Predatory Trading around Russell Reconstitution

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ABSTRACT

Using eight years of recent reconstitution history, we study the behavior of Russell 3000 additions and deletions on the day when the benchmark composition and weights are determined. We document evidence of strategic predatory trading, whereby closing prices of some securities on this day appear to be manipulated with the objective of influencing the resulting membership weight in the index. Specifically, we find that for the securities most likely to be targets of such trading (additions that are closer to the bottom of the newly formed Russell 3000 list and thus more likely to have been pushed into the index), the last day of May contributes a disproportionate share of the monthly return and the last minutes of the trading session contribute disproportionately to the return of this day. Smaller additions also show a greater commonality in their intraday returns on the event day. Perhaps most importantly, we show that smaller additions experience considerably higher event-day order flow imbalances and particularly so towards the end of the trading session. Lastly, we show that these securities do not experience an immediate post-event reversal, as is expected given the liquidity pressure and as is observed for the control group.

1. Introduction

Every year at the end of June, the Frank Russell Company reconstitutes all of its indices. Unlike the S&P 500 or Dow Jones indices, Russell membership is entirely rule-based. Index composition is determined solely as a function of market capitalization of the eligible universe as of the last trading day of May (one month ahead of the official reconstitution date) and, although there may be ambiguities in the calculation of inputs such as float and dual-class share adjustments, event-day changes are by and large predictable. We show that this predictability creates room for manipulative trading on the last trading day of May when index membership and the resulting benchmark weights are determined – we henceforth refer to this day as benchmark composition date or simply event date for expositional convenience.

Insofar as the list of new index constituents and their respective weights are a function of market capitalization on benchmark composition day, this day's closing price can have a significant impact on the reconstitution outcome. We argue that a predatory trader can potentially increase (decrease) an index member's weight or even push a given stock into (out of) the index by affecting the demand (supply) of the stock in question on the event day. Due to the size of passive assets linked to Russell benchmarks ($558 billion as of March 27, 2006)[1], index reconstitution leads to significant flows by passive, active index-tracking managers, and speculative hedge funds. By building a preemptive long (short) position in a security that will have to be bought (sold) by these parties later, a speculative trader can potentially extract significant gains.

[1] "Russell Reconstitution Analysis", Merrill Lynch, Equity Derivatives; May 02, 2006.

Using eight years of recent reconstitution history, we focus on the behavior of Russell 3000 additions and deletions. Intuitively, additions (deletions) that are smaller (larger) in size are more likely to have been borderline and to have thus been pushed into (out of) the index on the benchmark composition day. We document evidence supporting this predatory trading hypothesis. Specifically, we find that for the additions that are closer to the bottom of the newly formed Russell 3000 list the last day of May contributes a disproportionate share of the monthly return and the last minutes of the trading session contribute disproportionately to the benchmark composition day return. Furthermore, the smaller additions show a greater commonality in their intraday returns on this day – whereas the opposite is expected and observed for the nonevent stocks. Perhaps most importantly, we show that smaller additions experience considerably higher event day order flow imbalances and particularly so towards the end of the trading session. Lastly, we show that these securities do not experience an immediate post-event reversal, as is expected given the liquidity pressure and as is observed for the control group.

Not surprisingly, we do not find a symmetric effect for deletions. We believe this is attributable to several reasons. Arguably, it is harder to affect the price of these securities given short-sell constraints that were in place during our sample period, particularly since these are relatively small capitalization firms with low if any pools of lendable shares.[2] Moreover, as shown in Onayev and Zdorovtsov (2007), due to a combination of likely effects deletions experience net outflows over several months ahead of index reconstitution. Thus, the expected additional outflows triggered by pushing a stock out of the bottom of Russell 3000 will be relatively small economically, limiting the gains from this strategy.

[2] Tick and bid tests were eliminated by the SEC in July 2007, after the last reconstitution in our sample.

Previous work focuses on the official index reconstitution day and its effects on the affected securities, holding the new weights as given. We extend the literature by providing the first in-depth investigation of the trading activity on the day when benchmark weights are determined.

An additional contribution of the paper relates to its implications for public policy. Starting in 2007, the Frank Russell Company introduced buffer zones around market capitalization breaks for some of its indices to reduce turnover of the existing index members. Russell 3000 cutoff is, however, excluded from this new rule and the rule does not apply to new members entering the indices. Our results suggest that such a buffer zone is warranted for Russell 3000 as well and that the new index entrants should be subject to the same requirements as the existing constituents.

This paper is organized as follows. Section 2 presents relevant background and develops the hypotheses; Section 3 covers the data; Section 4 contains the empirical results; and Section 5 concludes.

2. Background and Hypothesis

2.1 Russell Index Reconstitution Background

The reconstitution of Russell indices has recently received a growing level of interest in the academic literature. Madhavan (2003) and Chen, Noronha and Singal (2006) document economically and statistically significant abnormal returns and wealth transfers associated with the annual reconstitution from 1995 to 2002. Anecdotal evidence suggests that Russell reconstitution has also attracted significant speculative trading interest and caused concerns that this trading leads to increased transaction costs and economic losses for index funds, which, in their attempts to minimize tracking error, are compelled to trade on or close to the day of reconstitution.[3]

In an effort to mitigate such arbitrage activity and liquidity pressure, the Frank Russell Company has adopted several recent changes to the reconstitution process. Since April 2002, share changes exceeding 5% are made on a monthly basis. Starting in September 2004, IPOs have been included into Russell indices once per quarter. Both changes serve to spread out the turnover over the year, reducing the size of the predictable universe reshuffling in June and making the reconstitution event less significant economically and, hence, potentially less appealing to arbitrageurs. Furthermore, beginning in 2004, provisional indices were introduced, allowing indexers a venue to rebalance their portfolios to the new membership gradually starting a month before the effective date. This transitional time was extended to a month after the event in 2005.[4] Onayev and Zdorovtsov (2007) re-examine the Russell reconstitution event in a more recent period and find that after 2002 the effect shown in previous studies weakened. They attribute this result to both increased speculative trading as well as the changes to the reconstitution methodology implemented by Frank Russell Company.

A procedural change by the Frank Russell Company that is more directly related to the subject of this study is the introduction of turnover buffer zones around market capitalization breaks starting in the year 2007. According to this new change, existing Russell 3000E Index (top 4000 companies in the U.S.) constituents will be evaluated on

[3] Common speculative trades related to Russell reconstitution include: addition-deletion spread; Russell 1000 to Russell 2000 demotion-promotion spread; bets on intra-index redistributions (share, float and growth-value related movements); ETF spread capture between sectors; as well as opportunistic directional trades around severe price dislodgments.

[4] For example, index-plus fund managers can run dual optimizations, arriving at portfolios with minimal tracking error against both the current and the provisional benchmarks. This allows for a smooth migration into the new benchmark and for a better break-up of the transition trades into partial tranches.

their capitalization rankings as before, as well as based on a cumulative market capitalization measure relative to a 5% buffer zone around index break points. If, for instance, the cumulative size of the top 1000 companies as a percentage of the top 4000 companies is 90.00%, the range will be 87.50% to 92.50%. Assuming a current Russell 1000 constituent is ranked 1002nd and corresponds to a cumulative market capitalization of 92.31%, it will stay in the Russell 1000 index as it is within this buffer zone, thereby reducing turnover. Such cumulative market capitalization buffers will be calculated at all the capitalization breaks for the Russell 1000, Russell Top 200, Russell 2000 and other indices. Note, however, there is no such percentile banding requirement at the bottom of Russell 3000, the area we examine in this analysis.

