Transaction Tax and Market Quality of the Taiwan Stock Index Futures

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Abstract

On May 1, 2000, the Taiwan government reduced the tax levied on futures transactions on the Taiwan Futures Exchange from 5 to 2.5 basis points. This event provides us with an excellent opportunity to test empirically the impact of a tax rate reduction on trading volume, bid-ask spreads, and price volatility. Intraday and daily time series data from May 1, 1999 to April 30, 2001 are tested in a three equation structural model. Our findings support the argument that transaction taxes have a negative impact on trading volume and bid-ask spread, as we found that trading volume increased and the bid-ask spread decreased in the period following the reduction in the transaction tax. Our analysis further finds no support for the argument that a transaction tax may have the benefit of reducing price volatility, as we do not find any increase in price volatility for the period following the tax reduction. Finally, we find that the reduction in the transaction tax did reduce tax revenues but in lesser proportion to the 50% reduction in the tax rate. Our results provide valuable empirical evidence for the on-going philosophical transaction tax debate in the US futures markets.

1 Introduction

There have been considerable debates by academics, industry professional and regulators on the costs and benefits of imposing transaction taxes on the securities and derivatives markets. Schwert and Seguin (1993) present an overview of the pros and cons of the transaction tax debate issue. In general, proponents of a transaction tax argue that it would generate revenues (see Kiefer (1990) and others) and discourage speculative trading. Others, such as Stiglitz (1989), argue that transaction taxes would discourage the short-term speculative trading by “throwing sand in the gears” of financial markets. In particular, by curbing the short-term trading, corporate managers can focus more on the long-term strategies, instead of implementing myopic policies to fulfill the needs of short-term traders. Transaction taxes can also help reduce noise trading, a significant source of price fluctuations, and hence decrease the return volatility (see Stiglitz (1989), and Summer and Summer (1989)).

Opponents argue that the benefits of a transaction tax are likely to be outweighed by its potential costs, because it would increase the cost of capital (see Amihud and Mendelson (1993)), reduce market liquidity (i.e., decrease in trading volume and increase in bid-ask spreads), not necessarily reduce excess price volatility (see Kupiec (1991) and Grundfest and Shoven (1990)), and bring down securities’ values (see Amihud and Mendelson (1990) and others). Recently, Lo, Mamaysky, and Wang (2003) develop a theoretical model showing that fixed transactions costs would induce large "no-trade" regions, decrease securities' liquidity and result in a significant illiquidity discount in asset prices. They show that even small fixed trading costs will generate a relatively large premium in asset prices.

Edwards (1993) examines whether the rationales for imposing a tax on security markets are applicable to futures markets and analyzes the potential effect of imposing a transaction tax on futures markets. He concludes: (1) The imposition of a tax on futures market transaction will not achieve any desirable social objectives and will not generate substantial tax revenues; (2) The imposition of a tax on futures markets will increase bid-ask spread and shift trading volume to overseas markets. Thus, this would weaken the international competitiveness of US futures markets; and (3) A transaction tax would generate indirect costs for hedgers because they need to pay higher risk premiums to speculators due to the reduction in trading volume.

There is limited empirical evidence evaluating the effect of imposing a transaction tax on the market quality of financial markets.[1] On the effect of volatility, Roll (1989) uses the cross-sectional data of twenty three countries for the period 1987 to 1989 to examine whether there are systematic differences that can be explained by margin requirements, price limits and transaction taxes. He does not find evidence that volatility is related to transaction taxes. Jones and Seguin (1997) examine the reduction in commission fees in 1975 as an analogy to a reduction in the transaction tax in the US security markets. They find that securities price volatility lessened as a result of the reduction in commission fees. Similarly, Umlauf (1993) finds that the introduction of, or increase in, the Swedish transaction tax led to an increase in stock market price volatility. By examining the effect of changes in transaction taxes in four Asian countries, Hu (1998) finds insignificant impact of transaction taxes on price volatility, but the impact on stock returns is generally negative and significant in some countries. Thus, these empirical results are mixed.

On the effect of a transaction tax on trading volume, Ericssion and Lindgren (1992) analyze the cross-sectional data for twenty three exchanges in twenty two countries. They find that an increase in the transaction tax would reduce average turnover (measured as trading volume/shares outstanding). Umlauf (1993) shows significant migration of trading volume from the actively traded Swedish stocks to London after the Swedish transaction tax was increased from 1% to 2% in 1986.

Empirical studies of the effects of a transaction tax on futures markets includes Wang and Yau (1994) who examine the relations among trading volume, bid ask spread, and price volatility in four US futures markets. Inferring that a transaction tax would have the same effects as wider bid-ask spreads, they find that such a tax will reduce trading volume, increase price volatility and generate moderate increase in tax revenues. Chou and Lee (2002) provide interesting empirical evidences of the effect of a transaction tax on liquidity and market efficiency. They demonstrate that after the tax reduction on the Taiwan Futures Exchange (TAIFEX), the TAIFEX assumed a leading role over the Singapore Stock Exchange (SGX) in the price discovery process for the index futures contracts. Hsieh (2004) also notes that the information advantage of SGX has diminished as the TAIFEX lowered its transaction tax. Finally, in a review article by Habermeier and Kirilenko (2003), they conclude that transactions taxes have a significant impact on the transformation of investor demands into transactions. Transaction taxes are found to delay the price discovery process, increase volatility, and reduce market liquidity.

