VOLATILITY AND TRADING DEMANDS IN STOCK INDEX FUTURES

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In this study we examine how volatility and the futures risk premium affect trading demands for hedging and speculation in the S&P 500 Stock Index futures contracts. To ascertain if different volatility measures matter in affecting the result, we employ three volatility estimates. Our empirical results show a positive relation between volatility and open interest for both hedgers and speculators, suggesting that an increase in volatility motivates both hedgers and speculators to engage in more trading in futures markets. However, the influence of volatility on futures trading, especially for hedging, is statistically significant only when spot volatility is used. We also find that the demand to trade by speculators is more sensitive to changes in the futures risk premium than is the demand to trade by hedgers. © 2003 Wiley Periodicals, Inc. Jrl Fut Mark 23:399–414, 2003

We thank an anonymous referee and Robert Webb (the editor) for helpful comments.
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Received February 2002; Accepted September 2002

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The Journal of Futures Markets, Vol. 23, No. 4, 399–414 (2003)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/fut.10067

INTRODUCTION

In the finance literature, many studies have examined the impact of futures trading on the volatility of the underlying securities. One issue that has received much attention is whether or not futures trading could destabilize the underlying market by inducing more speculative activities. Empirical findings to a large extent, however, do not warrant such a concern (see, for example, Stoll and Whaley [1988] and Darrat and Rahman [1995]). Indeed, studies (e.g., Peck [1981] and Bessembinder and Seguin [1992]) in general find a negative relation between volatility and the extent of futures market participation, suggesting that with futures trading, the underlying cash markets may become more stable.

While prior research focuses largely on the impact of futures trading on volatility, less attention is paid to how volatility affects trading demands for hedging and speculation in futures markets. Previous studies in the finance literature suggest that investors may increase their participation in futures trading when volatility increases. For instance, in Shalen's (1993) noisy rational expectations model of a futures market, speculators determine the size of their trading position on futures contracts based on the dispersion of beliefs among traders about the equilibrium price of futures. Shalen further suggests that the dispersion of expectations is closely related to volatility. In addition, a higher volatility may induce investors to increase trading in futures because futures contracts constitute a convenient means to adjust their investment positions (see Chen, Cuny, and Haugen [1995]). The Chen et al. model shows that when the stock market volatility increases, investors wishing to reduce risk exposure would sell stocks and stock index futures, thereby stimulating futures trading. The analyses of both Shalen and Chen et al. suggest that volatility is positively associated with trading demand. Empirically, Chen et al. do find a significant positive relation between volatility and open interest of the S&P 500 Stock Index futures. Chang, Chou, and Nelling (2000) also provide similar results, showing that open interest of hedgers increases when volatility is higher.

In this study, we extend Chang, Chou, and Nelling (2000) and provide further evidence on the effect of volatility on trading demands for hedging and speculation in the S&P 500 Stock Index futures contracts. Our study extends Chang et al.'s analysis in several aspects. First, while Chang et al. examine data over the period January 1984 to April 1990, the current study covers a more recent time period: from January 1993 to December 2000. Second, in addition to futures price volatility estimates that are employed in Chang et al., we also use spot volatility to check whether the analysis is sensitive to how volatility is measured.

Finally, we examine the effect of the futures risk premium on trading demands for hedging and speculation. Conventional wisdom suggests that higher futures risk premiums may encourage speculators to trade more because risk premiums represent a key component of the return that speculators expect to earn. In contrast, hedgers may not increase their positions if they estimate the hedging cost to be too high. Our empirical results indicate that volatility is positively related to trading demands for both speculators and hedgers. Our results also show that the demand to trade by speculators is more sensitive to changes in the futures risk premium than is the demand to trade by hedgers.

The rest of the article is organized as follows. Section I describes the empirical models that we employ to estimate the impact of volatility and the futures risk premium on trading demands for hedging and speculation. Section II summarizes the data used in this study and also discusses various volatility estimates employed and how we calculate futures risk premium. Section III presents the empirical results. The final section concludes the article.

I. TRADING DEMANDS, VOLATILITY, AND RISK PREMIUMS

To examine how volatility affects trading demands for hedging and speculation, we employ the following regression model:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2 \sigma_t + \varepsilon_t \quad (1)$$

where TD_t is the trading demand, measured by aggregate open interest, for hedgers or for speculators at time t, σ_t is a volatility estimate, and ε_t is an error term. We include lagged open interest as an independent variable to adjust for possible serial correlation in the data. The above model is estimated separately for long as well as short position for each type of trader.

