# Market Microstructure and the Ex-Date Return

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**ABSTRACT**

This article examines the role of measurement biases, due to order flow effects, in abnormal split ex-day returns. We conjecture that postsplit orders consist of numerous small buyers and fewer larger sellers. This change in order flow causes closing prices to occur more frequently at the ask price, consistent with Maloney and Mulherin (1992) and Grinblatt and Keim (1991). In addition, this change causes specialists' spreads to increase, perhaps to offset larger average inventories. We examine both NYSE and NASDAQ samples and find that order flow biases can explain approximately 80 percent (48 percent) of the NYSE (NASDAQ) ex-day return.

THIS ARTICLE EXAMINES THE role of measurement biases, associated with changes in trading patterns, in the abnormal split ex-date returns documented in Eades, Hess, and Kim (1984) and Grinblatt, Masulis, and Titman (1984). The notion that the split ex-day return may be caused by microstructure effects is discussed in Grinblatt, Masulis, and Titman (1984) and further developed by Grinblatt and Keim (1991) and Maloney and Mulherin (1992). Both Grinblatt and Keim (1991) and Maloney and Mulherin (1992) present evidence that closing prices on and after split ex dates tend to cluster at the ask, and Maloney and Mulherin (1992) also find an "asymmetric" increase in the ask price during this period (Grinblatt and Keim (1991) do not analyze ask prices or spreads).

We provide an explanation of the abnormal ex-date returns that is consistent with observed stylized facts surrounding stock splits. Our explanation is motivated by the fact that a substantial fraction of stock purchases are single or small round lot orders.[1] Given this, a trader who holds a round lot prior to

[1] Teweles and Bradley (1982) note that "100-share transactions are the most common type" of order. In addition, the *New York Stock Exchange Fact Book* (1982) reports that, although small orders are declining in importance, in 1981 (the last year in which 100-share trades were broken out individually in the *Fact Book*), 29.2 percent of the trades on the exchange were for 100 shares. More recently, the *New York Stock Exchange Fact Book* (1992) reports that "small" trades (defined as less than 900 shares) represent approximately 60 percent of total trades. Note

the split and sells subsequent to the split would be offering a relatively large number of shares compared to potential buyers (i.e., more than one round lot). The postsplit order flow will therefore tend to consist of buyers purchasing smaller (postsplit) round lots, while sellers are simultaneously selling larger (presplit) lots.[2] Consistent with the evidence in Grinblatt and Keim (1991) and Maloney and Mulherin (1992), this change in the order flow will cause the number of buy orders to outnumber sell orders in the postsplit period, leading to a higher probability of observing a closing transaction at the ask and hence a measured abnormal return. In addition to this, we also explore the possibility that these changes in the order flow lead to specialist order imbalances, which, in turn, cause the spread to increase. Such an increase may contribute to a measured abnormal ex-date return that cannot be "earned" by investors.

We examine prices, bid-ask quotes and measures of trading activity around split ex dates using both New York Stock Exchange (NYSE) and National Association of Securities Dealers Automated Quotation (NASDAQ)-National Market System (NMS) samples. We decompose transaction returns into bid-price returns ("true" returns) and order flow effects. The order flow effects are comprised of both changes in the tendency of a stock to close at the ask price, as well as changes in the spread. In the NYSE sample, order flow effects explain up to 80 percent of the ex-date transaction return in this sample; moreover, the total order flow effect and its components are significantly related to a measure of changes in the structure of trading on the ex date. We also find evidence of an increase in net demand on the day following the ex date, when both bid and ask prices experience a small but significant increase. In the sample of NASDAQ-NMS securities, order flow effects explain a smaller portion (up to 48 percent) of the measured ex-date return. While the increase in the ask price is generally two to three times as large as the increase in the bid price, there is also a significant increase in the bid price on the ex date and the days following, which is consistent with evidence

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that this explanation is consistent with Copeland (1979), who states: "an individual, who holds one round lot and who is likely to sell it to one buyer before a two-for-one split, may sell two round lots to two people after the split." In addition, a survey by Baker and Gallagher (1980) reports that 98.4 percent of reporting managers cite a brief that splits make it "easier for small shareholders to purchase round lots." This view suggests that capital-constrained investors make up at least part of the pool of new (smaller) buyers and provides one possible motivation for the increased number of buy orders in our model (for a more formal model, see Merton (1987)). This feature is also consistent with Lamoreaux and Poon (1987), who find that the number of shareholders increases significantly after a stock split.

