The Shrinking New York Stock Exchange Floor and the Hybrid Market

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Abstract

At the end of 2006 the New York Stock Exchange introduced its Hybrid market. Hybrid greatly expanded electronic trading and reduced floor trading. Using this change as an instrument for floor activity, we test the benefits of the repeated interactions available on the floor against the costs of on-floor traders being advantaged relative to off-floor traders. We find that measures of trading costs increase as floor activity decreases. In addition, cooperation on the floor decreases and transitory volatility increases. However, Hybrid increases speed of execution. Together these findings support there being a tradeoff along these measures of market quality. Hybrid moved the NYSE to a different position on that tradeoff.

1. Introduction

As electronic trading comes to dominate financial markets (Jain (2005)), is something is being lost in the transition from floor traders' physical collocation and repeated interactions to anonymous electronic trading? Studies have examined the reputational benefits of floor traders' repeated interaction (Battalio, Ellul, and Jennings (2007)) and have found that electronic trading is not sufficient for all trading environments (Barclay, Hendershott, and Kotz (2006)) and all traders' needs (Bessembinder and Venkataraman (2004)). However, because the use of physically collocated traders is endogenous in these studies, prior work has been unable to weigh the benefits of the repeated interactions available on the floor against the potential costs of floor participants' ability to take advantage of off-floor traders. In 2006 the New York Stock Exchange (NYSE) introduced its 'Hybrid' market, which significantly decreased floor trading.[1] We use this event to study the impact of the decline in NYSE floor trading.

In-person interactions on a trading floor provide an excellent forum for repeated dealings and even the observation of other traders' dealings with one another, allowing reputations to form. A number of papers argue that reputations formed in this way play a significant role in the trading process. Benveniste, Marcus, and Wilhelm (1992) develop a model of floor trading where participants interact repeatedly. The repeated transactions with floor brokers allow specialists to impose sanctions – less favorable access to information about other traders' trading interests or inferior execution of future trades – on traders who use private information to disadvantage other traders. This reduces adverse selection costs, which enhances liquidity. In a multi-period setting, Chan and Weinstein (1993) reach similar conclusions. In a setting not directly motivated by a trading floor, Carlin, Lobo, and Viswanathan (2006) conclude that "traders cooperate most of the time through repeated interaction, providing apparent liquidity to one another."

[1] Lucchetti (2007) discusses how NYSE member firms reduced the number of floor traders with Hybrid's introduction. The NYSE also closed parts of its trading floor and has announced plans to close more; see McGeehan (2007).

A number of studies empirically examine the trading of floor brokers.[2] Sofianos and Werner (2000), Werner (2003), Handa, Schwartz, and Tiwari (2004), and Moulton (2006) study the trading of floor participants on the NYSE and American Stock Exchange (AMEX). These papers find that the floor brokers provide liquidity to other traders and provide superior execution quality for their clients. To directly examine the impact of reputations in floor trading, Battalio, Ellul, and Jennings (2007) use reorganizations of stocks on the NYSE trading floor as an exogenous event. These reorganizations disrupt existing relationships and can lead to a breakdown in cooperation among floor traders. Consistent with models of repeated interactions, Battalio et al. find that trading costs: i) increase leading up to the reorganization; ii) remain higher immediately subsequent to the reorganization; and iii) decline to their original level over 3 months following the reorganization. These studies demonstrate that floor traders provide benefits under the NYSE's (and AMEX's) traditional organization of floor trading.

If floor traders use their advantageous role in the trading process to the disadvantage of off-floor traders (Rock (1990)), the costs to off-floor traders may outweigh the reputational benefits on the floor. Ready (1999) presents evidence that "unadvertised" liquidity provided by NYSE floor participants imposes adverse selection costs on limit order traders. The ability of floor traders to move last in the trading process enables them to use off-floor traders' orders as free trading options (Stoll and Schenzler (2006)).[3] Examining a technological change at the NYSE that reduced this trading option, Easley, Hendershott, and Ramadorai (2007) find evidence that leveling the playing field between on-floor and off-floor participants in terms of speed can lead to higher liquidity and stock prices. Easley et al.'s findings also suggest that time to execution may be an important dimension of market quality (see Boehmer (2005) for a discussion of different dimensions of execution quality).[4]

[2] There is also a long literature, e.g., Hasbrouck and Sofianos (1993) and Madhavan and Smidt (1993), examining the trading of NYSE specialists.

[3] See Ip and Craig (2003) for some details on the NYSE specialist investigations. While not studying a floor-based market, Christie and Schultz (1994), Christie, Harris, and Schultz (1994), and Barclay (1997) provide evidence on how intermediaries collude to use their advantages against outside investors.

[4] A number of papers study the relative costs of trading under different markets structures, e.g., Lee (1993), Huang and Stoll (1996), and Bessembinder and Kaufman (1997).

We begin by showing how the percentage of NYSE trading volume due to floor participants has declined from greater than 50% in the beginning of 1999 to less than 10% by the middle of 2007. While trading costs have shown a secular decline over this time period, a number of things have changed beyond the amount of floor trading. To empirically determine whether the benefits of floor trading exceed its costs, a market structure change that reduces floor trading would help provide identification. The introduction of the Hybrid market is such an event. Hybrid represents a number of changes to the NYSE's systems and rules designed to enhance the efficiency of the trading process and increase automatic execution and speed. These changes were introduced across stocks over the period from October 2006 through January 2007.

From the month prior to the month subsequent to each stock's Hybrid activation date, floor participants' share of NYSE trading volume drops from 15 percent to 11 percent. Over this two-month interval, the decline in floor activity is associated with increases in trading costs and transitory volatility, variables that are usually referred to as measures of market quality. To establish that these results are driven by declines in floor activity, we use hybrid's introduction as an instrument for changes in floor activity and find that higher floor activity is associated with lower trading costs and lower transitory volatility. The results are robust to a difference-in-difference approach that examines how the relative difference between the market quality of NYSE stocks and matched Nasdaq stocks changes with Hybrid's introduction. We extend our analysis to a full year surrounding the Hybrid introduction and show that the increases in spreads and volatility on the NYSE relative to Nasdaq are permanent. Finally, we examine Hybrid's impact on floor and system trading separately. We find that trading costs rise for all trade types: pure system, pure floor, and combined floor and system. The effective spread and the adverse selection component of the spread increase significantly for pure floor trades, suggesting that cooperation on the floor declines.

While market quality declines in terms of trading costs and transitory volatility, the introduction of Hybrid is also associated with a reduction in the time taken to execute incoming orders. Execution speed is an important component of execution quality for professional traders but has been little studied in the

academic literature. Boehmer, Jennings, and Wei (2007) confirm that execution speed matters to traders by finding that a market center receives more order flow when its reported execution speed increases. Boehmer (2005) provides a good discussion of several reasons that traders prefer faster executions. Delay induces uncertainty about the probability of execution or the price at which execution occurs. Traders' risk aversion makes these undesirable. Even if traders are risk neutral, many trading strategies are more difficult to implement with slower execution. Strategies contingent on prices, long-short strategies involving trades in multiple securities simultaneously, or strategies which break larger orders into smaller orders all perform worse as execution times increase.

Together the evidence from Hybrid's introduction shows that floor trading's decline leads to worsening spread and transitory volatility measures of market quality, but faster execution. Past work comparing execution costs and speed across markets has suggested that a tradeoff exists between these dimensions (Battalio, Hatch, and Jennings (2003) and Boehmer (2005)). By examining the change within a market we further establish the cost-speed tradeoff and link it to the amount floor trading. The Hybrid experience suggests that it may be difficult to capture both the repeated interaction benefits of face-to-face trading and the speed of electronic systems.

The remainder of the paper is organized as follows. Section 2 provides an overview of the Hybrid market changes. Section 3 describes our data and sample. Section 4 examines the relations between the Hybrid market introduction, the decline of floor trading, and market quality. Section 5 investigates how the changes in liquidity surrounding Hybrid are related to changes in the way traders interact on the NYSE. Section 6 explores the longer-term adjustment process to the Hybrid market. Section 7 examines how Hybrid influences time to execution. Section 8 concludes.

2. An Overview of the Hybrid Market

Before we discuss the Hybrid market changes, some background on how continuous trading on the NYSE was conducted before the Hybrid implementation is useful. The traditional auction mechanism on the NYSE requires that a specialist manually execute each trade, allowing the specialist and floor brokers

to provide liquidity and participate in trades at the point of sale. Electronic trading on the NYSE began with the DOT system in 1976 for market orders of 100 shares. The DOT system's capabilities were expanded over time to support limit orders and larger sizes, and the system was renamed SuperDOT in 1984. Harris and Hasbrouck (1996) report that floor trading was 70 percent of total volume for 1990-1991. Werner and Sofianos (2000) find that this fraction declines to 55 percent by 1997. By 1999 electronic and floor trading are roughly equal on the NYSE.

Figure 1 graphs aggregate floor trading as a percentage of aggregate NYSE dollar volume, as well as its breakdown by floor broker and specialist trading, for 1999 through mid-2006. Floor trading activity begins to noticeably decline in 2002. The beginning of this decline appears around the NYSE's January 2002 introduction of OpenBook, which provides limit-order book information to traders off the exchange floor (Boehmer, Saar, and Yu (2005)). Initially OpenBook data were released every 10 seconds, later reduced to every five seconds, and on May 1, 2006 OpenBook began to be disseminated as continuously as the NYSE systems allow. In addition to the frequency of dissemination, OpenBook is limited in that it does not include floor trader interest and there are still lags in executions on the floor. Despite these limitations, the substitution of electronic trading for floor trading identified in Boehmer, Saar, and Yu (2005) continues and grows from 2002 onwards. By June 2006 floor trading represents slightly more than 20 percent of NYSE volume.

[Figure 1 Here]

Automatic execution was introduced on the NYSE in 2000. Prior to the Hybrid market, automatic execution was restricted to priced orders (i.e., limit orders) of up to 1,099 shares and subject to a 30-second rule for repeat executions for accounts belonging to the same beneficial owners. Automatic execution orders could be executed only at the inside quote, i.e., the same trader could not "walk the book" by executing at multiple prices, and had to be specifically designated. Furthermore, the default treatment of marketable limit orders and the only option for market orders was execution via the auction mechanism. In 2003 the NYSE began automatically updating best bid and offer quotes to reflect changes in the limit order book; prior to 2003 the best bid and offer were refreshed manually by the specialist.

The NYSE gave three reasons for launching the Hybrid market (NYSE Group (2006b)). First, they believe that customers want a choice of using the existing auction mechanism for the possibility of better prices or accessing the book electronically to achieve faster execution. Second, they expect trading volume to continue to increase, and higher volume can be handled more efficiently in a more automated system. Third, the Securities and Exchange Commission (SEC) Reg NMS Order Protection Rule protects better-priced quotes from being traded through only in markets that are "fast", defined as markets that offer automatic execution at the posted quotes.

The biggest change in the Hybrid market is the expansion of automatic execution. Orders are no longer limited to 1,099 shares (the new limit is one million shares), the frequency restriction is eliminated, orders may walk the book beyond the best bid and offer, and non-priced (market) orders as well as limit orders are eligible for automatic execution. Market and marketable limit orders are now automatically executed by default, rather than requiring a special code. In Hybrid the NYSE also introduced Liquidity Replenishment Points (LRPs), which are stock-specific price ranges intended to defend against erroneous trades and dampen volatility by converting the market from fast (automatic execution available) to "auction only" (auction mechanism, no automatic execution available) when prices move quickly in either direction. Immediately following Hybrid introduction the market was fast 98.9 percent of the time (NYSE Group (2007)); in February 2007 the NYSE reset the LRPs to less restrictive levels.

The expansion of automatic execution reduces the opportunities for specialists and floor brokers to participate manually in executions. Another important set of changes in Hybrid gives the specialist and floor brokers ways to participate electronically that correspond to their prior trading capabilities: placing undisplayed as well as displayed orders on the limit order book. In addition, the specialist for each stock can use a proprietary algorithm to interact electronically with customer order flow, subject to a set of rules intended to replicate in an electronic framework what the specialist is allowed to do manually in the auction market (see NYSE Group (2006a)).

The Hybrid market changes apply only during continuous intraday trading: Automatic execution is not available during the opening and closing auctions, which are conducted manually by the specialist as

before. Hybrid activation was rolled out gradually between October 6, 2006, and January 24, 2007.[5] All stocks that trade in 100-share round lots were activated over the four-month period; 43 stocks that trade in round lots of 10 shares (e.g., Berkshire Hathaway Inc., which is priced near $100,000 per share) are not yet in Hybrid.

Figure 2 graphs overall floor trading as well as its breakdown by floor broker and specialist trading for the year surrounding the Hybrid rollout (June 2006 through May 2007). The floor activity at the beginning of Figure 2 does not line up exactly with the end of Figure 1 because the data in Figure 2 exclude certain trades that were unaffected by Hybrid and reflects only the 500 stocks in our sample; see the Data section for details. Using the scale on the right y-axis, Figure 2 also indicates the percentage of stocks for which Hybrid has been introduced. Relatively few stocks were introduced in the first two months of the rollout. Almost half of the stocks went Hybrid at the beginning of December 2006 and another 40 percent of stocks went Hybrid over the final few weeks of 2006. Floor activity declines gradually before and after the Hybrid introduction. When the transition of Hybrid is most intense in December 2006, floor activity declines steeply from 15 percent to 11 percent.