We also examine the relation between stock market volatility and trading demands under different volatility environments, since it is reasonable to expect traders, especially hedgers, to engage in trading only for the case of large volatility shifts. To capture such effects, we rerun the regression equation (1) as follows:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2 \sigma_t + \beta_3 D\sigma_t + \varepsilon_t \quad (2)$$

where D is a dummy variable that equals 1 if σ_t is at the top 25% of the volatility series, and 0 otherwise. In equation (2), the coefficient estimate for β_2 measures the impact of volatility that is within the third quartile of the series on traders' open interest, while the coefficient estimate for β_3 captures the difference in the impacts between high and normal-range volatilities. If investors trade in response to meaningful shifts in volatility, we would expect β_3 to be statistically significant. On the other hand, if an extremely high level of volatility does not induce investors to increase their positions in hedging or speculation, the coefficient estimate for β_3 would be expected to be insignificantly different from zero.

In addition to volatility, investors' demands in futures trading might be affected by futures risk premiums. For instance, speculators may determine the size of their positions based on how much of the futures risk premium they expect to earn. Similarly, hedgers might weigh the costs and benefits of hedging, which depend on futures risk premiums, when they determine their hedging decision. When the futures risk premium is high and, hence, hedging costs are higher, investors may have less incentive to hedge. To examine the impact of the futures risk premium on investors' trading demand, we add the futures risk premium as another independent variable to equation (1):

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2 \sigma_t + \beta_3 RP_t + \varepsilon_t \qquad (3)$$

where RP_t denotes the futures risk premium for the S&P 500 Index futures at time t. Equation (3) is, again, estimated separately for hedgers and speculators. The coefficient estimate for β_3 would reflect the impact that the futures risk premium has on futures trading.

II. DATA, VOLATILITY ESTIMATES, AND RISK PREMIUMS

The Data

In this study we analyze the S&P 500 Stock Index futures contracts traded at the Chicago Mercantile Exchange. Daily closing futures prices on the S&P 500 Index for the period of January 1993 through December 2000 are used.[1] Since nearby contracts are traded more actively, and the contracts have a cycle of maturities of March, June, September, and December, they are rolled over at the expirations to obtain a long time-series data. The data set is obtained from Bridge.[2]

[1]Our sample period starts from 1993 because the CFTC has published the COT data on a weekly basis since November 1992. Prior to November 1992, the COT data were published on a biweekly basis.

[2]The futures prices and implied volatility data used in this study are available from Bridge's InfoTech data set. See Bridge's Web site at www.crbindex.com for information about this data set.

The trading data for the S&P 500 Index futures contracts are retrieved from the COT reports compiled by the CFTC.[3] The COT reports contain each Tuesday's nonreportable as well as reportable positions in terms of open interest for two groups of large traders: commercial and noncommercial traders. Following common practice in the finance literature, commercial trading is considered for hedging purpose, while noncommercial trading is classified as speculative activity.

Volatility Estimates

We employ three volatility estimates, including an implied volatility, a conditional volatility estimate, and the CBOE's Volatility Index. The implied volatility estimate is computed by using S&P 500 Index futures options. The conditional volatility estimate is calculated from S&P 500 Index futures returns, based on a generalized autoregressive conditional heteroskedasticity (GARCH) model. The CBOE's Volatility Index, which is also an implied volatility estimate, is computed by using S&P 100 Index options. The data used for estimating these three volatility estimates are also retrieved from the Bridge data set.

The implied volatility estimate of the S&P 500 Index futures options is calculated using the Black (1976) futures option pricing model based on two nearest-to-the-money calls and puts. To be consistent with the data of futures prices, we use the implied volatility from the nearby futures options until option expiration, when we roll over to the next option expiration series.