TAIFEX reduced its transaction tax from 5 to 2.5 basis points on May 1, 2000. This change in the transaction tax offers a unique opportunity to evaluate empirically the impact of transaction taxes on the market quality of futures contracts. We will examine the change in market quality of the Taiwan Stock Exchange Capitalization Weighted Stock Index Futures (hereafter, TAIEX futures) in a structural equation framework. Market quality is measured by trading volume, bid-ask spread and price volatility. We select the TAIEX futures because it is the most actively traded contract on the exchange.

Our paper is organized as follows. Section 2 discusses the sources of the data and institutional details of the TAIFEX. Section 3 presents empirical models and empirical methodology. Empirical results on the impact of a tax reduction on market quality and on the tax revenue behavior are presented in Section 4. We conclude the paper in Section 5.

2 Institutional Details and the Data

TAIFEX was operated under an automated batch-call system from 9:00 am to 12:15 pm before December 2000 and the trading hours were extended to 1:45 pm in January 2001. Investors, through the help of brokers, submit orders to the automated trading system. There are no market makers. The automatic trading system sets a single transaction price that will clear the largest number of buy and sell orders periodically. The buy (sell) orders with higher (lower) limit prices than the set transaction price will be executed at the transaction price. The price limits on TAIFEX are 7% of the previous day's close. The trading unit of the TAIEX futures is the index value of the TAIEX times 200 New Taiwan Dollars (NT$).

The intraday futures data are obtained from the TAIFEX intraday futures database and the daily futures data are retrieved from the Taiwan Economic Journal (TEJ) database. The sample period covers May 1, 1999 to April 30, 2001. The index future prices are for the nearby contract and are rolled over to the next nearby contract five trading days before the expiration. The variables include the tick-by-tick futures index prices, trading volume, and bid and ask quotes.

The date of TAIFEX transaction tax reduction is May 1, 2000. The pre-tax reduction period is from May 1, 1999 to April 30, 2000 and the post-tax reduction period is from May 1, 2000 to April 30, 2001. Finally, trades and quotes that are time stamped outside the regular TAIFEX trading hours.

Both quoted and effective spreads are estimated using intraday bid-ask quotes. We estimate quoted spreads and effective spreads as follows:

$$\text{Quoted Bid-Ask Spread}_{t} = Q_t(A_t - B_t), \tag{1}$$

$$\text{Effective Spread}_{t} = Q_t(P_t - M_t), \tag{2}$$

where Q_t is an indicator variable, signed by the Lee and Ready (1991) algorithm, that is equal to one for customer buy orders and minus one for customer sell orders, P_t is the execution price of the t^{th} trade, M_t is the average of A_t (ask price of the t^{th} trade) and B_t (bid price of the t^{th} trade), considered as a proxy for the equilibrium price of the underlying asset.[2]

It should be mentioned that the quoted spread is not an accurate measure for trading costs when trades are executed at prices away from the quotes. The effective spread is a better measure of trading cost because it incorporates the information of the actual execution price. Our daily quoted and effective spreads are averages of their corresponding intraday measures.

To examine the impact of the reduction in transaction tax on the order processing component of the effective bid-ask spread, we use the indicator regression approach suggested by Huang and Stoll (1997) to perform a decomposition of the effective spread into two components : (1) an order processing component and (2) a combined inventory and adverse selection component. The indicator regression is specified as follows:

$$\Delta P_t = \beta_1(Q_t - Q_{t-1}) + \beta_2 * \beta_1 Q_{t-1} + e_t \,, \tag{3}$$

where Q_t is the buy and sell indicator as defined previously. It should be noted that β_1 is equal to half of the traded spread and β_2 is the sum of inventory and adverse selection component. Thus, order process component is equal to $(1\text{-}\beta_2)$. The parameters of equation (3) are estimated by nonlinear least squares.

Two daily volatility measures derived from the intraday data are used in this paper. Andersen et al. (2001) propose an estimator for realized volatility. Our daily realized volatility is defined as:

$$\hat{\sigma}_i^2 = \sum_{t=1}^{n_i} (r_t)^2 \,, \tag{4}$$

where n_{it} is the number of intraday 5-minute returns, and $r_t = (Ln(M_t) - Ln(M_{t-1}))$, is the 5-minute intraday return, M_t is the bid-ask midpoint of the t^{th} trade at the end of the five minute interval. It is a proxy for the equilibrium price and a simple way to minimize the influence of the bid-ask bounces.