   [2] Of course, some postsplit sellers may choose to sell only a fraction of their holdings. However, our explanation does not require that *every* seller offer more than one round lot, only that, immediately after the split, sellers offer to sell, on average, a larger block than postsplit buyers offer to buy.

presented in Grinblatt and Keim (1991). As in the NYSE sample, there is a tendency for securities to close at the ask price on and after the ex date, and the ex-date order flow effects are significantly and positively related to changes in trading on the ex date.

In an overview of the article, the order imbalance explanation for the ex-date return is presented in Section I, the data are described in Section II, results are discussed in Section III, and the article is concluded in Section IV.

## I. Ex-Date Returns and Order Flow

While stock splits are "purely cosmetic" events (Grinblatt and Keim (1991)) when one considers the firm's cash flows, changes in the number of shares may affect order flow in the stock. As one example, a trader who owns pre-split shares and wishes to sell subsequent to a split must offer a larger number of shares. If postsplit buyers purchase postsplit round lots, then the order flow after a split will temporarily consist of small (postsplit) buyers and large (presplit) sellers. This is consistent with evidence that (split-adjusted) volume de creases following a split (Copeland (1979)), while the number of transactions i ncreases (Conroy and Flood (1988)) (see also footnote 1).

Differences in the relative number of buyers and sellers can have an effect on measured returns. In particular, if there are relatively more buy orders after a stock split, the closing trade will more likely be at the ask price, resulting in an observed positive return. However, there is a second potential effect. Once a large seller "arrives," if the specialist must wait for a large number of smaller buy orders to arrive to rebalance the inventory, then the specialist has a higher probability of carrying a larger inventory. To compensate for the higher average carrying costs, the specialist will increase the spread.[3]

Increases in the spread can also affect measured returns; the specific effect will depend on the mechanism by which the spread is increased. A profit-maximizing specialist will choose to increase the spread by imposing the increased carrying costs on the investors (either buyers or sellers) with the most inelastic demand. For example, in a Ho-Stoll (1981) type model of specialist behavior, if buyers arrive twice as frequently as sellers, then buy orders are inelastic relative to sell orders. Therefore, the increase in the spread will be achieved by increasing the ask price. This will exacerbate the order flow bias, since an increase in the ask price alone can lead to a measured abnormal ex-date return.

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[3] For a formal model of the specialist's inventory problem with this type of order flow, see Conrad and Conroy (1991). Empirically, increases in the spread have been observed after stock splits (see Conroy, Harris and Benet (1988)).

To test for these effects, we decompose the order flow bias by using Keim's (1989) location parameter:

$$L_{it} = (P_{iTt} - P_{iBt})/(P_{iAt} - P_{iBt}) \tag{1}$$

where $P_{iTt}$ is the closing transaction price in security $i$ on day $t$, $P_{iBt}$ is the closing bid quote, and $P_{iAt}$ is the closing ask quote. A value between 0.50 and 1.0 signifies a tendency to close at the ask price; a value between 0 and 0.50 indicates a tendency to close at the bid price.[4]

Using this parameter and defining the proportional spread, $s_{it}$, as $(P_{At} - P_{Bt})/P_{Bt}$, the (continuously compounded) transaction returns, $r_{iTt}$, can be approximated for small values of $L_{it}s_{it}$ as:

$$r_{iTt} \approx r_{iBt} + L_{it}s_{it} - L_{i,t-1}s_{i,t-1} \tag{2}$$

where $r_{iBt}$ is the return measured in bid quotes.

Thus, the order flow effects $(L_{it}s_{it} - L_{i,t-1}s_{i,t-1})$ encompass both the changes in the relative tendency to close at bid or ask and changes in the size of the spread. If the tendency to close at the ask, $L_{it}$, increases from day $t - 1$, the transaction return will increase; if the proportional spread increases from day $t - 1$, the transaction return will also increase.

## II. Data

We analyze the effects of stock splits on both NYSE and NASDAQ-NMS stocks. For the NYSE sample, splits are identified from the *Standard and Poor's Daily Stock Price Record*. Bid and ask prices are obtained from Francis Emory Fitch, Inc. We obtained these data only for those splits that occurred in 1983 and during the period October 1980 through October 1982 in which the ex date occurred in the first five trading days of the month. In all, the NYSE sample consists of 217 splits.