The second volatility estimate is based on a GARCH model. Specifically, the daily S&P 500 Stock Index futures return series is processed as an ARMA(p, q)-GARCH(1, 1) model as follows:

$$R_t = a_0 + \sum_{i=1}^{p} \theta_i R_{t-i} + \sum_{i=1}^{q} \vartheta_i e_{t-i} + e_t \tag{4}$$

$$v_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \alpha_2 v_{t-1} \tag{5}$$

where R_t is rate of return at time t for the S&P 500 Index futures (calculated as the first difference of log prices) and e_t is the residual (or unexpected return) which is normally distributed with mean zero and time-varying variance v_t. The daily return series is modeled as an ARMA(p, q) model in the mean equation to adjust for possible serial correlation in the data. The fitted value for v_t can be seen as the expected conditional volatility as of date t and is known at the beginning of the date.

[3]The COT reports are made available at CFTC's Web site at www.cftc.gov.

Diagnostic tests for the appropriateness of a model are based on the Ljung-Box statistics for checking serial correlation in both normalized raw and squared residuals. Our results (not reported) show that an ARMA(1, 2)-GARCH(1, 1) model fits the data well and does not exhibit significant serial correlations in both normalized raw and squared residuals. From the expected conditional volatility series, we generate an annualized standard deviation series by multiplying by 250 and then taking a square root.

We use the CBOE's Volatility Index (*VIX*) as a third measure of volatility, which is calculated as a weighted average of the implied volatilities of eight at-the-money call and put options on the S&P 100 Index. The CBOE calculates its Volatility Index using options that have an average time to maturity of 30 days. Thus, the CBOE's Volatility Index represents volatility for short-term options. The Volatility Index has become a general indication of index option implied volatility. Empirically, Fleming, Ostdiek, and Whaley (1995) show that there is a strong relation between *VIX* and future realized stock return volatility.

Since the COT data are at a weekly frequency, we calculate the average of the three daily volatility series on a weekly interval as well. The three weekly volatility series plotted in Figure 1 demonstrate that they share a common pattern. The volatilities appear to become more erratic

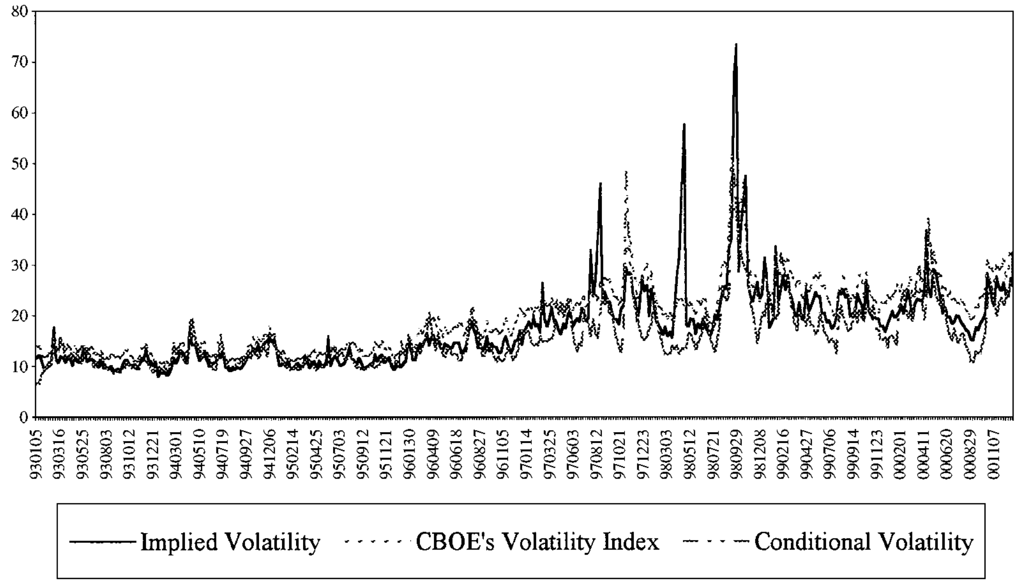

FIGURE 1

Volatility Trends in the S&P 500 Index. This figure traces the average of three volatility measures on a weekly interval, including implied volatility of the S&P 500 stock Index futures options, conditional volatility estimated from modeling S&P 500 Index futures returns as an ARMA(1, 2)-GARCH(1, 1) model, and CBOE's Volatility Index over the period of January 1993 through December 2000.

after 1997. Several spikes are also observed, such as the major ones in August 1997 and September 1998, and the minor one in April 2000.

