one day prior the effective day. The averages of cumulative short selling are 3.712 percent for the top tertile, 1.784 percent for the middle tertile, and 0.767 percent for the bottom tertile. The corresponding averages of cumulative abnormal returns are -37.239 percent, -24.495 percent, and -21.974 percent during the formation period. When we consider a testing period from the effective day to 20 days thereafter, the averages of the corresponding cumulative abnormal returns are 5.067 percent, 1.806 percent, and -0.570 percent, respectively. Subsequently, when we consider a testing period from the effective day to 40 days thereafter, the corresponding cumulative abnormal returns are 14.047 percent, 8.100 percent, and -0.604 percent, respectively. Moreover, the top tertile reversal reaches 21.977 percent at 60 days after the effective day, whereas the middle and bottom tertiles exhibit unremarkable subsequent changes. Here, we note that for each tertile the price also reverts very slowly after the actual deletion day, in contrast to the sharp price decline during the period from the announcement day to the actual deletion day. This evidence is consistent with prior

studies (Lynch and Mendenhall, 1997; Chen et al., 2004; Ahn et al., 2010). We contend that this undervaluation remains unresolved for three months is that investors on the buy side tend to be less sophisticated than investors on the sell side.[6] Hirose, Kato and Bremer (2009) provide empirical evidence supporting our suggestion. They find that, in Japan, margin buying is dominated by unsophisticated individual investors but margin selling is not.[7]

As seen in Panel A of Table 7, the difference in cumulative abnormal returns during the formation period between the top tertile and the bottom is -15.265 % and statistically significant at the 1 percent level. Although the top tertile exhibits larger cumulative abnormal returns after the effective date than the bottom tertile at the 10 percent significance level, the difference in cumulative abnormal returns during the testing period between the top and bottom tertiles is statistically significant at the 5 percent significance level when we consider a longer holding period. For example, when the holding period is 60 business days after the effective day, the difference in cumulative abnormal returns between the top and bottom tertiles is 17.562 %. When tertiles are grouped by abnormal net short selling (Panel B of Table 7), the tertile price dynamics and top minus bottom price dynamics show the same patterns as in tertiles grouped by abnormal short selling. If the short sellers had not front-run by selling, index funds would have sold shares at a price approximately 20 percent higher for the top abnormal short selling tertile or the top abnormal net short selling tertile. If short selling had been equally aggressive as in the bottom tertile, index funds would have sold at a price approximately 17 percent higher

[6] In Brunnermerier and Pederson (2005), the economy has two types of agents: large strategic traders (arbitrageurs) such as hedge funds and proprietary trading desks and passive long-term investors such as pension funds and individual investors. In the model, long-term investors are unsophisticated and cannot interpret information indicating that stock prices are undervalued.

[7] A symmetric price response to additions and deletions also supports our contention. Lynch and Mendenhall (1997) and Chen et al. (2004) show that the price reversals after actual additions to are notably smaller than those following deletions from the S&P 500. Ahn et al. (2010) report a similar tendency for additions to and deletions from the Nikkei 225.

for the top tertile.

Our results provide supportive evidence for Brunnermerier and Pederson (2005)'s theoretical prediction that predators' ability to front-run implies larger liquidation costs for distressed traders and greater price overshooting. Moreover, short sellers exploit profitable opportunities by employing the front-running strategy in which short sellers sell immediately after the announcement, as they expect liquidity induced price depreciations on the part of index funds around the deletion date, and begin buying back after the deletion day. Our results are consistent with Shikilko, Ness, and Ness (2012), who find that the magnitude of price declines that we investigate is directly proportional to the degree of abnormal short selling in a different manner.[8]

4 Conclusions

Liquidity induced events such as index composition changes could generate temporal price changes and deviations of prices from fundamental values. In this study, we focus on index deletion events that provoke sales by index funds around deletion dates. As index deletion events are pre-announced, sophisticated investors sell stocks prior to price declines due to liquidity induced sales and buy back the stocks when the prices begin reverting to fundamental values. Using daily short selling data, we find results consistent with this prediction. Short sellers employ front-running strategies and sell stocks immediately after the announcements of index deletions until the price reaches the bottom and start buying back from the actual deletion day. While stocks deleted from index compositions tend to decline during the period from the announcement day to the actual deletion day, the stocks tend to appreciate after the actual deletion days. The tendency is stronger among

[8]Price declines are grouped by magnitudes and exhibit higher short selling levels during larger reversals.

stocks with strong selling pressures during the period from the announcement day to the actual deletion day. Overall, our study confirms that short sellers exploit profitable opportunities by predicting liquidity induced sales by index funds around the deletion day and selling stocks before price declines occur. In addition, we examine how the trading activities of short sellers relate to price dynamics and liquidity in the stock market. This analysis contributes to the exiting literature by providing additional evidence on price-destabilizing and liquidity-reducing short selling. We find that the trades of short sellers around index deletion events reduce market liquidity and destabilize stock prices.