2.2 Development of Hypotheses

Brunnermeier and Pedersen (2005) define predatory trading as "trading which induces and/or exploits the need of other investors to reduce their positions." Although in the majority of cases predation causes the victim to reduce their exposures (a short squeeze being one such common example), the scenarios we consider potentially involve both increases and decreases of existing positions.[5]

Intuitively, we hypothesize that a speculative trader can identify securities which on the event day are on the verge of entering or leaving the Russell 3000 index and engage in manipulative trading with the goal of moving their capitalization rank to above or below 3000 by the close of the benchmark composition date, respectively. Once the trading session closes and the list is frozen, these securities, having unexpectedly moved into or out of the index, will have to be bought or sold by index-tracking managers either

[5] For an excellent review of both theoretical and empirical papers on predatory trading, see Shkilko, Van Ness, and Van Ness (2007).

immediately after the event day as these managers rebalance to the provisional indices, or later at the end of June when the official reconstitution takes place.

We expect that this effect will not be symmetric. The uptick and upbid tests are applicable throughout our sample period. Furthermore, given the size and liquidity profile of the potential Russell 3000 deletions, it is likely that the supply of their shares available for borrowing is very scarce. Additionally, Onayev and Zdorovtsov (2007) show that unlike additions, Russell 3000 deletions experience significant outflows far ahead of the official index reconstitution.[6] To the extent that short-selling constraints restrict one's ability to depress the price, and since the expected economic gains resulting from causing a borderline stock to move out of the index are smaller, we would expect the manipulative behavior to be less pronounced if not absent for the deletes. Thus, we posit that:

H1: Manipulative trading around the event date is more pronounced for Russell 3000 additions;

If stocks which are close to the bottom of the index on the day before the event day are subsequently manipulated to affect the event day ranking, we would expect their returns on the last day of May to have relatively higher magnitude. Focusing on the additions:

[6] The authors offer several potential explanations for this discrepancy. Arguably, it is easier to identify a subset of stocks in the index likely to be dropped than it is to determine those to be added from outside the familiar index universe due to considerably different scopes of the associated search problems. Also, by construction, index deletions are securities that have experienced significant negative returns prior to the event. Thus, quantitative factor models with a momentum component commonly used by index-plus mandates will likely progressively underweight these securities to negligible weights as the event approaches, necessitating less event-related flow in June. Lastly, due to small index weights for deletions, fund managers liquidating these ahead of the effective date do not suffer from significantly increased tracking error and may prefer to migrate out of them at times when the price impact is expected to be less pronounced.

H2: The smaller are the additions, the larger will be the contribution of the event day to their May return;

If borderline securities are bought or sold in bulk on benchmark composition date, their return behavior will exhibit a greater common systemic component. Notice that this is opposite of what would be expected for the control group. Larger and more liquid stocks generally show greater commonalities in their returns – see, for example, Madhavan and Cushing (2000). Focusing on additions:

H3: The smaller are the additions, the larger will be the commonality in their event day returns;

Examining the drivers of these commonalities directly, we would expect the order flow of these stocks to show abnormal imbalances. Focusing on additions:

H4: The smaller are the additions, the higher will be their event day order flow imbalance;

Again, notice that the conjecture above is also opposite of what would be expected for the control group. Since we take capitalization at the end of the event-day, by construction it will be positively related to event-day order flow, ceteris paribus, as greater inflows lead to higher prices and, consequently, to higher end of day capitalization.

A necessary condition for these speculative strategies to work is that the affected prices do not reverse immediately after the liquidity pressure stops. If the stocks pushed into (out of) the index proceed to see inflows and outflows as a result of their new membership status, speculative traders will have an opportunity to exit at a profit. Focusing on the additions:

H5: The smaller are the additions, the less likely they will be to show post-event return reversals;

Lastly, all of these effects should be amplified towards the end of the event day trading session.

3. Data

We obtain Russell 3000 membership records during the 2000-2007 window from the Frank Russell Company. Daily stock returns and volumes are extracted from IDC via FactSet Research Systems while the accounting data are from Compustat. Intraday data, including trades, quotes, and trade and quote sizes are extracted from the New York Stock Exchange Trades and Quotes (TAQ) database for a 127-trading day window centered on the event day.

We subdivide our sample into three groups: additions, deletions, and non-event stocks. Additions are stocks that enter Russell 3000 on the reconstitution day and deletions are stocks that are deleted from the index. Non-event stocks are the remaining Russell 3000 securities, excluding migrations from Russell 2000 (Russell 1000) to Russell 1000 (Russell 2000). We exclude migrations due to their economically significant rebalancing flows.[7] This differentiates our research design from Madhavan (2003), who treated migrations as part of the control group.

[7] Although the total level of assets managed against Russell 2000 is lower than that tied to Russell 1000, the increases in weights for stocks migrating into Russell 2000 from Russell 1000 typically more than offset these differences, resulting in a net positive reconstitution-related flows.

Returns and accounting data are obtained for the May-July window around each reconstitution event as well as in 5 minute increments on the last day of May.[8]

To measure event-related order flow imbalances, we classify the trades as buyer-initiated or seller-initiated using the position of the transaction price relative to the midquote price where the latter is the most recent quote posted at least two seconds prior to the trade (Lee and Ready (1991)). Trades at the midquote price are discarded.[9] Order flow imbalance is then calculated as the ratio of the difference between the dollar volume of buys and the dollar volume of sells, to the total dollar volume over the corresponding time window.

$$OrderFlowImbalance_i = \frac{Buys_i - Sells_i}{Buys_i + Sells_i}$$

Table 1 reports mean and median market value, book-to-market, daily volume, past 1-month return, and past 12-month return for additions, deletions, and non-event stocks. As expected, both additions and deletion, on average, are much smaller than non-event stocks. Additions tend to be small growth stocks with positive momentum. Deletions are even smaller in size value stocks with negative momentum. This suggests that most asset managers are going to be underweight or short deletions and overweight or long additions. Trading volume for both groups is similar, suggesting that they are equally liquid.

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8 Because reconstitution takes place on the last Friday of June since 2003, we define the corresponding reconstitution month returns as cumulative returns from May 31 until the last Friday of June.

9 We require intraday trades to have TAQ correction codes of 1 or 0. The accepted trade condition field flags are Blank, *, B, E, J, or K. Trades size and price are required to be above zero. Similarly, the quotes are required to have MODE of 1, 2, 3, 6, 10, or 12, Ask>Bid>0.01 and positive depths. Furthermore, to filter out outliers we require the bids to be larger than 0.5*(average price of trades throughout the day), and the asks to be smaller than 2*(average price of trades throughout the day). Lastly, because non-primary exchange quotes are not NBBO-eligible (see, e.g. Chordia, Roll, and Subrahmanyam (2001, 2002)), we limit all the quotes to only primary exchange designation.

4. Results

4.1 Analysis of Event Day and Event Day-end Returns

We begin our analysis by asking whether returns of additions and deletions on the day when benchmark composition is determined represent a large fraction of the monthly return. Hypothesis H2 makes the prediction that smaller additions will see a greater contribution of May returns coming from its last trading day. While this hypothesis can be also extended to deletions, due to the limitations described above, we expect to find weaker evidence in favor of H2 in case of deletions. We test hypothesis H2 as follows. First, we rank stocks by market capitalization at the end of the benchmark composition day and assign them into quintiles. Next within each group of stocks, we estimate a regression of the return in the month of May on the return during the last day of May. Panel A of Table 5 reports loadings on the event day return as well as the coefficients of determination from the pooled regressions. The regressions are estimated separately for additions, deletions, and non-events. The loadings and R-squareds of non-event stocks generally increase as a function of market capitalization. The coefficient of determination of large non-event stocks (5.84%) slightly exceeds the R-square implied from the naïve random walk model (4.76%, 1 out of 21 trading days). However, the results are very different for additions: R-squareds range from 2.49% in Q3 to 10.08% in Q1. The coefficient of determination for the largest additions (Q5) is 6.38%. The striking result is that the R-squared of the small additions is more than double of that implied by random walk model. In case of deletions, we do not observe any pattern in the R-squareds or parameter estimates. Overall, the findings in Panel A of Table 5 support H2, suggesting that smaller additions tend to experience larger price pressure on the benchmark composition day. Since our evidence on deletions does not support H2, we conclude that, consistent with H1, manipulative trading is more pronounced in additions.