[Figure 2 Here]

The fact that many stocks went Hybrid in close proximity to each other requires that our empirical strategy control for contemporaneous changes in market liquidity. We do this by matching NYSE stocks to Nasdaq stocks and following a difference-in-difference approach, examining how the hybrid event and consequent reduction in floor activity impact the difference between NYSE and Nasdaq stocks.

3. Data and Sample Selection

Our analysis uses data from the NYSE's Trade and Quote (TAQ) database, the Center for Research in Security Pricing (CRSP), the Chicago Board of Options Exchange (CBOE), SEC Rule 11Ac1-5 (Dash-5)

[5] We focus on the expansion of automatic execution under Hybrid, which the NYSE labeled Hybrid Phase 3. Hybrid Phase 1 (rolled out 12/1/05 through 4/5/06) and Phase 2 (rolled out 4/6/06 through 8/21/06) upgraded various NYSE systems to facilitate the Phase 3 expansion of automatic execution. Hybrid Phase 4 (rolled out 1/25/07 through 2/28/07) introduced changes required for the implementation of Reg NMS, such as new order types and new locking and crossing rules.

filings, and the NYSE internal Consolidated Equity Audit Trail (CAUD) database. We collect data from June 1, 2006 through May 31, 2007, which spans the period from roughly four months before to four months after the Hybrid activation interval. This period facilitates the testing of changes both in the window immediately surrounding each stock's Hybrid activation date and over a longer horizon to capture possible delayed adjustments to the changes. We focus on a sample of 500 NYSE-listed stocks that went Hybrid, using a matched sample of 500 Nasdaq-listed stocks to control for market-wide changes in market quality.

3.1 Sample Construction

We construct a sample of 500 NYSE-listed common stocks as follows. We begin by collecting from CRSP the market capitalizations and closing prices of all domestic common stocks listed on the NYSE as of March 31, 2006. From the TAQ Master History file we determine CUSIP numbers that correspond to the symbols in TAQ, to accurately match stocks in CRSP and TAQ. We also use the TAQ Master History file to eliminate stocks that were not listed continuously from March 2006 through May 2007 or changed symbol during the period. We eliminate stocks with prices below $1 or over $500, stocks with two or fewer trades per day on average according to the TAQ Trades file, and stocks that are not included in the Hybrid activation list posted on the NYSE website. Finally, we rank the remaining stocks by market capitalization and randomly select 50 stocks from each market capitalization decile.

We construct a matched sample of 500 Nasdaq-listed stocks as follows. Using one-to-one matching without replacement, we determine a unique Nasdaq match for each stock in our NYSE sample based on CRSP market capitalization and closing price.[6] We measure the matching criteria at the end of the first quarter of 2006, which precedes our analysis period. We randomize the order of matching by sorting NYSE stocks alphabetically by symbol. We then calculate the following matching error for each NYSE stock *i* and each remaining Nasdaq stock *j*:

[6] Davies and Kim (2007) find that one-to-one matching based on market capitalization and share price is the most appropriate method for comparing trade execution costs between NYSE and Nasdaq stocks. They also conclude that eliminating poor matches is not advisable.

$$\text{Matching error} = \frac{\left|\frac{MCAP_i}{MCAP_j} - 1\right| + \left|\frac{PRC_i}{PRC_j} - 1\right|}{2}, \quad (1)$$

where *MCAP* is the stock's market capitalization and *PRC* is the stock's closing price. The Nasdaq stock with the lowest matching error is selected as the match for that NYSE stock and removed from the list of potential Nasdaq matches for the remaining NYSE stocks. The mean matching error for the 500-stock sample is 0.62. In earlier analysis we used the same matching procedure for a sample of 200 stocks; the 200-stock sample had a mean matching error of 0.07. Because all results are qualitatively identical for the 200-stock subsample, we report only the full 500-stock sample results. Table 1 presents descriptive statistics for the NYSE and Nasdaq samples.

[Table 1 Here]

3.2 Data and Measures

The liquidity measures in Table 1 and throughout the paper are calculated from TAQ trade and quote data, as are the intraday volatility measures to follow. We determine floor and system trading participation from the CAUD database, which contains detailed information about all trades executed on the NYSE. We obtain execution speed from the SEC Dash-5 data. To measure market-wide volatility we use the daily opening CBOE volatility index (VIX), which is derived from S&P 500 stock index options.

We calculate liquidity and intraday volatility measures for NYSE stocks two ways: using trades and quotes from the NYSE only, and using trades and quotes from all markets.[7] As the results yield identical inference under both samples, we present only the measures and results based on NYSE trades and quotes. Liquidity and intraday volatility measures for Nasdaq stocks are calculated using trades and quotes from all markets. We use trades and quotes from regular-hours trading only. Upstairs-arranged

[7] We apply the following filters to clean the trade and quote data. We use only trades for which TAQ's CORR field is equal to zero, one, or two and for which the COND field is either blank or equal to @, E, F, I, J, or K. We eliminate trades with nonpositive prices or quantities. We eliminate trades with prices more than (less than) 150% (50%) of the previous trade price. We use only quotes for which TAQ's MODE field is equal to 1, 2, 6, 10, 12, 21, 22, 23, 24, 25, or 26. We eliminate quotes with nonpositive price or size or with bid price greater than ask price. We exclude quotes when the quoted spread is greater than 25% of the quote midpoint or when the ask price is more than 150% of the bid price.

trades (see Madhavan and Cheng (1997)), opening trades, and closing trades are excluded because they take place outside of the trading mechanisms that changed under the Hybrid market implementation.

We equally-weight liquidity measures across trades within the day to calculate measures for each stock each day.[8] The percentage quoted spread is the difference between the best ask price and the best bid price at the time of a trade, divided by the prevailing quote midpoint of the bid and ask prices.[9] We calculate quoted depth as the time-weighted average depth at the best bid and ask.

The effective spread for each trade captures the difference between an estimate of the true value of the security (the quote midpoint) and the actual transaction price. The percentage effective spread for stock j at time k on day t is calculated as:

$$ESpread_{j,k,t} = 2\, I_{j,k,t}\, (P_{j,k,t} - M_{j,k,t}) / M_{j,k,t}\,,$$

where $I_{j,k,t}$ is an indicator variable that equals one for buyer-initiated trades and negative one for seller-initiated trades, $P_{j,k,t}$ is the trade price, and $M_{j,k,t}$ is the matching quote midpoint. We follow the standard trade-signing approach of Lee and Ready (1991) and use contemporaneous quotes to sign trades—see Bessembinder (2003).

Figure 3 depicts the average effective spread by market capitalization quintile over the window from 20 days before to 20 days after Hybrid activation. For the largest four quintiles (Q1-Q4) effective spreads rise at day zero and remain higher for the next 20 days. Because of their larger mean and volatility, the smallest quintile (Q5) spreads are graphed using the scale on the right y-axis. These small stocks show no clear change with Hybrid's introduction. Because of the differences across quintiles, we will conduct most of our analysis by quintile. In addition, because the variance in small stocks is so much higher than the other quintiles, when estimating the results for the full sample we will allow for differences in coefficients between the larger quintiles and the smallest quintile.

[Figure 3 Here]

[8] Results using measures volume-weighted within the day yield qualitatively similar results, which are available from the authors upon request.

[9] Results using dollar spreads yield identical inference, so we present only percentage spreads for brevity. Dollar-spread results are available from the authors upon request.

Figure 4 follows the same format as Figure 3 and graphs the difference in effective spread between NYSE stocks and their Nasdaq matches. The changes following Hybrid's introduction in the difference between NYSE and Nasdaq spreads in Figure 4 are similar to Figure 3. This suggests that changes in spreads on the NYSE in the months surrounding Hybrid were not due to market-wide changes in liquidity that also affected Nasdaq stocks. If anything the changes in NYSE spreads subsequent to Hybrid appear larger after controlling for the spreads of matching Nasdaq stocks.

[Figure 4 Here]

In addition to our spread measures, we calculate two intraday volatility measures. The quote return volatility is the standard deviation of midquote returns in all non-overlapping five-minute periods of the day, calculated for each stock each day. The trading range is the five-minute high minus low traded price divided by the last traded price in each non-overlapping five-minute interval, averaged over the trading day for each stock each day. While the quote return volatility captures price changes at five-minute intervals, the trading range focuses on the most extreme price movements over five-minute windows. Therefore, the trading range may be better suited for detecting high frequency transitory volatility.

4. Hybrid, Floor Trading, and Market Quality

To examine how Hybrid affects market quality we move beyond the simple effective spread graphs. For each stock we calculate the above described measures for the 20 days before and the 20 days after Hybrid activation. The first columns of Table 2 present these results for quoted spread, effective spread, five-minute quote volatility, and five-minute trading range. Consistent with Figure 3, the effective and quoted spread measures in Table 2 show that NYSE spreads increase with Hybrid's introduction. Controlling for the matched Nasdaq stocks' spreads increases the pre/post difference (as in Figure 4). This implies that while NYSE stocks' spreads widen at the time of Hybrid, Nasdaq spreads narrow. Except for the smallest quintile stocks, which show little evidence of spreads being affected by Hybrid, the increase in spreads is wider for smaller stocks. This is consistent with reputational trading being more valuable for smaller stocks.

For the volatility measures, the five-minute quote volatility does not show robust changes with Hybrid's introduction. The five-minute trading range increases for all quintiles with and without using the Nasdaq controls. The change in the trading range is larger than the change in quoted or effective spreads, so the wider trading range is not due solely to the wider spreads following Hybrid.

[Table 2 Here]

The last three columns of Table 2 examine quoted depth, trading volume, and trade size. Trade size shows a clear decline with Hybrid's introduction. Floor trades are larger than system trades (e.g., Moulton (2006)), so the shrinking trade size is likely due to the reduction in floor activity. Quoted depth shows little change with Hybrid, which suggests the wider spreads are not associated with additional liquidity at the quote. Trading volume also shows no significant change.

Table 2 uses standard univariate *t*-tests to calculate the statistical significance of changes associated with Hybrid. Given that the pre- and post- periods surrounding Hybrid activation overlap for many stocks (Figure 2), the assumption of independence across observations may overstate statistical significance. To properly control for this we adopt a panel data approach in Table 3. For each market quality variable we run the following regression:

$$MQ_{i,t} = \alpha_i + \beta_1 Hybrid_{i,t} + \beta_2 Hybrid_{i,t} \times Q5_i + \gamma_1 Volatility_t + \gamma_2 Volatility_t \times Q5_i + \varepsilon_{i,t}, \qquad (2)$$

where $MQ_{i,t}$ is the average spread or intraday volatility measure for stock i on day t; α_i are stock fixed effects; $Hybrid_{i,t}$ is an indicator variable taking the value of one if the stock is in Hybrid mode on day t, otherwise zero; $Q5_i$ is an indicator variable taking the value of one if the stock is in market-capitalization quintile five (the smallest stocks), otherwise zero; and $Volatility_t$ is the opening value of CBOE's VIX index on day t. To control for contemporaneous correlation in the error terms, we calculate Rogers (clustered) standard errors throughout our analysis (see Petersen (2007) for a discussion of Rogers standard errors). Regressions omitting the Quintile 5 interaction terms are run by quintile.[10]

[10] On December 1, 2006, the NYSE eliminated the monthly transaction fee cap, raised the per-transaction fee, and eliminated specialist commissions. Including a dummy variable corresponding to the NYSE's fee structure change does not significantly affect the coefficients of interest.

[Table 3 Here]

For the individual quintiles the Hybrid coefficients in the quoted and effective spread regressions (first four columns of Table 3) are of the same magnitude as the averages in Table 2. The inclusion of volatility in Table 3 demonstrates that the increase in spreads is not due to changes in volatility affecting NYSE and Nasdaq securities differently. For the four largest quintiles the coefficients are positive and statistically significant, with the smallest *t*-statistic 4.1 and the largest 14.0. As in Table 2 the Hybrid impact generally increases in the smaller quintiles. For the largest four quintiles the full sample coefficient on Hybrid is 0.53 basis points. This is almost a 10 percent increase in spreads from the 5.56 basis point pre-Hybrid average in Table 2 (the average of the four largest quintiles). While the magnitude of the Hybrid coefficient is larger for smaller stocks, the spreads are also wider for smaller stocks. As a percentage of the pre-Hybrid average, the increase due to Hybrid is greatest for the largest stocks: 0.43 basis points on an average of 2.78 basis points (Table 2) for an increase of 16 percent. For the smallest stocks' effective spreads (Quintile 5), the Hybrid coefficient is 0.70 basis points, but this is noisily estimated with a *t*-statistic of only 0.7.

