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TRANSACTION TAX AND MARKET QUALITY OF U.S. FUTURES EXCHANGES: AN EX-ANTE ANALYSIS

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In this paper, we analyze the impact of a transaction tax on the market quality of U.S. futures markets by estimating the elasticity of trading volume and of price volatility with respect to bid-ask spread in a three-equation model framework for 11 financial, agricultural, metals, and energy futures for the period 2005–2010. We find that (1) Trading volume has a negative relationship with bid-ask spread and a positive relationship with price volatility after controlling for other factors; (2) bid-ask spread has a negative relationship with trading volume and a positive relationship with price volatility; and (3) price volatility has a positive relationship with bid-ask spread and with trading volume after controlling for other variables. We demonstrate that a transaction tax, which is analogous to a bigger bid-ask spread, will drastically reduce trading volume if the tax constitutes a significant increase in the total fixed trading cost, and/or the elasticity of trading volume with respect to transaction cost is high enough. Thus, a transaction tax may not raise substantial revenue for the government as suggested in other studies.

In reaction to the recent financial crisis and government budget deficit, there has been considerable interest in imposing taxes on financial transactions, including futures trading.[1] Legislative proposals on financial transaction taxes are not new to the United States as they have been sent to Congress for consideration from time to time for the purpose of either raising revenue for financing government

1. In the wake of the 2007–2008 global financial crisis, Korea urged the G-20 countries to consider an international levy on bank transactions at the G-20 meeting in 2010, while the IMF had presented its own bank-tax proposal at the same meeting (*The Wall Street Journal*, June 4, 2010, A14). The European Commission had also considered various financial transaction taxes, and a detailed plan of a financial transaction tax would be ready for approval by November 2011 (Zweig 2011).

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budget deficit or for funding regulatory agencies, such as the CFTC and/or SEC. For example, during the 1990 budget negotiation, the Bush administration proposed a broad-based 0.5% tax on transactions in stocks, bonds, and derivatives. In 1993 the Clinton administration proposed a fixed 14 cent tax on transactions in futures and options on futures. Recently, the Obama administration has proposed a user fee in the 2012 federal budget on all futures trading to fund the CFTC.[2] This has rekindled the debate on the potential costs and benefits of a financial transaction tax in the United States, and their potential impact on the futures markets.

In general, proponents of financial transaction taxes (FTTs)[3] argue that it would increase government revenue and curb excessive market volatility by reducing noise trading, a significant source of price fluctuations. Opponents of FTTs argue that transaction tax does not necessarily reduce excessive price volatility. Instead, it would adversely affect market liquidity in terms of wider bid-ask spread and lower trading volume, and increase the cost of hedging and cost of capital. The lack of or reduction in market liquidity might drive some or all securities trading to overseas markets not burdened by taxation, a major concern for the U.S. financial services industry, particularly the futures industry. Previous studies, theoretical and empirical, seem not to be able to offer a definitive conclusion about the desirability of such a tax. Most studies recognize that different assumptions used in theoretical models would lead to different conclusions. Thus, before one can make an informed judgment on the desirability of a transaction tax on U.S. futures, one should be able to estimate ex ante the potential impact of a transaction tax on the market quality (i.e., trading volume, bid-ask spread, and price volatility) of U.S. futures markets and on its contribution to government revenue.

The purpose of this paper is threefold. First, we apply a three-equation structural model to empirically estimate the relations among trading volume, bid-ask spread, and price volatility. Based on the empirical modeling, we are able to evaluate the relations among trading volume, bid-ask spread and price volatility for different types of futures, including financial, agricultural, metals, and energy. These relationships are important for understanding the impact of changes in transaction cost (via bid-ask spread) on trading volume and price volatility and their interaction and feedback dynamics. Second, we provide updated reliable elasticity estimates of trading volume with respect to trading costs, which are the major inputs for estimating realistic post-tax trading volume and tax revenue. Unlike previous studies, elasticity estimates are based on the more recent period (2005–2010) that covers episodes of volatile market conditions during the 2007–2008 financial crisis and the electronic trading regime.[4] This update is important because significant changes in

2. Twenty-eight members of the U.S. House of Representatives had co-sponsored a legislation that would impose a transaction tax on regulated futures transactions. The proposed tax is 0.02% of the notional amount of each futures transaction to be charged on each party of the transaction, projecting a forecast revenue of hundreds of billions of dollars per year (Cronin 2010; Noll 2010).

3. Financial transaction taxes (FTTs) can be classified into (1) securities transaction tax (STT); (2) currency transaction tax (CTT or Tobin tax); (3) capital levy or registration tax; (4) bank transaction tax (BTT); and (5) real estate transaction tax (Matheson 2011).

4. Transaction data for all 11 futures, except one, are from the electronic trading platform.

trading technology, market structure, and globalization of futures exchanges have taken place since the 1990s. Third, we provide estimates of the potential revenue that can be collected from a transaction tax in the selected U.S. futures markets using the more reliable estimates of elasticity of trading volume from our model.

The rest of the paper is organized as follows. Section I presents a literature review. Section II describes the data and variable measurement. Empirical models and the methodology for model estimation are presented in Section III. Empirical results are presented in Section IV. Section V applies the estimated elasticities of demand for futures trading to estimate the potential tax revenue under alternative tax rates. Section VI concludes the paper.

I. LITERATURE REVIEW

The extant literature has extensive theoretical treatises on the pros and cons of a financial transaction tax as well as empirical evidence and analyses of issues relating to a financial transaction tax.[5] We will briefly review the literature on the debate and analysis on the major issues related to the imposition of a transaction tax on financial markets: (1) theoretical studies on the pros and cons of imposing a transaction tax; (2) empirical studies on the verification of theoretical arguments for and against a financial transaction tax; (3) the impact of a transaction tax on the migration of trading and relative competitiveness of the futures industry; and (4) the estimation of the amount of potential tax revenue that can be raised from futures trading.

A. Theoretical Studies

First, on the impact of a transaction tax on market quality in terms of curbing excessive market volatility, one can make reference to the arguments originally put forward by Keynes (1936), and elaborated by Tobin (1978), Stiglitz (1989), and Summers and Summers (1989). Keynes (1936) argues that a transaction tax that makes speculative trading less profitable could reduce excess market volatility and stabilize the financial markets because he believes short-term speculative trading is the source of excess volatility. Friedman (1953), however, argues that speculation cannot in general be destabilizing since, if it were, the participants involved would lose money. Moreover, advocates of the Efficient Market Hypothesis argue that speculators, by rationally arbitraging the unexploited profit opportunities when market becomes inefficient, help clear markets, stabilize prices, and bring the assets and securities back to their fundamental values (Fama 1965). However, Tobin (1978) argues that a transaction tax that lowers excess volatility will promote a price formation mechanism more strongly focused on long-term fundamentals because corporate managers will focus more on long-term strategies, instead of implementing myopic policies to fulfill the wishes of short-term investors. He argues that markets

5. For example, see reviews in Schwert and Seguin (1993); Pollin, Baker, and Schaberg (2003); McCulloch and Pacillo (2010); Matheson (2011); and others.

are "fundamental valuation efficient" if prices reflect fundamental valuation without excess volatility. Stiglitz (1989) and Summers and Summers (1989) argue that a securities transactions tax could raise the efficiency of financial markets by crowding out market participants that behave irrationally or waste too many resources for this speculative zero-sum game. Summers and Summers (1989) further believe that the efficiency benefits derived from curbing speculation are likely to outweigh any costs of reduced liquidity or increased costs of capital that come from a financial transaction tax. In contrast, opponents argue that the benefits of transaction tax are likely to be outweighed by its potential costs, because it would increase the cost of capital and securities' values (e.g., Amihud and Mendelson 1993, 2003), and reduce market liquidity (i.e., decrease in trading volume and increase in bid-ask spreads).

Some advocates point out that, if differentiated across trading vehicles, the transaction tax could boost stability by creating incentives for financial market participants to move over-the-counter transactions to transparent and well regulated venues (Färm and Ludvigsson 2011).

Formal theoretical models have been developed to help demonstrate the impact of a transaction tax in a more complete equilibrium setting. For example, Kupiec (1996) demonstrates that, although a transaction tax can discourage noise traders from trading and thus reducing short-term destabilizing trading volume and price volatility, it will also depress asset prices to the extent that this drop in equilibrium prices results in higher return volatility. Since the initial decrease in price volatility will be overwhelmed by the unambiguous increase in return volatility due to the tax, a transaction tax may not reduce but actually increase the volatility of asset returns in a simple general equilibrium model. The implication is that we cannot simply separate and interpret the impact of a transaction tax on each of the relevant variables in a partial equilibrium setting.[6] Likewise, in a general equilibrium model, Song and Zhang (2005) show that a transaction tax may discourage not only the destabilizing trading activities of noise traders but also those of the rational and stabilizing value investors. The net effect of a transaction tax on volatility depends on the change of trader composition from the implementation of the tax. Furthermore, a transaction tax may decrease trading volume and increase bid-ask spread. Thus, short-term price volatility may increase due to the larger price impact of a given trade, while the net impact of a transaction tax on market price volatility could be decreasing or increasing. The final result depends on the relative magnitude and interaction of the change in trader composition and liquidity.