The NASDAQ-NMS sample was obtained from the NASDAQ files from the Center for Research in Security Prices at the University of Chicago. To be consistent with the NYSE definition of splits, we require that NASDAQ stock splits be a minimum of 5 for 4. These data are available from 1983 through 1990. In all, the NASDAQ sample consists of 1,419 splits.

Table I presents some characteristics of our sample of NYSE and NASDAQ splits. Consistent with Conroy, Harris, and Benet (1988), we find that proportional spreads increase on the ex date in both the NYSE and the NASDAQ-NMS samples, by 55.5 and 49.8 percent, respectively. We also find an increase in transactions on the ex date in both samples; in the NASDAQ-NMS sample; split-adjusted volume declines slightly, while the NYSE firms experience a slight increase in split-adjusted volume. However, the increase in

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[4] For both the NYSE and NASDAQ exchanges, nonsynchronous closing transactions prices may fall outside the closing bid-ask quotes, causing $L_{it}$ to be less than 0 or greater than 1; when this occurred (generally less than 3 percent of the sample on any given day), we set the location parameter, $L_{it}$, to missing.

Table I

## Data Characteristics of Sample of 217 Splitting NYSE Stocks and 1,419 Splitting NASDAQ-NMS Stocks

Split factor is the share adjustment as recorded by CRSP; a split factor of 1.0, e.g., represents a 2-for-1 split. *PROPSPD*( − 1) is the percentage proportional spread on the day before the ex-date, where the proportional spread is calculated as the raw spread (ask-bid price) over the bid price. *TRANS*( − 1) and *VOL*( − 1) are the number of transactions and volume, respectively, on the day before the ex date. *PROPSPD*(0), *TRANS*(0), and *VOL*(0) are the same variables calculated on the ex date, with volume adjusted for the split. The ex-date return is measured as the percentage difference in recorded closing transaction prices. The *t*-statistic tests the hypothesis that the NYSE and NASDAQ sample averages are significantly different. The *z*-score tests the hypothesis that the NYSE and NASDAQ sample medians are significantly different, using a normal approximation to the binomial distribution.

|  | NYSE Sample | | NASDAQ-NMS Sample | | Difference | |
| --- | --- | --- | --- | --- | --- | --- |
|  | Mean | Median | Mean | Median | *t*-Statistic | *z*-Statistic |
| Split factor | 0.877 | 1.00 | 0.745 | 0.5 | 4.06 | 5.82 |
| *PROPSPD*( − 1) | 0.768 | 0.680 | 2.332 | 1.639 | − 22.39 | − 13.63 |
| *TRANS*( − 1) | 38.08 | 20.0 | 33.32 | 13.0 | 1.26 | 5.32 |
| *VOL*( − 1) | 45,844.1 | 14,900.0 | 40,470.2 | 10,700.0 | 0.76 | 2.14 |
| *PROPSPD*(0) | 1.194 | 1.058 | 3.494 | 2.439 | − 21.92 | − 13.77 |
| *TRANS*(0) | 58.72 | 32.0 | 60.81 | 18.0 | − 0.31 | 5.04 |
| *VOL*(0) | 49,375.7 | 14,400.0 | 39,158.1 | 10,214.3 | 1.40 | 1.97 |
| Ex-date return | 0.358% | 0.00 | 1.719% | 1.289 | − 5.51 | − 4.30 |

volume (7.2 percent) for the NYSE sample is much smaller than the proportional increase in the number of transactions (54.2 percent) on the ex date.

To compare our sample with that of previous studies, Table I also shows raw ex-date returns, measured using closing transaction prices.[5] For the NYSE securities, the mean ex-date return is 0.358 percent. This is similar to the raw ex-date return of 0.477 percent reported by Eades, Hess, and Kim (1983) for their sample of stock splits.[6] In comparison, the average ex-date return for the NASDAQ securities is over four times as large, at 1.719 percent; the difference in ex-date returns across exchanges is significant. The large NASDAQ ex-date return may be the result of the significantly larger proportional spreads (which would be consistent with an order flow effect), or it may reflect differences in the institutional characteristics of the two exchanges. However, due to the large difference in the average ex-date return across exchanges, we perform all subsequent analyses on the separate exchange subsamples.

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[5]Returns presented throughout the tables are continuously compounded.