The volatility measures in Table 3 also tell a similar story to those in Table 2. The five-minute quote volatility shows little impact of Hybrid's introduction. The five-minute trading range increases significantly with Hybrid in all size quintiles.

While Figure 2 suggests that there is a decrease in floor activity with the introduction of Hybrid, Table 4 examines this directly. The percentage of trading volume is calculated each day for the system, floor broker, and specialist categories, using data from the NYSE CAUD file. Overall the decrease in floor activity (and increase in system activity) is 4.1 percent. This is split between specialist activity falling 2.3 percent (from 6.8 percent to 4.5 percent) and floor broker activity declining 1.8 percent (from 8.5 percent to 6.7 percent). The decline occurs in all size quintiles and is significant at the 0.01 level in all places. The decline in specialist activity is larger in the smaller stocks and the decline for floor brokers is larger in the larger stocks.

[Table 4 Here]

To directly attribute the decline in market quality in Tables 2 and 3 to the decrease in floor activity in Table 4, we use the Hybrid introduction as an instrument for floor activity in a two-stage least squares regression. The first stage is:

$$FlrAct_{i,t} = \alpha_i + \beta_1 Hybrid_{i,t} + \beta_2 Hybrid_{i,t} \times Q5_i + \gamma_1 Volatility_t + \gamma_2 Volatility_t \times Q5_i + \delta Daynum_t + \mu_{i,t} \quad (3)$$

$$FlrActQ5_{i,t} = \alpha_i + \beta_1 Hybrid_{i,t} + \beta_2 Hybrid_{i,t} \times Q5_i + \gamma_1 Volatility_t + \gamma_2 Volatility_t \times Q5_i + \delta Daynum_t + \nu_{i,t} \quad (4)$$

And the second stage is:

$$MQ_{i,t} = \alpha_i + \beta_1 FlrAct^P_{i,t} + \beta_2 FlrActQ5^P_{i,t} + \gamma_1 Volatility_t + \gamma_2 Volatility_t \times Q5_i + \delta Daynum_t + \varepsilon_{i,t} \quad (5)$$

where α_i are stock fixed effects; $Hybrid_{i,t}$ is an indicator variable taking the value of one if the stock is in Hybrid mode on day t, otherwise zero; $Q5_i$ is an indicator variable taking the value of one if the stock is in market-capitalization quintile five (the smallest stocks), otherwise zero; $Volatility_t$ is the opening value of CBOE's VIX index on day t; $FlrAct_{i,t}$ is the log of the odds ratio (p/(1-p)), with p equal to the percentage of trading executed by floor participants in stock i on day t; $Daynum_t$ is a time trend; and $FlrAct^P_{i,t}$ and $FlrActxQ5^P_{i,t}$ are the predicted values for $FlrAct_{i,t}$ and $FlrActQ5_{i,t}$ from the first stage regression equations. The log odds ratio is used because the floor activity is restricted to be between zero and one; using floor activity in a simple linear model provides similar inference. The time trend variable is included to control for any general decline in floor trading that is not related to Hybrid. The time trend in the second stage also controls for any downward trend in the market quality variables.

Table 5 presents the results of the instrumental variable (IV) regressions in the same format as Table 3. The negative coefficients on floor activity support the conclusion that more floor trading leads to higher market quality. Because floor activity declines with the Hybrid introduction, the negative coefficients on floor activity are consistent with the positive coefficients on the Hybrid dummy in Table

3. Therefore, the lower market quality—higher spreads and higher trading range volatility—following Hybrid's introduction is attributable to floor trading.

The magnitude of the effects in Table 5 is similar to those in Table 3. Floor activity declines from 16.7% to 12.6% for the largest size quintile (Table 4). This changes the log odds ratio from -0.70 to -0.84. Multiplying this difference of -0.14 by the Q1 floor activity coefficient of -2.38 gives an increase in effective spreads of 0.34, comparable to the coefficient of 0.43 in Table 3. If one is willing to using the coefficient estimates from the IV regressions to extrapolate out of sample, the impact of the decline in floor activity since 2002 can be estimated. For the largest quintile, if floor activity rose to back to 50 percent, the corresponding spread would be 2.2 basis points lower. This is more than two thirds of the average effective spread for this quintile from Table 2.

[Table 5 Here]

Consistent with Table 3, the five-minute trading range is negatively related to floor activity with significant *t*-statistics on the four largest quintiles. For the largest quintile of stocks the five-minute quote volatility is significantly negatively related to floor trading. The five-minute quote volatility for the largest four quintiles is also negative with a *t*-statistic of 1.9. This is the one area where the instrumental variable regression differs from using only the Hybrid variable. This may be due to Hybrid having an uneven impact on floor activity across stocks and the IV regression identifying stocks in which floor activity fell. However, outside of the largest quintile, five-minute quote volatility decreasing in floor activity is not reliably statistically significant.

The analysis in this section shows that trading costs and volatility as measured by the five-minute trading range increase following Hybrid. Further, we demonstrate that this is due to the fall in floor activity associated with Hybrid's introduction. This supports the notion that benefits of reputational trading on the NYSE outweigh the costs of floor participants' taking advantage of off-floor traders. Next we more fully explore how the changes in execution costs affect floor and system trading. In particular, we test whether or not the increases in trading costs are isolated to floor traders and whether there is evidence of declining cooperation among floor traders.

5. Separating Hybrid's Impact on the Costs of Floor and System Trading

Up to this point we have used the publicly available TAQ data to measure trading costs. The NYSE's CAUD file provides additional information on whether the counterparties in a trade are floor traders or electronic orders. The CAUD database matches buyers and sellers for each NYSE trade, providing information about all of the parties on each side of a trade. Note that there can be more than one type of participant on each side of a single trade. For example, a system buy order for 1000 shares of ABC may execute against a system offer of 500 shares, a floor broker offer of 300 shares, and a specialist offer of 200 shares, all at the same price and time. Participation rates are computed by summing the purchases and sales by each type of market participant (system, floor broker, and specialist) and dividing by twice total volume, since the numerator double-counts volume. In contrast, who trades with whom is determined by identifying all of the types of market participants involved in each trade and then categorizing the trade as follows:[11]

Pure Floor = Specialist and Floor Brokers, or Floor Brokers only;

Pure System = System participants only;

Floor and System Interaction = Specialist and System participants, or Floor Brokers and System participants, or Specialist, Floor Brokers, and System participants.

We further decompose floor and system interaction trades into those initiated by floor participants, those initiated by system participants, and those with mixed initiator types (meaning both floor and system participants on one or both sides of the trade).[12] The ABC trade described above would be categorized as a mixed-initiator floor and system interaction trade, because it involves a specialist, a floor broker, and system participants, and both floor and system participants are on one side of the trade. Who-trades-with-whom percentages are calculated by summing volume across trades in each category for each stock each day, then dividing by total traded volume in that stock that day.

[11] Percentage (CAP) executions are included as floor broker executions. Incoming Intermarket Trading System (ITS) executions are included as system participant executions.

[12] For more detailed decompositions of who trades with whom, see Moulton (2006).

Using this categorization of trades, Table 6 refines the breakdown of trading in Table 4. Because system and floor participation in interaction trades varies from close to zero to close to 100 percent, the who-trades-with-whom percentages in Table 6 cannot be easily aggregated into the simple floor versus system participation breakdown in Table 4. Table 6 shows that the most significant switch is a roughly 8 percent change towards pure system trading away from mixed initiator floor-system interaction trades. This likely stems from Hybrid's automatic execution precluding floor traders from joining what would otherwise have been pure system trades all along. The fraction of trading that is pure floor is relatively unchanged by Hybrid's introduction, remaining under two percent in all quintiles. Floor-initiated interaction trades decrease about one to two percent while system-initiated interaction trades increase a similar amount.

[Table 6 Here]

Effective spreads are perhaps the most common measure of trading costs. To examine changes in adverse selection and liquidity provider profits it is useful to decompose effective spreads into their permanent and transitory portions. The percentage price impact for each trade in stock j at time k on day t reflects the permanent effect and is calculated as:

$$PImpact_{j,k,t} = 2\, I_{j,k,t}\, (M_{j,k+5,t} - M_{j,k,t}) / M_{j,k,t}\,,$$

where $I_{j,k,t}$ is an indicator variable that equals one for buyer-initiated trades and negative one for seller-initiated trades (see Data section for details), $M_{j,k,t}$ is the matching quote midpoint, and $M_{j,k+5,t}$ is the quote midpoint five minutes after the trade. The realized spread reflects the temporary effect, approximating the profit earned by the liquidity provider, and is equal to the difference between the percentage effective spread and the price impact:

$$RSpread_{j,k,t} = 2\, I_{j,k,t}\, (P_{j,k,t} - M_{j,k+5,t}) / M_{j,k,t}\,.$$

where $P_{j,k,t}$ is the trade price and other variables are as defined above.

To study how Hybrid affects relationships on the trading floor and the interaction between the floor and system participants we run regressions of the following form:

$$SPR_{i,k,t} = \alpha_i + \sum_{k=2}^{5} \beta_k Type_k + \sum_{k=1}^{5} \beta_k Type_k \times Q5_i + \sum_{k=1}^{5} \gamma_k Type_k \times Hybrid_{i,t} + \sum_{k=1}^{5} \gamma_k Type_k \times Hybrid_{i,t} \times Q5_i + \delta_1 Volatility_t + \delta_2 Volatility_t \times Q5_i + \varepsilon_{i,t} \quad (6)$$

where $SPR_{i,k,t}$ is the effective spread, price impact, or realized spread for trades of type k in stock i on day t less the Nasdaq match; α_i are stock fixed effects; $Type_k$ is a dummy variable indicating the trade type (pure system, pure floor, floor-initiated interaction, system-initiated interaction, or mixed-initiator interaction); $Q5_i$ is an indicator variable taking the value of one if the stock is in market-capitalization quintile five (the smallest stocks), otherwise zero; $Hybrid_{i,t}$ is an indicator variable taking the value of one if the stock is in Hybrid mode on day t, otherwise zero; and $Volatility_t$ is the opening value of CBOE's VIX index on day t. The type dummy is omitted for pure system trades. Therefore, the coefficients on other type dummies represent differences from pure system trades. The coefficients on the trade type dummy variable interacted with the Hybrid dummy variable measure the change in that type trade following Hybrid's introduction.

Table 7 presents the regression results for effective spreads (Panel A), five-minute price impacts (Panel B), and five-minute realized spreads (Panel C). In Panel A of Table 7 effective spreads increase for all trade types with the Hybrid introduction. This shows that the increase in effective spreads occurs for all market participants and is not solely due to floor trading becoming more expensive. The pure system trades increase by an amount similar to the overall increase seen in Table 3. Floor traders appear more affected than system traders because effective spreads for the other type categories increase more than pure system trades, with pure floor and floor-initiated interaction trades increasing the most.

[Table 7 Here]

In Panel B of Table 7 price impacts increase by two basis points for pure floor trades. Prior to Hybrid pure floor trades have significantly less price impact than pure system trades. This is consistent

with repeated interaction leading to cooperation among floor traders, attenuating adverse selection. After Hybrid, pure floor trades have more adverse selection than pure system trades, suggesting a breakdown of cooperation on the floor. The price impact of system-initiated interaction trades increases by more than two basis points. This suggests that Hybrid makes it more difficult for floor traders to avoid electronically-arriving more informed order flow. Losing this ability could explain the continued decline of floor activity. The price impact of floor-initiated interaction trades declines. This may be due to floor traders' inability to utilize system latency to use off-floor limit orders as free trading options. Alternatively, Hybrid may enable the informed traders to get better execution using electronic orders, so they use floor traders less.

The realized spread analysis in Panel C of Table 7 provides evidence consistent with floor traders being less able to profit. The over two basis point increase in realized spreads for floor-initiated interaction trades translates into a rise in profitability for the system orders that provide liquidity. In contrast, system-initiated interaction trades become less profitable for floor-based liquidity providers. Using the realized spread as an *ex post* estimate of profitability suggests that Hybrid shifts the balance between floor traders and system traders of the profitability for liquidity demand and supply.

The analysis thus far establishes that Hybrid decreased market quality in terms of trading costs and five-minute transitory volatility. The trading costs changes arise from both increases in costs for trades that only involve system orders and from floor traders' losing their advantages and cooperating less. We next investigate whether this decline in market quality was a transitory adjustment to Hybrid or a permanent effect.

6. Longer-term Adjustment to Hybrid

Hybrid represents a significant change in the trading environment. It is possible that the negative effects in the month following Hybrid introduction are due to market participants' taking time to adjust their trading strategies. Therefore, we wish to test whether trading costs and transitory volatility return to

their pre-Hybrid levels after the introductory period. To do this we extend our panel data analysis from the two months surrounding Hybrid's introduction to the year around the event.

