The Journal of Financial Research • Vol. XXV, No. 2 • Pages 263–278 • Summer 2002

MERGER ANNOUNCEMENTS AND TRADING

N. Asli Ascioglu
Bryant College

Thomas H. McInish and Robert A. Wood
The University of Memphis

Abstract

We test whether an increase either in informed trades or in large liquidity trades leads to greater correlation of trading volume across markets. We confirm that both trading volume and positive returns of target companies are abnormally high before merger announcements. We find a statistically significant increase in the correlation between New York Stock Exchange and Nasdaq/regional trading volume before merger announcements. Furthermore, after merger announcements, we find evidence of both large liquidity trading and a statistically significant increase in the correlation of trading volume across markets.

JEL Classifications: G19

I. Introduction

Chowdhry and Nanda (1991) model the interactions of small liquidity traders, large liquidity traders, and informed traders in a multimarket setting to explain how information is incorporated into prices. We develop and test two hypotheses based on their model. Our first hypothesis is that an increase in informed trading leads to an increase in the correlation of trading volume across markets. Our second hypothesis is that an increase in trading by large liquidity traders leads to an increase in the correlation of trading volume across markets.

Before we can investigate informed trading, these trades must first be identified. For this purpose we turn to the merger literature where several studies such as Keown and Pinkerton (1981) show that insiders typically trade before merger announcements. By using a sample of firms announcing mergers, we can investigate the market behavior before the merger announcement date when we are confident informed traders are trading. For our tests we identify a sample of forty-four firms

We gratefully acknowledge the helpful comments of the referee, Vikram Nanda, and the participants in the Financial Management Association annual conference in October 2000.

that were merger targets during 1995. We confirm that trading volume and returns are abnormally high for these firms before the merger announcements.

Like Conrad and Niden (1992), we do not observe any widening of the spread before the announcement day. Conrad and Niden, as well as Cornell and Sirri (1992), provide evidence that spreads narrow after the merger announcements. We also present evidence of a significantly narrowing spread and a significantly lower adverse-selection component of the bid-ask spread that persists after the announcement. Our results indicate that the decrease in the adverse-selection component of the bid-ask spread is significant in every trade size category. Hence, we conclude that trading after the merger announcement is liquidity motivated.

Consistent with hypothesis 1, we find a statistically significant increase in the correlation between trading volume on the New York Stock Exchange (NYSE) and trading volume on the Nasdaq and regional exchanges just before the merger announcements. Also, consistent with hypothesis 2, we find a statistically significant increase in the correlation between NYSE and Nasdaq/regional trading volume in the period just after the merger announcements compared with earlier trading periods.

II. Development of Hypotheses

Chowdhry and Nanda (1991) develop a model in which informed traders and large liquidity traders split their orders across n markets, but small liquidity traders trade in a single market. In their model, the trades of small liquidity traders are uncorrelated across markets, whereas the trades of informed traders are perfectly correlated across markets, as are the trades of large liquidity traders. Therefore, an increase in trading by either informed or large liquidity traders leads to an increase in the correlation of trading volume across markets. Specifically, these authors derive Proposition I as follows:

$$\rho_{ij} = 0.5\left(1 + \frac{\sigma_d^2}{\sigma^2}\right) \quad \forall i\, \forall j, i \neq j, \tag{1}$$

where

ρ_{ij} = the correlation between the total order flows in market i and j;
σ_d^2 = the variance of the order flow of large liquidity traders; and
σ^2 = the variance of total order flow of large and small liquidity traders.

Proposition I holds only if the informed trader's trading volume is perfectly correlated across markets. Therefore, an increase in trading by informed traders also leads to an increase in the correlation of total order flow across markets. Hence, we develop the following hypothesis:

H_1: An increase in trading by informed traders leads to an increase in the correlation of order flow across markets.

Proposition I shows that the correlation of order flow across markets is an increasing function of the variance ratio (σ_d^2/σ^2) so that an increase in trading by large liquidity traders leads to an increase in the correlation of order flow across markets. This leads to hypothesis 2:

H_2: An increase in trading by large liquidity traders leads to an increase in the correlation of order flow across markets.

III. Data and Methodology

Data

The data for number of shares traded and quotes are obtained from tapes provided by the Institute for the Study of Security Markets (ISSM). The return data are obtained from the Center for Research in Security Prices (CRSP). Merger announcement dates are obtained from *Mergerstat*, a publication of Houlihan Lokey Hower and Zukin Specialty Investment Banking, Los Angeles. Our initial sample comprises forty-four firms that were targets of mergers in 1995 and with shares traded on the NYSE and on either Nasdaq or the regional exchanges. Our sample period comprises 146 trading days.