[6]Although the NYSE raw ex-date return is not significant at the 5 percent level, average ex-date *excess* returns, calculated as the average of the raw returns less the market index return, are 0.479 percent, with a *p*-value of 0.02.

## III. Tests

Our analyses consist of tests suggested by equation (2). Our first test examines the average location of the closing price within the spread. Next, in addition to transaction returns, we measure the returns in bid prices and examine changes in spreads around the ex day. We then calculate the total order flow effect in transaction returns around the ex date. Finally, we examine the relation between the total order flow effect and relative changes in the number of transactions and volume on the ex date.

### A. Movement within the Spread

Table II reports the average location of the closing transaction price within the spread for days $-5$ to $+10$ relative to the split ex date for both NYSE and NASDAQ-NMS samples. For both samples, we test whether the average estimated $L_{it}$ for the overall postsplit period, as well as for each individual day after the split, is significantly different from the overall presplit average $L_{it}$.

### Table II

### Placement of Closing Transaction Price within the Bid-Ask Spread for NYSE and NASDAQ-NMS Stocks

This table reports the relative position of the closing transaction price to the bid and ask quotes using the parameter $L_{it}$, where $L_{it} = (P_{T,it} - P_{B,it})/(P_{A,it} - P_{B,it})$, $P_{T,it}$ is the closing transaction price on day $t$ for security $i$ and $P_{B,it}, P_{A,it}$ are the closing bid and ask quotes, respectively, on day $t$ for security $i$. The location parameter, $L_{it}$, measures the tendency for security $i$ to close closer to the bid price ($L_{it} < 0.50$) or closer to the ask price ($L_{it} > 0.50$). The NYSE sample consists of 217 splits occurring between 1981 and 1983; the NASDAQ-NMS sample consists of 1,419 splits occurring between 1983 and 1990. The $t$-statistic reported tests the hypothesis that the average location parameter for that day is significantly different from the overall mean of $L_{it}$ in the preevent period (day $-5$ through day $-1$).

| Day | NYSE Sample $L_{it}$ | $t$-Statistic | NASDAQ-NMS Sample $L_{it}$ | $t$-Statistic |
|---|---|---|---|---|
| $-5$ | 0.543 | | 0.530 | |
| $-4$ | 0.583 | | 0.513 | |
| $-3$ | 0.529 | | 0.527 | |
| $-2$ | 0.521 | | 0.547 | |
| $-1$ | 0.585 | | 0.566 | |
| 0 | 0.627 | 2.86 | 0.606 | 5.29 |
| $+1$ | 0.562 | 0.30 | 0.622 | 6.50 |
| $+2$ | 0.622 | 2.50 | 0.597 | 4.55 |
| $+3$ | 0.577 | 0.76 | 0.600 | 4.78 |
| $+4$ | 0.574 | 0.70 | 0.567 | 2.21 |
| $+5$ | 0.574 | 0.71 | 0.589 | 3.87 |
| $+6$ | 0.524 | $-1.02$ | 0.581 | 3.27 |
| $+7$ | 0.585 | 1.17 | 0.570 | 2.47 |
| $+8$ | 0.583 | 1.05 | 0.563 | 1.95 |
| $+9$ | 0.592 | 1.38 | 0.551 | 1.06 |
| $+10$ | 0.575 | 0.77 | 0.556 | 1.39 |

Before the split, there is no tendency for security prices to close near the bid price, as Grinblatt, Masulis, and Titman (1986) suggest. Consistent with the evidence of both Maloney and Mulherin (1992) and Grinblatt and Keim (1991), there is a tendency, in both samples, for closing prices to fall nearer to the ask price on and after the ex date. For the sample of NYSE stocks, the average postsplit $L_{it}$ is significantly higher than the average presplit $L_{it}$ ($t$-statistic = 2.16). In addition, days 0 and +2 are each individually significantly different from the presplit mean. In the NASDAQ-NMS sample, this tendency is more pronounced: closing prices after the split are significantly closer to the ask on days 0 through 7, and the overall postsplit mean is significantly different from the presplit mean with a $t$-statistic of 6.84. The propensity of postsplit stocks to close at the ask price would contribute to a measured abnormal ex-date return.

