Information disclosure and market quality: The effect of SEC Rule 11Ac1-5 on trading cost

Abstract

The Securities and Exchange Commission adopted Rule 11Ac1-5 on November 15, 2000. The rule requires market centers to make monthly electronic disclosures of basic information regarding execution quality. The rule is intended to empower market forces with the means to achieve a more competitive and efficient national market system by increasing the visibility of execution quality. We find that the quoted, effective, and realized spreads of our sample of NYSE and AMEX stocks declined significantly after the rule implementation. The decline cannot be attributed to concurrent changes in stock attributes or the effect of decimal pricing. Although the quoted depth of NYSE stocks also declined, overall market quality is higher after the rule implementation because the increase in liquidity associated with narrower spreads is greater than the decrease in liquidity associated with smaller depths.

JEL classification: G18; G19

Key words: Execution costs; Market quality; Information disclosure; Market makers; Quote competition

1. Introduction

In this study we analyze the impact of information disclosure on competition and market quality using data surrounding the implementation of SEC Rule 11Ac1-5. Before 2001, traders did not have an easy access to information regarding execution quality on different market centers. Hence, traders made order routing decisions without explicit knowledge of the expected execution quality. Retail investors frequently opted for broker-dealers who offer lower commissions or faster executions, overlooking other dimensions of execution quality such as effective spreads and price improvements. As a result, market centers did not have a strong incentive to compete on these measures of execution quality.

On November 15, 2000, the Securities and Exchange Commission (SEC) adopted Rule 11Ac1-5 ("the Rule" hereafter) aimed at improving public disclosure of order execution quality. Under the Rule, market centers that trade national market system securities are required to make monthly electronic disclosures of basic information regarding execution quality on a stock-by-stock basis.[1] Such information should include, for example, the extent to which market orders in various size categories are executed at prices better than public quotes. For the first time, investors are informed about not only quoted spreads but also effective spreads (i.e., the spreads actually paid by investors whose orders are routed to a particular market center).

The Rule applies only to national market system securities traded on American Stock Exchange (AMEX), Boston Stock Exchange (BSE), Chicago Stock Exchange (CHX), Cincinnati Stock Exchange (CSE), National Association of Securities Dealers (NASD), New York Stock Exchange (NYSE), Pacific Exchange (PCX), and Philadelphia Stock Exchange (Phlx). The Rule applies to virtually all covered orders and any order that is smaller than 10,000 shares. The Rule requires market centers to report on orders in all national market system securities, excluding only those securities with fewer than five transactions per day during the preceding six months. The commission exempts from the Rule small market centers that do not focus their business (i.e., fewer than 200 transactions per day during the

[1] Market centers include exchange market makers, over-the-counter market makers, and market makers of alternative trading systems.

preceding six months) on the most actively traded securities. In short, the Rule covers all active national market system securities and the majority of orders that are smaller than 10,000 shares on seven market systems.

The purpose of the Rule is to "increase the visibility of execution quality of the U.S. securities markets for public investors."[2] To facilitate comparisons across market centers, the Rule adopts basic measures of execution quality (such as effective spreads, fill rates, and execution speed) and sets forth specific instructions on how they are to be calculated. For each security, the statistical information is categorized by five types of order (i.e., market order, marketable limit order, inside-the-quote limit order, on-the-quote limit order, and near-the-quote limit order) and four order size groups (i.e., 100-499 shares, 500-1,999 shares, 2,000-4,999 shares, and 5,000+ shares). For market orders and marketable limit orders, the Rule requires market centers to report effective spreads and price improvement rates. In addition, the Rule requires all market centers to post monthly order execution reports on their website under designated file names and using designated file format. Users of the data are able to analyze order executions for a particular security or for any particular group of securities, as well as for any size or type of orders across these groups of securities.

Several recent studies analyze SEC 11Ac-5 data. Bessembinder (2003c) examines the role of, and methods of correcting for, selection biases in market quality comparisons. He shows that non-NYSE venues are more likely to receive smaller orders in large capitalization, high volume stocks, and orders from uninformed trades than the NYSE. Based on this finding, Bessembinder suggests that comparisons of market quality measures across market centers without controlling for order characteristics are likely to provide misleading inferences as to market quality. The author further shows that although controlling for sample selection biases is important, the specific method of control has little practical effect on inferences regarding market quality. In particular, he shows that a simple regression-based method provides results that are generally similar to those obtained from more complex two-stage methods.

[2] See Securities Exchange Act Release No. 43590 (November 17, 2000), 65 FR 75414.

Boehmer (2003) performs a post-decimal comparison of market quality between NYSE and NASDAQ securities using Rule 11Ac1-5 data. He finds that although execution costs are smaller on the NYSE, NASDAQ orders are executed significantly faster for orders smaller than 5,000 shares. The author concludes that inferring execution quality from out-of-pocket costs alone may be problematic. Boehmer, Jennings, and Wei (2003) investigate whether brokers/traders use Rule 11Ac1-5 data in order routing decisions. The authors find that order routing decisions are significantly affected by execution quality. For example, market centers reporting low execution costs and fast fills subsequently receive more order flow. The study concludes that public disclosure of execution quality promotes competition for order flow.

Lipson (2004) examines competition among six market centers for NYSE-listed stocks using Rule 11Ac1-5 data. He shows that market centers competing with the NYSE execute orders in only a subset of stocks, order types, and order sizes. The study finds that differences in effective spreads between the NYSE and select market centers are related to stock attributes, and that order flow routed to the NYSE is more informed than order flow routed to broker-dealers and other exchanges. The author concludes that competition among market centers is imperfect and market centers carve out profitable niches in the stocks they trade and/or the orders they execute.

Prior studies shed light on brokers/traders' order routing decisions, the nature of competition among market centers, and the inter-market comparison of execution quality. However, none of these studies provided evidence as to whether public disclosure of execution quality has reduced execution costs, as anticipated by market regulators. The SEC believes that vigorous competition among buyers and sellers is the only reliable means to achieve the best prices and low cost executions for public investors. Prior to the Rule, few market centers provided detailed public disclosure regarding their execution quality. By increasing the visibility of order execution quality, the Rule is intended to empower market forces with the means to achieve a more competitive and efficient national market system for public investors. In this study, we examine whether the intended objective of Rule 11Ac1-5 has been achieved by testing whether execution costs differ significantly between the pre- and post-rule periods.

In a recent article, Boehmer, Saar, and Yu (2004) examine the effect of *pre*-trade transparency on market quality by analyzing the NYSE's OpenBook service that provides limit order book information to traders off the exchange floor. The authors find that traders attempt to manage limit order exposure by submitting smaller orders and canceling orders faster. The study also finds that greater pre-trade transparency led to the lower price impact of orders and the greater informational efficiency of prices. The authors conclude that an increase in pre-trade transparency affects investors' trading strategies and can improve certain dimensions of market quality. In the present study, we provide evidence on the effect of *post*-trade transparency on market quality.

We define March 2001 as the pre-rule period, May 2001 as the event period, and June and July 2001 as the post-rule period. We use the 1,000 NYSE-listed stocks and 200 AMEX-listed stocks that are subject to the Rule for the first time as our study sample and compare execution costs (e.g., the quoted, effective, and realized spreads) before and after the implementation of the Rule. Similarly, we examine how the Rule has affected the market depth. Our results show that for the 1,000 NYSE stocks, the average quoted spread declined by two cents (a 25% decline) after the Rule implementation. Similarly, we find a decrease of 2.76 cents in the quoted spread from a sample of 1,502 NYSE stocks that are included in the report by voluntary decisions of market centers. We show that the changes in quoted spreads cannot be attributed to concurrent changes in stock attributes or the effect of decimal pricing. Although the quoted depth of NYSE stocks also declined, overall market quality is higher after the Rule implementation because the increase in liquidity associated with narrower spreads is greater than the decrease in liquidity associated with smaller depths. We find similar results for AMEX stocks. Based on these findings, we conclude that SEC Rule 11Ac1-5 exerted a positive impact on market quality.

The paper is organized as follows. Section 2 briefly describes the intended purpose of SEC Rule 11Ac1-5 and its compliance dates. Section 3 explains the sample selection procedure and data source, and presents descriptive statistics. Section 4 presents our empirical findings. Section 5 checks the robustness of our results. Section 6 presents a concluding remark.

2. SEC Rule 11Ac1-5: Intended purpose and compliance dates

The SEC describes (see Release No. 34-43590) the main purpose of Rule 11Ac1-5 as "By making visible the execution quality of the securities markets, the rules are intended to spur more vigorous competition among market participants to provide the best possible prices for investor orders." To the extent that the Rule gives broker-dealers and investors meaningful information on execution quality, market centers are expected to attract order flow by providing, and developing a reputation for providing, superior execution. Hence, we expect that order execution quality improves upon the implementation of the Rule.

As to compliance dates, the SEC initially mandated that

> "the first phase-in of securities subject to the Rule will begin Monday, April 2, 2001. As of this date, the Rule will apply to the 1,000 NYSE securities, 1,000 NASDAQ securities, and 200 AMEX securities with the highest average daily share volume for the quarter ending December 31, 2000. Market centers must make their first report, for April 2001, available by the end of May 2001. The second phase-in date will be July 2, 2001. From this date forward, the Rule will apply to the next 1,000 NYSE securities, the next 1,000 NASDAQ securities, and the next 200 AMEX securities with the next highest average daily share volume for the quarter ending March 31, 2001. The third and final phase-in of Rule 11Ac1-5 will begin on October 1, 2001. From this date forward, the Rule will apply to all national market system securities."