Next, we ask whether the behavior of predatory traders intensifies as the end of the event trading session approaches. We regress the benchmark composition day return on the return in the last half an hour, grouping stocks into quintile portfolios by market capitalization and estimate pooled regression for each event category. Madhavan and Cushing (2000, 2001) show that over their July 1997-June 1998 sample a greater than expected fraction of daily returns is attributable to the last half an hour trading and that this is observed particularly in the most active stocks. Panel B of Table 5 presents estimates of the loadings on the 3:30 P.M. – 4:00 P.M return and the coefficients of determination. The random walk model would imply an R-squared of 6/78 (7.7%). Consistent with Madhavan and Cushing (2000, 2001), we find that across all event classes the last 30 minutes accounts for greater than expected percentage of the event-day return. Also in agreement with these studies is our finding that larger and hence more liquid non-event stocks generally see a slightly greater portion of their daily return materialize at the end of the trading session (11.51% versus 9.06%). For additions, however, the R-squareds are especially high for small and large additions – 26.23 % and 26.25%, respectively. While the abnormally high contribution for the large additions is puzzling, the high proportions of daily returns for the smallest additions are consistent with our conjecture. For deletions the results are mixed. In general, the return behavior in the last 30 minutes of the event-day trading session corroborates hypothesis H2.

4.2 Commonalities in Event Day Returns

In this section, we investigate whether the event-day returns of the stocks more likely to be affected by predatory trading display greater commonalities in their dynamics as posited by H3. We start by computing event-day intraday returns in 5-minute increments for all sample securities, skipping the first hour of the trading session to maximize the number of stocks which are open. For each market capitalization group and each event category we then perform principal component analysis (PCA) on the respective return correlation matrices. In Figure 1 we plot the first 10 eigenvalues for large (quintile 5), medium (quintile 3) and small (quintile 1) non-event stocks. Figures 2 and 3 present similar results for additions and deletions. Based on Figure 1, we find that for non-event firms the commonality in returns increases monotonically with market capitalization. The first eigenvalue for quintile 5 is more than double that of quintile 1. This result suggests that towards larger stocks generally tend to co-vary more. Turning to additions, Figure 2 shows that small stocks exhibit greater commonality in their intraday return dynamics on the event day, consistent with indiscriminate buying one would expect from manipulative trading. From Figure 3 suggests that no such clear link is visible for deletes, consistent with H1. Overall, PCA results are consistent with the prediction of hypothesis H3.

4.3 Event-day Order Flow Analysis

Next we examine the time series of order flow imbalances for additions, deletions, and non-event stocks. Each group of firms is ranked in five quintiles based on market capitalization at the close of last day of May. Because "small", the stocks ranked in the bottom market capitalization quintile, represent the group of stocks for which inclusion into the index was more uncertain, hypothesis H4 predicts that these stocks are more likely to have been subjected to predatory trading. "Large" stocks, on the other hand, should experience less buying pressure because their inclusion in the index is more certain and the weights are more difficult to manipulate due to increased liquidity. Figure 4 illustrates average daily order flow imbalances for five size portfolios of additions measured over a 21-day window around the last business day of May. On the event day, order flow spikes for all portfolios, illustrating increased buying pressure. Lending strong support to H4, order flow imbalances decrease with market capitalization – smaller additions appear to experience much greater buying pressure. Turning our attention to Figure 5, consistent with Onayev and Zdorovtsov (2007), we find that deletions are sold ahead of May-end as well as thereafter. Consistent with H1, the evidence for deletions is much weaker.

Taking a closer look at the order flow imbalance on the benchmark composition day, Table 3 reports mean OFI of small and large additions, deletions, and non-event stocks. The top (bottom) quintile-ranked additions are assigned into "large" ("small") portfolio. The same ranking procedure is performed for deletions and non-event issues. For each group, we average OFI on the day of the event, one day prior to the event, and one day after the event. On average, while both small and large additions experience positive OFI, the difference between small and large is positive and statistically significant (5.14%), suggesting that small additions are bought more than large ones. This result holds in six out of eight years. As for deletions, on average, both small and large deletions display negative OFI, implying that investors are selling deletions regardless of their market capitalization. However, on the event day the difference between the two is not statistically significant. Overall, these results confirm evidence in Figures 4 and 5. Looking at non-events, large non-event stocks experience strong positive buying pressure, while small non-events do not. On average, the spread between OFI of small and large non-event stocks is highly negative both on the event day as well as on days around the event day. The evidence that larger non-event stocks are bought more than smaller ones suggests that significantly higher OFI of smaller additions relative to that of larger additions is largely driven by speculative trading.

To provide further evidence on H4, we estimate a pooled regression of event-day order flow on Size measured by natural logarithm of market capitalization as of event-day close. We include the following control variables: book-to-market (BM), and 12-month momentum (MOM). In addition, we control for fixed year effects using d2001, d2002,…, and d2007 dummy variables. Table 4 reports regression estimates for additions, deletions, and non-event issues separately. For additions, the coefficient of the Size variable is negative and statistically significant at conventional levels. It is also the largest in magnitude relative to other two groups. The loading on BM is also negative and significant, implying that growth additions tend to be bought more. Given that growth stocks tend to be smaller in size and have uncertain valuations, this result is not surprising. Consistent with the previous evidence, the coefficient of Size for deletions is small and statically insignificant. For non-events stocks, the opposite is observed – the coefficient of Size is positive and statistically significant, suggesting that larger stocks tend to be bought more. In summary, the evidence documented in table 4 is consistent with H4.

In Figure 6, we plot order flow imbalances averaged over 30-minute intervals for additions and non-event stocks from 12P.M until 4 P.M. Consistent with the daily results, order flow of additions significantly higher than that of non-event stocks. To test whether predatory trading becomes more pronounced towards the end of the trading session (as would be expected), we compute an OFI spread measure, calculated as the difference between average OFI of small and large stocks. If predatory trading intensifies as the trading session nears its end, this variable should be positive and increasing towards the market close. Figure 7 plots the dynamics of the OFI spread over the 12 P.M. – 4 P.M. interval. Consistent with our prediction, not only is the OFI spread of additions highly positive, but also it reaches its peak in the last half-an-hour of trading. For non-event stocks, the consistently negative OFI spread attains its minimum in the last 30 minutes of trading.

4.4 Post Event Day Reversals

The question that still remains to be answered is whether predatory traders are able to exit their trades profitably. To address this question, one needs to examine the properties of the post-event returns of the securities identified as likely manipulation targets. In Table 5, we report mean cumulative contemporaneous and future returns for equal- and value-weighted portfolios of additions, deletions, and non-event issues. The contemporaneous return, Ret(-1, 0), is the benchmark composition day return. Ret(0,+1) is the return over the subsequent trading day; Ret(0,+5) is the return during five days following the event; and Ret(0,+R) is the return ending on the day of the reconstitution. On May 31, additions realize significantly greater contemporaneous returns as compared to deletions or non-event stocks both on an equal- and a value-weighted basis. This evidence suggests that during the day of the benchmark composition additions experience greatest price pressure. Also, consistent with evidence in Madhavan (2003) and Onayev and Zdorovtsov (2007), all future returns of additions are highly positive, suggesting that investors keep buying additions during entire reconstitution month of June.

If prices of the stocks increase during the event day as a result of non-predatory liquidity pressure, then we would expect a short-term reversal for the stocks which were bought the most.[10] Holding everything else held equal, additions should experience even stronger reversals as they are the ones subjected to the greater buying pressure on the event day. On the other hand, according to hypothesis H5, the reversal should be weaker for smaller additions as compared to larger additions or non-event stocks.

