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Differences in Trading Behavior across NYSE Specialist Firms

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ABSTRACT

Using a sample of NYSE-listed equities from 1992, this study examines whether market maker performance differs across specialist firms. We find that spreads and depth differ across specialist firms, but the competitiveness of NYSE quotes relative to other exchanges does not appear to be affected by these differences. Differences are also evident in measures of transitory volatility and in the frequency and duration of order-imbalance trading halts. The results suggest that specialists have a significant effect on execution costs, liquidity, and noise in security prices and that these effects are not completely eliminated by competition or the NYSE's monitoring mechanisms.

NEW YORK STOCK EXCHANGE (NYSE) specialists are responsible for maintaining a "fair and orderly market" in the securities assigned to them. As part of this responsibility, specialists are expected to post bid and ask quotes and dampen temporary price changes by trading against the market trend. At times of unusual information shocks, the specialist may also, with exchange approval, halt trading to assess market conditions and allow investors to react to new information. This study compares the performance of these market making functions across specialist firms. Specifically, we test whether spreads, depth, transitory volatility, and the use of trading halts differ across NYSE specialist firms.

Differences in performance across specialist firms may result from differences in specialist-firm characteristics such as risk aversion, organizational form, investment motives, and expertise.[1] However, specialist-firm perfor-

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[1] Coughenour and Deli (1997) find that specialist firm organizational form is related to market making costs. Stoll (1978), Ho and Stoll (1981), and O'Hara and Oldfield (1986) show that dealer pricing behavior is affected by the dealer's risk and level of risk aversion. Finally, Madhavan and Smidt (1993) find evidence consistent with a model in which specialists act as both dealers and investors.

mance is monitored closely by the NYSE and poor performance may be penalized with fines, reallocation of stocks, or ineligibility for future stock allocations. This monitoring, along with competition from other traders, should reduce differences across specialist firms.

Smidt (1971) and Barnea (1974) provide early discussions of specialist performance differences. Smidt examines liquidity and concludes that "some specialist firms turn in excellent performances; others perform in a wholly inadequate manner." Barnea examines a small sample of specialist firms and documents an independent specialist effect on both bid-ask spreads and price variability. More recently, Cao, Choe, and Hatheway (1997) find significant differences in execution costs across NYSE specialist firms. This study contributes to this literature by providing a broad analysis of differences in specialist performance across several market making functions.

The results indicate that both quoted spread and quoted depth differ across specialist firms. Further, after taking into account trades executed inside the quotes, we find that the effective spread and the proportion of trades receiving price improvement also differ across specialist firms. However, the observed differences in quotes and spreads do not appear to affect the competitiveness of NYSE quotes relative to other exchanges; there is no evidence that the proportion of time the NYSE has the best quotes differs across specialist firms.

Transitory volatility, as measured by a ratio of short-term to long-term variances, reflects noise in security prices. We find evidence of differences in transitory volatility across specialist firms, suggesting that specialists influence the level of noise in security prices. Differences are strongest for intraday measures of transitory volatility, but are also evident in measures of daily transitory volatility.

We analyze the specialist's impact on the trading-halt process by testing for differences in the frequency and duration of trading halts. Poisson regression results indicate that the frequency of order-imbalance halts differs significantly across specialist firms, whereas no differences exist for news halts. These results are consistent with the fact that only order-imbalance halts are initiated by the specialist. Importantly, the fact that differences are not apparent for news halts also provides evidence that our empirical tests have reliable size (i.e., we do not reject all null hypotheses). Finally, the duration of order-imbalance halts also differs across specialist firms, indicating that some firms are better able or more willing to quickly reopen trading once a halt is called.

Taken together, the results suggest that NYSE specialist firms have a significant impact on execution costs, liquidity, and the efficiency of prices. Although monitoring and regulation by the NYSE are designed to promote improved specialist performance, neither these controls nor competition appear to eliminate performance differences across specialist firms.

The results of this study are particularly important in light of recent NYSE policy changes. In November 1997, the NYSE Board of Directors approved changes to Exchange Rule 500 that would give listed firms more freedom to

voluntarily change listing venues (NYSE (1997a)).[2] This increased competition for listings makes an understanding of institutional features, including specialists, even more important. Furthermore, in March 1997 the Securities and Exchange Commission approved changes to the NYSE's *Allocation Policy and Procedures* that give listing firms more input in the specialist selection process (NYSE (1997b)).[3] Our results provide evidence that specialist firms affect market quality and suggest that having a choice of specialists may be valuable to listing firms.

The rest of the paper is organized as follows. In Section I, we discuss the role of the specialist and the performance measures used in the analysis. Section II describes the data, Section III presents the main results, and Section IV concludes.

I. The Role of the Specialist and Measures of Performance

Every security listed on the NYSE is assigned to a single specialist who is responsible for maintaining a fair and orderly market in that security. In return for this responsibility, specialists are given the sole right to make a market in the stocks they trade and have full access to the limit order book. In this section, we discuss the functions of the specialist and outline several performance measures related to these functions.

Individual specialists are employed by specialist firms (or units).[4] Ideally, this analysis would address performance differences across both specialist firms and individual specialists. However, the data sources employed in this study provide only firm-level specialist identification. Despite this limitation, analysis of firm-level differences is inherently interesting. First, firm-level differences may be more easily identified because within specialist firms, stocks are often traded by relief specialists (e.g., during breaks and absences) and may be redistributed between individual specialists. In contrast, transfers from one specialist firm to another are rare.[5] Second, the NYSE regulates specialists based on firm-level policies such as stock allocations and capital requirements. Finally, firm-level analysis may provide insight into the relationships between member organizations and the functioning of securities markets.

[2] Under the amended rule, a U.S. firm could delist its stock with the approval of the company's audit committee and a majority of the board of directors. A non-U.S. firm could delist with board approval. In both cases, shareholder notification would be required.

[3] The changes to the Allocation Policy allow listing firms to either (1) have their specialist unit selected by the NYSE's allocation committee, or (2) select from among three to five specialist units identified by the allocation committee. In both cases, the listing firm may submit a letter to the committee describing the general characteristics desired in a specialist unit.

[4] In some cases, two or more firms operate a joint specialist account. Because these joint accounts apply for and make markets in stocks as a single unit, they are analyzed as a single specialist firm throughout this study.

[5] Schwartz (1993) states that 11 stocks were reallocated due to poor specialist performance during the market crash of 1987. According to the NYSE, other instances of firm-level reallocations are rare.

A. Quotes and Spreads

The NYSE specialist's quotes represent the prices (and amounts) at which the specialist is willing to trade in the absence of other trading interest. We define five performance measures related to the specialist's quotes: quoted spread, effective spread, percentage of trades that receive price improvement, quoted depth, and percentage of time the specialist posts the best quotes.

The percentage quoted spread is calculated at the opening quote and at the last outstanding quote of each half hour during the trading day as follows:

$$\%\ Quoted\ Spread = 100 * \frac{Ask - Bid}{(Ask + Bid)/2}, \tag{1}$$

where *Ask* and *Bid* are the NYSE specialist's ask and bid quotes, respectively. The mean percentage quoted spread for each security is then calculated by averaging across all intraday periods and all trading days during the sample period.

