TRADING VOLUME AND TRANSACTION COSTS IN FUTURES MARKETS

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INTRODUCTION

Recently there has been considerable interest in the imposition of a user fee or transaction tax on futures transactions. Proponents argue that such a transaction tax would increase government revenues, could be used to fund the CFTC that regulates the futures markets. Those who oppose the transaction tax argue that a tax on securities transactions would increase the cost of capital, reduce market liquidity, and lower security values. In addition, a securities transaction tax could drive trading in some securities to overseas markets not burdened by taxation.[1] Thus, compe-

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[1]For a review of arguments, see Schwert and Seguin (1993) and for related tax issues, see Kiefer (1990), Kupiec, White and Duffee (1994), Ericsson and Lindgren (1992), Hubbard (1993), Summer and Summer (1989) and Umlauf (1993).

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tition from foreign exchanges is a major concern of the futures exchanges. Before one can properly evaluate the pros and cons of a transaction tax, one needs to know what impact an increase in transaction cost would have on trading volume and market liquidity within a general model framework. A transaction tax is only one of the components of the transaction cost. Other components include brokerage commissions, exchange and clearing fees, transfer fees, and taxes, as well as market impact [Collins and Fabozzi (1991)]. The market impact is the trade execution cost that reflects the bid–ask spread plus a price concession that compensates the market maker for the risk that the investor's transaction is information motivated.

Collins and Fabozzi (1991) include market timing cost as part of the trade execution costs. Market timing costs arise when, during the time of the transaction, the asset's price moves as the result of activity other than the particular transaction.[2] Unfortunately, few studies [Demsetz (1968), Epps (1976)] examine the relations between trading volume and transaction costs in the equity market, let alone those in the futures markets.

Demsetz (1968) examines the impact of transaction costs on transaction rates (i.e., the number of transactions over a given time period) of the NYSE stocks. Epps (1976) estimates the elasticities of trading volume of NYSE stocks with respect to transaction costs. The results of both studies on equities are consistent with the expectation that trading activity is inversely related to trading costs. Their model specification, however, is incomplete, because trading volume is assumed to be a function of transaction costs and/or price per share only. Similarly, George and Longstaff (1993) find a negative relationship between transaction rates and bid–ask spreads for the S&P 100 index options market, and provide the estimates of transaction rates with respect to bid–ask spreads in a structural equation model. Likewise, they do not examine the relationship between trading volume and transaction costs in their model. Martell and Wolf (1987) identify the major determinants of trading volume in the metal futures markets with the use of daily and monthly data. They conclude that trading volume is not only a function of volatility, but also of open interest, interest rates, exchange rates, and other variables. Unfortunately, they do not include any measure of transaction costs as an explanatory variable in the model. Hence, the extant literature does not

[2]Collins and Fabozzi (1991) also consider the opportunity costs, which are defined as the difference between the performance of an actual investment and the performance of a desired investment, adjusted for fixed costs and execution costs. Simply put, it is the cost of not transacting, that is, when a desired trade fails to be executed. Because it is difficult to know what the result would have been had the trade been executed as desired, it is unobservable.

provide any reliable estimates of the sensitivity (elasticity) of trading volume with respect to transaction costs in futures markets within a general model framework, albeit transaction costs do represent significant frictions in a continuous market [Karpoff (1986)].

This study examines the relations between trading volume and transaction costs in seven financial, agricultural, and metal futures. Specifically, the elasticity of trading volume is estimated with respect to the bid–ask spread, a major variable component of the transaction costs, in a two-equation structural model. By estimating the elasticities in a simultaneous-equation system, we explicitly formalize the relationship between trading volume and bid–ask spreads is jointly determined.

Our empirical tests confirm that trading volume and bid–ask spreads are jointly determined. Evidence indicates that there is a positive relationship between trading volume and intraday price volatility, and an inverse relationship between trading volume and bid–ask spreads, after controlling for other factors. New and reliable estimates of the elasticities of trading volume with respect to bid–ask spreads in the futures markets are presented. The methodology, with a few adjustments, can be used by researchers, policy makers and futures exchanges to assess both the impact and potential revenue of a transaction tax.

The rest of the article is organized as follows: Section II presents the specification of the empirical model. The data and empirical results are presented in Sections III and IV, respectively. Section V illustrates an application of estimated elasticities to estimating transaction fee revenue.

EMPIRICAL MODEL SPECIFICATION

With Martell and Wolf (1987) and the body of theory concerning bid–ask spreads as a basis, a two-equation model to explain the joint determinants of trading volume and bid–ask spreads in the futures markets is suggested:

Trading volume $= f$[changes in the reservation prices of speculators, change in the expected physical position of hedgers, transaction costs (including bid–ask spreads and other fixed fees), lagged open interest, institutional factors] (1)

Bid-ask spreads $= f$[price risk, trading volume, number of market makers in the pit, average price of futures] (2)

In eq. (1), changes in the reservation prices of interday and intraday speculators is the main motivation for their trading. The intraday price volatility, measured by the price range (i.e., high price minus low price), is used as a proxy for the changes in the reservation price. This is because speculators adjust their reservation price by observing intraday price volatility. The intraday price volatility is expected to be positively related to the trading volume. This is because trading volume and price volatility at fixed time intervals are both positive functions of a third variable: the arrival of information shocks.[3]

Changes in expected physical position is another major determinant of trading volume. Changes in expected physical position are usually due to a change in the information set available to hedgers. However, because factors affecting the information set vary with the nature of the commodity, it is impossible to incorporate all the relevant information variables in a single model.[4] Thus, lagged open interest and the 3-month Treasury bill rates are adopted in this study as surrogates for information variables affecting changes in the expected physical position of hedgers. Lagged open interest is the total number of outstanding contracts in the futures market lagged one period. High open interest indicates more trades will occur in the future. It is therefore expected to have a positive impact on trading volume. The 3-month T-bill rate is a variable reflecting the opportunity cost of holding inventory. In general, high interest rates increase the cost of carry in the cash or spot assets/commodities, thus reducing the hedging needs in the futures markets. This suggests that an increase in the short-term interest rates will raise the opportunity cost of holding inventory and reduce speculative trade by making alternative investments more attractive, and thus lower trading volume. The 3-month T-bill rate is expected to have a negative impact on trading volume.

