OPTIMAL CONTRACT DESIGN: FOR WHOM?

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In designing a derivative contract, an exchange carefully considers how its attributes affect the expected profits of its members. On November 3, 1997, the Chicago Mercantile Exchange doubled its tick size of its S&P 500 futures contract and halved the denomination, providing a rare opportunity to examine empirically the search for an optimal contract design. This article measures changes in the trading environment that occurred in the days surrounding the contract redesign. We find a discernible change in the incidence of price clustering, an increase in the bid/ask spread, a reduction in trading volume, and no meaningful change in dollar trade size. These results suggest that the contract redesign did not increase accessibility but

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did increase market maker revenue. Despite the increase, however, the bid/ask spread of the S&P 500 futures contract remains low relative to the costs of market making and the spreads in markets for competing instruments.

INTRODUCTION

Every time an exchange considers introducing a derivative security, it carefully considers contract specifications such as method of settlement, contract size, and minimum price increment (i.e., tick size). Guiding the exchange's deliberations are the interests of its members, who generate revenue from market making and/or brokering. Market makers provide immediacy of exchange, standing ready to buy at the bid and sell at the ask, earning the spread between the two prices. Brokers execute trades on behalf of customers and earn a commission quoted on a per-contract basis. The exchange's objective is to identify that set of contract attributes that will maximize the expected profit of its members.

From a practical standpoint, identifying the optimal combination of contract attributes that will maximize expected profit is difficult. The primary reason is that there is little experience to draw upon. An ideal environment for assessing net benefits would be one in which two competing contracts with different terms but written on the same underlying asset trade simultaneously. Such situations seldom occur. Even when they do, one market (usually the first established) dominates.[1] Another environment well suited for assessing the incremental net benefits is one in which market behavior before and after a change in contract design can be observed. Such opportunities are also rare. An exchange seldom tampers with a successful contract. When changes are made, they are usually a last-ditch effort to revive a contract that appears doomed.[2]

A rare violation of the maxim, "Let sleeping dogs lie . . ." occurred on November 3, 1997, when the Chicago Mercantile Exchange (CME) doubled the tick size of its S&P 500 futures contract from 0.05 to 0.10 and halved the multiplier from USD 500 to USD 250. This article evaluates

[1]The Chicago Mercantile Exchange (CME) and the Philadelphia Board of Trade (PBT), for example, both list currency futures. The CME's contract market was introduced 14 years earlier than the PBT's and dominates in terms of trading volume.

[2]In December 1984, the CME increased the multiplier of the S&P 100 futures contract from 200 to 500 in an attempt to promote market liquidity. Failing in that effort, the CME reduced the multiplier back to 200 in September 1987. The contract was later delisted. In 1988, the PBT increased the contract denomination and reduced the tick size of its British pound and French franc futures contracts in an attempt to be more competitive with the CME. The change was also unsuccessful. For other examples, see Brown et al. (1984, pp. 69–71).

the economic consequences of the CME's redesign of the S&P 500 futures.[3] Our goal is to determine whether and to what degree the welfare of CME members and users of the contract were affected by its new design.

At least two arguments support the move to a larger tick size. First, the tick size is the means by which an exchange allows market makers to earn sufficient revenue to recoup their costs of operation as well as provide an economic profit. To the extent costs have increased through time, an increase in tick size (or, equivalently, the minimum bid/ask spread) may be warranted. Second, a larger tick size reduces the number of possible prices at which to trade, thereby promoting operational efficiency.[4] By futures markets standards, the S&P 500 futures pit has become chaotic. With hundreds of traders competing for order flow, the pace of trading is rapid, and often multiple trades are executed within seconds of each other at different prices. In such an environment, a small tick size would perpetuate the disorder with more shouted bids and offers and increased likelihood of missed limit orders and other trade errors.

Our empirical analysis measures changes in the bid/ask spread after the contract redesign was implemented. We find that the bid/ask spread increased after controlling for the effects of inventory-holding costs and trading volume. The increase in the bid/ask spread appears warranted, however. We apply an option-based measure of the cost of supplying liquidity, and find that the difference between the realized bid/ask spread of the S&P 500 futures contract and its theoretical level is negative in the 2 years leading up to the contract redesign and is approximately zero in the year afterward. We also compare bid/ask spreads in the S&P 500 futures market with those in competing product markets and find them to be substantially lower. Given these results, the CME's decision to double the tick size can be interpreted as a justifiable attempt to improve liquidity by aiding market makers in recovering their costs of operation.

The primary argument supporting a move to a smaller contract size is investor accessibility. From the launch of trading in April 1982 until October 1997, the dollar value of a single S&P 500 futures contract rose from USD 58,750 to 462,050, a level now out of reach for many small investors. In addition, the large contract size may even affect large investors in the sense that it does not allow a high degree of precision in executing hedging and speculative trading strategies. Reducing the contract size, however, means increased trading costs. Trading costs such as

[3]We hereafter use the word "redesign" when referring to both changes simultaneously.
[4]See, for example, Grossman and Miller (1988) and Brown, Laux, and Schacter (1991).

brokerage commissions and exchange fees are quoted on a per contract basis. If the commission rate and the dollar trading volume remain unchanged after the split, the number of contracts traded, and hence, brokerage commission fees will double. Increased trading costs have the potential of curtailing trading demand.

Our analysis of trading volume indicates that dollar trading volume in the S&P 500 futures declined significantly after the contract redesign. Although the reduction in volume may be attributable to increased trading costs (i.e., the increased bid/ask spread from the increase in tick size and/or the increased dollar commissions from halving the contract denomination), there is also evidence to suggest that trading volume had been waning even before the redesign, perhaps as a result of migration to alternative exchange traded or over-the-counter vehicles. Our analysis of trade size indicates that halving the size of the contract had little impact in attracting smaller investors, as the demand for small trades remained unchanged.

The rest of the article is organized as follows. The first section contains our analyses of the effect of the contract redesign on price clustering and the bid/ask spread. The second section examines the trading volume in the S&P 500 futures market relative to other markets domestically and internationally. The third section examines whether the introduction of a smaller contract has attracted smaller investors. The final section provides a brief summary of the study and its main conclusions.

THE BID/ASK SPREAD

The purpose of this section is to examine how the CME's decision to increase the S&P 500 contract's tick size has affected the bid/ask spread.[5] Anshuman and Kalay (1998) develop a theoretical model in which the

[5]The move to decimalization in U.S. and Canadian equity markets provides insight regarding the CME's decision to double the S&P 500 futures tick size. A recent series of empirical studies examine decreases in tick size on the Toronto Stock Exchange (see Ahn et al., 1996; Bacidore, 1997; Porter & Weaver, 1997), the American Stock Exchange (see Ronen & Weaver, 1998), and the NYSE (see Bollen & Whaley, 1998; Goldstein & Kavajecz, 2000; Jones & Lipson, 2001). Early evidence indicated that the reductions in tick size improved market quality by lowering spreads and therefore encouraging liquidity. Bollen and Whaley, however, find that quoted depth decreased as well, especially for high-priced stocks, suggesting that the results are ambiguous. Goldstein and Kavajecz reconstruct the limit order book for 100 stocks and find total depth decreased, suggesting that a smaller tick size can actually dampen liquidity, perhaps by reducing the effectiveness of priority rules in the limit order book. Jones and Lipson track the total execution costs of large institutional orders and find that trading costs increased by 33% for the largest trades following the change to sixteenths. Although the S&P 500 futures market does not have a consolidated limit order book like stocks do, the evidence from equity markets suggests we might expect a positive relation between tick size and market depth, because a larger tick size makes supplying liquidity more profitable.

exchange sets the tick size so as to maximize market maker profit.[6] One implication of their model is that, if the exchange-mandated tick is too low, market makers will have an incentive to use alternative mechanisms to establish a desired bid/ask spread, such as trading on only certain multiples of the exchange-mandated tick. The notion that such clustering is a means of generating spreads above a competitive level received a great deal of attention following the work of Christie and Shultz (1994), who documented that market makers avoided odd-eighth quotes for stocks traded on the National Association of Securities Dealers Automated Quotation system (NASDAQ). Avoidance of certain prices, however, may arise naturally in response to changing market conditions. The closing level of the S&P 500 futures was 117.50 on April 21, 1982, the first date the contract traded, and was 924.10 on October 31, 1997, the last date before the contract redesign was implemented. Assuming S&P 500 return volatility was the same at both points in time, this means that the price-change volatility of the S&P 500 futures contract increased nearly eight times. Because the bid/ask spread is an increasing function of price-change volatility, spreads should have increased significantly. To distinguish between the two possible explanations, we proceed in three steps. First, we examine the incidence of price clustering in the period surrounding the contract redesign. Second, we study the changes in the bid/ask spread and its determinants directly, and evaluate the magnitude of spread in relation to a market maker's inventory-holding costs. Finally, we compare the magnitude of spreads in the S&P 500 futures market to spreads in competing exchange-traded products.

