TICK SIZE REDUCTION, EXECUTION COSTS, AND INFORMATIONAL EFFICIENCY IN THE REGULAR AND E-MINI NASDAQ-100 INDEX FUTURES MARKETS

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On April 2, 2006, the Chicago Mercantile Exchange reduced the minimum tick size of the floor-traded and E-mini Nasdaq-100 futures from 0.5 to 0.25 index points. This study examines the effect of this change in the contract design on execution costs, informational efficiency, and price discovery. The results show a significant reduction in the effective spreads in both of the contract markets but especially in the electronically traded E-mini futures. The paper also finds that the tick size reduction has improved price discovery and informational efficiency in the E-mini futures market. © 2008 Wiley Periodicals, Inc. Jrl Fut Mark 28:871–888, 2008

INTRODUCTION

Well-functioning markets minimize trading frictions and produce informative prices. Trading rules, such as minimum tick sizes and order priority rules,

The author thanks Grigori Erenburg, Mike Shaw, and an anonymous referee for their helpful comments and suggestions. The author is also grateful to the staff of the Commodity Futures Trading Commission (CFTC) for their help in obtaining the data used in this study.

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Received May 2007; Accepted October 2007

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The Journal of Futures Markets, Vol. 28, No. 9, 871–888 (2008)

Published online in Wiley InterScience (www.interscience.wiley.com).
DOI: 10.1002/fut.20341

significantly influence trading costs and price discovery. The effects of recent major changes in equity markets, including price decimalization and reduction of the tick size to one penny, have been extensively studied.[1] In contrast, few studies examine effects of significant changes in the design of successful derivative contracts. The microstructure of futures markets differs from that of equity markets. In particular, dealers and specialists holding significant inventory of individual stocks play an important role in providing liquidity in stock markets. In contrast, Manaster and Mann (1996) showed that market makers or so-called "scalpers," in futures markets tend to hold relatively small open positions and quickly reduce their inventory exposure. Different market making costs, as well as the generally lower level of information asymmetry in futures markets, may influence the effect of contract design changes on execution costs and market quality.

Bollen, Smith, and Whaley (2003) examined the effect of the split and doubling the tick size of the S&P 500 index futures in November 1997.[2] They showed that the contract redesign resulted in higher bid–ask spreads and reduced trading activity in the S&P 500 futures. Shortly before the S&P 500 futures contract redesign, in September 1997, the Chicago Mercantile Exchange (CME) introduced the E-mini S&P 500 futures, which trade on the CME's electronic platform GLOBEX. Several other E-mini futures contracts have been introduced since 1997. To make E-mini trading affordable to retail traders, these contracts are sized at one-fifth of the corresponding regular futures contracts traded on the CME floor. The E-mini futures are successful products, with combined daily trading volumes consistently exceeding one million contracts. The two most actively traded E-mini futures are the S&P 500 and Nasdaq-100 contracts. Hasbrouck (2003) showed that these two E-mini futures contracts account for most of the price discovery in their respective indexes.

Kurov and Zabotina (2005) found that the bid–ask spreads of the S&P 500 and Nasdaq-100 E-mini futures rarely exceed the minimum tick sizes. They argued that the minimum tick sizes of these contracts act as binding constraints on the bid–ask spreads and suggest that the CME should consider reducing these minimum tick sizes. On April 2, 2006, the CME reduced the minimum tick sizes of the regular and E-mini Nasdaq-100 futures from 0.5 to 0.25 index points (from $10 to $5) "in response to customer requests." This study examines the effect of this change in contract design on execution costs, informational efficiency, and relative rates of price discovery in the two Nasdaq-100 futures markets.

[1]See, for example, Bessembinder (2003), Bollen and Busse (2006), and Chakravarty, Wood, and Van Ness (2004).

[2]Karagozoglu and Martell (1999) examined the effects of a similar change in the design of the Australian Share Price Index futures.

The simultaneous change in the minimum tick sizes of the E-minis and the floor-traded contract provides an opportunity to compare the effects of the same change in contract design under two different trading mechanisms. Discussing open outcry futures markets, Grossman and Miller (1988) argued that the minimum tick size supports a minimum level of profit to market makers and guarantees provision of liquidity. Much of the liquidity in electronic markets, however, is "outsider liquidity" provided by speculators, hedgers, or investors rebalancing their portfolios (e.g., Locke & Sarkar, 2001). A smaller minimum tick size encourages such limit order traders to compete for execution, possibly leading to higher market liquidity. Following this view, Kurov and Zabotina (2005) argued that reducing the minimum tick sizes of the E-mini futures is likely to increase price competition and result in lower trading costs.

The results showed that execution costs for liquidity-demanding orders declined significantly after the tick sizes were reduced. The effective bid–ask spreads in the E-mini Nasdaq-100 futures immediately dropped by about 50%, whereas the effective spreads of the floor-traded contract showed a smaller but statistically significant decline. After the tick size reduction, trade prices in the E-mini market exhibit little clustering, whereas the prices of the regular Nasdaq-100 futures cluster at full index points and 0.5 index points.