Pellizzari and Westerhoff (2009) show the effectiveness of transaction taxes depends on the types of trading markets where market liquidity is determined either endogenously or exogenously. They show that in a continuous double auction market, the imposition of a transaction tax is not likely to reduce market volatility, whereas in a dealership market, a transaction tax may reduce market volatility. Lo, Mamaysky,

6. This lends support to our empirical modeling in this paper that market quality variables (trading volume, bid-ask spread, and price volatility) must be taken into consideration together simultaneously in the estimation procedure.

and Wang (2004), using a dynamic theoretical model of asset prices and trading volume, show that even small fixed trading costs will generate relatively large premium in asset prices and reduce trading volume significantly.

In addition to traditional models that assume agent rationality in the model and rational expectations about future events, other theoretical models also incorporate characteristics that are observed in the real financial markets, such as excess liquidity, excess price volatility, fat-tailed distribution of returns, volatility clustering, incomplete information, and not fully rational agents.[7]

In sum, extant theoretical models suggest mixed effects of a transaction tax on price volatility and trading volume. Impacts of transaction taxes on price volatility and trading volume depend very much on the assumptions of the theoretical model and the assumed channels through which the effect of a transaction tax passes.

B. Empirical Studies

Theoretical models reviewed above include models that are purely theoretical and models that incorporate some stylized facts observed in the real markets. The review of the extant literature on theory demonstrates that different conclusions and implications can be obtained from different models depending on the assumptions used. Thus, theoretical models cannot resolve the debate about the appropriateness of a transaction tax. We now proceed to review the empirical evidence related to the impact of transaction tax on trading cost, trading volume and price volatility in different countries.

Mulherin (1990) examines the relationship between trading costs in the NYSE and the daily volatility of the DJIA returns from 1897 to 1987, and concludes that the imposition of a transaction tax may not necessarily reduce volatility. Despite evidence of increased volatility after the introduction of a 1% transaction tax in 1986, Umlauf (1993) does not find a systematic relationship between transaction taxes and price volatility across tax regimes in Sweden. Likewise, Jones and Seguin (1997) find that volatility fell in the year after the abolishment of the minimum commission rates in NYSE and AMEX markets, but the decline in volatility was also observed in the NASDAQ market. Roll (1989) uses the cross-section data of 23 countries for the period 1987–1989 to examine whether there are systematic differences in price volatility that can be explained by margin requirements, transaction taxes, and price limits. He does not find evidence that volatility is negatively related to transaction taxes. Hu (1998) examines the effect of 14 transaction tax changes that occurred in Hong Kong, Japan, Korea, and Taiwan during the period 1975 to 1994, and finds that on average an increase in tax rate has no effect on market volatility. Chou and Wang (2006) find no significant changes in the daily price volatility of the Taiwan index futures after the tax reduction. In contrast, Liu and Zhu (2009) find evidence that reduction in transaction costs significantly increase price volatility in the Japanese equity market.

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7. For a review of the literature on alternative theoretical models, see Wang and Yau (2012).

Other studies document that there is a positive relationship between price volatility and transaction costs in equity markets. Bessembinder (2000) documents that larger tick sizes are associated with higher transaction costs and also with higher volatility, while Hau (2006) finds similar evidence in the French equity market. Bessembinder and Rath (2002) find that stocks that had moved from NASDAQ to NYSE where trading costs were lower experienced a reduction in volatility. Baltigi, Li, and Li (2006) find that an increase in transaction tax leads to greater price volatility in the Chinese stock markets.

There is limited empirical evidence on the impact of a transaction tax on the U.S. futures markets. Wang and Yau (2000) propose a three-equation structural model to estimate the elasticity of trading volume with respect to bid-ask spread and price volatility in the U.S. futures markets. They find a negative relationship between bid-ask spread and trading volume, and a positive relationship between bid-ask spread and price volatility. Inferring that a transaction tax would have the same effect as a bid-ask spread, they conclude that such a tax will reduce trading volume but may not reduce price volatility.[8] Aliber, Chowdhry, and Yan (2003) study the impact of a small transaction cost on the trading volume and price volatility of four currency futures traded on CME for the period 1977–1999. They find that an increase of 0.02% in the transaction cost leads to an increase of volatility by 0.5% points on these currency futures, coupled with a decline in asset prices due to the decline in demand because of higher transaction costs.

C. Migration of Trading and Relative Competitiveness

Previous literature on transaction tax also sheds light on the potential adverse effects of a financial transaction tax on the international competitiveness of the U.S. financial services industry. While Summers and Summers (1989) did not believe a transaction tax would cripple the U.S. equities trading in the United States back then in 1989, they admitted that for derivatives and commodities trading a transaction tax could have damaging impacts on the industry as evidenced in the demise of the Sweden Options and Futures Exchange due to an options transaction tax. Edwards (1992) believes even a very small transaction tax would be sufficient to drive all U.S. futures trading to overseas untaxed markets.[9] Umlauf (1993) and Campbell and Froot (1994) document evidence of a significant migration in trading volume from the actively traded Swedish stocks to London after the Swedish transaction tax was increased from 1% to 2% in May 1986. Chou and Wang (2006) document evidence that migration of significant trading volume of Taiwan stock index futures

8. Sahoo and Kumar (2011) applied the three-equation structural model proposed by Wang and Yau (2000) to examine the relations among trading volume, bid ask spread, and price volatility for five actively traded futures in India. They obtained similar empirical results as Wang and Yau (2000) did for the U.S. futures that there is a negative relationship between bid-ask spread and trading volume, and a positive relationship between bid-ask spread and price volatility.

9. Countries have indicated their concern for a transaction tax that is not global, and are aware that relative competitiveness may be changed by the burden of a non-global transaction tax. See *The Wall Street Journal* (June 4, 2010, A14) and Zweig (2011), in which he discusses the proposal on a global transaction tax on flash trading.

contracts from the Singapore Exchange (SGX) to TAIFEX occurred after the tax cut from 5 to 2.5 basis points on May 1, 2000.

D. Potential Tax Revenue

Proponents of a transaction tax suggest that the revenue potential of a transaction tax is formidable. Congressional Budget Office (CBO) estimates the revenue from a broadly based 0.5% securities transaction tax to be about $12 billion per year based on a five-year average. Based on the same tax rate used by the CBO, Summers and Summers (1989) suggest a similar figure (at least $10 billion a year). Pollin, Baker, and Schaberg (2003) suggest that revenue from a securities transaction tax could be as large as $70–$100 billion per year.[10] Outside the United States, Roll (1989) estimates that a securities transaction tax in Japan would bring in $12 billion a year. The European Commission in a June 2011 budget proposal expects a financial transaction tax to contribute €50 billion per year to the European budget, or €350 billion over a seven-year period (Uppal 2011).

Edwards (1992) doubts that a transaction tax on futures transactions will potentially generate significant tax revenue. He argues that the elasticity of trading volume in futures markets is much more elastic than that of equities because close substitutes are easily available in international futures markets with the advent in trading and information technologies.[11] In other words, competition from international futures exchanges is keen. Thus, he believes the potential revenue from a transaction tax estimated by the CBO was overstated because the elasticity of demand (-0.26) used in the estimate was based on U.S. equities assuming no good substitutes. Edwards (1992) argues that given a more elastic trading volume in futures, a transaction tax of the magnitude of 0.5% would probably eliminate all futures trading in the United States and drive all futures transactions overseas. In such a case, no revenue would be collected. According to his conservative estimate, not much revenue (only $287 million) could be raised from futures trading even if the lowest tax rate (0.0001%) and a low demand elasticity (-0.26) were assumed.[12] He concludes that a transaction tax on futures trading will not generate substantial revenue.

Chou and Wang (2006) find that the reduction in the transaction tax in the Taiwan index futures market did reduce tax revenue, and the proportional decrease in the tax revenue was less than the 50% reduction in the tax rate. Further, tax revenue increased in the second and third year after the tax reduction as compared

10. The estimate was based on 1997 levels of market activity for stocks, bonds, and swaps, and the March 1999 level of market activity for futures and options.

11. Wang, Yau, and Baptiste (1997) provide the first empirical estimates of the elasticity of trading volume for several U.S. futures contracts. They documented that estimates of the elasticity of trading volume with respect to trading costs were in the range of −0.116 to −2.72, which were less than those elasticities (−5 to −20) used by Edwards (1992), but higher than the elasticity of −0.26 used in CBO (1990).

12. −0.26 was the elasticity used in CBO (1990). Edwards (1992) also used elasticities ranging from −1 to −20 in estimating the potential tax revenue.

to the year before the tax reduction. This suggests that tax reduction has no permanent negative impact on tax revenue.

The contributions of our paper to futures market literature are as follows:

(1) We estimate the parameters of bid-ask spread, trading volume, and price volatility structural equations for 11 futures contracts with recent daily and intraday data from 2005 to 2010. This update is important because the futures trading face huge market volatility during this sample period and the environment and international competitions among futures exchanges in the past decades are significantly different than those in the 1990s. Thus, our results provide new empirical evidence to validate the pros and cons of the imposition of transaction tax on U.S. futures markets.

(2) We provide new estimates of the elasticity of trading volume with respect to trading cost for 11 futures contracts. These estimates are the required input to estimate potential tax revenue based on different proposed transaction tax rate schedules.