Table 8 replicates the regressions in Table 3 with the one-year sample period surrounding Hybrid's introduction: June 1, 2006 through May 31, 2007. The results for the spreads minus the Nasdaq matches are similar to the those for the shorter window. For example the effective spread increase attributed to Hybrid is 0.67 basis points in Table 8 versus 0.53 basis points in Table 3. Not surprisingly, extending the length of the sample period increases the statistical significance. One thing of note in Table 3 is that over the longer time period the actual spread on the NYSE declines. However, the decline for the NYSE stocks is less than the decline for the matching Nasdaq stocks.

[Table 8 Here]

The coefficients for NYSE minus match intraday volatility in the right-most columns are of the same sign as the corresponding coefficients in Table 3, but of larger magnitude. The five-minute trading range coefficient is 2.80 basis points for the year sample versus 1.25 basis points for the two-month sample. The five-minute quote volatility coefficients are larger and now statistically significant. As with the trading costs analysis for the year sample, volatility on the NYSE actually fell after Hybrid's introduction, but less than for the matching Nasdaq stocks. Similar to the analysis of the two-month sample in Tables 3 and 5, performing the IV regressions on the year sample shows that the declines in market quality in Table 8 are due to lower floor activity.[13]

Table 9 extends the analysis of spread changes by trade type (Table 7) to the one-year period surrounding Hybrid's introduction. In general the coefficients are of similar magnitude, but greater statistical significance, e.g., in the effective spread regression (Panel A) the coefficient on Hybrid for pure system trades is 0.51 with a *t*-statistic of 8.6 in Table 7 and the same coefficient is 0.69 with a *t*-statistic of 19.4 in Table 9. The interesting differences are price impacts and realized spreads for pure system trades. In the two-month sample, the hybrid coefficients for realized spreads are significantly positive and for price impact are positive but insignificant. These suggest that over the shorter horizon around Hybrid's

[13] Full-year results for the IV regressions are available from the authors upon request.

introduction the increase in effective spreads is due to greater profits for limit orders supplying liquidity. Over the one-year sample, Hybrid introduction leads to an increase in the price impact of pure system trades of 0.77 basis points with a *t*-statistic of 11.7. Hybrid's introduction leads to lower realized spreads for pure system trades, but the decline is not significant. Thus, over the longer term Hybrid leads to greater adverse selection for pure system trades, pure floor trades, and system-initiated floor-system interaction trades. This is consistent with the decline of cooperation on the floor and informed traders preferring anonymous electronic execution (as in Barclay, Hendershott, and McCormick (2003)).

[Table 9 Here]

7. Speed of Execution and Market Efficiency

The analysis up to this point provides evidence that Hybrid was uniformly negative for market quality. However, one of the stated reasons for Hybrid's introduction was to make execution faster. Boehmer (2005) and others have identified speed as an important dimension of market quality. Speed of execution is difficult to measure. Fortunately, the SEC requires markets to file monthly information on execution speed under Rule 11Ac1-5 (Dash-5). While the data are coarser than the daily data used elsewhere in this paper, monthly numbers may be sufficient to measure changes. Figure 5 graphs the NYSE's execution speed by quintile for all market and marketable limit orders aggregated across all size categories.

[Figure 5 Here]

Smaller stocks have longer times to execution before and after Hybrid. For the largest quintile execution time falls from about seven seconds to about two seconds with Hybrid's introduction.[14] For the smallest stocks execution time falls from 37 seconds to 16 seconds. For all quintiles the execution speed declines by more than 50 percent from the month before Hybrid's introduction to the month after.

[14] For market orders alone, excluding marketable limit orders, execution speed in the largest stock quintile falls from nine seconds four months pre-Hybrid to less than one second post-Hybrid.

Furthermore, Figure 6 shows that execution time fell for the smallest orders (under 500 shares) as well as overall, evidence that improved execution speed was not strictly a result of declining average trade sizes.

[Figure 6 Here]

These results show that while Hybrid lowers market quality on other dimensions, Hybrid succeeds in speeding up executions. The increase in execution speed could also increase market efficiency. We test this using two types of market efficiency measures. First, we construct intraday variance ratios as six times the variance of five-minute quote midpoint returns divided by the variance of 30-minute quote midpoint returns, calculated for each stock over the 20 days preceding and following its hybrid activation date. Second, we calculate R^2s from regressions of each stock's five-minute return on its lagged five-minute order imbalance, as in Chordia, Roll, and Subrahmanyam (2007), and average the R^2s over the 20 days preceding and following its hybrid activation date. In additional specifications we include each stock's own returns and market returns as explanatory variables along with order imbalance. Including lagged returns as explanatory variables relates the analysis to other measures of market efficiency, such as the return autocorrelations used in Boehmer, Saar, and Yu (2005).

[Table 10 Here]

The first two columns of Table 10 present our variance ratio results. Variance ratios exhibit insignificant changes around the Hybrid date, and their changes are similar to those experienced by the matched sample of Nasdaq stocks. The remaining columns of Table 10 show no systematic change in the R^2s from regressions of stock returns on lagged order imbalance (whether measured in number of trades or shares), with and without lagged stock returns and market returns. We find no evidence that market efficiency changes with the introduction of the Hybrid market.

8. Conclusion

The NYSE trading floor is one of the most famous and studied markets in the world. In this paper we examine the impact of the NYSE's introduction of its Hybrid market, an event that represents a major blow to trading on the NYSE floor. We show that the Hybrid market worsens market quality in terms of

trading costs and transitory volatility. We show that this decline is due to the reduction in floor activity. This demonstrates that along these dimensions the benefits of the repeated interactions available on the floor outweigh the potential costs of floor participants' ability to take advantage of off-floor traders. However, the trading process is faster. The Hybrid market represents a new position for the NYSE on the tradeoff between these different dimensions of market quality. The Hybrid experience suggests that it may be difficult to capture the benefits of both the repeated interaction that in-person trading offers and the speed at which electronic systems operate.

For some market participants, e.g., institutional traders working large orders via electronic limit orders or implementing complex strategies, the gains in speed may be more valuable than the wider spreads and higher transitory volatility. For small retail traders speed may be unimportant, in which case they are worse off under the new regime. An aggregate welfare analysis is difficult when there are changes along multiple dimensions of quality and traders have heterogeneous preferences.

The U.S. Securities and Exchange Commission intends to enhance competition between markets with Reg NMS. But by allowing faster markets to ignore slower markets' quotes, Reg NMS's Order Protection (trade-through) Rule effectively precludes traditional floor trading because human interaction is too slow. The goals of Reg NMS, to "give investors, particularly retail investors, greater confidence that they will be treated fairly when they participate in the equity markets" and to "promote deep and stable markets that minimize investor transaction costs" (SEC (2005)) are laudable. However, the Hybrid experience suggests that while investors who favor faster executions benefit, investors who are more concerned with lower execution costs or lower volatility than speed may be worse off in a world without floor trading.

An interesting question is the extent to which the benefits of human interaction can be replicated in fully electronic systems. In the context of the NYSE's introduction of the Hybrid market, could the benefits that derive from repeated interactions and lack of anonymity on the floor have been preserved in an increasingly electronic setting? Non-financial markets such as eBay demonstrate that reputations can be built in electronic markets. Whether such systems can work in financial markets where the potential gains from manipulation are substantial is a question of considerable practical and academic significance.

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Table 1: Sample Descriptive Statistics

Descriptive statistics are presented for the sample of 500 NYSE stocks and 500 Nasdaq stocks matched on market capitalization and price. Market capitalization and closing price are from CRSP as of March 31, 2006. Quoted spread (QSpread) and effective spread (ESpread) are calculated from TAQ data and averaged for each stock over the period January through March 2006. Mean, median, and standard deviation are calculated across 500 stocks in the full sample, 100 stocks in each quintile, with Quintile 1 comprising the largest stocks.

	NYSE Sample				Nasdaq Sample			
	Market Cap. ($ mil)	Closing Price ($)	QSpread (bps)	ESpread (bps)	Market Cap. ($ mil)	Closing Price ($)	QSpread (bps)	ESpread (bps)
Full Sample								
Mean	7,475	36.69	17.5	11.9	5,210	33.59	21.9	18.5
Median	2,078	32.70	9.0	6.4	1,681	29.71	9.8	8.9
Std. Deviation	17,819	26.12	29.4	19.0	17,266	26.87	42.1	33.5
Quintile 1								
Mean	29,035	51.41	4.7	3.3	18,895	39.38	6.5	6.7
Median	17,735	49.82	4.3	3.1	8,802	33.75	4.7	5.0
Std. Deviation	31,613	21.93	1.6	1.2	35,433	41.04	4.6	4.3
Quintile 2								
Mean	4,813	44.16	7.5	5.2	3,789	41.84	8.4	7.7
Median	4,473	40.32	6.4	4.4	3,606	37.55	6.8	6.6
Std. Deviation	1,423	28.29	7.2	4.4	1,882	21.29	8.9	7.2
Quintile 3								
Mean	2,132	40.87	10.3	7.2	1,963	40.07	11.0	9.6
Median	2,078	36.19	8.9	6.2	1,822	36.01	9.1	8.1
Std. Deviation	469	32.45	5.6	4.0	478	25.19	7.2	5.3
Quintile 4								
Mean	1,053	29.59	14.2	9.8	1,059	29.58	16.8	14.3
Median	1,007	27.99	12.5	8.7	1,023	28.35	13.0	11.3
Std. Deviation	234	13.78	5.9	4.0	234	13.74	13.7	11.9
Quintile 5								
Mean	340	17.44	50.7	33.9	344	17.08	67.2	54.6
Median	341	15.45	28.3	19.9	348	15.31	36.4	30.1
Std. Deviation	222	14.00	53.0	33.7	215	15.57	77.6	61.5

Table 2: Market Quality Measures Pre and Post Hybrid

Averages are calculated for each stock over the 20 days immediately preceding hybrid activation (Pre-Hybrid) and 20 days immediately following Hybrid activation (Post-Hybrid). Cross-sectional means and mean differences between NYSE stocks and their Nasdaq matches (labeled "- Match") are presented for the full sample of 500 stocks and by quintile, with Quintile 1 comprising the largest stocks. QSpread is the quoted spread; ESpread is the effective spread; QVolatility is the 5-minute midquote return volatility; TRange is the 5-minute trading range volatility; QDepth is the average quoted depth at the best bid and ask; Volume is daily dollar volume; Trade size is the average trade size. All measures are calculated from TAQ data. Significance levels of mean changes are from univariate t-tests; ** (*) denotes significance at the 1% (5%) level.

	QSpread (bps)	QSpread - Match (bps)	ESpread (bps)	ESpread - Match (bps)	QVolatility (bps)	QVolatility - Match (bps)	TRange (bps)	TRange - Match (bps)	QDepth (100s)	Volume ($ mn)	Trade Size (shares)
Full Sample											
Pre-Hybrid	14.7	-2.1	10.2	-3.4	15.0	-3.1	15.1	-6.0	14.5	30.1	376
Post-Hybrid	14.2	-2.1	10.3	-3.2	14.5	-2.8	15.9	-4.6	14.4	31.1	290
Change	-0.5	-0.1	0.2	0.3	-0.6 **	0.2	0.8 **	1.4 **	-0.1	1.0	-86 **
Quintile 1											
Pre-Hybrid	3.9	-1.6	2.8	-2.7	11.6	-4.7	14.5	-8.1	30.7	102.3	609
Post-Hybrid	4.1	-1.2	3.1	-2.3	11.4	-4.5	15.5	-6.7	29.5	106.0	414
Change	0.2 **	0.4 **	0.3 **	0.4 **	-0.2	0.2	1.0 **	1.5 **	-1.2	3.7	-195 **
Quintile 2											
Pre-Hybrid	6.4	-0.2	4.5	-1.4	12.5	-4.1	14.2	-6.4	15.2	26.1	386
Post-Hybrid	6.6	0.3	4.7	-1.0	12.2	-3.4	14.9	-4.7	15.8	26.5	302
Change	0.2	0.5 *	0.1	0.4 *	-0.3	0.7 *	0.7 **	1.7 **	0.6	0.4	-84 **
Quintile 3											
Pre-Hybrid	8.8	0.1	6.3	-1.0	14.3	-2.4	15.2	-4.3	9.5	12.2	305
Post-Hybrid	9.3	1.0	6.5	-0.6	14.0	-2.0	16.0	-3.2	9.6	12.7	256
Change	0.5 **	0.9 **	0.3 **	0.5 **	-0.3	0.4	0.8 **	1.1 **	0.1	0.4	-49 **
Quintile 4											
Pre-Hybrid	12.3	0.6	8.7	-0.6	17.0	-1.1	16.6	-3.4	9.0	7.7	286
Post-Hybrid	13.0	2.0	9.1	0.2	16.0	-1.1	16.9	-2.5	9.6	8.2	241
Change	0.7 **	1.4 **	0.5 **	0.8 **	-1.0 **	-0.1	0.3	0.9 *	0.6	0.5	-45 **
Quintile 5											
Pre-Hybrid	42.2	-9.3	28.6	-11.5	19.8	-3.2	14.8	-7.9	8.2	2.0	297
Post-Hybrid	38.0	-12.8	28.3	-12.3	18.8	-3.2	16.2	-5.9	7.6	2.1	239
Change	-4.2 *	-3.5	-0.4	-0.8	-1.0 *	0.0	1.4 **	2.1 *	-0.6	0.1	-58 **

Table 3: Panel Regression of Spreads and Intraday Volatility on Hybrid

Analysis period is the 40-day window surrounding each stock's Hybrid activation. Quoted spreads (QSpread), effective spreads (ESpread), 5-minute quote return volatility (QVolatility), and 5-minute trading range (TRange) for NYSE stocks and the differences between NYSE stocks and their matched Nasdaq stocks (- Match) are regressed on a dummy variable set equal to one if the stock has been activated in Hybrid (*Hybrid*), daily market *Volatility* as measured by the VIX index, and in the full sample specification both variables are interacted with a dummy variable *Q5* set equal to one for stocks in the fifth quintile (the smallest stocks). All regressions include stock fixed effects, not reported. All dependent variables are in basis points. Full sample is 500 stocks; Quintile 1 comprises the largest stocks. T-statistics, reported in parentheses below coefficient estimates, are calculated using Rogers standard errors clustered on date.