Transaction cost is inversely related to trading volume. When transaction cost is high, market makers have less opportunity to make profitable trades. Furthermore, market participants will search for alternative trading vehicles with lower transaction costs. All of these will lead to a decrease in trading volume. The bid–ask spread is the variable component of transaction costs, because every other component is stable over the period of this study. Hence, trading volume is expected to be negatively related to the magnitude of the bid–ask spread.

Two sets of dummy variables are used to capture the institutional factors affecting the behavior of trading volume. The first set of dummy variables (*Dis*) is used mainly for controlling the nonconstant variance in trading volume due to contract maturity effects. However, there is no a priori expectation on the signs of these coefficients because the dummy

[3]Further discussion on theory explaining the positive relationship between volume and price volatility is contained in Tauchen and Pitts (1983), Karpoff (1988), and others.
[4]See Martell and Wolf (1987).

coefficients reflect the maturity effect after accounting for all other explanatory variables in the equation. To capture the effects of changes in nonexchange member fees (retail customers only) over the sample period, a second set of dummy variables (*Dnfis*) is specified.[5] It is expected that a negative sign will result for the coefficient of the dummy variable representing a 4-cent increase in the nonexchange-member fee from July 1, 1991 to December 31, 1993. The coefficient of the dummy variable is expected to be positive for the period from January 1, 1994 to the end of sample period, when the nonexchange-member fee decreased from 20 to 16 cents. In general, an increase in trading costs is expected to result in lower trading volume.

The major determinants of daily bid–ask spreads are described in eq. (2).[6] The spread is measured by the mean of daily realized bid–ask spreads with the use of intraday time and sales data (transaction data). The methodology of computing the realized spread is the same as the CFTC's, as used in other studies [e.g., Wang, Michalski, Moriarty, and Jordan (1990)]. The realized bid–ask spreads are estimated as follows: (i) an empirical joint price distribution of ΔP_t and ΔP_{t-1} during a daily interval is created, (ii) the subset of price changes that exhibit price continuity (i.e., a positive change followed by another positive change) is discarded; (iii) absolute values of the price changes that are price reversals are taken; (iv) the mean of absolute values obtained in step (iii) is computed.[7] Intraday price volatility, used as a proxy for price risk in eq. (2), is expected to have a positive impact on the bid–ask spread because transaction price changes imply two types of risk for market makers. First, market makers may bear nonsystematic risk due to underdiversification in the assets they hold. Second, large price changes may be correlated with the presence of information traders, and dealers must increase spreads to compensate for expected losses when trading opposite informed traders.

A negative relationship is expected between the bid–ask spread and trading volume in eq. (2). As trading volume (a measure of market liquidity) increases, there is more opportunity for market makers to offset

[5]Further discussion on non-exchange-member fees can be found in Baptiste (1993a, 1993b).

[6]Current theory attributes the spread to three cost components: (a) order-processing [Demsetz (1968), Tinic (1972)]; (b) inventory [Stoll (1978), Amihud and Mendelson (1980, (1982), and Ho and Stoll (1981)], and (c) adverse information (Bagehot (1971), Copeland and Galai (1988), and others]. Competition would affect the size of the spread inversely. The inventory component should be an increasing function of price volatility and trade size. The adverse information component should also be positively correlated with price volatility and trade size.

[7]For a further discussion of alternative estimators of the bid–ask spread for intraday futures prices, see Bhattacharya (1983), Thompson and Waller (1988), Wang et al. (1990), and Ma, Peterson, and Sears (1992).

the undesirable positions of their inventories and hence reduce their price risk. Thus, bid–ask spreads will decrease.

Previous studies [Ho and Stoll (1983); Chan, Chung, and Johnson (1995)] suggest that the degree of competition in market making affects the intraday behavior of bid–ask spreads. In this study, the proxy for competition among market makers is the number of market makers trading in the pit during the day. It is expected to be negatively related to the size of the spreads. A large number of market makers will tend to keep the spreads at a minimum as they compete for trades. However, the number of market makers in the trading pits is highly correlated with trading volume, and consequently, it is dropped from the estimation of the bid–ask spreads equation.

Daily average price is employed to control the effect of different measurement scales for different price levels of contracts with different maturities.

The one-period lagged bid–ask spread variable is incorporated in the bid–ask-spread equation. This variable is used to capture the dynamic effect of the changes in bid–ask spreads. The coefficient is expected to be positive if the dynamic effect is geometrically declining.

The empirical model is written as follows:

$$\begin{aligned} \mathrm{TV}_{it} &= \beta_{10} + \overset{(-)}{\beta_{12}}\mathrm{BAS}_{it} + \overset{(+)}{\beta_{13}}\mathrm{IV}_{it} + \overset{(+)}{\beta_{14}}\mathrm{OI}_{it-1} \\ &\quad + \overset{(-)}{\beta_{15}}3\mathrm{TB}_{it} + Dis + Dnfis + e_{1it} \end{aligned} \tag{3}$$

$$\begin{aligned} \mathrm{BAS}_{it} &= \alpha_{20} + \overset{(-)}{\alpha_{22}}\mathrm{TV}_{it} + \overset{(+)}{\alpha_{23}}\mathrm{IV}_{it} + \overset{(+)}{\alpha_{24}}\mathrm{AVP}_{it} + \overset{(+)}{\alpha_{25}}\mathrm{BAS}_{it-1} \\ &\quad + \mathrm{Dis} + e_{2it} \end{aligned} \tag{4}$$

where

TV_{it} = trading volume of the i th contract on the tth day.