If trades are executed at prices inside the quotes, the round-trip execution cost is less than the quoted spread (see, e.g., Peterson and Fialkowski (1994)). For these trades, the difference between the posted quote and the transaction price is generally referred to as *price improvement*. To account for these trades, we calculate the percentage effective spread and the percentage of trades that receive price improvement.[6] For each transaction, the percentage effective spread is calculated as:

$$\%\ Effective\ Spread = 200 * \frac{|Price - Midpoint|}{Midpoint}, \tag{2}$$

where *Price* is the transaction price and *Midpoint* is the average of the best bid and best ask in effect 15 seconds prior to the trade.[7] The mean percentage effective spread for each security is then calculated by averaging over all transactions during the sample period. The percentage of price-improved trades is defined as 100 times the proportion of trades executed inside the best bid and ask quotes.

Depth is the maximum number of shares that can be traded at the bid and ask prices. Thus, quoted depth is closely related to the liquidity of the market. For the last outstanding quote of each half hour, we calculate total quoted

[6] For trades larger than the posted depth, transaction prices may actually be outside the posted quotes. Calculating effective spreads also takes these trades into account.

[7] Lee and Ready (1991) find that trades are often reported with a lag. Hasbrouck, Sofianos, and Sosebee (1993) report a median lag of 14 seconds. Thus, we match trades to quotes in effect 15 seconds prior to the trade time.

depth as the sum of bid and ask depth. We then calculate the mean quoted depth for each security by averaging across all intraday periods and all trading days during the sample period.

Finally, many securities listed on the NYSE are also traded on other exchanges. The existence of competing quotes on other trading facilities suggests an alternative measure of specialist performance: the percentage of time the NYSE specialist has the best quotes. At every point in time, we determine the highest bid and lowest ask quotes and the associated trading facilities. The percentage of time at the inside quotes is then calculated as 100 times the number of seconds the NYSE specialist has both the best bid and best ask, divided by the total number of seconds that quotes are posted for the security.

B. Transitory Volatility

In addition to providing liquidity, NYSE specialists are expected to stabilize stock price movements by trading from their own inventory against the market trend (NYSE (1992–96)). This stabilization function is intended to minimize transitory volatility or temporary price movements away from long-run values.[8] If some specialists are better price-stabilizers, prices in their shares should exhibit lower transitory volatility.

French and Roll (1986) argue that, if returns are independent, the sum of subperiod return variances will equal the variance of full-period returns. However, pricing errors (noise) in security prices lead to negative serial correlation in returns as errors are corrected. This negative serial correlation reduces the full-period variance relative to the sum of subperiod variances. Thus, ratios of variances computed over different intervals reflect transitory volatility in returns.[9]

We compute four variance ratios based on the following continuously compounded return series: an overnight close-to-open return series (R_0), thirteen 30-minute return series from the open to the close (R_1 through R_{13}), a six-hour return series from 10 a.m. to 4 p.m. (R_{6Hr}), a daily open-to-open return series (R_{Open}), a daily close-to-close return series (R_{Day}), and a five-day close-to-close return series (R_{5Day}). Variances are calculated over the 254 trading days in the sample period and are based on quote-midpoint returns to remove noise due to bid-ask bounce.

[8] The price-stabilizing activities of the specialist should not be confused with the type of stabilization carried out by underwriters in the IPO market (see, e.g., Hanley, Kumar, and Seguin (1993)). Specialist stabilization is intended to limit temporary price movements in either direction, not to prevent the stock price from declining.

[9] Schwartz and Whitcomb (1976) and Goldman and Beja (1979) point out that lower variance ratios may also result from positive serial correlation caused by specialist intervention to allow only partial price adjustment. This behavior would be consistent with the specialist's obligation to provide price continuity.

To calculate the first variance ratio, we sum the overnight return variance and the thirteen 30-minute return variances to form an aggregate 24-hour variance. The one-day variance ratio is then computed as

$$VR_{(1Day)} = \frac{\sum_{t=0}^{13} VAR(R_t)}{VAR(R_{Day})}. \tag{3}$$

To remove the effects of the overnight nontrading period and the opening call auction, we calculate a second intraday variance ratio. The six-hour variance ratio is based on return series from 10:00 a.m. to the close and is equal to

$$VR_{(6Hr)} = \frac{\sum_{t=2}^{13} VAR(R_t)}{VAR(R_{6Hr})}. \tag{4}$$

Although the specialist's impact is likely to be greatest during intraday intervals, the specialist may also have some impact on price movements across days. To address this possibility, we calculate a five-day variance ratio defined as

$$VR_{(5Day)} = \frac{5 \times VAR(R_{Day})}{VAR(R_{5Day})}. \tag{5}$$

Finally, following Amihud and Mendelson (1987, 1991) and Stoll and Whaley (1990), we calculate a variance ratio based on the open-to-open return variance and the close-to-close return variance. This ratio allows us to examine the efficiency of opening prices and is defined as

$$VR_{(OC)} = \frac{VAR(R_{Open})}{VAR(R_{Day})}. \tag{6}$$

C. Trading Halt Use

When significant information is revealed or extreme order imbalances occur, trading in a security may be halted. Trading halts limit the risks of the specialist during these unusual periods and protect investors by allowing them to change or cancel orders. However, excessive use of trading halts may also harm investors. First, investors cannot trade during halts. Second, trading halts decrease information flow, which may result in less efficient prices and increased transitory volatility (see Lee, Ready, and Seguin (1994)

and Gerety and Mulherin (1994)). We analyze trading-halt use by testing for differences across specialist firms in the frequency and duration of trading halts.

The two primary categories of trading halts on the NYSE are news (or regulatory) halts and order-imbalance (or nonregulatory) halts. News halts are initiated by *exchange officials* in response to actual or expected news announcements that may have a substantial impact on the price of a listed security (Hasbrouck et al. (1993)). Order-imbalance halts are called when a large imbalance exists between buy and sell orders. Unlike news halts, however, order imbalance halts are initiated by the *specialist* and subsequently approved by a floor official. Thus, the effects of specialists on halt frequency should be limited to order-imbalance halts.

Specialists also play a significant role in the resolution of trading halts. During a halt, the specialist posts indicator quotes that provide a range for a possible reopening price. The specialist then receives order commitments from the trading floor and posts updated indicator quotes until a new equilibrium price can be determined. We define duration as the number of trading minutes from the beginning of the halt to the reopening trade. This measure reflects the specialist's ability to resolve any order imbalance and determine the new equilibrium price.

II. Data and Summary Statistics

The sample period covers the 254 trading days from January 2 through December 31, 1992. The stocks traded by each specialist firm are identified using the NYSE's *Specialist Directory* from December 1, 1992. The resulting sample includes 2,044 common stocks (including ADRs, closed-end funds, real estate investment trusts (REITs), and Units) traded by 41 specialist firms.

Intraday quote and transaction data are collected from the Institute for the Study of Security Markets (ISSM). Only B.B.O. eligible and closing quotes are included, where B.B.O. refers to quotes that are eligible to be included in the National and NASD Best Bid and Offer calculations. Quotes excluded from the B.B.O. calculation include closing quotes, nonfirm quotes, preopening indications, and quotes during trading halts. Furthermore, we exclude quotes that are outside the 9:00–4:30 trading interval and screen out observations that are likely to be data errors.[10] Additional data are obtained from CRSP and the NYSE's trading-halt files.