References

[1] Ahn, H-J., Jun, C., Chung, J.M., 2010. Do informed traders trade more when the market is thick? Evidence from the Nikkei 225 Index redefinition of April 2000. Asia-Pacific Journal of Financial Studies 39, 495-523.

[2] Avramov, D., Chordia, T., Goyal, A., 2006. Liquidity and autocorrelations in individual stock returns. Journal of Finance 61, 2365-2393.

[3] Boehmer, E., Jones, C., Zhang, X., 2008. Which shorts are informed? Journal of Finance 63, 491-527.

[4] Blouin, J., Raedy, J., Shackelford, D., 2000. The impact of capital gains taxes on stock price reactions to S&P 500 inclusion. NBER Working Paper no. 8011.

[5] Brunnermeier, M., Pedersen, L.H., 2005. Predatory trading. Journal of Finance 60, 1825- 1863.

[6] Chen, H., Noronha, G., Singal, V., 2004. The price response to S&P 500 Index additions and deletions: Evidence of asymmetry and a new explanation. Journal of Finance 59, 1901-1929.

[7] Chen, J., Hanson, S., Hong, H., Stein, J., 2008. Do hedge funds profit from mutual fund distress? Working Paper.

[8] Corwin, S.A., Schuitz, P., 2012. A simple way to estimate bid-ask spreads from daily high and low prices., Journal of Finance 67, 719-760.

[9] Coval, J., Stafford, E., 2007. Asset fire sales (and purchases) in equity markets. Journal of Financial Economics 86, 479-512.

[10] Diamond, D., Verrecchia, R., 1987. Constraints on short-selling and asset price adjustment to private information. Journal of Financial Economics 18, 277-311.

[11] Diether, K., Lee, K., Werner, I., 2009. Short-sale strategies and return predictability. Review of Financial Studies 22, 575-607.

[12] Green, T.C., Jame, R., 2011. Strategic trading by index funds and liquidity provision around SP 500 index additions, Journal of Financial Markets 14, 605-624.

[13] Harris, L., Gurel, E., 1986. Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures. Journal of Finance 41, 815-829.

[14] Hirose, T., Kato, H., Bremer, M., 2009. Can margin traders predict future stock returns in Japan? Pacific-Basin Finance Journal 17, 41-57.

[15] Lynch, A., Mendenhall, R., 1997. New evidence of stock price effects associated with changes in the S&P 500 index. Journal of Business 70, 351-383.

[16] Madrigal, V., 1996. Non-fundamental speculation. Journal of Finance 51, 553-578.

[17] Miller, E., 1977. Risk, uncertainty, and divergence of opinion. Journal of Finance 32, 1151-1168.

[18] Shkilko, A., Van Ness, B., Van Ness, R., 2012. Short selling and intraday price pressures. Financial Management 41, 345-370.

[19] Takahashi, H., 2010. Short-sale inflow and stock returns: Evidence from Japan. Journal of Banking and Finance 34, 2403-2412.