We classify our sample into seven periods: 1 (-105 to -85), 2 (-84 to -64), 3 (-63 to -43), 4 (-42 to -22), 5 (-21 to -1), 6 (0 to 20), and 7 (21 to 41). Days are shown relative to merger announcement, where day 0 is the merger announcement date. Therefore, period 5 comprises the most recent twenty-one trading days before the announcement, and period 6 comprises the twenty-one trading days just after announcement, including the announcement date. We report the results of standard t-tests at the 1% level, but replication using a nonparametric Wilcoxon rank-sum test yielded the same conclusions.

Calculation of Across-Market Correlation of Trading Volume

We identify whether each trade occurs on the NYSE or Nasdaq/regional markets. For each firm for each trading day ($n = 146$) for each thirty-minute interval of the trading day (a total of thirteen intervals[1]), we calculate aggregate volume for the NYSE trades and for non-NYSE trades. Our goal is to estimate the correlation between NYSE and non-NYSE trading volume. There is a problem when trading does not occur on both the NYSE and the Nasdaq/regional market for a given interval, which we denote 00. If trading does not occur on both markets, our correlation estimate will be higher because both venues will have zero volume.

[1] We repeated our analysis for different intervals from fifteen minutes to forty-five minutes and conclude that our results are not sensitive the length of interval.

Because this seems inappropriate, we eliminate all periods with zero volume for both the NYSE and non-NYSE samples. Nevertheless, we replicated our results using a sample that included these trades and found our conclusions unchanged. Another problem with nontrading periods is that there may be trading on the NYSE or on the Nasdaq/regional markets, but not both, during a given period, which we denote 0+. In this case our hypothesis will be more strongly supported if the 0+ trading occurs in the period(s) before period 5. On the other hand if the 0+ trading occurs during period 5, the empirical support for our hypothesis will be weaker. We believe this is in line with the justification for our research design. We expect lower trading volume and more nontrading intervals for the non-NYSE sample in the pre-announcement periods of 1, 2, 3, and 4. Hence, we include these 0+ periods in the results presented later. Again, we replicated our analysis omitting all 00 and 0+ intervals and found our conclusions unchanged.

For each firm for each twenty-one-day period, we estimate the coefficient of correlation as follows:

$$\rho_p(\text{VOLNYSE}_i, \text{VOLNR}_i), \tag{2}$$

where VOLNYSE_i and VOLNR_i are, respectively, NYSE and Nasdaq/regional trading volume in each thirty-minute interval. This procedure produces 306 correlations (forty-four firms multiplied by seven periods—less two missing observations for period 7). Then, we average the correlation of coefficient numbers across firms for each period to get the mean correlation number for each period.

Calculation of Abnormal Volume

Let $V_{f,t}$ equal ln(1 + daily volume) for day t for firm f, and V_f equal the mean of $V_{f,t}$ for days −105 to −21. For day t for firm f, excess volume (EV) is:

$$EV_{f,t} = V_{f,t} - V_f \quad t = -105, \ldots, +41. \tag{3}$$

Then for day t for firm f, we calculate the cumulative excess volume (CEV):

$$CEV_{f,t} = EV_{f,t} + CEV_{f,t-1} \quad t = -105, \ldots, +41, \tag{4}$$

where $CEV_{-105} = EV_{-105}$ and day t is relative to the day of the merger announcement, where day 0 is the announcement day. If there are unusual trading patterns, the mean of $CEV_{f,t}$ across firms (CEV_t) will be significantly greater than zero.

Calculation of Excess Returns

To calculate excess returns, we estimated the market model:

$$R_{f,t} = \alpha_f + \beta_f R_{m,t} + \varepsilon_{f,t} \quad t = -105, \ldots, -21, \tag{5}$$

where $R_{f,t}$ is the return on the stock of firm f on day t, $R_{m,t}$ is the return on the S&P

500 stock index on day t, $\varepsilon_{f,t}$ is a random error term representing the unsystematic component of the return of the stock of firm f, and α_f and β_f are parameters to be estimated. To eliminate bias in the estimates of α_f and β_f, the estimation is carried out over the period -105 to -21. The estimated excess return is given by

$$ER_{f,t} = R_{f,t} - (\hat{\alpha}_f + \hat{\beta}_f R_{m,t}), \tag{6}$$

where $\hat{\alpha}$ and $\hat{\beta}$ are the estimates of α and β, respectively. Cumulative daily average excess return (*CER*) for day t for firm f is defined as:

$$CER_{f,t} = ER_{f,t} + CER_{f,t-1}, \tag{7}$$

where $CER_{-105} = ER_{-105}$.

If there are no unusual price movements before the announcement date, *CER*s fluctuate around zero. We use a one-tailed t-test to test the null hypothesis that the mean of the *CER*s for day t for the firms in our sample is greater than zero.