Estimate Futures Risk Premiums

Futures risk premium represents the expected payment to speculators from hedgers. Theoretical analysis suggests systematic risk and net positions of hedgers in futures markets (i.e., hedging pressure) to be the primary determinants of futures risk premiums. Bessembinder (1992) and de Roon, Nijman, and Veld (2000), however, find little evidence that hedging pressure affects returns in the S&P 500 Index futures. In this study, we estimate risk premiums of the S&P 500 Index futures following a two-step approach. First, conditional betas are estimated by regressing futures returns on returns to the S&P 500 Cash Index, using weekly data for 20 futures contracts for the 52 weeks before the week containing date t.[4] Following de Roon et al., the S&P 500 Cash Index is used as a proxy for the market index. Second, the price of market risk is estimated with a cross-sectional model that regresses the average return for each of the 20 futures contracts on the beta values estimated from the first stage. This two-step procedure yields a time series of beta estimates for each futures contract and a time series of uniform estimates of risk of market price across futures markets. The risk premium is then estimated from multiplying conditional beta by the price of risk.

III. EMPIRICAL RESULTS

Trading Demands and Volatility

Table I reports the coefficient estimates in the regression of weekly trading demands of speculators in the S&P 500 Stock Index futures contracts on volatility, based on equation (1). Trading demands are measured in terms of aggregate open interest in long and short positions for large speculators. The total open interest represents the commitments by large speculators in all S&P 500 Stock Index futures contracts, as reported by the CFTC. We estimate the impact of volatility on open interest for long and short positions separately as well as for a net speculative position. Following Working (1960), our measure of net speculative position

[4]The 20 futures contracts used are identical to those in de Roon et al. (2000), and include S&P 500, Value-Line, T-bill, T-bond, Eurodollar, wheat, cotton, corn, soybeans, live cattle, world sugar, gold, silver, platinum, crude oil, copper, British pound, Deutsche mark, Japanese yen, and Swiss franc. For the purpose of estimating futures risk premium, the sample period is from January 1992 to December 2000.

TABLE I
Speculators' Trading Demands and Volatility in the S&P 500 Stock Index Futures Markets

	α	β_1	β_2	Adjusted R^2
Panel A: Long Open Interest				
$\sigma_t = IV_t$	669.157	0.929	15.057	0.869
	(2.33)**	(36.56)***	(0.86)	
$\sigma_t = CV_t$	410.780	0.926	35.877	0.870
	(1.31)	(38.36)***	(1.74)*	
$\sigma_t = VIX_t$	308.308	0.915	40.965	0.871
	(1.06)	(34.91)***	(2.35)**	
Panel B: Short Open Interest				
$\sigma_t = IV_t$	1,473.010	0.932	20.972	0.865
	(2.21)**	(37.64)***	(0.82)	
$\sigma_t = CV_t$	1,062.410	0.929	54.635	0.866
	(1.31)	(36.14)***	(1.01)	
$\sigma_t = VIX_t$	1,441.050	0.932	19.582	0.865
	(1.73)*	(38.00)***	(0.60)	
Panel C: Speculation Index				
$\sigma_t = IV_t$	0.297	0.713	−0.001	0.502
	(6.63)***	(16.46)***	(−0.15)	
$\sigma_t = CV_t$	0.302	0.709	−0.001	0.505
	(6.66)***	(16.23)***	(−1.40)	
$\sigma_t = VIX_t$	0.298	0.713	−0.001	0.502
	(6.61)***	(16.42)***	(−0.51)	

Note. This table reports coefficient estimates in the regression of weekly trading demands for speculators on volatility for the S&P 500 Stock Index futures over the period of January 1993 through December 2000. The empirical model is:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2 \sigma_t + \varepsilon_t$$

where TD_t denotes trading demands at week t and σ_t represents average of daily volatility estimates for a weekly interval. Trading demands are measured in terms of speculators' long open interest, short open interest, or speculation index. The speculation index is defined as $1 + SL/(HL + HS)$, if $HL \geq HS$, and as $1 + SS/(HL + HS)$ if $HL < HS$, where SL and SS are speculation long and short open interests, respectively, and HL and HS are hedging long and short open interests, respectively. Three daily standard deviation estimates are used, including implied volatility of the S&P 500 Stock Index futures options (IV), conditional volatility estimated from modeling daily S&P 500 Index futures returns as an ARMA(1, 2)-GARCH(1, 1) model (CV), and CBOE's Volatility Index (VIX). Inside the parentheses are t-statistics computed using White's (1980) heteroskedasticity consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

is calculated as $1 + SL/(HL + HS)$, if $HL \geq HS$, and as $1 + SS/(HL + HS)$ if $HL < HS$, where SL and SS stand for speculation long and short open interests, respectively, and HL and HS represent hedging long and short open interests, respectively.