## B. Movement of the Quotes

Table III reports the average ex-date return, measured using bid and closing transactions prices, for the NYSE sample; Table IV reports the results for the NASDAQ-NMS sample.[7] On the ex date, the return measured from bid price to bid price is not significant in NYSE securities (mean return = 0.11 percent, $t$-statistic = 0.51). In NASDAQ-NMS securities, consistent with Grinblatt and Keim (1991), the bid-to-bid return is significantly positive on the ex date (mean return = 0.949 percent, $t$-statistic = 10.14), although it is significantly less than the return in transaction prices. The observation of a significantly larger ex-date return in transactions prices relative to bid prices is consistent with the specialist, faced with higher average inventories, choosing to increase the spread by increasing the ask quote.[8]

The increase in the ask price with no corresponding increase in the bid price leads to the significant increase in the ex-date spread observed in Table I. This increase, combined with the greater tendency of securities to close at the ask price after a split observed in Table II, biases the measured transaction return upward. Columns 4 and 5 in Tables III and IV report the sample averages of the proportional spread, $s_{it}$, and the total bias, $L_{it} s_{it} - L_{i,t-1} s_{i,t-1}$, by day for NYSE and NASDAQ-NMS securities, respectively. On the ex date, the biases due to order flow effects in the NYSE sample are a significant 0.288 percent ($t$-statisic = 8.44) and are responsible for 80 percent of the measured transaction return. In NASDAQ securities, the ex-date bias is a significant 0.825 percent and accounts for 48 percent of the total ex-date

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[7] For all returns, we also examined average excess returns (both simple and continuously compounded), where average excess returns were calculated as the mean (across securities) of raw returns less the market index return. All ex-date results with excess returns were quantitatively and qualitatively very similar to the raw return results that are reported. Substantial differences in raw and excess returns results will be noted in the article.

[8] In fact, the ask price increase on the ex date for NYSE securities is a significantly positive 0.53 percent, with a $t$-statistic of 2.47; for NASDAQ-NMS securities, the ask-to-ask return is 2.05 percent, with a $t$-statistic of 21.6.

## Table III

### Raw Returns Around Ex Date Measured in Closing and Bid Prices, Proportional Spreads, and Returns Biases for 217 Splitting NYSE Stocks, 1981 to 1983

For each security, raw returns are measured using transaction prices, bid prices, and ask prices. For each day relative to the ex date (day 0), individual security raw returns are averaged across the splitting securities in the sample for that day. *TRET* is the average transaction return less the market index. *BRET* is the average bid-to-bid return less the market index. *PROPSPD* is the proportional bid-ask spread, measured as $s_{it} = (P_{iAt} - P_{iBt})/P_{iBt}$. $\overline{L_{it}s_{it} - L_{i,t-1}s_{i,t-1}}$ is the average order flow effect in transaction returns, where $L_{it}$ represents the location of the transaction price within the spread $L_{it} = (P_{iTt} - P_{iBt})/(P_{iAt} - P_{iBt})$, $P_{iTt}$ is the transaction price of security $i$, day $t$, $P_{iBt}$ is the bid price of security $i$, day $t$, and $P_{iAt}$ is the ask price of security $i$, day $t$. Numbers in parentheses are $t$-statistics to test the hypothesis that the variable is significantly different from zero.