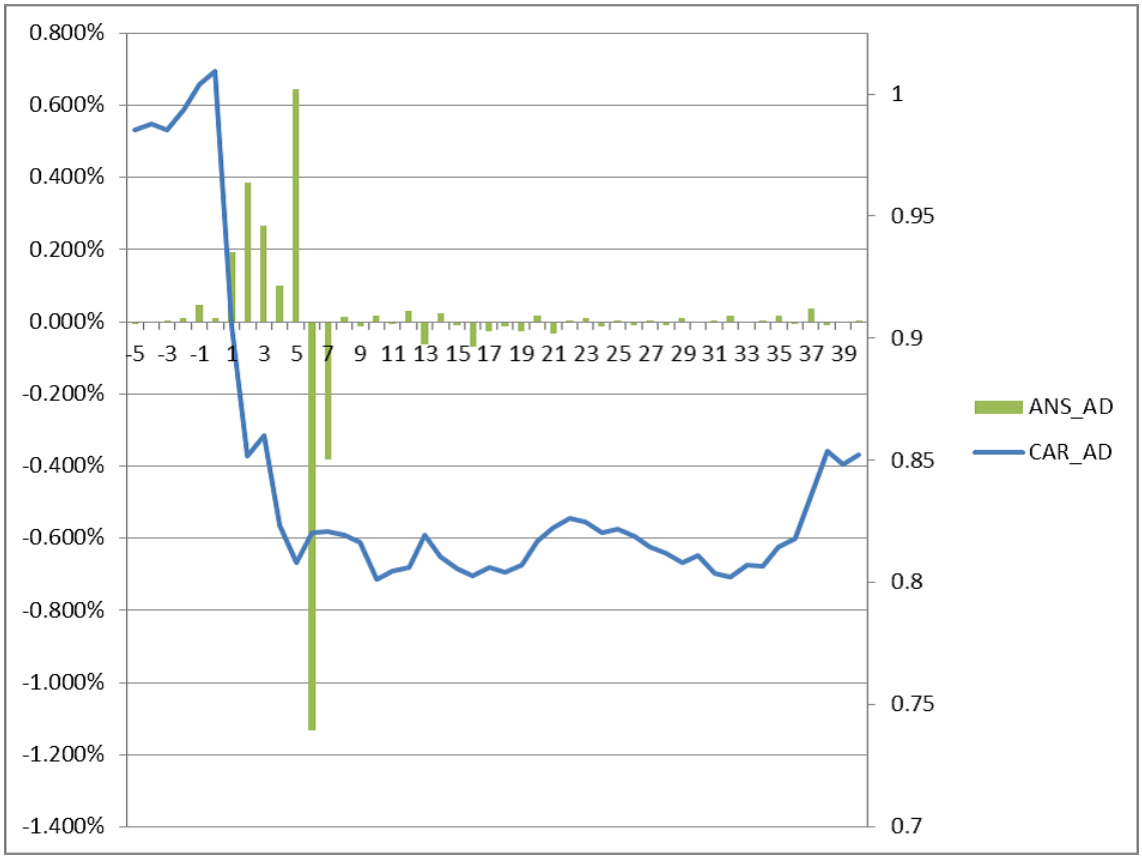

Figure 1: ANS and CAR around the announcement day. The figure depicts the average cumulative abnormal returns (CAR) and abnormal net short selling around the 46 deletions in the sample from 1998 to 2010. The horizontal axis depicts the event day, where day 0 is the announcement date. The vertical axis on the left is the abnormal net short selling reported in percent, and the vertical axis on the right is CAR.