Incidence of Price Clustering

The sample period of our study is 3 years—2 years before the S&P 500 contract redesign and 1 year after. The first year of the sample is called "PRE1," and extends from 951106 through 961101. The second year is called "PRE2," and extends from 961104 through 971031, and the third year is called "POST," and extends from 971103, the first day in which the S&P 500 futures traded in its redesigned form, through 981030. Each subperiod contains 52 full weeks of data.

[6]This does not necessarily imply a transfer of welfare from users of the contract to suppliers of liquidity, however, because a larger tick size may increase market depth by increasing the willingness of individuals to engage in market making either through scalping directly in the futures pit or through the placement of limit orders. Harris (1994) and Angel (1997) argue that in the stock market significant ticks provide stronger priority rules in the order book. If a tick is too low, some investors may offer marginally better prices, thereby gaining priority and discouraging other investors from placing limit orders. This argument does not apply to the futures market, however, because there is no means of enforcing time priority.

To investigate price clustering, Computerized Trade Reconstruction (CTR) data were obtained from the Commodities Futures Trading Commission (CFTC) for the 2 years before and the 1 year after the redesign. The data contain records of all trades by day, with each record identifying the contract month, the number of contracts traded, and the trade price. The CTR data for the nearby S&P 500 futures were used.[7] In the two subperiods before the redesign, the number of trades with prices ending in each 0.05-point increment was tabulated. In POST, the number of trades with prices ending in each 0.10-point increment was tabulated.

Figure 1 summarizes the results. In PRE1, trade prices in the 10 categories ending with "dimes" (e.g., 0.00, 0.10, 0.20) occurred 50% more often than expected under the null hypothesis of a uniform distribution across prices. Each dime category accounted for an average of 7.4% of all trades, compared to the 5% expected value, and nearly 75% in total. As a result, trade prices in the 10 categories ending in "nickels" (e.g., 0.05, 0.15, 0.25) accounted for an average of only 2.6% each and 25% in total. Due to the large number of trades, all category frequencies are statistically significantly different from 5%. Price clustering is therefore quite evident in PRE1.

In PRE2, the frequency distribution becomes even less uniform. Two features of the second chart of Figure 1 are noteworthy. First, the most common prices end in 0.00 and 0.50-point categories, which together accounted for more than 33.8% of the reported trade prices, rather than the 10% total expected under the null hypothesis. Second, the 10 nickel categories together accounted for only 12.4% of all trade prices, rather than the 50% expected under the null hypothesis. What this evidence suggests is that bid/ask spreads increased in PRE2 relative to PRE1. The bottom chart of Figure 1 is different from the top two because nickel prices have been eliminated. The frequency distribution is still not uniform across categories. Indeed, about 48% of all reported trade prices in POST end in 0.00 or 0.50, more than double the 20% expected under the null hypothesis. So, even after the tick size was doubled, there is strong evidence to suggest that the bid/ask spread exceeds the tick size.

[7]The S&P 500 futures contract expires on a quarterly cycle (i.e., March, June, September, December), and has 6 contract months listed at any one time. Of these available contract months, the one with the shortest time to expiration (i.e., the "nearby" or "near-month" contract) is by far the most actively traded. About a week prior to the nearby contract's expiration, however, the second nearby contract becomes more actively traded than the nearby. In this study, the "nearby" contract is defined as the near-month contract with at least 7 days remaining to expiration.

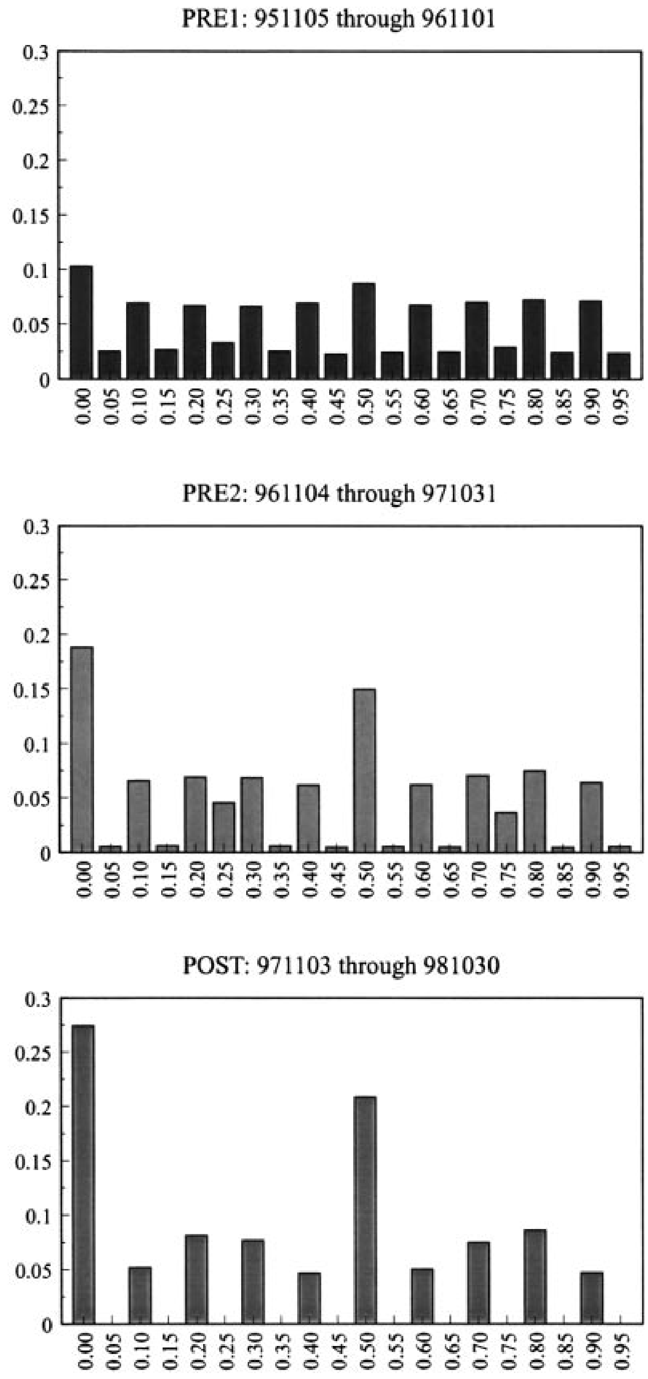

FIGURE 1

Percent of trade prices at each 0.05-point increment in the 2 years before and 1 year after the S&P 500 futures contract redesign. Percentages of trades at each 0.05-point increment are computed for the most active futures contract each trading day and then are averaged across all trading days during the subperiods PRE1 (951105 through 961101), PRE2 (961104 through 971031), and POST (971103 through 981030).

Time-Series Regression Analysis of the Bid/Ask Spread

The price clustering results indirectly suggest that the bid/ask spread in the S&P 500 futures increased over the sample period. We now measure market maker spreads directly. To isolate the effect of the contract redesign, we must control for other variables that may affect the bid/ask spread. In a competitive market, the magnitude of the bid/ask spread should reflect market maker costs. In theoretical models of the bid/ask spread, market maker costs generally fall into three categories: order-processing costs, inventory holding costs, and adverse information costs.[8] Order-processing costs are generally regarded to be fixed, and include items such as the exchange seat, floor space rent, computer costs, informational service costs, labor costs, and the opportunity cost of the market maker's time.[9] Inventory holding costs are the costs that a market maker incurs while being forced to carry a futures position acquired in supplying investors with immediacy of exchange. The costs of carrying open positions include the opportunity cost of funds used to finance the market maker's position and the risk of adverse futures price movements. With respect to the cost of funds, it is important to recognize that trading in futures contracts requires no capital investment other than interest-bearing margin. But, not even futures margin should affect the size of the spread because market makers generally day trade, do not carry positions overnight, and have no need to post margin.[10] The risk of adverse price movements in open positions, on the other hand, is an important economic factor. Finally, adverse selection costs arise when market makers trade with individuals who are better informed about the expected price movement of the underlying security. For individual stocks, it is easy to imagine that certain individuals possess "inside" information, concerning, for example, advance news of earnings or

[8]Stoll (1978a) categorizes the market maker's costs in this fashion. Theoretical and empirical work in the market microstructure area began with Demsetz (1968), and focused exclusively on order-processing and inventory holding costs. Tinic (1972), Tinic and West (1972, 1974), Benston and Hagerman (1974), and Stoll (1978b) are among the more notable studies of stock price spreads. Smith and Whaley (1994a) examine the behavior of S&P 500 futures spreads. More recently, the emphasis has turned to the costs of adverse selection. Here, the reader is referred to studies such as Copeland and Galai (1983), Glosten and Milgrom (1985), and Admati and Pfleiderer (1988).