Calculation of Bid-Ask Spreads

We calculate bid-ask spreads following McInish and Wood (1992). Only NYSE quotes are used. Quotations before the opening are not used and no quotation is carried overnight. To create second-by-second data, each quotation is carried forward until the next one arrives. For a given stock for every second, a percentage bid-ask spread is calculated as (ask − bid)/((ask + bid)/2). Next, for each firm, a series of time-weighted percentage bid-ask spreads (BAS) is created by averaging second-by-second quotations for each thirty-minute interval during the 146 days of the sample period. Then, for each stock, we average the time-weighted BAS for each day. For each day we average the time-weighted spreads across firms. To find the representative BAS for each period, the average of the daily BAS is calculated across twenty-one days. In addition, the standard deviation of BAS, BASSTD, for each day and for each period is calculated.

Calculation of Adverse-Selection Component of the Bid-Ask Spread

Using all NYSE quote midpoints and trades (except the first trade of the day), we estimate the adverse selection of the spread using the method of Lin, Sanger, and Booth (1995):

$$\Delta Q_{t+1} = \lambda Z_t + e_{t+1}, \tag{8}$$

where $\Delta Q_{t+1} = Q_{t+1} - Q_t$, Q_t is the log of midpoint quote at time t; Z_t equals $P_t - Q_t$; P_t is the log of trade price at time t; and e_{t+1} is the error term of the regression equation. The estimate of the adverse-selection component as a percentage of the effective spread is λ. We estimated equation (8) for each firm and for the trades of each firm categorized by size. Because our investigation showed no statistically significant differences in λ across size categories, we did not use these size categories in our subsequent analysis.

IV. Empirical Results

Hypothesis 1

The test of hypothesis 1 is in three parts. The first part of hypothesis 1 refers to increased trading by informed traders. We cannot identify informed traders directly. So we test for an increased level of overall trading before the merger announcement. Second, we show that the increased level of trading before announcements is a result of informed trading. Before merger announcements, we find evidence of excess trading volume, excess returns, and either no-change or a narrowing of the bid-ask spread. We believe that these facts together establish that informed trading increases before the merger announcement. We then test for an increase in the correlation of order flow across trading venues.

Part 1: Test for Increased Trading Volume Before the Merger Announcement

Table 1 provides values for *CEV* for days −105 to +41 surrounding the merger announcements. *CEV* becomes positive eleven days before the announcement date and continues to increase until twenty-five days after the announcement day. The t-statistics for *CEV* are positive and statistically greater than zero at the 10% level for each day from day −4 to day −1.

Part 2: Identification of Periods of Informed Trading

Next, we use three approaches to investigate whether informed trading occurs before the merger announcement.

Method 1: Excess Volume. Several studies indicate high insider trading in target firms' common stock before merger announcements. Meulbroek (1992) finds significant and positive pre-announcement abnormal volume for mergers that are known to have been preceded by illegal trading.

Eyssell and Arshadi (1993) examine the patterns of excess returns and volume before the first published information about an impending takeover bid for a sample of NYSE and American Stock Exchange firms. They show that increases in trading volume before published information are largely due to share purchases by registered insiders such as corporate officers, directors, and owners of 10% or more of a firm's outstanding shares. Moreover, Keown, Pinkerton, and Bolster (1992) study excess volume for merger announcements and find abnormally high trading volume of target companies beginning twenty-one days before the first public announcement. Conrad and Niden (1992) find that trading volume increases

TABLE 1. Daily Average Cumulative Excess Volume.

Day Relative	Average Cumulative Excess Volume	t-statistics
−105	−0.098	−0.663
−84	−1.782	−1.957
−62	−2.702	−2.021
−42	−2.184	−1.443
−25	−1.993	−1.650
−24	−1.795	−1.552
−23	−1.523	−1.321
−22	−1.144	−1.000
−21	−0.960	−0.878
−20	−0.900	−0.809
−19	−1.080	−0.991
−18	−0.965	−0.931
−17	−1.074	−1.062
−16	−0.881	−0.861
−15	−0.774	−0.725
−14	−0.561	−0.514
−13	−0.338	−0.297
−12	−0.037	−0.032
−11	0.154	0.128
−10	0.259	0.204
−9	0.422	0.323
−8	0.697	0.521
−7	1.000	0.746
−6	1.469	1.130
−5	1.868	1.428
−4	2.522	1.919*
−3	2.983	2.195*
−2	3.440	2.492*
−1	5.414	3.780*
0	7.970	5.395*
1	9.751	6.492*
2	11.319	7.348*
3	12.588	7.678*
4	13.811	8.111*
21	22.723	7.157*
41	21.114	3.049*

Note: Our goal is to test whether there is excess cumulative volume for day t. To begin, we let $V_{f,t}$ equal ln(1 + daily volume) on day t for firm f, and V_f equal the mean of $V_{f,t}$ for days −105 to −21. For day t for firm f, excess volume (EV) is $EV_{f,t} = V_{f,t} - V_f$ for $t = -105, \ldots, +41$. Then, for day t for firm f, we calculate the cumulative excess volume (CEV): $CEV_{f,t} = EV_{f,t} + CEV_{f,t-1}$, $t = -105, \ldots, +41$, where $CEV_{-105} = EV_{-105}$. In column 2 we present the average of the daily cumulative excess volume across firms. We use a one-tailed t-test to test the hypothesis that the mean of the cumulative excess volume for day t is greater than zero. Day t is relative to the day of the merger announcement, where day 0 is the announcement day.

