Prices, Liquidity, and the Information Content of Trades

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We investigate the effect of asymmetric information on prices and liquidity by analyzing trades, quotes, spreads, and depths. Information content should increase with trade size and the information asymmetry of the trading period. Results show that price and liquidity effects are significantly associated with information content as measured by both trade size and timing relative to information events. Results are stronger for purchases than sales. Quoted prices are better measures of information effects than transaction prices, because they control for bid-ask bounce. Finally, trades that a priori contain no information have no impact on prices and liquidity, despite their large size.

The effect of information on prices and liquidity has been the focus of extensive research in finance. A class of market microstructure models describes economies in which traders have different information, and the evolution of prices is a function of the information contained in trades [see, e.g., Grossman and Stiglitz (1980), Glosten and Milgrom (1985), Kyle (1985), and Easley and O'Hara (1987)]. Some theoretical models predict that large trades contain more information than smaller trades [Easley and O'Hara (1987), Glosten (1989), and Seppi (1990)]. Indeed, previous empirical research establishes a positive relation between trade size and price impact.[1] While this finding is consistent with the hypothesis that large trades contain more information, it is also consistent with other hypotheses, for example, that large trades have greater inventory effects. We examine the impact of trades of various sizes during a range of periods, which by assumption can be classified as having different degrees of asymmetric information. To the extent that inventory and

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[1] Kraus and Stoll (1972), Scholes (1972), Keim and Madhavan (1996), Chan and Lakonishok (1993), Hasbrouck (1988, 1991), and Holthausen, Leftwich, and Mayers (1987, 1990) among others provide empirical evidence of the price effects of large, block trades.

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other noninformation effects are constant across these periods, we are able to distinguish the impact of asymmetric information from other effects. We examine both price and liquidity (measured by spreads and depth) effects. In doing so we broaden the focus of previous research from transaction prices to quoted prices, spreads, and depth. Our approach is nonparametric, which allows insights not available from a regression specification. Finally, looking at quoted prices and other series enables us to avoid some potentially acute biases in transaction returns.

Prior research analyzes asymmetric information as a function of the degree of information asymmetry of the period. Easley and O'Hara (1987) assert that the amount of private information available to traders varies at different times. Several articles analyze variations in returns as a function of the timing of a trade, either in general or relative to information events such as earnings announcements.[2] Venkatesh and Chiang (1986), Krinsky and Lee (1996), and Lee, Mucklow and Ready (1993), among others compare bid-ask spreads during earnings announcement periods to benchmark levels. Most of the research cited above finds not only that average spreads widen during announcement periods, but also that trading volume and volatility increase during these periods.[3] One advantage of looking at the impact of an individual trade during different periods is that the transactions-level response of prices and liquidity to a single trade measures the effect of information more directly.

Relative to previous research, we analyze a much larger cross-sectional variation in information asymmetry by examining trades around dividend announcements, regular periods, ex-dividend day periods, and dividend capture trades. Consistent with Korajczyk, Lucas, and McDonald (1991, 1992), Seppi (1992), and Lee, Mucklow and Ready (1993), asymmetric information should be the greatest just before the announcement of dividends. In contrast, since many studies argue that the dominant motive for trading around ex-dividend days is differential valuation rather than differential information [see Elton and Gruber (1970), Kalay (1982), Boyd and Jagannathan (1994), and Michaely and Vila (1996), among many others], the information content of trades of a given size should be smaller during ex-dividend periods. Other periods (i.e., nonannouncement, non-ex, randomly chosen days) should represent an interim case, with moderate information asymmetries. In addition, we identify certain large, dividend capture trades that are known with certainty not to contain any adverse information; these trades should have no

[2] Foster and Viswanathan (1993) analyze variations in adverse selection trading costs during the day and during the week, hypothesizing that information asymmetries are greatest early in the trading day and early in the trading week. Korajczyk, Lucas, and McDonald (1991, 1992) find evidence consistent with the hypothesis that price effects of new seasoned equity issues are associated with the degree of asymmetric information, measured as the length of time since the last information release. Seppi (1992) finds that blocks during the week before earnings announcements explain much more of the earnings forecast error than blocks that are further away from the earnings announcement.

[3] Krinsky and Lee (1996) note that earnings announcement periods are accompanied by higher trading volume and higher volatility. Lee, Mucklow, and Ready (1993) show that changes in depth and spreads around announcements are primarily related to changes in trading volume.

information price or liquidity effects (see the appendix for a detailed explanation of these trades).

Our main results show that price and liquidity effects are positively related to information asymmetries as measured by the information environment of the trade and by trade size. The price impact of trades is largest in magnitude during announcement periods, somewhat smaller during regular periods, and even smaller during ex-dividend periods. Spreads are larger and depth is lower during announcement periods than during ex-dividend periods. Price and liquidity effects are more sensitive to the information environment after purchases than sales.[4] We also show that the information environment has a significant impact on the market reaction to block purchases even after controlling for the firms' characteristics such as size and trading volume.

We show that transaction returns are a biased measure of the effect of information on prices. We avoid this bias by analyzing quoted prices, spreads, and depth. Controlling for noise associated with bid-ask bounce, price effects are strongly related to trade size for both purchases and sales. Changes in bid-ask spreads and market depth after individual trades are also strongly related to the information contained in trade size. Finally, our results show that trades that are prearranged for dividend capture purposes, and therefore contain no adverse information, do not generate any price or liquidity effects, despite the fact that their average size is almost $50 million.

The remainder of this article is organized as follows. Section 1 describes the sample and methodology. Results concerning price effects are in Section 2. Section 3 presents results about liquidity. Section 4 describes results for the sample of dividend capture trades with no asymmetric information. Section 5 concludes.

1. Sample and Methodology

1.1 Sample

Using transaction data from the Institute for the Study of Securities Markets (ISSM), we construct four different samples, each corresponding to events during periods for which we have differing ex ante expectations about the information content of trades: announcement periods, regular periods, ex-dividend day periods, and dividend capture trades. The dividend capture sample represents an important benchmark because we know that these trades are initiated to capture dividend income and therefore contain no adverse information. As discussed in the appendix, a change in regulations early in 1989 greatly reduced this particular type of dividend capture trading. Therefore we select the sample year 1988, to allow a nontrivial sample of these dividend capture trades.

[4] This asymmetry between purchases and sales is consistent with previous results documented by Chan and Lakonishok (1993) and others.

We focus on New York Stock Exchange (NYSE)-listed companies in the Standard & Poor's (S&P) 500 at the end of 1987 that have 1988 transaction data available from the ISSM and that pay dividends. Our final sample contains 378 firms.[5] The firms in the sample are much larger than typical, with an average market capitalization at the beginning of the sample period of $4 billion versus an average of approximately $1 billion for all NYSE-listed firms during 1988 (NYSE *Fact Book for the Year 1996*, p. 107). However, there is still significant cross-sectional variation: market values for firms in our sample range from $59 million to $70 billion. Firms in our sample also vary in terms of trading activity. Average daily trading volume for these firms ranges from about 4000 shares to almost 1.8 million shares per day, and turnover (average daily trading volume as a percentage of shares outstanding) ranges from 0.06% to 2.5%. Average percentage bid-ask spreads are between 0.2% and 3.0% for the firms in our sample. These ranges suggest that sample firms vary considerably in terms of basic liquidity. Therefore, when calculating abnormal behavior (of spreads, depth, and returns), we use firm-specific benchmarks.

The announcement period consists of data during days -2 through 0 relative to dividend announcement day 0 for all regular quarterly cash dividends paid by these companies during this period.[6] The ex-dividend period consists of data during a 5-day window surrounding the ex-dividend date. There are 1296 dividend events for the 378 firms in the sample, an average of about 3.4 dividend events per firm during 1988. The regular period is a 5-day period sometime during 1988 but excluding 11 days around any dividend announcement or ex-dates. One regular event is obtained for each dividend event. The dividend capture sample, described in detail in the appendix, represents 859 trades occurring on the day before an ex-dividend day that we attribute to dividend capture trading by Japanese insurance companies for regulatory rather than tax or information reasons.

Following Holthausen, Leftwich, and Mayers (1990), we define blocks in terms of the number of shares: trades of at least 50,000 shares.[7] Table 1 provides descriptive statistics on the characteristics of trades during the announcement, regular, and ex-dividend periods, and all trades in the dividend capture sample. There were about 135,000 trades per day during the announcement period for the overall sample of 1296 dividend announcement events,

[5] There are only 378 firms from the S&P 500 included in our sample because some of the S&P 500 firms are not listed on the NYSE, and because some of these firms do not pay dividends.

[6] We choose the period immediately before the dividend announcement because we anticipate that large information asymmetries during this period may be resolved by the dividend announcement. Kim and Verrecchia (1994) present an alternate model in which earnings announcements increase rather than decrease information asymmetries, because market participants interpret the information differently. We also examine an announcement period consisting of days -2 through $+2$ relative to announcement day 0, with essentially identical results.

[7] We also define block trades in terms of the dollar size of the trade and as a percentage of shares outstanding. Results are essentially identical to those reported herein.

Table 1
Descriptive statistics

Statistic	Day −2	Day −1	Day 0	Day 1	Day 2
Panel A: *Announcement periods*					
All trades					
Number	131,435	133,078	142,279		
$ value	11,389,295	11,437,319	13,299,525		
Avg. # shares/trade	2.1	2.1	2.3		
Avg. $ value/trade	86.7	85.9	93.5		
Block purchases					
Number	188	170	232		
$ value	618,830	527,055	712,002		
Avg. # shares/trade	80.2	83.9	87.3		
Avg. $ value/trade	3291.6	3100.3	3069.0		
Block sales					
Number	201	203	251		
$ value	783,014	670,886	792,192		
Avg. # shares/trade	101.4	88.0	96.5		
Avg. $ value/trade	3895.6	3304.9	3156.1		
Panel B: *Regular periods*					
All trades					
Number	122,806	126,838	127,280	127,010	124,456
$ value	10,660,773	11,184,899	11,681,405	11,619,691	11,192,303
Avg. # shares/trade	2.1	2.1	2.1	2.1	2.1
Avg. $ value/trade	86.8	88.2	91.8	91.5	89.9
Block purchases					
Number	179	204	203	171	197
$ value	548,862	613,037	655,579	522,049	659,048
Avg. # shares/trade	83.8	78.7	83.6	85.6	93.5
Avg. $ value/trade	3066.3	3005.1	3229.5	3052.9	3345.4
Block sales					
Number	196	177	180	175	194
$ value	639,408	580,500	571,831	574,744	686,136
Avg. # shares/trade	92.7	86.5	86.6	89.7	104.5
Avg. $ value/trade	3262.3	3279.7	3176.8	3284.3	3536.8
Panel C: *Ex dividend periods*					
All trades					
Number	132,375	129,695	124,620	126,881	130,660
$ value	12,029,44	37,574,089	13,219,815	11,018,615	11,401,333
Avg. # shares/trade	2.2	9.0	2.6	2.1	2.1
Avg. $ value/trade	90.9	289.7	106.1	86.8	87.3
Block purchases					
Number	212	472	123	174	179
$ value	798,115	16,377,731	840,960	518,116	492,108
Avg. # shares/trade	120.4	1,158.1	171.0	86.0	78.6
Avg. $ value/trade	3764.7	34,698.6	6837.1	2977.7	2749.2
Block sales					
Number	205	191	121	179	216
$ value	632,931	2,341,087	548,438	618,782	677,618
Avg. # shares/trade	90.2	338.3	146.7	91.1	92.7
Avg. $ value/trade	3087.5	12,257.0	4532.5	3456.9	3137.1
Panel D: *Dividend capture trades*					
Number of trades		859			
$ value of trades		40,273,794			
Avg. # shares/trade		1636.6			
Avg. $ value/trade		46,884.5			

Descriptive statistics regarding all trades and block purchases and sales (defined as purchases and sales of at least 50,000 shares) during the announcement period (Panel A), regular period (Panel B), and ex-dividend period (Panel C). Panel D summarizes all trades in the dividend capture sample. Results are reported by day relative to the event day for each sample. All share volume and dollar value figures are in thousands.

implying an average of about 100 trades per day for each announcement event. There were only about 125,000 trades per day for the ex-dividend events and the benchmark periods.