Dependent Variable	QSpread	QSpread - Match	ESpread	ESpread - Match	QVolatility	QVolatility - Match	TRange	TRange - Match
Full Sample								
Hybrid	0.41	0.80	0.31	0.53	-0.40	0.28	0.76	1.25
	(5.6)	*(11.2)*	*(6.3)*	*(9.5)*	*(-1.7)*	*(0.8)*	*(2.7)*	*(9.8)*
Hybrid x Q5	-3.89	-2.44	-0.16	0.17	-0.58	-0.27	0.65	0.88
	(-5.2)	*(-2.0)*	*(-0.2)*	*(0.2)*	*(-1.7)*	*(-0.5)*	*(2.1)*	*(1.4)*
Volatility	0.20	-0.02	0.16	-0.03	0.81	-0.15	0.92	-0.48
	(3.5)	*(-0.4)*	*(3.8)*	*(-0.7)*	*(2.9)*	*(-0.7)*	*(2.5)*	*(-2.4)*
Volatility x Q5	1.59	1.32	1.29	1.43	0.04	0.00	0.05	0.39
	(2.2)	*(1.6)*	*(1.6)*	*(1.7)*	*(0.1)*	*(0.0)*	*(0.2)*	*(1.0)*
Quintile 1								
Hybrid	0.24	0.43	0.31	0.43	-0.17	0.12	1.02	1.42
	(6.0)	*(10.2)*	*(12.1)*	*(14.0)*	*(-0.7)*	*(0.6)*	*(3.3)*	*(7.1)*
Volatility	0.07	-0.01	0.05	-0.04	0.45	-0.47	0.54	-0.72
	(1.8)	*(-0.1)*	*(1.8)*	*(-1.1)*	*(1.9)*	*(-1.9)*	*(1.7)*	*(-2.5)*
Quintile 2								
Hybrid	0.19	0.53	0.14	0.39	-0.23	0.73	0.74	1.69
	(2.6)	*(4.7)*	*(3.1)*	*(4.6)*	*(-0.9)*	*(1.7)*	*(2.5)*	*(7.3)*
Volatility	0.06	-0.19	0.05	-0.17	0.65	-0.03	0.77	-0.42
	(1.1)	*(-2.6)*	*(1.5)*	*(-2.7)*	*(2.6)*	*(-0.1)*	*(2.1)*	*(-1.7)*
Quintile 3								
Hybrid	0.48	0.88	0.30	0.47	-0.26	0.36	0.87	1.09
	(4.5)	*(6.3)*	*(4.1)*	*(4.1)*	*(-0.9)*	*(0.8)*	*(2.6)*	*(4.6)*
Volatility	0.32	0.15	0.23	0.11	0.86	-0.08	0.96	-0.45
	(4.4)	*(1.5)*	*(4.5)*	*(1.5)*	*(2.6)*	*(-0.3)*	*(2.4)*	*(-2.5)*
Quintile 4								
Hybrid	0.75	1.36	0.50	0.82	-0.89	-0.08	0.44	0.82
	(6.4)	*(10.9)*	*(5.4)*	*(8.0)*	*(-3.1)*	*(-0.2)*	*(1.3)*	*(3.0)*
Volatility	0.36	-0.02	0.31	-0.02	1.25	-0.05	1.38	-0.34
	(3.5)	*(-0.2)*	*(4.0)*	*(-0.3)*	*(3.5)*	*(-0.2)*	*(3.0)*	*(-1.3)*
Quintile 5								
Hybrid	-3.48	-1.64	0.15	0.70	-0.97	0.01	1.41	2.14
	(-4.7)	*(-1.3)*	*(0.2)*	*(0.7)*	*(-2.5)*	*(0.0)*	*(4.3)*	*(3.5)*
Volatility	1.79	1.30	1.45	1.40	0.85	-0.16	0.96	-0.09
	(2.5)	*(1.6)*	*(1.8)*	*(1.7)*	*(2.3)*	*(-0.4)*	*(2.4)*	*(-0.2)*

Table 4: Who Trades Pre and Post Hybrid

Averages are calculated for each stock over the 20 days immediately preceding hybrid activation (Pre-Hybrid) and 20 days immediately following Hybrid activation (Post-Hybrid). Percentages are calculated for each participant type as that type's share volume divided by twice total volume. Cross-sectional means are presented for the full sample of 500 stocks and by quintile, with Quintile 1 comprising the largest stocks. All percentages are calculated from CAUD data. Significance levels of mean changes are from univariate t-tests; ** (*) denotes significance at the 1% (5%) level.

	System Volume	Specialist Volume	Floor Broker Volume	Specialist + Floor Broker Volume
Full Sample				
Pre-Hybrid	84.7%	6.8%	8.5%	15.3%
Post-Hybrid	88.8%	4.5%	6.7%	11.2%
Change	4.1% **	-2.3% **	-1.8% **	-4.1% **
Quintile 1				
Pre-Hybrid	83.3%	5.7%	11.1%	16.7%
Post-Hybrid	87.4%	4.0%	8.6%	12.6%
Change	4.1% **	-1.7% **	-2.4% **	-4.1% **
Quintile 2				
Pre-Hybrid	85.3%	5.4%	9.3%	14.7%
Post-Hybrid	89.3%	3.5%	7.2%	10.7%
Change	4.0% **	-1.9% **	-2.1% **	-4.0% **
Quintile 3				
Pre-Hybrid	86.1%	5.8%	8.1%	13.9%
Post-Hybrid	89.9%	3.6%	6.5%	10.1%
Change	3.8% **	-2.2% **	-1.6% **	-3.8% **
Quintile 4				
Pre-Hybrid	86.1%	6.2%	7.7%	13.9%
Post-Hybrid	89.7%	4.1%	6.2%	10.3%
Change	3.6% **	-2.1% **	-1.5% **	-3.6% **
Quintile 5				
Pre-Hybrid	82.9%	10.8%	6.3%	17.1%
Post-Hybrid	87.8%	7.1%	5.1%	12.2%
Change	4.8% **	-3.7% **	-1.1% **	-4.8% **

Table 5: Instrumental Variables Regression of Spreads and Intraday Volatility on Floor Activity

Analysis period is the 40-day window surrounding each stock's Hybrid activation. Quoted spreads (QSpread), effective spreads (ESpread), 5-minute quote return volatility (QVolatility), and 5-minute trading range (TRange) for NYSE stocks and the differences between NYSE stocks and their matched Nasdaq stocks (- Match) are regressed on: the log odds ratio of the floor volume percentage (*FlrActivity*), instrumented by a dummy variable set equal to 1 if the stock has been activated in Hybrid; daily market *Volatility* as measured by the VIX index; and in the full sample specification both variables interacted with a dummy variable *Q5* set equal to one for stocks in the fifth quintile (the smallest stocks). All regressions include stock fixed effects and a time trend, not reported. Full sample is 500 stocks; Quintile 1 comprises the largest stocks. T-statistics, reported in parentheses below coefficient estimates, are calculated using Rogers standard errors clustered on date.

Dependent Variable	QSpread	QSpread - Match	ESpread	ESpread - Match	QVolatility	QVolatility - Match	TRange	TRange - Match
Full Sample								
FlrActivity	-2.22	-0.91	-2.44	-1.11	0.43	-2.27	-4.02	-5.66
	(-2.8)	*(-0.7)*	*(-3.6)*	*(-1.0)*	*(0.4)*	*(-1.9)*	*(-3.0)*	*(-4.8)*
FlrActivity x Q5	5.56	1.02	-0.01	-2.23	0.78	0.29	-0.51	-0.74
	(5.4)	*(0.5)*	*(0.0)*	*(-1.4)*	*(1.3)*	*(0.3)*	*(-0.7)*	*(-0.6)*
Volatility	0.23	-0.06	0.20	-0.05	0.83	-0.12	0.96	-0.43
	(3.0)	*(-1.1)*	*(3.0)*	*(-1.0)*	*(3.1)*	*(-0.6)*	*(2.4)*	*(-2.6)*
Volatility x Q5	1.56	1.19	1.03	0.79	0.27	0.20	0.04	0.28
	(3.5)	*(1.6)*	*(2.5)*	*(1.2)*	*(0.9)*	*(0.6)*	*(0.2)*	*(0.9)*
Quintile 1								
FlrActivity	-1.86	-2.62	-1.96	-2.38	-3.59	-5.93	-11.34	-12.71
	(-3.7)	*(-3.5)*	*(-4.2)*	*(-3.7)*	*(-1.9)*	*(-2.9)*	*(-3.7)*	*(-4.2)*
Volatility	0.09	0.01	0.06	-0.03	0.53	-0.37	0.67	-0.59
	(1.7)	*(0.2)*	*(1.2)*	*(-0.5)*	*(2.1)*	*(-1.7)*	*(1.6)*	*(-2.1)*
Quintile 2								
FlrActivity	-2.03	-0.62	-1.26	-0.12	0.54	-4.91	-6.55	-10.37
	(-2.4)	*(-0.5)*	*(-2.2)*	*(-0.1)*	*(0.3)*	*(-1.7)*	*(-1.9)*	*(-2.7)*
Volatility	0.14	-0.21	0.10	-0.21	0.64	0.14	1.02	-0.07
	(1.9)	*(-2.3)*	*(2.0)*	*(-2.4)*	*(2.4)*	*(0.5)*	*(2.1)*	*(-0.3)*
Quintile 3								
FlrActivity	-2.16	-2.24	-1.62	-1.61	0.52	-0.98	-2.37	-3.66
	(-3.8)	*(-2.9)*	*(-4.2)*	*(-2.7)*	*(0.5)*	*(-0.8)*	*(-1.6)*	*(-2.7)*
Volatility	0.33	0.13	0.24	0.11	0.87	-0.09	0.94	-0.45
	(3.7)	*(1.2)*	*(3.7)*	*(1.4)*	*(2.8)*	*(-0.4)*	*(2.2)*	*(-2.8)*
Quintile 4								
FlrActivity	-2.74	-3.17	-2.01	-1.73	1.41	-2.75	-3.35	-5.24
	(-5.2)	*(-4.2)*	*(-5.2)*	*(-2.2)*	*(1.1)*	*(-1.5)*	*(-2.5)*	*(-3.3)*
Volatility	0.35	-0.07	0.31	-0.06	1.29	-0.02	1.39	-0.33
	(2.8)	*(-0.6)*	*(3.4)*	*(-0.6)*	*(3.9)*	*(-0.1)*	*(2.8)*	*(-1.2)*
Quintile 5								
FlrActivity	3.42	3.40	-4.04	-2.36	2.16	-0.21	-2.33	-3.60
	(1.3)	*(0.7)*	*(-1.6)*	*(-0.6)*	*(1.9)*	*(-0.1)*	*(-1.8)*	*(-1.4)*
Volatility	1.79	1.04	1.28	0.72	1.07	0.03	0.93	-0.22
	(3.7)	*(1.4)*	*(3.0)*	*(1.1)*	*(3.1)*	*(0.1)*	*(2.4)*	*(-0.6)*

Table 6: Who Trades with Whom Pre and Post Hybrid

Averages are calculated for each stock over the 20 days immediately preceding hybrid activation (Pre-Hybrid) and 20 days immediately following Hybrid activation (Post-Hybrid). Cross-sectional means are presented for the full sample of 500 stocks and by quintile, with Quintile 1 comprising the largest stocks. Pure System trades involve only system participants; Pure Floor trades involve only floor brokers and/or the specialist; Floor & System Interaction trades involve some combination of floor and system participants. Floor and System Interaction Trades are further categorized by which type of participant inititated the trade: Floor-Initiated, System-Initiated, and Mixed Initiator, which are trades in which floor and system participants are onthe same side. Who Trades with Whom percentages are calculated for trade type as share volume divided by total volume. Statistics are calculated from CAUD data. Significance levels of mean changes are from univariate t-tests; ** (*) denotes significance at the 1% (5%) level.