*Significant at the 10% level.

dramatically three days before the merger announcement. Our results also show excess volume beginning four days before the merger announcement.

Method 2: Excess Returns. Evidence of stock price increases before merger announcements is shown in many studies. Keown and Pinkerton (1981) examine abnormal returns before public announcement of acquisitions and show that cumulative average abnormal returns begin to be statistically significant and positive twenty-five days before the announcement. Denis and McConnell (1986), among others, also show positive abnormal stock price increases around twenty days before the merger announcement. Conrad and Niden (1992) provide evidence of positive abnormal returns beginning three days before merger announcement. Meulbroek (1992) analyzes 320 companies' stocks that were known for their insider trading. She finds a statistically significant and positive relation between insider trading and stock price increases.

Table 2 shows the daily average *CER*s and daily average *ER*s over 146 days. The *CER* and *ER* begin to be statistically significant and positive four days before the announcement. This also provides evidence for informed trading before the merger announcement.

Method 3: Excess Bid-Ask Spreads and Estimated Adverse-Selection Components of the Spread. Another way of identifying periods when informed traders are active is to examine the behavior of the bid-ask spread. Copeland and Galai (1983), among others, develop information models that are associated with wide spreads due to the increased adverse-selection costs of trading with informed traders. Cornell and Sirri (1992) analyze the effect of insider trading on market liquidity surrounding the acquisition of Campbell Taggart by Anheuser-Busch in 1982 and show that the estimated spread does not increase during the period of insider trading. Furthermore, Chakravarty and McConnell (1997) analyze prices and bid-ask spreads surrounding the acquisition of Carnation by Nestle caused by Ivan Boesky's illegal trading of Carnation stock before the merger announcement, and they report that informed trading does not affect spreads. They conclude that the adverse-selection component may not be a significant portion of the spread. Conrad and Niden (1992) also study the adverse-selection costs of NYSE firms at the time of acquisition announcements and find no significant change in the adverse-selection costs preceding the merger announcements. In addition, they show that at the announcement day, the spread declines significantly and persists at its lower level thereafter. Brooks (1994) finds that only one day before the earning announcements, quoted bid-ask spread and the estimated adverse-selection component are significantly higher than those of previous day. In addition, he shows that on and after the announcement days, bid-ask spread and the estimated adverse-selection cost decrease significantly.

Table 3 provides the mean and standard deviation of the daily time-weighted bid-ask spread and the mean estimate of the adverse-selection component of the bid-ask spread by period. There is a large decrease in BAS, BASSTD, and the

TABLE 2. Daily Average Cumulative Excess Returns.

Day Relative	Average Cumulative Excess Return	t-statistics	Average Excess Return	t-statistics
−105	−0.003	−1.845	−0.003	−1.845
−84	−0.016	−2.468	−0.001	−0.762
−62	−0.014	−1.997	0.009	2.016
−42	0.002	0.396	−0.002	−1.882
−25	−0.006	−2.213	−0.002	−1.072
−24	−0.001	−0.728	0.005	2.039
−23	0.001	0.967	0.003	1.599
−22	0.000	−0.279	−0.001	−0.967
−21	−0.002	−1.503	−0.002	−1.503
−20	−0.008	−4.165	−0.005	−3.236
−19	−0.008	−3.692	0.000	−0.353
−18	−0.005	−1.961	0.003	1.992
−17	−0.003	−0.866	0.003	1.968
−16	−0.003	−0.721	0.000	−0.032
−15	0.000	0.060	0.003	1.832
−14	0.005	1.020	0.005	3.101
−13	0.003	0.489	−0.003	−1.983
−12	0.002	0.268	−0.001	−0.815
−11	0.000	0.088	−0.001	−0.573
−10	−0.004	−0.764	−0.005	−3.493
−9	−0.006	−0.972	−0.002	−0.598
−8	0.004	0.600	0.010	4.688
−7	0.007	1.187	0.004	1.894
−6	0.006	1.036	−0.001	−0.748
−5	0.012	1.922	0.006	2.404
−4	0.024	2.587*	0.012	2.610*
−3	0.032	3.279*	0.008	2.440*
−2	0.044	4.273*	0.012	4.504*
−1	0.136	9.325*	0.092	8.378*
0	0.203	12.525*	0.067	6.554*
1	0.199	12.208*	−0.003	−2.250
2	0.199	12.413*	0.000	−0.130
3	0.199	12.571*	0.000	0.085
4	0.197	12.255*	−0.002	−2.133
21	0.194	10.442*	−0.004	−1.364
41	0.191	10.021*	0.000	−0.114