Since some of our analyses focus specifically on block trades, Table 1 also summarizes statistics for block purchases and sales. On average, there are 175–200 block purchases and sales per day during announcement and regular periods. There are significantly more block purchases on day −1 relative to the ex-dividend day. Some of these blocks represent trades that are also included in the dividend capture sample.[8] The average size of a block purchase on day −1 relative to the ex-dividend day is extremely large, almost $35 million per block versus typical blocks of $3.0–$3.5 million during announcement and regular periods. The average trade in the dividend capture sample is almost $50,000,000.

To examine the distribution of trading activity across firms, we calculate for each firm the average number of trades for a given day (such as for all the dividend announcement days for that firm). Table 2 reports the minimum, median, and maximum daily average number of trades and blocks across firms. Results in this table show that trading activity is not overly concentrated in any single firm. For example, of the 142,279 trades on the dividend announcement day, the maximum average across announcement days for any one firm is 948 trades (0.67% of the total). A typical firm experiences 78 trades on a dividend announcement day and 75 trades on a regular day. It is interesting to note that block trades are not a common event, even in a sample of large stocks like ours. In fact, of all the blocks during the 3-day announcement period window, there are typically between one and four (with a maximum of 14) blocks traded for any single firm on a particular day.

We also examine (in tables not reported) the distribution of trading activity by firm characteristics such as firm size and average trading volume. We find, not surprisingly, that more trades and more block trades occur for larger firms and for more actively traded firms. However, the distribution of total trades across firms is quite similar to the distribution of block trades across firms. Average trade size does not vary significantly with firm size. It does not appear that trading activity is concentrated in one particular type of firm (e.g., all small trades in small firms and large trades in large firms) in such a way as to bias our results. As additional evidence, we conduct and report multivariate tests to control for the impact of firm-specific characteristics on our results (see Section 2 below).

In most of the tables and figures in this article, results are reported in transaction event time. To provide some indication of the relative clock time

[8] The ex-dividend sample of block trades includes only standard settlement trades of at least 50,000 shares. The dividend capture sample includes standard and nonstandard settlement trades of all sizes that are specifically attributable to a certain dividend capture trading strategy. Therefore trades in the dividend capture sample are not a perfect subset of trades in the ex-dividend sample. We repeat our experiments, defining the ex-dividend period to include trades on day 0, the ex-dividend day, only (and therefore to exclude the dividend capture trades on day −1) with essentially identical results.

Table 2
Distribution of trading activity across Firms

Statistic	Day −2	Day −1	Day 0	Day 1	Day 2
Panel A: *Announcement periods*					
Number of trades					
Minimum	4	4	6		
Median	73	77	78		
Maximum	790	769	948		
Number of blocks					
Minimum	1	1	1		
Median	1	1	1		
Maximum	6	5	14		
Panel B: *Regular periods*					
Number of trades					
Minimum	5	5	4	5	7
Median	72	75	75	76	70
Maximum	571	644	648	679	631
Number of blocks					
Minimum	1	1	1	1	1
Median	1	1	1	1	1
Maximum	5	6	5	6	7
Panel C: *Ex dividend periods*					
Number of trades					
Minimum	6	4	5	3	5
Median	73	73	71	73	74
Maximum	657	616	650	581	516
Number of blocks					
Minimum	1	1	1	1	1
Median	1	2	1	1	1
Maximum	12	9	5	6	7

Distribution of number of trades per firm per day. Results are reported for total trades and for block trades (defined as trades of at least 50,000 shares). Results are reported by day for the announcement period (panel A), regular period (panel B), and ex-dividend period (panel C).

for these events, trades occur on average about 4 minutes apart, and quotes are updated approximately every 5–6 minutes for companies in this sample. When large block trades occur during announcement periods, they occur on average about 5 minutes after the prior trade and more than 7 minutes after the last posted quote. Quotes are revised within 1 minute after large block trades during announcement periods.

To facilitate the analysis of the impact of trades of different sizes, we also collect data on all trades of 500 shares (defined as small trades) and 5000 shares (defined as medium-size trades) during the announcement period, the ex day period and in the regular period. Smaller trades occur much more frequently than larger trades. For example, there are more than 12,000 small (500 share) purchases during announcement periods, compared to 4795 medium purchases of 5000 shares, and 590 large block purchases.

1.2 Classification of buy and sell transactions

Lee and Ready (1991) analyze the reliability of a tick test (comparing the execution price to the price of the previous trade) for classifying purchases and sales, and present an alternative classification system. We adopt a simplified version of this alternative to identify purchases and sales. Specifically, all trades that occur above the prevailing bid-ask midpoint are classified as purchases, and all trades that occur below the midpoint are classified as sales.[9] This system is also used by Hasbrouck (1991), Huang and Stoll (1994), and others.

1.3 Excess return and excess spread calculations

Following Holthausen, Leftwich, and Mayers (1990), we construct a benchmark return series for each firm from the returns for trades −20 through −11 relative to all trades of a given size in a particular sample. Mean excess returns are computed across purchases or sales of given size z for a single firm, then across firms (for the sample of 378 firms).[10] We use the methodology in Equation (1) to compute mean excess returns for large (z = 50,000+ shares), medium (z = 5000 shares), and small (z = 500 shares) purchases and sales as follows:

$$\overline{RX}_t(z) = \frac{\sum_{i=1}^{378} \sum_{j=1}^{N_{i,pur}(z)} [R_{i,j,t}(z) - BEN_i(z)]}{\sum_{i=1}^{378} N_{i,pur}(z)} \qquad t = -5, \ldots, +5, \quad (1)$$

where

$$BEN_i(z) = \frac{\sum_{j=1}^{N_{i,pur}(z)+N_{i,sal}(z)} \sum_{t=-20}^{-11} R_{i,j,t}(z)}{N_i(z)} \qquad i = 1, \ldots, 378,$$

and

$R_{i,j,t}(z) \equiv$ return for trade t relative to trade of interest j for firm i,

$N_{i,pur}(z) \equiv$ number of purchases of size z for firm i,

$N_{i,sal}(z) \equiv$ number of sales of size z for firm i,

$N_i(z) \equiv$ total number of transactions for firm i in the benchmark periods for all trades of size z.

Returns are computed using both transaction prices and quoted prices. We compute different benchmarks for transaction versus quoted prices for each trade size and during each trading period. For example, to compute mean excess returns relative to large block purchases during announcement periods,

[9] We exclude trades that occur at the midpoint. The alternative is to classify midpoint trades using the tick method. However Odders-White (1998) finds that the tick method does not work well for midpoint trades. In fact, she reports that over 37% of the midpoint trades are misclassified, and concludes that in many cases it is preferred to simply eliminate the midpoint trades as we have done. See also Lee and Radhakrishna (1996).

[10] Our methodology conditions on observing purchases or sales of a given size. To the extent that purchases are more likely to occur when purchases are anticipated by the market, our results may be downward-biased measurements of the unconditional price impact.

we first compute benchmark returns for each firm using trades −20 through −11 relative to all block trades during the announcement periods for that firm. Excess returns relative to the firm-specific benchmark are averaged across all block purchases for a single firm and then across firms.

Reported quote results for purchases represent ask quote excess returns, and results for sales are based on bid quotes (although results for both ask and bid quote series for purchases and sales are discussed in the text). The excess return for quote 0 relative to the trade of interest is defined as the excess return from the prevailing quote to the trade of interest. The excess return for quote +1 is defined as the excess return from the trade of interest to the first quote after the trade of interest. We report returns based on both transaction prices and quoted prices defined in this manner to illustrate the location of the trade of interest relative to the outstanding quotes. To measure the information impact on quoted prices directly, we also report (in Figures) revisions in quoted prices only. Following the convention of Hasbrouck (1991), Lee and Ready (1991), Lin, Sanger, and Booth (1995), and others, quoted prices are delayed 5 seconds relative to transactions to adjust for reporting differences in the sequencing of trades and quotes. Reported t-statistics are computed as the one sample t-statistic testing the null hypothesis that the mean excess return is zero, given the mean and standard deviation of the set of excess returns for purchases or sales of each sample.

To measure liquidity, we compute mean spreads relative to a purchase of interest as

$$\overline{S}_t(z) = \frac{\sum_{i=1}^{378} \sum_{j=1}^{N_{i,\,pur}(z)} S_{i,\,j,\,t}(z)}{\sum_{i=1}^{378} N_{i,\,pur}(z)} \quad t = -5, \ldots, +5, \tag{2}$$

where $S_{i,\,j,\,t}(z) \equiv$ percentage spread (ask minus bid, scaled by the average of the ask and bid) for firm i at trade t relative to the trade of interest j of size z. Using a methodology similar to that for excess returns, above, we also construct a benchmark spread series for each firm and during each period using the percentage bid-ask spread for quotes −20 through −11 relative to all trades of size z during the sample period. Mean excess spreads relative to purchases of size z during a particular period are computed as

$$\overline{RS}_t(z) = \frac{\sum_{i=1}^{378} \sum_{j=1}^{N_{i,\,pur}(z)} [S_{i,\,j,\,t}(z) - BENSPR_i(z)]}{\sum_{i=1}^{378} N_{i,\,pur}(z)} \qquad t = -5, \ldots, +5, \tag{3}$$

where

$$BENSPR_i(z) = \frac{\sum_{j=1}^{N_{i,\,pur}(z)+N_{i,\,sal}(z)} \sum_{t=-20}^{-11} S_{i,\,j,\,t}(z)}{N_i(z)} \qquad i = 1, \ldots, 378.$$

As a second measure of liquidity, we compute mean depths relative to purchases of size z as

$$\overline{D}_t(z) = \frac{\sum_{i=1}^{378} \sum_{j=1}^{N_{i,\,pur}(z)} D_{i,\,j,\,t}(z)}{\sum_{i=1}^{378} N_{i,\,pur}(z)} \quad t = -5, \ldots, +5, \tag{4}$$

where $D_{i,\,j,\,t}(z) \equiv$ depth (defined as the ask depth relative to purchases, and bid depth relative to sales, in hundreds of shares) for firm i at trade t relative to the trade of interest j of size z. We construct a benchmark depth series for each firm using the depth for quotes -20 through -11 relative to all trades of size z during the sample period. Mean excess depths relative to purchases are computed as

$$\overline{RD}_t(z) = \frac{\sum_{i=1}^{378} \sum_{j=1}^{N_{i,\,pur}(z)} [D_{i,\,j,\,t}(z) - BENDEP_i(z)]}{\sum_{i=1}^{378} N_{i,\,pur}(z)} \quad t = -5, \ldots, +5, \tag{5}$$

where

$$BENDEP_i(z) = \frac{\sum_{j=1}^{N_{i,\,pur}(z)+N_{i,\,sal}(z)} \sum_{t=-20}^{-11} D_{i,\,j,\,t}(z)}{N_i(z)} \quad i = 1, \ldots, 378.$$

We use this methodology to compute benchmark and excess spread and depth statistics relative to small, medium, and large purchases and sales.

2. Information and Price Effects

2.1 Transaction price effects

We are interested in the price effects of information as measured through changes in transaction prices and quoted prices. We present results using transaction prices first as a benchmark only, to allow comparison with prior research. Cumulative excess returns by trade relative to the trades of different sizes are illustrated in Figure 1 for purchases and Figure 2 for sales. (All results concerning the dividend capture sample are presented in Section 4, below.)