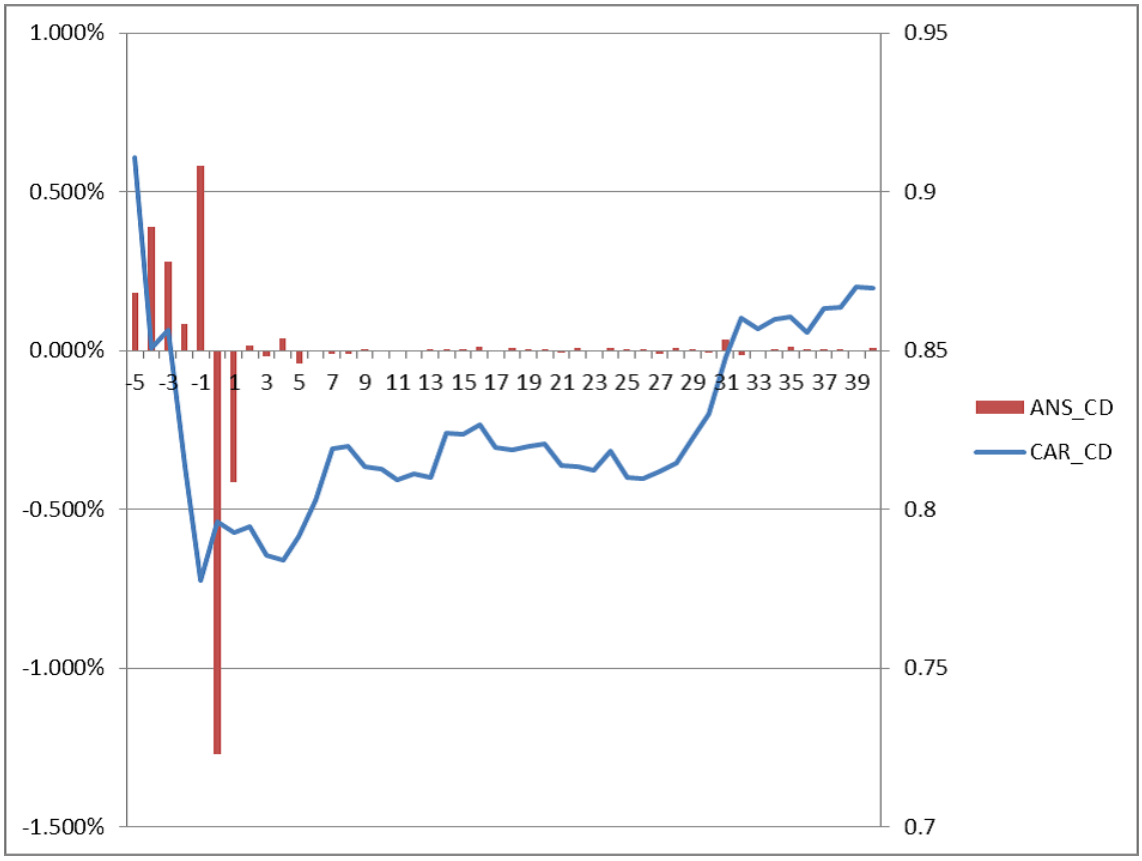

Figure 2: ANS and CAR around the effective day. The figure depicts the average cumulative abnormal returns (CAR) and abnormal net short selling around the 46 deletions in the sample from 1998 to 2010. The horizontal axis depicts the event day, where day 0 is the effective date. The vertical axis on the left is abnormal net short selling reported in percent, and the vertical axis on the right side is CAR.

Table 1: Summary statistics on short selling and returns around event days. This table reports summary statistics for the sample used in the analysis. Panel A and Panel B present summary statistics on short selling, short covering, and trading volume during the period from 120 days prior to the announcement to 10 days after the day index deletions become effective. Yen-based trading value ($*1,000$) and proportions in total outstanding of daily short selling, short covering, and trading volume ($*1,000$) are reported in panels A and B. The two panels reports cross-sectional mean, median, maximum, and minimum values after being averaged for each event. The panels also report summary statistics for the number of days between the announcement (AD) and the effective days (CD) of index deletions. Panel C reports abnormal returns (ARs) and cumulative abnormal returns (CARs) around event days (AD and CD).

	mean	median	maximum	minimum
Panel A: summary statistics of shorted share (full sample, N=111)				
av. daily shorted value	112,263	19,958	1,217,784	3,243
pctg of av. dshort share	0.033	0.028	0.224	0.003
av. daily covering value	102,176	21,721	1,190,411	2,985
pctg of av. dshort covers	0.031	0.027	0.231	0.003
av. daily trading volume	1,588,975	428,875	16,338,909	25,950
pctg of av. daily volume	0.536	0.384	6.200	0.099
number of days AD-CD	7.57	7.00	17.00	0.00
Panel B: summary statistics of shorted share (clean sample, N=46)				
av. daily shorted value	16,034	7,851	116,154	3,243
pctg of av. dshort share	0.044	0.036	0.224	0.015
av. daily covering value	15,571	7,733	118,671	2,985
pctg of av. dshort covers	0.041	0.032	0.231	0.013
av. daily trading volume	232,974	92,068	2,407,415	34,328
pctg of av. daily volume	0.536	0.415	4.467	0.185
number of days AD-CD	8.98	6.00	17.00	5.00
Panel C: summary statistics of abnormal returns (clean sample, N=46)				
one-day AR at AD	0.550	0.687	6.839	-11.129
five-day CAR after AD	-20.816	-20.533	6.686	-61.414
one-day CAR at CD	2.387	2.027	22.014	-14.431
five-day CAR after CD	1.812	3.695	24.893	-25.022