To be included in the final sample, a security is required to (i) have data available on both ISSM and CRSP, (ii) be listed the entire year, and (iii) have an average transaction price during 1992 of \$3 to \$400. The first restriction

[10] We exclude any transaction price (quote) that is negative or differs from the previous price (quote) by more than 20 percent. We also exclude quotes if the bid-ask spread is negative. Finally, for calculations of effective spreads, a transaction is excluded if it results in an effective spread greater than \$2.00 or if the outstanding quoted spread is greater than \$2.00 or is missing.

eliminates 58 stocks (2.8 percent of the sample). Restrictions (ii) and (iii) eliminate an additional 267 stocks (13.1 percent). Finally, we exclude Kubota CP (KUB) because the bid-ask spread for this security generally ranged from \$5 to \$10. The final sample includes 1,718 stocks.

Table I lists summary statistics for the entire sample and specialist-firm portfolios, where specialist firms are listed according to their unit numbers (e.g., M. J. Meehan is unit #20, Walter N. Frank is unit #34, etc.). The number of securities traded by a specialist firm averages 49.9 and ranges from 11 traded by Scholl & Levin to 216 traded by Spear, Leeds & Kellogg. Differences are also evident in the composition of specialist portfolios. For example, closed-end funds, REITs, and Units make up only 10 percent of the portfolio of Marcus Schloss & Co., but more than 43 percent of the securities traded by Weiskopf Silver/O. Gruss are investment funds. Results from χ^2-tests show that both the proportion of funds in a specialist-firm portfolio and the proportion of foreign securities differ significantly across specialist firms.

The mean market value and price in the sample are \$2.09 billion and \$25.64, respectively. The average daily volume in the sample is 131,000 shares. On average, 17.6 percent of share volume was traded on exchanges other than the NYSE and 33.9 percent was executed in block trades. Mean price, volume, regional volume, and block volume all differ significantly across specialist firms at the 10 percent level. Table I also lists the total number of trading halts called by each specialist firm during 1992 and the ratio of halts called relative to total stocks traded by the firm. The number of halts called per stock differs significantly across specialist firms (p-value = 0.000) and ranges from zero for Scholl & Levin to 1.1 for Fowler, Rosenau & Geary.

Table II provides summary statistics for the sample of news and order-imbalance trading halts that were called for the 1,718 sample stocks. Of the 1,017 trading halts, 667 were order-imbalance halts and 350 were news halts.[11] The mean halt duration for the entire sample is 53.08 minutes. However, 55 halts were extended to more than one trading day. Excluding these halts reduces the average duration in the sample to 50.40 minutes. News halts have a mean duration of 70.56 minutes and tend to last longer than order-imbalance halts, which have a mean duration of 46.00 minutes. The mean absolute price change for the entire sample is 6.70 percent, and varies from 5.20 percent for news halts to 7.49 percent for order-imbalance halts.

Summary statistics for the quote and spread variables are provided in Panel A of Table III. The average quoted spread is 1.36 percent and total quoted depth averages nearly 10,000 shares. On average, 22 percent of trades receive price-improvement, resulting in a mean effective spread of 0.94 percent. Finally, NYSE specialists' quotes represent both the best bid and best ask more than 75 percent of the time, on average. F-tests based on analysis of variance (Kruskal–Wallis tests) reject equality of means (medians) across specialist firms for all of the measures except quoted depth.

[11] One additional halt was classified as an equipment-failure halt. This halt is excluded from the analysis.

Summary statistics for the variance ratios are listed in Panel B of Table III. The mean one-day and six-hour variance ratios are 1.08 and 1.13, respectively. These values are consistent with noise in security prices that is corrected within the day. Additionally, the mean five-day variance ratio of 1.10 suggests that some noise in security prices may not be corrected by the end of the trading day. Equality of means across specialist firms is rejected for both one-day and six-hour variance ratios. Equality of medians is rejected for one-day, six-hour, and five-day variance ratios. These results suggest that the impact of specialist firms on transitory volatility is most important within the day.

The mean and median open-to-close variance ratios are 0.97 and 1.03, respectively. Neither the mean nor median differs significantly across specialist firms. It should be noted that we calculate open-to-close variance ratios based on opening quote-midpoints rather than opening call-auction prices as in Amihud and Mendelson (1987, 1991) and Stoll and Whaley (1990). Reestimation of the ratio based on call-auction prices results in mean and median values of 1.31 and 1.16, respectively. Differences in results based on these two measures are discussed in Section III.

III. Regression Analysis

The results in Section II provide at least preliminary evidence that performance differs across specialist firms. However, the results in Table I indicate that the characteristics of the stocks for which a firm makes a market also differ across specialist firms. In this section, we employ regression techniques to determine whether the observed differences in performance are due to the specialist firm or the characteristics of the securities traded by the firm.

The regressions include several variables shown in previous studies to affect spreads. These variables are trade size, number of trades, market capitalization, and the standard deviation of daily returns. Although these variables are derived from theories of dealer pricing (e.g., Ho and Stoll (1981), O'Hara and Oldfield (1986), Copeland and Galai (1983), and Glosten and Milgrom (1985)), they may also affect other measures of performance because they proxy for the asymmetric-information and inventory risks faced by the specialist. The regressions also include quote midpoint to control for price discreteness (Harris (1994)) and dummy variables to allow performance measures to differ for foreign securities and investment funds.[12]

To test for differences across the 41 specialist firms, we include dummy variables identifying 40 of the firms. The excluded specialist firm, Bocklet & Co., traded the median number of stocks and serves as a benchmark in

[12] The proportions of regional and block volume were also considered as explanatory variables. However, it could be argued that these variables are also affected by the specialist and by the levels of other performance measures such as bid-ask spreads. To avoid simultaneity problems, regional and block volume are not included in the regressions. The reported results are not sensitive to the inclusion of these variables.

Table I

Summary Statistics for Sample Securities and Specialist Portfolios

The sample includes all stocks listed on the NYSE during 1992 (according to the 12/1/92 NYSE *Specialist Directory)* that (i) had data available on both CRSP and ISSM, (ii) were listed the entire year of 1992, and (iii) had an average closing price during 1992 of $3 to $400. Investment Funds include closed-end funds, real estate investment trusts (REITs), and Units. Foreign Stocks include ADRs and stocks incorporated outside the United States. Market Capitalization equals shares outstanding at the end of 1992 multiplied by the last closing price of 1992. Price and Volume are average closing price and average daily share volume during 1992, respectively. Regional Volume is the percentage of 1992 share volume transacted on exchanges other than the NYSE. Block Volume is the percentage of 1992 share volume executed in trades of at least 10,000 shares. Trading halts include all news and order-imbalance halts called during 1992 that involved one of the 2,044 stocks in the original sample. Investment fund and foreign security frequencies are based on the 2,026 stocks with available CRSP data. All other statistics are based on the 1,718 sample stocks. For mean values, we report the F-statistic (p-value) for the test of the restriction that means are equal across specialist firms based on analysis of variance. For trading halt, investment fund, and foreign security proportions, we report the χ^2-statistic (p-value) for the test of the restriction that proportions are equal across specialist firms.