II. DATA AND VARIABLE MEASUREMENT

Data for this study include the following 11 futures contracts:

Futures	Trading Platform	Time periods
1. Financial Futures		
(a) S&P 500 (CME)	Pit floor	Jan 2005- Dec 2010
(b) E-mini S&P500 (CME)	Electronic	Jan 2005- Dec 2010
(c) 30-Year T-bond (CBOT)	Electronic	Jan 2005- Dec 2010
(d) 10-Year T-Note (CBOT)	Electronic	Jan 2009- Dec 2010
(e) British Pound (CME)	Electronic	Jan 2008- Dec 2010
2. Agricultural Futures		
(a) Wheat (CBOT)	Electronic	Jan 2007- Dec 2010
(b) Soybean (CBOT)	Electronic	Jan 2007- Dec 2010
3. Metals Futures		
(a) Copper (COMEX)	Electronic	Jan 2008- Dec 2010
(b) Gold (COMEX)	Electronic	Jan 2008- Dec 2010
4. Energy Futures		
(a) Crude Oil (NYMEX)	Electronic	Jan 2008- Dec 2010
(b) Heating Oil (NYMEX)	Electronic	Jan 2008- Dec 2010

These futures are chosen because they cover several categories, including financial, agricultural, metals, and energy futures. They are actively traded futures in their own categories, hence mitigating the problem of infrequent trading. Furthermore, since the majority of futures contracts are now executed on the electronic platform, futures trading on the electronic platform are selected to mitigate the potential problems arising from insufficient liquidity.

We use the first position contract of each month as the nearby contract, and the next contract following the nearby contract the first deferred contract.[13] The inclusion of two contracts with differing maturities ensures a representative cross-sectional sample of the futures market with maximum variations in the bid-ask spread and price volatility, which allow reliable estimation of the relative importance of each explanatory variable in determining the trading volume in different futures markets.

The time and sales intraday data from the Institute for Financial Markets are used to estimate the daily mean of the effective bid-ask spreads, intraday price volatility, average daily price level, and trading volume for contracts traded on the electronic platform. The trading volume of the S&P 500 index futures and open interest of all contracts are obtained from Bloomberg for the time period under study.

We use the price reversal methodology to calculate the daily effective bid-ask spread (see Wang, Yau, and Baptiste 1997). The effective bid-ask spread is estimated as follows: (1) an empirical joint price distribution of ΔP_t and ΔP_{t-1} during a daily interval is created; (2) the subset of price changes that exhibit price continuity (i.e., a positive (negative) change followed by another positive (negative) change) is discarded; (3) the absolute values of price changes that are price reversals are taken; (4) the mean of absolute values obtained in the step (3) is computed as the average daily effective bid-ask spread.

Two daily unconditional volatility measures are derived from the intraday time and sales data and used in this study. Based on Anderson et al. (2001), our first daily realized volatility is defined as:

$$\hat{\sigma} = \sqrt{\sum_{t=1}^{n} r_t^2}\, x100 \tag{1}$$

where n is the number of intraday five-minute returns, and $r_t = (\ln(P_t) - \ln(P_{t-1}))$ is the five-minute intraday return at each five-minute interval. The second volatility estimator is the high-low estimator proposed by Parkinson (1980), which is defined as:

$$\hat{\sigma} = (\sqrt{\frac{(1\text{n}(H_t - \ln(L_t))^2}{4\ln(2)}})x100 \tag{2}$$

where H_t and L_t are the daily high and low prices, respectively.[14]

13. During the delivery month period, we use trading volume as an indicator of contract rollover to determine the timing of contract roll-over that takes place when the current open position in the nearby contract is being rolled over to the next contract with a new expiration. For example, when the trading volume of the first deferred futures is greater than that of the current nearby futures, we make the first deferred contract to become the nearby contract and the second deferred contract the first deferred contract for the next contract month period.

14. For further discussion on estimating the daily volatility from intraday data, see Bollen and Inder (2002).

III. EMPIRICAL MODELS AND ESTIMATION METHODOLOGY

To estimate the potential impact of a transaction tax on market quality (i.e., in terms of liquidity as measured by the magnitude of trading volume, bid-ask spread, and price volatility and their subsequent changes after the tax) of a futures market,

$$TV_{it} = \beta_{10} + \beta_{11} BAS_{it} + \beta_{12} IV_{it} + \beta_{13} 3TB_{it} + \beta_{14} OI_{it-1} + \beta_{15} TV_{it-1} + D_1 + e_{1it} \quad (3)$$

$$BAS_{it} = \alpha_{20} + \alpha_{21} TV_{it} + \alpha_{22} IV_{it} + \alpha_{23} MP_{it} + \alpha_{24} BAS_{it-1} + D_1 + e_{2it} \quad (4)$$

$$IV_{it} = \delta_{30} + \delta_{31} TV_{it} + \delta_{32} BAS_{it} + \delta_{33} OI_{it-1} + \sum_{j=1}^{k} \delta_{3j} IV_{it-j} + D_1 + e_{3it} \quad (5)$$

we use a three-equation structural model framework.[15] The empirical model is specified as follows:

Equation (3) is the trading volume equation, where TV_{it} is the trading volume of the futures contract at i^{th} maturity time on the t^{th} day. Trading volume is specified as a function of the effective bid-ask spread (BAS_{it}), price volatility (IV_{it}), three-month T-bill ($3TB_{it}$), one-period lagged open interest (OI_{it-1}) and one-period lagged trading volume ($TV_{i\,t-1}$).

BAS_{it} is the mean of intraday effective bid-ask spreads of a futures contract at i^{th} maturity time on the t^{th} day. Bid-ask spread is a major component of the transaction cost. Higher transaction costs would decrease the opportunity for market participants, leading them to search for alternative trading vehicles with lower transaction costs. Hence, trading volume is expected to be negatively related to the size of the bid-ask spread.

IV_{it} is the intraday price volatility of a futures market on the t^{th} day. Based on the mixture distributions hypothesis, price volatility is expected to be positively related to trading volume.[16] The three-month T-bill ($3TB_{it}$) is used as a surrogate for the information variable that affects changes in the expected physical position of hedgers. A change in the expected physical position is another determinant of trading volume. The three-month T-bill rate is expected to be inversely related to trading volume, reflecting the opportunity cost of holding inventory.

OI_{it-1} represents the one-period lagged open interest of the i^{th} futures contract. Open interest is the total number of outstanding, unsettled contracts. It is expected to have a positive impact on trading volume because higher open interest will generate

15. The three-equation structural model of trading volume, bid-ask spread, and price volatility was first proposed and used by Wang and Yau (2000).

16. The mixture distributions hypothesis (e.g., Clark 1973 and Tauchen and Pitts 1983) is a theoretical model that explains the positive relation between trading volume and price volatility induced by a third latent variable, that is, new information arrivals.

greater trading volume when market participants close out their unsettled positions.

Equation (4) is the bid-ask spread equation, where bid-ask spread is a function of the price risk (measured by price volatility, IV_{it}), trading volume (TV_{it}), daily mean price (MP_{it}), and one-period lagged bid-ask spread (BAS_{it-1}). These variables are included here because they were found to be significant in previous studies (e.g., Wang and Yau 2000).

Trading volume is a simple measure of market liquidity. As trading volume increases, we expect that there is greater opportunity for market participants to offset the undesirable position of their inventories, which reduces their price risk. This in turn makes market participants lower their bid-ask spreads. Accordingly, we expect a negative relationship between the bid-ask spread and trading volume in equation (4).

Transaction price changes (i.e., the price risk) imply two types of risk for market makers. First, market makers may bear nonsystematic risk due to the under-diversification in assets they hold. Second, large price changes may correlate with the presence of information traders, and market makers must increase the bid-ask spread to compensate for the expected trading losses against informed traders. Hence, intraday price volatility, a proxy for the price risk in equation (4), is expected to have a positive relationship with bid-ask spreads. The daily average price (MP_{it}) of the futures contracts is used to control for the effect of differing measurement scale on the same futures with different price levels due to different expiration dates (the nearby and first deferred contracts).

Equation (5) is the price volatility equation. We specify the intraday price volatility (IV_{it}) as a function of trading volume (TV_{it}), bid-ask spread (BAS_{it}), one-period lagged trading volume (TV_{it-1}) and several lagged price volatility ($IV_{i,t-j}$) j = 1,…, 6. The greater the trading volume is, the greater the possibility that prices fluctuate, thus creating greater price volatility. In addition, the change in volume may be due to information arrivals, which will increase volatility according to the mixture distributions hypothesis. Another source of intraday price volatility is due to bounces in the bid-ask spread. Market makers demand wider bid-ask spreads when they trade with informed traders or when they take the opposite position of a large trade (i.e., they demand a larger liquidity premium facing such trades). Thus, greater transaction price movements may also be attributed to large variations in the bid-ask spread.

At this juncture, a note on the one-period lagged explanatory variables in equations (3) through (5) is warranted. These one-period lagged explanatory variables are specified as partial adjustments to our model to take account of the distributed lag effect in the dependent variables. In addition, for the price volatility equation, a few more lag terms of price volatility are included in the equation to take into account of the persistence effect of price volatility.

In all three equations, we use a dummy variable as a fixed model effect in pooling the nearby and first deferred contracts. The dummy variable, D1, is equal to one for observations for the first deferred contract and zero otherwise. Finally, e_{1it} , e_{2it} , and e_{3it} are the error terms of equations (3), (4), and (5), respectively.

We proceed with our empirical estimation in three steps. First, all variables in equations (3) through (5) are transformed into natural log, enabling us to stabilize the variance of the error terms toward a symmetric distribution. In addition, estimated coefficients from the equations can be readily interpreted as the elasticity of trading volume, effective bid-ask spread, and price volatility with respect to their explanatory variables.