The results in Table I indicate that, when volatility is measured either by the conditional volatility estimate of the GARCH model or by the CBOE's Volatility Index, it statistically significantly increases speculators' demand for entering into a long position. The implied volatility of the S&P 500 Stock Index futures options, however, does not appear to affect the speculative long open interest. For the short open interest, the impact of volatility on the trading demand of speculators is also positive, though not statistically significant, regardless of the volatility measure used. Our finding of a positive impact of volatility on the trading demand for speculation is supportive of Chen, Cuny, and Haugen's (1995) theoretical model that suggests open interest increases with volatility. In contrast, the speculation index discloses a negative relation with volatility, which seems to be consistent with Peck's (1981) finding. Peck hypothesizes that a larger speculation index implies an increase in the market liquidity provided by speculators to hedgers and hence would lead to a decrease in volatility. Also, consistent with the stylized fact that trading volume is positively autocorrelated, we find that the coefficient for the lagged open interest is highly significant and is close to one.

Table II provides the regression results as to the relation between volatility and hedging demand. The results reveal that hedgers' open interest in either long or short positions increase significantly with volatility, when the CBOE's Volatility Index is used. As volatility is estimated from futures prices (i.e., *IV* or *CV*), the relation is also positive, though not statistically significant. Thus, our result conforms to the literature that states that investors' demand to hedge their spot positions would increase as asset prices become more volatile (see Chen et al., 1995). We also examine the effect of volatility on hedgers' net positions, measured by a hedging pressure variable. The hedging pressure is constructed in a way similar to de Roon et al. (2000), and is defined as $(HS - HL)/(HS + HL)$, where *HS* and *HL* denote short and long hedge open interests, respectively. As de Roon et al. point out, the hedging pressure variable represents net positions of hedging in a futures market, and can be seen as a proxy for nonmarketable risks that hedgers do not want to trade. When hedging pressure is the dependent variable, the estimate of coefficient β_2 is significantly different from zero for the *VIX* volatility measure, suggesting that spot volatility has explanatory power for hedgers' net positions.

Taken together, the evidence in Tables I and II suggests that the statistical significance of the relation between volatility and investors' trading demands, especially hedgers', depends on what volatility estimate is used. When volatility measure is based on the implied volatility of futures options or the GARCH estimate calculated from futures prices, the relation tends to be insignificant. However, a statistically significant relation is obtained, particularly for hedging, when using the implied volatility of the S&P 100 Index options, which is shown to be strongly related to future realized stock return volatility (Fleming et al., 1995). It

TABLE II
Hedgers' Trading Demands and Volatility in the S&P 500 Stock Index Futures Markets

	α	β_1	β_2	*Adjusted* R^2
Panel A: Long Open Interest				
$\sigma_t = IV_t$	3,001.230	0.964	262.521	0.963
	(1.52)	(49.36)***	(1.48)	
$\sigma_t = CV_t$	418.201	0.948	675.044	0.965
	(0.21)	(33.15)***	(1.55)	
$\sigma_t = VIX_t$	1,608.280	0.942	559.978	0.964
	(0.61)	(33.80)***	(1.97)**	
Panel B: Short Open Interest				
$\sigma_t = IV_t$	1,294.730	0.984	138.862	0.971
	(0.73)	(57.39)***	(0.72)	
$\sigma_t = CV_t$	−1,869.400	0.970	529.296	0.972
	(−0.41)	(42.82)***	(1.30)	
$\sigma_t = VIX_t$	−1,844.830	0.960	517.230	0.972
	(−0.92)	(40.23)***	(1.81)*	
Panel C: Hedging Pressure				
$\sigma_t = IV_t$	−0.001	0.973	−0.000	0.933
	(−0.24)	(64.38)***	(−0.01)	
$\sigma_t = CV_t$	−0.002	0.970	0.001	0.933
	(−0.78)	(66.78)***	(0.58)	
$\sigma_t = VIX_t$	−0.007	0.956	0.001	0.934
	(−1.94)*	(59.38)***	(1.85)*	