[9]To our knowledge, the only variable costs faced by market makers in the S&P 500 futures pit are an exchange fee of either \$0.07 or \$0.30 cents per contract, depending on whether the exchange seat is owned or leased, and a clearing fee that ranges up to 25 cents per contract.

[10]Manaster and Mann (1996) use audit trail transaction records for all CME futures trades for the first half of 1992 to examine daily net inventory changes by trader and find that such changes are highly concentrated about zero. In other words, if traders are starting the day flat, they are generally ending the day flat.

corporate restructurings. For index futures contracts, however, the importance of informational advantages is less clear.

Based upon these cost considerations, we model the determinants of the bid/ask spread in the time-series regression,

$$SPRD_t = \alpha_0 + \alpha_1 I_{1,t} + \alpha_2 I_{2,t} + \alpha_3 IHP_t + \alpha_4(1/V_t) + \varepsilon_t \qquad (1)$$

where $SPRD_t$ denotes the average daily bid/ask spread on day t, IHP_t is the inventory-holding premium, and V_t is the number of futures contracts traded. $I_{1,t}(I_{2,t})$ is an indicator variable that is 1 if the observation occurs in PRE2 and POST (in only POST), and zero otherwise. Hence, the coefficient α_1 measures the degree to which the bid/ask spread is different in PRE2 than in PRE1 after controlling for risk and trading volume, and α_2 measures the degree to which the bid/ask spread is different in POST than in PRE2. The expected sign of the coefficient α_3 is positive as a result of inventory holding costs. The expected sign of α_4 is unclear. Although spreading order-processing costs across the number of contracts traded suggests the sign should be positive, the number of scalpers in the futures pit may also increase with trading volume, in which case the sign will be ambiguous. In addition, trading volume and information flow are directly related. To the extent that the market maker is unaware of the information driving the increased trading demand, he may widen his spread.

The inventory-holding premium variable, IHP_t, measures the expected cost of adverse price movements while a contract position is open. To understand the intuition underlying this cost measure, consider a market maker who has zero inventory and accommodates a market order to buy by selling at the ask. While a futures market maker has a number of hedging vehicles available,[11] he is unlikely to have the time to fully hedge his open position, let alone to do it costlessly. The market maker's only real choice is set the spread at a level that he gets compensated should price falling below his purchase price before an offsetting trade arrives. Bollen, Smith and Whaley (2002) model the expected loss as an at-the-money option.[12] Their so-called "inventory-holding premium" is

$$IHP = F[2N(.5\sigma E(\sqrt{T}) - 1] \qquad (2)$$

where F is the futures price at which the market maker opens his position, $N(\cdot)$ is the cumulative unit normal density function, σ is the

[11]A futures market maker can hedge his position using with different contract months on the same underlying commodity, futures options, options, or futures on other commodities.

[12]At-the-money call and put options written on a futures contract have the same value.

standard deviation of the futures returns, and $E(\sqrt{T})$ is the expected square root of the length of time between offsetting trades.[13] The interest rate is set equal to zero because all open positions are assumed to be closed by the end of the trading day.

Variable Measurement

The regression Equation (1) is fitted to the daily time-series of the nearby S&P 500 futures contract over the sample period 951106 through 981030. Daily trading volume for the nearby S&P 500 futures was taken from the daily trading activity files obtained from the Futures Industry Institute (FII) in Washington, D.C. The inventory-holding premium (2) requires estimates of the futures price, the futures volatility rate, and the expected square root of the time between offsetting trades. The futures price is the daily closing settlement price, and the volatility estimate is the implied volatility estimated using closing prices of at-the-money S&P 500 futures options. The futures and futures option prices also were taken from the FII's daily trading activity files. The expected square root of the time between offsetting trades equals the square root of the ratio of 405 (i.e., the number of minutes in the trading day) to the number of price changes in the day reported in the intraday time and sales data.[14] This proxy for the number of minutes between offsetting trades is downward biased in the sense that it assumes there is a single market maker. If trading volume was uniformly distributed across all market makers, we could multiply the time between trades by the number of market makers to arrive at an estimate of the time between offsetting trades for a typical market maker. Absent knowing the number of traders in the S&P 500 futures pit each day and in what capacity they are trading, we allow the data to infer the square root of the average time between trades. The times and sales data for the S&P 500 futures contract were also obtained from the FII.

The bid/ask spread for the S&P 500 futures contract is estimated each day using the time and sales data and the Smith/Whaley (1994b)

[13]See Bollen, Smith, and Whaley (2002) for a detailed derivation of the inventory-holding premium. In their derivation, the time between offsetting trades is assumed to be stochastic, however, because an at-the-money option is linear in the square root of time, the expected square root of time replaces the time to expiration parameter in the Black-Scholes (1973) and Merton (1973) option valuation formula.

[14]Time and sales data are a form of censored transaction data recorded by futures exchanges throughout the trading day. Instead of recording the time and price of each trade, the exchange records only the time and price of a transaction if the price is different from the previously recorded price. Bid and ask quotes appear in this file only if the bid quote exceeds or if the ask quote is below the previously recorded transaction price and are rare.

(hereafter SW) method of moments procedure. The intuition underlying the SW procedure is that the mean squared price change of the futures is driven by the bid/ask spread, *SPRD*, and true price-change variance, $\sigma^2_{\Delta F}$. Assuming that the true price change is normally distributed with mean zero and variance $\sigma^2_{\Delta F}$ and that observed prices are equally likely to be at a bid or an ask level, Smith and Whaley (1994b, pp. 441–443) show that the expected absolute observed price change is

$$E(|\Delta F^o|) = \sqrt{\frac{2}{\pi}}\sigma_{\Delta F} e^{-SPRD^2/2\sigma^2_{\Delta F}} - SPRD\left[1 - 2N\left(\frac{SPRD}{\sigma_{\Delta F}}\right)\right] \quad (3)$$

where $N(\cdot)$ is the cumulative unit normal density function, and the expected squared absolute price change is

$$E(|\Delta F^o|^2) = \sigma^2_{\Delta F} + SPRD^2 \quad (4)$$

To estimate the effective spread, $E(|\Delta F^o|)$ and $E(|\Delta F^o|^2)$ are replaced by the mean absolute price change and the mean squared price change from the sequence of futures prices reported in the time and sales data during the day, and the system of equations is solved iteratively. To test the robustness of the regression results to the bid/ask spread measure, we also use the mean absolute price change between successive trades as an alternative estimator. Although this estimator is upward biased, it has been commonly used in the empirical literature focusing on spreads in the futures market. See, for example, Thompson and Waller (1988) and CFTC (1989).

Summary Statistics

Before turning to the regression results, it is worthwhile to examine the daily spread estimates displayed in Figure 2(a) as well as the summary statistics reported in Table I. In PRE1, the average (median) bid/ask spread was 0.0598 (0.0573). On a handful of days the spread spiked upward as a result of abnormal market volatility. The highest value of the bid/ask spread in PRE1, 0.1423, occurred on 960308. On the same day, the estimated inventory-holding premium was 0.0543—45% higher than the average reported for the subperiod, and trading volume was 144,220 contracts—88% higher than average. There are three instances in which the estimated spread was below the tick size, 0.05. Given the assumptions underlying the SW method of moments estimator, occasional violations should be expected.

Table I shows that the mean (median) bid/ask spread in PRE2 is discernibly higher than in PRE1—0.0598(.0573) versus 0.1058 (0.0903).