Note: To calculate excess returns, we estimate the market model:

$$R_{f,t} = \alpha_f + \beta_f R_{m,t} + \varepsilon_{f,t} \quad t = -105, \ldots, -21,$$

where $R_{f,t}$ is the return on the stock of firm f on day t, $R_{m,t}$ is the return on the S&P 500 stock index on day t, $\varepsilon_{f,t}$ is a random error term representing the unsystematic component of the stock of firm f's return, and α_f and β_f are parameters to be estimated. The estimated excess return is given by

$$ER_{f,t} = R_{f,t} - (\hat{\alpha}_f + \hat{\beta}_f R_{m,t}),$$

where $\hat{\alpha}$ and $\hat{\beta}$ are the estimates of α and β, respectively. For the day indicated, column 4 shows the average *ER* across the firms in our sample. For each day, we use a standard t-test to test the null hypothesis that the *ER*s are significantly different from zero. The results of this test are reported in column 5. Daily cumulative excess return for day t for firm f is:

$$CER_{f,t} = ER_{f,t} + CER_{f,t-1},$$

where $CER_{-105} = ER_{-105}$. For the day indicated, column 2 shows the average of the *CER*s across the firms in our sample. If there are no unusual price movements before the announcement date, *CER*s fluctuate around zero. We use a one-tailed t-test to test the null hypothesis that the mean of the *CER*s for day t for the firms in our sample is greater than zero. The results of these tests are reported in column 3. All days are relative to the announcement day.

*Significant at the 10% level.

TABLE 3. Mean and Standard Deviation of Daily Time-Weighted Bid-Ask Spreads and the Estimate of the Adverse-Selection Cost.

Period	BAS	BASSTD	Average Estimate λ
Panel A. Test of Whether BAS > 0, by Period			
1	1.12***	0.80	0.454***
2	1.13***	0.82	0.459***
3	1.13***	0.91	0.456***
4	1.09***	0.84	0.440***
5	1.07***†	0.82	0.453***†
6	0.74***†	0.53	0.340***†
7	0.77***	0.59	0.362***
Panel B. Test of Whether BAS for Periods 1–5 Combined > for Periods 6–7 Combined			
1–5	1.111††	0.843††	0.458††
6–7	0.761††	0.563††	0.348††

Note: For a given stock for every second, a percentage bid-ask spread is calculated as ((ask − bid)/((ask + bid)/2)). Bids and asks are averaged within seconds. For each firm for each day t, we calculate the average spread. Because we retain each quote until it is updated, our spreads are time weighted. Quotes with longer lives have more weight in calculating the average daily spread. For each period individually and for periods 1–5 and 6–7 combined, the mean (BAS) and standard deviation (BASSTD) of the daily bid-ask spreads are presented in columns 2 and 3, respectively. All tests in this table are at the 1% level. In Panel A, for each of our seven periods, we test whether the mean BAS is significantly greater than zero. We reject the null hypothesis in each case. We also test whether values for period 5 are significantly higher than for period 6. We reject the hypothesis of equality. In Panel B, we test whether the mean daily BAS for days −105 through −1 (the days in periods 1–5) is greater than the mean daily BAS for days 0 through 41 (the days in periods 6 and 7) using a standard t-test. We conduct a similar test for the BASSTD. In both cases we reject the hypothesis of equality. Next, the adverse-selection component of the bid-ask spread for each firm is estimated by using the regression model of Lin, Sanger, and Booth (1995):

$$\Delta Q_{t+1} = \lambda Z_t + e_{t+1},$$

where $\Delta Q_{t+1} = Q_{t+1} - Q_t$, Q_t is the log of the midpoint quote at time t, Z_t equals $P_t - Q_t$, P_t is the log of trade price at time t, and e_{t+1} is a random error term. The adverse-selection component is represented by the coefficient term λ. We average the estimated adverse-selection component across the firms for each period. In Panel A, for each of our seven periods, we test whether the estimated adverse-selection cost is significantly greater than zero. In each case we reject the null hypothesis. We test for equality of the mean adverse-selection components for periods 5 and 6 and reject the hypothesis of equality. Panel B shows the comparison of the estimated adverse-selection costs for periods 1–5 and periods 6–7. We reject the hypothesis of equality.