Second, the augmented Dickey-Fuller (ADF) test (Fuller 1996) is applied to each time series to test for a unit root in the time series sample. Results from the ADF test will provide guidance as to whether the model should be estimated in the level or first-difference form. Table 1 presents results of the ADF tests on the log transformed variables. Results indicate that trading volume, bid-ask spread, price volatility, and open interest are free of the unit root problem, whereas three-month T-bill and the daily mean futures price have a unit root.[17] After taking the first difference, three-month T-bill and the daily mean futures price are reduced to stationary time series. Based on these results, the three-equation model is estimated in level form for all variables, except for three-month T-bill and the daily mean futures prices where first differences are used.

Third, the generalized method of moments (GMM) procedure (Hansen 1982) with the optimal weighted matrix proposed by Newey and West (1987) is used to estimate the parameters of the three-equation model.

IV. EMPIRICAL RESULTS

Tables 2 through 12 present the empirical results of the trading volume, bid-ask spread, and price volatility equations for the selected futures. Table 13 reports the point and interval estimates of the elasticity of trading volume with respect to transaction cost for these futures.

A. Trading Volume Equation

In the trading volume equation, the coefficients of bid-ask spread (ln(BAS)) are negatively related to trading volume and are statistically significant at the 1% level for all eleven futures. These negative coefficients can be interpreted as estimates of the elasticity of trading volume (TV) with respect to BAS for the futures contracts examined in this paper (4th row and 2nd column, Tables 2 through 12).

Table 13 reports the point and 95% interval estimates of the elasticity of trading volume with respect to transaction cost (bid-ask spread) in the second and third column respectively for the futures contracts studied. The point elasticity ranges from –2.6 (E-mini S&P 500 index futures) to –0.81 (Heating Oil). In other words, trading volume and transaction cost (bid-ask spread) are negatively related for all

17. We also applied Maddala and Wu’s (1999) simple unit root test to our panel data. The results are qualitatively the same as those of the separate unit root tests for the nearby and first deferred samples. To save space, we do not report these results here.

futures contracts in this study. For example, the elasticity of –2.6 for the E-mini S&P500 index futures indicates that trading volume for this futures will decrease 2.6% for each 1% increase in the bid-ask spread. The lower-end of the corresponding interval estimates with a 95% confidence level are all greater than one, except for 30-year T-bond (–0.972) and Heating Oil (–0.923). These results suggest that the elasticity of trading volume with respect to transaction cost (such as the bid-ask spread) had been very high during the period 2005–2010 for most futures examined. The important implication is that an increase in the bid-ask spread due to, say, a new transaction tax on futures trading, could substantially reduce trading volume and decrease liquidity for the U.S. futures exchanges.

The coefficients of price volatility (ln(IV)) in the trading volume equation are all positive and statistically significant at the 1% level for all 11 futures (Tables 2–12). This result is as expected as theory suggests that an increase in price volatility changes the reservation price of speculators and increase the demand for risk transfer by hedgers. Both effects should lead to a higher trading volume (Martell and Wolf 1987). This empirical result is also consistent with those of previous studies, such as Tauchen and Pitts (1983), Wang, Yau, and Baptiste (1997), and Wang and Yau (2000).

In general, higher short-term interest rate increases the cost of carry in the cash or spot assets or commodities, reduces hedging needs in the futures market, and reduces speculative trading by making alternative investments more attractive. Thus, a reduction in speculative and hedging activities in the futures markets would lower trading volume. Thus, it is expected that there is a negative relationship between trading volume and short term risk-free rate (measured by the three-month T-bill). However, the coefficients of three-month T-bill in the trading volume equations are mixed for the 11 futures. For example, the coefficient of three-month T-bill in the E-mini S&P 500's (Copper's) trading volume equation is negative (positive) and significant at the 10% level. The coefficients of three-month T-bill in the trading volume equation for other futures in the sample are either negative or positive, but none of them are significant at the 10% level.

The coefficients of open interest lagged one period (OI_{t-1}) in the trading volume equation of Crude Oil, and all five financial futures are positive and significant at least at the 5% level, whereas the coefficients for Soybean and Gold futures are also positive but not significant. The coefficients of lagged open interest for Wheat, Copper, and Heating Oil futures are negative, although only the coefficient for Copper futures is significant at the 1% level. It is generally agreed that higher open interest indicates more trades are likely in the future.

All coefficients of one period lagged trading volume ($\ln(TV_{t-1})$) are significantly positive at the 1% level. They range from 0.72 for the 30-Year T-bond futures to 0.37 for Gold futures. Significance in the coefficients of lagged trading volume for all 11 futures in our sample lends strong support to our partial adjustment model specification, affirming persistence in trading volume.

Thus far, two interesting empirical results are noteworthy. First, the elasticities of trading volume with respect to transaction cost (proxied by the bid-ask spread)

Table 1. Empirical Results of Augmented Dickey-Fuller (ADF) Tests on the Stationary of Time Series Data.

Contract	Ln (TV_i)	Ln(IV_i)	Ln(BAS_i)	Ln (OI_i)	Ln ($3TB_i$)	Ln (MP_i)
S&P500 futures						
Nearby	-8.88**	-4.20**	-2.92	-8.62**	-0.74	-1.39
First deferred	-9.10**	-3.80**	-9.97*	-19.38**	-1.21	-1.29
E-mini S&P 500						
Nearby	- 3.81**	-4.36**	-4.66**	-4.99**	-0.39	-1.35
First deferred	-10.52**	-4.70**	-10.04**	-9.97**	-0.99	-1.21
30-Year T-bond						
Nearby	-4.99**	-3.24*	-2.93*	-8.98**	-0.83	-2.24
First deferred	-9.42**	-4.07**	-8.76**	-6.99**	-1.37	-2.60
10 -Year T-Note						
Nearby	-4.41**	-3.88**	-22.56**	-6.23**	-2.16	-2.06
First deferred	-7.20**	-7.58**	-7.72**	-6.44**	-1.85	-2.33
British Pound						
Nearby	-5.87**	-3.33*	-2.78	-6.47**	-2.11	-1.74
First deferred	-8.29**	-5.19**	-6.13**	-7.23**	-1.80	-1.59
Wheat						
Nearby	-8.48**	-7.37**	-2.78	-8.66**	-0.87	-1.67
First deferred	-7.01**	-7.68**	-5.15**	-4.98**	-1.11	-1.72

Table 1, continued. Empirical Results of Augmented Dickey-Fuller (ADF) Tests on the Stationary of Time Series Data.

Contract	Ln (TV_i)	Ln(IV_i)	Ln(BAS_i)	Ln (OI_i)	Ln ($3TB_i$)	Ln (MP_i)
S&P500 futures						
Soybean						
Nearby	-4.78**	-3.10*	-3.81**	-9.72**	-1.34	-2.43
First deferred	-7.00**	-3.52**	-6.18**	-5.33**	-0.92	-1.94
Copper						
Nearby	-4.97**	-3.7**	-5.78**	-9.17**	-2.17	-0.57
First deferred	-5.96**	-3.46**	-6.46**	-5.23**	-1.98	-1.23
Gold						
Nearby	-4.03**	-3.43**	-4.03**	-6.66**	-1.92	-0.66
First deferred	-5.65**	-4.16**	-6.10**	-4.75**	-1.69	-1.92
Crude Oil						
Nearby	-6.6**	-2.94*	-2.74	-15.29**	1.87	-1.37
First deferred	-12.0**	-3.45*	-5.92**	-10.96**	-1.74	-1.29
Heating oil						
Nearby	-9.33**	-3.20*	-1.34	-14.25**	-2.08	-1.21
First deferred	-12.56**	-3.31*	-5.45**	-7.00**	-1.83	-1.31

Note: The critical values of the ADF unit root test are -3.425, -2.864, and -2.56 for the 1%, 5%, and 10% level of significance, respectively. ** and * denote significance at the 1% and 5%, respectively.