In further analysis, The paper shows that after the tick size reduction the relative informational contribution of the E-mini Nasdaq-100 contract increased. It is also found that the volatility of the pricing error in the E-mini Nasdaq-100 futures, which measures deviations of the observed trade price from the implicit efficient price, declined by more than 50% after the tick size reduction. Overall, the results show that the minimum tick change increased the relative attractiveness of the E-mini contract to off-exchange traders.

DATA

The data used in this study are obtained from the Commodity Futures Trading Commission (CFTC). For the E-mini Nasdaq-100 futures, GLOBEX trade data were used. The data contain the trade date, order submission time, and trade time to the nearest second, contract month, buy/sell code, number of contracts traded, trade price, customer type indicator (CTI), CTI of the counterparty, trade type (regular or spread trade), and order type. The CTI identifies trades as executed for an account of an exchange local (CTI1), an institutional member of the exchange (CTI2), another floor trader (CTI3), or off-exchange customer (CTI4).

For the regular Nasdaq-100 futures, the computerized trade reconstruction (CTR) data and the time and sales sequence are used. The layout of the CTR data is similar to that of the GLOBEX trade data discussed above, although execution times are estimated based on available trading records. Using transactions data with trader type classifications allows analyzing execution costs and trading volumes of off-exchange customers. Forty-six trading days from March 1, 2006, to May 4, 2006, were examined and only the most actively traded contracts for every trading day were considered. The sample period is divided into two equal subperiods immediately before and after the tick size change.

EMPIRICAL TESTS AND RESULTS

Effective Spreads

Kurov and Zabotina (2005) showed that the bid–ask spreads of the E-mini contracts rarely exceed the minimum tick sizes and suggest that a tick size reduction is likely to result in lower execution costs. This subsection examines whether the effective bid–ask spreads of the regular and E-mini Nasdaq-100 futures did in fact decline after the tick size reduction. As the data do not contain bid–ask quotes, following Kurov and Zabotina (2005), the effective spreads for liquidity-demanding orders as the average *opposite direction* absolute price change are estimated.[3] Price changes in the same direction as the preceding price changes are removed to reduce the impact of changes in the underlying futures price that are unrelated to fluctuations between the bid–ask quotes.

Figure 1 shows the estimated effective bid–ask spreads for the regular and E-mini Nasdaq-100 futures before and after the tick size reduction. In the floor-traded contract, there appears to be a moderate decline in the effective spread immediately after April 2, 2006, when the minimum tick size was reduced to 0.25 index points. In contrast, the E-mini contract shows a sharp drop in the effective spread from about 0.5 to about 0.25 index points, suggesting that even the newly reduced minimum tick size is binding.

Table I shows that the decline in the effective spreads in both markets is statistically significant. Before the tick size reduction, the effective spread of the regular contract exceeds that of the E-mini contract by about 31% (0.66 versus 0.50 index points). After the tick size reduction, however, the E-mini effective spread is less than half of the effective spread in the regular contract market. This change in relative execution costs may become a sufficient incentive for some traders using the floor-traded contract to switch to the electronic market.

Customer execution spreads before and after the tick size reduction are examined. The execution spread is calculated as mean customer (CTI4) buy

[3]This effective spread estimator is suggested by Wang, Michalski, Jordan, and Moriarty (1994) and Wang, Yau, and Baptiste (1997) and is used by the CFTC.

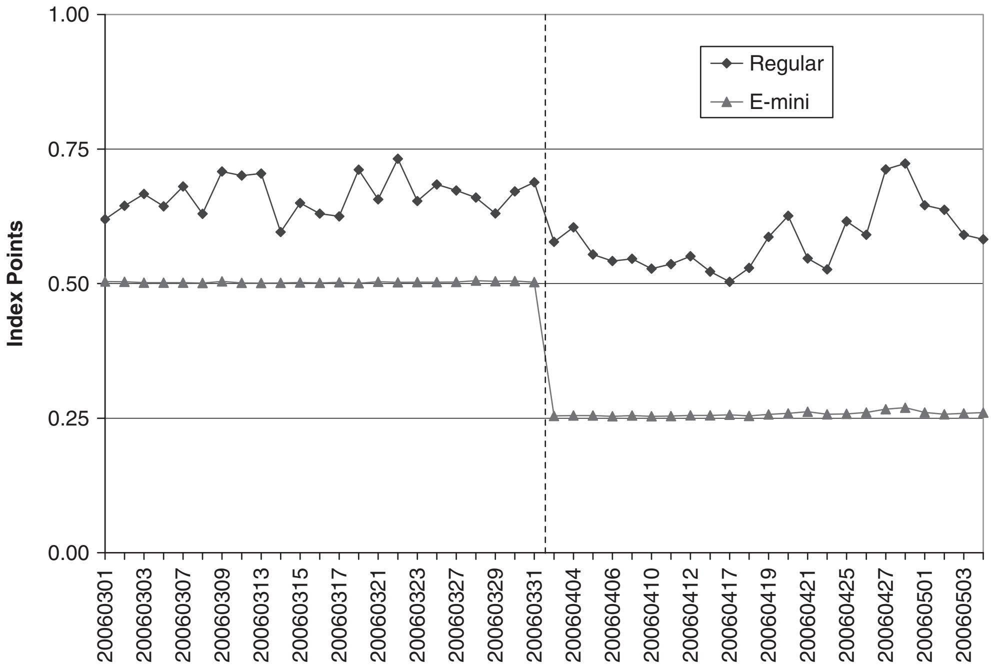

FIGURE 1

Estimated effective bid–ask spreads in the regular and E-mini Nasdaq-100 futures before and after the tick size reduction. The effective bid–ask spread is estimated as the average absolute value of price reversals.