| Day | TRET | BRET | PROPSPD | $\overline{L_{it}s_{it} - L_{i,t-1}s_{i,t-1}}$ |
|-----|------|------|---------|------------------------------------------------|
| −5 | 0.293 | 0.259 | 0.0075 | 0.012 |
|  | (1.89) | (1.74) |  | (0.47) |
| −4 | 0.364 | 0.363 | 0.0072 | −0.007 |
|  | (2.55) | (2.57) |  | (−0.24) |
| −3 | 0.248 | 0.266 | 0.0076 | −0.019 |
|  | (1.63) | (1.75) |  | (−0.76) |
| −2 | 0.150 | 0.173 | 0.0070 | −0.013 |
|  | (0.98) | (1.15) |  | (−0.47) |
| −1 | 0.252 | 0.205 | 0.0076 | 0.037 |
|  | (1.75) | (1.43) |  | (1.29) |
| 0 | 0.358 | 0.110 | 0.0119 | 0.288 |
|  | (1.63) | (0.51) |  | (8.44) |
| +1 | 0.738 | 0.813 | 0.0113 | −0.069 |
|  | (2.86) | (3.13) |  | (−1.58) |
| +2 | 0.550 | 0.466 | 0.0111 | 0.041 |
|  | (2.29) | (1.99) |  | (1.00) |
| +3 | 0.328 | 0.475 | 0.0106 | −0.063 |
|  | (1.42) | (2.02) |  | (−1.59) |
| +4 | 0.046 | −0.046 | 0.0114 | 0.031 |
|  | (0.21) | (−0.23) |  | (0.73) |
| +5 | 0.077 | 0.068 | 0.0111 | −0.000 |
|  | (0.39) | (0.35) |  | (−0.02) |
| +6 | −0.018 | 0.082 | 0.0108 | −0.074 |
|  | (−0.08) | (0.39) |  | (−2.00) |
| +7 | 0.386 | 0.328 | 0.0113 | 0.082 |
|  | (1.80) | (1.53) |  | (2.17) |
| +8 | 0.367 | 0.346 | 0.0105 | −0.034 |
|  | (1.65) | (1.56) |  | (−0.91) |
| +9 | 0.073 | −0.019 | 0.0114 | 0.071 |
|  | (0.34) | (−0.09) |  | (1.75) |
| +10 | −0.097 | −0.022 | 0.0109 | −0.075 |
|  | (−0.46) | (−0.10) |  | (−2.06) |

Table IV

# Raw Returns Around Ex Date Measured in Closing and Bid Prices, Proportional Spreads, and Returns Biases for 1,419 Splitting NASDAQ-NMS Stocks, 1983 to 1990

For each security, raw returns are measured using transaction prices, bid prices, and ask prices. For each day relative to the ex date (day 0), individual security raw returns are averaged across the splitting securities in the sample for that day. *TRET* is the average transaction return less the market index. *BRET* is the average bid-to-bid return less the market index. *PROPSPD* is the proportional bid-ask spread, measured as $s_{it} = (P_{iAt} - P_{iBt})/P_{iBt}$. $\overline{L_{it}s_{it} - L_{i,t-1}s_{i,t-1}}$ is the average order flow effect in transaction returns, where $L_{it}$ represents the location of the transaction price within the spread $L_{it} = (P_{iTt} - P_{iBt})/(P_{iAt} - P_{iBt})$, $P_{iTt}$ is the transaction price of security $i$, day $t$, $P_{iBt}$ is the bid price of security $i$, day $t$, and $P_{iAt}$ is the ask price of security $i$, day $t$. Numbers in parentheses are $t$-statistics to test the hypothesis that the variable is significantly different from zero.

| Day | *TRET* | BRET | *PROPSPD* | $\overline{L_{it}s_{it} - L_{i,t-1}s_{i,t-1}}$ |
|---|---|---|---|---|
| −5 | 0.045 | −0.003 | 0.0234 | |
| | (0.58) | (−0.04) | | |
| −4 | −0.049 | 0.026 | 0.0234 | −0.047 |
| | (−0.64) | (0.41) | | (−1.07) |
| −3 | 0.102 | 0.029 | 0.0239 | 0.070 |
| | (1.38) | (0.49) | | (1.43) |
| −2 | 0.209 | 0.218 | 0.0232 | 0.005 |
| | (2.84) | (3.58) | | (0.11) |
| −1 | 0.381 | 0.343 | 0.0233 | 0.025 |
| | (5.61) | (5.87) | | (0.51) |
| 0 | 1.719 | 0.949 | 0.0349 | 0.825 |
| | (15.21) | (10.14) | | (10.68) |
| +1 | 0.595 | 0.616 | 0.0328 | −0.015 |
| | (5.77) | (7.05) | | (−0.21) |
| +2 | 0.392 | 0.482 | 0.0322 | −0.098 |
| | (3.91) | (5.71) | | (−1.40) |
| +3 | 0.220 | 0.243 | 0.0317 | −0.031 |
| | (2.40) | (3.20) | | (−0.45) |
| +4 | −0.010 | 0.124 | 0.0317 | −0.173 |
| | (−0.10) | (1.49) | | (−2.62) |
| +5 | −0.083 | −0.099 | 0.0315 | 0.018 |
| | (−0.86) | (−1.32) | | (0.27) |
| +6 | 0.120 | 0.133 | 0.0311 | −0.002 |
| | (1.29) | (1.67) | | (−0.04) |
| +7 | −0.087 | −0.031 | 0.0311 | −0.040 |
| | (−0.94) | (−0.39) | | (−0.61) |
| +8 | 0.113 | 0.069 | 0.0307 | 0.046 |
| | (1.16) | (0.96) | | (0.66) |
| +9 | −0.187 | −0.138 | 0.0305 | −0.041 |
| | (−1.97) | (−1.70) | | (−0.68) |
| +10 | −0.034 | −0.004 | 0.0305 | −0.036 |
| | (−0.36) | (−0.05) | | (−0.57) |