BAS_{it} = mean of daily realized bid–ask spreads of the ith contract on the tth day.

IV_{it} = intraday price volatility of the ith contract on the tth day.

OI_{it-1} = open interest of the ith contract on the tth day lagged one period.

$3\mathrm{TB}_{it}$ = daily 3-month T-bill rate.

AVP_{it} = the average price of the ith contract on the tth day.

BAS_{it-1} = BAS_{it} lagged one day.

Dis = dummy variables to reflect differences in contract months for a futures commodity, i = 1, 2. For example, D1 = 1 for observations belonging to first deferred contract at time t, and zero otherwise.

*Dnf*2 = a dummy variable to capture the effect of an increase in non-exchange-member fee (retail customers only) from 20 cents to 24 cents from July 1, 1991 and January 1, 1994. *Df*2 = 1 for t between July 1, 1991 and January 1, 1994 and equal to zero otherwise.

*Dnf*3 = a dummy variable to capture the effect of a reduction of the National Futures Association (NFA) fee from 20 to 16 cents since January 1, 1994. *Dnf*3 = 1 for t greater than January 1, 1994 and equal to zero otherwise.

e_{1it} and e_{2it} are error terms of eqs. (3) and (4), respectively.

DATA AND METHODOLOGY

The sample for this study is based on the following contracts:

1. Financial Futures	Contract Months
(a) S&P 500 Index futures (CME)	March, June, September, December
(b) Deutsche mark (CME)	January, March, April, June, July, September, October, December
(c) Treasury bond futures (CBT)	March, June, September, December
2. Agricultural Futures	**Contract Months**
(a) Wheat (CBT)	July, September, December, March, May
(b) Soybean (CBT)	September, November, January, March, May, July, August
3. Metal Futures	**Contract Months**
(a) Copper (COMEX)	January, March, May, July, September, October, December
(b) Gold (COMEX)	February, April, June, August, October, December

These futures are selected primarily because they are the most actively traded futures in their own categories, thus minimizing the problem of infrequent trading.

The first contract under each maturity month is the nearby contract, and the other two contracts are deferred contracts. The inclusion of two or three contracts with differing maturities ensures a representative cross-sectional sample of the futures market with maximum variations in the bid–ask spreads. This allows reliable estimation of the relative importance of each explanatory variable in determining the trading volume in different futures markets. Thus, the daily time series of cross-sectional data (i.e., nearby, first, and second deferred contracts) of these futures from the Chicago Board of Trade (CBT) and Chicago Mercantile Exchange (CME), and the Commodity Exchange (COMEX) over the time period from January 2, 1990 to April 29, 1994, form the sample for estimating the parameters of the models.

The time and sales intraday data from the three exchanges are used to estimate the daily mean of realized bid–ask spreads, the intraday price volatility and the average price level. The computerized trade reconstruction (CTR) intraday data from each exchange is used to construct a measure of daily trade volume for the nearby and deferred contracts. Daily open interest for each contract is obtained from the CFTC database for the time period under study.

All variables in eqs. (3) and (4) are transformed into log form. This transformation stabilizes the variance of the error terms and allows the approximation of the error terms toward a symmetric distribution. Furthermore, resulting coefficients can be readily interpreted as the elasticities of trading volume and realized bid–ask spreads with respect to their explanatory variables.

The endogenous variable in eqs. (3) and (4) are trading volume and bid–ask spreads. The explanatory variables are either exogenous or predetermined.[8] The Hausman specification test is used to confirm that the trading volume and bid–ask spreads are in fact jointly determined [Hausman (1978)].[9] Results of the Hausman specification test, reported in Table XIII confirm that trading volume and bid–ask spreads are jointly determined (during the daily interval).[10] Consequently, estimation by

[8]Each equation in the model is either exactly identified or overidentified. This is because the number of predetermined variables excluded from the equation of interest is at least equal to or greater than the number of endogenous variables included, less one [see Johnston (1984, p. 455)].

[9]The basic idea of the Hausman test is to compare the statistical difference between 2SLS and OLS estimates when a simultaneity problem occurs. If there is a serious simultaneous equation problem, then the 2SLS and OLS estimates of the coefficients of explanatory endogenous variable would be quite different. Hausman (1978) provides a statistical test to test for the differences between these two sets of estimates. Table IV presents a comparison of 2SLS and OLS estimates of the coefficient of explanatory endogenous variables in trading-volume equations. Results clearly demonstrate that there are sizable differences between 2SLS and OLS estimates in this situation. The results of the Hausman test presented in table XIII confirm that there is a statistically significant difference at least at the 5% level between 2SLS and OLS estimates. Formal testing for simultaneous equation specification errors was not done in previous studies [e.g., Berkman (1993)] even when a simultaneous system approach was used.

[10]The null hypothesis H_0 is that the bid–ask spread is an exogenous variable in the volume equation; the alternative hypothesis is that it is not. The augmented (expanded) regression approach is used to implement the test. The rejection of H_0 suggests that bid–ask spreads and trading volume should be considered as jointly determined in the estimation of the coefficients of the trading volume equation.