However, the actual compliance dates were extended several times at the request of the NYSE and NASDAQ. First, the initial compliance date was moved back by one month to May 1, 2001.[3] Accordingly, the first monthly reports (for execution quality in May 2001) were required to be made available to the public by the end of June 2001. Second, the SEC issued a temporary exemption from the reporting requirements until July 31, 2001 for NASDAQ securities.[4] Hence, the first monthly reports (for execution quality in August 2001) for the 2,000 most actively traded NASDAQ securities were to be made available to the public by the end of September 2001. Furthermore, due to the market closure following the September 11 tragedy, the SEC issued a further exemption from the Rule for NASDAQ

[3] See Securities Exchange Act Release No. 44060 (March 9, 2001), 66 FR 15028.
[4] Letter to Stuart J. Kaswell, Senior Vice President and General Counsel, Securities Industry Association, from Annette L. Nazareth, Director, Division, dated April 12, 2001.

securities until October 1, 2001.[5] The first monthly reports for NASDAQ securities (for execution quality in October 2001) were to be made available to the public by November 30, 2001.

To summarize, the first monthly reports for order execution quality were for May 2001, and the reports were due by the end of June 2001. The Rule applies to the 1,000 most active NYSE securities and 200 most active AMEX securities. All NASDAQ securities were required to make reports for October 2001, and the reports were due by November 30, 2001. Figure 1 shows the timeline for Rule 11Ac1-5.

3. Sample selection, data sources, and descriptive statistics

Our initial study sample comprises the most active 1,000 NYSE and 200 AMEX securities that were subject to the Rule for the first time (i.e., the first phase-in securities).[6] We do not include securities that were subject to the Rule at later dates to avoid the effect of the September 11 tragedy on the study sample. Evidence shows that the tragedy had a profound impact on market liquidity, including its impact on spreads.[7] Because the original compliance date for the first phase-in securities was April 2, 2001, and then moved back by one month to May 1, 2001, we define March 2001 as the pre-rule period, May 2001 as the event period, and June and July 2001 as the post-rule period (see Figure 1). We define March 2001 (instead of April 2001) as the pre-rule period because some market centers would have already begun preparing the order execution quality data in April and thus the spread measures could have started to decline from April.[8]

We obtain the data used in this study from the NYSE's Trade and Quote (TAQ) database. We use only NYSE quotes for our NYSE stocks and only AMEX quotes for our AMEX stocks.[9] In addition, we

[5] Letter to Patrick Campbell, Chief Operating Officer, the NASDAQ Stock Market, Inc., from Annette L. Nazareth, Director, Division, dated September 21, 2001.

[6] These stocks are chosen based on their average daily share volumes for the last quarter of 2000 obtained from the NYSE's Trade and Quote (TAQ) database.

[7] We find significant increases in the quoted dollar and percentage spreads on the NYSE and NASDAQ in September 2001. The results are available from the authors upon request.

[8] Indeed, we find a decrease in the quoted dollar spread between March 2001 and April 2001 (see Figure 2).

[9] Blume and Goldstein (1997) show that both sides of the quotes displayed by the NYSE typically match the best displayed prices (i.e., national best bids or offers): the NYSE bid price equals the best bid price 97.1% of the time and the NYSE ask price equals the best ask price 96.9% of the time. Hence, our results are not likely to be materially different from those based on national best bids and offers (NBBO). Schultz (2000) also uses only NYSE/AMEX

exclude the following trades and quotes to minimize data errors: (1) quotes if either the ask or the bid is less than or equal to zero; (2) quotes if either the ask size or the bid size is less than or equal to zero; (3) quotes if the bid-ask spread is greater than $5 or less than zero; (4) before-the-open and after-the-close trades and quotes; (5) trades if the price or volume is less than or equal to zero; (6) trade price, p_t, if $|(p_t - p_{t-1})/p_{t-1}| > 0.5$; (7) ask quote, a_t, if $|(a_t - a_{t-1})/a_{t-1}| > 0.5$; and (8) bid quote, b_t, if $|(b_t - b_{t-1})/b_{t-1}| > 0.5$.

Table 1 shows select attributes of our study sample. We measure trading volume by the average daily number of shares traded for the quarter ending December 31, 2000 from the TAQ database. Table 1 shows the trading volume during the last quarter of 2000 (instead of our study period) because the SEC selected the first phase-in securities using the same criterion. We measure share price by the mean value of quote midpoints and trade size by the average dollar transaction in March 2001. The number of trades is the total number of transactions during March 2001. We measure return volatility by the standard deviation of daily quote midpoint returns.

The average daily trading volume for the quarter ending December 31, 2000 for our NYSE sample is 1,246,246 and the corresponding figure for our AMEX sample is 439,428. The average share price and number of trades in March 2001 for the NYSE sample are $32.59 and 15,809, respectively, and the corresponding figures for the AMEX sample are $18.53 and 6,176. The average trade size and mean value of the standard deviation of daily returns for the NYSE sample are $40,424 and 0.0239, respectively, and the corresponding figures for the AMEX sample are $31,668 and 0.0445. Overall, our NYSE stocks are more active than AMEX stocks in terms of daily share volume, number of trades, and trade size. The NYSE sample also has higher share price and lower return volatility than the AMEX sample.

4. Empirical findings

In this section, we examine the impact of SEC Rule 11Ac1-5 on market quality by comparing several measures of execution quality between the pre- and post-rule periods. Although the Rule requires

---

quotes in his analysis of stock splits based on both Blume and Goldstein's finding and the fact that quotes of regional exchanges are usually good for much smaller sizes than NYSE/AMEX quotes.

market centers to report execution costs as well as other execution quality measures (e.g., fill rates and execution speeds), data on the latter are not available for the pre-rule period. Hence, we focus only on the three measures of execution cost (i.e., the quoted, effective, and realized spreads) that can be calculated from the TAQ database for both the pre- and post-rule periods.

We calculate the quoted dollar and percentage spreads as follows:

$$Quoted\ dollar\ spread_{it} = A_{it} - B_{it}, \tag{1}$$

$$Quoted\ \ percentage\ spread_{it} = 100(A_{it} - B_{it})/M_{it}, \tag{2}$$

where A_{it} is the posted ask price for stock i at time t, B_{it} is the posted bid price for stock i at time t, and M_{it} is the mean of A_{it} and B_{it}.

To measure trading costs when trades occur at prices inside the posted bid and ask quotes, we calculate the effective dollar and percentage spreads using the following formulas:

$$Effective\ dollar\ spread_{it} = 2D_{it}(P_{it} - M_{it}), \tag{3}$$

$$Effective\ \ percentage\ spread_{it} = 200D_{it}(P_{it} - M_{it})/M_{it}, \tag{4}$$

where P_{it} is the transaction price for security i at time t, M_{it} is the midpoint of the most recently posted bid and ask quotes for security i, and D_{it} is a binary variable which equals one for customer buy orders and negative one for customer sell orders.[10] We use quotes that are at least one-second old. The effective spread measures the actual execution cost paid by the trader.

We calculate the realized dollar and percentage spreads using the following formulas:

$$\mathrm{Re}alized\ \ dollar\ \ Spread_{it} = 2D_{it}(P_{it} - P_{it+5}), \tag{5}$$

$$\mathrm{Re}alized\ \ \ percentage\ Spread_{it} = 200D_{it}(P_{it} - P_{it+5})/M_{it}, \tag{6}$$

[10] We estimate D_{it} using the algorithm in Bessembinder (2003a).

where P_{it+5} denotes the first transaction price observed at least five minutes after the trade for which the realized spread is measured and the other variables are the same as defined above. The realized spread measures the average price reversal after a trade (or market-making revenue net of losses to better informed traders).

To examine if there were any changes in market depth around the Rule implementation, we also calculate the total quoted depth (in round lots) at the bid and ask, i.e.,

$$Quoted\ depth_{it} = BidSize_{it} + AskSize_{it}, \tag{7}$$

where $BidSize_{it}$ is the quoted bid size and $AskSize_{it}$ is the quoted ask size for security i at time t.

For each stock, we calculate the average time-weighted quoted spread and the time-weighted quoted depth in each month by weighting each quote by the elapsed time before it is updated. We calculate the trade-weighted effective and realized spreads for each stock. To assess the sensitivity of our results with respect to different averaging methods, we calculate both the equal- and volume-weighted cross-sectional means of these variables.[11] Table 2 shows the differences in these measures between the pre-rule period (March 2001) and the event/post-rule periods (May/June-July 2001), and whether the differences are statistically significant. Panel A and Panel B show the results for the NYSE sample and Panel C and Panel D show the results for the AMEX sample. Panel A and Panel C report the equal-weighted means, and Panel B and Panel D report the volume-weighted means.

Panel A shows that all six spread measures during the event/post-rule period are smaller than the corresponding values during the pre-rule period and the differences are statistically significant at the 1% level in most cases. Between March and July, the quoted dollar spread for the NYSE sample declined by two cents (a 25% decline) and the quoted percentage spread declined by 0.0868 (a 20% decline). Similarly, the effective dollar (percentage) spread declined by 22% (17%) during the same period. We

[11] Bessembinder (2003b) and Chung, Van Ness, and Van Ness (2004) show that averaging methods are critical in inter-market comparisons of execution cost. However, our before and after comparison of execution quality within each market is less sensitive to averaging methods because inter-temporal variation in trading volume for a given stock is typically smaller than inter-stock variation in trading volume during a given period.

observe somewhat smaller declines in the realized spread. Panel A also shows that the quoted depth declined after the Rule implementation. Between March and July, the quoted depth declined by about 3.8 round lots (a 7% decline), which is significant at the 5% level.

Because both the spread and depth declined after the Rule implementation, we calculate the following market quality index (MQI) suggested by Bollen and Whaley (1998) to measure the net effect of the Rule on overall market liquidity:[12]

$$MQI_{it} = \frac{(1/2)Quoted\ depth_{it}}{Quoted\ \ percentage\ spread_{it}}. \tag{8}$$

We first calculate the time-weighted MQI for each stock and then obtain its cross-sectional mean using both the equal- and volume-weighted averaging methods. The last row of Panel A shows that the values of MQI during the event/post-rule period are all significantly greater than the corresponding figure during the pre-rule period – MQI in May, June, and July are 106.19, 119.79, and 117.88, respectively, whereas MQI in March is only 95.44. In relative term, MQI increased by 24% between March and July. These results indicate that although the implementation of the Rule led to a decrease in both the spread and depth, the increase in liquidity associated with narrower spreads dominates the decrease in liquidity associated with smaller depths, resulting in a net increase in market quality. We find qualitatively similar results (see Panel B) from the volume-weighted spreads, depth, and MQI.