							Mean Values				
Sample/Specialist Firm	Total Stocks	Sample Stocks	Total Trading Halts	Avg. Halts per Stock	Investment Funds (%)	Foreign Stocks (%)	Market Cap. ($ mil)	Price ($)	Daily Volume (000)	Regional Volume (%)	Block Volume (%)
Complete Sample	2,044	1,718	1,125	0.55	21.17	6.37	2,092	25.64	131	17.57	33.87
M.J. Meehan	46	38	24	0.52	15.22	17.39	4,435	32.41	267	14.81	39.58
Walter N. Frank	43	34	18	0.42	35.71	11.90	999	21.14	117	22.91	34.16
Fagenson/Frankel/Streicher/Cohen	60	54	27	0.45	28.33	6.67	1,711	20.78	102	19.24	28.19
Benjamin Jacobson & Sons	54	40	44	0.81	20.75	5.66	2,820	28.59	168	15.65	37.33
Lawrence, O'Donnell, Marcus	57	50	46	0.81	15.79	5.26	2,020	30.23	142	14.53	35.27
Stokes, Hoyt	34	28	10	0.29	23.53	5.88	3,777	27.32	102	18.32	32.40
MMS & N	77	67	53	0.69	17.11	5.26	2,239	27.48	134	15.53	36.68
La Branche	93	78	53	0.57	10.99	12.09	2,614	24.87	161	14.75	36.98
Henderson Brothers	94	81	41	0.44	16.13	5.38	1,765	28.98	132	17.20	38.44
Ernst/Ware & Keelips/Homans	46	40	17	0.37	26.09	0.00	3,932	24.07	171	19.15	34.97
RSF Partners	38	33	20	0.53	21.05	0.00	1,322	21.97	98	20.18	32.67
Buttonwood Specialists	20	16	5	0.25	30.00	5.00	631	20.69	63	18.32	29.84
Mercator Partners	74	59	38	0.51	14.86	1.35	224	26.51	144	16.50	40.06
Einhorn	29	23	30	1.03	17.86	3.57	2,439	25.41	116	16.65	34.89
RPM Specialist Corp.	85	75	62	0.73	20.24	1.19	3,046	31.92	137	15.41	31.59
AC Partners	73	63	23	0.32	19.44	4.17	1,539	23.41	114	17.85	38.20
Marcus Schloss and Co.	21	17	22	1.05	10.00	10.00	2,984	31.58	259	16.01	45.44

Spear, Leeds & Kellogg	216	186	115	0.53	14.49	4.67	1,964	27.87	124	16.61	34.27
Fernandez, Bartsch & Mirra	38	34	10	0.26	21.05	7.89	1,967	22.96	90	18.67	29.65
Stern & Kennedy	32	24	27	0.84	21.88	0.00	1,664	26.57	124	14.98	38.28
Wagner, Stott	42	38	16	0.38	23.81	4.76	3,260	30.11	209	18.15	31.91
Stuart, Scotto, Cella	17	15	6	0.35	25.00	0.00	717	19.70	79	22.00	31.53
Gavin, Benton	47	38	18	0.38	36.96	2.17	808	18.87	83	21.73	26.84
Scavone, McKenna, Cloud	33	27	8	0.24	33.33	6.06	1,053	28.76	77	17.82	25.62
JJC Specialist Corp.	87	70	34	0.39	19.54	5.75	1,331	22.40	88	17.92	31.56
Surnamer, Weissman	27	23	8	0.30	25.93	11.11	1,551	21.21	91	17.05	32.58
Purcell, Graham/R. Adrian	14	10	5	0.36	21.43	7.14	2,267	21.72	168	14.45	33.11
Bocklet	38	30	28	0.74	28.95	10.53	1,260	21.52	168	17.06	35.10
Scholl & Levin Corp.	11	8	0	0.00	18.18	0.00	4,870	38.84	274	25.53	45.95
Corroon, Lichtenstein	38	30	21	0.55	21.05	10.53	989	19.84	101	18.07	38.38
Foster, Marks, Natoli, Safir	33	25	31	0.94	15.15	3.03	2,081	27.45	173	21.25	33.64
Bear/Hunter Specialists	58	48	24	0.41	20.69	12.07	1,492	22.35	112	18.84	35.78
Nick, Lyden	38	33	35	0.92	34.21	13.16	1,106	21.18	102	17.58	32.75
Weiskopf Silver/O. Gruss	23	18	6	0.26	43.48	17.39	376	18.72	38	17.62	27.09
Merrill Lynch Specialists	85	79	50	0.59	20.00	5.88	2,998	26.14	179	18.60	28.76
Benton, Corcoran, Leib	27	23	12	0.44	73.08	0.00	1,044	20.07	116	22.84	20.01
Stern Bros.	46	39	26	0.57	13.33	4.44	2,498	30.56	121	16.78	31.87
Fowler, Rosenau & Geary	56	50	62	1.11	16.07	7.14	3,225	28.24	138	17.76	34.01
Webco Securities	32	26	16	0.50	25.00	3.13	701	14.82	80	20.62	30.15
ABD-NY	24	18	18	0.75	29.17	12.50	246	16.06	38	20.56	31.49
Equitrade Partners	38	30	16	0.42	19.44	22.22	2,319	30.17	113	16.25	32.31
$F[\chi^2]$-statistic	—	—	—	[364.361]	[97.360]	[71.923]	1.085	2.010	1.435	1.695	2.461
(p-value)				(0.000)	(0.000)	(0.001)	(0.331)	(0.000)	(0.039)	(0.004)	(0.000)

Table II

Summary Statistics for NYSE Trading Halts

The sample includes all stocks listed on the NYSE during 1992 (according to the 12/1/92 NYSE *Specialist Directory)* that (i) had data available on both CRSP and ISSM, (ii) were listed the entire year of 1992, and (iii) had an average closing price during 1992 of $3 to $400. Trading halts during 1992 are identified for the sample stocks using the NYSE's trading halt files. The resulting sample includes 1,017 trading halts and opening delays. News halts include both news-dissemination and news-pending halts. Duration is the number of minutes from the beginning of the trading halt to the reopening trade. For multiple-day halts, duration excludes the nontrading period from 4:00 p.m. to 9:30 a.m. Reopening volume is the number of shares traded in the reopening transaction. The price change during the halt is the difference between the reopening transaction price and the most recent transaction price prior to the halt. Percentage Price Change is the price change divided by the pre-halt price (multiplied by 100). Absolute Percentage Price Change is the absolute value of the percentage price change. The *F*-statistic (*p*-value) tests the restriction that means are equal across specialist firms based on analysis of variance.

		Mean Values			
Sample	Number of Halts	Duration in Minutes	Reopening Volume	Percentage Price Change	Absolute Percentage Price Change
Full sample	1,017	53.08	133,016	−1.19	6.70
Subsamples:					
Order imbalance	667	35.78	167,869	−1.58	7.49
News	350	86.15	66,406	−0.44	5.20
Opening delays	723	46.00	145,009	−1.41	7.29
Intraday halts	294	70.56	103,423	−0.62	5.26
Positive price change	417	48.38	122,570	6.69	6.69
Zero price change	59	74.58	64,405	—	—
Negative price change	541	54.36	148,361	−7.45	7.45
F-statistic	—	1.327	2.234	1.199	1.965
(*p*-value)		(0.088)	(0.000)	(0.190)	(0.000)

the regressions. Significance tests are based on White's (1980) heteroskedasticity-consistent χ^2-test if homoskedasticity is rejected at the 5 percent level.