			Floor & System Interaction		
	Pure System	Pure Floor	Floor-Initiated	System-Initiated	Mixed Initiator
Full Sample					
Pre-Hybrid	69.3%	1.4%	5.3%	9.5%	14.5%
Post-Hybrid	77.5%	1.4%	3.9%	11.0%	6.2%
Change	8.2% **	0.0%	-1.4% **	1.5% **	-8.2% **
Quintile 1					
Pre-Hybrid	67.0%	1.4%	5.1%	7.0%	19.5%
Post-Hybrid	75.0%	1.6%	4.1%	11.3%	8.0%
Change	8.0% **	0.2%	-1.0% **	4.3% **	-11.5% **
Quintile 2					
Pre-Hybrid	70.7%	1.3%	4.8%	8.1%	15.0%
Post-Hybrid	78.6%	1.4%	3.3%	10.4%	6.3%
Change	7.9% **	0.0%	-1.6% **	2.3% **	-8.7% **
Quintile 3					
Pre-Hybrid	72.3%	1.5%	4.5%	8.8%	12.9%
Post-Hybrid	79.8%	1.3%	3.2%	9.9%	5.8%
Change	7.4% **	-0.1%	-1.3% **	1.1% **	-7.1% **
Quintile 4					
Pre-Hybrid	71.9%	1.3%	4.6%	9.7%	12.6%
Post-Hybrid	79.4%	1.3%	3.4%	10.4%	5.6%
Change	7.5% **	-0.1%	-1.2% **	0.8%	-7.0% **
Quintile 5					
Pre-Hybrid	64.7%	1.4%	7.5%	14.0%	12.3%
Post-Hybrid	74.7%	1.2%	5.7%	12.9%	5.5%
Change	10.0% **	-0.2%	-1.8% **	-1.1%	-6.8% **

Table 7: Panel Regression of Spreads on Hybrid by Who Trades with Whom Type
Analysis period is the 40-day window surrounding each stock's Hybrid activation. Effective spread (Panel A), price impact (Panel B), and realized spread (Panel C) differences between NYSE stocks and their matched Nasdaq stocks (ESpread - Match, PImpact - Match, and RSpread - Match) are regressed on dummy variables set equal to one for each of the five who-trades-with-whom categories (*Type*), *Type* times a dummy variable equal to one for stocks that are in the Quintile 5 (*TypexQ5*), *Type* times a dummy variable equal to one for stocks that have been activated in Hybrid (*TypexHybrid*), and *Type* times *Hybrid* times the *Q5* dummy (*TypexHybridxQ5*). Volatility as measured by the VIX index, Volatility interacted with the Q5 dummy, and stock fixed effects are also included in the regressions but not reported. Sample is 500 stocks. T-statistics, reported in parentheses below coefficient estimates, are calculated using Rogers standard errors clustered on date.

Panel A: Dependent Variable = ESpread - Match (bps)

			Floor & System Interaction		
WTWW Type	Pure System	Pure Floor	Floor-Initiated	System-Initiated	Mixed Initiator
Type	--	-0.13	-0.62	-0.12	0.93
	--	*(-1.4)*	*(-17.5)*	*(-3.7)*	*(19.2)*
Type x Q5	-19.10	-20.57	-23.97	-19.67	-17.85
	(-2.8)	*(-3.2)*	*(-3.6)*	*(-2.9)*	*(-2.7)*
Type x Hybrid	0.51	1.37	1.60	0.95	0.74
	(8.6)	*(10.2)*	*(18.5)*	*(8.8)*	*(7.3)*
Type x Hybrid x Q5	-0.59	1.29	4.09	1.77	4.07
	(-0.6)	*(1.0)*	*(4.0)*	*(2.1)*	*(3.7)*

Panel B: Dependent Variable = PImpact - Match (bps)

			Floor & System Interaction		
WTWW Type	Pure System	Pure Floor	Floor-Initiated	System-Initiated	Mixed Initiator
Type	--	-0.88	-0.85	-2.07	0.83
	--	*(-2.5)*	*(-4.8)*	*(-13.3)*	*(7.6)*
Type x Q5	-19.24	-20.71	-25.63	-17.18	-17.64
	(-2.8)	*(-2.8)*	*(-3.6)*	*(-2.5)*	*(-2.5)*
Type x Hybrid	0.11	1.96	-0.69	2.24	1.11
	(1.3)	*(4.0)*	*(-2.8)*	*(9.6)*	*(4.9)*
Type x Hybrid x Q5	0.43	4.72	3.27	4.85	1.18
	(0.5)	*(1.7)*	*(2.6)*	*(3.6)*	*(0.8)*

Panel C: Dependent Variable = RSpread - Match (bps)

			Floor & System Interaction		
WTWW Type	Pure System	Pure Floor	Floor-Initiated	System-Initiated	Mixed Initiator
Type	--	0.72	0.23	1.95	0.10
	--	*(2.1)*	*(1.3)*	*(13.3)*	*(0.7)*
Type x Q5	1.32	1.38	2.91	-1.31	0.93
	(0.2)	*(0.2)*	*(0.5)*	*(-0.2)*	*(0.2)*
Type x Hybrid	0.40	-0.62	2.25	-1.30	-0.40
	(5.1)	*(-1.2)*	*(8.5)*	*(-5.9)*	*(-1.7)*
Type x Hybrid x Q5	-0.99	-3.54	0.84	-3.05	2.97
	(-0.8)	*(-1.2)*	*(0.5)*	*(-2.3)*	*(1.7)*

Table 8: Panel Regression of Spreads and Intraday Volatility on Hybrid

Analysis period is June 1, 2006 through May 31, 2007. Quoted spread (QSpread), effective spread (ESpread), 5-minute quote return volatility (QVolatility), and 5-minute trading range (TRange) for NYSE stocks and the differences between NYSE stocks and their matched Nasdaq stocks (- Match) are regressed on a dummy variable set equal to one if the stock has been activated in Hybrid (*Hybrid*), daily market *Volatility* as measured by the VIX index, and in the full sample specification both variables are interacted with a dummy variable *Q5* set equal to one for stocks in the fifth quintile (the smallest stocks). All regressions include stock fixed effects, not reported. All dependent variables are in basis points. Full sample is 500 stocks; Quintile 1 comprises the largest stocks. T-statistics, reported in parentheses below coefficient estimates, are calculated using Rogers standard errors clustered on date.

Dependent Variable	QSpread	QSpread - Match	ESpread	ESpread - Match	QVolatility	QVolatility - Match	TRange	TRange - Match
Full Sample								
Hybrid	-1.08	0.61	-0.85	0.67	-2.28	0.86	-1.38	2.80
	(-12.7)	*(13.2)*	*(-12.5)*	*(18.1)*	*(-9.2)*	*(6.5)*	*(-4.4)*	*(21.2)*
Hybrid x Q5	-9.14	1.25	-4.40	4.06	-0.86	-1.25	1.36	-0.71
	(-22.9)	*(2.0)*	*(-12.0)*	*(7.7)*	*(-4.9)*	*(-4.5)*	*(6.7)*	*(-2.4)*
Volatility	0.24	0.02	0.19	-0.01	0.74	-0.02	0.93	-0.08
	(13.9)	*(2.4)*	*(13.5)*	*(-1.5)*	*(11.2)*	*(-0.4)*	*(11.3)*	*(-2.2)*
Volatility x Q5	0.76	-0.10	0.54	-0.17	0.25	0.18	-0.11	0.19
	(8.9)	*(-0.6)*	*(7.1)*	*(-1.3)*	*(6.2)*	*(3.3)*	*(-2.1)*	*(2.7)*
Quintile 1								
Hybrid	-0.51	0.74	-0.22	0.74	-1.31	1.66	-0.54	3.95
	(-12.4)	*(23.1)*	*(-6.8)*	*(23.1)*	*(-6.1)*	*(10.5)*	*(-1.8)*	*(19.4)*
Volatility	0.11	-0.06	0.09	-0.06	0.54	-0.09	0.79	-0.16
	(12.1)	*(-7.1)*	*(12.4)*	*(-7.1)*	*(9.7)*	*(-2.2)*	*(10.3)*	*(-2.9)*
Quintile 2								
Hybrid	-1.11	0.54	-0.76	0.54	-1.94	0.91	-1.18	2.88
	(-15.3)	*(11.3)*	*(-13.9)*	*(11.3)*	*(-8.5)*	*(5.8)*	*(-4.1)*	*(17.4)*
Volatility	0.19	-0.01	0.15	-0.01	0.65	0.01	0.82	-0.12
	(13.6)	*(-1.0)*	*(13.4)*	*(-1.0)*	*(11.2)*	*(0.3)*	*(10.8)*	*(-2.8)*
Quintile 3								
Hybrid	-1.25	0.34	-1.08	0.34	-2.82	0.50	-2.15	2.40
	(-12.5)	*(6.0)*	*(-13.6)*	*(6.0)*	*(-10.5)*	*(3.2)*	*(-6.3)*	*(15.7)*
Volatility	0.23	0.01	0.19	0.01	0.80	-0.01	1.00	-0.06
	(11.4)	*(0.6)*	*(11.5)*	*(0.6)*	*(11.2)*	*(-0.2)*	*(11.3)*	*(-1.4)*
Quintile 4								
Hybrid	-1.51	1.04	-1.40	1.04	-3.11	0.36	-1.70	1.95
	(-10.8)	*(16.1)*	*(-11.9)*	*(16.1)*	*(-9.9)*	*(2.1)*	*(-4.6)*	*(13.0)*
Volatility	0.43	0.01	0.33	0.01	1.00	0.03	1.13	0.02
	(14.2)	*(0.8)*	*(13.6)*	*(0.8)*	*(11.5)*	*(0.7)*	*(11.4)*	*(0.5)*
Quintile 5								
Hybrid	-10.23	4.73	-5.25	4.73	-3.14	-0.39	-0.01	2.09
	(-22.8)	*(8.9)*	*(-13.0)*	*(8.9)*	*(-10.1)*	*(-1.3)*	*(0.0)*	*(7.5)*
Volatility	1.00	-0.18	0.73	-0.18	0.99	0.17	0.82	0.11
	(10.9)	*(-1.3)*	*(9.0)*	*(-1.3)*	*(12.7)*	*(2.9)*	*(12.4)*	*(1.4)*

Table 9: Panel Regression of Spreads on Hybrid by Who Trades with Whom Type
Analysis period is June 1, 2006 through May 31, 2007. Effective spread (Panel A), price impact (Panel B), and realized spread (Panel C) differences between NYSE stocks and their matched Nasdaq stocks (ESpread - Match, PImpact - Match, and RSpread - Match) are regressed on dummy variables set equal to one for each of the five who-trades-with-whom categories (*Type*), *Type* times a dummy variable equal to one for stocks that are in the Quintile 5 (*TypexQ5*), *Type* times a dummy variable equal to one for stocks that have been activated in Hybrid (*TypexHybrid*), and *Type* times *Hybrid* times the *Q5* dummy (*TypexHybridxQ5*). Volatility as measured by the VIX index, Volatility interacted with the Q5 dummy, and stock fixed effects are also included in the regressions but not reported. Sample is 500 stocks. T-statistics, reported in parentheses below coefficient estimates, are calculated using Rogers standard errors clustered on date.