Panel C shows that the equal-weighted mean spreads during the event/post-rule period are generally narrower than those during the pre-rule period for AMEX-listed stocks, although the statistical significance of the results is somewhat weaker than that for our NYSE sample. In contrast to NYSE-listed stocks, the mean depths during the event/post-rule periods are all greater than the corresponding figure during the pre-event period. The last row of Panel C shows that the values of MQI during the event/post-rule period are all greater than the corresponding figure during the pre-rule period – MQI in May, June,

[12] This measure assumes a linear liquidity supply schedule (i.e., a linear tradeoff between the spread and depth), which may not correctly capture actual preferences of liquidity providers.

and July are 391.70, 522.95, and 529.62, respectively, whereas MQI in March is only 288.83. We find qualitatively similar results from the volume-weighted figures in Panel D.

On the whole, our results indicate that overall market quality during the event/post-rule periods is higher than that during the pre-rule period for our sample of NYSE and AMEX stocks. These results are supportive of our conjecture that higher visibility of execution quality spurs greater competition among market centers and thereby improves market quality.

Although Table 2 shows significant declines in execution cost after the Rule implementation, the results could have been driven by the changes in stock attributes surrounding the first phase-in period of the Rule. For example, if there were a significant decrease in the average share price between the pre- and post-rule periods, we would observe an increase in the quoted percentage spread and a decrease in the quoted dollar spread. Similarly, if there were a significant decrease in return volatility or trade size, or an increase in trading activity, we would observe a decrease in the spread.

To determine whether the differences in execution cost between the pre- and post-rule periods are due to changes in stock attributes over time, we employ the following approach. For each stock, we calculate four stock attributes (i.e., average share price, return volatility, average trade size, and the number of trades) that are known to explain cross-sectional and time-series variations in the spread. We then regress each spread measure[13] on the four stock attributes and a dummy variable each for May, June, and July, respectively, using monthly observations of the dependent and independent variables. We use the log of trade size and the log of number of trades because the distribution of these variables is skewed.

Panel A of Table 3 shows the regression results for the NYSE sample and Panel B shows the results for the AMEX sample. We report White's (1980) t-statistics in parenthesis. Panel A shows that for the NYSE sample, the regression coefficients for May, June, and July dummy variables are all significantly negative except for one regression. This result suggests that the mean spread during May, June, and July, respectively, are all significantly smaller than the mean spread during March, after

[13] Our regression analysis is limited to the quoted, effective, and realized spreads because there is no well-defined model of depths or MQI.

controlling for differences in the stock attributes. Consistent with the results in Table 2, we find that the Rule has a weaker effect on the AMEX sample: although the regression coefficients for May, June, and July dummy variables are all negative, only half of them are significant at the 1% level. Overall, our regression results are consistent with the univariate test results reported in Table 2.

We note that one can never prove that the observed decline in the spread is indeed due to the Rule because it is possible that the decline could have been driven by some unknown factors that are unrelated to the Rule. According to our results, however, we cannot reject the hypothesis that the Rule has exerted a positive impact on market quality.

Because the Rule applies only to *orders* that are smaller than 10,000 shares, it would be of interest to find out whether the magnitude of spread changes around the Rule implementation differs between orders greater than 10,000 shares and orders smaller than 10,000 shares. We are unable to perform a direct test of this because the TAQ database does not contain order data. Therefore, we perform an indirect test by examining whether the change in effective spreads around the Rule implementation differs between *trades* greater than or equal to 10,000 shares and *trades* smaller than 10,000 shares. Because order size and trade size are not always equal, the results should be interpreted with caution.

We calculate the trade-weighted average effective dollar and percentage spreads during the pre- and event/post-rule periods using trades that are smaller than 10,000 shares for each stock. We repeat the same calculation using trades that are greater than or equal to 10,000 shares. In addition, we calculate the percentage change in the effective spread between the pre- and event/post-rule periods for each stock. Finally, we calculate both the equal- and volume-weighted cross-sectional means of the effective spread during the pre- and event/post-rule periods and the percentage change.

Table 4 shows that the effective spread declined for both the small and large trade-size groups after the Rule implementation.[14] The results of paired-comparison t-tests indicate that the observed changes are all statistically significant. More importantly, we find that the decline in the effective spread

[14] Consistent with the finding of previous studies (see, e.g., Bessembinder, 2003b), the effective spread for large trades is generally greater than the effective spread for small trades.

for trades smaller than 10,000 shares is significantly larger than the corresponding figure for trades greater than or equal to 10,000 shares according to paired-comparison t-tests. For example, between March and July, the effective dollar spread declined by 19% for trades smaller than 10,000 shares, while it declined by only 17% for trades greater than or equal to 10,000 shares. Similarly, the effective percentage spread declined by 18% for trades smaller than 10,000 shares, while the corresponding figure is 16% for trades greater than or equal to 10,000 shares. We find qualitatively similar results from the volume-weighted spread (see Panel B), although the difference between the two trade-size groups is somewhat smaller.

Why the effective spread for trades greater than 10,000 shares declined after the Rule implementation is somewhat puzzling given the fact that market centers are required to report execution quality only for orders that are smaller than 10,000 shares. One possible explanation for this result is that at least some market centers began to charge lower spreads for all orders (not just for orders smaller than 10,000 shares) when they were required to report execution quality. These market centers might have found it cumbersome to offer different price improvements according to order sizes.

5. Robustness tests

In this section, we test the robustness of our results using control samples of stocks.

5.1. Effect of the Rule on other NYSE stocks

Given that the spread declined after the introduction of the Rule, a natural question is whether there were similar changes in the spread for those NYSE stocks that were *not* required to report execution quality by the end of June 2001. However, we are unable to examine this issue with clarity because the first monthly execution quality reports made to the public included 3,539 NYSE-listed securities, despite the fact that the SEC mandated the Rule only on the most active 1,000 stocks. As stated by SEC officials, "Nothing prohibits a market center from reporting on all national market system securities covered by the

Rule prior to the scheduled phase-in dates."[15] This statement clearly describes the case of the NYSE. By the end of June, marker centers reported execution quality data on virtually all NYSE-listed stocks. Because of this reason, it is not possible to obtain a control sample of NYSE stocks that were *not* affected by the Rule during the study period.

Given the fact that market centers reported execution quality on stocks that were not subject to the Rule, we examine whether the Rule had any impact on these stocks as well. For this, we replicate both Table 2 and Table 3 using data for 1,502 NYSE-listed stocks that were not required to report but included in the June report. Of 3,539 securities included in the report, we drop 2,037 securities for the following reasons: 781 securities that are different classes of 1,502 stocks included in the study sample,[16] 1,000 securities that are included in the first phase-in of the Rule, and 256 securities whose data not available from the TAQ database for the entire study period. This leaves us with a sample of 1,502 securities.

Similar to the 1,000 NYSE sample, we find significant declines in the quoted, effective, and realized spreads of these stocks. In addition, although the quoted depth declined slightly, the market quality index (MQI) increased after the Rule implementation.[17] To examine whether the decreases in spreads are due to concurrent changes in the stock attributes, we replicate Table 3 with data for 1,502 stocks and report the regression results in Panel A of Table 5.[18] Note that the regression coefficients for May, June, and July dummy variables are all significantly negative at the 1% level, indicating that the observed declines in spreads are not due to changes in the stock attributes.

Overall, our results suggest that all those NYSE stocks that were included in the June 2001 execution quality reports exhibit a significant decrease in execution cost around the first phase-in period, regardless of whether or not they belong to the first phase-in group of securities. We interpret this result as evidence that market centers began to post uniformly narrower spreads for all NYSE stocks (not just

[15] Market Regulation: Staff Legal Bulletin No. 12 Revised (FAQ about Rule 11Ac1-5), dated June 22, 2001.
[16] For example, for ticker symbol AGC (American General Corporation), the report also includes the order execution quality data for AGCPRA, AGCPRB, AGCPRM, AGCPRMCL, AGCPRN, and AGCPRNCL, each as a separate security symbol. We exclude these latter ticker symbols from the study sample.
[17] We do not report the univariate test results for brevity. The results are available from the authors upon request.
[18] We obtain similar results when we use the dollar (quoted, effective, and realized) spreads as the dependent variables.

for the first phase-in stocks) when they were required to report execution quality. This result should not come as a surprise considering that it would have been cumbersome for market centers to differentiate stocks and post different spreads according to the rule compliance dates. The incremental administrative cost of differentiating stocks and posting different spreads according to the rule compliance dates may outweigh the additional revenue from the incrementally larger spreads for some stocks.

5.2. Effect of the Rule on a control sample of NASDAQ stocks

In this section, we use a sample of NASDAQ stocks that were not subject to the Rule during the first phase-in period for NYSE stocks and examine whether these NASDAQ stocks exhibit any decline in the spread. To the extent that the observed declines in the spread of our NYSE stocks were indeed due to the Rule rather than due to market conditions or liquidity shocks during the post-rule period, we should not observe similar declines in the spread on NASDAQ.

We include in this control sample only those NASDAQ stocks that belong to the first and second pilot programs of decimalization. The first pilot program, which included 14 NASDAQ stocks, began on March 12, 2001. The second pilot program began on March 26, 2001 for 199 NADAQ stocks. All remaining NASDAQ securities converted to decimal trading on April 9, 2001. Because the last phase-in date (i.e., April 9, 2001) of NASDAQ decimalization is between the original and revised compliance dates (i.e., April 2, 2001 and May 1, 2001) of Rule 11Ac1-5 for the first phase-in NYSE securities, we do not include the last group of NASDAQ stocks in the control sample.