The cumulative excess return (from trade -5 through trade 5 relative to the particular trade of interest) monotonically increases with the size of the purchase and monotonically decreases with the size of the sale. The revision is not linear in trade size; price revisions are substantially greater after large trades than medium or small trades, consistent with results documented previously by Madhavan and Smidt (1991). The top panel of Figure 1 also indicates that the transaction price reaction for large block purchases varies by period. Price effects are greatest during announcement periods and less strong during regular periods. The price impact of block purchases is weakest during ex-dividend periods, despite the fact that these block purchases are

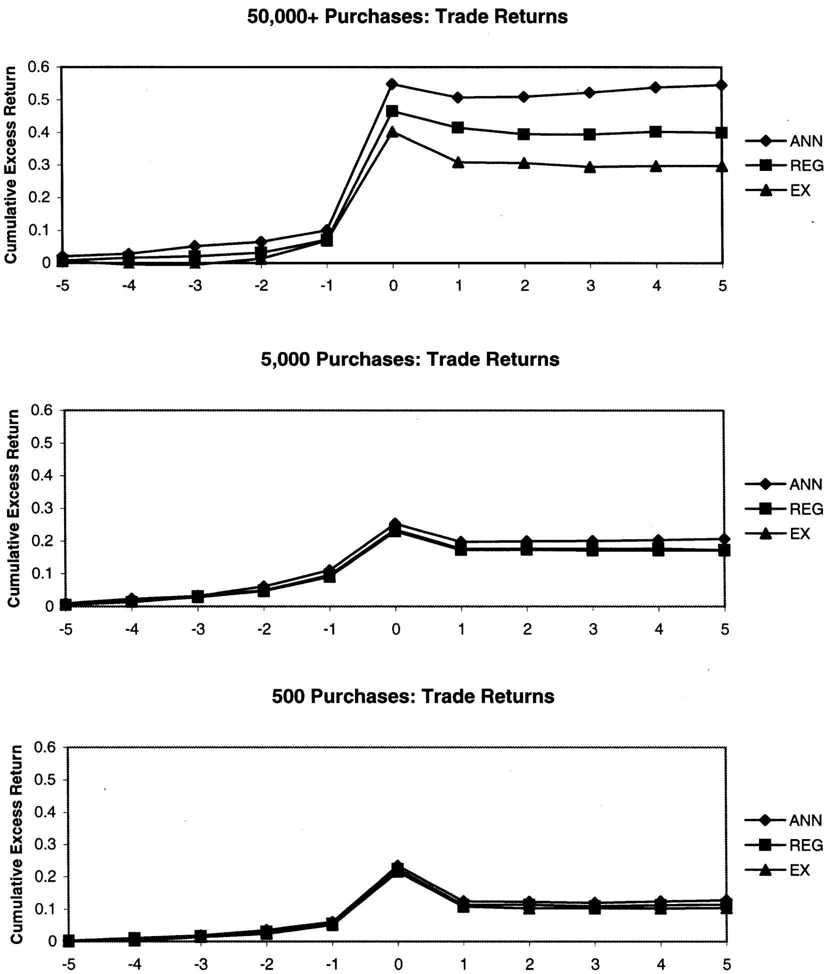

Figure 1
Cumulative excess trade returns relative to purchases
Cumulative excess returns based on transaction prices by trade relative to the purchase of interest (trade 0) for purchases of 50,000+, 5000, and 500 shares. ANN, REG, and EX denote the announcement, regular, and ex-dividend periods, respectively.

significantly larger than block purchases during other periods (see Table 1). These results are consistent with the predictions of Seppi (1992), Krinsky and Lee (1996), and others that asymmetry of information between informed and uninformed traders peaks around information releases such as earnings and dividend announcements. In other words, these results give an indication that large trades are perceived as informed, especially around information events.

There is no corresponding variation across periods for large block sales, suggesting that price effects for sales are less dependent on variations in the

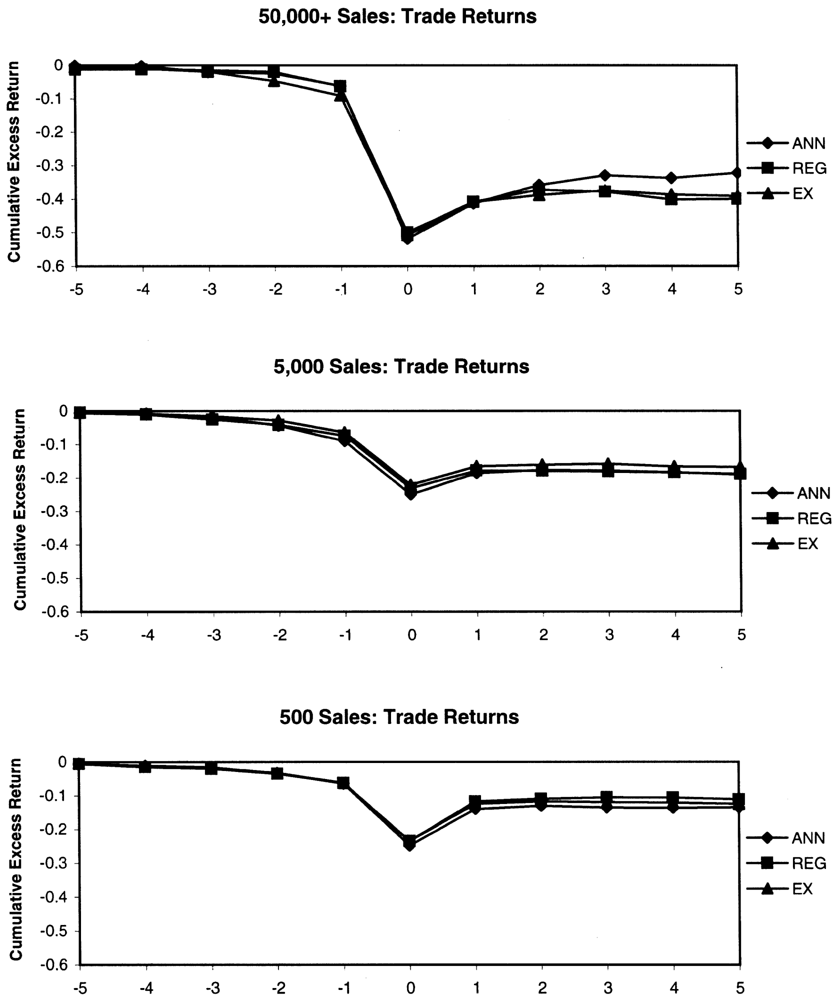

Figure 2
Cumulative excess trade returns relative to sales
Cumulative excess returns based on transaction prices by trade relative to the sale of interest (trade 0) for sales of 50,000+, 5000, and 500 shares. ANN, REG, and EX denote the announcement, regular, and ex-dividend periods, respectively.

information asymmetry of the period. Madhavan and Smidt (1991), Chan and Lakonishok (1993), and Keim and Madhavan (1996) find that block purchases have a greater permanent price impact than block sales. They hypothesize that block sales are less likely to contain information because they are more likely to be liquidity motivated, are less costly to arrange, and do not require identification of existing shareholders with whom to trade.

Differences between purchases and sales may also reflect the asymmetry in the reporting mechanism. Reporting conventions require that sellers report trades, so buys may be split up in reporting when they are satisfied by two or more sellers, but sells would be reported as a single trade if they are satisfied by two or more buyers. Therefore, for a given (reported) size, a purchase may indicate more underlying purchase interest than a sale of comparable size. To examine the possibility that reporting conventions may split up trades, we implement additional tests as suggested by Easley et al. (1996, p. 1416). Specifically, all trades that occur within 5 seconds of each other at the same price without intervening quote revisions are collapsed into one trade. This convention increases the number of observations included in our samples of large block purchases and sales by less than 5% and inferences are essentially identical to those based on results reported in the tables. Splitting up purchases for reporting purposes does not seem to be the primary explanation for the difference between the price effects of block purchases and sales that we document.

It is important to note, however, that although price effects for sales do not vary by period, Figure 2 indicates that they are large in magnitude. Either the determinants of price changes for sales are not information based but important in magnitude, or they are information based but do not vary with the informational environment of the trade.

There is also no corresponding variation of price effects across periods for either purchases or sales of medium and small trades. To the extent that there are any information-related price effects for trades in these size ranges, they do not vary by period.

A closer examination of results in Figure 1 shows (1) a price increase before purchases of all sizes, (2) a positive immediate (trade 0) price effect in response to purchases of all sizes, and (3) a subsequent partial reversal after trades of all sizes and during all periods, evidence of a significant temporary price effect. Analogous results hold around sales in Figure 2. Regarding the first point, Holthausen, Leftwich, and Mayers (1990) find significantly negative excess returns for trade -1 relative to block purchases, evidence of bid-ask bounce given their tick classification. Using the Lee and Ready (1991) classification, we find excess returns that are positive for the trade prior to the block purchase. In other words, the negative excess return for trade -1 found in several prior studies is likely to be an artifact of the classification method. The positive excess return prior to the trade we document is consistent with the leakage of information if blocks are shopped [see Seppi (1992, p. 292)].

Regarding the second point, there is a positive initial price effect in response to purchases of all sizes and a negative effect in response to sales of all sizes during all periods. Regardless of the event period, block trades have a significantly larger initial price impact than smaller trades. For example, during the announcement period a t-test shows that the initial return of 0.447% for large purchases is highly significantly different from the initial return of 0.143% for medium purchases. Of interest, results comparing small to medium-size trades show greater initial price effects for the small trades; the trade 0 return is 0.173% for 500 share purchases during announcement periods versus 0.143% for 5000 share purchases. These results are inconsistent with the hypothesis that trade size is correlated with information for the smaller trade sizes. However, as we show below, these results are a consequence of a measurement bias using transaction rather than quoted prices.

Finally, after the initial reaction there is a significant price reversal, consistent with a temporary price effect. The reversal equals −0.041%, −0.056%, and −0.109% after large, medium, and small purchases, respectively, during announcement periods. The reversal for the block trades is somewhat smaller than what has been reported by Holthausen, Leftwich, and Mayers (1990), who find a reversal of −0.19% after an initial return of 1.18%. More importantly, it should be noted that the reversal is often smaller for large trades than small trades. As the quotes analysis below indicates, the temporary effects for small and medium-size trades (as well as the larger initial response of small trades relative to medium-size trades) are artifacts of measurement effects attributable to bid-ask bounce.

2.2 Information and changes in the levels of bid and ask quoted prices

This section analyzes price effects as measured by changes in the bid and ask quoted prices. Table 3 reports mean excess returns as defined in Equation (1), computed using quoted prices during announcement periods (panel A), regular periods (panel B), and ex-dividend periods (panel C).[11] Figures 3 and 4 illustrate cumulative excess returns computed using ask quotes around purchases and bid quotes around sales, respectively.[12] Consistent with results reported above for trades, the cumulative excess return monotonically increases with the size of the purchase and monotonically decreases with the size of the sale. Again, this relation is not linear in trade size. Also, as documented above, cumulative price effects measured using quoted prices differ significantly as a function of the information asymmetry of the period for large block purchases only. However, examination of the behavior of transaction prices relative to bid and ask quoted prices provides much more evidence about the actual behavior of prices around block trades, and clarifies some inferences about the impact of asymmetric information.

Consider, first, the behavior of quotes before block trades. Ask quotes begin to increase prior to the arrival of a block purchase and bid quotes

[11] We also compute median excess returns (not reported). Inferences based on medians, and a corresponding nonparametric Wilcoxon signed-rank test of the null hypothesis that the median excess return equals zero support results and inferences based on means, so we will focus most of our discussion on mean results.