For all of the performance measures except trading halt frequency, we estimate OLS regressions using a log specification for the dependent variables. The log specification is used to account for the fact that these performance measures are nonnegative by construction. The results are similar if the performance measure is used as the dependent variable rather than its log. The regressions take the following general form:

$$\begin{aligned} \textit{Dependent Variable} = {} & \gamma_0 + \gamma_1 \operatorname{Ln}(\textit{Midpoint}) + \gamma_2 \operatorname{Ln}(\textit{Number of Trades}) \\ & + \gamma_3 \operatorname{Ln}(\textit{Trade Size}) + \gamma_4 \operatorname{Ln}(\textit{Market Capitalization}) \\ & + \gamma_5 \textit{Standard Deviation} + \gamma_6 \textit{Fund} + \gamma_7 \textit{Foreign} \\ & + \sum_{j=1}^{40} \delta_j D_j + \epsilon. \end{aligned} \tag{7}$$

Table III

Summary Statistics for Specialist Performance Measures

The sample includes all stocks listed on the NYSE during 1992 (according to the 12/1/92 NYSE *Specialist Directory)* that (i) had data available on both CRSP and ISSM, (ii) were listed the entire year of 1992, and (iii) had an average closing price during 1992 of \$3 to \$400. Spread and depth variables are listed in Panel A. Panel B lists summary statistics for transitory volatility measures. Variance ratios are calculated using an overnight (close-to-open) return series (R_0), 13 half-hour return series between the open and the close (R_1–R_{13}), a six-hour return series from 10:00 a.m. to the close (R_{6Hr}), a one-day close-to-close return series (R_{Day}), a one-day open-to-open return series (R_{Open}), and a five-day (close-to-close) return series (R_{5Day}). All return series are calculated from bid-ask quote midpoints. $VAR(R)$ is the variance of return series R over all trading days in 1992 for which the returns could be calculated. The F-statistic (p-value) tests the restriction that means are equal across specialist firms based on analysis of variance. The χ^2-statistic (p-value) is for the Kruskal–Wallis test of the restriction that medians are equal across specialist firms.

	N	Mean	Median	F-statistic (p-value)	χ^2-statistic (p-value)
Panel A: Quotes and Spreads					
Quoted spread (%)	1,718	1.36	1.11	1.901 (0.000)	96.696 (0.000)
Effective spread (%)	1,718	0.94	0.76	2.129 (0.000)	101.770 (0.000)
Total quoted depth (000)	1,718	9.92	7.49	1.138 (0.257)	44.057 (0.303)
Price improved trades (%)	1,718	21.97	21.97	4.823 (0.000)	180.010 (0.000)
Time at inside quotes (%)	1,718	75.91	79.08	2.283 (0.000)	97.055 (0.000)
Panel B: Transitory Volatility					
$VR_{(1Day)} = \frac{\sum_{t=0}^{13} VAR(R_t)}{VAR(R_{Day})}$	1,718	1.0862	1.0421	2.249 (0.000)	94.884 (0.000)
$\text{VR}_{(6\text{Hr})} = \frac{\sum_{t=2}^{13} VAR(R_t)}{VAR(R_{6Hr})}$	1,718	1.1305	1.0597	2.683 (0.000)	106.740 (0.000)
$\text{VR}_{(5\text{Day})} = \frac{VAR(R_{Day}) \times 5}{VAR(R_{5Day})}$	1,717	1.1034	1.0175	0.528 (0.993)	59.611 (0.023)
$\text{VR}_{(OC)} = \frac{VAR(R_{Open})}{VAR(R_{Day})}$	1,718	0.9760	1.0331	1.166 (0.221)	38.812 (0.523)

Midpoint, *Number of Trades*, and *Trade Size* are the average quote-midpoint, average number of trades per day, and average trade size in shares during 1992. *Market Capitalization* equals price times shares outstanding as of December 31, 1992. The *Standard Deviation* of daily returns is calculated over the 254 trading days in 1992, where daily returns are calculated from bid-

ask midpoints and are continuously compounded.[13] *Fund* is a dummy variable equal to one if the stock is a closed-end fund, REIT, or Unit, and zero otherwise. *Foreign* is a dummy variable equal to one if the stock is a foreign security and zero otherwise. $D_j, j = 1, \ldots, 40$, are dummy variables that equal one if the indicated specialist firm traded the stock and zero otherwise. Duration regressions include one observation per halt. All other regressions include one observation per stock.

We use a Poisson regression to model trading halt frequency.[14] This model accounts for the discrete nature of the data and works well for count data of this type.[15] We assume that the number of trading halts called for a security, H, is drawn from the following Poisson distribution:

$$f(H) = \frac{\lambda^H e^{-\lambda}}{H!}, \qquad H = 0,1,2,\ldots. \tag{8}$$

Further, we assume that the mean number of halts called, λ, is conditioned on a set of explanatory variables according to the equation:

$$\begin{aligned} \mathrm{Ln}(\lambda) = {} & \gamma_0 + \gamma_1 \mathrm{Ln}(\textit{Midpoint}) + \gamma_2 \mathrm{Ln}(\textit{Number of Trades}) \\ & + \gamma_3 \mathrm{Ln}(\textit{Trade Size}) + \gamma_4 \mathrm{Ln}(\textit{Market Cap.}) \\ & + \gamma_5 \textit{Standard Deviation} + \gamma_6 \textit{Fund} + \gamma_7 \textit{Foreign} \\ & + \sum_{j=1}^{40} \delta_j D_j + \epsilon, \end{aligned} \tag{9}$$

where the explanatory variables are defined as above. This model includes one observation per stock and λ and H are based on the number of halts called during 1992.

A. Quotes and Spreads

A.1. Specialist Identity

Regression results for the quote and spread variables are shown in Panel A of Table IV. Consistent with previous studies, the number of trades, trade size, and market capitalization are negatively related to quoted and effective

[13] Calculating standard deviations based on daily returns and bid-ask midpoints should mitigate the effects of the specialist on this variable. However, subsequent analysis reveals that even daily volatility may be affected by the specialist. The results are unchanged if this variable is excluded from the regressions.

[14] We thank the referee for suggesting this specification. As an alternative specification, we estimated a probit model for the likelihood of a trading halt. That model includes one observation per security per day where the dependent variable equals one if a halt is called on the given day and zero otherwise. The conclusions from the probit model are similar to those reported for the Poisson model.

[15] See, for example, Hausman, Hall, and Griliches (1984). For a more complete discussion of Poisson regressions, see Greene (1997).

spreads and positively related to quoted depth. Return standard deviation is positively related to spread and negatively related to depth. Consistent with Harris (1994), the coefficient on quote midpoint is negative and significant in both spread regressions. Quote midpoint has a positive coefficient in the price improvement regression. This result is consistent with the fact that price improvement, as defined here, is not possible when the spread is equal to the minimum tick size.

The last row in Panel A lists the results of an F-test (or χ^2-test) of the restriction that the dependent variable is equal across specialist firms. Consistent with Cao et al. (1997), the tests strongly reject the restrictions that quoted and effective spreads are equal across specialist firms (p-values = 0.000). Furthermore, quoted depth and the proportion of trades receiving price improvement also differ significantly across specialist firms (p-values = 0.010 and 0.000, respectively).

The results suggest that both execution costs and liquidity differ across specialist firms. However, these differences do not appear to affect the competitiveness of NYSE quotes relative to other trading facilities; there is no evidence that the proportion of time the NYSE has the best quotes differs across specialist firms (p-value = 0.703).

A.2. Specialist Firm Characteristics

Differences in performance across specialist firms may be related to observable specialist-firm characteristics. To address this possibility, we reestimate the regressions replacing specialist-firm dummy-variables with proxies for specialist-firm characteristics and specialist-firm portfolio characteristics. The proxies are described below.

The first proxy, N, is the number of stocks traded by the specialist firm. This variable represents the size of the specialist firm and may be related to other specialist firm characteristics such as capitalization. Tinic (1972) and Branch and Freed (1977) find a positive relationship between N and bid-ask spreads.