The second volatility estimator is the high-low estimator proposed by Parkinson (1980), which is defined as:

$$\hat{\sigma}_i^2 = \frac{(Ln(H_t) - Ln(L_t))^2}{4Ln(2)}, \tag{5}$$

where H_t and L_t are the daily high and low prices, respectively.[3]

3 Empirical Models and Empirical Methodology

3.1 Empirical Models

We estimate the impact of the tax rate reduction on market quality (i.e. trading volume, bid-ask spread, and price volatility) of the TAIEX futures in a three-equation structural model framework. The empirical structural model is specified as follows:[4]

$$TV_t = \beta_{11} + \beta_{12}BAS_t + \beta_{13}IV_t + \beta_{14}RF_t + \beta_{15}OI_{t-1} + \beta_{16}TV_{t-1} + \beta_{17}D_1 + e_{1t} \tag{6}$$

$$BAS_t = \alpha_{21} + \alpha_{22}TV_t + \alpha_{23}IV_t + \alpha_{24}SP_t + \alpha_{25}BAS_{t-1} + \alpha_{26}D_1 + e_{2t} \tag{7}$$

$$IV_t = \delta_{31} + \delta_{32}TV_t + \delta_{33}BAS_t + \delta_{34}TV_{t-1} + \delta_{35}IV_{t-1} + \delta_{36}D_1 + e_{3it} \tag{8}$$

Equation (6) is the trading volume equation. TV_t is trading volume of the TAIEX futures on the t^{th} day. Trading volume is specified as a function of effective bid-ask spread (BAS_t), price volatility (IV_t), risk-free rate (RF_t), lagged open interest (OI_{t-1}), and lagged trading volume (TV_{t-1}).

BAS_t is the mean intraday effective bid-ask spreads of the TAIEX futures on the t^{th} day. The bid-ask spread represents a major component of the transaction cost, which is believed to impact trading volume adversely. Higher transaction costs would decrease the opportunity for market participants to make profitable trades, thus lead 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_t is intraday price volatility of the TAIEX futures on the t^{th} day. We use the realized volatility as a measure of the intraday price volatility. We expect the intraday price volatility to be positively related to trading volume according to the mixture distributions' hypothesis.[5]

The risk-free rate (RF_t) is adopted in this study as a surrogate for the information variables that affect changes in the expected physical position of hedgers. A change in the expected physical position of hedgers is another major determinant of trading volume. The risk-free rate is expected to be inversely related to trading volume, reflecting the opportunity cost of holding inventory.[6] Since the Taiwan government does not issue treasury bills regularly, as is the case in the US, the risk-free rate, RF_t, is proxied by the average of the 3-month certificate of deposit rates of the three largest banks in Taiwan.

OI_{t-1} denotes the lagged open interest of the TAIEX futures. Open interest is the total number of outstanding TAIEX futures contract. It is expected to a have a positive impact on trading volume because higher open interests generate more trading volume.

In equation (7), the bid-ask spread (BAS_t) equation is a function of the price risk (or volatility risk measure, IV_t), trading volume (TV_t), settlement price of futures (SP_t), and lagged bid-ask spread (BAS_{t-1}). These determinants are found to be significant in previous studies.

If we consider trading volume (TV_t) as a measure of market liquidity, then we should expect to see that as trading volume increases, there is greater opportunity for market makers to offset the undesirable positions of their inventories, which reduces their price risk. This, in turn, will cause bid-ask spreads to decrease. Accordingly, we expect a negative relationship between the bid-ask spread and trading volume in equation (7).

Transaction price changes (i.e. the price risk) imply two types of risk for market makers. First, market makers may bear non-systematic risk due to under-diversification in the assets they hold. Second, large price changes may be correlated with the presence of information traders, and dealers must increase the bid-ask spread to be compensated for the expected losses of trading with informed traders. Hence, intraday price volatility (IV_t), a proxy for the price risk in equation (7), is expected to have a positive impact on the bid-ask spread. SP_t, the daily settlement price of the nearby contract is employed to control for the effect of measurement scale for the same contract with different price levels.

In equation (8), the price volatility equation, we specify the observed price volatility (IV_t) as a function of the trading volume (TV_t), bid-ask spread (BAS_t), lagged trading volume (TV_{t-1}), and its own one-day lagged variable (IV_{t-1}). The greater the trading volume, the greater the possibility that prices will move, thus creating greater price volatility. In addition, the changes in volume may be caused by information arrivals, which will increase volatility according to the mixture distributions' hypothesis. Similarly, wider bid-ask spreads, which may be attributable to orders from informed traders, will eventually lead to greater transaction price movements due to the bid-ask bounces.

At this point, a note on the lagged variables in equations (6), (7) and (8) (i.e., TV_{t-1}, BAS_{t-1}, and IV_{t-1}) is warranted. A partial adjustment model is specified in each equation to take into account the distributed lags (persistence) effect in the dependent endogenous variable. Thus, the lagged term of the dependent endogenous variable in each equation is entered as an explanatory variable in the model.