Note. This table reports coefficient estimates in the regression of weekly trading demands for hedgers on volatility for the S&P 500 Stock Index futures over the period of January 1993 through December 2000. The empirical model is:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2 \sigma_t + \varepsilon_t$$

where TD_t denotes trading demands at week t and σ_t represents average of daily volatility estimates for a weekly interval. Trading demands are measured in terms of hedgers' long open interest, short open interest, or hedging pressure. The hedging pressure is defined as $(HS - HL)/(HS + HL)$. Inside the parentheses are t-statistics computed using White's (1980) heteroskedasticity consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

is noteworthy that the three volatility estimates may not measure the same thing. While the S&P 500 Stock Index futures option implied volatility and the GARCH conditional volatility estimate both reflect futures price variations, the CBOT's Volatility Index measures the price variation in the cash market. Since hedging is usually done to reduce the fluctuation in the value of an existing or anticipated position in the cash market, a spot volatility measure such as the CBOT's Volatility Index appears to be a more relevant volatility measure than the other two futures price volatility measures in examining the relation between volatility and hedging demands. Indeed, we find this relation is statistically significant only when the spot volatility is used.

Trading Demands and Volatility Regimes

Considering extreme levels of volatility may induce traders to revise their positions, we use regression model (2) to gauge the differential impact of two volatility regimes, the top 25% of the volatility series versus a normal range that is defined as volatility below the 75th percentile of the series, on trading demands. The regression results for speculators are shown in Table III. As can be seen, while there is a positive relation between long speculation open interest and normal volatility, speculators tend to reduce their long position when volatility is too high, as indicated by a negative β_3 coefficient. Nevertheless, the impact of different volatility regimes on the speculative long position is not statistically significant.

TABLE III

Asymmetric Speculators' Trading Demands and Volatility in the S&P 500 Stock Index Futures Markets

	α	β_1	β_2	β_3	*Adjusted* R^2
Panel A: Long Open Interest					
$\sigma_t = IV_t$	465.050	0.927	32.969	−12.383	0.869
	(0.98)	(37.25)***	(1.01)	(−0.66)	
$\sigma_t = CV_t$	259.291	0.914	44.477	−2.243	0.870
	(0.53)	(35.89)***	(1.58)	(−0.14)	
$\sigma_t = VIX_t$	387.199	0.926	37.967	−1.308	0.870
	(0.76)	(38.11)***	(0.91)	(−0.06)	
Panel B: Short Open Interest					
$\sigma_t = IV_t$	2,944.860	0.927	−87.289	77.575	0.866
	(2.65)***	(36.47)***	(−1.56)	(1.93)*	
$\sigma_t = CV_t$	3,306.270	0.922	−87.108	72.047	0.867
	(2.26)**	(33.79)***	(−1.39)	(1.89)*	
$\sigma_t = VIX_t$	743.956	0.929	80.321	−16.423	0.865
	(0.52)	(35.65)***	(0.80)	(−0.34)	
Panel C: Speculation Index					
$\sigma_t = IV_t$	0.300	0.709	0.000	−0.000	0.502
	(6.70)***	(16.39)***	(0.56)	(−0.62)	
$\sigma_t = CV_t$	0.300	0.709	0.000	−0.000	0.502
	(6.67)***	(16.33)***	(0.58)	(−0.85)	
$\sigma_t = VIX_t$	0.300	0.714	−0.000	0.000	0.504
	(6.40)***	(15.66)***	(−1.65)*	(0.83)	

Note. This table reports coefficient estimates in the regression of weekly trading demands for speculators on volatility for the S&P 500 Stock Index futures over the period of January 1993 through December 2000. The empirical model is:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2\sigma_t + \beta_3 D\sigma_t + \varepsilon_t$$

where D is a dummy variable that equals 1 if σ_t is at the top 25% of the volatility series. Inside the parentheses are *t*-statistics computed using White's (1980) heteroskedasticity consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Just to the opposite of the speculative long position, the speculative short open interest reacts to the normal range of the futures price volatility (i.e., *IV* and *CV*) negatively, meaning higher volatility is associated with less short selling in the S&P 500 Index futures contract by speculators. However, when we focus on the spot volatility (i.e., *VIX*), the relation is reversed, though not significant. For the net position of speculators, volatility regimes do not appear to have a statistically significant effect.