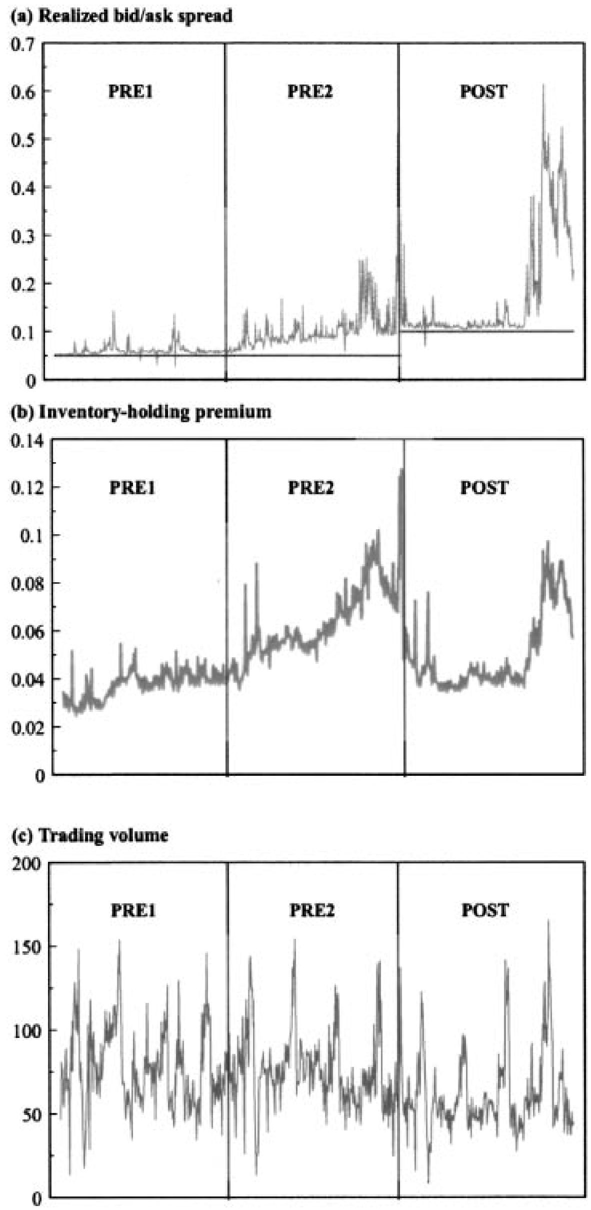

FIGURE 2
Daily values of the realized bid/ask spread, inventory-holding premium, and trading volume of the nearby S&P 500 futures contracts from 951106 through 981030. (a) Shows the realized bid/ask spread estimated using a method of moments estimator and time and sales data. The tick size in each subperiod is also shown. (b) Shows the inventory-holding premium. It is based on the closing price of the S&P 500 futures, the implied volatility of the ATM S&P 500 futures option, and the average time between trades. (c) Shows the number of contracts traded in thousands. Both the inventory-holding premium and trading volume are reduced by a factor of two in the POST subperiod to account for the change in the contract multiplier. The subperiods are: PRE1, 951106 through 961101; PRE2, 961104 through 971031; and POST, 971103 through 981030.

TABLE I

Summary Statistics of the Daily Bid/Ask Spreads Estimated from Time and Sales Data of the Nearby S&P 500 Futures Contract, Closing S&P 500 Index, and Nearby Futures Prices, Implied Volatility Using at-the-Money S&P 500 Futures Options, the Number of Minutes between Price Changes, the Inventory-Holding Premium, the Number of Futures Contracts Traded in Thousands, and the Inverse of the Number of Contracts Traded

		Subperiod		
Description	*Statistic*	*PRE1*	*PRE2*	*POST*
	No. of obs.	252	252	251
Method of moments spread estimate	Mean	0.0598	0.1058	0.1731
	Median	0.0573	0.0903	0.1145
Mean absolute price change	Mean	0.0614	0.1103	0.1767
	Median	0.0577	0.0925	0.1154
Index level	Mean	649.69	839.62	1049.77
Nearby futures price	Mean	652.67	844.20	1056.05
Option-implied return volatility	Mean	14.26%	19.37%	23.33%
Number of minutes between trades	Mean	0.1065	0.0961	0.1034
Inventory-holding premium	Mean	0.0375	0.0638	0.0494
Number of contracts traded in thousands	Mean	76.534	75.330	60.638
Inverse of number of contracts traded	Mean	0.01468	0.01481	0.00948

Note. The subperiods are: PRE1, 951106 through 961101; PRE2, 961104 through 971031; and POST, 971103 through 981030.

Figure 2(a) shows that the bid/ask spread increases steadily during PRE2 and is well in excess of the 0.05 tick size. By the end of the year, the market appears to have settled on a minimum bid/ask spread of about 0.10, which might explain the increased appearance of price clustering on dimes, as reported earlier in this section. There are also days during the year in which spreads appear to be about 0.25 and 0.50. The POST subperiod in Figure 2(a) clearly shows the impact of the increase in tick size in the sense that early in the year it hovers around 0.10. By year end, however, higher spreads are observed with greater frequency. The mean (median) bid/ask spread across all days in POST is 0.1731 (0.1145).

Figure 2(b) and (c) shows the inventory-holding premium and trading volume of the S&P 500 futures. Note that these variables are deflated by a factor of 2 in POST to account for the reduction in contract size. Figure 2(b) shows that the inventory-holding premium increases steadily during PRE1 and PRE2, with the rate of increase being highest in PRE2. Table I shows why. The inventory-holding premium is an increasing function of both the futures price and the futures return volatility. The average futures price is much higher in PRE2 than in PRE1 (839.62 versus 652.67), as is the average volatility rate (19.37% versus 14.26%). Figure 2(c) shows that trading volume is quite erratic from day to day, and appears to be lower on average in the subperiod after the contract redesign. Table I shows that the average daily trading volume in POST was 60,638 contracts (deflated by a factor of 2 to account for the change in contract size), compared with 76,534 contracts in PRE1 and 75,330 in PRE2. We analyze the change in trading volume in the next section.

Regression Results

The bid/ask spread regression results are reported in Table II. Coefficient magnitudes, signs, and levels of significance using heteroskedastic and autocorrelation consistent (HAC) standard errors are consistent across the two spread measures. The coefficient of the inventory-holding premium variable is positive and significant in a statistical sense. The fact that its magnitude is greater than 1 reflects the fact that we are using the

TABLE II

Summary Results from the Time Series Regression of the Daily Bid/Ask Spread of the S&P 500 Futures Contract During the Period 951106 Through 981030 ($n = 755$)

	Method of Moments Spread Measure				
	α_0	α_1	α_2	α_3	α_4
Estimate	−0.0641	−0.0684	0.1411	4.3628	−2.6989
t-Ratio	−3.35	−3.82	7.04	7.05	−4.75
Adjusted *R*-squared	0.7759				
	Mean Absolute Price Change Measure				
	α_0	α_1	α_2	α_3	α_4
Estimate	−0.0665	−0.0690	0.1425	4.4967	−2.7721
t-Ratio	−3.47	−3.97	7.39	7.47	−4.65
Adjusted *R*-squared	0.7791				

Note. The regression model is:

$$SPRD_t = \alpha_0 + \alpha_1 I_{1,t} + \alpha_2 I_{2,t} + \alpha_3 IHP_t + \alpha_4 (1/V)_t + \varepsilon_t$$

where $SPRD_t$ is the realized bid/ask spread of the nearby S&P 500 futures on day t, IHP_t is the inventory-holding premium, and V_t is the total number of S&P 500 futures contracts traded. The indicator variable $I_{1,t}$ is 0 in the PRE1 subperiod (951106 through 961101) and 1 otherwise. The indicator variable $I_{2,t}$ is 1 in the POST subperiod (971103 through 981030) and 0 otherwise. In the POST subperiod the number of contracts is reduced by a factor of two to account for the change in the contract multiplier. The two bid/ask spread measures are the method of moments estimator and the mean absolute price-change estimator.

average time between trades as a proxy for the average time between offsetting trades for a *single* market maker. Indeed, we can use the coefficient value 4.3628 to construct an estimate of the number of active market makers in our sample. Because the inventory-holding premium is linear in the square root of time between offsetting trades, we can scale the time between trades by the number of active market makers such that the coefficient on the resulting inventory-holding premium is 1. Because 4.3628 is the appropriate scaling factor for the average square root of the time between trades, the appropriate scaling factor for the average time between trades 4.3628^2, or approximately 19. Thus, for our sample period November 1995 through October 1998, the average number of *active* market makers appears to be about 19, well below the number of people actually standing in the futures pit.

The coefficient of trading volume is negative and significant. Recall that order-processing costs are fixed, the sign of the coefficient should be positive. Apparently market makers increase spreads on high volume days, perhaps as compensation for the increased likelihood of trading with better informed individuals.

Probably the most striking results in Table II are the estimates of the intercept and the coefficients of the indicator variables. It appears that market makers were losing money in PRE1 and PRE2, and that the contract redesign brought things back into alignment. Consider the PRE1 subperiod, for example. From Table I, we know that the average inventory-holding premium is 0.0375 and the average inverse trading volume is 0.01468. Multiplying these values by their respective coefficient estimates in Table II and summing, we get

$$4.3628 \times .0375 - 2.6989 \times .01468 = 0.1239$$

In other words, the market maker costs of operation during PRE1 were 0.1239 per contract, while their revenue was 0.0589. The difference (and the intercept estimate in the regression, −0.0641, is the market maker's loss per contract. In PRE2, the loss grows to −0.0641–0.0684 = −0.1325, and, in POST, there appears to be a small profit, that is, −0.0641–0.0684 + 0.1411 = 0.0086.