Second, we include the variance of returns on a value-weighted portfolio of the firm's specialty stocks. The variance is further broken down into systematic and unsystematic components based on the beta from a regression of specialist-portfolio returns on S&P index returns during 1992. These measures represent the risk of the market making portfolio.

Finally, we include a dummy variable to identify whether the specialist firm is an agency firm or a principal firm. Coughenour and Deli (1997) find that the organizational form of specialist firms is related to the costs of market making. Where our samples overlap, we use the specialist-firm classifications listed in Coughenour and Deli (1997). For the remaining specialist firms in our sample, we follow Coughenour and Deli in classifying a specialist firm as a principal firm if either (i) some of the individual specialists are partners in the firm or (ii) the last name of one of the individual specialists appears in the name of the firm.

Table IV

Quote and Spread Variable Regressions

The sample includes all stocks listed on the NYSE during 1992 (according to the 12/1/92 NYSE *Specialist Directory)* that (i) had data available on both CRSP and ISSM, (ii) were listed the entire year of 1992, and (iii) had an average closing price during 1992 of \$3 to \$400. A log specification is used for each of the dependent variables. Panel A lists results from OLS regressions of quote and spread variables. Quote midpoint, number of trades, and trade size are the average quote-midpoint, average number of trades per day, and average trade size in shares during 1992, respectively. Market capitalization equals price times shares outstanding as of December 31, 1992. The standard deviation of daily returns is calculated over the 254 trading days in 1992. Investment funds include closed-end funds, real estate investment trusts, and units. Foreign securities include stocks or ADRs issued by non-U.S. firms. D_1–D_{40} are dummy variables identifying specialist firms, where D_j equals one if specialist firm j traded the stock and zero otherwise. To allow estimation, the dummy variable for Bocklet & Co. is excluded. The F-statistic (p-value) tests the restriction that all specialist-firm dummy-variable coefficients equal zero. Panel B lists results from regressions including specialist firm characteristics. N is the number of stocks traded by the specialist firm. Principal is a dummy variable equal to one if the specialist firm is a principal firm and zero otherwise. Systematic and unsystematic variance are based on the variance of returns on the value-weighted portfolio of stocks traded by the specialist firm. The F-statistic (p-value) tests the restriction that all specialist-firm characteristic coefficients equal zero. A heteroskedasticity-consistent χ^2-statistic is reported if homoskedasticity is rejected at the 5 percent level.

	Percentage Quoted Spread	Percentage Effective Spread	Total Quoted Depth	Percentage Price Improved Trades	Percentage Time at Inside Quotes
Panel A: Regressions Including Specialist Firm Dummy Variables					
Intercept	3.3756***	2.9727***	2.7708***	3.2794***	5.1814***
Ln(Quote midpoint)	−0.6350***	−0.7081***	−0.2982***	0.6435***	−0.1283***
Ln(Number of trades)	−0.1292***	−0.1030***	0.2193***	−0.2475***	−0.1170***
Ln(Trade size)	−0.0672***	−0.0777***	0.3580***	0.0264	−0.0219**
Ln(Market capitalization)	−0.0631***	−0.0512***	0.0498***	−0.1165***	−0.0004
Return standard deviation	4.4980***	3.8858***	−1.9740**	8.4398***	−1.7407***
Investment fund dummy	−0.1788***	−0.0673***	0.5158***	−0.6759***	0.0357***
Foreign security dummy	−0.0450***	0.0293*	0.3458***	−0.4036***	0.0667***
Adj. R^2 excluding Ds	0.9531	0.9500	0.4159	0.5565	0.6117
Adj. R^2 including Ds	0.9588	0.9538	0.4240	0.5861	0.6105
H_0: $D_1 = D_2 = \ldots = D_{40}$					
$F[\chi^2]$-statistic	6.9835	4.5218	1.6025	[198.6523]	0.8691
(p-value)	(0.000)	(0.000)	(0.010)	(0.000)	(0.703)
Panel B: Regressions Including Specialist Firm Characteristics					
Intercept	3.7110***	3.4203***	2.8481***	3.6246***	4.8154***
Ln(Quote midpoint)	−0.6289***	−0.7051***	−0.2964***	0.6512***	−0.1289***
Ln(Number of trades)	−0.1300***	−0.1027***	0.2216***	−0.2515***	−0.1160***
Ln(Trade size)	−0.0579***	−0.0752***	0.3517***	0.0464*	−0.0247**
Ln(Market capitalization)	−0.0652***	−0.0521***	0.0479**	−0.1201***	0.0000
Return standard deviation	4.5028***	3.8972***	−1.9528*	8.3855***	−1.7757***
Investment fund dummy	−0.1814***	−0.0674***	0.5096***	−0.6867***	0.0366***
Foreign security dummy	−0.0502***	0.0223	0.3398***	−0.3912***	0.0659***
Specialist characteristics:					
Ln(N)	0.0319**	0.0344**	−0.1191**	0.0509	−0.0061
Principal dummy	0.0176*	0.0280***	−0.0590*	−0.0231	−0.0072
Systematic variance	0.0125	0.0145	0.0178	0.0469	−0.0282**
Unsystematic variance	0.0345***	0.0421***	−0.0666	0.0107	−0.0067
Adj. R^2	0.9534	0.9508	0.4170	0.5582	0.6122
H_0: $\beta_{Char_i} = \beta_{Char_j} = \ldots$					
$F[\chi^2]$-statistic	[16.2867]	[32.4651]	[5.7626]	[10.9500]	[6.7017]
(p-value)	(0.002)	(0.000)	(0.217)	(0.027)	(0.152)

***, **, and * indicate significance of the coefficient at the 1, 5, and 10 percent levels, respectively.

Results from regressions including these variables are reported in Panel B of Table IV. Consistent with Tinic (1972) and Branch and Freed (1977), the number of stocks traded by the firm is positively related to both quoted and effective spreads. Furthermore, unsystematic portfolio variance is positively related to spreads and principal firms appear to set wider spreads. The restriction that all specialist-characteristic coefficients equal zero is rejected at the 1 percent level for the spread regressions and at the 5 percent level for the price-improvement regression. However, the restriction cannot be rejected for the quoted depth or time-at-the-inside regressions.

The results in Panel B of Table IV indicate that the characteristics of the specialist firm and the market making portfolio do not completely explain the observed differences in performance across specialist firms. The unexplained differences are likely attributable to differences in unobservable characteristics such as skill. However, the lack of explanatory power may also be the result of using inadequate proxies. For example, performance differences may be related to other characteristics, such as capitalization, for which we do not have data.

B. Transitory Volatility

Regression results for the one-day, six-hour, five-day, and open-to-close variance ratios are provided in columns one through four of Table V. Return standard deviation is not included as an explanatory variable in these regressions because it is included in the dependent variable. The coefficients on midpoint and trade size are generally negative, indicating that transitory volatility is higher for low priced stocks and inactive stocks. The coefficient on market capitalization is positive for all variance ratios and significant for all except the open-to-close variance ratio. Finally, transitory volatility appears to be higher for both investment funds and foreign securities relative to other stocks.

The restriction that all dummy-variable coefficients jointly equal zero is rejected for all four variance ratios. The weaker rejection for the five-day ratio is consistent with the specialist having a greater impact on transitory volatility within the day than across days. Overall, the results suggest that the specialist has a significant impact on the level of noise in security prices.