To test the reversal effects, we regress contemporaneous and future returns on the order flow computed from the opening until close of the benchmark composition day (OFI). We control for book-to-market (BM), momentum (MOM), and fixed year effects. Panels A and B of Table 6 show estimation results for non-event stocks additions, respectively. The contemporaneous relationship between OFI and return is positive and statically significant for both non-events and additions. It is worth noting that the magnitude of the OFI coefficient is almost 1.5 times greater for additions. This suggests that additions are much more sensitive to order flow, not a surprising result given their lower liquidity. Under normal circumstances, we should observe a greater reversal for additions. The coefficient associated with next day return is negative and statically

[10] See, for example, the market-maker inventory control model in Garman (1976), wherein differences between the actual and target levels of dealer inventory lead to temporary price concessions and subsequent reversals. For models and empirical evidence of price pressure effects, see Lakonishok and Smidt (1984), Shleifer (1986), Harris and Gurel (1986), Ritter (1988), Grossman and Miller (1988), Blume et al. (1989), Stoll and Whaley (1990), Jegadeesh and Titman (1995), Lynch and Mendenhall (1997).

significant (-0.42) for non-event stocks, indicating that reversals are indeed observed for the control group and that they are also economically significant. This coefficient for additions is, however, not statically significant for additions and is also economically negligible (-0.02). This suggests that the reversal is not present for additions and indicates that a speculative trader can exit his positions at a profit. The results for next 5 days and 1-month are consistent with the next day regression results. In summary, the evidence in Table 6 support H5.

5. Conclusions

Using eight years of recent reconstitution history, we study the behavior of Russell 3000 additions and deletions on the day when the benchmark composition and weights are determined. We document evidence supporting the predatory trading hypothesis, according to which a group of investors manipulate closing prices of some securities on this day with the objective of influencing their membership in the index. Specifically, we find that for the additions that are closer to the bottom of the newly formed Russell 3000 list, the last day of May contributes a disproportionate share of the monthly return and the last minutes of the trading session contribute disproportionately to the return of this day. Furthermore, the smaller additions show a greater commonality in their intraday returns on the event day, a behavior opposite to that for the nonevent stocks. Perhaps most importantly, we show that smaller additions experience considerably higher event-day order flow imbalances and particularly so towards the end of the trading session. Lastly, we show that these securities do not experience an immediate post-event reversal, as is expected given the liquidity pressure and as is observed for the control group.

Our study has important implications for regulators, practitioners, and the Frank Russell Company. We show that strategic trading behavior of some market participants can affect the composition of the benchmark and lead to a transfer of wealth from the index-tracking investors to those engaging in such activity. One possible way to mitigate this phenomenon is to extend the capitalization-break buffer zone to the bottom of Russell 3000 also. Another, perhaps more robust, alternative is to determine the composition of the indices by using an average of capitalization ranks over several days towards the end of May, as manipulatively influencing the ranking outcome on multiple days would be prohibitively costly.

References

Blume, E., Mackinlay, A. and Terker, B., 'Order imbalances and stock price movements on October 19 and 20, 1987', Journal of Finance, Vol. 44, 1989, pp. 827–848.

Brunnermeier, M. and Pedersen L.H., 'Predatory trading', Journal of Finance, Vol. 60, 2005, pp. 1825-1863.

Chen, H., Noronha, G., and Singal, V., 'Index changes and losses to index fund investors', Financial Analysts Journal, Vol.62, 2006, pp. 31-47.

Chordia, T., Roll, R., and Subrahmanyam, A., 'Market liquidity and trading activity', Journal of Finance, Vol. 56, 2001, pp. 501-530.

Chordia, T., Roll, R., and Subrahmanyam, A., 'Order imbalance, liquidity and market returns', Journal of Financial Economics , Vol. 65, 2002, pp. 111-130.

Garman, M., 'Market microstructure', Journal of Financial Economics, Vol. 3, 1976, pp. 257-275.

Grossman, S. and Miller, M., 'Liquidity and market structure', Journal of Finance, Vol. 43, 1988, pp. 617–633.

Harris, L. and Gurel, E., 'Price and volume effects associated with changes in the S&P 500 List: new evidence for the existence of price pressures', Journal of Finance, Vol. 41, 1986, pp. 815–829.

Jegadeesh, N. and Titman, S., 'Short-horizon return reversals and the bid-ask spread', Journal of Financial Intermediation, Vol. 4, 1995, pp. 116–132.

Lakonishok, J. and Smidt, S., 'Are seasonal anomalies real? A ninety-year perspective', Review of Financial Studies, Vol. 1, 1984, pp. 403–425.

Lee, Charles M. C., and Mark J. Ready, 'Inferring trade direction from intraday data', Journal of Finance, Vol. 46, 1991, pp. 733-754.

Lynch, A. and Mendenhall, R., 'New evidence on stock price effects associated with changes in the S & P 500 Index', Journal of Business, Vol. 70, 1997, pp. 351–383.

Madhavan, A., 'The Russell reconstitution effect', Financial Analysts Journal, Vol. 59, 2003, pp. 51-64.

Madhavan, A. and Cushing, D., 'Stock returns and trading at the close', Journal of Financial Markets, Vol. 3, 2000, pp. 45-67.

Madhavan, A. and Cushing, D., 'The hidden cost of trading at the close', Transaction Costs, Spring 2001, pp. 12-19.

Onayev, Z. and Zdorovtsov, V., 'Russell reconstitution effect revisited', SSgA Working Paper, 2007.

Shleifer, A., 'Do demand curves for stocks slope down?' Journal of Finance, Vol. 41, 1986, pp. 579–590.

Shkilko, A., Nan Ness, B., and Van Ness, R., 'Market Price-destabilizing short selling', University of Mississippi Working Paper.

Stoll, H. and Whaley, R., 'Stock market structure and volatility', Review of Financial Studies, Vol. 3, 1990, pp. 37–71.

Ritter, J., 'The buying and selling behavior of individual investors at the turn of the year', Journal of Finance, Vol. 43, 1988, pp. 701–717.

Table 1. Sample Statistics

			Mean					Median				
Event Type	**Year**	**Obs.**	**MC, $mill.**	**BM**	**AVOL**	**RETN1m**	**RETN12m**	**MC, $mill.**	**BM**	**AVOL**	**RETN1m**	**RETN12m**
Non-event	2000	2,032	6,816	2.73	20,391	-1.50	1.57	854	0.41	5,577	-1.08	0.46
	2001	2,121	6,047	0.52	19,810	3.90	1.99	868	0.42	4,213	2.72	2.06
	2002	2,256	4,972	0.50	20,091	-3.60	0.86	737	0.44	3,788	-2.70	1.07
	2003	2,417	4,283	0.53	17,508	12.07	0.54	646	0.50	3,743	8.66	0.30
	2004	2,421	5,128	0.46	19,902	1.31	2.72	853	0.43	5,876	0.89	2.37
	2005	2,469	5,381	0.45	19,846	6.58	1.18	934	0.42	5,663	5.18	1.10
	2006	2,469	5,765	0.44	21,174	-4.47	1.62	1,100	0.40	6,425	-4.05	1.33
	2007	2,553	6,656	0.41	24,137	4.08	1.65	1,313	0.37	7,375	3.12	1.54
	Total	**18,738**	**5,613**	**0.71**	**20,397**	**2.41**	**1.51**	**904**	**0.42**	**5,349**	**1.63**	**1.31**
Additions	2000	547	457	0.34	5,794	-10.05	5.46	351	0.22	3,008	-11.69	6.88
	2001	481	292	0.49	1,896	23.33	5.99	237	0.41	832	19.61	5.67
	2002	360	260	0.47	1,918	5.84	6.41	187	0.42	687	3.41	5.28
	2003	275	214	0.46	1,606	19.52	6.86	156	0.41	401	11.79	4.95
	2004	294	333	0.33	5,354	3.86	8.14	270	0.27	2,430	1.63	8.47
	2005	194	307	0.34	4,657	13.87	6.24	239	0.29	1,308	9.14	4.60
	2006	223	391	0.27	5,045	-2.12	6.58	308	0.26	1,990	-2.37	6.26
	2007	221	581	0.32	4,808	6.57	5.42	373	0.27	2,269	3.60	4.67
	Total	**2,595**	**353**	**0.39**	**3,734**	**7.05**	**6.30**	**264**	**0.31**	**1,431**	**4.76**	**5.75**
Deletions	2000	303	118	1.51	4,345	-15.45	-5.62	117	1.06	1,405	-15.28	-5.05
	2001	263	73	1.56	2,027	-1.72	-6.20	69	1.08	1,062	-7.97	-6.16
	2002	218	75	1.01	2,599	-20.13	-7.01	72	0.88	1,034	-21.69	-6.52
	2003	180	79	1.26	1,256	19.95	-3.72	84	0.98	653	16.84	-3.47
	2004	194	130	0.73	2,053	-6.63	-1.28	132	0.63	606	-5.20	-0.82
	2005	208	127	0.55	3,605	-0.17	-4.54	136	0.61	1,867	1.99	-4.08
	2006	165	167	0.53	4,582	-10.58	-2.41	173	0.61	1,836	-8.76	-1.66
	2007	170	206	0.55	4,980	0.17	-2.62	217	0.51	2,331	-0.32	-2.20
	Total	**1,701**	**117**	**1.03**	**3,174**	**-5.27**	**-4.45**	**111**	**0.73**	**1,218**	**-6.07**	**-3.71**