return. Note that, for both exchanges, most of the bias is due to the increase in the spread on the ex date. Not surprisingly, a $t$-test rejects the hypothesis that the proportional spread on and after the ex date is equal to the average presplit proportional spread for both samples.[9]

In both samples, there are significant increases in the bid price in the days following the ex date. In the NYSE sample, significant bid returns are observed on day $+1$, with marginally significant increases on days $+2$ and $+3$ (although the increases past day $+1$ do not survive market adjustment). The magnitude of the day $+1$ return is very similar to the excess return that Grinblatt, Masulis, and Titman (1986) find in their sample on day $+1$. For NASDAQ-NMS firms, we again see significant returns in bid prices on days $+1$ through $+3$. Overall, we see evidence that measured returns around the ex date are due to both order flow effects *and* equilibrium price increases; there is much stronger evidence of the latter in the NASDAQ-NMS securities, with up to 52 percent of the (much larger) ex-date return due to increases in the bid quotes and continued significant increases in the quotes in the days immediately following the split.[10]

Maloney and Mulherin (1992), examining NASDAQ-NMS securities, also report an increased propensity for prices to close at the ask after splits, as well as an increase in the ask price. Despite these similar results, note that our interpretation of the causes of the ex-date return is different from that of Maloney and Mulherin (1992). In their article, lower postsplit transactions costs cause investors to "flock to the stock on the ex-day" [p. 56]. This buying pressure pushes up the ask price; the bid price remains relatively flat due to selling pressure from diversifying investors who also face lower postsplit transactions costs. This argument seems to suggest an increase in volume (for which neither Maloney and Mulherin (1992) nor we find evidence), as well as increases in the number of *both* buyers and sellers. As long as the increases in buys and sells are roughly equal, the latter is not consistent with an increased propensity to close at the ask price; to explain the increased tendency to close at ask, Maloney and Mulherin (1992) argue that this will occur whenever prices increase.

## C. Returns and Trading

The order flow effects described in Section I are caused by an increase in the number of (buy) transactions on and after the ex date that are unaccompanied by an increase in volume. In this section, we test whether there is a

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[9] The bid returns plus the bias in Tables III and IV may not precisely add up to the transaction return due to both rounding errors and missing values of $L_{it}$ caused by transaction prices occurring outside the spread.

[10] The portion of the abnormal split ex-date return that is due to changes in order flow should be temporary and would therefore dissipate as the order flow returned to its "normal" presplit state. When we examine the behavior of our average order flow bias measure, $\overline{L_{it}s_{it} - L_{i,t-1}s_{i,t-1}}$ it does decline on average for both NYSE and NASDAQ samples. For the NYSE sample, the order flow bias declines by 0.09 in the ten days following the split, or 31 percent of the total ex-day effect. In the NASDAQ firms, approximately 45 percent of the ex-day order flow bias dissipates in the ten days following the split.

significant relation in *individual securities* between the ex-date order flow effects measured by the last term in equation (2) and a simple measure of the difference between transactions and volume on the ex date. This measure is calculated as:

$$TRANS_{it} = \log[T_{it}/T_{i,t-1}] - \log[V_{it}/(1 + SFAC)(V_{i,t-1})] \qquad (3)$$

where $T_{it}$ is the number of transactions in security $i$ on the ex date, $T_{i,t-1}$ is the number of transactions on the day prior to the ex date, $V_{it}$ and $V_{i,t-1}$ are the equivalent volume measure in number of shares on the same days, and *SFAC* is the split factor. *TRANS* measures the difference in the ex date growth rates of the number of trades relative to the split-adjusted volume; it is also the reciprocal of the change in average order size on the ex date. Therefore, if order size decreases after the split, *TRANS* increases. Since the returns biases in equation (2) are associated with a large number of small buy orders, there should be a positive relation between *TRANS* and these order flow effects. We regress the ex-date change in individual components of order flow effects, $L_{it}$ and $s_{it}$, as well as the total effect, $L_{it}s_{it} - L_{i,t-1}s_{i,t-1}$, on *TRANS* for both NYSE and NASDAQ securities. The results are presented in Table V.