For completeness, we also estimate a regression for open-to-close variance ratios calculated from opening call-auction prices rather than opening quotes. We only summarize the results of that regression. The coefficients on security characteristics have the same signs as those reported in Table V. However, when opening call-auction prices are used, the restriction that open-to-close variance ratios are equal across specialist firms cannot be rejected (p-value = 0.85). The identify of the specialist appears to have little impact on opening call-auction prices.

As an alternative analysis, we decomposed the daily variance into noise, intrinsic, and price-adjustment components using the Brisley and Theobald (1996) correction to the Damodaran (1993) variance decomposition. Consis-

Table V

Variance Ratio Regressions

The sample includes all stocks listed on the NYSE during 1992 (according to the 12/1/92 NYSE Specialist Directory) that (i) had data available on both CRSP and ISSM, (ii) were listed the entire year of 1992, and (iii) had an average closing price during 1992 of \$3 to \$400. The table lists estimates from OLS regressions of variance ratios on security characteristics and specialist-firm dummy variables. Quote midpoint, number of trades, and trade size are the average quote-midpoint, average number of trades per day, and average trade size in shares during 1992, respectively. Market capitalization equals price times shares outstanding as of December 31, 1992. The standard deviation of daily returns is calculated over the 254 trading days in 1992. Investment funds include closed-end funds, real estate investment trusts, and units. Foreign securities include stocks or ADRs issued by non-U.S. firms. D_1–D_{40} are dummy variables identifying specialist firms, where D_j equals one if specialist firm j traded the stock and zero otherwise. To allow estimation, the dummy variable for Bocklet & Co. is excluded. The dependent variables are variance ratios calculated using an overnight (close-to-open) return series (R_0), 13 half-hour return series between the open and the close (R_1–R_{13}), a six-hour return series from 10:00 a.m. to the close (R_{6Hr}), a one-day close-to-close return series (R_{Day}), a one-day open-to-open return series (R_{Open}), and a five-day (close-to-close) return series (R_{5Day}). All return series are calculated from bid-ask quote midpoints. $VAR(R)$ is the variance of return series R over all trading days in 1992 for which the return could be calculated. A log specification is used for each of the dependent variables. The F-statistic (p-value) tests the restriction that all specialist-firm dummy-variable coefficients equal zero. A heteroskedasticity-consistent χ^2-statistic is reported if homoskedasticity is rejected at the 5 percent level.

	$VR_{(1Day)} = \frac{\sum_{t=0}^{13} VAR(R_t)}{VAR(R_{Day})}$	$\text{VR}_{(6Hr)} = \frac{\sum_{t=2}^{13} VAR(R_t)}{VAR(R_{6Hr})}$	$\text{VR}_{(5Day)} = \frac{VAR(R_{Day})\cdot 5}{VAR(R_{5Day})}$	$\text{VR}_{(OC)} = \frac{VAR(R_{Open})}{VAR(R_{Day})}$
Intercept	0.7004***	0.3111***	−0.1074	0.4896**
Ln(Quote midpoint)	−0.4420***	−0.2554***	−0.0943***	−0.1718***
Ln(Number of trades)	−0.0560**	0.0005	0.0215**	−0.0008
Ln(Trade size)	−0.1941***	−0.1133***	−0.0345**	−0.0638
Ln(Market capitalization)	0.0883***	0.0566***	0.0306***	0.0020
Investment fund dummy	0.4121***	0.2800***	0.1400***	0.1420***
Foreign dummy	0.1733**	0.1604***	−0.0229	0.0703
Adj. R^2 excluding Ds	0.2273	0.3661	0.0857	0.0534
Adj. R^2 including Ds	0.2295	0.3858	0.0968	0.0515
H_0: $D_1 = D_2 = \ldots = D_{40}$				
$F[\chi^2]$-statistic	[474.9706]	2.3678	1.5255	[75.8359]
(p-value)	(0.000)	(0.000)	(0.0193)	(0.000)

***, **, and * indicate significance of the coefficient at the 1, 5, and 10 percent levels, respectively.

tent with the results above, the noise component of variance differs significantly across specialist firms (p-value = 0.013). The results further suggest that the price-adjustment portion of the variance differs across specialist firms (p-value = 0.031), but the intrinsic component of variance does not differ across specialist firms (p-value = 0.173). The fact that we find no difference across specialist firms in the intrinsic variance component provides evidence that our empirical tests have reliable size (i.e., we do not reject all null hypotheses). These results are available from the author.

To determine whether the observed differences in transitory volatility are explained by the characteristics of the specialists, we reestimated the model replacing the specialist-firm dummy variables with the specialist-firm characteristics described in Section III.A. The restriction that all specialist-firm characteristic coefficients jointly equal zero is not rejected at the 10 percent level for any of the variance-ratio models. To conserve space, the results from these regressions are not reported.

C. Trading Halt Use

The results from Poisson regressions of trading halt frequency are provided in Table VI. For these regressions, the reported R^2 is a likelihood-ratio index (*LRI*) that equals one minus the ratio of the computed log-likelihood to the log-likelihood of a model in which all slopes equal zero. Results for the full sample of trading halts are listed in the first column. Trading halts appear to be more frequent for active securities and securities with more volatile returns.[16] Additionally, foreign securities and investment funds are associated with less frequent trading halts. The restriction that all specialist-firm dummy-variable coefficients equal zero is rejected in the full sample with a p-value of 0.000.[17]

The second and third columns of Table VI list results from the Poisson model estimated separately for order-imbalance and news halts. The coefficients in both models are similar to those reported for the full sample. The restriction that all specialist-firm dummy-variable coefficients equal zero is rejected for order-imbalance halts (p-value = 0.000), but not for news halts (p-value = 0.108). This is consistent with the fact that only order-imbalance halts are initiated by the specialist. The lack of a rejection in the news halt sample, where we expect the specialist to have little impact, provides additional evidence that our tests have reliable size.

[16] It could be argued that news events jointly cause volatility and trading halts. Furthermore, Lee et al. (1994) provide evidence that both volume and volatility increase following trading halts. As a robustness check, we reestimated the halt frequency models excluding return standard deviation, trade size, and number of trades. The conclusions are unchanged.

[17] Scholl & Levin Corp. was not involved in any trading halts during the sample period and Purcell, Graham/R. Adrian was not involved in any order-imbalance halts during the period. The conclusions are unchanged if these specialist firms are excluded from the Poisson analysis. These specialist firms are excluded from the analysis of halt duration described below.

Table VI

Trading Halt Regressions

The sample includes all stocks listed on the NYSE during 1992 (according to the 12/1/92 NYSE *Specialist Directory)* that (i) had data available on both CRSP and ISSM, (ii) were listed the entire year of 1992, and (iii) had an average closing price during 1992 of $3 to $400. A Poisson regression is estimated for trading halt frequency, where the dependent variable is the number of times the security was halted during 1992. An OLS regression is estimated for halt duration, where the dependent variable is the natural log of the number of minutes from the beginning of the halt to the reopening trade (excluding the overnight nontrading period). Quote midpoint, number of trades, and trade size are the average quote-midpoint, average number of trades per day, and average trade size in shares during 1992, respectively. Market capitalization equals price times shares outstanding as of December 31, 1992. The standard deviation of daily returns is calculated over the 254 trading days in 1992. Investment funds include closed-end funds, real estate investment trusts, and units. Foreign securities include stocks or ADRs issued by non-U.S. firms. D_1–D_{40} are dummy variables identifying specialist firms, where D_j equals one if specialist firm j traded the stock and zero otherwise. To allow estimation, the dummy variable for Bocklet & Co. is excluded. For the halt-frequency tests, the χ^2-statistic (p-value) is from the likelihood-ratio test of the restriction that all dummy variable coefficients equal zero and the reported R^2 is a likelihood-ratio index (LRI) equal to one minus the ratio of the computed log-likelihood to the log-likelihood of a model in which all slopes equal zero. For the duration tests, we report the F-statistic (p-value) for the test of the restriction that all specialist-firm dummy-variable coefficients equal zero.