TABLE I

Execution Costs in Regular and E-mini Nasdaq-100 Futures Before and After the Tick Size Reduction

	Regular		*E-mini*	
	Before	*After*	*Before*	*After*
Panel A. Effective bid–ask spreads				
Mean	0.660	0.577	0.503	0.258
Median	0.500	0.500***	0.500	0.250***
Number of observations	7,383	6,548	74,593	120,409
Panel B. Customer execution spread				
Mean	0.342	0.390	0.225	0.188
Median	0.345	0.312	0.188	0.132**
Number of observations	561	552	621	621

Note. Effective spreads and execution spreads are in index points. "Before" includes 23 trading days before the tick size reduction. "After" includes 23 trading days after the tick size reduction. The effective bid–ask spread is estimated as the average absolute value of price reversals. Execution spread is calculated as mean customer buy price minus mean customer sell price for a five-minute interval, with prices weighted by trade size. *, **, *** indicate that the linear rank sum z-statistic of the two-sample test for difference between medians for the two subperiods is statistically significant at 10, 5, and 1% levels, respectively. This nonparametric test statistic is used because the normality assumption for the t test is not satisfied. Median scores using in calculation of the z-statistic are assigned based on whether the value of a particular observation is greater than the median.

price minus mean customer sell price for a five-minute interval, with prices weighted by trade size. This direct measure of execution costs in futures markets was suggested by Locke and Venkatesh (1997) and used by Ferguson and Mann (2001), among others.

The mean execution spreads for the regular and E-mini Nasdaq-100 futures are reported in Panel B of Table I. Surprisingly, the mean customer execution spread in the regular contract increased from 0.34 to 0.39 index points after the tick size reduction, although this increase is not statistically significant. The execution spreads are calculated by aggregating across all customer orders, including limit and market orders. The increase in the mean execution spread may suggest that some customers switched from limit to market orders after the drop in the bid–ask spreads following the tick size reduction. The mean customer execution spread in the E-mini contract declined from 0.23 to 0.19 index points after the tick size reduction and the median dropped from 0.19 to 0.13 index points. Overall, the results in Table I show a significant decline in execution costs in the E-mini Nasdaq-100 futures after the tick size reduction.

Price Impacts

The effective spreads estimated in the previous subsection measure the cost of executing a round-trip trade at the best quotes. However, large orders are often executed in multiple trades, moving the price when the market depth at the best bid or offer is insufficient to fill the entire order. Such price impacts increase execution costs for large orders. To further examine the effect of the tick size reduction on liquidity in the E-mini Nasdaq-100 market, the following regression is estimated[4]:

$$R_t = \lambda_1 D_t (Signed\sqrt{Volume})_t + \lambda_2 (1 - D_t)(Signed\sqrt{Volume})_t + \varepsilon_t \qquad (1)$$

where R_t is the futures return, the signed volume is estimated as buy minus sell volume, and D_t is a dummy variable equal to one after the tick size change and zero before the tick size change.[5] Returns and signed volumes are aggregated over five-minute intervals. Coefficients λ_2 and λ_1 measure the price impacts of order flow before and after the tick size reduction. This approach to estimating price impacts of order flow was introduced by Hasbrouck (2006). It is motivated by the equilibrium relationship between prices and order flow in Kyle (1985).

[4]Price impacts of order flow only for the E-mini contract are examined because the CTR data available for the floor-traded contract do not allow for accurate signing of trades.

[5]The square root of signed volume is used because existing research has shown that price impact is a concave rather than linear function of trade size.

TABLE II
Price Impacts of Order Flow in the E-mini Nasdaq-100 Futures Before and After the Tick Size Reduction

	OLS	*Robust Regression*
After tick size reduction ($\lambda_1 \times 10^3$)	2.70 (0.09)***	2.56 (0.06)***
Before tick size reduction ($\lambda_2 \times 10^3$)	2.90 (0.07)***	2.79 (0.05)***
$\lambda_1 - \lambda_2$	−0.20 (0.11)*	−0.24 (0.08)***

Note. The reported coefficients are for the following regression: $R_t = \lambda_1 D_t (Signed\sqrt{Volume})_t + \lambda_2(1 - D_t)(Signed\sqrt{Volume})_t + \varepsilon_t$, where R_t is futures return in the five-minute interval t, the signed volume in five-minute intervals is estimated as buy minus sell volume, and D_t is a dummy variable equal to one after the tick size change and zero before the tick size change.