A dummy variable, D_1, is used in equations (6) – (8) to take account for the effect of reducing the tax rate from 5 to 2.5 basis points. It is specified as D_1 = 1 when the data come from the period after May 1, 2000 (that is, period following the tax rate reduction) and $D_1 = 0$, otherwise. Finally, e_{1t}, e_{2t} and e_{3t} are the error terms of equations (6), (7) and (8), respectively.[7]

3.2 Empirical Methodology

We note that the following precautions have been taken to mitigate the econometric problems that frequently plague the time series data.[8] First, all variables in equations (6) – (8) are transformed into the log forms. This enables us to stabilize the variance of the error terms and approximate error terms toward a symmetric distribution. Also, coefficients can be readily interpreted as the elasticity of trading volume, effective bid-ask spreads, and price volatility with respect to their explanatory variables.

Second, to avoid any spurious relationship among the variables due to the presence of a unit root in the time series, the augmented Dickey-Fuller test (ADF) is applied to test for stationary. Results from the ADF tests form the basis for deciding whether the model should be estimated in the level or in the first-difference form. The empirical results of the ADF tests are reported in Table 1. We find that the time series of trading volume, bid-ask spreads, price volatility and open interest are free of the unit root problems, whereas the risk-free rates and futures settlement prices have a unit root. After taking the first difference, the risk-free rates and futures settlement prices are reduced to stationary time series. Based on these results, we estimate our three-equation model in the level form for all variables, except for the risk-free rates, and futures settlement prices in the first difference form.

To take account for the potential simultaneous equation bias, we use the Generalized Method of Moments (GMM) procedure, an instrumental variable method suggested by Hansen (1982), to estimate the parameters. The optimal weighted matrix is the estimated consistent covariance matrix under a serially correlated and heteroskedastic error process (proposed by Newey and West (1987)). The merit of this procedure is that it provides a set of consistent estimates of parameters, as well as corresponding robust standard errors for each of the parameter estimates.

4 Empirical Results

4.1 Exploratory Data Analysis

Panel A of Table 2 presents the descriptive statistics. We find that the median trading volume increase from 2492.0 to 5137.0 and the median open interests increase from 3523.0 to 5154.0. These results suggest that both speculators and hedgers have increased their trading activities in the post tax reduction period. The median quoted spreads decrease from 5.874 to 4.834 and the median effective bid-ask spreads decrease from 4.669 to 3.598. These results support the arguments by the transaction tax opponents that the imposition of a transaction tax would reduce market liquidity. However, the median realized volatility and the median high-low volatility increase from 1.039%, and 0.944% to 1.302% and 1.349%, respectively. These results seem to be consistent with the argument suggested by the transaction tax supporters that one benefit of the transaction tax is to reduce the influences of noise traders, who cause excessive return volatility. Nevertheless, as we will show later, these changes in volatility are not found to be significant after we control for the effects of other variables in the structural model framework.

We also observe that both the medians settlement prices and short term interest rates have decreased in the post tax rate reduction period. Panel B of Table 2 reports the regression results on the test of equality of sample means of the variables reported in Panel A. The results confirm that all differences are statically significant at the 5 % level or better.

Panel A of Table 3 reports the results of decomposing effective bid-ask spreads based on the Huang and Stoll's (1997) procedure. The median order processing component has declined from 80.2 % of the effective spread in the pre-tax reduction period to 73.9 % in the post-tax reduction period. This result indicates that a reduction in the transaction tax also reduces the order processing component, a measure of the implicit trading costs. The combined inventory and adverse selection component has increased in the post-tax reduction period. This is expected because the estimated combined inventory and adverse selection component is one minus the order processing component in a two-way decomposition.

The estimated traded spread from the indicator regression has also reduced in the post-tax reduction period. Panel B of Table 3 reports the regression results of testing the equality of the sample means of order processing component, combined inventory and adverse selection component and traded spreads in the pre- and post-tax reduction periods. These test results confirm that the order processing component and traded spreads are lower in the post-tax reduction period.

4.2 Confirmatory Analysis

This section reports the empirical results of the impact of tax reduction on trading volume, bid-ask spreads and price volatility in a three structural equation model.

4.2.1 Effect of the Tax Reduction on Trading Volume

The empirical estimates of the TAIEX futures trading volume equation are reported in Tables 4. The bid-ask spreads are negatively related to the trading volume and the coefficients are statistically significant at the 1% level. It is interesting to note that the coefficient of the bid-ask spread is -0.564 before the tax rate reduction and -0.846 after the tax rate reduction. The differences between these two coefficients are statistically significant. The negative coefficients can be interpreted as the short-run estimates of the elasticity of trading volume with respect to the bid-ask spreads for the futures contracts. In this regard, Table 4 shows that the trading volume for the TAIEX futures would decrease 0.564% for each 1% increase in the bid-ask spread before the tax rate reduction and it would decrease 0.846% for each 1% increase in the bid-ask spread after the tax reduction. This finding suggests that market participants change their trading behavior before and after the tax reduction. Our results are consistent with the proposition of Lucas Critique (see Lucas (1976)).[9]

The coefficient of the daily realized price volatility (IV_t) is positive and statistically significant at the 1% level, as shown in the first column of Tables 4.[10] This result is as expected and consistent with the empirical findings of Tauchen and Pitts (1983), Martell and Wolf (1987), Bessembinder and Seguin (1993) and Wang, Yau and Baptiste (1997). In addition, the result 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 trading volume.