[12] It is possible that revisions in the ask quote after purchases reflect the fact that a large purchase order can clean out outstanding limit sell orders at the ask quote. In this case, even absent any information effects, we may observe positive ask quote returns. To control for this possibility, we also compute revisions in bid quotes after purchases and ask quotes after sales. Results are essentially identical to those reported herein. We thank Lawrence Glosten, the editor, for this suggestion.

Table 3

Quote excess returns by size of trade and trading period

	Quote relative to trade of interest (trade 0)									
	Purchases					Sales				
Size of trade	−2	−1	0	1	2	−2	−1	0	1	2
Panel A: *Announcement periods*										
500 shares										
Mean (%)	−0.006	−0.027	−0.035	0.139	0.023	0.003	0.021	0.032	−0.152	−0.028
t: Mean = 0	−2.56	−12.55	−32.53	62.63	9.93	1.05	8.96	26.79	−62.23	−10.80
5000 shares										
Mean (%)	−0.002	−0.022	−0.021	0.223	0.006	−0.004	0.029	0.014	−0.231	−0.005
t: Mean = 0	−0.60	−6.21	−12.83	61.81	1.73	−0.83	6.69	5.59	−47.34	−1.03
50,000+ shares										
Mean (%)	0.004	0.047	0.145	0.341	−0.028	−0.003	−0.076	−0.098	−0.320	0.086
t: Mean = 0	0.29	4.02	5.55	29.50	−1.76	−0.31	−6.76	−5.18	−19.71	8.00
Panel B: *Regular periods*										
500 shares										
Mean (%)	−0.007	−0.023	−0.036	0.137	0.026	0.004	0.028	0.033	−0.138	−0.023
t: Mean = 0	−3.42	−13.02	−42.73	75.88	13.63	2.26	14.98	36.42	−71.64	−11.27
5000 shares										
Mean (%)	0.001	−0.023	−0.018	0.212	0.000	0.004	0.032	0.014	−0.224	−0.006
t: Mean = 0	0.46	−8.89	−15.07	73.65	0.09	1.13	10.57	9.13	−68.97	−1.85

Table 3 *continued*

	Quote relative to trade of interest (trade 0)									
	Purchases					Sales				
Size of trade	−2	−1	0	1	2	−2	−1	0	1	2
50,000+ shares										
Mean (%)	0.007	0.040	0.093	0.323	−0.037	−0.009	−0.072	−0.102	−0.317	0.047
t: Mean = 0	0.93	4.91	7.39	37.88	−4.06	−1.05	−7.40	−6.55	−29.52	5.36
Panel C: *Ex dividend periods*										
500 shares										
Mean (%)	−0.004	−0.026	−0.034	0.135	0.025	0.007	0.028	0.033	−0.137	−0.024
t: Mean = 0	−1.95	−14.78	−39.32	74.13	13.47	3.39	14.53	34.53	−68.90	−11.79
5000 shares										
Mean (%)	0.001	−0.021	−0.018	0.218	0.004	0.011	0.033	0.017	−0.226	−0.001
t: Mean = 0	0.35	−8.13	−12.15	73.98	1.41	3.31	9.84	11.45	−64.31	−0.26
50,000+ shares										
Mean (%)	−0.010	0.026	0.087	0.273	−0.016	−0.008	−0.069	−0.082	−0.305	0.033
t: Mean = 0	−1.40	3.48	6.33	29.57	−2.06	−1.05	−6.40	−6.16	−30.04	3.65

Excess returns by quote relative to trades of 500 shares, 5000 shares, and at least 50,000 shares. Quote-to-quote returns are computed from ask quote to ask quote for purchases, and from bid quote to bid quote for sales. The excess return for quote 0 relative to the block trade is defined as the excess return from the prevailing quote to the block trade. The excess return for quote +1 is defined as the excess return from the block trade to the first quote after the block trade. *Mean (%)* is the mean excess return in percent. t: $Mean = 0$ is the t-statistic for the test of the null hypothesis that the mean excess return equals zero. Results are reported for the announcement period (panel A), regular period (panel B), and ex-dividend period (panel C).

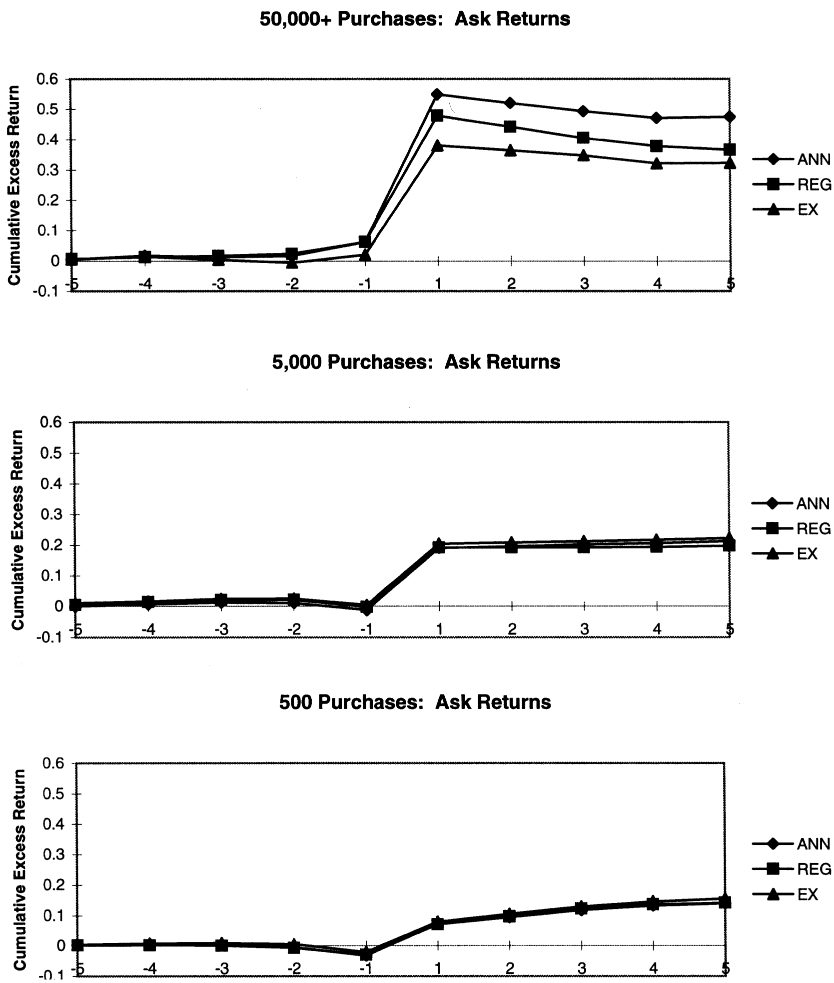

Figure 3
Cumulative excess quote returns relative to purchases
Cumulative excess returns based on quotation prices by quote relative to the purchase of interest (trade 0) for purchases of 50,000+, 5000, and 500 shares. ANN, REG, and EX denote the announcement, regular, and ex-dividend periods, respectively.

begin to decrease prior to the arrival of a block sale, evidence consistent with the leakage of information as the block is shopped, or with reporting delays for larger and potentially more complicated transactions. Prior to small and medium-size trades, however, quotes behave quite differently. For two to three quotes before small and medium purchases, the ask quotes decrease significantly during all information periods. Bid quotes (not reported) also increase before these trades, so bid-ask spreads are significantly narrower right before small and medium purchases. Similar results hold before small

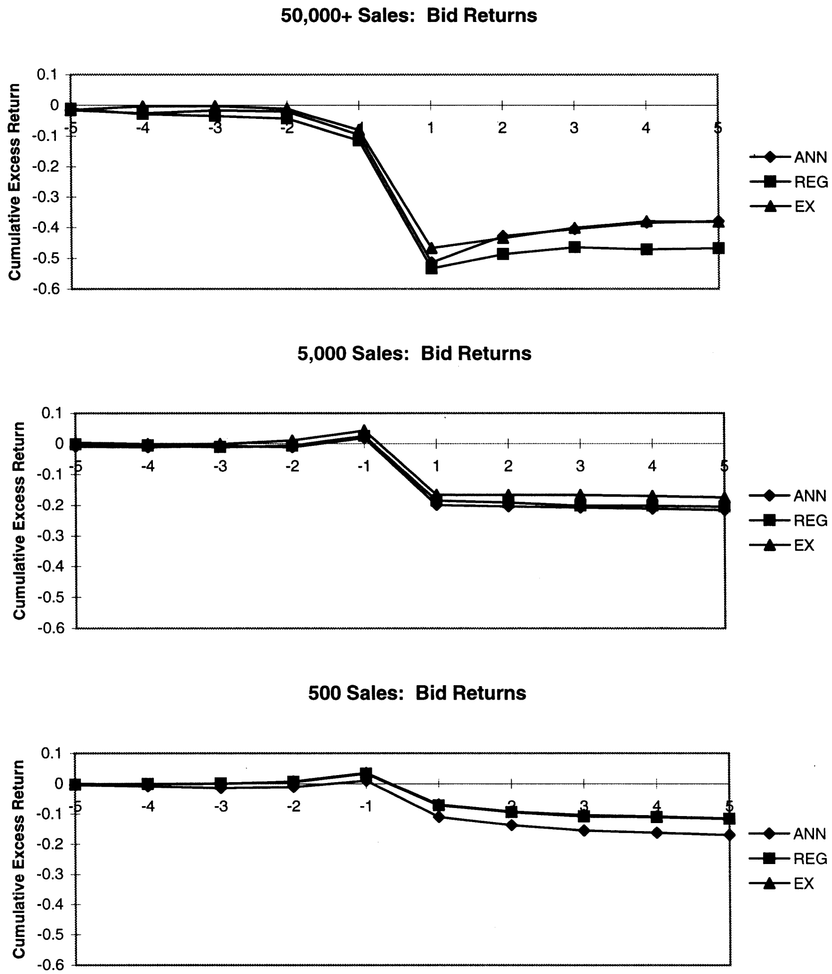

Figure 4
Cumulative excess quote returns relative to sales
Cumulative excess returns based on quotation prices by quote relative to the sale of interest (trade 0) for sales of 50,000+, 5000, and 500 shares. ANN, REG, and EX denote the announcement, regular, and ex-dividend periods, respectively.

and medium sales. Small and medium trades tend to take place when prices are more favorable and spreads are smaller, suggesting that the demand to trade (at least for these trade sizes) is price elastic. This result would not be evident in a parametric analysis of transaction returns or even returns based on quote midpoints. We revisit this issue in our discussion of liquidity in Section 3.

Unlike transaction prices, initial revisions in the quotes are monotone in trade size, as predicted if trade size is correlated with information. For example, quote +1 returns during announcement periods are 0.139%, 0.223%, and 0.341% after small, medium, and block purchases, respectively (see Table 3, panel A). Differences by trade size are consistent and highly statistically significant after purchases and sales during all periods. One potential explanation for the difference between trade and quote results is that price effects measured using transaction prices are obscured by noise associated with bid-ask bounce. Quote revisions are not subject to this noise and therefore illustrate price effects more cleanly.

Transaction prices demonstrate a significant temporary price effect. After small purchases during announcement periods, the immediate, trade 0 effect of 0.173% is followed by an excess return of −0.109% on the subsequent trade. The initial price effect is almost completely reversed. Surprisingly this temporary effect is negatively related to trade size. A large temporary effect could be attributed to bid-ask bounce, or to other transitory factors such as inventory or a temporary information effect [see Easley and O'Hara (1987)]. If the temporary effect is purely bid-ask bounce, it will not be evident in quote returns; other things equal, movements of the average trade within the spread will not change the levels of the quotes. If the temporary effect is due to other factors such as inventory or temporary information effects, it should cause a temporary revision in bid or ask prices and/or depths also. Ask quote returns in Table 3, panel A, for small purchases show that the quote +1 return is 0.139%. There is no subsequent negative quote return, so the change in quotes, although small in magnitude, is permanent. Similar results hold after small and medium purchases and sales during all periods. Collectively these results suggest that the temporary price effect that is present in transaction returns for smaller trades results from bid-ask bounce rather than other transitory effects.