Dependent Variable = ESpread - Match (bps)					
			Floor & System Interaction		
WTWW Type	Pure System	Pure Floor	Floor-Initiated	System-Initiated	Mixed Initiator
Type	--	-0.10	-0.56	-0.05	1.00
	--	*(-2.2)*	*(-31.2)*	*(-2.7)*	*(58.0)*
Type x Q5	-9.10	-9.63	-11.55	-9.02	-5.64
	(-7.2)	*(-7.8)*	*(-9.1)*	*(-7.3)*	*(-4.4)*
Type x Hybrid	0.69	1.87	2.07	1.18	0.92
	(19.4)	*(14.5)*	*(31.6)*	*(23.9)*	*(15.4)*
Type x Hybrid x Q5	3.36	3.87	5.79	4.84	3.63
	(7.0)	*(5.8)*	*(12.4)*	*(10.2)*	*(6.8)*

Dependent Variable = PImpact - Match (bps)					
			Floor & System Interaction		
WTWW Type	Pure System	Pure Floor	Floor-Initiated	System-Initiated	Mixed Initiator
Type	--	-1.21	-0.74	-2.70	1.08
	--	*(-9.6)*	*(-9.0)*	*(-34.5)*	*(21.8)*
Type x Q5	-2.56	-2.19	-8.12	0.08	0.24
	(-1.6)	*(-1.2)*	*(-4.9)*	*(0.0)*	*(0.1)*
Type x Hybrid	0.77	2.35	-0.13	3.58	1.14
	(11.7)	*(10.9)*	*(-0.7)*	*(28.2)*	*(7.5)*
Type x Hybrid x Q5	1.75	2.67	0.43	5.45	-2.04
	(3.7)	*(2.0)*	*(0.6)*	*(8.9)*	*(-2.5)*

Dependent Variable = RSpread - Match (bps)					
			Floor & System Interaction		
WTWW Type	Pure System	Pure Floor	Floor-Initiated	System-Initiated	Mixed Initiator
Type	--	1.05	0.17	2.64	-0.08
	--	*(8.5)*	*(2.1)*	*(34.5)*	*(-1.6)*
Type x Q5	-6.63	-7.61	-3.48	-9.17	-5.97
	(-3.3)	*(-3.7)*	*(-1.7)*	*(-4.6)*	*(-2.9)*
Type x Hybrid	-0.11	-0.49	2.14	-2.43	-0.25
	(-1.5)	*(-2.1)*	*(10.9)*	*(-19.8)*	*(-1.7)*
Type x Hybrid x Q5	1.63	1.29	5.34	-0.65	5.60
	(2.7)	*(1.0)*	*(6.8)*	*(-1.0)*	*(6.7)*

Table 10: Market Efficiency Measures Pre and Post Hybrid

Averages are calculated for each stock over the 20 days immediately preceding hybrid activation (Pre-Hybrid) and 20 days immediately following Hybrid activation (Post-Hybrid). Cross-sectional means and mean differences between NYSE stocks and their Nasdaq matches (labeled "- Match") are presented for the full sample of 500 stocks and by quintile, with Quintile 1 comprising the largest stocks. Variance ratio is the five-minute to 30-minute variance ratio. Model 1 regresses returns on lagged order imbalance; Model 2 regresses returns on lagged order imbalance and lagged same-stock returns; Model 3 regresses returns on three lags of order imbalance, three lags of same-stock returns, and three lags of market returns. OIBtrades indicates order imbalance measured in number of trades; OIBshares indicates order imbalance measured in number of shares. All measures are calculated from TAQ data. Significance levels of mean changes are from univariate t-tests; ** (*) denotes significance at the 1% (5%) level.

	Variance Ratio	Variance Ratio - Match	R^2(%) from Model 1		R^2(%) from Model 2		R^2(%) from Model 3	
			OIBtrades	OIBshares	OIBtrades	OIBshares	OIBtrades	OIBshares
Full Sample								
Pre-Hybrid	1.39	0.18	1.7	1.8	4.8	4.9	17.2	17.3
Post-Hybrid	1.43	0.18	1.7	1.7	4.8	4.8	17.2	17.2
Change	0.04	0.00	0.0	-0.1	0.0	-0.1	0.0	-0.1
Quintile 1								
Pre-Hybrid	1.39	0.15	1.6	1.6	4.5	4.5	16.8	16.9
Post-Hybrid	1.44	0.17	1.7	1.7	4.4	4.4	17.1	16.9
Change	0.05	0.02	0.2 *	0.1	-0.1	-0.1	0.2	0.0
Quintile 2								
Pre-Hybrid	1.43	0.12	1.6	1.7	4.9	5.0	17.3	17.3
Post-Hybrid	1.48	0.13	1.8	1.6	5.0	4.8	17.4	17.2
Change	0.05	0.01	0.1	-0.1	0.1	-0.2	0.0	-0.1
Quintile 3								
Pre-Hybrid	1.41	0.12	1.6	1.6	4.7	4.7	17.1	17.1
Post-Hybrid	1.44	0.10	1.7	1.6	4.8	4.7	17.3	17.3
Change	0.03	-0.02	0.1	0.0	0.1	0.1	0.2	0.2
Quintile 4								
Pre-Hybrid	1.39	0.16	1.7	1.8	4.6	4.6	17.0	17.0
Post-Hybrid	1.40	0.13	1.6	1.7	4.4	4.5	16.9	17.0
Change	0.01	-0.03	-0.1	0.0	-0.2	-0.1	-0.1	0.0
Quintile 5								
Pre-Hybrid	1.36	0.33	2.1	2.2	5.4	5.6	17.8	18.0
Post-Hybrid	1.40	0.34	1.9	2.0	5.2	5.3	17.6	17.8
Change	0.04	0.02	-0.2	-0.2	-0.2	-0.3	-0.2	-0.2

Figure 1: Long-run Floor Activity

This chart graphs the participation of specialists, floor brokers, and the entire floor (specialists plus floor brokers), measured as a percentage of twice total regular-hours trading volume for each stock each day. Daily percentages are equal-weighted averages across all NYSE stocks from January 1999 through May 2006, and the 20-day moving average is presented in the chart. Data in this chart represent all NYSE trading whereas data in the rest of the paper excludes certain types of trades. Data are from the NYSE CAUD file.

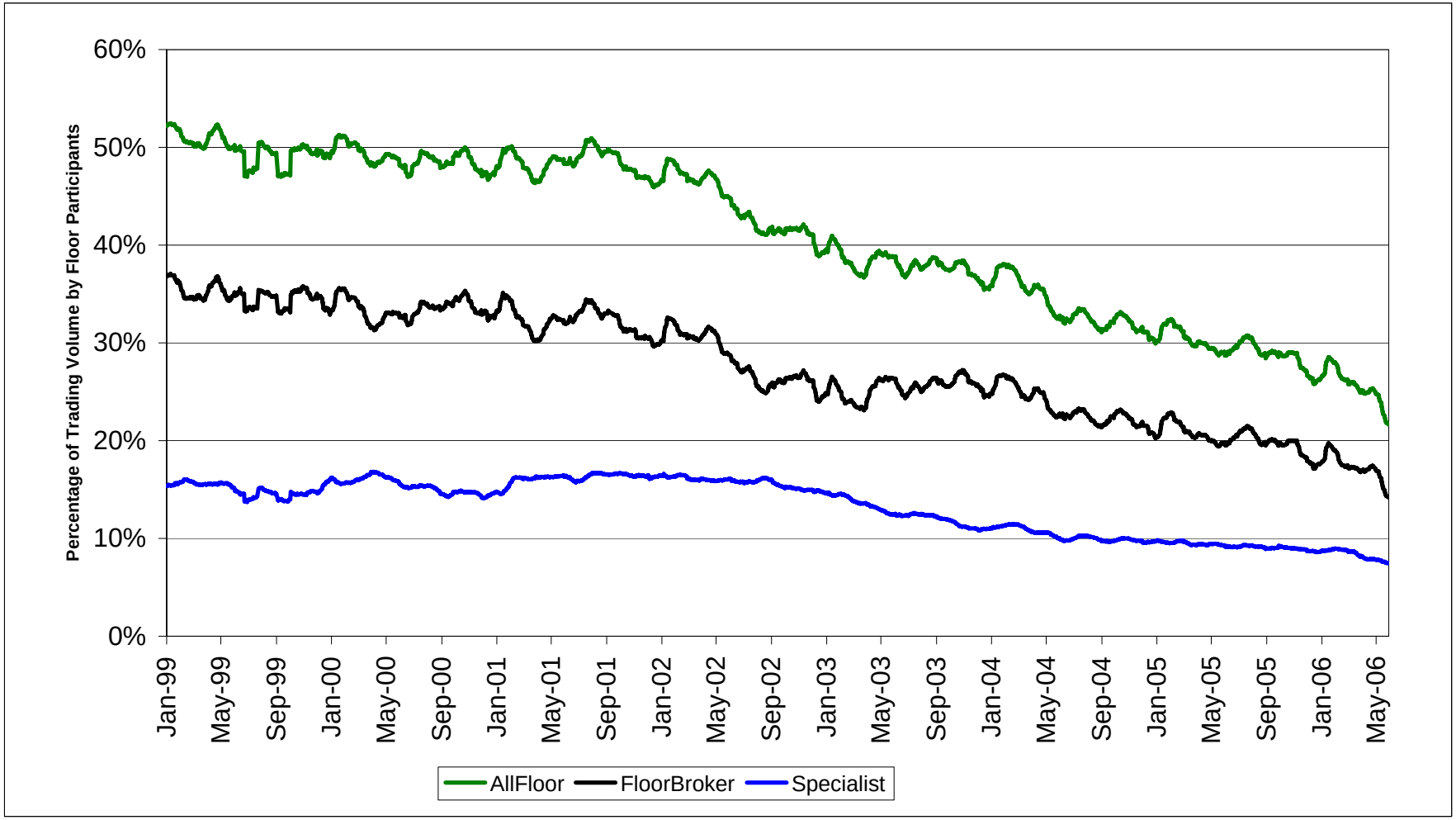

Figure 2: Floor Activity versus Hybrid Activation

This chart graphs the average participation of specialists, floor brokers, and the entire floor (specialists plus floor brokers), measured as a percentage of twice regular-hours trading volume for each stock each day, excluding opening and closing trades. Daily percentages are equal-weighted averages across the sample of 500 NYSE stocks from June 2006 through May 2007. The Hybrid line represents the cumulative percentage of the 500 stocks that have been activated in Hybrid; the box highlights the Hybrid activation period. Data are from the NYSE CAUD file.

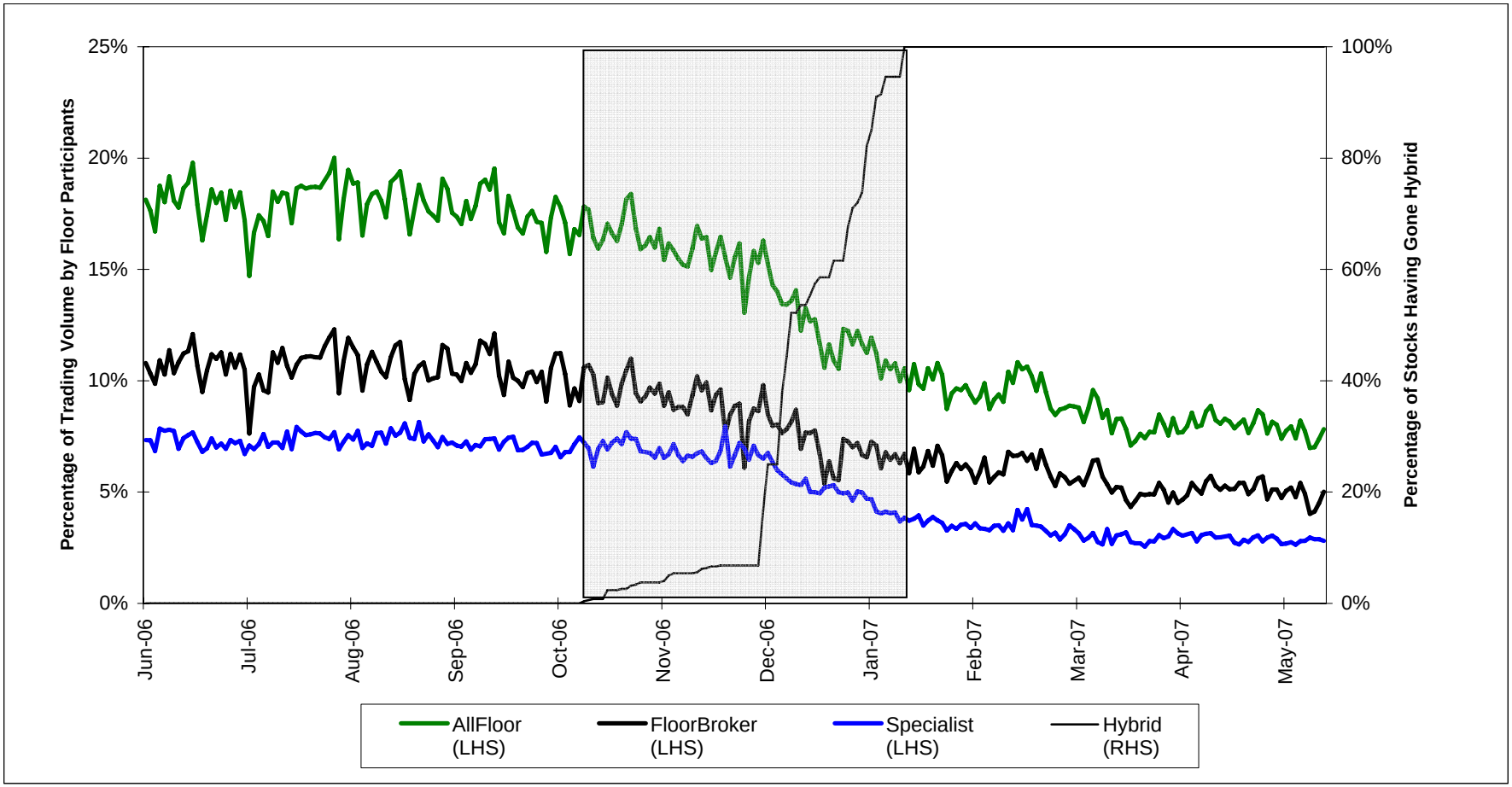

Figure 3: Effective Spreads

This chart graphs average effective spreads in basis points for the NYSE sample over the 40-day window surrounding the hybrid activation date for each stock. Equal-weighted averages across stocks are presented by quintile, where Q1 comprises the 100 largest stocks in the 500-stock sample. The largest four quintiles are plotted on the scale on the left y-axis and the smallest quintile is plotted on the scale on the right y-axis. Spreads are calculated from TAQ data.