To illustrate these results in even a more vivid way, consider Figure 3, which shows the realized and predicted bid/ask spreads levels during the entire sample period. To highlight the differences in the average levels of the bid/ask spread in each subperiod, the predictions are generated without the intercept and indicator variables, that is,

$$\text{Predicted } SPRD_t = \hat{\alpha}_3 IHP_t + \hat{\alpha}_4(1/V_t) \tag{5}$$

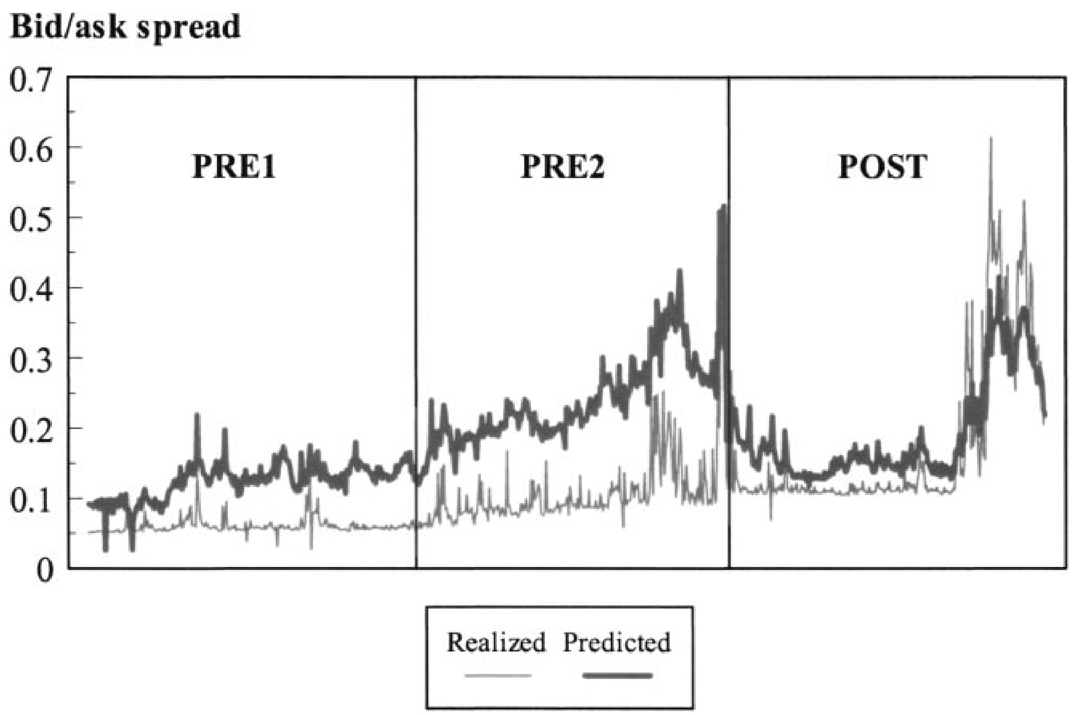

FIGURE 3

Realized and predicted bid/ask spread of the nearby S&P 500 futures contracts estimated daily from 951106 through 981030. The realized bid/ask spread is estimated using a method of moments estimator and time and sales data of the nearby S&P 500 futures contract. The predicted spread is based on the parameter estimates obtained from the regression model,

$$SPRD_t = \alpha_0 + \alpha_1 I_{1,t} + \alpha_2 I_{2,t} + \alpha_3 IHP_t + \alpha_4(1/V_t) + \varepsilon_t$$

where $SPRD_t$ is the realized bid/ask spread of the nearby S&P 500 futures on day t, IHP_t is the inventory-holding premium, and V_t is the total number of S&P 500 futures contracts traded in thousands. The indicator variable $I_{1,t}$ is zero in the PRE1 subperiod (951106 through 961101) and 1 otherwise. The indicator variable $I_{2,t}$ is 1 in the POST subperiod (971103 through 981030) and zero otherwise. In the POST subperiod the number of contracts is reduced by a factor of 2 to account for the change in the contract multiplier. The predicted values are generated ignoring the indictor variables, that is,

$$\text{Predicted } SPRD_t = \hat{\alpha}_3 IHP_t + \hat{\alpha}_4(1/V_t).$$

Throughout PRE1 and PRE2, the costs of operation are consistently higher than the revenue generated by the bid/ask spread. The difference between the predicted and realized spreads climbs steadily during PRE2 as a result of an increasing inventory-holding premium. Following the contract redesign, the difference between the predicted and realized spreads is smaller; however, it remains positive during most of POST. Apparently the increase in tick size was not large enough. By the end of the subperiod, realized spreads are much higher than the minimum tick size and are close to their predicted levels.

Analysis of S&P 500 Futures Spreads Vis-à-Vis SPDRs

The results in the last subsection indicate that the increase in tick size was justified from the perspective of the exchange. But, even with the increase, it appears that the spreads in POST are merely adequate in covering costs. To test the robustness of these results, we examine the volume-weighted effective bid/ask spreads of the American Stock Exchange's (AMEX) Standard & Poor's Depositary Receipts (or SPDRs) Trust Series I. SPDRs are a pooled investment designed to provide investment results that generally correspond to the price and yield performance, before fees and expenses, of the S&P 500 Index. Although there is no assurance that the performance of the S&P 500 Index can be fully matched, trading SPDRs is generally regarded to be a close substitute for trading the S&P 500 Index portfolio or the S&P 500 futures. The volume-weighted effective spread is

$$\text{Volume-weighted effective spread} = \sum_{i=1}^{n} \left(\frac{\text{volume}_i}{\text{daily volume}} \right) 2 \left| \text{trade price}_i - \text{midpoint}_i \right| \qquad (6)$$

where n is the number of trades in a given day, the term in parenthesis is the proportion of total daily trading volume accounted for by trade i, and the absolute value operator applies to the difference between the trade price and the average of the prevailing bid/ask price quotes of trade i.

Table III contains a comparison of the bid/ask spreads of the S&P 500 futures with those of the SPDRs during POST. As the table shows, the

TABLE III

Comparison of Realized and Theoretical Bid/Ask Spreads for the S&P 500 Futures and the SPDRs During the POST Subperiod 971103 Through 981030

Item	*S&P 500 Futures (CME)*	*SPDRs (AMEX)*
Index level	1,049.77	105.1295
Tick size	0.10	0.03125
Mean absolute bid/ask spread	0.1731	0.1232
Median absolute bid/ask spread	0.1145	0.1016
Mean relative bid/ask spread	0.0165%	0.1172%
Median relative bid/ask spread	0.0109%	0.0966%

Note. The values reported are average daily estimates for the year. The bid/ask spread for the S&P 500 futures is from the Smith/Whaley (1994b) estimator using times and sales data. The bid/ask spread for the SPDRs is the volume-weighted effective spread using trade and quote data.

average daily closing index level of the S&P 500 Index was 1,049.77, while the average SPDRs price was 105.13. The mean realized spread of the S&P 500 futures is 0.1731, as noted earlier, and the mean bid/ask spreads for the SPDRs is 0.1232. To bring the two S&P 500 instruments to a common base, relative spreads are computed. The relative spread of the SPDRs is 0.1232%, over seven times the mean relative spread of the S&P 500 futures, 0.0165%. Even after the increase in tick size, the S&P 500 futures contract remains the most trading-cost-effective S&P 500 instrument for investors.

TRADING VOLUME

Thus far, the results indicate that the CME's decision to double the tick size of the S&P 500 futures contract was justifiable on economic grounds. With higher trading costs, however, it is possible that demand for contract use has been curtailed. This section assesses whether the contract redesign affected trading volume.

Few studies have focused on the effects of contract redenomination on the trading volume of a futures contract.[15] Halving the size of a futures is not unlike a stock split, however, and the effects of stock splits have been examined in detail. Two results that are relevant to our work are that stock splits broaden the investor base (e.g., Lamoureux & Poon, 1987; Maloney & Mulherin, 1992, show that the number of shareholders increases significantly following a stock split) and generate increased trading volume (e.g., Gray et al., 2003, shows an increase in the number of trades and trading volume following a split). We must interpret the equity market evidence with caution, however. Unlike a stock split that creates a less pricey, more accessible investment vehicle, the splitting of the S&P 500 futures creates nothing new considering the S&P 500 e-mini futures contract was already active, providing for the demands of small investors. In addition, unlike a stock split where the firm sets its relative tick size of its stock indirectly through its split policy, the exchange mandates the tick size of its futures. To the extent that the decision makers have different objective functions, we should not expect to observe identical reactions to a split in both markets.

To attribute changes in trading volume to the contract redesign, we must control for other factors that might affect volume. We do this in two ways. First, we model S&P 500 futures volume as a function of volatility. Second, we compare trading volumes of various stock index products to

[15]Martini and Dymke (1995) and Karagozogula and Martell (1999) are two examples; however, they analyze Sydney Futures Exchange contracts with relatively light trading volume.

the S&P 500 futures volume. The data used to investigate trading volume come from a variety of sources. In general, futures exchanges summarize daily trading activity by reporting open, high, low, and settlement prices as well as the trading volume and closing open interest of each contract month. This information is then recorded and maintained in historical data banks. The source of the daily data for the CME's S&P 500 futures, the New York Board of Trade's (NYBOT's) NYSE Composite Index futures, and the London International Financial Futures and Options Exchange's (LIFFE's) FT-SE 100 futures was the FII. For the SFE's All Ordinary Share Price Index futures and for the Marché A Terme d'Instruments Financiers' (MATIF's) CAC 40 Index futures,[16] data were obtained from the exchanges' Web sites. Price and volume data for the CME's S&P 500 e-mini futures contract were obtained from *Datastream*. Stock market data were also used. Daily share volume and dollar share volume for all stocks traded on the NYSE were obtained from the NYSE's Web site. Daily share volume and dollar volume for the AMEX's SPDRs were drawn from the NYSE's TAQ data base.