To compare the relation between quoted prices and transaction prices more directly and to analyze changes in the bid and ask quotes individually, we plot the changes in the levels of the quoted prices and transaction prices for large block purchases and sales across different periods in Figures 5 and 6. We plot actual price levels rather than returns, normalized such that the prevailing bid-ask midpoint at the time of the block equals 1.0. These figures show that block trades occur outside the prevailing bid-ask spread for large block purchases and sales during all periods. In contrast, results in Table 3 indicate that small and medium trades occur on average inside the spread.[13]

Thus the use of quoted returns in addition to traded returns clarifies inferences in several ways. First, while the use of traded prices indicates that the initial price revision in response to trades is not monotone in trade size, the analysis of quoted prices indicates that the price revision is monotone

[13] The negative quote 0 returns indicate that small and medium purchases occur on average below the last quoted ask price. The subsequent ask price is revised upward (positive quote +1 returns), but the order of magnitude of this adjustment is much smaller than the revision after a block purchase. A similar picture emerges for small and medium sales.

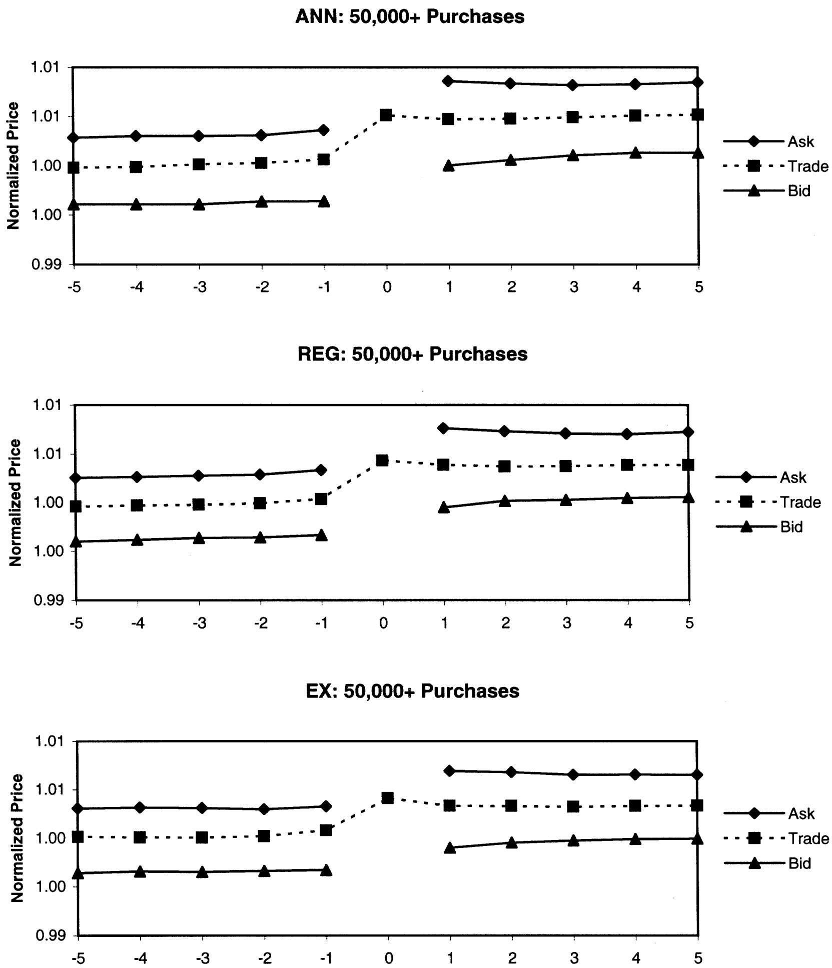

Figure 5
Ask, bid, and trade prices relative to large block purchases
Average ask, bid, and trade prices, normalized by the midpoint of the prevailing bid and ask quotes at the time of the trade of interest (trade 0), for large block purchases of at least 50,000 shares. ANN, REG, and EX denote the announcement, regular, and ex-dividend periods, respectively.

in trade size. The difference can be explained by the effect that bid-ask bounce has on traded prices but not on quoted prices. Second, changes in quoted prices suggest that the temporary price effect that is present in transaction returns for smaller trades results from bid-ask bounce rather than other transitory effects. The temporary effect of large trades cannot be attributed solely to the bid-ask spread, because it is also present when quoted prices are analyzed. Collectively these results suggest that transaction price returns, in particular for small and medium trades, reflect movements of the average

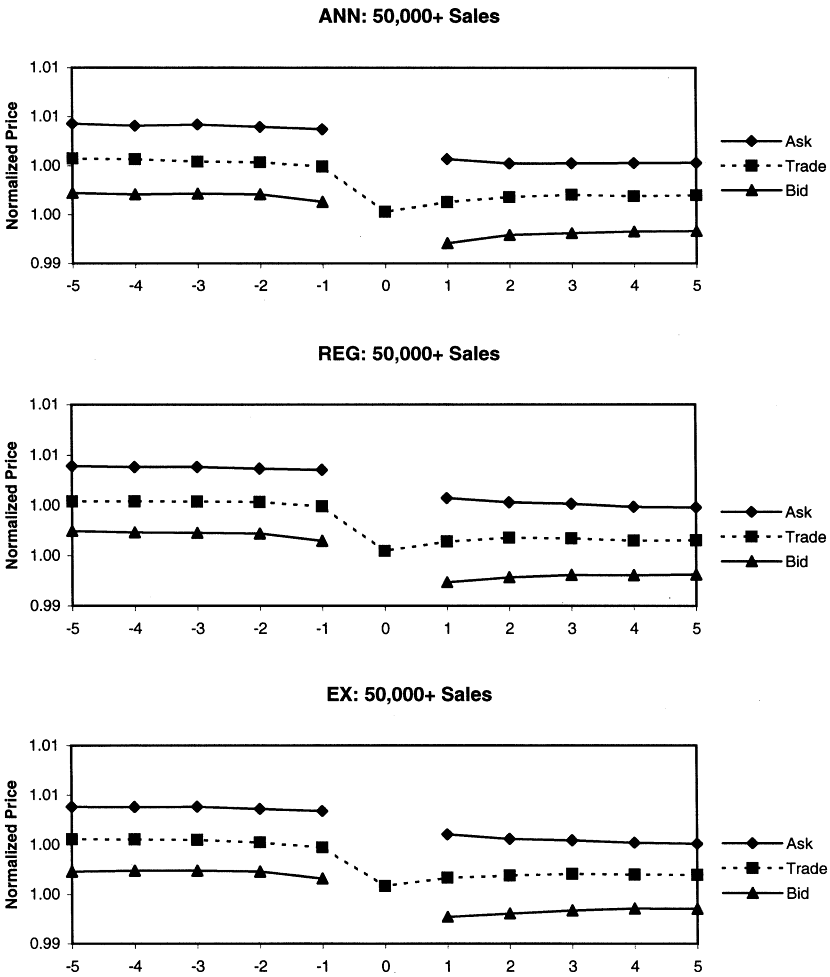

Figure 6
Ask, bid, and trade prices relative to large block sales
Average ask, bid, and trade prices, normalized by the midpoint of the prevailing bid and ask quotes at the time of the trade of interest (trade 0), for large block sales of at least 50,000 shares. ANN, REG, and EX denote the announcement, regular, and ex-dividend periods, respectively.

transaction within the spread rather than revisions in the levels of prices. Third, quoted prices behave quite differently before large trades than they do before smaller trades. Ask quotes increase prior to large purchases (suggesting the leakage of information or reporting delays), but decrease prior to smaller transactions (suggesting price elasticity). A comparison of quoted prices to transaction prices also indicates that larger transactions occur outside the quoted spread, while smaller transactions occur on average inside the spread.

To examine the robustness of our results to the research design, we conduct some additional tests. First, we measure excess returns for a longer time period after the block trades, in case temporary effects persist longer than five trades. Inferences based on excess returns for 25 quotes subsequent to the block trade look substantially similar to those discussed in the article.

Second, we examine cross-sectional variation in excess returns as a function of several firm and event characteristics. In particular, we estimate the following regression equation:

$$RX5_b = \alpha_b + \beta_{1b}\mathrm{EVENT}_b + \beta_{2b}\mathrm{SIZE}_i + \beta_{3b}\mathrm{MEANVOL}_i + \beta_{4b}\mathrm{RET2DAY}_j + \beta_{5b}\mathrm{NBLOCK}_j + \epsilon_b. \tag{6}$$

The dependent variable, $RX5_b$, is the cumulative excess return from quote -1 through quote $+5$ relative to block b. Independent variables include EVENT_b, an indicator variable equal to 1 if block b occurs during the announcement period, 2 if block b occurs during the regular period, and 3 if block b occurs during the ex-dividend period, to measure variation in excess returns as a function of the information asymmetry of the trading period. The work of Easley et al. (1996) also suggests that large trades in stocks with higher volume will have a lower impact on prices than comparable trades in low-volume stocks. Consequently we also include two firm-specific independent variables to measure variations in excess returns as a function of firm size and normal trading volume. These two variables are SIZE_i, the equity market value as of January 1, 1988 ($ billions) of firm i, and $\mathrm{MEANVOL}_i$, the average daily trading volume (1000s of shares) during the regular period for firm i. We anticipate that excess returns will be greater in absolute magnitude for smaller firms and for less actively traded firms if size and trading activity are related to the degree of information asymmetry associated with a particular firm. Finally, we include two event-specific independent variables: $\mathrm{RET2DAY}_j$, the excess return around event j, measured from closing quotes on day -1 to day $+1$ relative to the event day, and NBLOCK_j, equal to the number of block purchases or sales during event period j.[14] These variables measure the information content and trading activity for a particular event, for example, a dividend announcement event. It is interesting to note that the 2-day mean excess return for events associated with block purchases is 0.369%, significantly different from zero, and the 2-day mean excess return for events associated with block sales is -0.048%, insignificantly different from zero. This result indicates that block purchases are associated with

[14] The dependent variable (excess return in the five quotes around the block trade) is a subset of $\mathrm{RET2DAY}_j$ (excess return in the 2 days around the event). However, the 2-day excess return may be affected by many factors in addition to the price effects of a single block, and particularly by the actual information at the announcement. Therefore it is a good measure of the information content of the event itself. We also run the regression without this variable. Results for the other coefficients are essentially identical if we omit this independent variable.

"good news" events and sales (to a lesser extent) are associated with "bad news" events, consistent with Seppi (1992).