***Significantly different from zero at the 1% level.
†Values for period 5 are significantly higher than for period 6 at the 1% level.
††Values for periods 1–5 are significantly higher than for periods 6–7 at the 1% level.

adverse-selection component after the merger announcement. We confirm that the means of the 105 pre-announcement BASs and BASSTDs are significantly greater than the means of the forty-two post-announcement BASs and BASSTDs ($t = 78$ and $t = 39$, respectively). The estimated pre- and post-announcement adverse-selection costs are 0.458 and 0.348, respectively.[2] Also note that the mean of the 105 pre-announcement adverse-selection cost estimates is significantly higher than the mean of the forty-two post-announcement adverse-selection cost estimates ($t = 7.4$).

We estimate the order-processing cost component of the bid-ask spread using the approach of Lin, Sanger, and Booth (1995).[3] Comparison of the estimated order-processing cost for periods before and after the announcement does not show any statistically significant difference. Before the merger announcement and after the merger announcement the average order-processing costs are 0.373 and 0.396 of the spread, respectively (not shown).[4] Therefore, we conclude that the significant decrease in spread after the announcement is due to a decrease in the adverse-selection component of the spread.

Moreover, the means of BASs and BASSTDs in period 5 are significantly higher than the means of each of these variables in period 6 ($t = 37$ and $t = 19.6$, respectively). The estimated adverse-selection cost in period 5, 0.453, is also significantly higher than the estimated adverse-selection cost in period 6, 0.340 ($t = 7.2$). These results are consistent with the view that the adverse-selection component of the bid-ask spread decreases after the merger announcement because of the decrease in the asymmetric information problem among market players.

The mean of the BASs at period 5 is significantly less than the mean of the BASs for the previous four months ($t = 4.6$). Furthermore, there is no significant difference between the estimated adverse-selection cost in period 5 and that cost in the previous four months. This is consistent with information models of Copeland and Galai (1983), because market makers, not knowing about upcoming merger announcements and informed trading, would not increase the spread and the adverse-selection component of the spread. Cornell and Sirri (1992) find no significant increase in the bid-ask spread of Campbell Taggart before the merger announcement and postulate that an increase in trading volume attracts uninformed traders. Our findings also support the idea that increased trading volume due to informed trading also attracts uninformed trading before merger announcements; consequently, we do not observe an increase in the bid-ask spread before merger announcements. However, we do not support the idea that the adverse-selection component of the bid-ask spread is small (Chakravarty and McConnell 1997).

---

[2]Lin, Sanger, and Booth's (1995) estimate of the adverse-selection cost is 35% for 150 NYSE firms.

[3]Lin, Sanger, and Booth (1995) assume inventory-holding costs are relatively small and, consequently, do not provide an estimation for this cost.

[4]Similarly, Lin, Sanger, and Booth (1995) find that the order-processing component is almost 33% of the spread, and Brockman and Chung (1999) find that the order-processing component is 44% for an order-driven market.

TABLE 4. Coefficients of Correlation of NYSE and Nasdaq/Regional Trading Volume by Period.

Period	Correlation
1	0.218
2	0.196
3	0.231
4	0.185
5	0.385
6	0.319
7	0.167

Note: For each firm for each period, we calculate the coefficient of correlation between the thirty-minute-interval trading volume data on the NYSE, VOLNYSE, and the thirty-minute-interval trading volume data on the Nasdaq/regional exchanges, VOLNR. Column 2 reports the mean of the coefficients of the correlation within periods across days and firms. We use a standard t-test and report our results at the 1% level. We find that the mean of the correlations for period 5 is significantly greater than the mean for periods 1–4 combined and the means for each of the periods 1–4. We also find that the mean of the correlations for period 6 is significantly greater than the mean for periods 1–4 combined and the mean for each of the periods 1–4.

Part 3: Test of Increased Across-Market Correlation of Trading Volume Before the Merger Announcement

Having confirmed that there is both increased trading and informed trading before the merger announcement, we test whether there is an increase in the correlation of volume across markets.

For each of the seven periods, Table 4 shows the mean correlation between NYSE and Nasdaq/regional trading volume across firms. Our results show that the correlations for period 5 are significantly higher than those for the remaining periods ($t = 9.2$), confirming hypothesis 1. We also compare the mean correlation of period 5 with each of the previous four periods' mean correlation. In every case, we find that the period 5 correlation is significantly higher.[5]

[5]Note that the significant increase in volume correlation between the NYSE and the Nasdaq/regional markets at period 5 is not due to the increase in trading volume. Daily average trading volume at period 5 and period 6 are 2,817 and 4,653, respectively (not shown in the table). This volume increase is statistically significant at the 1% level. On the other hand, the volume correlation from period 5 to period 6 shows a decrease, significant at the 1% level. Therefore, we conclude that correlation values presented in Table 4 do not depend on trading volume.