Table 2. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of S&P 500 Index Futures (Chicago Mercantile Exchange), January 2005 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	-0.27	0.36**	-0.61**
	(-0.32)	(4.14)	(-4.85)
D_1	0.66**	0.64**	-0.20**
	(5.21)	(10.63)	(-6.45)
$\ln(TV_t)$	---	-0.12**	0.04**
	---	(-14.09)	(5.70)
$\ln(BAS_t)$	-0.81**	---	0.27**
	(-6.98)	---	(11.53)
$\ln(IV_t)$	0.52**	0.35**	---
	(7.32)	(16.86)	---
ΔMP_t	---	-1.13	---
	---	(-1.52)	---
$\ln(OI_{t-1})$	0.37**	---	0.05**
	(4.46)	---	(3.76)
$\ln(TV_{t-1})$	0.45**	---	---
	(14.66)	---	---
$\ln(BAS_{t-1})$	---	0.42**	---
	---	(14.56)	---
$\ln(IV_{t-1})$	---	---	0.28**
	---	---	(12.31)
$\ln(IV_{t-2})$	---	---	0.13**
	---	---	(5.62)
$\ln(IV_{t-3})$	---	---	0.10**
	---	---	(4.25)
$\ln(IV_{t-4})$	---	---	0.12**
	---	---	(5.26)
$\ln(IV_{t-5})$	---	---	0.09**
	---	---	(4.13)
$\ln(IV_{t-6})$	---	---	0.06**
	---	---	(2.88)
$\Delta(\ln(3TB_t))$	-0.13	---	---
	(-0.65)	---	---
R^2 Adj	0.78	0.88	0.71
F Stat	1,601.48**	3,773.06**	655.33**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 3. Empirical Results on Trading Volume, Bid-Ask Spread and Price Volatility Equations of E-mini S&P 500 Index Futures (Chicago Mercantile Exchange), January 2005 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	3.21**	0.66**	-0.49**
	(7.75)	(15.94)	(-6.04)
D_1	-0.97**	-0.10**	0.14**
	(-6.45)	(-5.90)	(4.91)
$\ln(TV_t)$	---	-0.11**	0.11**
	---	(-20.96)	(12.41)
$\ln(BAS_t)$	-2.60**	---	0.51**
	(-12.76)	---	(17.01)
$\ln(IV_t)$	0.76**	0.17**	---
	(12.33)	(12.63)	---
ΔMP_t	---	-0.95**	---
	---	(-3.81)	---
$\ln(OI_{t-1})$	0.10**	---	-0.02**
	(3.20)	---	(-2.42)
$\ln(TV_{t-1})$	0.43**	---	---
	(13.71)	---	---
$\ln(BAS_{t-1})$	---	0.32**	---
	---	(9.53)	---
$\ln(IV_{t-1})$	---	---	0.43**
	---	---	(22.62)
$\ln(IV_{t-2})$	---	---	0.15**
	---	---	(7.82)
$\ln(IV_{t-3})$	---	---	0.06**
	---	---	(3.30)
$\ln(IV_{t-4})$	---	---	0.07**
	---	---	(3.80)
$\ln(IV_{t-5})$	---	---	0.09**
	---	---	(4.74)
$\ln(IV_{t-6})$	---	---	0.03*
	---	---	(1.69)
$\Delta(\ln(3TB_t))$	-0.32*	---	---
	(-1.74)	---	---
R^2 Adj	0.96	0.92	0.81
F Stat	11,204.78**	6,368.82**	1,211.31**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 4. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of U.S. Treasury Bond Futures (Chicago Mercantile Exchange), January 2005 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	0.14	-1.03**	0.14*
	(0.61)	(-10.70)	(2.05)
D_1	-0.87**	-0.04	0.09**
	(-6.42)	(-0.84)	(4.32)
$\ln(TV_t)$	---	-0.10**	0.04**
	---	(-11.96)	(7.59)
$\ln(BAS_t)$	-0.87**	---	0.19**
	(-8.31)	---	(9.83)
$\ln(IV_t)$	0.28**	0.15**	---
	(3.77)	(3.90)	---
ΔMP_t	---	-1.60	---
	---	(-1.12)	---
$\ln(OI_{t-1})$	0.03**	---	-0.00
	(2.33)	---	(-0.71)
$\ln(TV_{t-1})$	0.72**	---	---
	(26.79)	---	---
$\ln(BAS_{t-1})$	---	0.36**	---
	---	(7.75)	---
$\ln(IV_{t-1})$	---	---	0.18**
	---	---	(8.42)
$\ln(IV_{t-2})$	---	---	0.12**
	---	---	(5.81)
$\ln(IV_{t-3})$	---	---	0.13**
	---	---	(5.58)
$\ln(IV_{t-4})$	---	---	0.13**
	---	---	(6.07)
$\ln(IV_{t-5})$	---	---	0.17**
	---	---	(8.06)
$\ln(IV_{t-6})$	---	---	0.13**
	---	---	(6.16)
$\Delta(\ln(3TB_t))$	-0.19	---	---
	(-0.86)	---	---
R^2 Adj	0.92	0.68	0.43
F Stat	5,201.18**	1,179.07**	215.02**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t -statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 5. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of 10-Year U.S. Treasury Note Futures (Chicago Board of Trade), January 2009 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	-1.62**	-1.50**	0.24
	(-3.61)	(-9.46)	(1.59)
D_1	-0.64**	-0.08*	0.10**
	(-3.87)	(-2.15)	(2.93)
$\ln(TV_t)$	---	-0.14**	0.05**
	---	(-16.44)	(3.75)
$\ln(BAS_t)$	-1.36**	---	0.30**
	(-6.49)	---	(5.46)
$\ln(IV_t)$	0.49**	0.31**	---
	(3.63)	(6.63)	---
ΔMP_t	---	-3.12	---
	---	(-1.03)	---
$\ln(OI_{t-1})$	0.08**	---	-0.00
	(3.09)	---	(-0.13)
$\ln(TV_{t-1})$	0.66**	---	---
	(14.51)	---	---
$\ln(BAS_{t-1})$	---	0.10*	---
	---	(2.04)	---
$\ln(IV_{t-1})$	---	---	0.10**
	---	---	(2.42)
$\ln(IV_{t-2})$	---	---	0.12**
	---	---	(2.75)
$\ln(IV_{t-3})$	---	---	0.15**
	---	---	(3.50)
$\ln(IV_{t-4})$	---	---	0.09**
	---	---	(2.56)
$\ln(IV_{t-5})$	---	---	0.10**
	---	---	(2.52)
$\ln(IV_{t-6})$	---	---	0.10**
	---	---	(3.41)
$\Delta(\ln(3TB_t))$	-0.16	---	---
	(-1.01)	---	---
R^2 Adj	0.94	0.78	0.29
F Stat	2,773.93**	781.57**	48.70**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 6. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of British Pound Futures (Chicago Mercantile Exchange) from January 2008 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	-5.14**	-4.73**	1.22**
	(-8.82)	(-15.75)	(5.65)
D_1	-0.83**	0.01	0.00
	(-4.18)	(0.22)	(0.04)
$\ln(TV_t)$	---	-0.25**	0.07**
	---	(-20.38)	(3.74)
$\ln(BAS_t)$	-0.97**	---	0.22**
	(-8.44)	---	(6.69)
$\ln(IV_t)$	0.34**	0.35**	---
	(4.44)	(10.76)	---
ΔMP_t	---	-0.14	---
	---	(-0.09)	---
$\ln(OI_{t-1})$	0.27**	---	-0.02
	(6.32)	---	(-1.00)
$\ln(TV_{t-1})$	0.41**	---	---
	(8.94)	---	---
$\ln(BAS_{t-1})$	---	0.14**	---
	---	(3.47)	---
$\ln(IV_{t-1})$	---	---	0.14**
	---	---	(3.71)
$\ln(IV_{t-2})$	---	---	0.08**
	---	---	(2.67)
$\ln(IV_{t-3})$	---	---	0.17**
	---	---	(5.27)
$\ln(IV_{t-4})$	---	---	0.10**
	---	---	(3.75)
$\ln(IV_{t-5})$	---	---	0.11**
	---	---	(3.96)
$\ln(IV_{t-6})$	---	---	0.11**
	---	---	(3.64)
$\Delta(\ln(3TB_t))$	-0.14	---	---
	(-1.21)	---	---
R^2 Adj	0.94	0.86	0.46
F Stat	3,846.58**	1,704.93**	115.36**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 7. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of Wheat Futures (Chicago Board of Trade) from January 2007 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	2.01**	0.29**	-0.85**
	(11.53)	(5.45)	(-8.42)
D_1	-0.25**	-0.01	0.09**
	(-7.70)	(-0.79)	(4.43)
$\ln(TV_t)$	---	-0.08**	0.19**
	---	(-9.82)	(15.03)
$\ln(BAS_t)$	-0.98**	---	0.68**
	(-11.53)	---	(13.96)
$\ln(IV_t)$	0.74**	0.22**	---
	(18.36)	(10.86)	---
ΔMP_t	---	0.21	---
	---	(1.00)	---
$\ln(OI_{t-1})$	-0.00	---	0.00
	(-0.44)	---	(0.03)
$\ln(TV_{t-1})$	0.66**	---	---
	(27.86)	---	---
$\ln(BAS_{t-1})$	---	0.63**	---
	---	(20.97)	---
$\ln(IV_{t-1})$	---	---	0.20**
	---	---	(10.23)
$\ln(IV_{t-2})$	---	---	0.02
	---	---	(1.12)
$\ln(IV_{t-3})$	---	---	0.05**
	---	---	(2.72)
$\ln(IV_{t-4})$	---	---	0.08**
	---	---	(3.82)
$\ln(IV_{t-5})$	---	---	0.01
	---	---	(0.40)
$\ln(IV_{t-6})$	---	---	0.01
	---	---	(0.61)
$\Delta(\ln(3TB_t))$	-0.07	---	---
	(-1.05)	---	---
R^2 Adj	0.89	0.84	0.52
F Stat	2,690.28**	2,039.94**	216.34**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 8. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of Soybean Futures (Chicago Board of Trade), January 2007 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	2.14**	0.43**	-0.83**
	(11.15)	(8.43)	(-9.68)
D_1	-0.12**	-0.01*	0.05**
	(-3.96)	(-1.94)	(2.85)
$\ln(TV_t)$	---	-0.09**	0.19**
	---	(-10.97)	(16.80)
$\ln(BAS_t)$	-1.66**	---	0.86**
	(-11.42)	---	(13.28)
$\ln(IV_t)$	0.77**	0.17**	---
	(13.97)	(9.56)	---
ΔMP_t	---	-0.18	---
	---	(-1.20)	---
$\ln(OI_{t-1})$	0.00	---	-0.01*
	(0.20)	---	(-2.10)
$\ln(TV_{t-1})$	0.60**	---	---
	(20.03)	---	---
$\ln(BAS_{t-1})$	---	0.56**	---
	---	(15.37)	---
$\ln(IV_{t-1})$	---	---	0.18**
	---	---	(7.56)
$\ln(IV_{t-2})$	---	---	0.15**
	---	---	(4.72)
$\ln(IV_{t-3})$	---	---	0.03
	---	---	(1.38)
$\ln(IV_{t-4})$	---	---	0.03
	---	---	(1.13)
$\ln(IV_{t-5})$	---	---	0.07**
	---	---	(2.33)
$\ln(IV_{t-6})$	---	---	0.00
	---	---	(0.16)
$\Delta(\ln(3TB_t))$	-0.07	---	---
	(-0.87)	---	---
R^2 Adj	0.90	0.88	0.58
F Stat	2,883.11**	2,760.88**	270.49**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 9. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of Copper Futures (Commodity Exchange) from January 2008 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	1.92**	0.38**	-0.07
	(8.13)	(8.46)	(-0.88)
D_1	0.21**	0.01	-0.01
	(3.44)	(0.36)	(-0.36)
$\ln(TV_t)$	---	-0.27**	0.08**
	---	(-29.38)	(5.66)
$\ln(BAS_t)$	-1.44**	---	0.26**
	(-13.09)	---	(6.59)
$\ln(IV_t)$	0.43**	0.24**	---
	(6.81)	(8.92)	---
ΔMP_t	---	-0.17	---
	---	(-0.50)	---
$\ln(OI_{t-1})$	-0.10**	---	0.00
	(-4.03)	---	(0.32)
$\ln(TV_{t-1})$	0.45**	---	---
	(11.33)	---	---
$\ln(BAS_{t-1})$	---	0.19**	---
	---	(6.89)	---
$\ln(IV_{t-1})$	---	---	0.15**
	---	---	(4.87)
$\ln(IV_{t-2})$	---	---	0.15**
	---	---	(4.84)
$\ln(IV_{t-3})$	---	---	0.14**
	---	---	(4.11)
$\ln(IV_{t-4})$	---	---	0.21**
	---	---	(7.14)
$\ln(IV_{t-5})$	---	---	0.08**
	---	---	(2.68)
$\ln(IV_{t-6})$	---	---	0.10**
	---	---	(3.54)
$\Delta(\ln(3TB_t))$	0.19*	---	---
	(1.66)	---	---
R^2 Adj	0.89	0.84	0.51
F Stat	1,982.57**	1,576.17**	152.28**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 10. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of Gold Futures (Commodity Exchange) from January 2008 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	2.77**	0.90**	-0.86**
	(13.69)	(12.39)	(-11.37)
D_1	0.06	0.06**	-0.01
	(1.39)	(3.23)	(-0.73)
$\ln(TV_t)$	---	-0.21**	0.19**
	---	(-15.41)	(14.19)
$\ln(BAS_t)$	-2.02**	---	0.63**
	(-16.59)	---	(13.71)
$\ln(IV_t)$	0.93**	0.33**	---
	(18.67)	(14.43)	---
ΔMP_t	---	-0.25	---
	---	(-0.76)	---
$\ln(OI_{t-1})$	0.01	---	-0.00
	(1.56)	---	(-1.20)
$\ln(TV_{t-1})$	0.37**	---	---
	(10.41)	---	---
$\ln(BAS_{t-1})$	---	0.29**	---
	---	(6.32)	---
$\ln(IV_{t-1})$	---	---	0.20**
	---	---	(7.37)
$\ln(IV_{t-2})$	---	---	0.15**
	---	---	(6.54)
$\ln(IV_{t-3})$	---	---	0.06**
	---	---	(2.56)
$\ln(IV_{t-4})$	---	---	0.05**
	---	---	(2.38)
$\ln(IV_{t-5})$	---	---	0.13**
	---	---	(5.63)
$\ln(IV_{t-6})$	---	---	0.04*
	---	---	(2.06)
$\Delta(\ln(3TB_t))$	0.01	---	---
	(0.14)	---	---
R^2 Adj	0.94	0.94	0.68
F Stat	4,070.27**	4,427.94**	310.38**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 11. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of Crude Oil Futures (New York Mercantile Exchange) from January 2008 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	0.69*	-0.24**	0.10
	(1.68)	(-3.85)	(0.57)
D_1	-0.54**	-0.04**	0.18**
	(-10.43)	(-6.13)	(7.26)
$\ln(TV_t)$	---	-0.07**	0.18**
	---	(-11.03)	(13.70)
$\ln(BAS_t)$	-1.00**	---	0.41**
	(-9.65)	---	(10.59)
$\ln(IV_t)$	0.38**	0.08**	---
	(9.39)	(11.40)	---
ΔMP_t	---	0.01	---
	---	(0.07)	---
$\ln(OI_{t-1})$	0.06**	---	-0.03**
	(4.14)	---	(-4.70)
$\ln(TV_{t-1})$	0.50**	---	---
	(18.76)	---	---
$\ln(BAS_{t-1})$	---	0.77**	---
	---	(37.96)	---
$\ln(IV_{t-1})$	---	---	0.24**
	---	---	(8.34)
$\ln(IV_{t-2})$	---	---	0.13**
	---	---	(5.46)
$\ln(IV_{t-3})$	---	---	0.14**
	---	---	(5.84)
$\ln(IV_{t-4})$	---	---	0.12**
	---	---	(4.55)
$\ln(IV_{t-5})$	---	---	0.13**
	---	---	(5.78)
$\ln(IV_{t-6})$	---	---	0.10**
	---	---	(4.17)
$\Delta(\ln(3TB_t))$	0.01	---	---
	(0.21)	---	---
R^2 Adj	0.86	0.89	0.79
F Stat	1,444.42**	2,492.48**	539.30**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 12. Empirical Results on the Trading Volume, Bid-Ask Spread and Price Volatility Equations of Heating Oil Futures (New York Mercantile Exchange) from January 2008 to December 2010.