We expect the regression coefficient for the risk-free rates would be negatively related to trading volume. Higher short-term interest rates increase the cost-of-carry of the cash or spot assets/commodities and thus reduce the hedging needs in the futures market. In addition, higher interest rates reduce speculative trading by making alternative investments more attractive. We observe that the coefficient of the risk-free rates in the trading volume equation has a negative sign, which is inconsistent with our expectation, but it is statistically insignificant.

The coefficient of open interest (OI_{t-1}) is positive and statistically significant at the 1% level, indicating that an increase in open interest will result in an increase in trading volume, a result that is consistent with our expectation. The coefficients of lagged trading volume (TV_{t-1}) are positively significant at the 1% level. Significance in the coefficients of lagged volume agrees with previous literature that persistence in volume exists (see Wang etc. (1997) and others). Once again, the empirical evidence lends support to our partial adjustment model specification.

The coefficient of the dummy variable, which measures the impact of tax reduction on trading volume, is positive and significant at the 1 %level. After controlling for the effects of other variables, the reduction of transaction tax has a positive impact on trading volume. In other words, the imposition of a transaction tax is likely to impede trading volume, as we show that the increase (decrease) in transaction tax has a negative (positive) impact on trading volume in the index futures market.

4.2.2 Effects of the Tax reduction on the Bid-Ask Spread

The second column of Table 4 presents the empirical estimates of the bid-ask spread equation (7). The coefficient of trading volume (TV_t) is negative and statistically significant at the 1% level. This result is consistent with those of Benston and Hagerman (1974) and Wang, etc (1999). The coefficient is approximately -0.214. This means that a 10% increase in trading volume will result in a 2.14% decrease in the bid-ask spread.

The coefficient of price volatility (IV_t) is significantly positive. This result is expected because an increase in price volatility implies higher risk for the market marker, as mentioned previously. In terms of magnitude, the elasticity of bid-ask spreads with respect to price volatility is 0.339.

The variable measuring change in the daily settlement price (SP_t) is employed to control for the effect of different price levels. The coefficients for the change in SP_t is negative and statistically significant in the bid-ask spread equation. The coefficient of the lagged bid-ask spreads (BAS_{t-1}) is 0.512 and is statistically significant at the 1% level. Again, this result supports our specification of partial adjustment in the bid-ask equation.

The coefficient of the transaction tax reduction dummy variable is negative and statistically significant at the 1% level. This result confirms that the bid-ask spread of TAIEX futures has decreased due to the reduction in the transaction tax, after controlling for the effects of other variables.

In sum, univariate statistics in Table 2 indicate that the reduction in the transaction tax has decreased the bid-ask spreads. The negatively significant coefficient of the transaction tax dummy variable confirms that the bid-ask spreads has decreased, after controlling for the effects of change in other variables in the bid-ask spread equation.

4.2.3 Effect the Tax Reduction on Price Volatility

The structural estimates of the determinants of price volatility are reported in the third column of Table 4. The coefficients for both trading volume (TV_t) and bid-ask spreads (BAS_t) are positive and significant at the 1% level. From the estimated price volatility equation, we can trace the sources of change in the observed price volatility into two components: (1) the information component approximated by trading volume (TV_t); and (2) the intraday liquidity component represented by the bid-ask spreads (BAS_t). As expected, trading volume and price volatility are positively related. This is consistent with results that are well documented in the literature. Likewise, our finding of a positive relationship between the bid-ask spread and observed price volatility is also consistent with results reported by Wang, et al. (1994, 1997). This finding shows that, for a given level of trading volume, an increase in liquidity (i.e., narrower bid-ask spreads) will reduce price volatility.

It is interesting to note that the coefficient of lagged open interests (OI_{t-1}) is negative and significant at the 1% level. This result is consistent with Bessembinder and Seguin (1993), who find that the open interest (interpreted as a measure of liquidity) has a negative and significant impact on price volatility. The coefficient of lagged price volatility (IV_{t-1}) is significantly positive, and these results suggest that there is also a persistence effect in price volatility.

Finally, the coefficient of the tax reduction dummy variable is insignificant after we control for other variables in the structural equation. We do not find evidence that transaction taxes can help reduce return volatility, which is inconsistent with the argument by supporters of transaction taxes, who claim that the imposition of a transaction tax would reduce the impact of noise traders and thus reduce return volatility.