	Trading Halt Frequency			Trading Halt Duration		
	All Halts	Imbalance Halts	News Halts	All Halts	Imbalance Halts	News Halts
Intercept	−1.5509***	−4.3734***	0.0810	4.6330***	3.2863***	5.2163***
Ln(Quote midpoint)	1.1465***	1.6068***	0.3744***	—	—	—
Ln(Number of trades)	0.8848***	1.0926***	0.5272***	—	—	—
Ln(Trade size)	0.9351***	1.3108***	0.4740***	—	—	—
Ln(Market capitalization)	−0.6809***	−0.8204***	−0.4363***	−0.0328***	−0.0036	−0.0713***
Return standard deviation	7.2131***	9.1928***	3.6364	—	—	—
Investment fund dummy	−0.9388***	−0.6441**	−1.3308***	—	—	—
Foreign dummy	−0.5820***	−0.7809***	−0.3325	—	—	—
Absolute halt return	—	—	—	1.6173***	1.9948***	1.3016***
Imbalance halt dummy	—	—	—	−0.8805***	—	—
Adj. R^2 (LRI) excluding Ds	(0.2901)	(0.3526)	(0.0680)	0.4407	0.0688	0.1121
Adj. R^2 (LRI) including Ds	(0.3251)	(0.3952)	(0.0963)	0.4495	0.1141	0.1119
H_0: $D_1 = D_2 = \ldots = D_{40}$						
$F[\chi^2]$-statistic	[108.5068]	[110.7788]	[51.3037]	1.4156	1.8874	0.9982
(p-value)	(0.000)	(0.000)	(0.108)	(0.048)	(0.000)	(0.478)

***, **, and * indicate significance of the coefficients at the 1, 5, and 10 percent levels, respectively.

Results from OLS regressions of trading halt duration are shown in the last three columns of Table VI. The models for duration differ slightly from the general specification shown in equation (7). First, to account for the fact that halts with larger information shocks may be more difficult to resolve, we include the absolute value of the return during the halt. Second, to allow duration to differ across order-imbalance and news halts, we include a dummy variable identifying order-imbalance halts.

The coefficients are consistent across the three models. Order-imbalance halts are significantly shorter in duration than news halts, and trading halts with larger price shocks take longer to resolve. Consistent with Bhattacharya and Spiegel (1998), duration appears to be shorter for larger securities, as measured by market capitalization. The restriction that all other security-characteristic coefficients jointly equal zero could not be rejected at the 10 percent level for any of the duration models. We therefore report results including only market capitalization. The conclusions regarding differences across specialist firms are similar if other security characteristics are included in the regressions.

The restriction that trading halt duration is equal across specialist firms is rejected at the 5 percent level in the full sample of trading halts. However, examination of subsample results reveals that the rejection comes solely from the order-imbalance subsample. The restriction is rejected for order-imbalance halts (p-value = 0.000), but cannot be rejected for news halts (p-value = 0.478). This difference may reflect the specialist's active role in locating traders during order-imbalance halts and the fact that news halts are more likely to involve waiting for news dissemination. Overall, the duration results are consistent with the hypothesis that some specialist firms are better able or more willing to quickly reopen trading once a trading halt has been called.

To determine whether the differences in halt duration and halt frequency are explained by specialist characteristics, we reestimated the models including the specialist-firm characteristics defined in Section III.A. The restriction that all specialist-firm characteristic coefficients jointly equal zero is not rejected at the 10 percent level for any of the regressions. We do not report these results.

IV. Conclusion

This study provides evidence of significant differences in performance across NYSE specialist firms. Differences are evident in measures of quoted and effective spreads, quoted depth, transitory volatility, trading halt frequency, and trading halt duration. The results suggest that specialists have a significant impact on execution costs, liquidity, and the efficiency of prices. Although the NYSE's allocation process and other monitoring mechanisms are designed to promote improved specialist performance, the results suggest that neither these monitoring mechanisms nor competition from other traders results in equivalent market making behavior across specialist firms.

Table VII

Correlations between Specialist Firm Performance Measures

The sample includes all stocks listed on the NYSE during 1992 (according to the 12/1/92 NYSE *Specialist Directory)* that (i) had data available on both CRSP and ISSM, (ii) were listed the entire year of 1992, and (iii) had an average closing price during 1992 of $3 to $400. The table lists Pearson correlation coefficients (*p*-values) between specialist-firm dummy-variable coefficients from regressions of the performance measures on security characteristics and a set of specialist-firm dummy-variables.

Dependent Variables	Percentage Effective Spread	Total Quoted Depth	Percentage Price Improved Trades	Percentage Time at Inside Quotes	Variance Ratio (6-hour)	Imbalance Halt Frequency	Imbalance Halt Duration
Quoted spread (%)	0.675***	0.182	0.697***	−0.696***	0.085	0.148	0.181
Effective spread (%)	—	0.023	0.025	−0.403***	0.425***	−0.151	0.240
Total quoted depth	—	—	0.247	−0.138	0.050	0.154	0.025
Price improved trades (%)	—	—	—	−0.595***	−0.219	0.318**	−0.058
Time at inside quotes (%)	—	—	—	—	−0.007	0.023	−0.131
Variance ratio (6-hour)	—	—	—	—	—	−0.219	0.297*
Imbalance halt frequency	—	—	—	—	—	—	−0.146

***, **, and * indicate significance of the correlation coefficient at the 1, 5, and 10 percent levels, respectively.

The results in this study lead to an interesting question: Do some specialist firms perform poorly in all categories, or do different specialist firms dominate in different areas? To address this question, we report in Table VII the correlations between the dummy-variable coefficients based on the alternative performance metrics. Consistent with intuition, specialist firms with wider quoted and effective spreads are at the inside quotes less frequently. These correlations also suggest that wider spreads are associated with more frequent price improvement and increased depth.

Interestingly, specialists who set wider spreads are also associated with increased transitory volatility. Since the transitory volatility measure does not include bid-ask bounce, this result is consistent with poor specialist performance across multiple aspects of marketmaking.

In contrast, specialist firms that halt trading more frequently are associated with lower effective spreads, more frequent price improvement, and lower transitory volatility. These results are consistent with the trade-off between price-protection mechanisms discussed in Lee et al. (1994). Specialists may be willing to supply liquidity at lower costs (and put more capital at risk to stabilize prices) if they can halt trading in the event of a large information shock. Thus, some specialists may set narrow spreads and call halts more frequently, while others set wide spreads and refrain from using trading halts. One should draw conclusions cautiously, however, because only a few of the correlations in Table VII are significant at the 10 percent level.

Recent rule changes on the NYSE have increased competition for listings between exchanges, as well as competition for allocations between specialist firms. Approved changes to NYSE Rule 500 would make it easier for NYSE-listed firms to voluntarily change listing venues. In addition, revisions to the exchange's Allocation Policy give listed firms more input into the selection of their specialist unit. If the choice of specialist affects market quality, then these rule changes may benefit listing firms as well as investors. This study improves our understanding of the role of NYSE specialists in the trading process and provides evidence that the identity of the specialist does, in fact, affect market quality.

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