	$\ln(TV_t)$	$\ln(BAS_t)$	$\ln(IV_t)$
Intercept	-1.35**	-0.95**	0.97**
	(-3.74)	(-7.62)	(5.13)
D_1	-0.20**	-0.04**	0.06**
	(-5.53)	(-3.57)	(3.82)
$\ln(TV_t)$	---	-0.16**	0.17**
	---	(-12.08)	(11.45)
$\ln(BAS_t)$	-0.80**	---	0.31**
	(-13.78)	---	(11.87)
$\ln(IV_t)$	0.48**	0.19**	---
	(12.18)	(11.25)	---
Δ MP_t	---	0.08	---
	---	(0.35)	---
$\ln(OI_{t-1})$	-0.00	---	-0.02
	(-0.24)	---	(-1.48)
$\ln(TV_{t-1})$	0.48**	---	---
	(16.56)	---	---
$\ln(BAS_{t-1})$	---	0.69**	---
	---	(28.02)	---
$\ln(IV_{t-1})$	---	---	0.23**
	---	---	(8.09)
$\ln(IV_{t-2})$	---	---	0.15**
	---	---	(5.98)
$\ln(IV_{t-3})$	---	---	0.11**
	---	---	(4.34)
$\ln(IV_{t-4})$	---	---	0.08**
	---	---	(3.34)
$\ln(IV_{t-5})$	---	---	0.11**
	---	---	(4.31)
$\ln(IV_{t-6})$	---	---	0.11**
	---	---	(4.40)
$\Delta(\ln(3TB_t))$	-0.03	---	---
	(-0.91)	---	---
R^2 Adj	0.76	0.89	0.75
F Stat	755.85**	2,264.19**	439.43**

The table reports the parameter estimates of the trading volume, effective bid-ask spread, and price volatility in the three equation model specified in Section III, equations (3) to (5). All variables are in log form. The definition of each variable is as follows: TV=trading volume; BAS=effective bid-ask spread; IV=realized volatility; OI=open interest. 3TB=Three-month T-bill; D_1=1 if it is the first deferred contract and zero otherwise; and subscript t-j, j=1…6, denotes the number of lagged periods. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 13. Elasticity of Trading Volume with Respect to Transaction Costs in Selected U.S. Futures Markets.

Contract	Point Estimates[1]	Interval Estimates[2]
1. Financial futures		
S&P500	-0.81 (0.12)	(-1.043, -0.577)
E-mini S&P500	-2.60 (0.06)	(-2.723, -2.477)
30-Year T-Bond	-0.87 (0.10)	(-0.972, -0.671)
10-Year T-Note	-1.36 (0.22)	(-1.794, -0.925)
British Pond	-0.97 (0.13)	(-1.214, -0.726)
2. Agricultural futures		
Wheat	-0.98 (0.09)	(-1.171, -0.789)
Soybean	-1.66 (0.15)	(-1.960, -1.360)
3. Metals futures		
Copper	-1.44 (0.10)	(-1.640, -1.240)
Gold	-2.02 (0.13)	(-2.275, -1.765)
4. Energy futures		
Crude Oil	-1.00 (0.11)	(-1.216, -0.784)
Heating Oil	-0.80 (0.06)	(-0.923, -0.677)

Notes: 1. Numbers in parentheses denote standard errors for the corresponding point estimates. 2. Interval estimates are given for a 95% confidence level.

for most of the 11 futures in our sample have become very elastic. This empirical result corroborates the significant progress in the globalization of international futures trading made during the period of 2005–2010, enabling cross-border trading easier. Thus, any regulation that leads to an increase in the futures trading cost would significantly reduce trading volume and weaken the relative competitiveness of the U.S. futures industry. Second, given our results, the elasticity used in the CBO's 1990 report, which is the –0.26 elasticity estimated by Epps (1976) based on U.S. stock data, seriously understates the current elasticities in the futures markets. Hence, the CBO's study overestimates the potential revenue of a transaction tax in futures markets.