In contrast to the speculative long position, Table IV shows that hedgers tend to engage in more futures trading as volatility moves up to an extraordinarily higher level. The result is in line with the notion that

TABLE IV
Asymmetric Hedgers' Trading Demands and Volatility in the S&P 500 Stock Index Futures Markets

	α	β_1	β_2	β_3	*Adjusted* R^2
Panel A: Long Open Interest					
$\sigma_t = IV_t$	4,233.050	0.964	165.433	69.479	0.963
	(1.42)	(49.29)***	(0.84)	(0.62)	
$\sigma_t = CV_t$	4,239.840	0.939	377.237	134.148	0.965
	(1.59)	(32.77)***	(1.57)	(1.37)	
$\sigma_t = VIX_t$	−711.276	0.948	752.564	−60.538	0.965
	(−0.17)	(33.05)***	(1.23)	(−0.38)	
Panel B: Short Open Interest					
$\sigma_t = IV_t$	2,319.240	0.984	53.998	59.407	0.971
	(0.84)	(57.72)***	(0.23)	(0.49)	
$\sigma_t = CV_t$	−325.276	0.960	418.119	67.397	0.972
	(−0.13)	(40.10)***	(1.54)	(0.68)	
$\sigma_t = VIX_t$	−1,566.600	0.970	503.372	16.310	0.972
	(−0.30)	(42.23)***	(0.82)	(0.10)	
Panel C: Hedging Pressure					
$\sigma_t = IV_t$	−0.003	0.971	0.000	−0.000	0.933
	(−0.66)	(61.22)***	(0.60)	(−0.78)	
$\sigma_t = CV_t$	−0.0120	0.950	0.001	−0.000	0.934
	(−2.46)**	(57.02)***	(2.33)**	(−1.65)	
$\sigma_t = VIX_t$	−0.001	0.971	−0.000	−0.000	0.933
	(−0.17)	(66.39)***	(−0.10)	(0.42)	

Note. This table reports coefficient estimates in the regression of weekly trading demands for hedgers on volatility for the S&P 500 Stock Index futures over the period of January 1993 through December 2000. The empirical model is:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2\sigma_t + \beta_3 D\sigma_t + \varepsilon_t$$

where D is a dummy variable that equals 1 if σ_t is at the top 25% of the volatility series. Inside the parentheses are *t*-statistics computed using White's (1980) heteroskedasticity consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

hedgers determine their trading positions based on how large the volatility is. Nevertheless, none of the coefficient estimates is significant at any conventional level.

Trading Demands, Volatility, and Risk Premiums

Table V discloses the effect of risk premiums on the open interest of speculators. The coefficient estimate for risk premiums, β_3, is positive for both short open interest and the speculative index, suggesting that speculators tend to increase their short and net positions when the risk premium increases. This result is consistent with the notion that speculators trade

TABLE V

Speculators' Trading Demands, Volatility, and Risk Premiums in the S&P 500 Stock Index Futures Markets

	α	β_1	β_2	β_3	Adjusted R^2
Panel A: Long Open Interest					
$\sigma_t = IV_t$	667.739	0.929	15.308	−42.233	0.869
	(2.32)***	(36.72)***	(0.83)	(−0.06)	
$\sigma_t = CV_t$	410.291	0.926	35.810	40.781	0.870
	(1.31)	(38.39)***	(1.73)*	(0.06)	
$\sigma_t = VIX_t$	301.387	0.915	41.896	−159.735	0.870
	(1.04)	(34.99)***	(2.34)**	(−0.25)	
Panel B: Short Open Interest					
$\sigma_t = IV_t$	1,474.200	0.932	17.948	455.072	0.865
	(2.22)**	(37.38)***	(0.70)	(0.40)	
$\sigma_t = CV_t$	1,033.97	0.929	53.127	488.790	0.866
	(1.25)	(36.00)***	(0.99)	(0.44)	
$\sigma_t = VIX_t$	1,452.810	0.932	16.036	526.306	0.865
	(1.75)*	(37.84)***	(0.50)	(0.48)	
Panel C: Speculation Index					
$\sigma_t = IV_t$	0.334	0.677	−0.001	0.008	0.511
	(6.75)***	(14.17)***	(−1.11)	(3.03)***	
$\sigma_t = CV_t$	0.339	0.673	−0.001	0.008	0.514
	(6.82)***	(14.06)***	(−1.83)*	(3.11)***	
$\sigma_t = VIX_t$	0.336	0.676	−0.001	0.008	0.512
	(6.74)***	(14.06)***	(−1.33)	(3.11)***	