Of 213 stocks that belong to the first and second pilots, 63 stocks either do not have complete data in the TAQ database or have five-letter ticker symbols.[19] After we omit these stocks, we are left with a sample of 140 NASDAQ stocks. Because these NASDAQ stocks were not subject to the Rule until October 2001 and because they went into decimal pricing at least two months prior to the post-rule months (June and

[19] The fifth letter refers to an American Depository Receipt, stock with several classes, a company that is currently delinquent in the periodic filings with the SEC, a company involved in bankruptcy proceedings, and a host of other things. A partial list of fifth letter identifiers includes: A (Class A), B (Class B), D (New), E (Delinquent in required SEC filings), F (Foreign securities), G, H and I (Additional warrants or preferred), J (Voting), K (Nonvoting), and Z (Miscellaneous situations, such as stubs, depositary receipts, limited partnership units, or additional warrants).

July of 2001), evidence of any significant decline in the spread of these stocks would weaken our interpretation that the declines in the spread of NYSE stocks during the post-rule months are due to the Rule implementation.

Panel B of Table 5 shows the regression results from the control sample of NASDAQ stocks. We include four dummy variables (MARCH, MAY, JUNE, and JULY) to determine whether the mean spread during April is significantly different from the mean spread during March, May, June, and July, respectively. The results show that the regression coefficients for MARCH are significantly positive, indicating that March has a higher mean spread than April after controlling for the differences in stock attributes. We interpret this result as evidence of the impact of decimal pricing because the mean spreads during March capture only the partial effect of decimal pricing (i.e., decimal pricing began during, not at the beginning of, March), whereas the mean spreads during April are more likely to reflect the full impact of decimal pricing. The coefficients for MAY, JUNE, and JULY are all insignificant, suggesting there were no measurable changes in the spread in May, June, and July 2001.

The results from the NASDAQ sample also suggest that liquidity providers adapt to the smaller tick size rather quickly. It appears that the adjustment process takes no more than a month. Accordingly, we argue that the decreases in the spread for NYSE and AMEX sample reported in Table 2 are not due to the gradual effect of decimalization, but due to the reporting requirements of Rule 11Ac1-5. In the next section, we provide further evidence on this issue.

5.3. Further tests

On January 29, 2001, all NYSE- and AMEX-listed stocks began trading in decimals. As shown in prior studies (e.g., Bessembinder, 2003b; Chakravarty, Wood, and Van Ness, 2004; Chung, Van Ness, and Van Ness, 2004), decimalization brought execution costs (spreads) down. In this section, we provide a detailed analysis of whether the decrease in NYSE spreads shown in our study could be accounted for by the effect of decimalization.

Figure 2 shows the quoted dollar and percentage spreads from December 2000 to August 2001 for the sample of 1,000 NYSE stocks. The figure shows that most decreases in the spread occurred in January and February 2001: a 32% decrease in the time-weighted dollar spread and a 46% decrease in the time-weighted percentage spread from December 2000 to February 2001. These results are consistent with the finding of prior studies. From February to March, however, we do not observe any significant decline in the spread. Although the time-weighted dollar spread declined by 0.3% and the time-weighted percentage spread increased by 0.8%, neither of them is statistically significant. These results suggest that the effect of decimal pricing on spreads has been completed by the end of February 2001.

Figure 2 shows a significant decline in spreads between March and May. As shown in Table 2, the quoted dollar and percentage spreads declined by 19% and 23%, respectively, during this period. To further examine whether differential spreads between March and May are due to the Rule rather than due to a residual effect of decimalization (although the effect is not observed from February to March), we identify NYSE stocks that were subject to decimal pricing prior to January 29, 2001. This sample includes 158 securities that belong to the three pilot programs of decimalization (i.e., seven securities phased-in on August 28, 2000, 57 securities phased-in on September 25, 2000, and 94 securities phased-in on December 4, 2000). From this sample, we exclude stocks that are not included in the TAQ database for the whole testing period and stocks with several classes (e.g., ADR). The final sample consists of 71 NYSE stocks: 5 stocks from the first phase-in, 25 stocks from the second phase-in, and 41 stocks from the third phase-in pilot programs. Because these stocks were subject to decimal pricing before the Rule implementation, any change in the spread of these stocks is more likely to be due to the Rule itself rather than due to the residual effect of decimal pricing.

We show the mean dollar and percentage spreads from July 2000 to July 2001in Figure 3.a through Figure 3.c. for each phase-in sample. In each figure, there are three dates: Date 1 represents the day on which each pilot program began, Date 2 represents January 29, 2001, and Date 3 represents the first phase-in date of SEC Rule 11Ac1-5. Consistent with the finding of prior studies, these stocks experienced large and significant declines in spreads on their phase-in dates, but small and insignificant

declines on January 29, 2001. More importantly, we find drastic and significant declines in spreads around the first phase-in period of the Rule. When we replicate Table 3 using data for this sample of 71 stocks, the results are qualitatively identical (see Panel C of Table 5): these stocks experienced large and significant declines in spreads from March to July 2001 and these declines cannot be explained by changes in stock attributes over time.

6. Conclusion

People and organizations generally perform better when they are closely watched and their performances are monitored and disclosed. Based on this premise, the SEC introduced Rule 11Ac1-5, which requires market centers to disclose basic measures of execution quality on a stock-by-stock basis. The Rule is intended to spur more competition among market centers and thereby reduce trading costs and improve market quality. In the present study, we examine whether the intended objective of the SEC has been achieved using a sample of stocks that were subject to the Rule. Our results show that there were significant declines in execution cost measures around the implementation of the Rule. Our results also indicate that these declines cannot be attributed to concurrent changes in stock attributes or the effect of decimal pricing. Based on these results, we conclude that the SEC's goal to raise execution quality through more transparent markets has been achieved.

An interesting area for future research would be the analysis of SEC Rule 11Ac1-6 on market quality. Rule 11Ac1-6, adopted in November 2000, requires all broker-dealers that route orders in equity and option securities to make available quarterly reports that present a general overview of their order routing practices. The reports must identify the significant venues to which customer orders were routed for execution and disclose the material aspects of the broker-dealer's relationship with such venues. It would be of significant interest to both market regulators and investors to find out whether and how order routing decisions affect execution quality.

References

Bessembinder, H., 2003a. Issues in assessing trade execution costs. *Journal of Financial Markets 6*, 233-257.

Bessembinder, H., 2003b. Trade execution costs and market quality after decimalization. *Journal of Financial and Quantitative Analysis 38*, 747-777.

Bessembinder, H., 2003c. Selection biases and cross-market trading cost comparisons. Working paper. University of Utah.

Boehmer, E., 2003. Dimensions of execution quality: Recent evidence for U.S. equity markets. Working paper. Texas A&M University.

Boehmer, E., R. Jennings, and L. Wei, 2003. Public disclosure and private decisions: The case of equity market execution quality. Working paper. Texas A&M University.

Boehmer, E., G. Saar, and L. Yu, 2004. Lifting the veil: An analysis of pre-trade Transparency at the NYSE. *Journal of Finance*, forthcoming.

Bollen, N., and R. Whaley, 1998. Are 'Teenies' better? *Journal of Portfolio Management 25*, 10-24.

Blume, M., and M. Goldstein, 1997. Quotes, order flow, and price discovery. *Journal of Finance 52*, 221-244.

Chakravarty, S., R. Wood, and R. Van Ness, 2004. Decimals and liquidity: A study of the NYSE. *Journal of Financial Research*, forthcoming.

Chung, K.H., B. Van Ness, and R. Van Ness, 2004. Trading costs and quote clustering on the NYSE and NASDAQ after decimalization. *Journal of Financial Research*, forthcoming.

Lipson, M., 2004. Competition among market centers. Working paper. University of Georgia.

Schultz, P., 2000. Stock splits, tick size, and sponsorship. *Journal of Finance* 55, 429-450.

United States Securities and Exchange Commission (SEC), 2000. Final rule: Disclosure of order execution and routing practices.

White, H, 1980. A heteroskedasticity-consistent covariance estimator and a direct test for heteroskedasticity. *Econometrica 48*, 817-838.

Table 1
Descriptive statistics for 1,000 NYSE stocks and 200 AMEX stocks that are subject to SEC Rule 11Ac1-5

This table shows select attributes of our study sample of 1,000 NYSE and 200 AMEX securities that are subject to the Rule for the first time. We measure trading volume by the average daily number of shares traded for the quarter ending December 31, 2000 from the TAQ database. We measure share price by the mean value of quote midpoints and trade size by the average dollar transaction in March 2001. The number of trades is the total number of transactions during March 2001. We measure return volatility by the standard deviation of daily quote midpoint returns.

			Percentile				
Variable	Mean	Standard deviation	Min	25	50	75	Max
Panel A. Descriptive statistics for 1,000 NYSE-listed stocks							
Trading volume	1,246,246	2,294,583	158,203	279,297	525,016	1,222,980	27,738,508
Share price ($)	32.59	20.50	0.29	17.71	29.04	43.43	144.38
Number of trades	15,809	20,570	311	5,068	9,470	14,622	246,132
Trade size ($)	40,424	27,735	699	20,929	33,122	53,593	183,964
Return volatility	0.0239	0.0157	0.0016	0.0142	0.0199	0.0287	0.1651
Panel B. Descriptive statistics for 200 AMEX-listed stocks							
Trading volume	439,428	3,325,010	36,138	55,002	86,371	174,212	46,460,571
Share price ($)	18.53	30.71	0.09	1.13	4.22	20.54	154.03
Number of trades	6,176	50,734	53	390	873	2,079	676,360
Trade size ($)	31,668	64,234	437	1,795	5,394	25,727	385,259
Return volatility	0.0445	0.0320	0.0000	0.0188	0.0373	0.0610	0.1604

Table 2
Comparison of market quality measures between the pre- and post-rule periods

This table reports the mean market quality measures during the pre- and post-rule periods for 1,000 NYSE and 200 AMEX stocks that were subject to SEC Rule 11Ac1-5. The quoted dollar spread is calculated as $(A_{it} - B_{it})$, where A_{it} is the posted ask price for stock i at time t, and B_{it} is the posted bid price for stock i at time t. The quoted percentage spread is calculated as $(A_{it} - B_{it})/M_{it}$, where M_{it} is the mean of A_{it} and B_{it}. The effective dollar (percentage) spread measures the dollar (percentage) execution costs actually paid by the trader. The realized dollar (percentage) spread measures price reversals after trades. Quoted depth is calculated as the sum of quoted bid size and quoted ask size. Market quality index is calculated as (1/2)Quoted depth/Quoted percentage spread. This table also shows the difference in the quoted, effective, and realized spreads between the pre-rule period (i.e., March 2001) and the event/post-rule periods (May/June-July 2001), and whether the difference is statistically significant according to paired comparison t-tests.