4.3 The Behavior of Tax Revenues before and after the Tax Reduction

As we have shown, a reduction in the transaction tax will reduce futures transaction costs, thus attract speculators and hedgers to trade futures contracts more intensively, and increase the overall volume, which would benefit the futures exchanges. However, it may also be argued that a reduction in the transaction tax rate would reduce tax revenues for the government. This section evaluates the impact of the reduction in transaction tax rate on tax revenues collected from the TAIEX futures in the pre- and post-tax reduction periods. The Taiwan government does not disclose details of the daily futures tax revenues it collects from individual futures contracts. However, the daily tax revenues on TAIEX futures can be easily estimated. Our estimation of tax revenues is estimated by multiplying the dollar value of the futures contract, the tick-by-tick trading volume and the tax rate in effect.

Table 5 reports that the average daily tax revenue is NT$ 1,905,955 in the pre-tax reduction period and NT$ 1,605,925 in the post-tax reduction period.[11] The reduction in the transaction tax from 5 to 2.5 basis points (i.e., a 50% reduction) results in a drop in actual tax revenues of only about 15%. Table 5 also reports the daily tax revenues calculated based on the naïve method, which assumes that the trading volume in the post-tax reduction period does not change. Clearly, the estimate of the naïve method seriously overestimates the loss of tax revenues due to the tax reduction.[12] In particular, this method fails to account for the increase in trading volume due to the tax reduction. Our results demonstrate that: (1) an increase or decrease in transaction tax does not result in the same percentage increase or decrease in the tax revenues; and (2) using a naïve method to estimate changes in the tax revenues due to change in the tax rate can seriously over- or under- estimate the magnitude of changes in the tax revenues.

5 Conclusions and Policy Implications

This paper examines the impact of the transaction tax reduction on trading volume, bid-ask spreads and price volatility on the Taiwan stock index futures market in a three structural equations model. Several interesting results emerge from the study: (1) trading volume has increased and the bid-ask spread has decreased in the post transaction tax reduction period. These results provide empirical evidences supporting the arguments by opponents of transaction taxes on financial markets; (2) price volatility has not increased in the post-tax reduction period. This result does not support the argument by the transaction tax supporters who hypothesize that the imposition of transaction tax would reduce the impact of noise traders and, therefore, reduce price volatility; and (3) transaction tax revenues during the year following the reduction in the transaction tax declined by 15%, compared to the transaction tax revenues in the pre-tax reduction period. However, this reduction in tax revenues is not in proportion to the 50% reduction in transaction tax rate. Our empirical results provide valuable evidence for the on-going transaction tax debates in the US.

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Table 1 Unit Root Tests

	$Ln(TV_t)$	$Ln(BAS_t)$	$Ln(IV_{1t})$	$Ln(TV_{2t})$	$Ln(OI_t)$	$Ln(RF_t)$	$Ln(SP_t)$
ADF Test	-7.328**	-4.224**	-4.226**	-5.266**	-9.639**	3.505	-1.812

The Table reports the empirical results of the Augmented Dickey-Fuller (ADF) unit root test. The regression model of the ADF test is implemented as follows:

$$\Delta Ln(y_t) = \beta_0 + \beta_1 D_1 + (\delta - 1)Ln(y_{t-1}) + \sum_{i=1}^{5} \theta_i \Delta Ln(y_{t-i}) + u_t$$

We test the null hypothesis that $\delta = 1$ versus alternative $\delta < 1$. The definition of each variable is as follows: (1) TV_t = trading volume; (2) BAS_t = effective bid-ask spread; (3) IV_{1t} = realized volatility; (4) IV_{2t} = high-low volatility; (5) OI_t = open interests; (7) SP_t = settlement price and (8) RF_t = risk-free interest rates. y_t refer to any of the time series data used in this study. D_1 = 1 if t is equal to or greater than May 1, 2000 and zero otherwise. The purpose of incorporating the dummy variable in the equation is to take account of potential structural change due to the tax rate reduction. The occurrence of structure change can reduce the power of the ADF test (see Perron (1989)). The critical value of this t-ratio has been tabulated by Fuller (1994, P642). The critical values of the ADF unit root test at the 1% and the 5% levels are –3.382 and –2.884, respectively. ** and * denote significance at the 1% and 5% levels, respectively

Table 2 Exploratory Data Analysis

Panel A: Descriptive Statistic

	Before the tax rate reduction: (5/1/1999 to 4/30/2000)			After the tax rate reduction (5/1/2000 to 4/30/2001)		
Variable	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
TV_t	2536.80	2492.00	1066.08	5671.18	5137.00	3198.55
BAS_{1t}	5.048	4.670	1.926	3.902	3.598	1.585
BAS_{2t}	6.606	5.874	2.732	5.371	4.833	2.298
IV_{1t}	1.195	1.039	0.568	1.572	1.300	0.779
IV_{2t}	1.161	0.944	0.708	1.521	1.349	1.057
OI_t	3727.409	3523.000	1621.500	5275.430	5154.000	2052.880
SP_t	8363.430	8019.000	879.660	6709.624	5960.000	1397.300
RF_t	5.012	5.020	0.012	4.908	5.000	0.177