Note: The table provides summary statistics based on the data for the last business day of May from 2000 until 2007. The sample is all stock holdings of the Russell 3000 indexes from 2000 until 2007 from the Frank Russell Company. Additions are stocks that are added to Russell index on the reconstitution day and deletions are stocks that are deleted from the index following the reconstitution. Non-event stocks are the remaining stocks in Russell 3000, excluding migrations from Russell 2000 (Russell 1000) to Russell 1000 (Russell 2000). The table reports mean and median market value (MC), book-to-market (BM), 1-month average daily share trading volume (AVOL), past 1-month return (RETN1m), and past 12-month return (RETN12m).

Table 2. Daily and Intraday Regressions

Panel A. Regression of monthly return in May on daily return in the last day of May

event	Size Rank	Coeff.	Adj. R-squared
Non-event	Q1 (small)	0.96	3.98
Non-event	Q2	1.28	5.28
Non-event	Q3	1.28	6.21
Non-event	Q4	1.07	5.48
Non-event	Q5 (large)	1.17	5.84
Additions	Q1 (small)	1.47	10.08
Additions	Q2	1.03	5.00
Additions	Q3	0.88	2.49
Additions	Q4	1.42	6.94
Additions	Q5 (large)	1.18	6.38
Deletions	Q1 (small)	0.85	3.42
Deletions	Q2	1.07	5.37
Deletions	Q3	0.66	3.52
Deletions	Q4	1.20	7.12
Deletions	Q5 (large)	0.97	4.67

Panel B. Regression of the return in the last day of May on the return in the last half an hour of the benchmark composition day

event	Size Rank	Coeff.	Adj. R-squared
Non-event	Q1 (small)	0.70	11.51
Non-event	Q2	0.90	19.09
Non-event	Q3	0.82	11.95
Non-event	Q4	0.92	9.63
Non-event	Q5 (large)	0.73	9.06
Additions	Q1 (small)	0.97	26.23
Additions	Q2	1.12	22.84
Additions	Q3	1.00	13.74
Additions	Q4	0.91	16.75
Additions	Q5 (large)	0.95	26.25
Deletions	Q1 (small)	0.67	10.95
Deletions	Q2	1.02	27.18
Deletions	Q3	0.69	7.69
Deletions	Q4	1.00	29.77
Deletions	Q5 (large)	1.02	30.39

Note: Panel A of the table presents the results of the pooled regression of the return from the beginning to end of May on daily return in the last trading day of May. Panel B of the table presents the results of the pooled regression of the return in the last trading day of May on the return in last 30 minutes of the benchmark composition day. The sample includes only one observation per company per year. It covers all stock holdings of the Russell 3000 indices from 2000 until 2007 from the Frank Russell Company. Additions (deletions) are stocks that are added to (dropped from) the Russell 3000 index on the reconstitution day. Non-event stocks are the remaining stocks in Russell 3000, excluding migrations from Russell 2000 (Russell 1000) to Russell 1000 (Russell 2000).

Table 3. Order Flow Around Event Day by Year

		Additions							Deletions							Non-events						
Portfolio	year	obs	Event-1		Event		Event+1		obs	Event-1		Event		Event+1		obs	Event-1		Event		Event+1	
small	2000	101	-3.78		-9.96	***	8.22	**	55	3.63		3.49		-8.29		365	7.72	***	-9.27	***	0.91	
small	2001	88	-2.58		10.22	***	-0.84		46	-18.42	***	-26.83	***	-13.14	**	391	-12.31	***	-6.12	***	2.59	
small	2002	70	4.50		28.15	***	-14.94	***	41	-6.36		-7.94		-11.11	**	426	-4.86	***	-5.71	***	-23.01	***
small	2003	53	2.43		8.17		7.08		34	5.83		2.56		5.43		458	7.29	***	14.65	***	7.27	***
small	2004	57	16.17	***	9.98	**	10.79	***	38	-13.42	**	-11.94	*	-7.33		474	3.10	**	7.27	***	10.69	***
small	2005	35	4.95		13.01	*	9.47		38	-0.40		-3.54		-0.28		444	2.40		-1.76		5.66	***
small	2006	43	8.21		12.25	**	18.15	***	32	-19.56	***	0.98		5.32		488	-12.84	***	-2.55	**	8.06	***
small	2007	44	-0.78		-0.53		3.77		34	-5.81		-1.47		2.30		508	-1.04		-0.91		-1.14	
small	**All**	**491**	**2.54**		**7.79**	*******	**4.03**	******	**318**	**-6.47**	*******	**-5.94**	*******	**-4.31**	******	**3554**	**-1.40**	******	**-0.15**		**1.63**	*******
large	2000	101	-1.35		-4.67	**	3.46		55	3.75		-6.99		-3.96		365	15.00	***	9.28	***	11.32	***
large	2001	88	-0.92		7.40	***	5.42	*	47	-17.48	***	-12.60	**	-10.94	**	391	6.73	***	10.38	***	12.35	***
large	2002	70	-15.16	***	-1.31		-10.60	***	41	-0.28		-9.85	*	-16.00	***	427	10.30	***	11.66	***	3.20	***
large	2003	53	-4.45		6.16		9.35	**	34	24.71	***	18.53	***	7.09		458	8.85	***	13.08	***	10.21	***
large	2004	57	0.77		5.49		-2.62		38	-13.16	**	-2.59		-2.61		474	11.23	***	11.41	***	9.22	***
large	2005	35	6.93		2.70		8.67		38	3.20		-5.44		-2.96		444	5.96	***	4.49	***	6.93	***
large	2006	43	-5.78		5.40		2.95		33	-18.38	***	-9.98	*	12.73	***	489	1.80	***	7.01	***	6.60	***
large	2007	44	11.81	***	5.62		2.83		34	-4.27		0.62		-8.40	*	509	6.41	***	4.14	***	3.68	***
large	**All**	**491**	**-1.95**		**2.65**	******	**2.01**		**320**	**-2.87**		**-4.26**	******	**-3.82**	*****	**3557**	**8.06**	*******	**8.82**	*******	**7.75**	*******
spread	**All**	**491**	**4.49**	*******	**5.14**	*******	**2.02**	******	**319**	**-3.61**	******	**-1.67**		**-0.49**		**3556**	**-9.46**	*******	**-8.97**	*******	**-6.11**	*******

Note: The table presents mean order flow imbalances for the small and large additions, deletions, and non-event stocks on the event day (Event), one day prior to the event (Event-1) and one day after the event (Event+1). Event day is defined as the last business day of May. The sample covers all stock holdings of the Russell 3000 indices from 2000 until 2007 from the Frank Russell Company. Additions (deletions) are stocks that are added to (dropped from) the Russell 3000 index on the reconstitution day. Non-event stocks are the remaining stocks in Russell 3000, excluding migrations from Russell 2000 (Russell 1000) to Russell 1000 (Russell 2000). "small" ("large") portfolio is composed of stocks that belong to the bottom (top) quintile ranked by market value at the close of the last day of May. "spread" is the difference between mean OFI of small and large portfolios (small-large). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 4. Regressions of event-day OFI on firm characteristics