OLS would yield inconsistent estimates, and its application is inappropriate in this situation. Thus, the parameters of each equation are estimated by the two-stage least-square (2SLS) procedure. This estimator will ensure consistent estimates of the parameters of the proposed two-equation structural model.

EMPIRICAL RESULTS

Statistical properties of each log-transformed variable are reported in Table I. Statistics include standard and simple robust estimates of location and scale parameters, 75 and 25 percentile values (*Q*-3 and *Q*-1). These data provide information about the distribution properties of each transformed variable and the relative variations of these data during the sample period.

Trading-Volume Equation

In the trading-volume (TV) equation, the coefficients of the bid–ask spreads (BAS) are negatively related to trading volume and statistically significant at the 1% level, except for wheat futures (see Tables II through VIII). These results suggest that trading volume will decrease as transaction cost increases. A discussion of the implications of differing coefficients of trading volume will be presented in subsection C.

The coefficients of intraday price volatility (IV) are positive and statistically significant at the 1% level for all three categories of futures contracts. This result is consistent with the empirical findings of Cornell (1981), Tauchen and Pitts (1983), Martell and Wolf (1987), Bessembinder and Seguin (1993), and others. In addition, it is consistent with the theory that an increase in price volatility will change the reservation price of speculators and increase the demand for risk transfer by hedgers. Both effects should lead to a higher volume. The elasticities of trading volume with respect to price volatility are less than 1 for financial and agricultural futures examined in this study, but slightly greater than 1 for copper and gold futures.

It was expected that the regression coefficient for the 3-month T-bill rate (3TB) would be negatively related to trading volume. However, the resulting coefficients have mixed signs. The coefficients of the 3-month T-bill rate in S&P 500 index, Deutsche mark futures and wheat futures are positive but not statistically different from zero at the conventional 5% level, while those for the T-bond, soybean, copper, and gold futures are negative and statistically significant at the 5% level.

TABLE I

Summary Statistics of Log Transformed Data Used in the Analysis

Variable	*S&P 500 Index Futures*	*T-Bond Futures*	*Deutsche Mark Futures*	*Wheat Futures*	*Soybean Futures*	*Copper Futures*	*Gold Futures*
1. ln (TV_{it})							
Mean	8.272	9.344	7.974	9.413	10.310	6.552	7.609
Median	9.044	8.958	8.511	9.616	10.383	6.568	7.464
Std. Dev.	2.577	2.639	2.697	1.098	1.200	1.772	2.213
Q3	10.689	12.231	10.542	10.272	11.348	8.199	9.736
Q1	5.971	7.301	5.609	8.714	9.494	5.182	6.006
2. ln (BAS_{it})							
Mean	−1.878	−3.611.	−8.325	−5.776	−5.678	−1.989	−1.255
Median	−2.036	−3.819	−8.479	−5.879	−5.826	−2.186	−1.358
Std. Dev.	0.962	1.008	0.906	0.333	0.383	0.834	0.849
Q3	−1.151	−3.001	−7.6001	−5.731	−5.541	−1.609	−0.789
Q1	−2.770	−4.577	−9.191	−5.946	−5.931	−2.623	−1.952
3. ln(IV_{it})							
Mean	1.322	−0.422	−5.464	−3.119	−2.687	0.014	0.901
Median	1.321	−0.421	−5.449	−3.101	−2.733	0.048	0.916
Std. Dev.	0.453	0.509	0.541	0.456	0.494	0.705	0.727
Q3	1.629	−0.031	−5.116	−2.813	−2.354	0.500	1.411
Q1	1.012	−0.757	−5.809	−3.427	−3.047	−0.431	0.405
4. ln (AVP_{it})							
Mean	5.989	4.615	−0.496	1.187	1.794	4.610	5.903
Median	6.015	4.599	−0.507	1.205	1.779	4.617	5.901
Std. Dev.	0.119	0.081	0.053	0.117	0.069	0.132	0.060
Q3	6.101	4.681	−0.464	1.268	1.827	4.699	5.942
Q1	5.911	4.547	−0.533	1.098	1.746	4.559	5.861
5. ln ($3TB_{it}$)							
Mean	1.490	1.489	1.489	1.489	1.489	1.489	1.489
Median	1.381	1.381	1.381	1.381	1.381	1.368	1.368
Std. Dev.	0.351	0.351	0.353	0.350	0.350	0.353	0.353
Q3	1.787	1.787	1.787	1.787	1.787	1.787	1.792
Q1	1.147	1.147	1.147	1.147	1.147	1.147	1.147
6. ln (OI_{it-1})							
Mean	10.089	10.698	9.512	11.012	11.508	8.452	9.538
Median	10.560	10.435	9.673	11.242	11.735	8.739	9.722
Std. Dev.	1.813	1.487	1.833	0.937	1.052	1.430	1.582
Q3	11.825	12.366	11.121	11.710	12.304	9.762	10.779
Q1	8.432	9.418	8.069	11.654	10.990	7.155	9.021

*Q3 and Q1 denote 75 percentile value and 25 percentile value, respectively.

TABLE II

Empirical Results on Trading Volume and Bic–Ask Spread Equation of S&P 500 Index Futures (CME) from January 2, 1990 to April 29, 1994

Variables	*ln* (TV_{it})	*ln* (BAS_{it})
1. Constant	−2.311	0.016
	(−0.22)	(0.04)
2. ln (TV_{it})	—	−0.259**
		(−25.64)
3. ln (BAS_{it})	−2.025**	—
	(−10.16)	
4. ln (IV_{it})	0.821**	0.304**
	(13.56)	(15.38)
5. ln (AVP_{it})	—	0.01
		(0.00)
6. ln (BAS_{it-i})	—	0.144**
		(6.81)
7. ln ($3TB_t$)	0.129	—
	(0.05)	
8. ln (OI_{it-1})	0.489**	—
	(5.70)	
9. *D*1	0.343**	0.183**
	(3.90)	(5.62)
10. *D*2	0.542**	0.283**
	(3.84)	(5.25)
11. *DNF*2	−0.062	—
	(−0.68)	
12. *DNF*3	−0.014	—
	(−0.13)	
R^2	0.874	0.825

Note: Each equation is estimated by 2SLS and the number of observations is 2358. Variables are defined in Section III. Numbers in parentheses denote *t* statistics.
*Denotes significance at the 5% level.
**Denotes significance at the 1% level.