Panel B: Regression results of testing the equality of sample means

Variable	TV_t	BAS_t	IV_{1t}	IV_{2t}	OI_t	SP_t	RF_t
Intercept	2536.802	5.048	1.195	1.161	3727.409	8363.430	5.012
	(21.03)	(19.86)	(16.81)	(15.57)	(16.65)	(61.07)	(9701.67)
D_1	3134.380**	-1.146**	0.377**	0.360**	1189.888**	-1653.806**	-0.104**
	(7.64)	(-3.66)	(3.07)	(2.66)	(3.69)	(-6.46)	(-3.87)
R^2	0.301	0.333	0.099	0.054	0.101	0.335	0.145

Panel A of thes table reports descriptive statistic of the variables used in our analysis. The definition of each variable is as follows: (1) TV_t = trading volume; (2) BAS_{1t} = effective bid-ask spread; (3) BAS_{2t} = quoted spreads; (4) IV_{1t} = realized volatility; (5) IV_{2t} = high-low volatility; (6) OI_t = open interests; (7) SP_t = settlement price and (8) RF_t = risk-free interest rates. Panel B of the table reports the regression results of the one-way analysis of variance on testing the equality of sample means. We calculate the standard error of estimates based on the Newey-West procedure to take account of autocorrelation and heteroscedastic errors. The number in parentheses is the associated t statistics. ** and * denote significance at the 1% and 5% levels, respectively

Table 3 Decomposition of Effective Spreads

Panel A: Summary Statistic

Variable	Before the tax rate reduction: (5/1/1999 to 4/30/2000)			After the tax rate reduction (5/1/2000 to 4/30/2001)		
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
Order Processing Component	0.809	0.802	0.169	0.742	0.739	0.136
Inventory and Adverse Component	0.191	0.197	0.169	0.257	0.261	0.136
Traded Spread	4.923	4.207	1.885	4.268	4.150	1.857

Panel B: Regression results of testing the equality of sample means

Variables	Order Processing Component	Inventory and Adverse Selection Component	Traded Spread
Intercept	5.0480	0.1907	4.9267
	(60.18)	(19.93)	(20.94)
D_1	-0.0667**	0.0667**	-0.6592*
	(-3.78)	(4.95)	(-2.07)
R^2	0.17	0.17	0.32

Panel A of the table presents empirical estimates of decomposing effective bid-ask spreads into two components:

(1) Order processing component and (2) combined inventory and adverse selection components. We employ the Huang and Stoll (1997) procedure to perform our decomposition analysis. Panel B of the table reports the regression results of the one-way analysis of variance on testing the equality of sample means. We calculate the standard error of estimates based on the Newey-West procedure (1987) to take account for autocorrelation and heteroscedastic errors. The number in parentheses is the associated *t* statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 4 Empirical results on trading volume, bid-ask spreads and price volatility of Taiwan Stock Index Futures

Variable	$Ln(TV_t)$	$Ln(BAS_t)$	$Ln(IV_t)$
Constant	3.7184**	2.4001**	-4.4874**
	(4.30)	(6.46)	(-11.98)
D_1	0.5210**	-.0737**	0.0293
	(3.21)	(-3.27)	(0.77)
$Ln(TV_t)$	---	-0.2141**	0.5642**
		(-5.66)	(14.50)
$Ln(BAS_t)$	-0.5638**	---	0.6881**
	(-5.76)		(10.11)
D_1*$Ln(BAS_t)$	-0.2820**	---	---
	(-2.42)		
$Ln(IV_t)$	0.7197**	0.3388**	---
	(10.53)	(6.62)	
$\Delta Ln(SP_t)$	---	-0.6763	---
		(-2.14)	
$Ln(OI_{t-1})$	0.1139**	---	-0.1193**
	(3.02)		(-3.34)
$Ln(TV_{t-1})$	0.2782**	---	---
	(6.22)		
$Ln(BAS_{t-1})$	---	0.5117**	---
		(9.57)	
$Ln(IV_{t-1})$	---	---	0.2183**
			(5.40)
$\Delta Ln(RF_{t-1})$	1.1680	---	---
	(1.79)		
R^2	0.91	0.85	0.78

The table reports the parameter estimates of the trading volume, effective bid-ask spread and price volatility in the following structural equations. We apply the GMM procedure (Hansen (1982)) to estimate the parameters in order to avoid the potential simultaneous equation bias. The optimal weight covariance matrix used in the estimation is the estimated covariance matrix under the serially correlated and heteroscedastic error process (see Newey and West (1987)).

$$TV_t = \beta_{10} + \beta_{12}BAS_t + \beta_{13}IV_t + \beta_{14}RF_t + \beta_{15}OI_{t-1} + \beta_{16}TV_{t-1} + D_1 + e_{1t}$$
$$BAS_t = \alpha_{20} + \alpha_{22}TV_t + \alpha_{23}IV_t + \alpha_{24}SP_t + \alpha_{25}BAS_{t-1} + D_1 + e_{2t}$$
$$IV_t = \delta_{30} + \delta_{32}TV_t + \delta_{33}BAS_t + \delta_{34}TV_{t-1} + \delta_{35}IV_{t-1} + D_1 + e_{3t}$$

The definition of each variable is as follows: : (1) TV_t = trading volume; (2) BAS_t = effective bid-ask spread; (3) IV_t = realized volatility; (4) OI_t = open interests; (5) SP_t = settlement price ; (6) RF_t = risk-free interest rates; (7) D_1 = 1 for t equal to or greater than May 1, 2000 and equal to zero otherwise; and the subscript *t-1* denotes one period lagged variable. Numbers in parentheses denote t-statistics. ** and * denote significance at the 1% and 5% levels, respectively.