Results of this regression are reported in Table 4 for block purchases (panel A) and block sales (panel B). Parameter estimates for the variable EVENT are statistically significantly negative in the regression for block purchases, indicating that abnormal returns are greater during the announcement period and smaller during the ex-dividend period. This coefficient is not statistically significant for block sales. Thus the information environment of the trade has a significant impact on the market reaction to the block trade even after controlling for all of those firms' and events' characteristics for block purchases. There is no differential reaction to block sales with different information environments, consistent with the univariate analysis. For block purchases (panel A), excess returns are significantly negatively related to firm size and positively related to the 2-day abnormal return associated with the event. These results indicate that the price impact of block purchases is greater for smaller firms and for block trades that occur during event periods with higher information content measured as 2-day abnormal returns. In panel B, block sales are significantly positively related to firm size and the 2-day abnormal

Table 4

Regression analysis of cross-sectional variation in quote excess returns

Explanatory variable	Parameter estimate	t-statistic	p	Adjusted R^2
Panel A: *Purchases*				
				0.0157
INTERCEPT	0.005237	11.23	0.00	
EVENT	−0.000667	−3.63	0.00	
SIZE	−0.000050	−2.92	0.00	
MEANVOL	0.000000	0.29	0.77	
RET2DAY	0.017974	3.50	0.00	
NBLOCK	0.000090	1.42	0.16	
Panel B: *Sales*				
				0.0022
INTERCEPT	−0.002877	−7.26	0.00	
EVENT	−0.000163	−1.00	0.32	
SIZE	0.000036	2.08	0.04	
MEANVOL	−0.000001	−2.07	0.04	
RET2DAY	0.009234	1.99	0.05	
NBLOCK	0.000044	0.63	0.53	

Results of OLS regressions of excess returns around large block trades (at least 50,000 shares) on various firm and event characteristics. The regression equation estimated is

$$RX5_b = \alpha_b + \beta_{1b}\text{EVENT}_j + \beta_{2b}\text{SIZE}_i + \beta_{3b}\text{MEANVOL}_i + \beta_{4b}\text{RET2DAY}_j + \beta_{5b}\text{NBLOCK}_j + \epsilon_b.$$

The dependent variable $RX5_b$ is the cumulative excesss return from quote −1 through quote +5 relative to block b. Independent variables are (1) EVENT_j, a dummy variable equal to 1 if block b occurs during the announcement period, 2 if block b occurs during the regular period, and 3 if block b occurs during the ex-dividend period; (2) SIZE_i, equity market value as of January 1, 1988 ($ billions) of firm i; (3) MEANVOL_i, average daily trading volume (1000s) during the regular period for firm i; (4) RET2DAY_j, the excess return around event j, measured from closing quotes on day −1 to day +1 relative to the event day; and (5) NBLOCK_j, equal to the number of block purchases or sales during event period j. Results are reported for block purchases (panel A) and block sales (panel B). Quote-to-quote returns are computed from ask quote to ask quote for purchases, and from bid quote to bid quote for sales. t-statistics and p-values are for tests of the null hypothesis that parameter estimates equal zero.

return. The price impact of block sales is more negative for smaller firms. Since the average 2-day return for events associated with block sales is negative, the positive coefficient on this variable implies that the price impact of block sales is larger in magnitude in events associated with more "bad news." Contrary to predictions, results in panel B for MEANVOL show that excess returns are less negative for less actively traded firms. The coefficient on NBLOCK is not significant in either regression, indicating that excess returns are not related to the number of other block trades that occur around the event. Overall, results support the hypotheses that the price effects of trades are significantly related to information asymmetries as reflected in trade size and the timing of the trade relative to information events.

Can non-information-related liquidity or inventory effects be responsible for some of the findings documented in this section? For several reasons we argue that our results should be interpreted as information effects. Inventory models describe the behavior of market-maker's quoted prices when the market maker participates directly in trades and thus experiences changes in inventory. Many block trades are negotiated directly between buyers and sellers, for example, in the upstairs market [see Keim and Madhavan (1996) and Madhavan and Cheng (1997)]. If the market maker does not participate in a block trade [see Easley and O'Hara (1987), O'Hara and Oldfield (1986), and Madhavan and Smidt (1993)], the trade will not affect inventory, which precludes inventory-based explanations for any resulting price effects. Notice, however, that quoted prices reflect information effects, even if the market maker does not participate directly in the trade, because the market maker is aware that a potentially informed trader has acted. Hasbrouck and Sofianos (1993) find information effects regardless of whether the market maker participates, but inventory effects only when the market maker participates in trades. [Unfortunately, with the ISSM data, we cannot identify who takes the other side of the trade or whether the trade is executed in the upstairs market, but Keim and Madhavan (1996) and Madhavan and Cheng (1997), who use specialized databases for this purpose, report that a significant portion of the block trades are executed in the upstairs market where inventory considerations are not an issue.] Finally, Hasbrouck (1991) and Madhavan and Smidt (1991) show that while inventory considerations may have a price impact, they are much less likely to have an impact on the spread. Thus examining spreads in addition to prices—which we do in the next section—enables us to better identify the source of the price movement.

3. Impact of Asymmetric Information on Liquidity

Changes in asymmetric information should be associated with changes in prices and liquidity. This section analyzes changes in two measures of liquidity: the spread between the bid and ask quoted prices, and the associated market depth. [See Lee, Mucklow, and Ready (1993), Knez and Ready (1996), and Kavajecz (1999) for empirical studies incorporating depth as a measure of liquidity.] Liquidity should decrease as information asymmetries increase. Therefore spreads should be higher and depth lower during announcement periods than during regular or ex-dividend periods. Regarding block trades, if the arrival of a block trade signals to the market that there is a greater probability that private information exists [Easley and O'Hara (1987) and Hasbrouck (1991)], then the adverse selection problem increases and liquidity should decrease after a block trade. A priori, it can alternatively be argued that large transactions potentially resolve rather than increase the degree of information asymmetry and consequently lead to smaller spreads and greater depth after such trades. Our investigation of spread and depth behavior after large trades can help us to distinguish between these hypotheses.

Table 5 reports average percentage spreads [as defined in Equation (2)] and excess spreads [Equation (3)] as a function of trade size for purchases and sales during different periods. Table 6 reports average depth [defined in Equation (4)] and excess depth [Equation (5)] as a function of trade size around purchases and sales during different periods.[15] To compare both measures of liquidity directly, Figures 7 and 8 plot changes in percentage spreads and depth around purchases and sales, respectively, of different sizes during announcement periods.

Results show that excess bid-ask spreads immediately after a trade are strongly related to trade size (Table 5). For example, during the announcement period, the excess spread immediately after large block purchases is 0.160%. This value compares to excess spreads immediately after 5000 share purchases of 0.054% and immediately after 500 share purchases of −0.007%. These differences are highly statistically significant. Similar results hold for purchases and sales during all periods. Results in Table 5 also show that spreads narrow significantly prior to small and medium trades, confirming the results discussed above. Small and medium trades occur when bid-ask spreads are narrow, and therefore liquidity is high.

Regarding the timing of the trade relative to information events, results in Table 5 show that percentage spreads immediately after block purchases average 0.855% during announcement periods, 0.808% during regular periods, and 0.789% during ex-dividend periods. Percentage spreads are significantly wider during announcement periods than during regular periods ($p = .041$) and than during ex-dividend periods ($p = .003$). The relation of average percentage spread to the degree of information asymmetries of the period reflects two different factors: benchmark spreads and excess spreads. Benchmark spreads represent average spreads for trades −11 through −20 relative to all trades of the specified size for a given firm. Benchmark spreads (not reported

[15] In reported results, we define depth as the depth quoted at the ask quote around purchases and the depth quoted at the bid quote around sales. Inferences are similar if we define depth as the average of the depth quoted at the ask and bid, or as the bid quote depth after purchases and the ask quote depth after sales.

Table 5

Bid-ask spreads by size of trade and trading period

	Quote relative to trade of interest (trade 0)									
	Purchases					Sales				
Size of trade	−2	−1	1	2	3	−2	−1	1	2	3
Panel A: *Announcement periods*										
500 shares										
Mean % spread	0.636	0.598	0.645	0.653	0.657	0.633	0.595	0.645	0.650	0.654
Mean % excess spread	−0.016	−0.055	−0.007	0.001	0.005	−0.022	−0.059	−0.009	−0.004	−0.000
t: Excess spread = 0	−6.53	−23.01	−2.93	0.21	1.94	−7.98	−22.01	−3.26	−1.56	−0.14
5000 shares										
Mean % spread	0.580	0.540	0.655	0.634	0.615	0.583	0.541	0.664	0.633	0.614
Mean % excess spread	−0.021	−0.062	0.054	0.033	0.014	−0.018	−0.061	0.063	0.032	0.013
t: Excess spread = 0	−5.77	−17.62	13.85	8.50	3.64	−3.85	−12.99	12.93	6.87	2.79
50,000+ shares										
Mean % spread	0.674	0.722	0.855	0.775	0.709	0.687	0.744	0.866	0.735	0.716
Mean % excess spread	−0.022	0.027	0.160	0.080	0.013	0.002	0.058	0.180	0.050	0.031
t: Excess spread = 0	−1.72	2.03	13.63	6.41	1.14	0.15	4.50	14.68	4.14	2.70
Panel B: *Regular periods*										
500 shares										
Mean % spread	0.617	0.585	0.628	0.635	0.637	0.616	0.576	0.628	0.635	0.640
Mean % excess spread	−0.016	−0.048	−0.004	0.002	0.004	−0.025	−0.064	−0.013	−0.006	−0.001
t: Excess spread = 0	−8.12	−24.68	−1.99	1.06	1.97	−11.86	−31.60	−6.06	−2.94	−0.38
5000 shares										
Mean % spread	0.545	0.509	0.629	0.600	0.585	0.559	0.513	0.636	0.605	0.598
Mean % excess spread	−0.027	−0.063	0.057	0.027	0.013	−0.026	−0.072	0.051	0.020	0.013
t: Excess spread = 0	−9.61	−21.63	18.25	8.93	4.25	−8.01	−21.78	14.69	5.78	3.83

Table 5 *continued*

50,000+ shares										
Mean % spread	0.646	0.666	0.808	0.711	0.680	0.643	0.702	0.839	0.749	0.708
Mean % excess spread	−0.014	0.006	0.147	0.050	0.019	−0.020	0.039	0.176	0.086	0.046
t: Excess spread = 0	−1.73	0.63	15.84	5.69	2.27	−2.20	3.73	17.48	8.43	4.95
Panel C: *Ex dividend periods*										
500 shares										
Mean % spread	0.621	0.586	0.629	0.633	0.637	0.608	0.569	0.618	0.626	0.630
Mean % excess spread	−0.018	−0.053	−0.009	−0.005	−0.001	−0.027	−0.067	−0.018	−0.009	−0.006
t: Excess spread = 0	−8.81	−26.73	−4.61	−2.49	−0.71	−12.71	−31.64	−7.86	−4.25	−2.74
5000 shares										
Mean % spread	0.558	0.515	0.633	0.607	0.589	0.556	0.516	0.639	0.611	0.595
Mean % excess spread	−0.023	−0.066	0.052	0.026	0.008	−0.025	−0.064	0.058	0.031	0.014
t: Excess spread = 0	−7.83	−23.80	16.91	8.23	2.52	−7.29	−18.68	15.59	8.20	3.99
50,000+ shares										
Mean % spread	0.637	0.655	0.789	0.720	0.672	0.634	0.682	0.833	0.756	0.710
Mean % excess spread	−0.033	−0.015	0.120	0.050	0.002	−0.016	0.033	0.184	0.107	0.061
t: Excess spread = 0	−4.07	−1.84	14.28	5.58	0.28	−1.80	3.18	17.27	10.91	6.44

Summary statistics regarding bid-ask spreads for quotes relative to purchases of 500 shares, 5000 shares, and at least 50,000 shares. *Mean % spread* is the mean percentage bid-ask spread. Excess spreads are spreads in excess of a benchmark level, computed using spreads −20 through −11 relative to trades of a given size. For excess spreads, reported results include *Mean % Excess spread* and *t: Excess spread=0* (the t-statistic for the test of the null hypothesis that the mean excess spread equals zero). Results are reported for the announcement period (panel A), regular period (panel B), and ex-dividend period (panel C).