The coefficients of open interest lagged one period (OI) are positive and statistically significant at the 1% level. The elasticity of trading volume with respect to open interest (lagged one period) varies with the nature of the futures contract. For example, the elasticities of trading volume with respect to lagged open interest are greater than 1 for T-bond futures (1.43), 0.929 for soybean futures, 0.907 for wheat futures, and less than 0.5 for all the other futures studied.

The empirical results of the dummy variables (*Dfn*) designed to measure the impact of the changes in NFA fees on trading volume are mixed. Hence, no conclusive statements can be made based on these results.

TABLE III

Empirical Results on Trading Volume and Bid–Ask Spread Equation of *T*-bond Futures (CBT) from January 2, 1990 to April 29, 1994

Variables	$ln\ (TV_{it})$	$ln\ (BAS_{it})$
1. Constant	35.757* (2.39)	−6.382** (−6.10)
2. $\ln(TV_{it})$	—	−0.019 (−1.31)
3. $\ln(BAS_{it})$	−1.168** (−5.13)	—
4. $\ln(IV_{it})$	0.875** (9.25)	0.326** (8.79)
5. $\ln(AVP_{it})$	—	0.717** (3.26)
6. $\ln(BAS_{it-i})$	—	0.116** (6.31)
7. $\ln(3TB_t)$	−10.017** (−3.00)	—
8. $\ln(OI_{it-1})$	1.437** (41.69)	—
9. $D1$	−0.321** (3.75)	0.055 (0.97)
10. D_2	0.187 (0.80)	0.655** (7.61)
11. $DNF2$	0.310* (2.22)	—
12. $DNF3$	−0.287 (−1.61)	—
R^2	0.754	0.164

Note: Each equation is estimated by 2SLS and the number of observations used in estimation is 2,704. Variables are defined in Section III. Numbers in parentheses denote *t* statistics.
*Denotes significance at the 5% level.
**Denotes significance at 1% level.

Bid–Ask Spread Equation

The coefficient of trading volume (TV) is negative and statistically significant at the 1% level for all three sectors. The associated elasticities are less than −0.312. This implies that a decrease of 10% in trading volume will result in a less than 3.12% increase in the bid–ask spread.

The coefficients of the price risk variable (IV) (measured by price volatility) are positive and significant for all three sectors. This result is expected because an increase in price volatility implies two types of risk for market makers. Market makers may bear nonsystematic risk due to underdiversification in the assets held. Second, because a large price change may imply an increased cost of dealing with information traders, dealers must increase spreads to compensate for losses suffered on trans-

TABLE IV

Empirical Results on Trading Volume and Bid–Ask Spread Equation of Deutsche Mark Futures (CME) from January 2, 1990 to April 29, 1994

Variables	$ln\ (TV_{it})$	$ln\ (BAS_{it})$
1. Constant	−33.737*	−3.166**
	(−2.47)	(−18.90)
2. ln (TV_{it})	—	−0.248**
		(−23.54)
3. ln (BAS_{it})	−2.717**	—
	(−20.84)	
4. ln (IV_{it})	0.991**	0.307**
	(20.54)	(18.98)
5. ln (AVP_{it})	—	0.006
		(0.04)
6. ln (BAS_{it-i})	—	0.185**
		(8.42)
7. ln ($3TB_t$)	5.002	—
	(1.68)	
8. ln (OI_{it-1})	0.176**	—
	(2.89)	
9. *D1*	0.061	0.067**
	(0.62)	(2.06)
10. *D2*	−0.114	0.046
	(−0.70)	(0.85)
11. *DNF2*	0.036	—
	(0.34)	
12. *DNF3*	−0.171	—
	(−1.30)	
R^2	0.853	0.822

Each equation is estimated by 2SLS and the number of observations used in estimation is 2,383. Variables are defined in Section III. Numbers in parentheses denote *t* statistics.
*Denotes significance at the 5%.
**Denotes significance at the 1% level.

actions opposite informed traders. In terms of magnitude, the elasticity of price risk is highest for metal commodity futures [copper (0.478), gold (0.377)], followed by financial futures [T-bond futures (0.326), Deutsche marks (0.306), and S&P 500 (0.304)], and agricultural futures [wheat (0.262), and soybean futures (0.204)].

Daily average price (AVP) is employed to control the effect of different price levels of contracts with differing maturities. All the coefficients of daily average price are significantly positive, except in the case of agricultural futures, where they are statistically insignificant.