Variable	Additions		Deletions		Non-Events	
	estimate*100	p-value	estimate*100	p-value	estimate*100	p-value
Intercept	13.28	0.106	-2.62	0.818	-14.70	0.000
d2001	13.50	0.000	-17.36	0.000	2.78	0.001
d2002	16.24	0.000	-4.27	0.209	4.23	0.000
d2003	9.32	0.000	12.40	0.001	14.79	0.000
d2004	13.62	0.000	-7.79	0.023	8.11	0.000
d2005	10.62	0.000	-0.32	0.924	2.51	0.002
d2006	13.05	0.000	-4.09	0.253	2.55	0.001
d2007	10.98	0.000	1.00	0.784	2.67	0.001
Size	-3.03	0.024	0.14	0.949	2.01	0.000
BM	-3.14	0.035	-0.12	0.800	0.01	0.246
MOM	0.04	0.575	-0.03	0.916	0.22	0.000
Adj. R-squared	3.18		4.36		3.95	

Note: The table presents the results of the pooled regression of order flow on size at the close of the last business day of May. The sample covers all stock holdings of the Russell 3000 indices from 2000 until 2007 from the Frank Russell Company. Additions (deletions) are stocks that are added to (dropped from) the Russell 3000 index on the reconstitution day. Non-event stocks are the remaining stocks in Russell 3000, excluding migrations from Russell 2000 (Russell 1000) to Russell 1000 (Russell 2000). The dependent variable is the order flow from the opening until the close of the last business day of May. The independent variables include Size, BM, MOM, and year specific dummy variables. Size is the natural logarithm of market capitalization, BM is book-to-market, and MOM is 12-month past return. d2001, d2002… and d2007 are yearly dummy variables.

Table 5. Returns on and post May-end

Event Type	Year	Obs.	Equal-Weighted Ret(-1,0)	Equal-Weighted Ret(0,+1)	Equal-Weighted Ret(0,+5)	Equal-Weighted Ret(0,+R)	Value-Weighted Ret(-1,0)	Value-Weighted Ret(0,+1)	Value-Weighted Ret(0,+5)	Value-Weighted Ret(0,+R)
Non-event	2000	2,032	-0.03	2.13	4.67	3.91	-0.05	2.34	4.56	3.45
	2001	2,121	0.84	1.02	3.68	3.96	0.75	0.54	2.11	-1.67
	2002	2,256	-0.01	-2.89	-4.23	-5.81	0.22	-2.44	-3.53	-7.09
	2003	2,417	1.92	0.43	3.00	3.23	1.59	0.37	2.56	3.33
	2004	2,421	0.00	0.59	1.79	3.09	0.00	0.13	1.72	1.38
	2005	2,469	-0.13	1.00	1.04	2.31	-0.47	0.93	0.62	0.42
	2006	2,469	1.31	1.82	-1.68	-0.20	0.98	1.31	-1.25	0.07
	2007	2,553	0.42	0.72	-2.44	-1.28	0.16	0.46	-2.55	-1.72
	Total	**18,738**	**0.55**	**0.60**	**0.61**	**1.09**	**0.37**	**0.53**	**0.43**	**-0.23**
Additions	2000	547	0.94	5.04	22.03	37.33	1.35	5.19	23.82	37.31
	2001	481	2.00	0.87	1.05	3.62	1.78	0.95	1.31	1.89
	2002	360	2.04	-2.40	-4.37	0.77	1.83	-2.30	-3.77	-0.87
	2003	275	1.51	-0.13	1.58	4.75	1.28	-0.06	1.71	4.90
	2004	294	0.00	0.37	1.18	1.47	0.00	0.16	0.65	1.41
	2005	194	0.66	0.54	2.54	6.30	0.51	0.47	2.37	5.47
	2006	223	1.38	1.32	0.51	-4.46	1.31	1.22	-0.30	-5.01
	2007	221	0.57	0.92	-1.87	-2.21	0.46	0.89	-2.28	-1.63
	Total	**2,595**	**1.23**	**1.15**	**4.61**	**9.22**	**1.13**	**1.61**	**6.33**	**10.54**
Deletions	2000	303	0.20	0.62	5.56	-0.31	-0.11	0.74	4.83	-0.88
	2001	263	0.00	0.05	5.89	-6.99	-0.22	0.24	6.12	-5.43
	2002	218	-0.94	-3.55	-6.16	-16.83	-0.33	-3.47	-6.44	-17.43
	2003	180	2.45	2.27	8.80	5.32	2.44	2.21	7.66	4.08
	2004	194	0.00	0.24	4.22	-1.61	0.00	0.25	3.84	-1.59
	2005	208	0.07	2.25	0.01	1.55	0.04	1.81	-0.31	0.35
	2006	165	0.98	2.16	-2.88	0.80	0.94	2.11	-3.05	0.34
	2007	170	0.74	0.90	-1.70	2.96	0.66	0.75	-1.84	2.32
	Total	**1,701**	**0.35**	**0.51**	**2.08**	**-2.35**	**0.36**	**0.72**	**1.17**	**-1.51**

Note: The table report equal- and value-weighted returns of the portfolios formed form additions, deletions, and non-event stocks. The sample covers all stock holdings of the Russell 3000 indices from 2000 until 2007 from the Frank Russell Company. Additions (deletions) are stocks that are added to (dropped from) the Russell 3000 index on the reconstitution day. Non-event stocks are the remaining stocks in Russell 3000, excluding migrations from Russell 2000 (Russell 1000) to Russell 1000 (Russell 2000). Ret (-1,0) denotes contemporaneous return of the portfolio from close of day -1 until close of day 0 (last business day of May). Ret(0,+1) denotes next day return from close of day 0 until close of next day (day +1). Ret (0,+R) is the total return from close of day 0 until close of Reconstitution day (day R). The timing of the reconstitution varies by year.

Table 6. Regressions of Contemporaneous and Future Returns on Event-day Order Flow

Panel A. Non-events

DepVar	intercept	d2001	d2002	d2003	d2004	d2005	d2006	d2007	OFI0	BM	MOM	R-squared
Ret (-1,0)	-0.13	0.84	0.07	1.75	-0.11	-0.08	1.33	0.41	2.30	0.00	0.03	11.99
	0.027	0.000	0.415	0.000	0.174	0.317	0.000	0.000	0.000	0.678	0.000	
Ret(0,+1)	1.96	-1.13	-4.91	-1.54	-2.17	-1.06	-0.26	-1.36	-0.42	0.00	0.08	24.07
	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.493	0.000	
Ret(0,+5)	4.08	-0.80	-8.38	-0.98	-4.68	-3.27	-6.05	-6.82	-1.27	0.00	0.21	19.24
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.823	0.000	
Ret(0, R)	3.00	0.17	-9.04	0.36	-0.41	-1.25	-3.94	-5.08	-1.99	0.00	0.52	8.37
	0.000	0.666	0.000	0.352	0.275	0.001	0.000	0.000	0.000	0.840	0.000	

Panel B. Additions

DepVar	intercept	d2001	d2002	d2003	d2004	d2005	d2006	d2007	OFI	BM	MOM	R-squared
Ret (-1,0)	1.00	0.68	0.63	0.29	-0.48	-0.70	0.08	-0.63	3.34	-0.43	0.03	6.62
	0.000	0.032	0.063	0.426	0.188	0.098	0.840	0.116	0.000	0.041	0.001	
Ret(0,+1)	4.99	-4.34	-7.58	-5.26	-5.16	-4.60	-3.66	-4.26	-0.02	0.21	0.01	22.43
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.929	0.290	0.163	
Ret(0,+5)	21.74	-20.44	-25.70	-19.95	-21.39	-19.73	-20.90	-23.20	-0.83	-1.05	0.03	37.16
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.262	0.047	0.266	
Ret(0, R)	35.64	-31.87	-34.84	-31.14	-36.47	-30.39	-40.10	-38.27	-1.21	-2.28	0.18	25.70
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.432	0.038	0.000	

Note: The table presents pooled regressions of contemporaneous and future returns on the event-day order flow, OFI. Contemporaneous return, Ret(-1,0) is the return from close of day -1 until close of day 0 (Event day). Forward return Ret (0,+1) represents return from close of day 0 until close of next trading day (day +1). Ret(0,R) is the return from close of day 0 until close of the reconstitution day (day R). The timing of the reconstitution varies by year. The sample covers all stock holdings of the Russell 3000 indices from 2000 until 2007 from the Frank Russell Company. Additions (deletions) are stocks that are added to (dropped from) the Russell 3000 index on the reconstitution day. Non-event stocks are the remaining stocks in Russell 3000, excluding migrations from Russell 2000 (Russell 1000) to Russell 1000 (Russell 2000). The dependent variable is the order flow from the opening until the close of the last business day of May. The independent variables include Size, BM, MOM, and time dummy variables. Size is the natural logarithm of market capitalization at the close of May-end, BM is book-to-market, and MOM is 12-month past return. d2001, d2002… and d2007 are dummy variables.