Table 6

Depth by size of trade and trading period

	Quote relative to trade of interest (trade 0)									
	Purchases					Sales				
Size of trade	−2	−1	1	2	3	−2	−1	1	2	3
Panel A: *Announcement periods*										
500 shares										
Mean depth	70.7	64.8	68.5	70.8	71.6	61.5	56.4	61.6	63.4	64.2
Mean excess depth	−0.8	−6.6	−2.9	−0.7	0.1	−1.2	−6.3	−1.1	0.6	1.5
t: Excess depth = 0	−0.92	−7.89	−3.35	−0.74	0.16	−1.47	−8.54	−1.41	0.76	1.80
5000 shares										
Mean depth	84.1	78.6	78.1	78.4	79.1	72.8	68.3	70.1	69.8	68.5
Mean excess depth	3.8	−1.6	−2.2	−1.9	−1.1	3.8	−0.8	1.0	0.7	−0.5
t: Excess depth = 0	2.75	−1.26	−1.55	−1.29	−0.78	2.94	−0.68	0.70	0.51	−0.39
50,000+ shares										
Mean depth	170.5	164.5	114.9	112.9	116.4	108.8	119.3	93.5	81.0	79.8
Mean excess depth	46.3	40.3	−9.2	−11.3	−7.8	13.4	23.9	−1.9	−14.4	−15.6
t: Excess depth = 0	5.62	4.92	−1.48	−1.83	−1.21	2.56	4.18	−0.40	−3.24	−3.63
Panel B: *Regular periods*										
500 shares										
Mean depth	65.6	60.9	65.0	67.0	69.3	67.1	62.0	66.0	68.4	70.0
Mean excess depth	−1.9	−6.6	−2.5	−0.5	1.7	−0.5	−5.6	−1.5	0.9	2.4
t: Excess depth = 0	−2.85	−10.28	−3.74	−0.67	2.43	−0.70	−7.90	−2.08	1.11	3.11
5000 shares										
Mean depth	79.3	74.2	73.7	72.6	73.4	78.9	71.6	73.0	73.1	72.5
Mean excess depth	2.0	−3.1	−3.5	−4.6	−3.9	5.6	−1.7	−0.3	−0.2	−0.8
t: Excess depth = 0	1.79	−2.97	−3.00	−4.06	−3.39	4.57	−1.58	−0.23	−0.19	−0.63

Table 6 *continued*

50,000+ shares										
Mean depth	156.7	165.1	107.6	104.8	111.8	123.1	124.3	92.3	87.6	87.7
Mean excess depth	38.4	46.7	−10.7	−13.6	−6.5	22.8	24.0	−7.9	−12.7	−12.6
t: Excess depth = 0	6.14	6.93	−2.21	−2.92	−1.34	4.32	4.53	−1.75	−3.08	−3.30
Panel C: *Ex dividend periods*										
500 shares										
Mean depth	75.1	68.7	73.8	75.5	75.6	66.6	61.2	65.8	68.0	69.1
Mean excess depth	0.1	−6.2	−1.2	0.6	0.6	−1.5	−6.9	−2.3	−0.1	1.0
t: Excess depth = 0	0.11	−8.10	−1.46	0.71	0.78	−2.20	−10.30	−3.24	−0.12	1.35
5000 shares										
Mean depth	84.7	77.0	76.8	78.6	78.9	75.8	68.3	71.2	71.9	72.6
Mean excess depth	2.2	−5.5	−5.7	−3.9	−3.7	1.7	−5.8	−2.9	−2.2	−1.5
t: Excess depth = 0	1.79	−5.16	−4.73	−3.15	−2.89	1.47	−5.61	−2.50	−1.86	−1.18
50,000+ shares										
Mean depth	172.3	182.3	134.9	139.8	135.5	138.0	142.0	99.5	98.7	98.9
Mean excess depth	40.3	50.3	2.9	7.8	3.5	24.4	28.4	−14.2	−15.0	−14.7
t: Excess depth = 0	6.74	8.07	0.57	1.54	0.69	4.47	5.01	−2.98	−3.43	−3.33

Summary statistics regarding depth for quotes relative to purchases of 500 shares, 5000 shares, and at least 50,000 shares. Depth is defined as the ask quote depth relative to purchases and bid quote depth relative to sales. *Mean depth* is the mean depth in hundreds of shares. Excess depth is depth in excess of a benchmark level, computed using depth for quotes −20 through −11 relative to trades of a given size. For excess depth, reported results include *Mean excess depth* and *t: Excess depth* = 0 (the t-statistic for the test of the null hypothesis that the mean excess depth equals zero). Results are reported for the announcement period (panel A), regular period (panel B), and ex-dividend period (panel C).

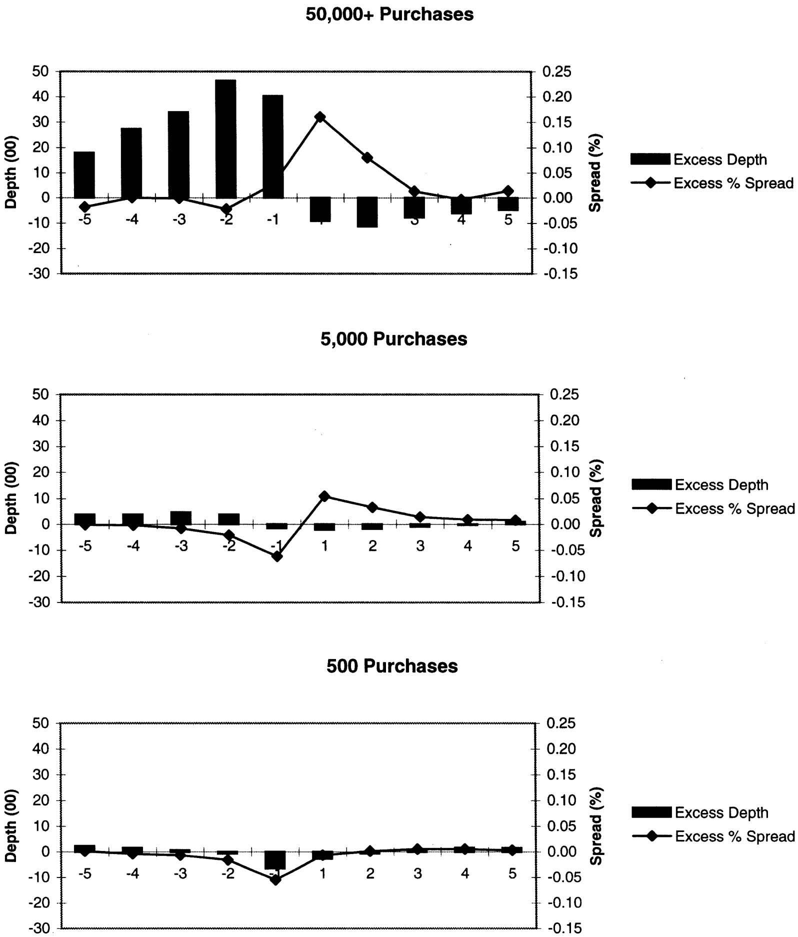

Figure 7
Liquidity relative to announcement period purchases
Excess bid-ask spreads (%) and excess market depth (ask quote depth) relative to purchases of various sizes during announcement periods. Depth is in hundreds of shares. Trade 0 represents the block trade of interest. Depth is indicated on the left-hand scale; spread is indicated on the right-hand scale.

in the tables) are significantly wider during announcement periods than either regular periods or ex-dividend periods. These results are consistent with the findings of Kim and Verrecchia (1994), Krinsky and Lee (1996), and others that the adverse selection component of the spread is wider around earnings announcements because earnings announcements increase the information asymmetry between traders and market makers.[16] Second, the excess spread

[16] In contrast, Frank and Jagannathan (1998) find that effective bid-ask spreads widen around ex-dividend days for a sample of Hong Kong stocks.

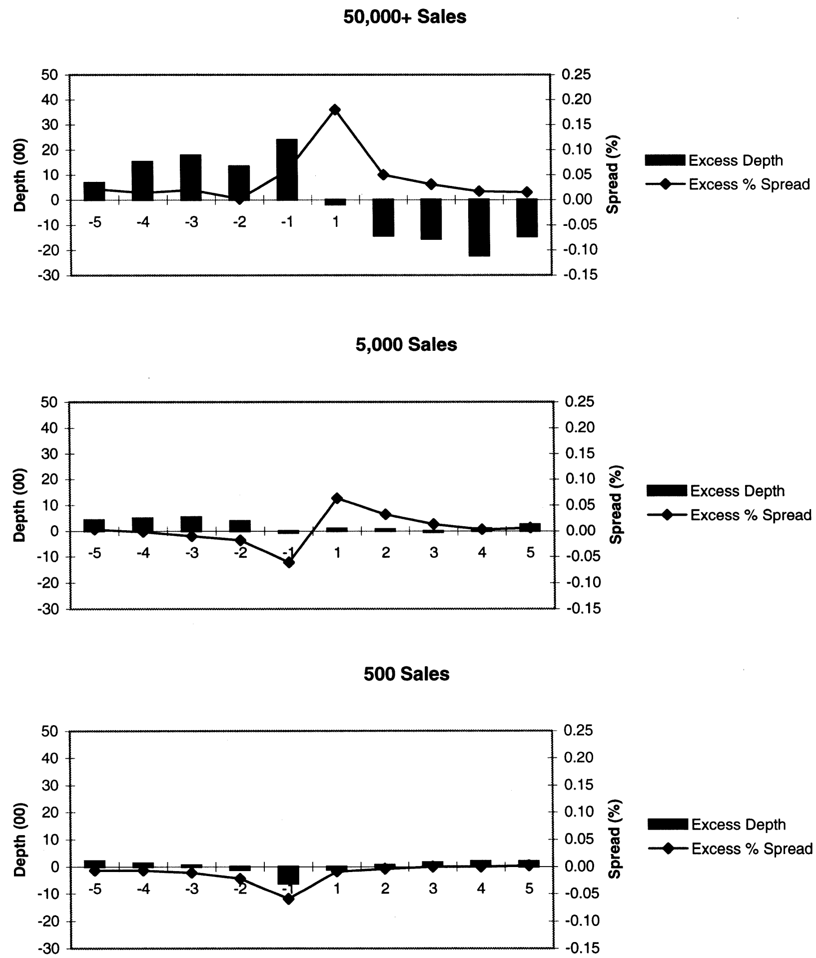

Figure 8
Liquidity relative to announcement period sales
Excess bid-ask spreads (%) and excess market depth (bid quote depth) relative to sales of various sizes during announcement periods. Depth is in hundreds of shares. Trade 0 represents the block trade of interest. Depth is indicated on the left-hand scale; spread is indicated on the right-hand scale.

immediately after a block trade is also related to its timing relative to information events. Excess spreads [the amounts by which spreads exceed benchmark levels, as defined in Equation (3)] immediately after block purchases are 0.160% during announcement periods, 0.147% during regular periods, and 0.120% during ex-dividend periods. Announcement period and regular period excess spreads differ significantly from ex-dividend excess spreads at the 5% level.

As shown in Table 5, spreads also increase significantly after block sales and remain wider for up to three subsequent quotes. Mean spreads immediately after block sales are also positively related to the information asymmetry of the trading period; mean spreads widen to 0.866% immediately after block sales during announcement periods, 0.839% during regular periods, and 0.833% during ex-dividend periods. However, excess spreads are essentially identical after sales, ranging from 0.176% to 0.184% for the three periods. Therefore most of the variation by period results from differences in benchmark levels rather than differences in the excess spreads after large trades. In contrast, as discussed above, variation by period after purchases results from differences in benchmark levels and variation in excess spreads.

Wider spreads after block trades suggest that block trades increase, rather than resolve, asymmetric information. The increase in spreads is temporary, disappearing within three to four quotes after the block. These results are consistent with temporary information effects as modeled by Easley and O'Hara (1987). Alternatively, the temporary increase in spreads could reflect frictions in the placement of limit orders, if new limit orders only slowly replace those cleared by the block trade.

Changes in depth after individual trades (Table 6) are not as strong as changes in spreads. Large trades have a significant effect on quoted depth; after a large block purchase during an announcement period, for example, quoted depth drops from 164.5 hundred shares to 114.9 hundred shares (this change is highly statistically significant). Large block trades cause a significant decrease in liquidity measured as depth, from abnormally high levels prior to the block to normal or slightly below normal levels immediately after the block. There is no such effect for small or medium-size trades.