The coefficients of lagged bid–ask spreads are all positive and significant at the 1% level. This suggests that the dynamic adjustment of the

TABLE V

Empirical Results on Trading Volume and Bid–Ask Spread Equation of Wheat Futures (CBT) from January 2, 1990 to April 29, 1994

Variables	$ln\ (TV_{it})$	$ln\ (BAS_{it})$
1. Constant	−4.363	−2.379**
	(−0.93)	(21.21)
2. ln (TV_{it})	—	−0.176**
		(−26.28)
3. ln (Bas_{it})	−0.116	—
	(−0.56)	
4. ln (IV_{it})	0.607**	0.262**
	(14.49)	(21.46)
5. ln (AVP_{it})	—	0.151**
		(3.60)
6. ln (BAS_{it-i})	—	0.179**
		(9.91)
7. ln ($3TB_t$)	1.155	—
	(1.14)	
8. ln (OI_{it-1})	0.907**	—
	(19.49)	
9. *D*1	−0.144**	0.066**
	(−6.21)	(5.56)
10. *D*2	−0.527**	−0.134**
	(−22.04)	(−10.73)
11. *DNF*2	−0.059	—
	(−1.39)	
12. *DNF*3	−0.059	—
	(−1.17)	
R^2	0.81	0.40

Note: Each equation is estimated by 2SLS and the number of observations used in estimation is 3,210. Variables are defined in Section III. Numbers in parentheses denote t statistics.
*Denotes significance at the 5% level.
**Denotes significance at the 1% level.

bid–ask spread is usually not completed in a 1-day period for the futures studied.

The reasonably high R-squares for trading volume equations indicate that the model adequately explains the behavior of trading volume for the period studied. Furthermore, the R-squares for the bid–ask equation are always lower than the those for the corresponding trading volume equation. This is expected because the coefficients of variation in bid–ask spreads are uniformly lower than the coefficient of variation of their corresponding trading volume variable, such as in the case of the T-bond future, where the variation of bid–ask spread is very small compared to that of the trading volume.

TABLE VI

Empirical Results on Trading Volume and Bid–Ask Spread Equation of Soybean Futures (CBT) from January 2, 1990 to April 29, 1994

Variables	*ln* (TV_{it})	*ln* (BAS_{it})
1. Constant	−19.854**	−1.810**
	(4.08)	(−11.97)
2. ln (TV_{it})	—	−0.104**
		(−19.21)
3. ln (BAS_{it})	−0.165**	—
	(−2.69)	
4. ln (IV_{it})	0.470**	0.204**
	(19.13)	(20.59)
5. ln (AVP_{it})	—	0.392**
		(5.78)
6. ln (BAS_{it-i})	—	0.506**
		(33.41)
7. ln $(3TB_t)$	−4.274**	—
	(−3.97)	
8. ln (OI_{it-1})	0.929**	—
	(56.01)	
9. *D*1	−0.427**	−0.090**
	(−18.48)	(−8.21)
10. *D*2	−1.090**	0.131**
	(−50.71)	(−11.15)
11. *DNF*2	0.105*	—
	(2.51)	
12. *DNF*3	0.107*	—
	(2.08)	
R^2	0.84	0.622

Note: Each equation is estimated by 2SLS, and the number of observations used in estimation is 3,045. Variables are defined in Section III. Numbers in parentheses denote are *t* statistics.
*Denotes significance at the 5% level.
**Denotes significance at the 1% level.

The Elasticity of Trading Volume with Respect to Transaction Cost

The elasticities of trading volume with respect to transaction costs are reported in Table IX. For S&P 500 index futures and Deutsche mark futures, the point elasticities are −2.03 and −2.72, respectively, whereas the elasticity is for T-bond futures is −1.17. This suggests that the trading volume of S&P 500 will decrease 2.03% in response to a 1% increase in transaction costs. For copper and gold futures, the point elasticities are −2.29 and −2.69, respectively. Both are statistically significant at the 1% level. For soybean futures, the point elasticity is 0.165 and is statistically significant from zero at the 1% level. The point elasticity for wheat futures is −0.116, but is statistically insignificant from zero. These

TABLE VII

Empirical Results on Trading Volume and Bid–Ask Spread Equation of Copper Futures (COMEX) from January 2, 1990 to April 29, 1994

Variables	$ln\ (TV_{it})$	$ln\ (BAS_{it})$
1. Constant	35.08** (2.96)	0.376 (−0.81)
2. ln (TV_{it})	—	−0.312** (−29.11)
3. ln(BAS_{it})	−2.29** (−11.36)	—
4. ln (IV_{it})	1.05** (14.55)	0.478** (21.69)
5. ln (AVP_{it})	—	0.133 (1.37)
6. ln (BAS_{it-i})	—	0.090** (5.07)
7. ln ($3TB_t$)	−7.70** (−2.9)	—
8. ln (OI_{it-1})	0.289** (3.88)	—
9. *D*1	−0.219** (−2.78)	0.016 (−0.57)
10. *D*2	−0.367** (−4.43)	0.051 (−1.77)
11. *DNF*2	−0.362** (−2.87)	—
12. *DNF*3	−0.225 (−1.37)	—
R^2	0.55	0.41

Note: Each equation is estimated by 2SLS and the number of observations used in estimation is 3,203. Variables are defined in Section III. Numbers in parentheses denote *t* statistics.
*Denotes significance at the 5% level.
**Denotes significance at the 1% level.

results suggest that the trading volumes of agricultural futures are very inelastic during the sample period, which is consistent with the assertion of the National Futures Association (May, 1993).

These findings also support the notion that the magnitude of elasticity depends on the availability of close substitutes in the form of overseas futures contracts. Thus, it makes sense that the elasticities of trading volume of the financial and metal futures are higher than those of the agricultural futures.