The sample period includes 46 trading days from March 1, 2006, to May 4, 2006. The regressions are estimated using (1) ordinary least squares (OLS) with the White (1980) heteroskedasticity-consistent covariance matrix and (2) MM weighted least squares procedure introduced by Yohai (1987). Standard errors are given in parentheses. *, **, *** indicate that the coefficient is statistically significant at 10, 5, and 1% levels, respectively.

The GLOBEX order submission times to sign the E-mini trades, assuming that the trader who submitted the order last initiated the trade are used. When the submission times for both sides of the trade are the same, the trade is signed using the tick rule.[6] As ordinary least squares (OLS) estimation could be sensitive to the presence of outliers, the regression in (1) is estimated using the MM weighted least-squares procedure introduced by Yohai (1987). This procedure maintains robustness in the presence of a large number of outliers.

The regression results are reported in Table II. The OLS estimate of the price impact coefficient λ_2 implies that before the tick size reduction a 10,000 contract order would move the price by about 0.29%. After the tick size reduction, a similar order would move the price by about 0.27%. The difference between the two price impact coefficients is statistically significant at the ten percent level. The robust regression results are similar, with the difference between λ_1 and λ_2 significant at the one percent level.[7] The price impact results support the conclusion that execution costs in the E-mini Nasdaq-100 futures market declined after the tick size reduction.

Price Clustering

Although the tick size sets the minimum price increment, traders may choose to trade at larger price increments, for example, to simplify price negotiation. Negotiation costs are likely to be higher in open outcry markets, such as the regular Nasdaq-100 futures, than in electronic markets like GLOBEX.

[6]Finucane (2000) showed that the tick rule performs well only for nonzero-tick trades. Therefore, zero-tick trades with the same submission time for both sides are discarded.
[7]The difference between the two price impact coefficients is also significant at the one percent level for OLS estimation when the returns and signed volumes are winsorized at the 1st and 99th percentile.

Consistent with this notion, Kurov and Zabotina (2005) and Chung and Chiang (2006) showed that price clustering is much more pronounced in the floor-traded index futures contracts than in their E-mini counterparts. Ap Gwilym and Alibo (2003) documented a large decrease in price clustering in the FTSE 100 index futures contracts following a move to electronic trading. This subsection examines whether Nasdaq-100 futures traders fully utilize the finer price grid that became available after the tick size reduction.

Figure 2 shows a significant degree of clustering in the regular contract trades, both before and after the tick size reduction. In the month before April 2, 2006, more than 60% of the Nasdaq-100 futures trades occurred at full index points. After the tick size was reduced, more than 87% of trades were at 0.0 and 0.5 index points, showing that traders rarely use the new quarter-point price increments. In contrast, trades in the E-mini futures were approximately evenly distributed across all possible ticks both before and after the tick size reduction. This result helps to explain the much larger decline in the effective spreads of the E-mini contract. Consistent with earlier research, traders appear to be more willing to use the full range of allowed price increments under electronic trading, possibly reflecting higher price competition in the electronic market.

Price Discovery and Informational Efficiency

A large minimum tick size may hinder impounding of information into the prices if movements of the underlying value are often smaller than the tick size. A reduced minimum tick size may improve the price discovery process. Consistent with this notion, Beaulieu, Ebrahim, and Morgan (2003) and Chou and Chung (2006) showed that the price discovery process in several exchange-traded funds improved after a tick size reduction. Given the results on effective spreads and price clustering, it is reasonable to expect that the tick size reduction had a beneficial effect on price discovery in the E-mini Nasdaq-100 futures.

To examine the effect of the tick size reduction on relative rates of price discovery in the regular and E-mini Nasdaq-100 futures markets, the Hasbrouck (1995) model is used. The security price is represented as

$$p_t = m_t + s_t \tag{2}$$

$$m_t = m_{t-1} + w_t. \tag{3}$$

m_t is a random walk component or "efficient price" that reflects a conditional expectation of the security's terminal value. The efficient price innovations (w_t) reflect new information arriving at time t. s_t is a transitory component that represents the pricing error, i.e. the difference between the actual trade price