Note. This table reports coefficient estimates in the regression of weekly trading demands for speculators on volatility and risk premium for the S&P 500 Stock Index futures over the period of January 1993 through December 2000. The empirical model is:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2 \sigma_t + \beta_3 RP_t + \varepsilon_t$$

where RP_t denotes risk premium for the S&P 500 Index futures. Inside the parentheses are *t*-statistics computed using White's (1980) heteroskedasticity consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

more if they expect to earn higher risk premiums. However, we do not find such a positive relation between speculative long open interest and the futures risk premium.

Table VI contains the results that show how futures risk premiums influence the trading demand for hedging. Since risk premium represents the cost that hedgers need to pay when they transfer any unwanted risk to speculators, it is reasonable to expect that hedging positions decrease with risk premiums. That is, optimal hedging positions decrease with the cost of hedging. Consistent with this usual hypothesis, our results show that futures risk premiums are negatively related to

TABLE VI
Hedgers' Trading Demands, Volatility, and Risk Premiums in the S&P 500 Stock Index Futures Markets

	α	β_1	β_2	β_3	*Adjusted* R^2
Panel A: Long Open Interest					
$\sigma_t = IV_t$	3,035.240	0.964	275.039	−1,488.680	0.963
	(1.54)	(49.18)***	(1.53)	(−0.37)	
$\sigma_t = CV_t$	416.112	0.948	656.917	54.179	0.965
	(0.19)	(32.99)***	(1.56)	(0.01)	
$\sigma_t = VIX_t$	1,061.410	0.940	589.727	−2,797.260	0.964
	(0.61)	(33.73)***	(2.09)**	(−0.76)	
Panel B: Short Open Interest					
$\sigma_t = IV_t$	1,317.150	0.983	159.351	−2,392.020	0.971
	(0.74)	(57.50)***	(0.81)	(−0.58)	
$\sigma_t = CV_t$	−1,790.110	0.970	533.723	−1,822.140	0.972
	(−0.63)	(42.53)***	(1.32)	(−0.47)	
$\sigma_t = VIX_t$	−1,969.640	0.957	571.470	−4,742.900	0.972
	(−0.98)	(40.54)***	(2.01)**	(−1.28)	
Panel C: Hedging Pressure					
$\sigma_t = IV_t$	−0.001	0.973	−0.000	0.001	0.933
	(−0.24)	(65.62)***	(−0.03)	(0.09)	
$\sigma_t = CV_t$	−0.002	0.970	0.000	0.001	0.933
	(−0.78)	(67.89)***	(0.58)	(0.08)	
$\sigma_t = VIX_t$	−0.007	0.956	0.001	−0.001	0.933
	(−1.93)*	(60.09)***	(1.87)*	(−0.18)	

Note. This table reports coefficient estimates in the regression of weekly trading demands for hedgers on volatility and risk premium for the S&P 500 Stock Index futures over the period of January 1993 through December 2000. The empirical model is:

$$TD_t = \alpha + \beta_1 TD_{t-1} + \beta_2 \sigma_t + \beta_3 RP_t + \varepsilon_t$$

where RP_t denotes risk premium for the S&P 500 index futures. Inside the parentheses are t-statistics computed using White's (1980) heteroskedasticity consistent standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

both hedging long and short open interest, although none of the coefficient estimate is statistically significant at any conventional significance level.

IV. CONCLUSIONS

In this study, we examine how volatility and futures risk premium affect trading demands for hedging and speculation in the S&P 500 Stock Index futures over the period from January 1993 through December 2000. We use open interest data to measure investors' trading demands, and employ three volatility estimates. The results indicate that volatility positively affects open interest of both speculators and hedgers. However, the statistical significance of this relation is sensitive to the volatility estimates used. Specifically, the positive relation between volatility and investors' trading demands, especially for hedgers, is statistically significant only when an estimate of spot volatility is used.

Furthermore, there is some evidence that in high volatility periods, speculators increase their short positions slightly, although no such evidence is found for hedgers. As to futures risk premiums, it has an effect on just speculators' open interest, not hedgers'.

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