Given these results, the elasticity estimates used by the Congressional Budget Office (CBO, 1992)—for example, the −0.26 estimate of Epps (1976), who used stock market data—seriously underestimate current futures market elasticities. Hence, the CBO study overestimates po-

TABLE VIII

Empirical Results on Trading Volume and Bid–Ask Spread Equation of Gold Futures (COMEX) from January 2, 1990 to April 29, 1994

Variables	*ln* (TV_{it})	*ln* (BAS_{it})
1. Constant	41.51*	−6.508**
	(2.50)	(−5.03)
2. ln (TV_{it})	—	−0.221**
		(−27.46)
3. ln (BAS_{it})	−2.644**	—
	(−15.84)	
4. ln (IV_{it})	1.263**	0.377
	(17.84)	(19.42)
5. ln (AVP_{it})	—	1.148**
		(5.21)
6. ln (BAS_{it-i})	—	0.145**
		(8.14)
7. ln $(3TB_t)$	−9.102*	—
	(−2.48)	
8. ln (OI_{it-1})	0.370**	—
	(7.09)	
9. *D*1	−0.238**	0.032
	(−2.98)	(−1.18)
10. *D*2	−0.553**	0.020
	(−5.19)	(−1.73)
11. *DNF*2	−0.276*	—
	(−1.91)	
12. *DNF*3	−0.200	—
	(−1.06)	
R^2	0.58	0.44

Note: Each equation is estimated by 2SLS and the number of observations used in estimation is 2,916. Variables are defined in Section III. Numbers in parentheses denote t statistics.
*Denotes significance at the 5% level.
**Denotes significance at the 1% level.

tential revenue from user's fee. On the other hand, Edward's (1992) assumed elasticity of less than −5.0 in his simulation of the impact of a user's fee on S&P 500 index futures is not supported by the findings. It appears that he has overestimated the magnitude of elasticity, and thus underestimated the potential tax revenue.

ESTIMATION OF TRANSACTION FEE REVENUE

Any increase in the cost of undertaking futures transactions will cause participants to reevaluate the benefits associated with that instrument. Depending on the magnitude of the added expense, a customer may elect

TABLE IX

Elasticities of Trading Volume with Respect to Transaction Costs in Commodity Futures Markets

Commodity Classes	*Point Estimates*[a]	*Interval Estimates*[b]
1. Financial futures		
T-bond futures	−1.169 (0.23)	(−1.62, −0.72)
S&P 500 Index futures	−2.03 (0.20)	(−2.42, −1.64)
Deutsche mark futures	−2.72 (0.13)	(−2.97, −2.47)
2. Agricultural futures		
Wheat futures	−0.116 (0.20)	(−0.51, 0.27)
Soybean futures	−0.165 (0.06)	(−0.29, −0.05)
3. Mineral futures		
Copper futures	−2.29 (0.20)	(−2.68, −1.90)
Gold Futures	−2.64 (0.17)	(−2.96, −2.32)

[a]Numbers in parentheses denote corresponding standard error.
[b]Denotes a 95% confidence interval.

to use other hedging strategies. Thus, overall volume may decline and adversely impact a futures exchange. This study's simultaneous equation model of trading volume provides reliable elasticity estimates to calculate the probable revenue impact of imposing, for example, a $0.14 transaction fee. Previous studies have failed to empirically account for the size of a decline in trading activity, which can result from an increase in the fixed cost associated with the execution of a futures transaction. The following section illustrates how to use the elasticity estimates to assess the impact on trading volume and potential revenue of a transaction tax.

The fixed cost components for executing a futures transaction are gathered from three representative U.S. exchanges. At each exchange, management imposes fees to cover anticipated costs for providing the facility and environment to trade futures and options contracts. All fees are identified which are imposed by the exchange on a nonmember futures transaction. In certain cases, an exchange may have a wholly owned clearing corporation and elect not to impose a direct charge with each transaction. Additionally, the National Futures Association (NFA) fee is identified. Table X lists these nonvarying costs associated with each futures transaction. Thus, one is able to calculate the total minimum costs

TABLE X

Transaction Costs in Selected Futures Markets

Contract	*Exchange*	*Minimum Tick*	*Exchange Fee*[a]	*NFA*[b] *Fee*[a]	*Clearing Fee*[a]	*Brokerage Fee*[a]	*Total Fixed Transaction Cost*
Wheat	CBT	$12.50	$0.50	$0.12	$0.050	$1.00	$14.17
Soybean	CBT	$12.50	$0.50	$0.12	$0.050	$1.00	$14.17
T bond	CBT	$31.25	$0.12	$0.12	$0.050	$1.00	$32.54
D mark	CME	$12.50	$0.70	$0.12	$0.000	$1.00	$14.32
S&P 500	CME	$25.00	$0.70	$0.12	$0.000	$1.50	$27.32
Copper	COMEX	$12.50	$0.40	$0.12	$0.330	$1.00	$14.35
Gold	COMEX	$10.00	$0.33	$0.12	$0.330	$1.00	$11.78

[a]Per side. These are fees charged to a non-exchnage member.
[b]National Futures Association.

TABLE XI

Estimates of Post-Tax Trading Volume in Selected Futures Markets

Contract	*Exchange*	*Total Volume Jan.–Dec. 1993*	*Transaction Tax as a % of Total Fixed Transaction Cost*	*Current Elasticity*	*Change in Volume*	*Post-Tax Volume*
Wheat	CBT	3,019,629	0.99%	−0.116	(3,468)	3,016,161
Soybean	CBT	11,649,333	0.99%	−0.165	(19,029)	11,630,304
T-bond	CBT	79,428,474	0.43%	−1.169	(399,263)	79,029,211
D-mark	CME	12,866,415	0.98%	−2.720	(342,967)	12,523,448
S&P 500	CME	13,204,413	0.51%	−2.030	(136,705)	13,203,046
Copper	COMEX	2,064,629	0.98%	−2.290	(46,334)	2,018,295
Gold	COMEX	8,916,195	1.19%	−2,640	(280,111)	8,636,084

of a futures transaction.[11] Opportunity costs are not included nor are firm-specific allocations of overhead.