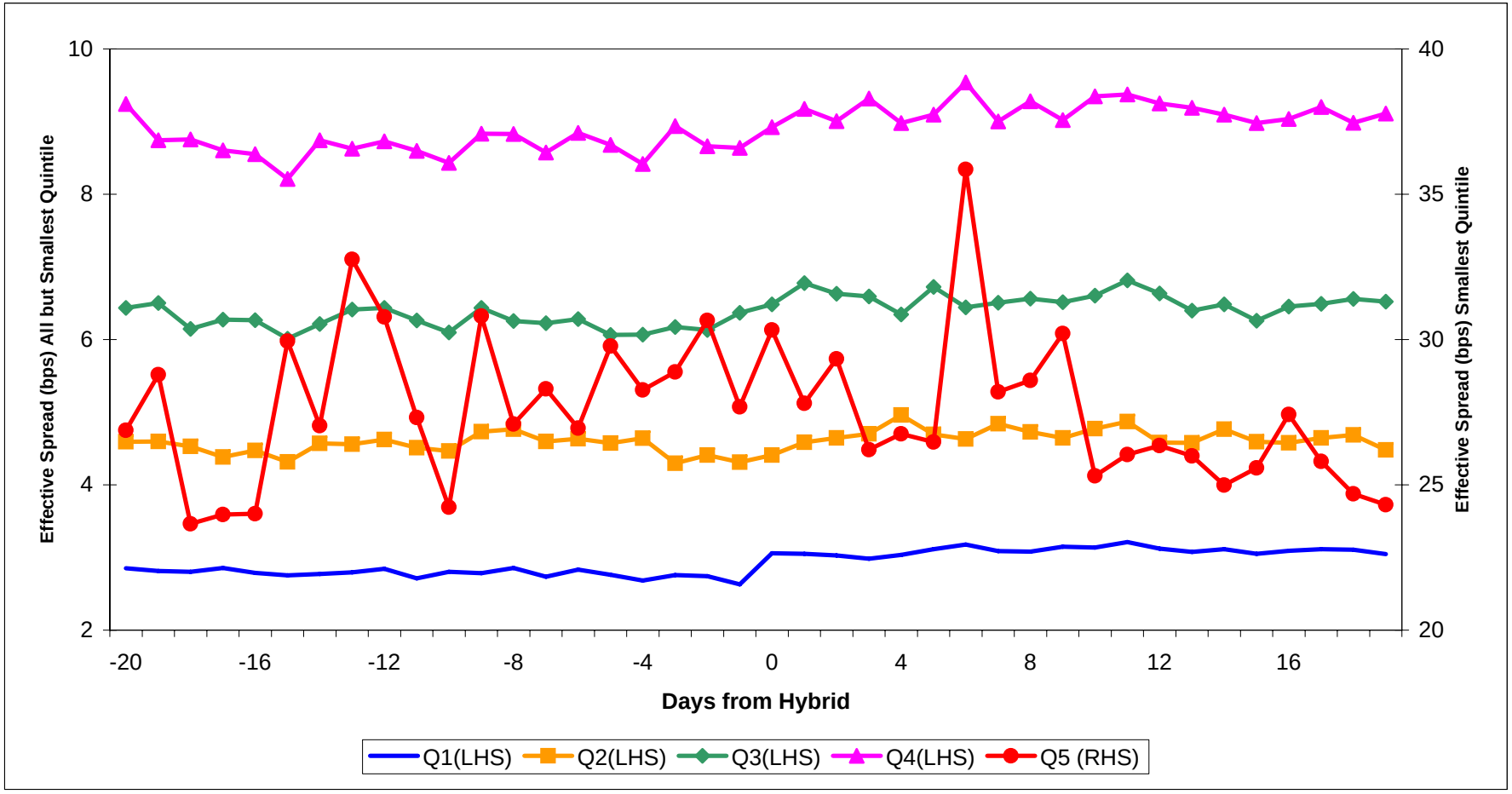

Figure 4: NYSE - Nasdaq Effective Spread Differences

This chart graphs average effective spread difference in basis points for the NYSE stocks minus their Nasdaq matches over the 40-day window surrounding the hybrid activation date for each NYSE stock. The effective spread difference is calculated for each stock each day; equal-weighted averages across stocks are presented by quintile, where Q1 comprises the 100 largest stocks in the 500-stock sample. The largest four quintiles are plotted on the scale on the left y-axis and the smallest quintile is plotted on the scale on the right y-axis. Spreads are calculated from TAQ data.

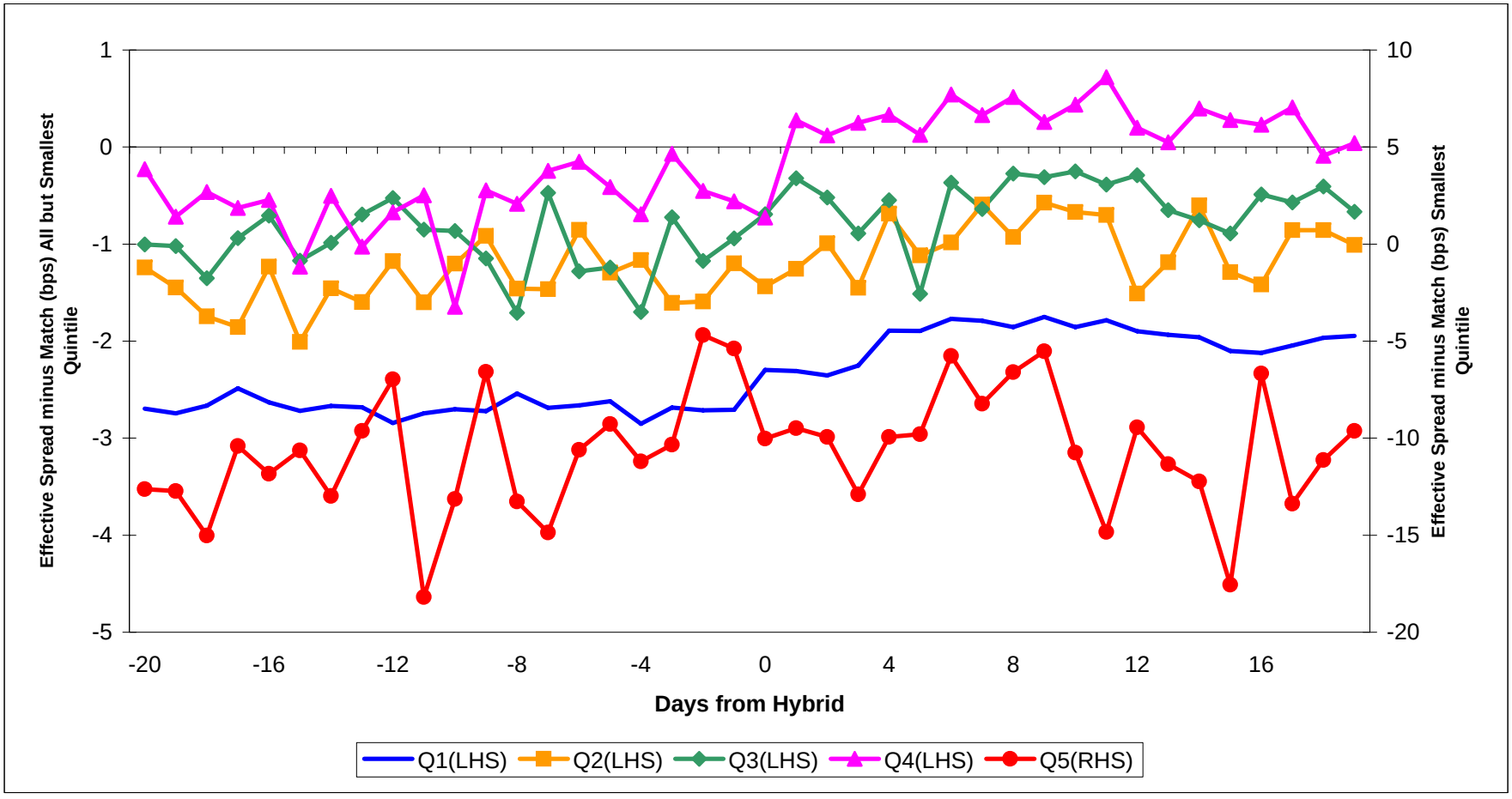

Figure 5: Execution Speeds by Stock Quintile, Market and Marketable Limit Orders
This chart graphs average execution speed in seconds for the NYSE sample over the eight-month window surrounding the hybrid activation date for each stock. Execution speed for each stock each month is averaged across all market and marketable limit orders and all size categories. Equal-weighted averages across stocks are presented by quintile, where Q1 comprises the 100 largest stocks in the 500-stock sample. Data are from Dash-5.

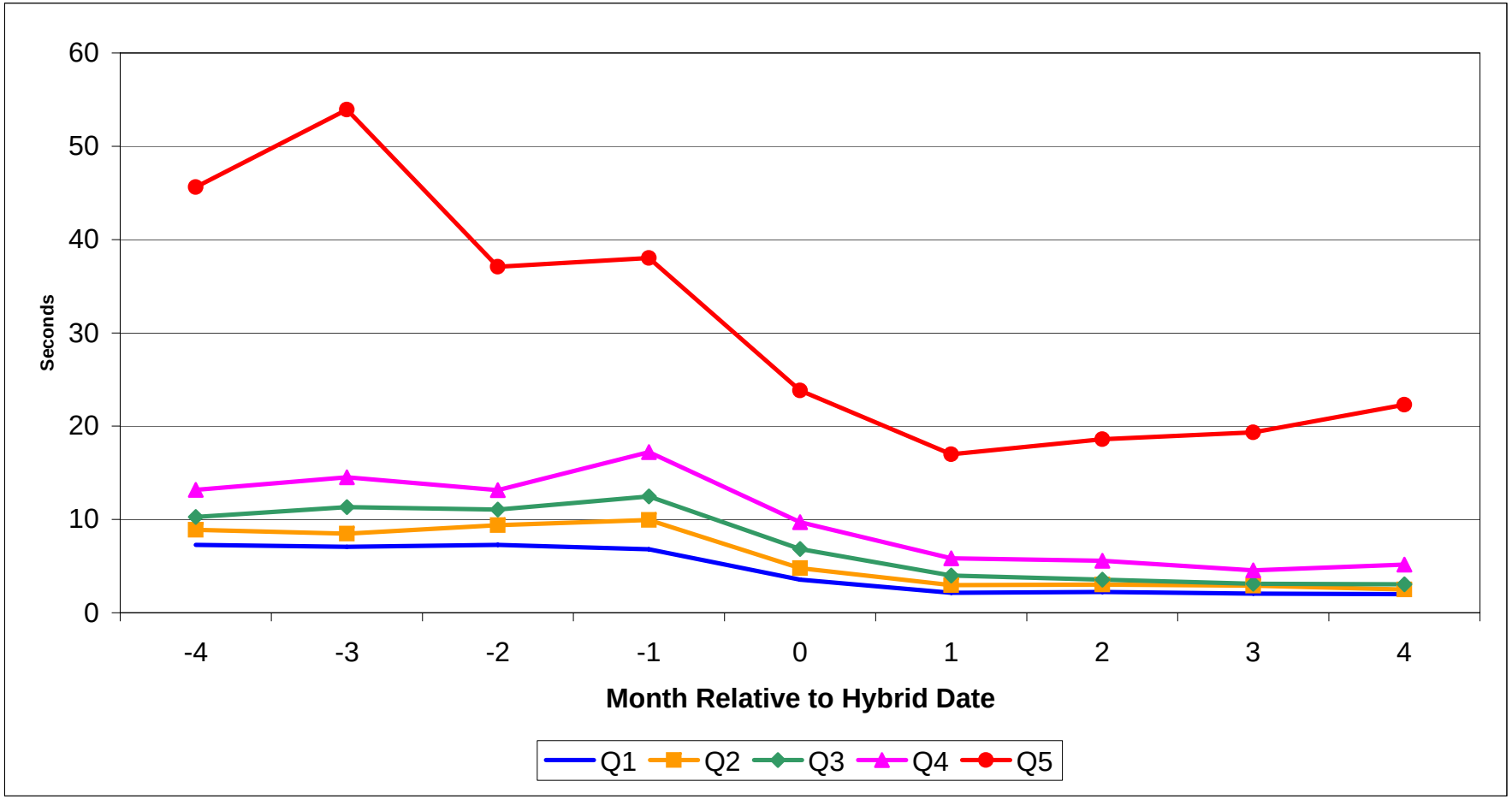

Figure 6: Execution Speeds by Order Type and Size

This chart graphs average execution speed in seconds for the NYSE sample over the eight-month window surrounding the hybrid activation date for each stock. The solid lines represent execution speed averaged across all order size categories for market orders (Mkt) and marketable limit (MLimit) orders. The dashed lines represent execution speed for market orders and marketable limit orders of fewer than 500 shares. Equal-weighted averages are calculated across all 500 stocks. Data are from Dash-5.