Table 2: Abnormal short selling around announcement days of index deletions. This table reports abnormal short selling (AS) and abnormal net short selling (ANS) around the announcements of index deletions. Abnormal shorted shares (short covers) are defined as daily shorted shares (short covers) divided by shares outstanding (standardized shorts) minus normal standardized shorted shares (short covers) over the $(-125, -6)$ window preceding the announcement day. Abnormal daily net shorts are calculated as daily shorted net shorts minus normal net shorts over the $(-125, -6)$ window preceding the announcement day. Net shorts are defined as daily shorted shares divided by shares outstanding minus daily short covers. AS, ANS, AR, and CAR are reported in percentages. Asterisks $*$, $**$, and $***$ indicate that the value is significantly different from 0 at the 10 percent, 5 percent, and 1 percent significance levels. While t-tests are employed in the case of means, (Wilcoxon) signed-rank tests are used in the case of medians.

	AS around AD		ANS around AD		AR	CAR
d	mean	median	mean	median		
-5	-0.008**	-0.006***	-0.008*	-0.008	-1.449***	0.986
-4	-0.009	-0.010***	-0.003	-0.003	0.245	0.988
-3	0.002	-0.002	0.000	0.011***	-0.275	0.985
-2	0.004	0.002	0.010**	0.009**	0.837**	0.993
-1	0.036*	0.014***	0.045**	0.024***	1.037**	1.004
0	0.021**	0.007***	0.010	0.003	0.550	1.009
1	0.233***	0.201***	0.193***	0.161***	-10.352***	0.905
2	0.426***	0.323***	0.386***	0.274***	-5.856***	0.852
3	0.322***	0.228***	0.266***	0.160***	1.005	0.860
4	0.125***	0.095***	0.099***	0.082***	-4.292***	0.823
5	0.716***	0.577***	0.644***	0.483***	-1.871*	0.808
6	0.019*	-0.004	-1.132***	-0.835***	1.557	0.821
7	0.009*	-0.001	-0.382***	-0.050	0.047	0.821
8	0.035**	0.005	0.014	0.001	-0.165	0.820
9	0.018*	-0.009	-0.013	-0.007	-0.399	0.816
10	0.023*	-0.001	0.016	0.005	-1.866***	0.801

Table 3: Abnormal short covering around effective days of index deletions. This table reports abnormal short covering (AC) and abnormal net short selling (ANS) around the effective days of index deletions. Abnormal shorted shares (short covers) are defined as daily shorted shares (short covers) divided by shares outstanding (standardized shorts) minus normal standardized shorted shares (short covers) over the $(-125, -6)$ window preceding the announcement day. Abnormal daily net shorts are calculated as daily shorted net shorts minus normal net shorts over the $(-125, -6)$ window preceding the announcement day. Net shorts are defined as daily shorted shares divided by shares outstanding minus daily short covers. AC, ANS, AR, and CAR are reported in percentages. Asterisks $*$, $**$, and $***$ indicate that the value is significantly different from 0 at the 10 percent, 5 percent, and 1 percent significance levels. While t-tests are employed in the case of means, (Wilcoxon) signed-rank tests are used in the case of medians.

	AC around CD		ANS around CD		AR	CAR
d	mean	median	mean	median		
-5	0.027***	0.018*	0.180***	0.148***	-8.924***	0.911
-4	0.024**	-0.007	0.389***	0.289***	-6.601***	0.851
-3	0.074***	0.059***	0.277***	0.164***	0.693	0.857
-2	0.061***	0.027***	0.083***	0.091***	-5.014***	0.814
-1	0.211***	0.117***	0.581***	0.562**	-4.422***	0.778
0	1.293***	0.975***	-1.274***	-0.892***	2.387**	0.796
1	0.415***	0.120***	-0.415***	-0.119***	-0.420	0.793
2	0.007	-0.006	0.015	0.005	0.200	0.794
3	0.037**	0.011	-0.018	-0.016*	-1.113*	0.786
4	0.005	-0.009*	0.035*	0.005	-0.199	0.784
5	0.032*	-0.003	-0.041**	-0.011*	0.957**	0.792
6	0.000	-0.011***	-0.003	0.000	1.451***	0.803
7	0.005	-0.009***	-0.014	-0.005	1.978***	0.819
8	0.002	-0.013***	-0.013	-0.002	0.108	0.820
9	-0.008	-0.014***	-0.001	0.000	-0.777***	0.813
10	-0.005	-0.012***	-0.003	-0.002	-0.113	0.812