Average depth is significantly higher during ex-dividend periods than during other periods, consistent with greater average liquidity during this period. However, there are no other systematic and significant variations in excess depth for purchases or sales as a function of the information environment.

We analyze liquidity in transaction event time rather than clock time. Our results may be affected by systematic differences across trading periods in the rate at which spreads and depth are updated. To examine this possibility, we also analyze liquidity in clock time. Not all quotes are updated immediately after block trades, so the full impact on spreads and depth takes 25–30 seconds for all three samples. There do not appear to be significant variations across information environments in the speed with which quotes are updated after blocks. Average percentage spreads 100 seconds after a block purchase are 0.83 during announcement periods, 0.77 during regular periods, and 0.75 during ex-dividend periods. Overall, this analysis supports our main inference that the impact of blocks on spreads varies significantly with the information environment. Changes in depth after blocks do not show corresponding variations across periods, although overall depth is on average higher during the ex-dividend periods. Results based on 1-minute sampling intervals are similar. The full adjustment in spreads occurs within the first minute, and spreads decrease marginally over the next 10 minutes. Overall, our conclusion from this analysis in clock time is that our main inferences regarding the initial impact of a block appear to be supported.

To summarize, results in this section show that liquidity is responsive to the information contained in trades in ways generally consistent with the theory. By examining spreads and excess spreads as a function both of the information asymmetries of the trading period and trade size, we are able to identify variations in overall, average levels of liquidity during different periods, and variations in excess spreads as a function of the size and timing of an individual trade for both sales and purchases. Excess spreads after large purchases are the most pronounced in periods when the amount of information asymmetry is the highest, the dividend announcement period. While block sales cause a significant increase in spreads, this increase does not vary with the information environment of the trade. Liquidity as measured by depth decreases significantly after large block trades, but not after medium or smaller trades. Average depth is greatest during periods when asymmetric information is lowest, the ex-dividend period.

4. Dividend Capture Trades

The dividend capture sample represents trades that are known to be dividend-related trades and therefore are known by the market not to contain any information. These trades typically consist of sets of two to three large block trades. The first trade is a large block purchase of stock with the dividend, and the second trade (or trades) are the resale of the same block of stock ex-dividend. The purchase and sale of these blocks occur within a few seconds of each other, typically using nonstandard settlement provisions to span the record date. As shown in Table 1, these trades average more than 1.6 million shares. Defining the first trade (the standard settlement purchase of stock) as the block trade of interest, Table 7 reports results for trade returns, ask quote returns, percentage bid-ask spreads, and market depth around these block trades. Panel A of Table 7 shows a significantly positive excess return of 0.147% at the block and a significantly negative excess return of nearly identical magnitude (−0.146%) on the first trade subsequent to the block. These results show that the initial dividend capture purchase occurs at a price above the previous transaction price, but that any price movement is completely reversed in the subsequent trade. Thus, as predicted, there is no permanent price effect for dividend capture trades. Note also that the order of magnitude of these excess returns, although significantly different from zero, is still much smaller than results for large block trades reported in Section 2 above. Panel B in Table 7 shows a significantly negative excess return of −0.102% for (ask) quote zero, indicating that the return from the prevailing ask quote to the block trade is negative. Even though the dividend capture purchase occurs above the previous trade on average, it occurs below the prevailing ask quote. The excess return is almost exactly reversed by a

Table 7
Dividend capture trades

	Observation relative to block trade (trade 0)					
	−2	−1	0	1	2	3
Panel A: *Trade returns*						
Mean (%)	0.015	0.055	0.147	−0.146	0.005	−0.006
t: Mean = 0	0.86	2.89	10.78	−8.85	0.27	−0.32
Panel B: *Ask quote returns*						
Mean (%)	−0.033	0.013	−0.102	0.109	−0.006	−0.039
t: Mean = 0	−2.44	0.92	−7.72	7.29	−0.40	−2.25
Panel C: *% Bid-ask spread*						
Mean % spread	0.645	0.651		0.655	0.650	0.620
Mean excess spread	−0.032	−0.026		−0.021	−0.026	−0.057
t: Excess spread = 0	−2.06	−1.66		−1.39	−1.74	−4.15
Panel D: *Depth (00s)*						
Mean depth	139.8	167.2		168.7	172.6	180.8
Mean excess depth	0.0	27.4		29.0	32.8	41.1
t: Excess depth = 0	0.01	2.82		3.07	3.28	3.77

The dividend capture sample represents trades that satisfy the following criteria: (1) block trades on day prior to the ex dividend day; (2) (total) one-way volume of at least 100,000 shares; (3) two trades (or sets of trades) with essentially the same total volume; (4) at least one set used nonstandard settlement; and (5) round-trip trades occurred within a few seconds. The ask quote excess return for quote 0 relative to the block trade is defined as the excess return from the prevailing ask quote to the block trade. The excess return for quote +1 is defined as the excess return from the block trade to the first ask quote after the block trade. *Mean* is the mean statistic value, and *t: Mean = 0* is the t-statistic for the test of the null hypothesis that the mean equals zero. Depth figures reflect the average of the ask and bid quote depth and are reported in 100s of shares.

positive excess return of 0.109% in the next ask quote. Trade and ask quote returns for dividend capture trades appear to reflect temporary movements within the bid-ask spread rather than permanent price effects.

As noted above, dividend capture trades are part of complete, round-trip sets. We have arbitrarily defined the initial purchase as the relevant block trade, but these purchases are followed almost immediately by large (nonstandard settlement) block sales of the same shares. Perhaps any positive price effects of the initial purchases are not visible because they are immediately reversed by the negative effects of the large block sales. Thus the results of price effects of dividend capture trades are inconclusive.

Tests of the liquidity effects of these dividend capture sets are not subject to this concern. If these trades, either purchases or sales, increase asymmetric information, the bid-ask spread should widen and depth should decrease in response to these trades. Panels C and D in Table 7 show that there is no significant change in liquidity measured as bid-ask spread or depth associated with dividend capture trades. It is reassuring that when trades are known not to contain information, there are no information-related liquidity effects.

5. Conclusions

In this article we distinguish between information and other effects of trades by examining trades of different sizes during periods which differ with respect to asymmetric information. We also broaden the focus of previous research from transaction prices to quoted prices, spreads, and depth. Our nonparametric approach presents a more complete picture of the impact of block trades and shows how transaction prices can be biased. We test the hypothesis that trades containing more information have a greater impact on prices and liquidity (spreads and depth).

We analyze the price and liquidity impact of trades of different sizes around three distinct periods: dividend announcement periods, regular periods, and ex-dividend periods. It is more likely that a trade in an announcement period will contain information than a similar-size trade on a regular day. A trade around the ex-dividend day is least likely to contain information since much of the ex-day trading is tax rather than informationally motivated. We also examine a fourth, extreme, case in which market participants know a priori that trades have no information content. Theory predicts that these trades should not have any information-based impact on either prices or liquidity.

We show that information asymmetry as manifested in trade size and the information environment of the trade has an impact on both prices and liquidity. Large trades have a greater price impact during times when asymmetric information is at its greatest. The latter holds for purchases only, and there is no corresponding variation across periods for large sale transactions. The timing of block purchases relative to information events has a significant impact on the market reaction to the block trade even after controlling for several firm and event characteristics. Regarding liquidity, average spreads are higher, and depth lower, during announcement periods than during ex-dividend periods. Moreover, excess spreads after large purchases are relatively greater during announcement periods than regular or ex-dividend periods. Thus the impact of an individual trade on spreads is most pronounced during periods when the amount of information asymmetry is highest.

We show that the market responds to the information contained in trade size. Controlling for bid-ask bounce, price impact is positively related to trade size, but the impact is not linear in trade size. Spreads increase significantly and depths decrease significantly after large trades but not after small trades.

The use of quoted returns in addition to traded returns helps us isolate the impact of information on prices in several ways. While the use of traded prices indicates that the initial price revision in response to trades is not monotone in trade size, the analysis of quoted prices indicates that the price revision is monotone in trade size. The difference can be explained by the effect that bid-ask bounce has on traded prices but not on quoted prices. Also, changes in quoted prices suggest that the temporary price effect that is present in transaction returns for smaller trades results from bid-ask bounce rather than other transitory effects. The temporary effect of large trades cannot be attributed solely to the bid-ask spread, because it is also present when quoted prices are analyzed. Collectively these results suggest that transaction price returns, in particular for small and medium trades, reflect movements of the average transaction within the spread rather than revisions in the levels of prices in response to information. We conclude that asymmetric information as measured by trade size or the timing of the trade relative to information events affects both prices and liquidity significantly.

Appendix A: Description of Nonstandard Settlement Dividend Capture Sample

A standard trade on the New York Stock Exchange (NYSE) settled in 5 business days during 1988. To receive a dividend, an investor must qualify as the owner of the stock by the record day and so must have purchased the stock at least 5 days earlier. The trading day 4 business days prior to the record day was known as the ex-dividend day, because it was the first day on which a standard settlement trade would not qualify to receive a forthcoming dividend. However, the NYSE permits transactions with alternative, nonstandard settlement provisions that allow anything from immediate settlement to settlement in 60 days. By using special settlement provisions, traders move the effective ex-dividend day to any time within a wide range of dates. Any trader, including an individual investor, may use nonstandard settlement provisions. The proportion of nonstandard settlement trades increased significantly around ex-dividend days during 1988.

Japanese insurance companies actively engaged in dividend capture trading using nonstandard settlement, especially during the late 1980s. According to the *Wall Street Journal*, Japanese life insurers in the 1980s were obligated to pay 7% to 8% annual yields to life insurance policyholders, but were required by Japanese regulators to make these payments from current income (dividends and interest) rather than capital gains.[17] To convert capital gains to dividend income, a Japanese insurance company would buy a large block of stock cum dividend and immediately sell it back ex-dividend for delayed settlement. The typical counterparty was a U.S. pension fund that was tax exempt and thus unaffected by the tax consequences of the deal. Although the capital gain realized by the U.S. pension fund usually exactly equaled the dividends forgone, the capital gain was realized immediately, whereas the dividend would not have been received for about 5 weeks. This type of trading activity reached a peak during 1988, accounting for more than 12% of NYSE average daily trading volume during the second and third quarters; in early 1989, Japanese insurance regulators relaxed the restrictions that gave rise to this type of trading.

To examine the effect of dividend capture trading by Japanese insurance companies on overall trading during 1988, Koski (1993) used the nonstandard settlement feature of these trades to identify dividend capture transactions on the day prior to the ex-dividend day totaling more than 1.7 billion shares. [The original sample of ex-dividend days in Koski (1993) corresponds to the ex-dividend sample analyzed in this article.] Special settlement codes in the ISSM data contain errors, so Koski (1993) estimated capture transactions based on both settlement codes and trade characteristics. Nonstandard settlement trades included in the sample met the following criteria: (1) block trades on the day prior to the ex-dividend day, (2) (total) one-way volume of at least 100,000 shares, (3) two trades (or sets of trades) with essentially the same total volume, (4) at least one set used nonstandard settlement, and (5) round-trip trades occurred within a few seconds. Smaller capture transactions were harder to isolate and may be incorrectly classified. Although it is not possible to identify trades specifically by Japanese insurance companies, most of the capture trades in this sample closely parallel the trading characteristics of Japanese insurance company trading as outlined by the *Wall Street Journal* and discussed above. It is likely that most of these trades are dividend capture trades by Japanese insurance companies. See Koski (1993) for more details about this sample.

[17] Anders (1988) documents specific trades by Japanese insurance companies to capture the dividend for GTE Corp. on May 16, 1988. See also Power and Sesit (1989).

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