The first step in preparing the data for analysis was to compute total dollar trading volume for each futures each day. Total volume (expressed in the local currency), $TVLC_t$, was computed as the sum of the products of each contract month's daily settlement price, $S_{i,t}$, number of contracts traded, $N_{i,t}$, and contract multiplier, $M_{i,t}$, that is,

$$TVLC_t = \sum_{i=1}^{n} S_{i,t}N_{i,t}M_{i,t} \tag{7}$$

where n is the number of different contract months. The contract multipliers for the S&P 500 e-mini futures, the All Ordinaries Index futures, and the FT-SE 100 futures remained constant at USD 50, AD 25, and BP 25 during the sample period. The MATIF changed the multiplier of the CAC 40 futures from FF 200 to FF 50 on July 1, 1998, and the CME changed the multiplier of the S&P 500 futures from USD 500 to USD 250 on November 3, 1997. For the non-U.S. contracts, the total daily trading volume in the local currency was converted into U.S. dollars using the closing exchange rate each day. The source of the currency rates was *Datastream*.

The second step in preparing the data involved computing average daily trading volumes over biweekly periods. In the analysis that follows, the daily trading volumes of different futures traded internationally are

[16]In an effort to make the conversion to the Euro as easy as possible, the MATIF changed the multiplier of its CAC 40 futures from FF 200 to FF 50 on July 1, 1998. Consequently, all trading volumes reported for the CAC 40 futures from July 1, 1998, through October 31, 1998, were divided by 4.

compared contemporaneously. Using daily volumes would introduce errors into the analysis because different futures have different (sometimes nonoverlapping) trading hours, different countries have different customs regarding national holidays, and so on. To mitigate these idiosyncratic effects, biweekly averages are used. Each of the three subperiods contains exactly 26 biweekly observations.

Summary Statistics

Table IV contains summary statistics of the trading volume. In the first two columns are the average daily number of contracts traded and the average daily trading volume in U.S. dollars. The last column contains the average of the biweekly ratios of the dollar volume of the non-S&P 500 futures to the dollar volume of the S&P 500 futures. For the S&P 500 futures contract only, the biweekly ratio is the average daily dollar volume of all NYSE stocks to the dollar volume of the S&P 500 futures. The rows labeled PRE1, PRE2, and POST correspond to the subperiods in the sample.

Table IV shows three salient results. First, while the average daily number of S&P 500 futures contracts traded remained relatively flat during PRE1 and PRE2, the number of contracts traded in POST was 60,638, 20% lower than in PRE2.[17] The average daily dollar volume did not fall by a corresponding amount, however. The reason is that the S&P 500 Index increased significantly over the sample period. The average S&P 500 Index level was 649.69, 839.62, and 1,049.77 in PRE1, PRE2, and POST, respectively. When the dollar volumes are considered, the declining number of contracts traded was more than offset by the increase in the level of the S&P 500 Index. In the final column of the S&P 500 futures panel in Table IV, relative trading volume is reported. NYSE stock trading volume appears to have increased relative to S&P 500 futures over the sample period. In PRE1, the dollar volume of all NYSE stocks averaged about 63.8% of the dollar volume of the S&P 500 futures. The percentage increased to 70.8% in PRE2 and to 93.1% in POST. The increase in equity trading vis-à-vis S&P 500 futures in PRE2 may have been one of the reasons motivating the CME to reduce the S&P 500 futures multiplier. A lower multiplier might attract new customers and promote trading activity. The change did not appear to stem the tide, however. NYSE dollar trading volume continued to increase and at an even more rapid rate.

[17]Note that the trading volume figures for the S&P 500 futures have been deflated by a factor of 2 in POST to reflect the change in contract denomination. Thus, the reported figure, 60,638, is actually 121,276.

TABLE IV

Average Daily Trading Volumes of Selected Futures Contracts in the Period Surrounding the S&P 500 Futures Contract Redesign

Subperiod	*Average Daily Number of Contracts Traded*	*Average Daily Volume in USD*	*Relative to S&P 500 Futures USD Volume*
S&P 500 Futures Excluding E-mini (CME)			
PRE1	76,534	24,942	0.6378
PRE2	75,330	31,555	0.7082
POST	60,638	31,893	0.9309
S&P 500 Futures Including E-mini (CME)			
PRE1	76,534	24,942	0.6378
PRE2	75,500	31,636	0.7061
POST	62,242	32,742	0.9054
SPDRs (AMEX)			
PRE1	763,688	50	0.0021
PRE2	2,658,319	231	0.0074
POST	6,565,480	690	0.0218
NYSE Composite Futures (NYBOT)			
PRE1	3,065	535	0.0219
PRE2	3,794	840	0.0270
POST	2,359	637	0.0201
AOI Futures (SFE)			
PRE1	9,390	410	0.0173
PRE2	10,481	506	0.0161
POST	12,246	512	0.0168
FT-SE 100 Futures (LIFFE)			
PRE1	17,035	250	0.0100
PRE2	14,931	277	0.0087
POST	25,610	595	0.0179
CAC 40 Futures (MATIF)			
PRE1	23,396	1,861	0.0786
PRE2	25,579	2,378	0.0770
POST	52,704	3,042	0.1012

Note. The table lists average daily trading volume during three separate subperiods: PRE1, 951106 through 961101; PRE2, 961104 through 971031; and POST, 971103 through 981030. The seven categories are: (a) the CME's S&P 500 futures excluding the e-mini contract, (b) the CME's S&P 500 futures including the e-mini contract, (c) the AMEX's SPDRs, (d) the NYBOT's NYSE Composite futures, (e) the SFE's AOI futures, (f) the LIFFE's FT-SE 100 futures, and (g) the MATIF's CAC 40 futures. The average number of contracts traded includes all maturities. For the S&P 500 futures, in the POST subperiod the number of contracts is reduced by a factor of 2 to account for the change in the contract multiplier. The average daily volume is the product of the contract volume, the settlement price, and the contract denomination. For the foreign contracts, the volume is converted to U.S. dollars using the day's prevailing foreign exchange rate. For the SPDRs, the number of contracts is the number of shares traded. Relative trading volume is the daily dollar volume of the futures/security divided by the daily dollar volume of the S&P 500 futures. For the S&P 500 futures panel, the relative trading volume is the total market value of all stocks traded on the New York Stock Exchange divided by the dollar trading volume of the S&P 500 futures.

Second, the trading volume of the NYSE Composite Index futures pales by comparison to the S&P 500 futures. In PRE1, for example, dollar trading volume of the NYSE futures was only 2.2% of that of the S&P 500 futures. This is not surprising. The correlation between the rates of return of the two indexes is extraordinarily high, which means that in the absence of trading costs the futures on these indexes are near perfect substitutes for one another. Because the NYSE futures was introduced well after the S&P 500 futures market was established, it has never captured a meaningful market share. It is interesting also to note that the relative dollar trading declined in POST relative to PRE1 and PRE2. One possible explanation is that the increase in trading costs in the S&P 500 futures contract reduced the amount of arbitrage activity between NYSE Composite and S&P 500 futures contract markets.

Third, the summary statistics for index futures in other countries are consistent with each other in the sense that average dollar trading volume of the various futures contracts increased from PRE2 to POST, both in absolute amount and relative to the S&P 500 futures. Although the trading volume of all of the foreign contracts is small relative to the S&P 500 futures, the results reported in Table IV indicate that the slowing of S&P 500 futures trading in POST is not common to index futures markets in other countries.

Total Trading Volume Test

There is a substantial body of literature that provides empirical evidence of a positive correlation between daily trading volume and return volatility. Included are Clark (1973), Anderson (1996), Foster and Vishwanathan (1995), Gallant et al. (1992), Heimstra and Jones (1994), Richardson and Smith (1994), Epps and Epps (1976), and Tauchen and Pitts (1983). The mixture of distributions hypothesis (MDH) suggests trading volume and volatility are jointly dependent on information flow, that is, the more new information flowing into the market, the greater the trading volume and market volatility.

Our analysis of trading volume, therefore, relies on the least squares estimation of:

$$N_t = \alpha_0 + \alpha_1 I_{1,t} + \alpha_2 I_{2,t} + \alpha_3 \sigma_t + \varepsilon_t \tag{8}$$

where N_t is the average daily number of S&P 500 futures contracts traded (in 000's) in each biweekly period, $I_{1,t}(I_{2,t})$ is an indicator variable that is 1 if the observation occurs in PRE2 and POST (just POST) and is zero otherwise, and σ_t is the daily close-to-close return volatility of the S&P 500 Index in each biweekly interval. The number of contracts traded has been divided by 2 in POST to account for the change in contract denomination. The indicator variables, therefore, capture the abnormal changes in trading volume in the year prior to and after the contract redesign.