Variable	March	May	Change	t-stat	June	Change	t-stat	July	Change	t-stat
	(1)	(2)	(2) - (1)		(3)	(3) - (1)		(4)	(4) - (1)	
Panel A. Market quality measures for 1,000 NYSE-listed stocks subject to first phase-in of the rule (Equal-weighted average)										
Quoted dollar spread ($)	0.0831	0.0671	-0.0160	-30.93**	0.0644	-0.0187	-29.85**	0.0626	-0.0205	-28.20**
Quoted percentage spread (%)	0.4339	0.3328	-0.1010	-15.71**	0.3353	-0.0985	-10.78**	0.3470	-0.0868	-8.06**
Effective dollar spread ($)	0.0543	0.0450	-0.0093	-28.66**	0.0431	-0.0112	-27.69**	0.0425	-0.0118	-25.03**
Effective percentage spread (%)	0.2892	0.2276	-0.0616	-14.69**	0.2297	-0.0596	-9.24**	0.2397	-0.0495	-6.94**
Realized dollar spread ($)	0.0021	0.0003	-0.0017	-1.02	-0.0020	-0.0041	-2.48*	0.0002	-0.0019	-1.11
Realized percentage spread (%)	0.0761	0.0551	-0.0210	-3.41**	0.0492	-0.0269	-4.24**	0.0629	-0.0132	-1.86
Quoted depth (round lots)	52.62	46.40	-6.23	-6.74**	50.25	-2.38	-0.99	48.84	-3.78	-2.10*
Market quality index	95.44	106.19	10.75	5.59**	119.79	24.35	3.17**	117.88	22.44	3.38**
Panel B. Market quality measures for 1,000 NYSE-listed stocks subject to first phase-in of the rule (Volume-weighted average)										
Quoted dollar spread ($)	0.0730	0.0551	-0.0179	-40.16**	0.0533	-0.0197	-37.91**	0.0506	-0.0224	-36.89**
Quoted percentage spread (%)	0.2587	0.1897	-0.0690	-23.90**	0.1976	-0.0611	-13.82**	0.2011	-0.0576	-10.83**
Effective dollar spread ($)	0.0459	0.0360	-0.0099	-39.67**	0.0348	-0.0111	-36.50**	0.0334	-0.0125	-35.30**
Effective percentage spread (%)	0.1660	0.1254	-0.0406	-20.73**	0.1314	-0.0346	-11.18**	0.1345	-0.0315	-8.82**
Realized dollar spread ($)	-0.0065	-0.0113	-0.0048	-2.94**	-0.0048	0.0017	1.13	-0.0095	-0.0030	-1.75
Realized percentage spread (%)	0.0029	-0.0096	-0.0125	-2.89**	0.0018	-0.0011	-0.26	0.0036	0.0007	0.14
Quoted depth (round lots)	75.33	61.91	-13.42	-14.89**	70.66	-4.67	-2.32*	68.17	-7.16	-5.18**
Market quality index	188.30	215.25	26.94	11.66**	240.11	51.80	7.88**	224.36	36.06	7.73**

Table 2. (Continued)

Variable	March (1)	May (2)	Change (2) - (1)	t-stat	June (3)	Change (3) - (1)	t-stat	July (4)	Change (4) - (1)	t-stat
Panel C. Market quality measures for 200 AMEX stocks subject to first phase-in of the rule (Equal-weighted average)										
Quoted dollar spread ($)	0.1184	0.1038	-0.0146	-5.61**	0.1018	-0.0167	-5.86**	0.0977	-0.0207	-6.46**
Quoted percentage spread (%)	3.8894	3.5023	-0.3871	-2.52*	3.5851	-0.3042	-2.92**	3.8190	-0.0704	-0.46
Effective dollar spread ($)	0.0953	0.0818	-0.0135	-5.89**	0.0794	-0.0159	-6.80**	0.0761	-0.0192	-7.23**
Effective percentage spread (%)	3.0442	2.7690	-0.2753	-2.65**	2.9448	-0.0994	-0.86	3.0642	0.0199	0.15
Realized dollar spread ($)	0.0955	0.0819	-0.0136	-5.84**	0.0794	-0.0160	-6.77**	0.0764	-0.0191	-7.07**
Realized percentage spread (%)	1.5043	1.5204	0.0161	0.14	1.5385	0.0342	0.28	1.7483	0.2439	1.51
Quoted depth (round lots)	235.11	281.45	46.35	1.29	315.25	80.15	2.26*	334.98	99.87	2.83**
Market quality index	288.83	391.70	102.87	1.79	522.95	234.12	2.67**	529.62	240.79	2.83**
Panel D. Market quality measures for 200 AMEX stocks subject to first phase-in of the rule (Volume-weighted average)										
Quoted dollar spread ($)	0.0975	0.0721	-0.0254	-11.54**	0.0722	-0.0254	-10.59**	0.0655	-0.0321	-12.65**
Quoted percentage spread (%)	0.5941	0.4924	-0.1017	-2.80**	0.5035	-0.0905	-3.07**	0.5399	-0.0541	-1.22
Effective dollar spread ($)	0.0705	0.0527	-0.0178	-10.17**	0.0516	-0.0189	-10.83**	0.0473	-0.0232	-12.54**
Effective percentage spread (%)	0.4514	0.3820	-0.0694	-2.75**	0.3963	-0.0551	-2.02*	0.4256	-0.0258	-0.65
Realized dollar spread ($)	0.0705	0.0528	-0.0178	-10.15**	0.0517	-0.0189	-10.78**	0.0474	-0.0231	-12.46**
Realized percentage spread (%)	0.2817	0.1722	-0.1095	-3.97**	0.1926	-0.0891	-3.12**	0.2426	-0.0390	-0.84
Quoted depth (round lots)	188.74	245.29	56.56	1.49	241.52	52.79	2.71**	263.99	75.26	3.94**
Market quality index	577.90	911.38	333.48	5.42**	877.28	299.38	6.31**	1000.03	422.13	10.43**

*Significant at the 5% level.
**Significant at the 1% level.

Table 3
Regression results

To determine whether the differences in execution costs between the pre- and post-rule periods are due to changes in stock attributes over time, we employ the following approach. First, for each stock, we calculate the average spread measures during the pre-rule period (i.e., March), the event period (May), and the post-rule period (June and July), respectively. Similarly, for each stock, we calculate four stock attributes (i.e., average share price, return volatility, average trade size, and total number of trades) during each month. We then regress each spread measure on the four stock attributes and a dummy variable each for May, June, and July, respectively, using monthly observations of both the dependent and independent variables. We use the log of trade size and number of trades in the regressions because the distribution of these variables is skewed. White's (1980) t-statistics are reported in parentheses.

Panel A. Regression results for 1,000 NYSE-listed stocks subject to the first phase-in of the rule

	Dependent variable					
Independent variables	Quoted dollar spread ($)	Quoted percentage spread (%)	Effective dollar spread ($)	Effective percentage spread (%)	Realized dollar spread ($)	Realized percentage spread (%)
Intercept	0.2091	2.2111	0.1423	1.4846	0.0757	0.6740
	(28.33**)	(39.73**)	(28.85**)	(40.09**)	(6.70**)	(17.91**)
1/Price		2.2878		1.6488		1.0555
		(94.40**)		(102.25**)		(64.42**)
Price	0.0011		0.0007		-0.0004	
	(37.70**)		(36.64**)		(-8.24**)	
Return volatility	0.0010	0.0118	0.0007	0.0078	0.0010	0.0061
	(0.80)	(1.15)	(0.83)	(1.15)	(0.52)	(0.88)
log(Trade size)	-0.0026	-0.1286	-0.0017	-0.0863	0.0000	-0.0326
	(-3.01**)	(-20.30**)	(-2.90**)	(-20.48**)	(-0.04)	(-7.61**)
log(Number of trades)	-0.0144	-0.0642	-0.0101	-0.0442	-0.0067	-0.0358
	(-27.93**)	(-14.93**)	(-29.14**)	(-15.45**)	(-8.48**)	(-12.31**)
MAY	-0.0177	-0.0944	-0.0103	-0.0566	-0.0008	-0.0168
	(-15.62**)	(-10.05**)	(-13.69**)	(-9.06**)	(-0.44)	(-2.64**)
JUNE	-0.0204	-0.1049	-0.0123	-0.0637	-0.0039	-0.0285
	(-18.04**)	(-11.18**)	(-16.24**)	(-10.20**)	(-2.24*)	(-4.49**)
JULY	-0.0211	-0.1153	-0.0123	-0.0692	-0.0020	-0.0233
	(-18.67**)	(-12.27**)	(-16.25**)	(-11.06**)	(-1.15)	(-3.67**)
Adjusted R^2	0.4177	0.8415	0.4025	0.8580	0.0938	0.6878
F-value	384.96**	2854.30**	363.17**	3250.18**	56.62**	1185.54**

Table 3. (Continued)

Panel B. Regression results for 200 Amex-listed stocks subject to the first phase-in of the rule