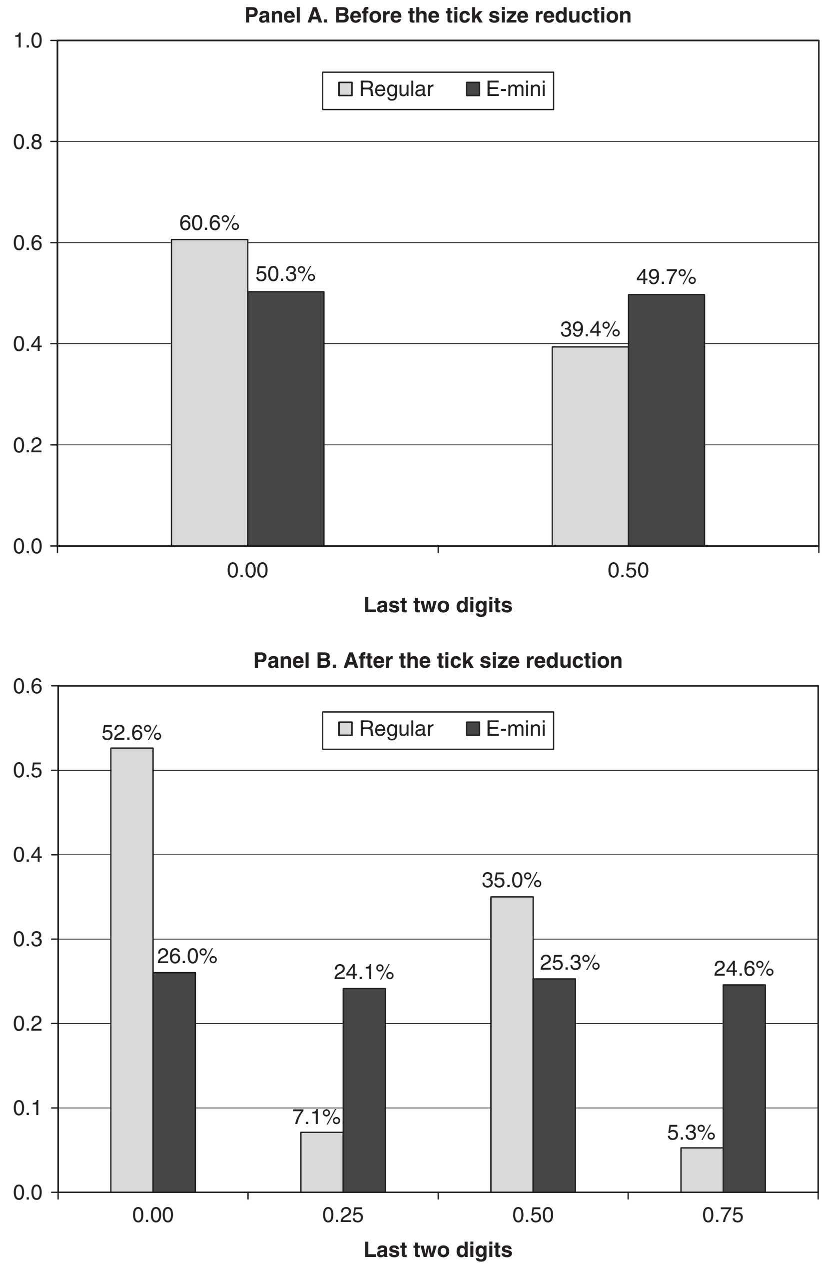

FIGURE 2

Percent of trade prices at each tick increment for the regular and E-mini Nasdaq-100 futures. Panel A. Before the tick size reduction. Panel B. After the tick size reduction. The sample period includes 46 trading days from March 1, 2006, to May 4, 2006.

and the efficient price. The pricing error is driven by microstructure imperfections and noise trading.

When the security trades in several different markets, the price series in those markets will be cointegrated and will share a common random walk component. For example, in the bivariate case the price vector can be represented as

$$p_t = \begin{bmatrix} p_{1t} \\ p_{2t} \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} m_t + \begin{bmatrix} s_{1t} \\ s_{2t} \end{bmatrix}. \tag{4}$$

Hasbrouck (1995) showed how to estimate the variance of the efficient price and calculated "information shares" (i.e. informational contributions) of each of the markets. As the first step in calculating information shares, price changes in n cointegrated markets are represented using the following vector error-correction model (VECM):

$$\Delta p_t = \gamma\alpha' p_{t-1} + \sum_{i=1}^{k} A_i \Delta p_{t-i} + \varepsilon_t \tag{5}$$

where p_t is an $n \times 1$ vector of prices, A_i are $n \times n$ matrices of autoregressive coefficients, k is the number of lags, $\alpha' p_{t-1}$ is an $(n - 1) \times 1$ vector of error-correction terms, γ is an $n \times (n - 1)$ matrix of error-correction coefficients, and ε_t is an $n \times 1$ vector of price disturbances with covariance matrix Ω.

The error-correction representation uses the intuition that price changes in cointegrated markets are affected by the current deviation from the long-term equilibrium relationship. In the case of the pricing relationship between regular and E-mini Nasdaq-100 futures, the error-correction term is $\alpha p_{t-1} = p_{t-1}^{regular} - p_{t-1}^{E-mini}$.[8] The coefficients γ of the error-correction term measure the price reaction to the deviation of the price difference between the two markets from zero. The greater the coefficient, the more the particular market reacts to such price deviations.