The regression results for the S&P 500 futures contract are reported in Panel A of Table V. The coefficient of the return volatility variable is

TABLE V

Summary Results from the Time Series Regression of Biweekly Trading Volume During the Period 951106 Through 981030 ($n = 78$)

	α_0	α_1	α_2	α_3
A. Total Trading Volume				
S&P 500 futures (CME)				
Estimate	68.231	−5.159	−16.300	77.689
t-Ratio	21.44	−0.93	−3.10	5.67
Adjusted *R*-squared	0.2283			
B. Relative Trading Volume				
NYSE stocks				
Estimate	0.63780	0.07039	0.22267	
t-Ratio	32.33	1.96	4.97	
Adjusted *R*-squared	0.3962			
SPDRs				
Estimate	0.00207	0.00530	0.01439	
t-Ratio	9.20	3.02	3.97	
Adjusted *R*-squared	0.6594			
NYSE composite futures				
Estimate	0.02189	0.00507	−0.00690	
t-Ratio	28.74	3.12	−2.59	
Adjusted *R*-squared	0.2743			
AOI futures				
Estimate	0.01731	−0.00116	0.00063	
t-Ratio	33.37	−1.19	0.77	
Adjusted *R*-squared	−0.0206			
FT-SE 100 futures				
Estimate	0.01002	−0.00127	0.00915	
t-Ratio	6.23	−0.72	3.46	
Adjusted *R*-squared	0.3604			
CAC 40 futures				
Estimate	0.07861	−0.00158	0.02419	
t-Ratio	20.83	−0.39	4.30	
Adjusted *R*-squared	0.0741			

Note. Panel A lists the results of the regression:

$$N_t = \alpha_0 + \alpha_1 I_{1,t} + \alpha_2 I_{2,t} + \alpha_3 \sigma_t$$

where N_t is the number of S&P 500 futures contracts traded and σ_t is the close-to-close return volatility of the S&P 500 futures over the biweekly period. The indicator variable $I_{1,t}$ is 0 in the PRE1 subperiod (951106 through 961101) and 1 otherwise. The indicator variable $I_{2,t}$ is 1 in the POST subperiod (971103 through 981030) and 0 otherwise. In the POST subperiod the number of contracts is reduced by a factor of 2 to account for the change in the contract multiplier. In panel B, the volatility variable is omitted and the dependent variable is the ratio of the USD trading volume of the listed security to the dollar volume of the S&P 500 futures contract.

positive and significant in a statistical sense using heteroskedastic and autocorrelation consistent (HAC) standard errors. The coefficients on the indicator variables are both negative. The first is insignificant, indicating that there was no meaningful change in the number of contracts traded from PRE1 to PRE2 after the effects of volatility are taken into account. The second indicator variable coefficient is negative and significant, implying that trading volume fell significantly from PRE2 to POST. The magnitude of the estimated coefficient in the regression indicates that S&P 500 futures trading volume dropped by 16,300 contracts after controlling for volatility. As shown in Table IV, the average daily volume was about 76,000 prior to the redesign. Holding the effects of volatility constant, the reduction in the year following the redesign is therefore approximately 21.4%.

Tests of Relative Trading Volume

To test the robustness of the inference regarding trading volume, six more regressions are performed. The ratios of the trading volumes of NYSE stocks, the SPDRs, and the four futures contracts to the S&P 500 futures trading volume (excluding the e-mini contract) are used as dependent variables in place of the trading volume of the S&P 500 futures. The results are reported in Panel B of Table V. Given the regression model (4), the measure of volatility now becomes relative volatility. Because none of the coefficients of the relative volatility variable were significant in the estimation, Panel B reports only the results of the regression specification that includes only the intercept and the two indicator variables.

The regression results reported in Panel B are reasonably consistent. For the NYSE stocks, the FT-SE 100 futures, and the CAC 40 futures, the coefficient of the first indicator variable is insignificantly different from zero and the coefficient of the second indicator variable is significantly positive. For the SPDRs, the coefficients of both indicator variables are positive and significant. What this means is that the dollar trading volume of NYSE stocks, SPDRs, FT-SE 100 futures, and CAC 40 futures all increased relative to the S&P 500 futures in POST. Because these are all actively traded markets, one can reasonably infer that the trading volume of the S&P 500 futures has declined after its redesign. The coefficients of the indicator variables in the NYSE futures regression are significantly positive and significantly negative, respectively. This means that relative trading volume was higher in PRE2 than in PRE1 and was lower in POST than in PRE2. Neither indicator variable coefficient is significantly different from zero in the case of the AOI futures. All in all, the S&P 500 futures volume appears to have lost ground after the contract's redesign, at least relative to other stock index products and the stock market as a whole.

TRADE SIZE

One of the reasons for reducing the S&P 500 contract size was to provide greater accessibility to smaller investors. This section analyzes the distribution of trade sizes in the S&P 500 futures contract before and after the redesign to assess whether the redesign had the desired effect. Huang and Stoll (1998, p. 26, Fig. 2) report average S&P 500 futures trade sizes of 3.52, 3.13, 3.23, and 3.63 contracts in the years 1986, 1989, 1992, and 1995, respectively. They also show that the distribution of trade sizes appears constant over the years, with approximately 50% of all trades being for one contract. The stationarity of the distribution over the 9-year period offers little support for the notion that the contract had become too large and unwieldly for existing users. If this were the case, the mass of the distribution should have shifted to the left over time, with smaller trade sizes becoming much more frequent. What the distributions do not show, as Huang and Stoll correctly point out, is whether anyone was deterred from trading the S&P 500 futures as a result of the large contract size. Small investors, for example, may have opted not to trade at all. In addition, there may be incremental demands by large investors who may want to improve the precision of their risk management strategies.

To examine the effects of the redesign on trade size, we again use the CFTC's CTR data. A single trade identification number appears for both the buy and sell legs (records) of a transaction. Occasionally, a single buy trade is matched against multiple sells, and vice versa. The trade size is therefore computed as the sum of the number of contracts across all of the buy legs of a particular trade identification number at a particular time of the day (to the nearest second). Naturally, summing the volume across all sell legs would produce the same result.

Figure 4 shows the frequencies of trades of different sizes as a proportion of all trades. In PRE1 and PRE2, 52% and 54% of trades were for one contract. These percentages are consistent with those reported by Huang and Stoll (1998). The average trade sizes in these two subperiods were 3.55 and 3.41 contracts, again in line with the Huang and Stoll numbers for earlier years. In POST, however, the frequency of one-contract trades dropped to 44%, and the average trade size increased to 5.08 contracts. The fact that the average trade size did not double suggests that there has been some new demand generated by the smaller contract. Nonetheless, the preponderance of contract volume is large trades. The 5+ trade size category had over 60% of volume in all subperiods and nearly 80% in POST.