Figure 1. First 10 Eignevalues from PCA on event-day 5-minute returns of non-event issues

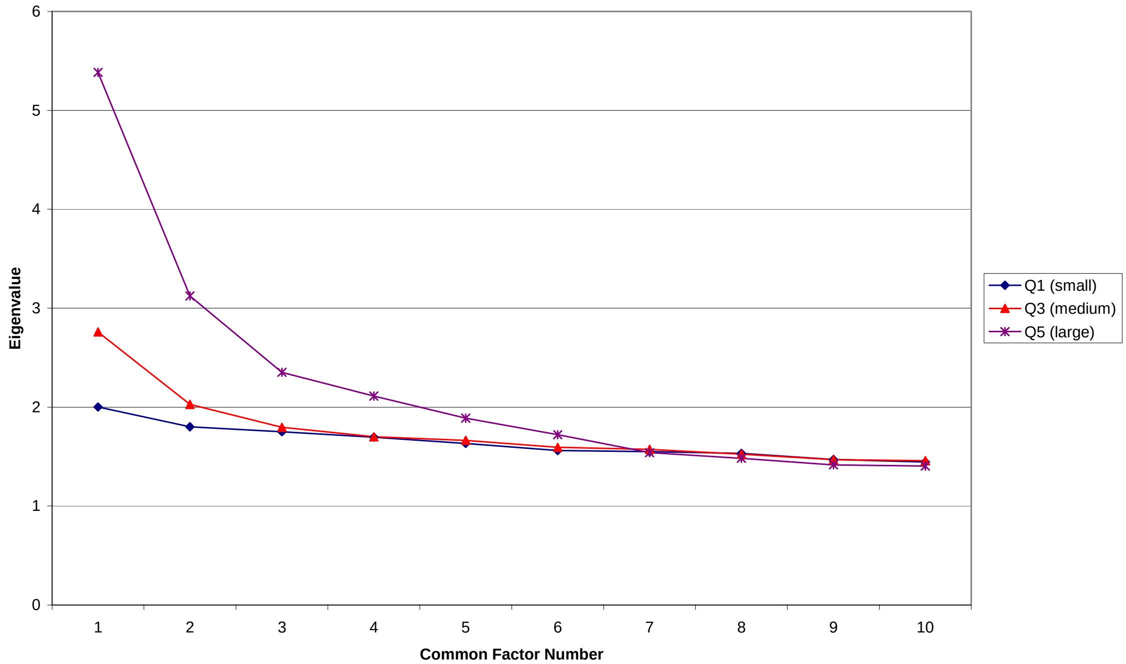

Figure 2. First 10 Eignevalues from PCA on event-day 5-minute returns of additions

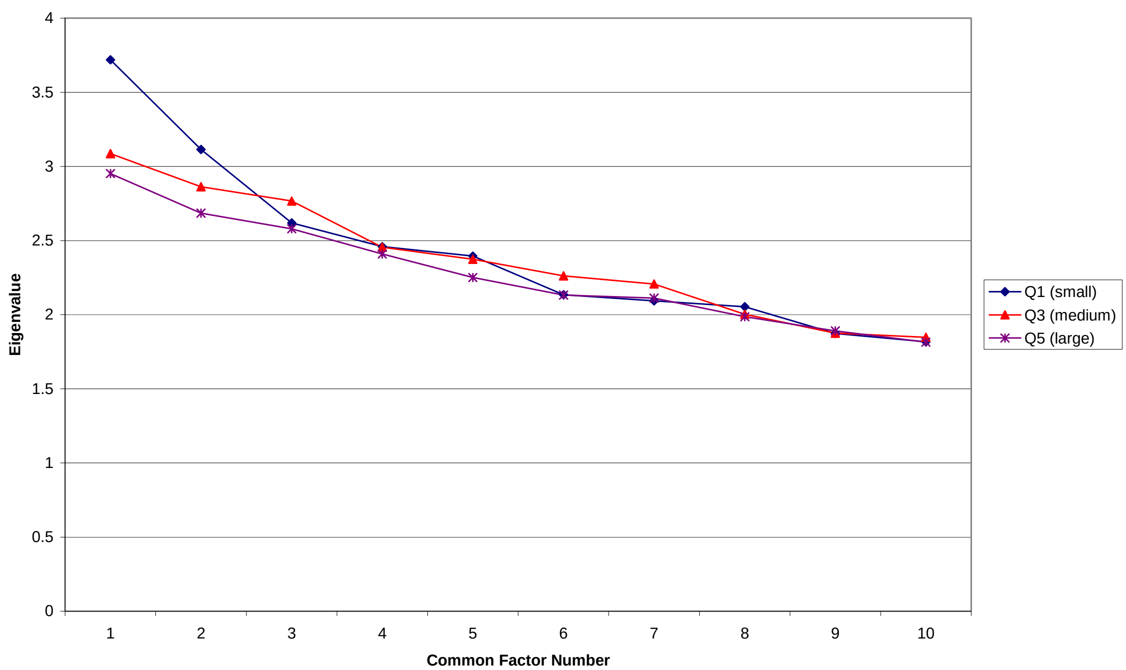

Figure 3. First 10 Eignevalues from PCA on event-day 5-minute returns of deletions