Table 4: Prediction of short covering using short selling. This table presents abnormal short covering around the effective day of index deletions after grouping the entire sample into three tertiles (15 : 16 : 15) sorted in descending order by abnormal short selling around the announcements. The rows labeled "Top minus bottom" describe differences between the top tertile and the bottom tertile with p-values. P-values provided in the last rows in each panel are calculated using Welch's t-tests. AS_{ad}, $AC[0,j]_{cd}$, and $ANS[0,j]_{cd}$ are abnormal short selling around the announcement day, abnormal short covering during the period from the effective day to j days after the event, and abnormal net short selling during the period from the effective day to j days after the event. Four types of proxies for short selling are employed in the sorting process: $AS[0,1]_{ad}$ (Panel A), $AS[0,5]_{ad}$ (Panel B), $ANS[0,1]_{ad}$ (Panel C), and $ANS[0,5]_{ad}$ (Panel D). $AS[0,j]_{ad}$ is abnormal short selling during the period from the announcement day to j days after the event. $ANS[0,5]_{ad}$ is abnormal net short selling during the period from the announcement day to j days after the event. AC, AS, and ANS are reported in percentages.

	AS_{ad}	$AC[0,1]_{cd}$	$AC[0,5]_{cd}$	$ANS[0,1]_{cd}$	$ANS[0,5]_{cd}$
Panel A: predicted by $AS[0,1]_{ad}$					
tertile 1 (top)	0.226	1.312	0.445	-1.316	-0.441
tertile 2 (middle)	0.113	0.782	0.269	-0.763	-0.264
tertile 3 (bottom)	0.043	0.473	0.182	-0.458	-0.145
top minus bottom	0.183	0.839	0.263	-0.858	-0.296
p-value	$< .0001$	0.0019	0.0052	0.0019	0.0018
Panel B: predicted by $AS[0,5]_{ad}$					
tertile 1 (top)	0.627	1.719	0.591	-1.729	-0.578
tertile 2 (middle)	0.248	0.658	0.229	-0.636	-0.222
tertile 3 (bottom)	0.052	0.198	0.079	-0.181	-0.052
top minus bottom	0.575	1.520	0.511	-1.548	-0.527
p-value	$< .0001$	$< .0001$	$< .0001$	$< .0001$	$< .0001$
Panel C: predicted by $ANS[0,1]_{ad}$					
tertile 1 (top)	0.202	1.311	0.441	-1.323	-0.441
tertile 2 (middle)	0.091	0.771	0.266	-0.747	-0.253
tertile 3 (bottom)	0.014	0.485	0.189	-0.470	-0.156
top minus bottom	0.188	0.826	0.251	-0.853	-0.285
p-value	$< .0001$	0.0022	0.0083	0.0018	0.0024
Panel D: predicted by $ANS[0,5]_{ad}$					
tertile 1 (top)	0.565	1.725	0.592	-1.730	-0.580
tertile 2 (middle)	0.211	0.610	0.209	-0.597	-0.205
tertile 3 (bottom)	0.026	0.242	0.099	-0.222	-0.068
top minus bottom	0.540	1.483	0.494	-1.508	-0.512
p-value	$< .0001$	$< .0001$	$< .0001$	$< .0001$	$< .0001$

Table 5: Non-shorted trading around event days. This table reports the abnormal non-shorted turnover ratio (ANST) around the announcement and effective days of index deletions. The non-shorted turnover ratio (NST) is defined as trading shares minus average shares of shorts and covers divided by outstanding shares. As in the calculation of abnormal short selling/covering, we define the average of the NSTs over the $(-125, -6)$ window preceding the announcement day as the normal standardized non-shorted turnover ratio. ANST is defined as NST minus its normal standardized NST. This table also reports Spearman correlations with abnormal short selling (SPcor with AS) and abnormal net short selling (SPcor with ANS). The rows present abnormal NSTs during the five days prior to the events and the six days (including the event days) after the events. AD and CD denote the announcement and the effective days of index deletions, respectively. ANST are reported in percentages. P-values testing whether the estimates are statistically significantly different from zero are presented below the estimates.