### Table V
## Estimates of Regression of Order Flow Components on Change in Order Flow for NASDAQ-NMS Stocks

Changes in ex-date order flow effects are regressed on *TRANS*, where $TRANS = \log(T_{it}/T_{i,t-1})$ $- \log(V_{it}/(1 + SFAC)(V_{i,t-1}))$ and measures the difference in the ex-date change in transactions and split-adjusted volume. *SFAC* is the split factor. The order flow components are (1) $L_{it} - L_{i,t-1}$ or the ex-date change in the location parameter $L_{it}$, (2) $s_{it} - s_{i,t-1}$ or the ex-date change in the proportional spread, and (3) $L_{it}s_{it} - L_{i,t-1}s_{i,t-1}$ or the total ex-date order flow effect. The $R$-squared reported is in percent. $t$-Statistics, corrected for heteroscedasticity using White's method, are in parentheses.

| Dependent Variable | Intercept | *TRANS* | Adj. $R$-squared (%) |
|---|---|---|---|
| Panel A: NYSE Securities | | | |
| $L_{it} - L_{i,t-1}$ | 0.00694 | 0.08975 | 2.54 |
| | (0.20) | (2.59) | |
| $s_{it} - s_{i,t-1}$ | 0.00430 | 0.00004 | $-0.48$ |
| | (10.51) | (0.08) | |
| $L_{it}s_{it} - L_{i,t-1}s_{i,t-1}$ | 0.0025 | 0.00099 | 2.92 |
| | (7.40) | (2.66) | |
| Panel B: NASDAQ-NMS Securities | | | |
| $L_{it} - L_{i,t-1}$ | 0.02344 | 0.03655 | 0.28 |
| | (1.34) | (2.37) | |
| $s_{it} - s_{i,t-1}$ | 0.0113 | 0.00103 | 0.13 |
| | (16.12) | (1.46) | |
| $L_{it}s_{it} - L_{i,t-1}s_{i,t-1}$ | 0.0076 | 0.0015 | 0.18 |
| | (8.25) | (1.86) | |

Although the proportion of variation explained is uniformly low, there is a positive and significant relationship between our measure of changes in orders, *TRANS*, and the total order flow effect in equation (2) for both exchanges. There is also a positive and significant relation between *TRANS* and the ex date change in the location parameter, $L_{it}$, for both NYSE and NASDAQ-NMS firms. In the regression of the change in the proportional spread measure, $s_{it}$, or *TRANS*, the coefficient is positive and significant at the 10 percent level of NASDAQ-NMS securities; for NYSE firms, the coefficient is positive, but not significant. These regressions show weak evidence for a cross-sectional relationship between changes in the ex-date order flow and the ex-date changes in the proportional spread measure, stronger evidence for a relationship between order flow changes and the placement of the closing transaction price within the bid-ask spread, and evidence for a relationship between the total measured order flow effects in equation (2) and changes in the structure of the order flow.

## IV. Conclusion

This article analyzes the importance of order flow biases in the measurement of ex-date returns in splitting stocks. Empirically, stock splits have been associated with large increases in the number of transactions, small decreases in volume, and increases in the spread. These stylized facts are consistent with postsplit order flow, which consists of more numerous, smaller (post-split) buy orders and fewer, larger (presplit) sell orders. This shift can have two consequences: first, there may be an increased tendency for the security's closing transaction to occur at the ask price. Second, there may be an average increase in the specialist's inventory, leading to an increase in the spread. Both of these shifts can contribute to a measured abnormal ex-date return.

We examine splitting stocks on both the NYSE and NASDAQ-NMS exchange. We decompose transactions returns into "true" returns plus biases due to order flow effects. We find that, on average, order flow effects can account for 80 percent of the ex-date return for the sample of NYSE stocks and 48 percent of the ex-date return for NASDAQ-NMS stocks. These effects are comprised of both a significantly larger increase in the ask price relative to the bid price and a greater propensity to close at the ask. In individual securities there is a significant relationship between a measure of the change in trading activity and the total order flow effect, as well as the difference in the location of the closing transaction price within the spread for both exchanges.

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