Hypothesis 2

We turn next to hypothesis 2, which we test in three parts. The first part of hypothesis 2 refers to increased trading by liquidity traders. Just as we cannot identify informed traders directly, we cannot identify liquidity traders directly. So we test for an increased level of overall trading after the merger announcement and offer evidence that this trading is likely to be by liquidity traders rather than by informed traders. We then test the hypothesis that there is an increase in the correlation of order flow across trading venues.

Part 1: Test for Increased Trading Volume After the Merger Announcement

As noted previously, Table 1 provides values for *CEV* for day −105 to day +41 surrounding the merger announcements. *CEV* becomes positive eleven days before the announcement date and continues to increase until twenty-five days after the announcement day. The t-statistics for *CEV* are positive and statistically greater than zero at the 10% level for each day from day 0 to day +25 (not all of these are shown in Table 1). Hence, this evidence confirms that there is an increase in trading volume after the merger announcement relative to the comparison period.

Part 2: Evidence of Liquidity Trading After the Merger Announcement

We use three ways to test whether the increased trading after the merger announcement is due to liquidity traders. First, we examine average trade size on the belief that large, uninformed liquidity traders trade in larger sizes. Furthermore, we expect that liquidity trading is associated with narrower bid-ask spreads and smaller adverse-selection costs.

Method 1: Daily Average Trade Size. If there is an increase in trading by large investors after the merger announcement, we expect a statistically significant increase in average daily trade size after the merger announcement. Therefore, we compare the average daily trade size before and after the merger announcement. Table 5 provides the daily average trade size by period. We test for the difference in average trade size between period 5 and period 6. The average trade size is 1,964 in period 5 and 3,104 in period 6. We confirm that the average trade size in period 6 is statistically higher than the average trade size in period 5 (t = 23.4). Therefore, we conclude that after the merger announcement, the trading occurs mostly by large liquidity traders at larger trade sizes.

Method 2: Bid-Ask Spreads and Estimated Adverse-Selection Costs of Spread. Kim and Verrecchia (1991) develop a model in which the bid-ask spread widens significantly before the merger announcement and then decreases significantly during uninformed trading, consistent with increased trading by informed traders before the merger announcement and increased trading by liquidity traders after the merger announcement. In addition, we expect an increase in liquidity

TABLE 5. Daily Average Trade Size by Period.

Period	Average Trade Size
1	1,679
2	1,515
3	1,701
4	1,968
5	1,964***
6	3,104***
7	2,563

Note: We calculate the average daily trade size for each of the forty-four firms in our sample for each day. There are twenty-one days in each period so that there are (44 firms $\times$ 21 days =) 924 observations if there is at least one trade in each day. In column 2 we present the mean of these observations for each period. We test whether the mean for period 6 ($n = 881$) is significantly greater than for period 5 ($n = 902$). Our results show that the mean for period 6 is significantly higher than the mean for period 5.

***Significantly different ($t = 23.4$) at the 1% level.

trading after the merger announcement as portfolio managers seek to restore the risk profile of their portfolios.

Table 3 provides the mean and standard deviation of the daily time-weighted bid-ask spread and the estimate of the adverse-selection component by period. The table reveals a large decrease in both BAS and BASSTD and in the estimated adverse-selection component after the merger announcement. We confirm that the means of the 105 pre-announcement BASs and BASSTDs are significantly greater than the means of the 42 post-announcement BASs and BASSTDs ($t = 78$ and $t = 39$, respectively). Moreover, the mean pre-announcement adverse-selection cost is significantly higher than the mean post-announcement adverse-selection cost ($t = 7.4$).

We conclude that the adverse-selection component decreases after the merger announcement, which gives further evidence that the increase in trading volume after the merger announcement comes from uninformed traders rather than from informed traders. After the announcement, large uninformed liquidity traders may seek to rebalance their portfolios to control risk, to add or remove stocks that no longer meet their industry requirements, and so on. This view is consistent with our findings of lower BAS, lower estimated adverse-selection cost, and higher average trade size after the announcement. In addition, given the decrease in the adverse-selection costs after the announcement, it is consistent with our findings that uninformed traders become more willing to submit larger orders by increasing the average trade size as a result of a decrease in information asymmetry in the market.

TABLE 6. Trade Size and Estimated Adverse-Selection Component of the Bid-Ask Spread.