B. Bid-Ask Spread Equation

The third column in Tables 2–12 presents the coefficient estimates of the explanatory variables in the bid-ask spread equation. The coefficients of trading volume are negative and statistically significant at the 1% level for all 11 futures. They range from –0.27 (Copper) to –0.07 (Crude Oil). For example, a 10% decrease in the Copper futures' trading volume will result in a 2.7% increase in the bid-ask spread. These results affirm that a decrease in trading volume would increase the bid-ask spread (transaction or trading cost), reducing market liquidity. These results are consistent with those of Wang, Yau, and Baptiste (1997), Wang and Yau (2000), Chou and Wang (2006), and Sahoo and Kumar (2011).

The coefficients of price volatility (IV) are significantly positive for all 11 contracts. This result is expected because an increase in price volatility implies market-makers face inventory risk and risk of trading with informed traders. Therefore, they will increase the bid-ask spread to minimize their potential loss. The magnitude of the elasticity of bid-ask spread with respect to price volatility falls in the range of 0.35 (S&P 500 and British Pound) to 0.07 (Crude Oil).

Changes in daily mean price (ΔMP) are used to control for the measurement scale effect of differing price levels of futures contracts with different maturities. Most of the coefficients for the changes in daily mean price are negative but not significant, except for the E-mini S&P 500 index futures.

The coefficients of one-period lagged bid-ask spread (BAS_{t-1}) are positive and statistically significant for all 11 futures. This indicates that the dynamic adjustment of BAS is not usually complete within a one-day period for these eleven futures.

C. Price Volatility Equation

The fourth column in Tables 2–12 presents the empirical results on the price volatility equation. The coefficients of trading volume (TV) and bid-ask spread (BAS) are significantly positive at the 1% level for all 11 futures. This can be interpreted that trading volume increases because of arrival of new information. Likewise, our finding that a positive relationship exists between BAS and price volatility is also consistent with the theory that bounces in the bid-ask spread have a positive impact on price volatility in the futures literature (e.g., Wang, Yau, and Baptiste 1997; Wang and Yau 2000; Chou and Wang 2006; Sahoo and Kumar 2011). This result is also consistent with Hau's (2006) result that an increase in minimum tick size led to an increase in price volatility in the French equity market.

Since the relations between price volatility and trading volume, and between price volatility and bid-ask spread (proxy for a transaction tax), are both positive, our findings suggest that the impact of a transaction tax on price volatility depends on the net effect of the decreasing trading volume and widening bid-ask spread on price volatility. However, we observe that the coefficient of bid-ask spread is relatively larger than the coefficient of trading volume in the price volatility equation for all the futures we studied. For example, in Table 2, the coefficient of trading volume is 0.04, whereas the coefficient of bid-ask spread is 0.27 for the S&P 500 index futures. Thus, the positive impact of an increase in the bid-ask spread on price volatility will offset the negative impact on price volatility from a declining trading volume, which has a smaller positive coefficient with price volatility than with bid-ask spread. That is, an increase in bid-ask spread due to an increase in transaction tax may not reduce price volatility; it depends on the net effects of an increase in bid-ask spread and a decline in trading volume.

The coefficient of one-period lagged open interest is expected to be negative

Table 14. Estimates of Transaction Costs in Selected U.S. Futures Markets.

(1) Contract	(2) Exchange	(3) Minimum Tick	(4) No-member Clearing[a]	(5) Exchange Fee[a]	(6) NFA[b] Fee[a]	(7) Brokerage Fee	(8) Total Fixed Transaction Cost[c]
S&P500	CME	$12.50	$0.78	$0.00	$0.02	$1.50	$14.80
E-mini S&P500	CME	$12.50	$0.39	$0.75	$0.02	$1.14	$14.80
30-Year T-Bond	CBOT	$31.25	$0.06	$0.50	$0.02	$1.37	$33.20
10-Year T-Note	CBOT	$15.62	$0.06	$0.50	$0.02	$1.37	$17.57
British Pound	CME	$6.25	$0.60	$1.00	$0.02	$0.33	$8.20
Wheat	CBOT	$12.50	$0.06	$1.75	$0.02	$1.68	$16.01
Soybean	CBOT	$12.50	$0.06	$1.75	$0.02	$1.62	$15.95
Copper	COMEX	$10.00	$1.45	$0.00	$0.02	$1.48	$12.95
Gold	COMEX	$12.50	$1.45	$0.00	$0.02	$1.48	$15.45
Crude Oil	NYMEX	$10.00	$1.45	$0.00	$0.02	$1.48	$12.95
Heating Oil	NYMEX	$4.20	$1.45	$0.00	$0.02	$1.48	$7.15

Notes: [a] Per side. These fees charges to a non-exchange member. [b] National Futures Association. [c] Total fixed transaction cost (column (8)) is the sum of columns (3)-(7).

Table 15. Estimates of Post-Tax Trading Volume in Selected U.S. Futures Markets.

(1) Contract	(2) Total Trading Volume (2010)[a]	(3) Average Yearly Price (2010)	(4) Total Fixed Transaction Cost	(5) Current Elasticity[b]
S&P500	7,689,961	$283,981	$14.80	-0.81
E-mini S&P 500	555,328,670	$56,776	$14.80	-2.60
30-Year T-Bond	83,509,754	$124,069	$33.20	-0.87
10-Year T-Note	293,718,907	$121,174	$17.57	-1.36
British Pound	30,220,239	$96,522	$8.20	-0.97
Wheat	23,090,255	$29,512	$16.01	-0.98
Soybean	36,993,960	$52,434	$15.95	-1.66
Copper	10,305,670	$8,572	$12.95	-1.44
Gold	44,730,345	$122,616	$15.45	-2.02
Crude Oil	168,652,141	$79,621	$12.95	-1.00
Heating Oil	26,970,106	$9,033	$7.15	-0.80

because it is used as a measure of the overall liquidity lagged one period. We find that the coefficients of lagged open interest are negative and significant in the price volatility equations for three futures (E-mini S&P500 index, Soybean and Copper), whereas those for the rest of the sample are mixed in sign and statistically insignificant.

The coefficients of six lagged intraday volatility ((TV_{t-j}) j = 1,…, 6) are all significantly positive for all 11 futures. Magnitudes of these coefficients are monotonically declining. These results suggest that price volatility has a persistence effect, and the recent lagged volatility has a larger influence on the current volatility.

Finally, the F-statistics for all equations are significant at the 1% level with high values of R-squared, suggesting that our models adequately explain the daily variations of trading volume, bid-ask spread, and price volatility in all selected futures markets.

V. ESTIMATION OF POTENTIAL TAX REVENUE

One of the major issues being debated on a transaction tax proposal is whether a transaction tax could generate substantial tax revenue. In this section, we estimate the potential tax revenue that could be raised from futures transactions given our estimates of elasticity of trading volume as presented above.

Transaction cost is one of the major factors in determining the profitability in trading in a given financial market. Any increase in the transaction cost of undertaking a futures transaction will cause participants to re-evaluate the benefits associated with that instrument. Depending on the magnitude of a transaction tax relative to

Table 15, continued. Estimates of Post-Tax Trading Volume in Selected U.S. Futures Markets.

Tax Rate: 0.02%			Tax Rate: 0.002%		
(6) Transaction Tax as % of Total Fixed Transaction Cost[c]	(7) Change in Volume[d]	(8) Post-Tax Volume[e]	(9) Transaction Tax as % of Total Fixed Transaction Cost[f]	(10) Change in Volume[g]	(11) Post-Tax Volume[h]
383.76%	-23,903,786	- 100%	38.38%	-2,390,379	5,299,582
76.72%	-1,107,792,715	-100%	7.67%	-110,779,271	444,549,399
74.74%	-53,301,299	29,208,455	7.47%	-5,430,130	78,079,624
137.93%	-550,983,687	-100%	13.79%	-55,098,369	238,620,538
235.42%	-69,010,009	-100%	23.54%	-6,901,001	23,319,238
36.87%	-8,342,529	14,747,726	3.69%	-834,253	22,256,002
65.75%	-40,309,945	-100%	6.58%	-4,030,994	32,902,966
13.24%	-1,964,737	8,340,933	1.32%	-196,474	10,109,196
158.73%	-143,418,044	-100%	15.87%	-14,341,804	30,388,541
122.93%	-26,089,467	-100%	12.29%	-20,727,348	147,924,793
25.27%	-5,451,749	21,518,357	2.53%	-545,175	26,424,931

[a]Total trading volume for each contract in year 2010 is obtained from FIA volume statistics. [b]Coefficients of ln(BAS) on the TV equation from column 2, row 4 of Tables 2-12. [c]Transaction tax as % of total fixed transaction cost (column (6)) = [Average yearly price (column (3)) x 0.02%] / Total fixed transaction (column (4)) [d]Change in trading volume (column (7)) = Post-tax volume (column (8)) - Trading volume (column (2)) [e]Post-tax volume (column (8)) = Total trading volume (column (2)) x (1+[current elasticity (column (5)) x Transaction tax as % of total fixed transaction cost (column (6))]; if <0, column (8) is indicated by - 100% [f]Transaction tax as % of total fixed transaction cost (column (9)) = [Average yearly price (column (3)) x 0.002%] / Total fixed transaction (column (4)) [g]Change in trading volume (column (10)) = Post-tax volume (column (10)) - Trading volume (column (2)) [h]Post-tax volume (column (11)) = Total trading volume (column (2)) x (1+[current elasticity (column (5)) x Transaction tax as % of total fixed transaction cost (column (9))]; if <0, column (11) is indicated by - 100%

the total transaction cost, a customer may elect to use alternative hedging and speculative strategies. Thus, a decline in trading volume induced by a transaction tax could have an adverse impact on the businesses of futures exchanges.