	Dependent variable					
Independent variables	Quoted dollar spread ($)	Quoted percentage spread (%)	Effective dollar spread ($)	Effective percentage spread (%)	Realized dollar spread ($)	Realized percentage spread (%)
Intercept	0.1323	15.3214	0.1195	11.8707	0.1207	5.7944
	(6.61**)	(23.84**)	(7.49**)	(24.07**)	(7.53**)	(15.61**)
1/Price		1.3907		1.1832		0.8080
		(23.19**)		(25.72**)		(23.33**)
Price	0.0022		0.0017		0.0017	
	(18.05**)		(17.53**)		(17.49**)	
Return volatility	0.0007	0.0266	0.0007	0.0188	0.0007	-0.0136
	(0.40)	(0.43)	(0.51)	(0.40)	(0.51)	(-0.39)
log(Trade size)	0.0098	-0.8408	0.0086	-0.6512	0.0086	-0.3161
	(4.23**)	(-12.37**)	(4.65**)	(-12.48**)	(4.63**)	(-8.05**)
log(Number of trades)	-0.0199	-0.7102	-0.0186	-0.5571	-0.0187	-0.2951
	(-9.44**)	(-9.30**)	(-11.08**)	(-9.50**)	(-11.12**)	(-6.69**)
MAY	-0.0173	-0.4055	-0.0155	-0.2942	-0.0156	-0.0044
	(-2.63**)	(-1.70)	(-2.96**)	(-1.61)	(-2.96**)	(-0.03)
JUNE	-0.0217	-0.5523	-0.0203	-0.3059	-0.0205	-0.0945
	(-3.31**)	(-2.31*)	(-3.89**)	(-1.67)	(-3.90**)	(-0.69)
JULY	-0.0259	-0.7273	-0.0241	-0.5228	-0.0239	-0.0920
	(-3.93**)	(-3.03**)	(-4.57**)	(-2.84**)	(-4.53**)	(-0.66)
Adjusted R^2	0.5712	0.7471	0.564	0.7704	0.5625	0.6883
F-value	134.03**	295.98**	130.18**	336.00**	129.40**	218.35**

*Significant at the 5% level.
**Significant at the 1% level.

Table 4
Testing whether the changes in the effective spread around SEC Rule 11Ac1-5 implementation differ between large and small trades

This table reports the trade-weighted average effective spread during the pre- and event/post-rule periods for 1,000 NYSE stocks that were subject to SEC Rule 11Ac1-5. The table also shows the percentage change in the effective spreads between the pre-rule period (i.e., March 2001) and the event/post-rule periods (May/June-July 2001), and whether the difference is statistically significant according to paired comparison t-tests (t-statistics are reported in parenthesis). # denotes that the percentage change in the effective spread for trades greater than or equal to 10,000 shares is significantly (p-value < 0.05) different from the corresponding figure for trades smaller than 10,000 shares.

Variable	March	May	%Change	June	%Change	July	%Change
	(1)	(2)	100{(2) - (1)}/(1)	(3)	100{(3) - (1)}/(1)	(4)	100{(4) - (1)}/(1)
A. Equal-weighted average							
Trade size < 10,000 shares							
Effective dollar spread ($)	0.0535	0.0445	-16.03	0.0426	-18.45	0.0420	-19.13
			(-32.17**)		(-31.70**)		(-28.66**)
Effective percentage spread (%)	0.2848	0.2245	-21.09	0.2266	-20.64	0.2364	-18.08
			(-39.37**)		(-25.04**)		(-18.57**)
Trade size ≥ 10,000 shares							
Effective dollar spread ($)	0.0854	0.0711	-12.13#	0.0685	-14.34#	0.0670	-16.62#
			(-12.38**)		(-13.11**)		(-13.74**)
Effective percentage spread (%)	0.4244	0.3299	-17.71#	0.3353	-16.90#	0.3480	-15.51#
			(-18.80**)		(-14.94**)		(-9.83**)
B. Volume-weighted average							
Trade size < 10,000 shares							
Effective dollar spread ($)	0.0443	0.0351	-19.99	0.0339	-22.27	0.0326	-24.87
			(-48.90**)		(-46.58**)		(-46.83**)
Effective percentage spread (%)	0.1604	0.1224	-24.68	0.1279	-21.35	0.1311	-19.52
			(-52.21**)		(-28.83**)		(-23.15**)
Trade size ≥ 10,000 shares							
Effective dollar spread ($)	0.0737	0.0588	-18.35#	0.0566	-21.10#	0.0538	-24.70
			(-28.08**)		(-27.81**)		(-29.49**)
Effective percentage spread (%)	0.2572	0.1936	-23.73#	0.2026	-20.52	0.2064	-19.88
			(-36.57**)		(-24.00**)		(-17.12**)

*Significant at the 5% level.
**Significant at the 1% level.

Table 5
Regression results for different control samples

The table reports regression results for different control samples. To determine whether the differences in execution costs between the pre- and post-rule periods are due to changes in stock attributes over time, we regress each spread measure on the four stock attributes and a dummy variable each for May, June, and July, respectively, using monthly observations of both the dependent and independent variables. We use the log of trade size and number of trades in the regressions because the distribution of these variables is skewed. Panel B shows the regression results. White's (1980) t-statistics are reported in parentheses. Panel A reports the regression results for 1,502 NYSE-listed stocks that were not required to report but included in the June report. Panel B reports the results for 140 NASDAQ stocks. A dummy variable for MARCH is added in the regressions for these stocks. Panel C reports the results for 71 NYSE-listed stocks.

	Independent variables								
Dependent variable	Intercept	1/Price	Return volatility	log (Trade size)	log (# of trades)	MAY	JUNE	JULY	Adjusted R^2 F-value
Panel A. Regression results for 1,502 NYSE-listed stocks									
Quoted spread (%)	5.3086	4.6105	0.0437	-0.3338	-0.2188	-0.1795	-0.2437	-0.2506	0.7103
	(34.25**)	(72.94**)	(3.66**)	(-20.17**)	(-28.13**)	(-6.86**)	(-9.30**)	(-9.56**)	2105.33**
Effective spread (%)	3.5224	3.2765	0.0237	-0.2131	-0.1583	-0.1004	-0.1427	-0.1455	0.7098
	(32.45**)	(74.03**)	(2.84**)	(-18.38**)	(-29.06**)	(-5.48**)	(-7.78**)	(-7.93**)	2100.08**
Realized spread (%)	0.9595	1.9409	0.0071	-0.0459	-0.0597	-0.0526	-0.0562	-0.0543	0.4661
	(10.31**)	(51.13**)	(0.99)	(-4.62**)	(-12.77**)	(-3.35**)	(-3.57**)	(-3.45**)	750.11**

Table 5. (Continued)

	Independent variables									
Dependent variable	Intercept	1/Price	Return volatility	log (Trade size)	log (# of trades)	MARCH	MAY	JUNE	JULY	Adjusted R^2 F-value
Panel B. Regression results for 140 NASDAQ stocks										
Quoted spread (%)	8.8878	2.1968	0.0797	-0.4726	-0.4187	0.6979	-0.1482	-0.1343	-0.0573	0.5901
	(9.78**)	(8.91**)	(1.85)	(-4.50**)	(-14.63**)	(3.19**)	(-0.68)	(-0.61)	(-0.26)	123.20**
Effective spread (%)	7.9104	1.3702	0.0964	-0.4944	-0.2983	0.5879	-0.0532	-0.0419	-0.0752	0.6643
	(13.52**)	(8.63**)	(3.48**)	(-7.31**)	(-16.19**)	(4.17**)	(-0.38)	(-0.30)	(-0.53)	168.96**
Realized spread (%)	5.3307	0.9036	0.1238	-0.2959	-0.2598	0.3169	-0.1157	0.0124	0.0310	0.5086
	(8.91**)	(5.57**)	(4.37**)	(-4.28**)	(-13.80**)	(2.20*)	(-0.80)	(0.09)	(0.21)	88.86**
Panel C. Regression results for 71 NYSE-listed stocks										
Quoted spread (%)	0.7397	6.3176	-2.2366	0.1589	-0.2342		-0.1236	-0.1933	-0.1798	0.8007
	(2.09*)	(18.56**)	(-1.39)	(3.61**)	(-11.82**)		(-2.40*)	(-3.75**)	(-3.50**)	170.28**
Effective spread (%)	0.5466	3.8329	0.4081	0.0824	-0.1413		-0.0579	-0.0945	-0.0893	0.8371
	(2.75**)	(20.06**)	(0.45)	(3.34**)	(-12.72**)		(-2.01*)	(-3.27**)	(-3.09**)	217.52**
Realized spread (%)	0.5523	2.1342	-4.3595	-0.0107	-0.0388		-0.0701	-0.0485	-0.0688	0.5902
	(3.04**)	(12.22**)	(-5.30**)	(-0.47)	(-3.82**)		(-2.66**)	(-1.83)	(-2.61**)	61.69**

*Significant at the 5% level.
**Significant at the 1% level.