Hasbrouck (1995) transformed the VECM in (5) into the following vector moving average (VMA) representation:

$$\Delta p_t = \Psi(L)\varepsilon_t \tag{6}$$

and its integrated form:

$$p_t = \Psi(1) \sum_{s=1}^{t} \varepsilon_s + \Phi(L)\varepsilon_t \tag{7}$$

[8] The cointegrating vector $\alpha = [1 \ -1]'$ can be specified a priori, because arbitrage insures that prices of regular and E-mini futures do not diverge without bound.

where $\Psi(L)$ and $\Phi(L)$ are matrix polynomials in the lag operator, and $\Psi(1)$ is the matrix sum of the VMA coefficients. The first term in (7) is the common random walk component and the second term is the transitory component representing the pricing errors in (4). The VMA coefficients can be estimated by forecasting the VECM after unit innovations to the prices. These coefficients can be used to calculate the variance of the underlying efficient price:

$$\sigma_w^2 = \psi\Omega\psi' \tag{8}$$

where ψ is a row vector from $\Psi(1)$.[9] After transforming Ω into a lower triangular matrix F by the Cholesky factorization, $\Omega = FF'$, the information share of market i is calculated as

$$I_i = \frac{(\psi F)_i^2}{\sigma_w^2} \tag{9}$$

where $(\psi F)_i$ is the ith element of the row matrix ψF.

The information share represents a proportional contribution of a particular market to the innovations in the efficient price and is a natural measure of that market's relative contribution to price discovery. When the price innovations are correlated across the price series, the Hasbrouck model produces estimates of the upper (lower) bound of the information share for the first (last) variable in the factorization. Hasbrouck suggested reordering variables in factorization to estimate lower and upper bounds of the information shares for each market. The VECM uses a second-by-second series of log prices and employs 20 lags. The model is estimated with OLS separately for each day in the sample.[10]

The information share statistics are shown in Table III. Before the tick size reduction, the average midpoint of the upper and lower bounds of the information share for the E-mini Nasdaq-100 futures is 96.6%, suggesting that the E-mini futures dominate the price discovery process. This result is consistent with Kurov and Lasser (2004), who examined an earlier sample period. The median information share of the regular contract declined from about 3.1% to only 0.32% after the tick size reduction. In other words, after the tick size reduction, the E-mini Nasdaq-100 futures accounted for more than 99% of the price discovery. The significant clustering in the trade prices of the regular contract documented in the previous subsection may explain the lower relative contribution of this contract to price discovery after the tick size reduction. The E-mini traders fully use the newly available finer price grid, whereas most trades in the regular contract continue to occur at the coarser half-point grid.

[9]As the long-term impact of a price innovation on all markets is the same, the rows in $\Psi(1)$ are identical.
[10]The number of lags is determined using the Schwartz information criterion.

TABLE III
Information Share Statistics of Regular and E-mini Nasdaq-100 Futures Before and After the Tick Size Reduction

	Regular			*E-mini*		
	Upper Bound (%)	*Lower Bound (%)*	*Midpoint (%)*	*Upper Bound (%)*	*Lower Bound (%)*	*Midpoint (%)*
Panel A. Before tick size reduction						
Median	**3.2**	**2.9**	**3.1**	**97.1**	**96.8**	**96.9**
Mean	3.8	3.1	3.4	96.9	96.2	96.6
St. Error of Mean	0.45	0.41	0.43	0.41	0.45	0.43
St. Deviation	2.2	2.0	2.1	2.0	2.2	2.1
Panel B. After tick size reduction						
Median	**0.40**	**0.29**	**0.32**	**99.7**	**99.6**	**99.7**
Mean	0.71	0.58	0.64%	99.4	99.3	99.4
Standard. error of mean	0.16	0.14	0.15	0.14	0.16	0.15
Standard. deviation	0.75	0.67	0.71%	0.7	0.8	0.7

Note. The statistics are for regular trading hours. If several trades occur during one second, only the last trade is used in calculations. The statistics are calculated based on the sample of daily estimates. "Before" includes 23 trading days before the tick size reduction. "After" includes 23 trading days after the tick size reduction. Bold text indicates that the linear rank sum *z*-statistic of the two-sample test for difference between medians for the two subperiods is significant at the 1% level.

Hasbrouck (1995, footnote 2) pointed out that the variances of the pricing errors in Equation (4) can be estimated by a simple generalization of the analysis in Hasbrouck (1993). The variance of the pricing error is a natural measure of market quality, as lower variance implies lower trading costs incurred by traders who initiate trades, as well as greater informational efficiency of a given market. With two markets included in the VECM (5), the pricing errors may be represented as

$$s_{it} = \sum_{j=0}^{\infty} \phi_{ij} \varepsilon_{1,t-j} + \sum_{j=0}^{\infty} \varphi_{ij} \varepsilon_{2,t-j}, \quad i = 1, 2. \tag{10}$$

The coefficients in Equation (10) are obtained from the VMA coefficients as follows:

$$\begin{aligned} \phi_{ij} &= -\sum_{k=j+1}^{\infty} \psi_{i1,k} \\ \phi_{ij} &= -\sum_{k=j+1}^{\infty} \psi_{i2,k}. \end{aligned} \tag{11}$$

Equations (10) and (11) show that the pricing errors are driven by temporary impacts of price innovations, as well as by lagged adjustment to information. The variance of the pricing error for market i can be estimated as

$$\sigma_{si}^2 = \sum_{j=0}^{\infty} [\phi_{ij} \quad \varphi_{ij}] \, \Omega \begin{bmatrix} \phi_{ij} \\ \varphi_{ij} \end{bmatrix}. \tag{12}$$