Table 5 Changes in Tax Revenues

Panel A: Daily Tax Revenues

Variable	Before the tax rate reduction (5/1/1999 to 4/30/2000) Mean	Median	Standard Deviation	After the tax rate reduction (5/1/2000 to 4/30/2001) Mean	Median	Standard Deviation
Daily Tax Revenues (NT$)	1,905,955	1,878,595	842,227	1,605,925	1,620,925	769,762
Naïve Daily Tax Revenues (NT$)	---	---	---	941,387	932,227	403,371

Panel B: Total Tax Revenue Before and After Tax Rate Reduction

Total Tax Revenues (NT $)	454,354,528	393,014,040
Naïve Total Tax Revenues (NT$)	---	224,050,106

Panel C: Regression Results of Testing Equality of Sample Means

$$Y_t = 1{,}905{,}955 - 300030.7 * D_1$$
$$(20.13) \qquad (-2.43)$$

Panel A of the table reports descriptive statistic of daily tax revenues. Daily tax revenues are estimated by multiplying the dollar value of the futures contract, the tick-by-tick trading volume and the tax rate in effect. The post-reduction naïve daily tax revenues are estimated by multiplying the dollar value of the futures contract, the post-reduction tax rate and the trading volume *before* the tax reduction. Panel B of the table represents total tax revenue of 238 days before and after the tax rate reduction. Panel C of the table reports the regression analysis of one-way analysis of variance on the testing the equality of sample means. We calculated the standard error of estimates based on the Newey-West procedure to take account of autocorrelated and heteroscedastic errors. The number in parentheses is associated *t* statistics. Y_t = daily total tax revenue.

Endnotes

[1] Schwert and Seguin (1993) provide limited literature review prior to 1993 on empirical evidences of the impacts of transaction taxes on market quality of equity markets. Campbell and Froot (1994) document international experiences with securities transaction tax. Westerholm (2003) studies the impact of transaction tax reduction on Sweden's and Finland's equity markets. To the best of our knowledge, there are relatively few studies to report the impacts of a change in transaction tax on the market quality of futures markets.

[2] We try two methods of classifying trade signs, one without a lag and another one with a 5-second lag in quote prices. The results are qualitatively similar, and only results without a lag in quote prices are reported. Bessembinder (2003, P.246-250) presents an excellent comparison on the impact of selecting different lag seconds from zero to thirty seconds in the identification of buy and sell classification algorithm proposed by Lee and Ready (1991). They find similar empirical results regardless of the choice of the lag seconds.

[3] Further discussion on the estimating daily volatility from intraday data is referred to Bollen and Inder (2002).

[4] The three-equation model of trading volume, bid-ask spread and price volatility was proposed by Wang and Yau (2000).

[5] Mixture distribution hypothesis (see Clark (1973), Tauchen and Pitts (1983) and others) is a theoretical model to explain the positive relation between trading volume and price volatility due to a third latent variable - new information arrivals.

[6] Further discussion on this variable is referred to Martel and Wolf (1987).

[7] Each equation in our model is either exactly identified or over-identified because the number of pre-determined variables excluded from the equation of our interest is at least equal to or greater than the number of endogenous variables included, less one (see Johnston (1984), p.455).

[8] The modeling procedure adopted in this paper follows the modeling procedure by Wang and Yau (2000) to estimate the parameters of trading volume, bid-ask spreads and price volatility in a system of equations.

[9] Lucas critique (1976) suggests if the exogenous variables in the simultaneous equation model are changed due to outside intervention and profit-maximizing agents see the change coming, they would modify their behavior accordingly. Thus it is expected that some coefficients in the simultaneous equation model may also change when some exogenous variables change.

[10] We have also used V_{2t}, the high-low volatility estimator (Parkinson (1980)), as an alternative measure of volatility in our three-equation model. The empirical results are qualitatively similar to the results used the volatility measure of V_{1t} (realized

volatility). In order to save the space, we do not report here. Interest readers can obtain the results from the authors.

[11] Decreases in the Taiwan stock index levels (see Table 2) in the post-tax reduction period is another factor responsible for decreases in the tax revenues after the tax reduction.

[12] Naïve method was used by Kiefer (1990) to estimate potential tax revenues generate from the imposition of broadly tax of 0.5 percent on the sale of all securities (both equity and debt securities, except Treasury securities).