Figure 1. Timeline for SEC Rule 11Ac1-5

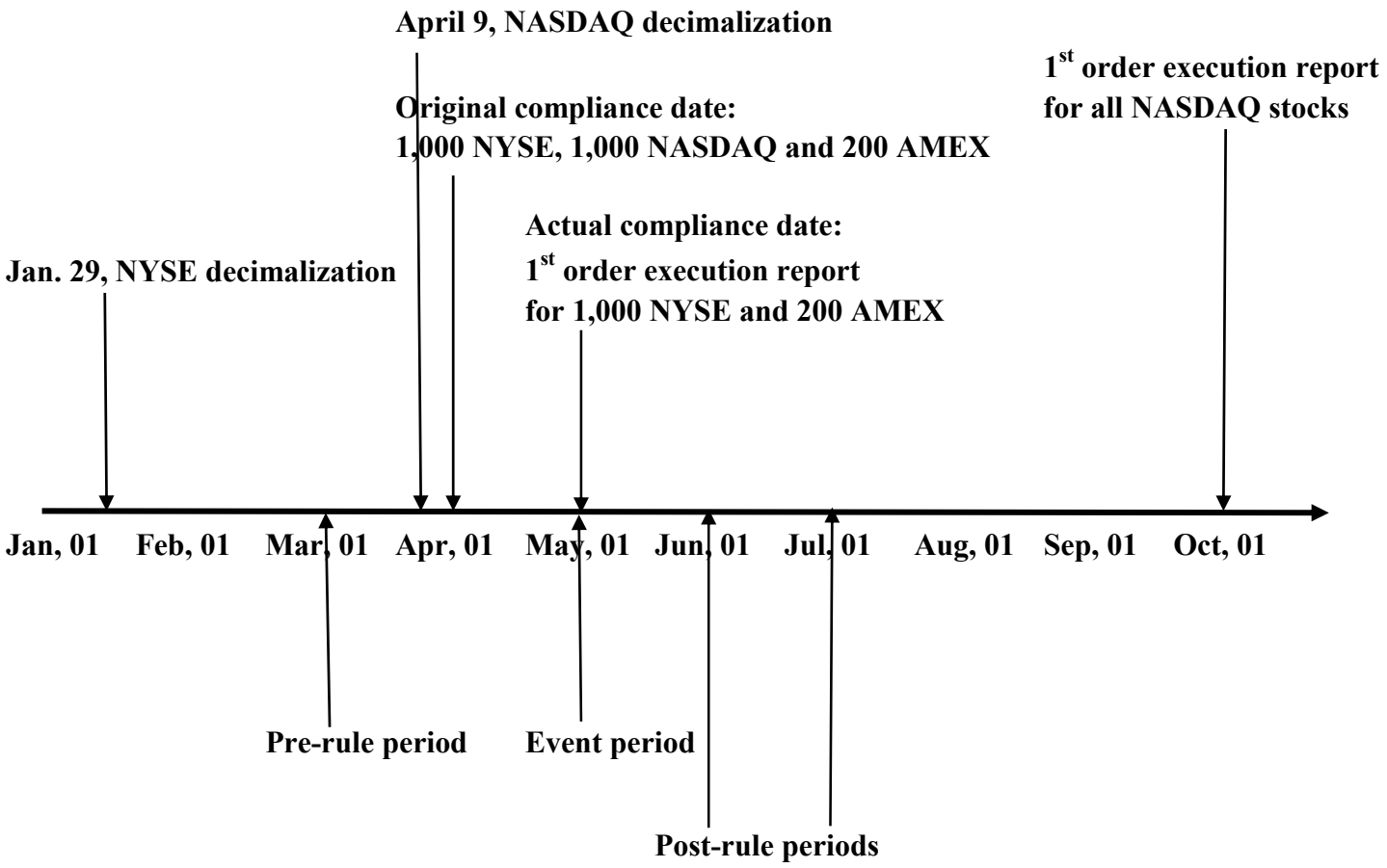


Figure 2. Historical Spread Pattern for 1,000 NYSE Stocks

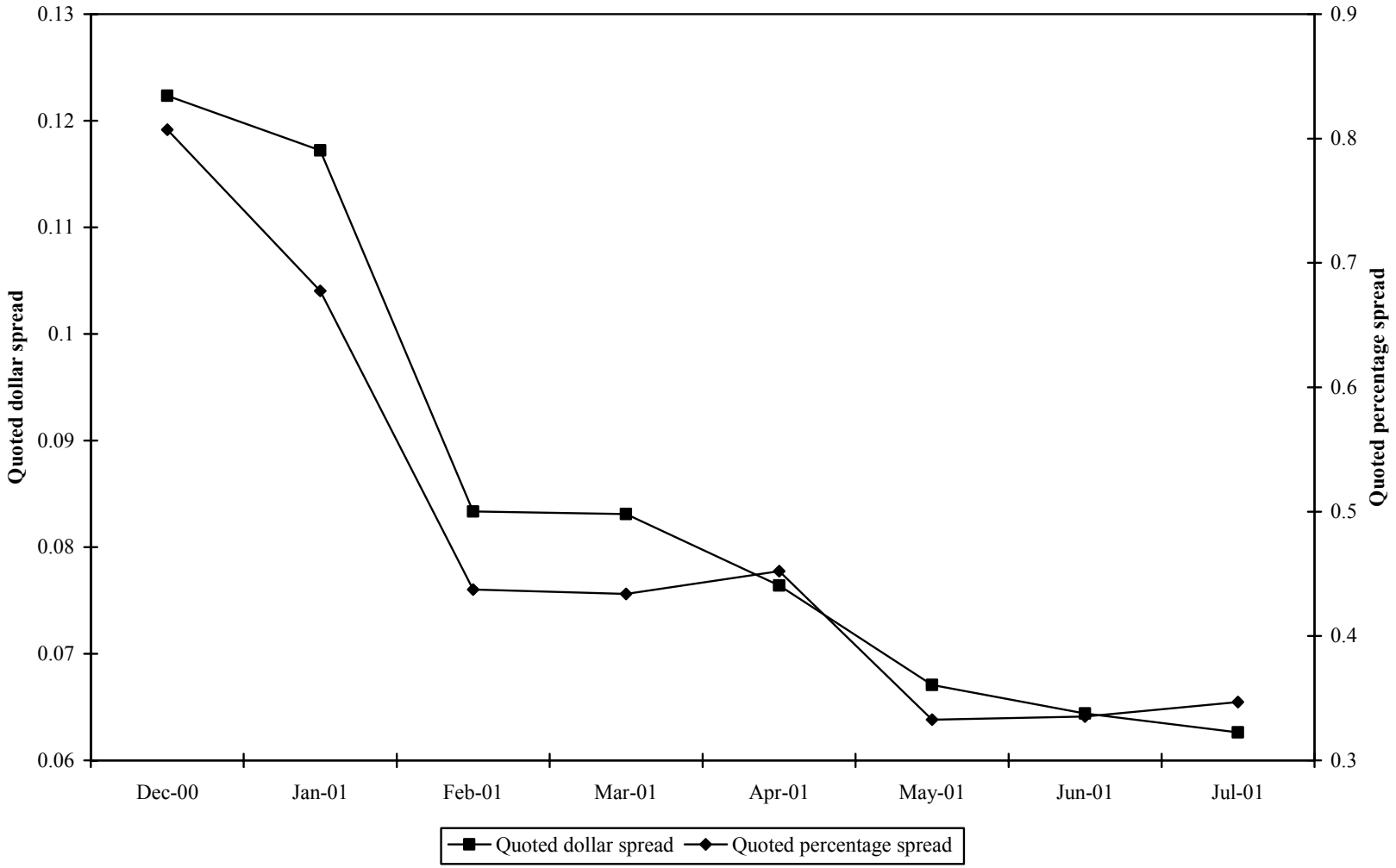
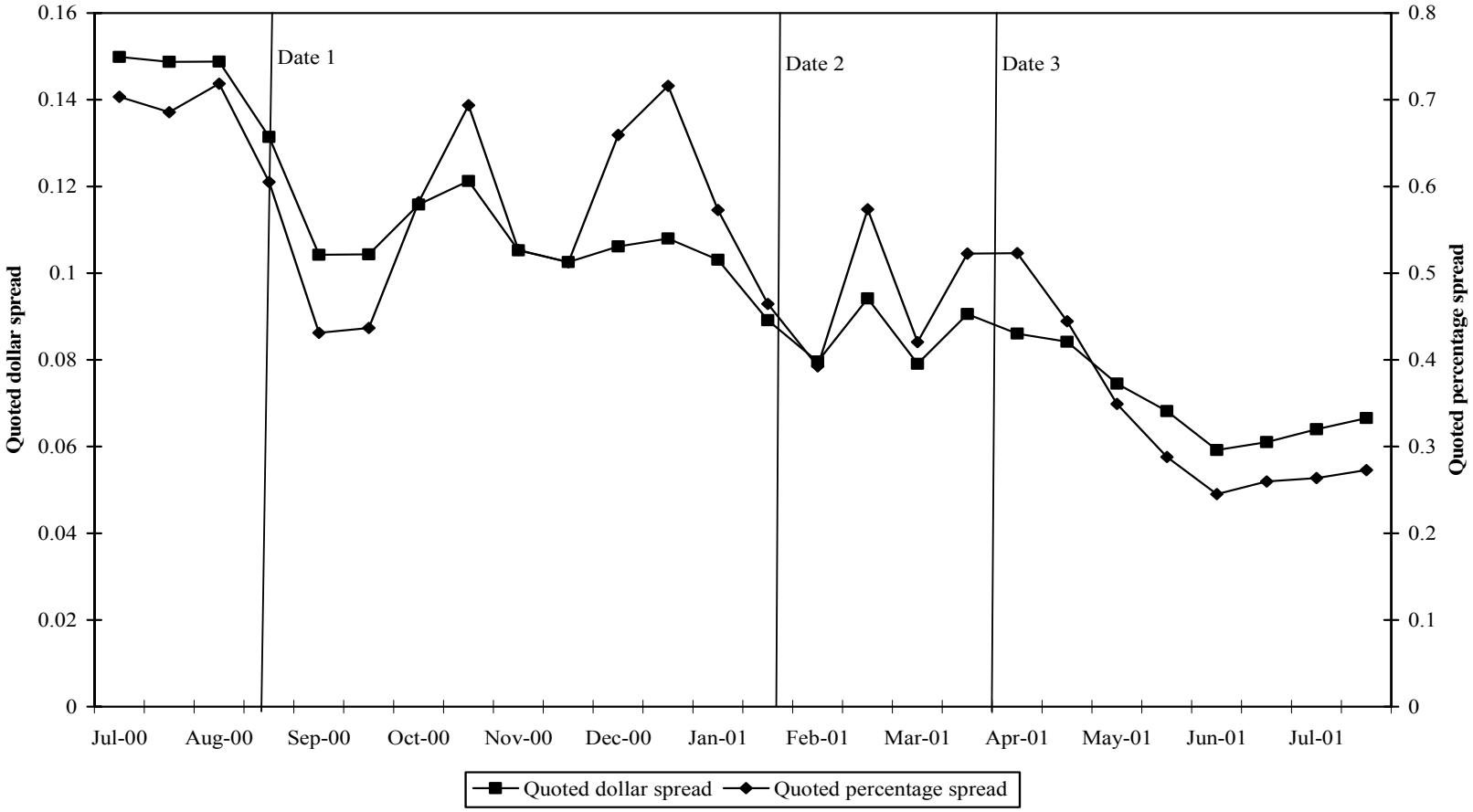
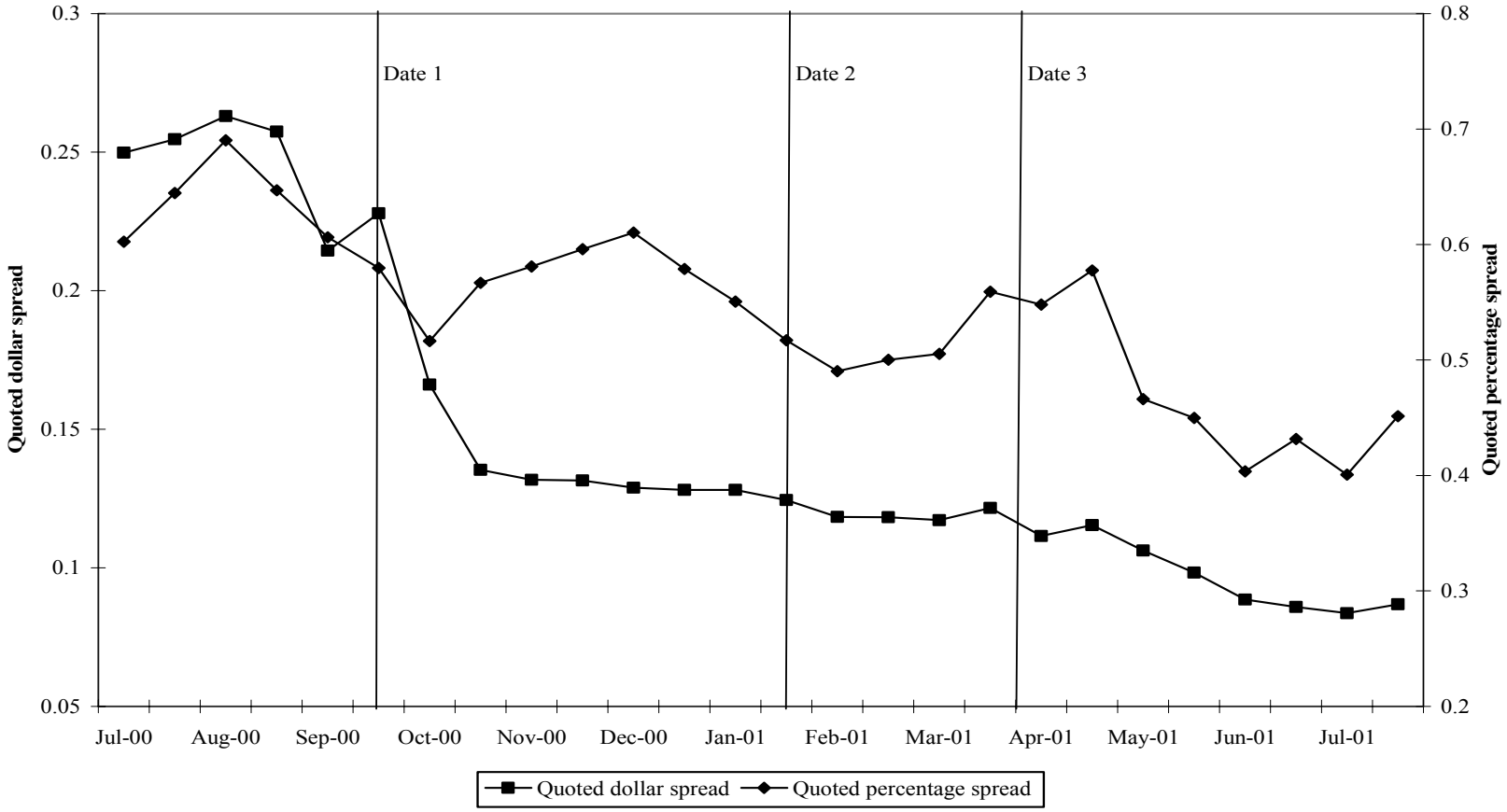