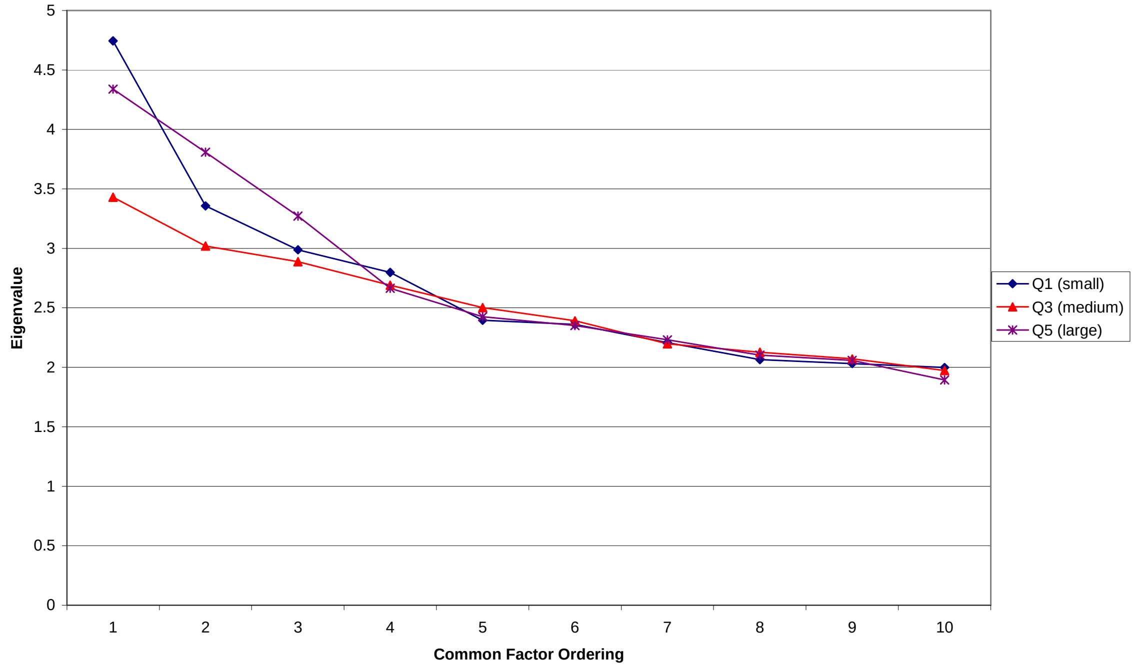

Figure 4. OFI of Additions around the Benchmark Composition Day, 2000-2007

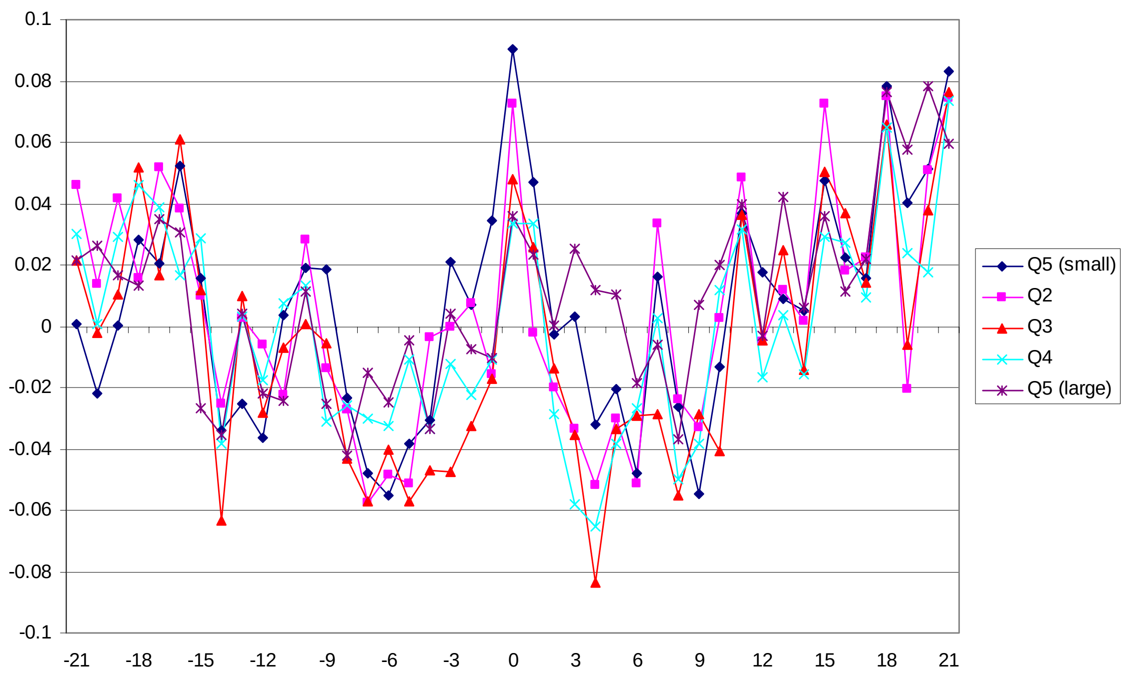

Figure 5. OFI of Deletions around the Benchmark Composition Day, 2000-2007

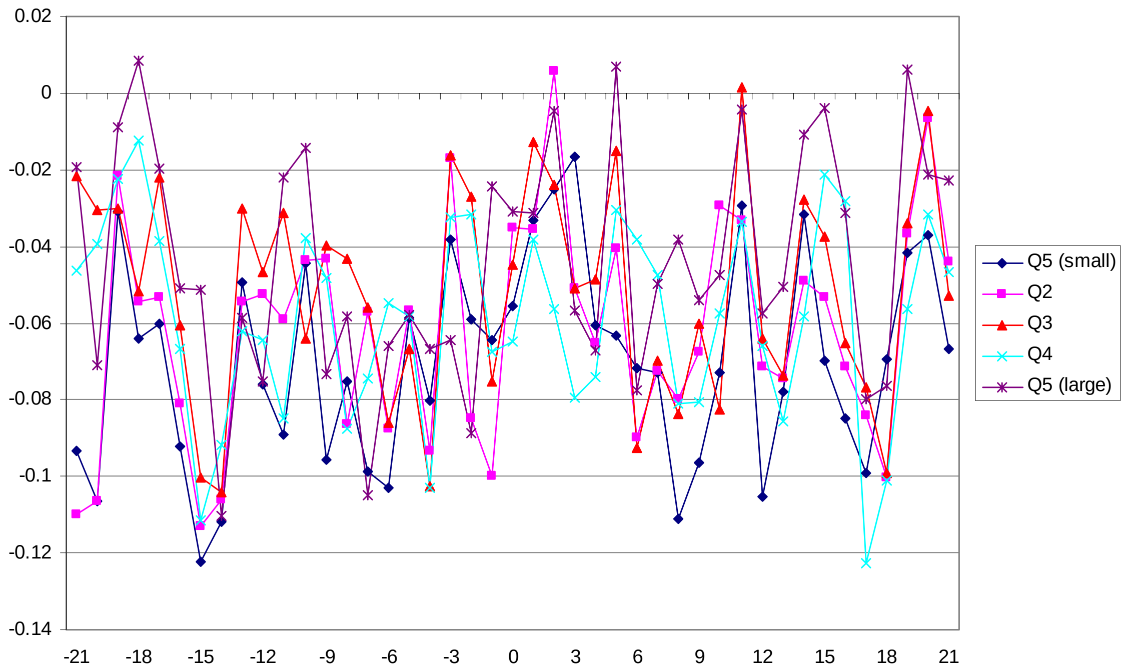

Figure 6. Intraday Behavior of OFI on the Event Day, 2000-2007

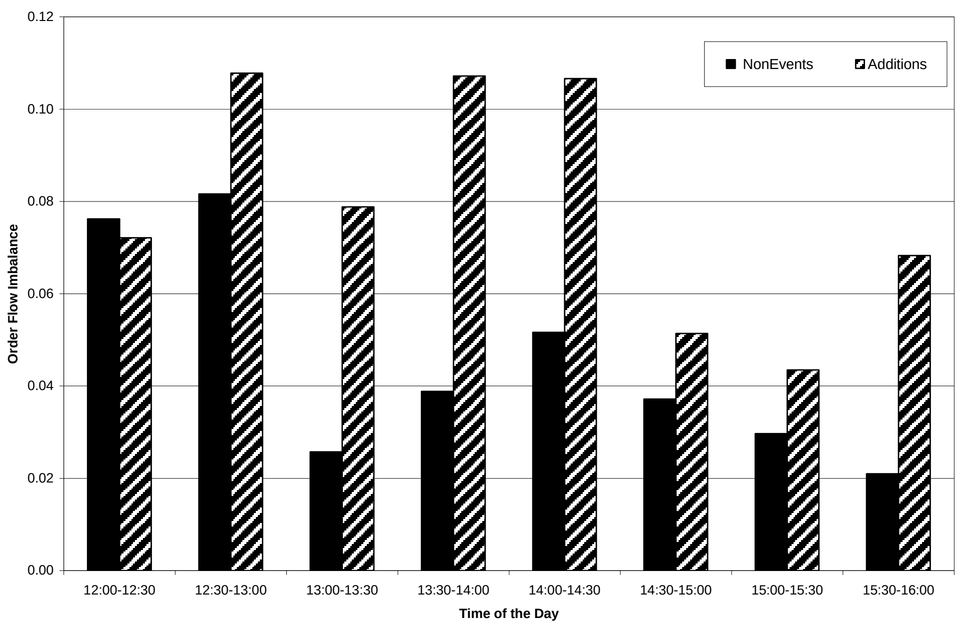

Figure 7. Intraday Behavior of OFI Spread on the Event Day, 2000-2007