TABLE IV

Pricing Error Standard Deviation and Signal-to-Noise Ratios of Regular and E-mini Nasdaq-100 Futures Before and After the Tick Size Reduction

	Regular		*E-mini*	
	Before	*After*	*Before*	*After*
Mean $\sigma_s \times 10^4$	3.03	2.95	**0.68**	**0.28**
Mean signal-to-noise ratio (σ_w^2/σ_s^2)	0.036	0.029	**0.80**	**4.91**

Note. The means are calculated based on the samples of daily estimates in the before and after subsamples. "Before" includes 23 trading days before the tick size reduction. "After" includes 23 trading days after the tick size reduction. Bold text indicates that the linear rank sum *z*-statistic of the two-sample test for difference between medians for the two sub-periods is significant at the 1% level.

Table IV reports the standard deviations of the pricing errors for the two Nasdaq-100 futures contracts estimated using the VECM in (5) and a second-by-second price series.[11] The pricing error variance in the floor-traded contract shows little change after the tick size reduction. In the E-mini Nasdaq-100 futures, however, the volatility of the pricing error declined by about 59% after April 2, 2006 (from $0.68(10^{-4})$ to $0.28(10^{-4})$). Figure 3 shows a sharp drop in the volatility of the pricing error of the E-mini contract immediately after the tick size reduction.

This decline in the volatility of the pricing error means that after the tick size reduction, the E-mini trade prices follow the underlying efficient price much more closely, implying a significant improvement in market quality afforded by the smaller minimum price increment. This result is not necessarily implied by the decline in the bid–ask spreads documented above. For example, Tse and Zabotina (2001) showed that the variance of the pricing error in the FTSE 100 index futures market increased after the move from open outcry to electronic trading, even though the bid–ask spread declined. The results in Table IV show that after the tick size reduction, the pricing error standard deviation in the E-mini Nasdaq-100 market is less than that in the regular futures by a factor of ten, suggesting a significantly higher informational efficiency in the electronic market.

To verify that the decline in the pricing error standard deviation in the E-mini market is not induced by an overall drop in price volatility, the changes in the signal-to-noise ratios are also examined. The signal-to-noise ratio for market i is calculated as

$$STN_i = \sigma_w^2/\sigma_{si}^2. \tag{13}$$

[11]The volatility of the pricing error for the E-mini contract is also estimated using the vector autoregression of signed trades and trade-by-trade returns, as in Hasbrouck (1993). The results were qualitatively similar.

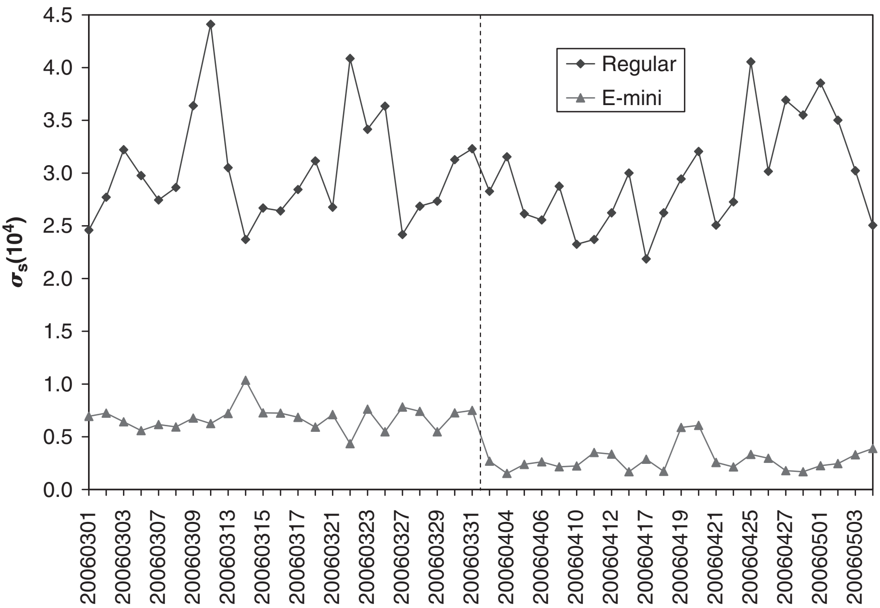

FIGURE 3
Standard deviation of the pricing error in the regular and E-mini Nasdaq-100 futures before and after the tick size reduction.

Table IV shows that the signal-to-noise ratio of the E-mini market increased from about 0.80 to about 4.91 after the tick size reduction. This finding lends further evidence that the tick size reduction resulted in an increase in the informational efficiency of the electronic market. In contrast, the signal-to-noise ratio of the floor-traded contract actually declined from about 0.036 to about 0.029.