In order to estimate a transaction tax as a percentage of the total fixed transaction cost, we collect various fixed fees for the 11 futures contracts in our samples from associated futures exchanges and on-line brokerage firms for non-clearing members.[18] Table 14 presents the total fixed transaction cost (column 8), which is the sum of two major components: (1) the bid-ask spread approximated by the minimum tick size (column 3); and (2) various transaction fees, including the

18. Exchange and NFA fees for futures are obtained from Ira Epstein Division of Linn Group, Inc. Recent changes in exchange fees are obtained from the website of CME.

Table 16. Estimates of Post-Tax Revenue in Selected U.S. Futures Markets.

			Tax Rate: 0.02%			Tax Rate: 0.002%		
(1) Contract	(2) Average Yearly Price (2010)	(3) Current Elasticity	(4) Naïve Method[a]	(5) Elasticity Adjusted[b]	(6) % Change to the Naïve Method[c]	(7) Naïve Method[a]	(8) Elasticity Adjusted[b]	(9) % Change to the Naïve Method[c]
S&P 500	$283,981	-0.81	$436,760,532	$0.00	-100%	$43,676,053	$30,099,612	-31.08%
E-mini S&P 500	$56,776	-2.60	$6,305,896,991	$0.00	-100%	$630,589,699	$504,797,045	-19.95%
30-Year T-Bond	$124,069	-0.87	$2,072,187,486	$724,770,376	-65.02%	$207,218,749	$193,845,281	-6.45%
10-Year T-Note	$121,174	-1.36	$7,118,223,079	$0.00	-100%	$711,822,308	$578,292,436	-18.76%
British Pound	$96,522	-0.97	$583,383,582	$0.00	-100%	$58,338,358	$45,016,390	-22.84%
Wheat	$29,512	-0.98	$136,289,676	$87,0481,01	-36.13%	$13,628,968	$13,136,552	-3.61%
Soybean	$52,434	-1.66	$387,315,432	$0.00	-100%	$38,731,543	$34,504,359	-10.91%
Copper	$8,572	-1.44	$17,668,989	$14,300,463	-19.06%	$1,766,899	$1,733,214	-1.91%
Gold	$122,616	-2.02	$1,096,935,043	$0.00	-100%	$109,693,504	$74,522,687	-32.06%
Crude Oil	$79,621	-1.00	$2,685,649,749	$0.00	-100%	$268,564,975	$235,496,271	-12.31%
Heating Oil	$9,033	-0.80	$48,725,003	$38,875,710	-20.21%	$4,872,500	$4,774,007	-2.02%

Notes: [a] Estimated potential revenue under this method is computed as: Trading volume 2010 (column 2, Table 15) x Average Yearly Price (2010) (column 2, Table 16) x Tax rate [b] Estimated potential revenue under this method is computed as: Post-tax trading volume (column 8 for 0.02% tax rate, column 11 for 0.002% tax rate, Table 15) x Average Yearly Price (2010) (column 2, Table 16) x Tax rate non-member clearing fee, exchange fee, National Futures Association (NFA) fee, and brokerage fee (columns 4–7, respectively). Table 14 does not include any variable cost associated with each futures transaction, firm-specific overhead fixed costs, or the market impact cost associated with large trades. Thus, the total fixed transaction cost presented in Table 14 is actually the minimum trading cost for a futures transaction.[19] As indicated, trading in the Crude Oil futures costs the most and the British Pound futures the least.

Table l5 presents our estimates of the post-tax trading volume under assumed tax rates of 0.02% and 0.002% for the eleven futures.[20] We first calculate the 0.02% tax on a futures transaction based on the notional value of the futures contract, as approximated by the average yearly price (column 3) in this study. We then express the transaction tax as a percentage of the total fixed transaction cost (column 4) in column 6. Second, we compute the post-tax volume (column 8), that is, the estimated trading volume after a transaction tax is imposed, based on one plus the product of the transaction tax as a percentage of the total fixed cost (column 6), current elasticity (column 5), and total trading volume (column 2). Third, we compute the change in trading volume (column 7), which is equal to the post-tax volume (column 8) minus the total trading volume (2010) (column 2). We compute the same for 0.002% tax rate as well.

Results from Table 15 show that with a transaction tax of 0.02%, trading in seven out of the eleven futures would be totally eliminated from local trading or simply be migrated to overseas exchanges (column 8). These seven futures contracts are (1) S&P 500 index; (2) E-mini S&P 500 index; (3) 10-year T-Note; (4) British Pound; (5) Soybean; (6) Gold; and (7) Crude Oil. This result suggests that the impact of a transaction tax on trading costs and trading volume varies significantly with different types of futures.

Table 16 presents estimates of the potential post-tax revenue (columns 5 and 8 for 0.02% and 0.002% tax rates, respectively) for the 11 futures using the estimated post-tax trading volume (columns 8 and 11, Table 15) based on the estimated elasticity of trading volume from our models. For comparison purposes, we also estimate the post-tax revenue calculated by the naïve method (columns 4 and 7), which simply calculates the tax revenue from multiplying the trading volume (2010, column 2, Table 15) and the notional contract value (average yearly price, 2010, column 2), by the two assumed tax rates. The tax revenue generated by the naïve method (column 4) is often used by proponents of transaction tax as the basis for arguing that transaction tax would generate substantial tax revenue.[21] For the 0.02% tax rate, seven futures (S&P 500, E-mini S&P 500, 10-Year T-Note, British Pound, Soybean,

19. The estimated total fixed transaction cost in Table 14 might be lower than the actual transaction cost because the effective bid-ask spread is often greater than the minimum tick size that we used in Table 14.

20. We used a tax rate of 0.02% of the notional value of each futures contact because the House of Representatives had proposed to impose a 0.02% tax on futures transactions (see Cronin 2010 and Noll 2010).

21. CBO's (1990) study also used an elasticity of −0.26 as the input to calculate the post-tax volume and potential tax revenue.

Gold, and Crude Oil) with zero post-tax volume would therefore generate zero tax revenue (column 5), which is 100% less than the corresponding tax revenue calculated by the naïve method. The other four futures (30-Year T-Bond, Wheat, Copper, and Heating Oil) generate tax revenues that are less than the corresponding estimated tax revenues from the naïve method in the range of –19.06% to –65.02% (column 6).

There are three noteworthy findings. First, the magnitude of the decline in the post-tax volume depends on the relative importance of the transaction tax to the total fixed cost and/or the elasticity of trading volume with respect to transaction costs for each futures. For example, the post-tax trading volume of the S&P 500 index futures is reduced to zero when the transaction tax is 383.76% of the total fixed transaction cost with an elasticity equals to –0.81. In the Soybean case, the elasticity is high (i.e., –1.66) but the post-tax volume still drops to zero even if the transaction tax is only 65.75% of the total fixed transaction cost. Second, the impact of a transaction tax on the transaction cost and trading volume varies significantly with different types of futures. Third, the transaction tax revenue estimated by the pre-tax volume or with an unrealistically low elasticity can seriously over-estimate the post- tax revenue.

VI. CONCLUSION

This paper examines the potential impact of a transaction tax on the market quality (i.e. trading volume, bid-ask spread and price volatility) of the U.S. futures markets. To this end, we estimate the empirical relations among trading volume, bid-ask spread, and price volatility within a three-equation structural model for 11 active U.S. futures, including financial, agricultural, metals, and energy futures. Our results indicate that (1) trading volume is negatively related to bid-ask spread, and positively related to price volatility after controlling for other factors; (2) bid-ask spread is negatively related to trading volume and positively related to price volatility; and (3) price volatility has a positive relationship with bid-ask spread and with trading volume after controlling for other variables. These results confirm that a transaction tax, which is analogous to a greater bid-ask spread, will reduce trading volume, increase bid-ask spread, and may not reduce market price volatility in the futures markets studied. Furthermore, the impact of a transaction tax on transaction cost and trading volume varies significantly with the type of futures contracts.

We also estimate the potential post-tax trading volume and tax revenue with the update estimates of the elasticity of trading volume with respect to trading costs under alternative tax rates. For a 0.02% tax rate of the notional value of the contract, we find that the trading volume for seven futures (S&P 500, E-mini S&P 500, 10-Year T-Note, British Pound, Soybean, Gold, and Crude Oil) would be totally eliminated, resulting in a zero post-tax revenue from these seven futures. Thus, a transaction tax of 0.02% on futures trading hardly seems like a promising avenue for raising tax revenue.

In summary, an increase in transaction cost due to a sizable transaction tax could have significant adverse impacts on market quality. A transaction tax will likely not raise substantial revenue for the government as suggested in other studies, but it may hurt the international competitiveness of the U.S. futures markets.

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