Figure 3.a. Historical Spread Pattern for 5 NYSE Stocks
Subject to the First Pilot Decimalization Program



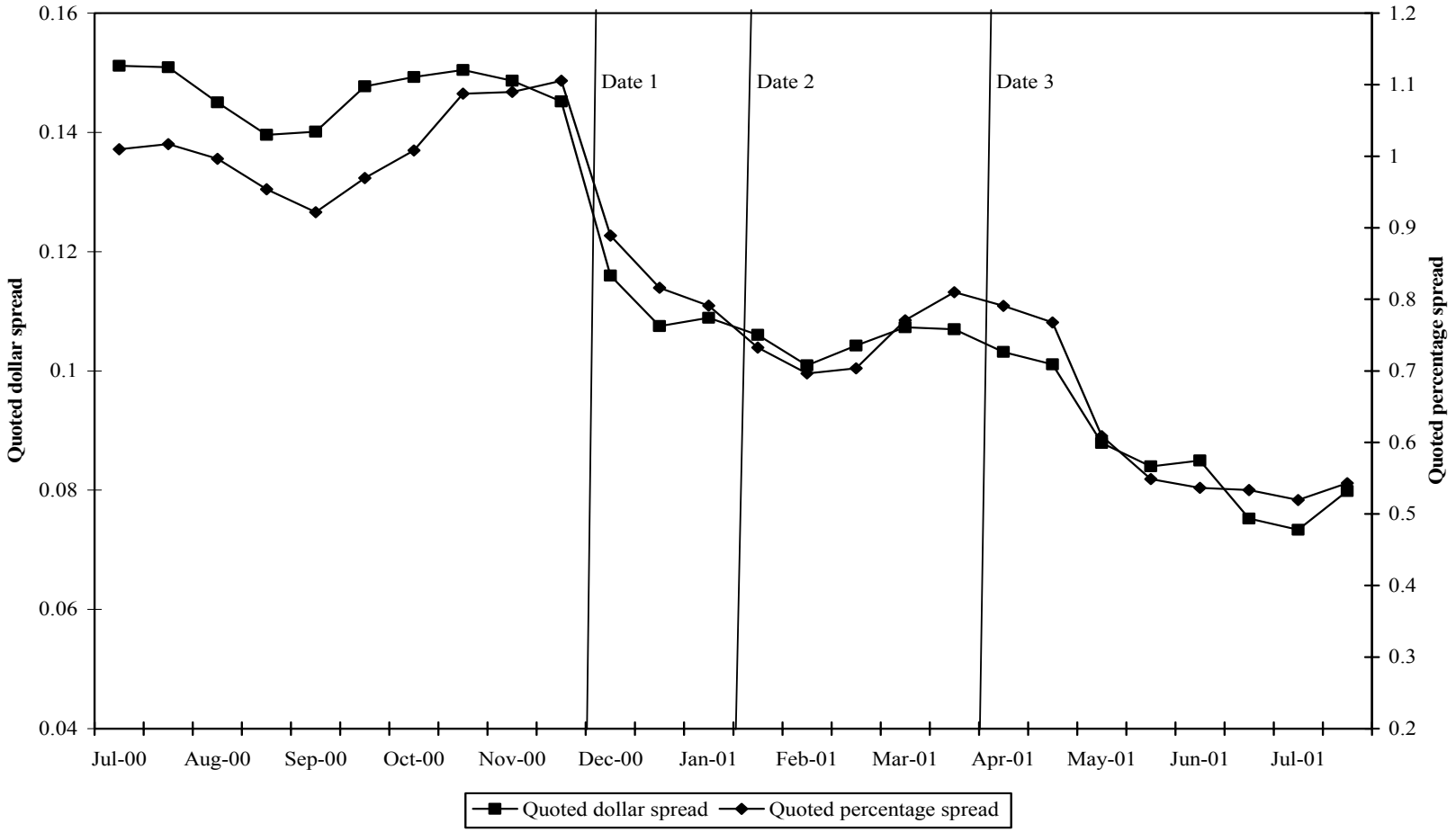
Notes: This figure shows the historical spread pattern for five NYSE stocks subject to the first pilot decimalization program. Date 1 represents the first phase-in date of decimalization effective on August 28, 2000. Date 2 represents January 29, 2001, which is the effective date for decimalization for all listed stocks on NYSE. Date 3 represents the first phase-in date of SEC Rule 11Ac1-5.

Figure 3.b. Historical Spread Pattern for 25 NYSE Stocks
Subject to the Second Pilot Decimalization Program



Notes: This figure shows the historical spread pattern for 25 NYSE stocks subject to the second pilot decimalization program. Date 1 represents the second phase-in date of decimalization effective on September 25, 2000. Date 2 represents January 29, 2001, which is the effective date for decimalization for all listed stocks on NYSE. Date 3 represents the first phase-in date of SEC Rule 11Ac1-5.

Figure 3.c. Historical Spread Pattern for 41 NYSE Stocks Subject to the Third Pilot Decimalization Program



Notes: This figure shows the historical spread pattern for 41 NYSE stocks subject to the third pilot decimalization program. Date 1 represents the third phase-in date of decimalization effective on December 4, 2000. Date 2 represents January 29, 2001, which is the effective date for decimalization for all listed stocks on NYSE. Date 3 represents the first phase-in date of SEC Rule 11Ac1-5.