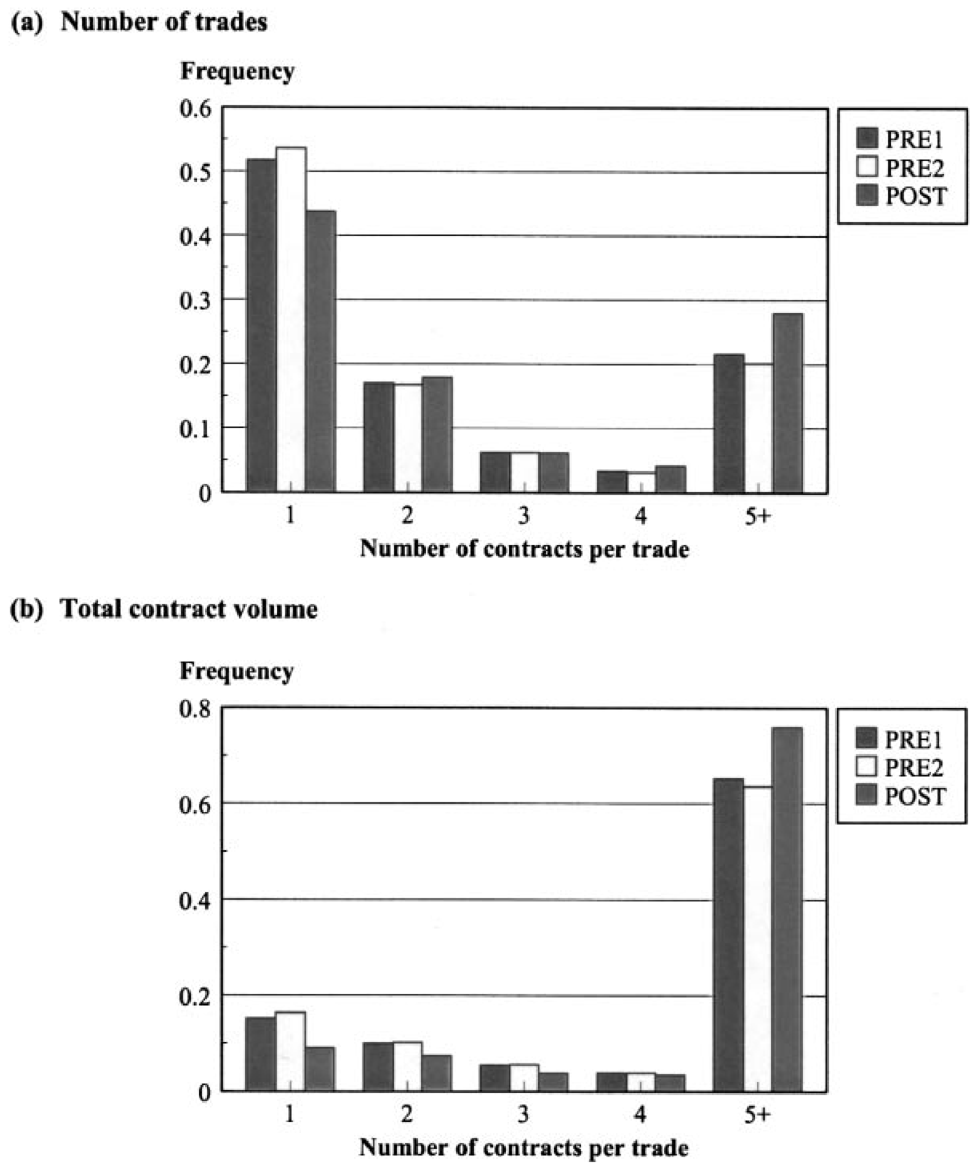

FIGURE 4

Frequency of trade size by number of trades and by total contract volume. Figures are based on the total number of trades and total contract volume of the S&P 500 futures during the subperiods PRE1 (951105 through 961101), PRE2 (961104 through 971031), and POST (971103 through 981030).

To test whether small-trade volume increased following redesign, we compute total contract volume for trade sizes between one and five contracts in PRE2 and between one and 11 contracts in POST. More trade-size categories are used in POST because the contract denomination is half. Table VI shows that, in PRE2, the total small-trade volume was 9,015,337. The total small-trade volume in POST was 16,468,984.

TABLE VI

Summary of S&P 500 Futures Trading Volume by Trade Size in the Year Before (PRE2) and the Year After (POST) Contract Redesign on November 3, 1997

S&P 500 Futures Contracts					
Before (PRE2)		*After (POST)*			
Trade Size	*Actual No. of Contracts Traded*	*Trade Size*	*Actual No. of Contracts Traded*	*Adjusted No. of Contracts Traded*	*Percent Change in Trading Volume*
1	2,820,735	1	2,444,442	2,575,495	−8.69%
		2	2,124,806		
		3	1,163,484		
2	1,891,000	4	1,037,244	1,561,723	−17.41%
		5	3,008,920		
3	1,078,221	6	653,160	1,182,401	9.66%
		7	414,365		
4	738,056	8	506,072	429,194	−41.85%
		9	290,268		
5	2,487,325	10	4,658,660	2,443,788	−1.75%
		11	167,563		
Totals	9,015,337		16,468,984	8,192,601	−9.13%
S&P 500 e-mini futures trading volume				405,119	
Total S&P 500 futures trading volume				8,597,720	−4.63%

Note. Adjusted contract volume is an estimate of the number of contracts traded after redesign but expressed in PRE2 contract units. The adjusted trading volume in the PRE2 trade-size 1 category, for example, equals the sum of the number of contracts traded in (a) the POST trade-size 1 category, and (b) the POST trade-size 2 category, as well as (c) half the number of contracts traded in the POST trade-size 3 category divided by 2 (to adjust for the new contract size). For the remaining PRE2 trade-size categories, the adjusted trading volume for the PRE2 trade-size category i equals the sum of (a) half of the trading volume in the POST trade-size $2i - 1$ category, (b) the trading volume in the POST trade-size $2i$ category, and (c) half of the trading volume in the POST trade-size $2i + 1$ category divided by 2.

To compare the trading volumes of the different trade size classifications across the two subperiods, we adjust POST trading volumes to fit the PRE2 trade-size classifications. Underlying our volume aggregation is the assumption that an investor who traded n contracts in PRE2 had an actual contract demand of between $n - 1/2$ and $n + 1/2$ contracts. Anything less, and the investor would have traded one less contract. Anything more, and the investor would have traded more contracts. Thus, an investor who traded one contract in PRE2 is assumed to trade either one, two, or three contracts in POST, depending on whether his original demand was closer to 0.5, one, or 1.5 contracts. To compute POST trading volume for PRE2 trade-size one classification, we add the POST trade-size one volume, the POST trade-size two volume, and one-half the POST trade-size three volume,[18] and then divide the sum by two to account for the redenomination. Using the figures reported in Table VI,

$$\frac{2{,}444{,}442 + 2{,}124{,}806 + (1/2)1{,}163{,}484}{2} = 2{,}575{,}495$$

An investor who traded two contracts in PRE2 is assumed to trade three, four, or five contracts in POST, so we add one-half the POST trade-size three volume, the POST trade-size four volume, and one-half the POST trade-size five volume, and then divide the sum by 2. Calculations for the other PRE2 trade sizes are made in a similar fashion.

Table VI contains a summary of the results. In general, small-trade contract volume appears to have decreased. The total trading volume of one-contract trades was 2,820,735 in PRE2 and 2,575,495 in POST, a decline of about 8.7%. The total trading volume of two-contract trades was 1,891,000 in PRE2 and 1,561,723 in POST, a drop of more than 17%. Indeed, with exception of the three-contract trade-size category, all categories experienced reduced trading volume. Across all small-trade categories, trading volume fell by about 9.1%. The evidence suggests that neither small (nor large investors with more precise needs) created incremental demand for the S&P 500 futures.

One possible explanation for the lack of increase in small-trade volume in POST is that the CME introduced the S&P 500 e-mini futures 2 months earlier. Perhaps the e-mini futures had already absorbed the market demand for a smaller contract. At best, however, this is only a partial explanation. The total number of e-mini futures traded in POST was 4,051,190, which translates to 405,119 in adjusted trading volume.[19] Even with all e-mini futures trading volume included as small trade size categories used in Table VI, however, S&P 500 futures trading volume fell by 4.6% from PRE2 to POST.

CONCLUSIONS

On November 3, 1997, the CME changed the specifications of its S&P 500 futures contract by increasing the tick size from 0.05 to 0.10 index points and reducing the multiplier from USD 500 to 250. This study

[18]Note that the POST trade-size three volume is assumed to be shared equally between PRE2 trade-size one investors whose actual demand was near 1.5 (from below), and PRE2 trade-size two investors whose actual demand was near 1.5 (from above).
[19]Recall the S&P 500 e-mini futures is 1/10th the size of the full contract before redenomination.

examines the effects that these changes have had on the cost of trading and the trading activity in the S&P 500 futures market.

The contract redesign increased trading costs in two ways. First, aggregate brokerage fees increased because anecdotal evidence suggests brokerage rates did not change and, with the redenomination, an investor must trade twice as many contracts as before in order to achieve the same level of equity exposure. Second, doubling the tick size doubled the lower bound on the bid/ask spread, which increased following the contract redesign even after controlling for the effects of volume and volatility.

We assess whether the increase in the bid/ask spread following the contract redesign is justified by the costs of supplying liquidity and find market making costs exceed the realized spread in the 2 years leading up to the redesign, and that the difference is significantly reduced, but remains positive, in the year after. Although the increased tick size benefited market makers, however, it remains low in light of the fact that the relative spreads for the AMEX's SDPRs are seven times higher.

Increased trading costs may account for the fact that S&P 500 futures trading volume dropped by 20% in the year following redesign after adjusting for the change in contract multiplier. We also find that dollar trading volume of the S&P 500 futures declined significantly in the year after the change, at least relative to stock trading on the NYSE, SPDRs trading on the AMEX, and stock index futures trading on the LIFFE and the MATIF. There is also some evidence to suggest that dollar trading volume fell relative to NYSE stocks in the year before the contract redesign, perhaps contributing to the CME's motivation in wanting to create a smaller contract. Our analysis of trade size, however, gives little indication that the redesign managed to attract smaller investors.

In summary, our results indicate that the CME's changes to the S&P 500 futures contract design enhanced the welfare of its members. Although halving the contract size did not increase demand among small investors, the number of new smaller contracts traded, and hence brokerage revenue increased. In addition, the doubling of the tick size provided an effective means of enforcing a higher bid/ask spread, thereby increasing market maker revenue. Even with the increase in tick size, however, the new levels of the bid/ask spread appear justified based on the market maker's costs of providing liquidity. Although investors may be worse off on an after-transaction-cost basis, there does not appear to be any other S&P 500 instrument that is more cost-effective.

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