Trading Activity

The reduction in execution costs in the E-mini market documented above may lead to an increase in trading activity. To examine the effect of the tick size reduction on trading volume in the regular and E-mini Nasdaq-100 markets, the following regression is estimated:

$$V_t = \beta_0 + \beta_1 D_t + \beta_2 \sigma_t^2 + \varepsilon_t \tag{14}$$

where V_t is the trading volume (in '000s contracts) or relative trading volume, D_t is a dummy variable equal to one after the tick size change and zero otherwise, and σ_t^2 is the variance of daily returns of the E-mini Nasdaq-100 futures, estimated with a GARCH(1,1) model.

The regression results are shown in Table V. The total trading volume in the regular futures market declined somewhat after the tick size reduction,

TABLE V
The Effect of the Tick Size Reduction on Trading Volume in Regular and E-mini Nasdaq-100 Futures

	Regular	*E-mini*	*Relative Volume: E-mini/ Regular*
Panel A. Total trading volume			
Intercept	4.35 (1.71)**	279.2 (130.7)**	9.86 (5.13)*
Tick reduction Dummy	−0.59 (0.39)	−11.37 (26.47)	3.14 (1.08)***
Volatility	−1.38 (2.05)	−5.14 (162.5)	9.28 (6.67)
Adjusted R^2	0.0144	−0.0399	0.0832
Panel B. Customer trading volume			
Intercept	3.79 (1.38)***	153.1 (75.4)**	4.50 (3.76)
Tick reduction Dummy	−0.57 (0.31)*	0.13 (15.93)	3.39 (0.83)***
Volatility	−1.68 (1.64)	−20.93 (92.99)	8.49 (4.74)***
Adjusted R^2	0.0353	−0.0444	0.2249

Note. The reported coefficients are for the following regression: $V_t = \beta_0 + \beta_1 D_t + \beta_2 \sigma_t^2 + \varepsilon_t$, where V_t is the daily trading volume (in '000s contracts) or relative trading volume, D_t is a dummy variable equal to one after the tick size change and zero before the tick size change, and σ_t^2 is variance of daily returns of the E-mini Nasdaq-100 futures, estimated with a GARCH(1,1) model. The E-mini trading volume is divided by five in calculation of the relative trading volume.

The sample period includes 46 trading days from March 1, 2006, to May 4, 2006. Newey and West (1987) standard errors are given in parentheses. *, **, *** indicate that the coefficient is statistically significant at 10, 5, and 1% levels, respectively.

although this drop is not statistically significant. The results also show no significant change in the trading activity of the E-mini market. The relative trading volume, calculated as the ratio of the daily trading volumes of the E-mini and regular futures, increased significantly after the tick size reduction.

The results obtained using customer (CTI4) trading volumes are qualitatively similar but appear to be stronger than the total volume results. In particular, the volume drop in the regular futures is statistically significant. The increase in the relative trading volume after the tick size reduction appears to be larger than the similar increase when the total trading volumes are used. Overall, the trading volume results suggest that the tick size reduction increased the attractiveness of the E-mini market relative to the floor-traded contract for off-exchange traders.

CONCLUSIONS

This study examines the effect of a reduction in the minimum tick size on execution costs, price discovery, and informational efficiency in the regular and E-mini Nasdaq-100 futures markets. The empirical results show a large decline in execution costs for liquidity-demanding orders in the electronically traded E-mini futures. After the tick size reduction, E-mini trades are evenly distributed across all possible price points, whereas trades in the floor contract continue to occur primarily at half-point increments. Perhaps owing to this difference in trade price clustering, the modest informational contribution of the floor-traded contract declined further after the tick size reduction. Finally, the study finds that the market quality of the E-mini market, measured by the deviations of trade prices from the implicit efficient price, improved significantly after the tick size reduction.

Overall, the results show a significant improvement in execution quality and informational efficiency of the E-mini Nasdaq-100 market after the tick size reduction. These findings suggest that it would be appropriate for the CME to re-examine the design of its E-mini S&P 500 futures contract. The current minimum tick size of this contract is 0.25 index points, whereas the corresponding floor-traded contract trades at 0.1 point increments. The evidence for the regular and E-mini Nasdaq-100 futures presented in this study suggests that the optimal tick sizes of electronically traded derivative contracts are likely to be smaller than those of similar floor-traded instruments.

The CME's decision to cut the minimum tick size of the Nasdaq-100 futures, while leaving the tick size of the E-mini S&P 500 futures unchanged, may be related to the relative changes in trading activity in the two contract markets. In 2005, the average daily trading volume in the E-mini Nasdaq-100 futures declined by about five percent compared with 2004, whereas the trading activity in the E-mini S&P 500 market increased by more than 20%. Derivative exchanges rarely change attributes of successful contracts. It is also possible that, owing to the continuing strong representation of floor traders in the CME management, the exchange is reluctant to take actions that are likely to accelerate the transition from open outcry to electronic trading.[12]

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[12]CME members, through their ownership of class B shares, have the right to elect 6 out of 20 members of the CME Holdings' board of directors. The CME's 2006 proxy statement shows that all of the members of the Class B Nominating Committees are floor traders. The CME's Charter also contains an explicit commitment to maintain floor trading "as long as the open outcry market is liquid."

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