Table XI lists the percentage increase in transaction cost due to the imposition of a 14-cent tax (see column 4 of Table XI). The percentage increase in transaction cost (column 4) is multiplied by the elasticity corresponding to each contract (column 5 of Table XI). This enables one to gauge the volume impact of additional expenses associated with the execution of a futures transaction. This is presented in Table XI, column 6. Hence, one is able to estimate the post-transaction tax volume for each futures contract.

The current elasticity impacted volume is compared with that obtained by simply imposing an across-the-board 14-cent fee, without any adjustment for a decline in trading volume (due to the transaction tax), which can result in overestimating the transaction tax revenue. This is identified in Table XII as the *naive method*. Total estimated revenue estimated by the naive method is measurably higher than this study's elasticity method. Finally, the prior revenue estimates derived from the assumptions of elasticity equal to -0.26 are examined.[12] As expected, this study's elasticity method estimate provides a more realistic calculation of expected tax revenue.[13] In summary, this study suggests that:

1. The impact of a transaction tax on transaction costs and trading volume varies with different types of futures contracts.

[11]The estimated total fixed transaction cost reported in Table X (column 8) might be lower than actual transaction cost because the realized bid–ask spread is often greater then the minimum tick size.

[12]Congressional Budget Office study (1992) used the elasticity of -0.26.

[13]If the transaction fee is not imposed on all types of futures transactions, for example, the transactions of market markers, then the total revenue based on adjusted total volume would be seriously overestimated.

TABLE XII

Estimates of Post-Tax Total Revenue in Selected Futures Markets

Contract	*Exchange*	*Naive Method*[a]	*Current Elasticity Method*	*% Change Relative to the Naive Method*
Wheat	CBT	$422,748	$422,263	−0.12%
Soybean	CBT	$1,630,907	$1,628,243	−0.16%
T-Bond	CBT	$11,119,986	$11,064,90	−0.50%
D-Mark	CME	$1,801,298	$1,753,283	−2.67%
S&P 500	CME	$1,848,618	$1,848,426	−1.04%
Copper	COMEX	$289,048	$282,561	−2.23%
Gold	COMEX	$1,248,267	$1,170,832	−3.12%
Contract	*Exchange*	*Naive Method*[a]	*Previous Study Elasticity Method*	*% Change Relative to the Naive Method*
Wheat	CBT	$422,748	$421,660	−0.26%
Soybean	CBT	$1,630,907	$1,626,709	−0.26%
T-Bond	CBT	$11,119,986	$11,107,554	−0.11%
D-Mark	CME	$1,801,298	$1,796,708	−0.26%
S&P 500	CME	$1,848,618	$1,846,167	0.13%
Copper	COMEX	$289,048	$288,315	−0.25%
Gold	COMEX	$1,248,267	$1,244,438	−0.31%

[a]Total volume × tax rate (14 cents).

2. The transaction tax revenue estimated by previous studies with assumed elasticities is either over- or underestimated (See subsection C of Section 4)

CONCLUSION

In this study, the relationship between trading volume and bid–ask spreads in seven selected futures markets are examined in a two-equation structural model with the use of a two-stage least-squares estimation procedure. The seven futures markets include financial, agricultural, and metal futures. Empirical results confirm that trading volume and bid–ask spreads are jointly determined. Results also indicate that trading volume has a positive relationship with intraday price volatility and a negative relationship with bid–ask spreads, after controlling for other factors. In addition, new and reliable estimates of the elasticity of trading volume with respect to bid–ask spreads in the selected futures markets are presented. This article illustrates how to use elasticity estimates to determine their impact on trading volume and potential revenue of a transaction tax.

TABLE XIII

The Empirical Results of Hausman's Specification Test [Augmented (expanded) Regression Approach][a]

Commodity Classes	*Coefficient of $\hat{V}$ in Trading Volume Equation (3)*
1. S&P 500 index futures	0.49
	(3.28)
2. T-bond futures	0.57
	(3.88)
3. Deutsche mark futures	0.82
	(6.24)
4. Wheat futures	1.44
	(8.09)
5. Soybean futures	0.46
	(8.76)
6. Copper futures	0.64
	(4.90)
7. Gold futures	1.15
	(10.51)

Note: Numbers parentheses denote *t* statistics, all of which are significant at least at the 1% level.
[a]The variable $\hat{V}$ denotes the residuals from the regression of bid–ask spreads on the set of predetermined variables in the two equation models. Then the trading volume equation (3) is estimated after adding $\hat{V}$ by OLS, and testing the hypothesis that $\hat{V} = 0$ with the use of the *t* test.

TABLE XIV

A Comparison of the Estimated Coefficients of Explanatory Endogenous Variable, the Bid–Ask Spread, in the Trading Volume Equation by the 2SLS and OLS Procedures

Contracts	*2SLS Estimates*[a]	*OLS Estimates*[a]
1. S&P 500 index futures	−2.025	−0.427
(CME)	(−10.16)	(−12.80)
2. T-bond futures	−1.168	−0.006
(CBT)	(−5.13)	(−0.31)
3. Deutsche mark futures	−2.717	−0.895
(CME)	(−20.84)	(−23.99)
4. Wheat futures	−0.116	−0.065
(CBT)	(−0.56)	(−2.30)
5. Soybean futures	−0.165	−0.139
(CBT)	(−2.69)	(−5.89)
6. Copper futures	−2.29	−0.249
(COMEX)	(−11.36)	(−12.16)
7. Gold futures	−2.644	−0.422
(COMEX)	(−15.84)	(−14.90)

[a]Numbers in parentheses denote the corresponding standard errors.

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