	ANST	SPcor with AS	SPcor with ANS
$[AD-5, AD-1]$	-0.070	0.363	0.008
	0.4292	0.0131	0.9601
$[AD, AD+5]$	1.294	0.966	0.919
	$< .0001$	$< .0001$	$< .0001$
$[CD-5, CD-1]$	1.830	0.629	0.554
	$< .0001$	$< .0001$	$< .0001$
$[CD, CD+5]$	0.840	0.244	0.236
	$< .0001$	0.1016	0.1139

Table 6: High-low bid-ask spreads around event days. This table reports abnormal high-low spreads around the announcement and effective days of index deletions. Adopting a stock liquidity measure proposed in Corwin and Schultz (2012), the stock liquidity estimates are calculated using daily high and low prices. For abnormal levels of stock liquidity, we compare stock liquidity during the event period to that during the $(-125, -6)$ window preceding the announcement day. The difference is defined as the abnormal bid-ask spread (labeled "abnormal HLspread"). This table also reports Spearman correlations with abnormal short selling (SPcor with AS) and abnormal net short selling (SPcor with ANS). The rows present abnormal HLspreads during the five days prior to the events and the six days (including the event days) after the events. AD and CD denote the announcement and effective days of index deletions, respectively. HLspreads are reported in percentages. P-values testing whether the estimates are statistically significantly different from zero are presented below the estimates.

	HLspread	SPcor with AS	SPcor with ANS
$[AD-5, AD-1]$	-1.064	0.322	-0.004
	$< .0001$	0.0289	0.9776
$[AD, AD+5]$	6.917	0.585	0.537
	$< .0001$	$< .0001$	0.0001
$[CD-5, CD-1]$	8.870	0.504	0.544
	$< .0001$	0.0004	$< .0001$
$[CD, CD+5]$	1.621	0.123	0.178
	0.0018	0.4139	0.2371

Table 7: Short selling, contemporaneous returns, and future returns. This table presents cumulative abnormal returns during the contemporaneous period and after the effective day for the three tertile portfolios sorted according to abnormal short selling measures during the period from the announcement day to one day prior to the effective day. The clean sample used in the analysis is sorted by two measures for abnormal short selling: $AS[AD, CD-1]$ is abnormal short selling during the period from the announcement day to one day prior to the effective day. $ANS[AD, CD-1]$ is abnormal net short selling during the period from the announcement day to one day prior to the effective day. As holding periods, three types of investment horizons are employed: 21 business days from the effective day ($[CD, CD+20]$), 41 business days from the effective day ($[CD, CD+40]$), and 61 business days from the effective day ($[CD, CD+60]$). The difference in cumulative abnormal returns during the formation and testing period between the top and bottom tertiles (top minus bottom) is also described with t-statistics. T-statistics are calculated using cross-sectional standard errors that account for heteroskedasticity. AS, ANS, and cumulative abnormal returns are reported in percentages.

	AS/ANS	$ret[AD, CD-1]$	$ret[CD, CD+20]$	$ret[CD, CD+40]$	$ret[CD, CD+60]$
Panel A: predicted by $AS[AD, CD-1]$					
tertile 1 (top)	3.712	-37.239	5.067	14.047	21.977
	(15.03)	(-7.44)	(1.61)	(2.37)	(3.19)
tertile 2 (middle)	1.784	-24.495	1.806	8.100	8.723
	(24.24)	(-8.26)	(0.61)	(2.19)	(1.87)
tertile 3 (bottom)	0.767	-21.974	-0.570	-0.604	4.415
	(4.99)	(-8.96)	(-0.28)	(-0.20)	(0.92)
top minus bottom	2.945	-15.265	5.637	14.650	17.562
	(10.13)	(-2.74)	(1.51)	(2.21)	(2.09)
Panel B: predicted by $ANS[AD, CD-1]$					
tertile 1 (top)	3.285	-41.438	4.438	14.598	20.457
	(12.24)	(-11.40)	(1.39)	(2.49)	(2.88)
tertile 2 (middle)	1.346	-24.843	1.582	5.061	11.301
	(17.94)	(-7.73)	(0.53)	(1.30)	(2.02)
tertile 3 (bottom)	0.217	-17.471	0.255	1.504	3.679
	(1.69)	(-7.46)	(0.13)	(0.49)	(0.97)
top minus bottom	3.068	-23.967	4.184	13.094	16.778
	(10.31)	(-5.54)	(1.11)	(1.97)	(2.08)