	Adverse Selection (λ)		
Trade Size (percentiles)	Entire Period	Pre-Announcement	Post-Announcement
<25	0.426	0.434	0.331
25–50	0.446	0.455	0.345
50–75	0.462	0.462	0.406
75–90	0.477	0.492	0.418
90<	0.468	0.491	0.393

Note: The adverse-selection cost is estimated for trade size categories. Trade size categories are created to take into account the effect of trade size on the adverse-selection component. For each firm, all trades are dividend into five categories from lowest trade size to highest trade size as follows: less than 25%, 25%−50%, 50%−75%, 75%−90%, and higher than 90%. Then, the adverse-selection cost for each firm and for each size category is estimated using the regression model of Lin, Sanger, and Booth (1995):

$$\Delta Q_{t+1} = \lambda Z_t + e_{t+1},$$

where $\Delta Q_{t+1} = Q_{t+1} - Q_t$, Q_t is the log of midpoint quote at time t. Z_t equals $P_t - Q_t$, P_t is the log of trade price at time t, and e_{t+1} is a random error term. The adverse-selection component is represented by the coefficient term λ. We average the estimated adverse-selection component across firms for each size category. We present the adverse-selection component for the entire sample, for the before period, and for the after period in columns 2–4, respectively. Using a standard t-test, for the overall sample we find no significant differences in the adverse-selection component between each category and the immediately smaller category. However, comparing columns 3 and 4 for each size category, we do find that in each case the adverse-selection component is smaller in the post-announcement period.

We also analyze the relation between trade size and the estimated adverse-selection cost. Lin, Sanger, and Booth (1995) find that the adverse-selection component increases uniformly with trade size except for the largest trade size. Table 6 shows the estimated adverse-selection cost for each size category for the entire sample period. Although there is an increasing trend in the estimated adverse-selection cost except in the highest trade size category, the difference is not statistically significant. The pre- and post-announcement adverse-selection costs are also compared for each trade size category in Table 6. We confirm that for each size category, there is a significant decrease in estimated adverse-selection cost after the announcement at the 1% level.

Part 3: Test of Increased Across-Market Correlation of Trading Volume After the Merger Announcement

There is an increase in the correlation of order flow across markets after the merger announcement. To confirm this part of hypothesis 2, we compare the across-market correlations for periods after the merger announcement with those for earlier periods not contaminated by the merger announcement. For each of the seven periods, Table 4 shows the mean correlation between the NYSE and Nasdaq/regional trading volume across firms. We find that the correlations for period 6 are significantly higher than for other periods ($t = 4.7$), confirming hypothesis 2.

V. Summary and Conclusions

Chowdhry and Nanda (1991) introduce a model in which simultaneous multimarket trading by large liquidity traders and informed traders affects price information in the market. We derive two hypotheses based on their model and test these using a sample of firms that were targets of mergers. We find that before (after) the merger announcement, an increase in informed (liquidity) trading leads to an increase in the correlation of order flow between trading on and off the NYSE.

References

Brockman, P. and D. Chung, 1999, Bid-ask spread components in an order-driven environment, *Journal of Financial Research* 22, 227–46.

Brooks, R., 1994, Bid-ask spread components around anticipated announcements, *Journal of Financial Research* 17, 375–86.

Chakravarty, S. and J. J. McConnell, 1997, An analysis of prices, bid/ask spreads, and bid and ask depths surrounding Ivan Boesky's illegal trading in Carnation's stock, *Financial Management* 26, 18–34.

Chowdhry, B. and V. Nanda, 1991, Multi-market trading and market liquidity, *Review of Financial Studies* 4, 483–511.

Conrad, J. and C. M. Niden, 1992, Order flow, trading costs and corporate acquisition announcements, *Financial Management* 21, 22–31.

Copeland, T. E. and D. Galai, 1983, Information effects on the bid-ask spread, *Journal of Finance* 38, 1457–69.

Cornell, B. and E. Sirri, 1992, The reaction of investors and stock prices to insider trading, *Journal of Finance* 47, 1031–59.

Denis, D. K. and F. McConnell, 1986, Corporate mergers and security returns, *Journal of Financial Economics* 16, 143–88.

Eyssell, T. H. and N. Arshadi, 1993, Insiders, outsiders, or trend chasers?: An investigation of pre-takeover transactions in the shares of target firms, *Journal of Financial Research* 11, 49–59.

Keown, J. and M. Pinkerton, 1981, Merger announcements and insider trading activity: An empirical investigation, *Journal of Finance* 4, 855–69.

Keown, J., M. Pinkerton, and P. Bolster, 1992, Merger announcements, asymmetrical information, and trading volume: An empirical investigation, *Journal of Business Finance & Accounting* 19, 901–10.

Kim, O. and R. Verrecchia, 1991, Market reaction to anticipates announcements, *Journal of Financial Economics* 30, 273–310.

Lin, J. C., G. Sanger, and G. G. Booth, 1995, Trade size and components of the bid-ask spread, *Review of Financial Studies* 8, 1153–83.

McInish, T. and R. Wood, 1992, An analysis of intraday patterns in bid/ask spreads for NYSE stocks, *Journal of Finance* 47, 753–64.

Meulbroek, L., 1992, An empirical analysis of illegal insider trading, *Journal of Finance* 47, 1661–99.