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交易稅對台灣股價指數期貨波動與交易活動關係的影響

Effect of Transaction Tax on the Relationship Between Volatility and Trading Activities of Taiwan Stock Index Futures

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摘要：本文主要探討調降期貨交易稅 (台灣股價指數期貨在 2006 年 1 月 1 日時，交易稅由現行的千分之 0.25 調降成為千分之 0.1) 對於台灣期貨市場的台指期、小指期、電子期與金融期等四種股價指數近月契約之報酬波動和交易活動之間關係的影響。我們考量時間趨勢及季節因素對於期貨波動和交易活動的效應，使用 Luu and Martens (2003) 的彈性傅立葉形式 (Flexible Fourier Form, FFF) 進行個別檢定，同時並將 FFF 加入到日內總報酬波動與交易量 (投機性交易活動) 所組成的兩結構方程式中以檢定交易稅、時間趨勢及季節效應。研究期間從 2004 年 7 月 1 日起至 2007 年 6 月 31 日止，使用

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每日與日內 5 分鐘的交易資料進行實證分析。主要結果顯示四種期貨的降稅效果有所差異，台指期、小指期和電子期的交易量在降稅後會顯著地增加，但金融期則是顯著的減少，可能原因與投機性交易活動有關。另外也發現在降稅後，這四種期貨的投機性交易活動均會明顯地增加；同時，有部分的研究結果指出調降交易稅會造成期貨的報酬波動增加。最後，我們也發現四種期貨的交易活動均存在時間趨勢及季節效應。

關鍵詞：指數期貨；交易稅；彈性傅立葉形式；波動性；投機性交易活動

Abstract: This paper examines the impact of the reduction of futures transaction taxes on the correlation between return volatility and trading activities of nearby contracts of the four stock index futures, i.e. TX futures, MTX futures, TE futures and TF futures on the Taiwan Futures Market. (The Taiwan futures transaction tax was lowered from 0.025% to 0.01% on January 1, 2006.) This paper considers the effects of time trends and seasonal factors on return volatility and trading activities by performing individual tests with Flexible Fourier Form (FFF) developed by Luu and Martens (2003). Meanwhile, this paper incorporates FFF into the two-equation structural model, which consists of the sum of intraday return volatility and trading volume (speculative trading activities) in order to test transaction taxes, time trends and seasonal effects. The research covers the period starting on July 1, 2004 through June 31, 2007. It performs an empirical analysis with daily and 5-minute intraday time series data. The result shows that there are variances in the effects of transaction taxes on the four futures. The trading volumes of TX futures, MTX futures and TE futures increased significantly after tax reductions; whereas the trading volume of TF futures fell markedly. This may be due to speculative trading activities. This paper also finds that after tax reductions, the speculative trading activities of these four futures dramatically picked up after tax cuts. Meanwhile, some studies indicate that the reduction of transaction taxes results in an increase in futures return volatility. Finally, we find that the trading activities of the four futures show time trends and seasonal effects.

Keywords: Index Futures; Transaction Tax; Flexible Fourier Form; Volatility; Speculative Trading Activities

1. Introduction

Stock index futures were first introduced in the US futures market in 1982. Similar index futures were introduced in Europe and Asia later. In Taiwan, Taiwan Futures Exchange (TAIFEX) was established in September 1997. In July 21, 1998, the first futures product, Taiwan Stock Exchange Capitalization Weighted Stock Index futures (TX futures) was launched. As a response to market demand, on July 21, 1999, two stock index futures were introduced, i.e. Taiwan Stock Exchange Electronic Sector Index futures (TE futures) and Taiwan Stock Exchange Finance Sector Index futures (TF futures). On April 9, 2001 and December 24, 2001, two more new products, i.e. MTX futures (Mini-TAIEX futures) and TAIEX options were created. To meet the demand of international markets and investors, three USD-denominated futures, i.e. MSCI Taiwan Index Futures, MSCI Taiwan Index Options and Gold Futures, and SGX-DT's MSCI Taiwan Index Futures were introduced on December 27, 2006. According to statistics from Futures Industry Association (FIA), the trading volume of the Taiwan futures market ranked the 57th around the world in 1998. The ranking went up to the 18th in 2006. The trading volume of Taiwan index options was the 3rd largest in the world, next only to that of KOSPI 200 options in Korea and that of Dow Jones Euro Stoxx 50 in the US. These numbers demonstrate the rapid growth of the Taiwan futures market over the recent years.

There have been no consistent views or conclusions regarding the influence of transaction taxes on securities markets or futures markets. The scholars for the levy of transaction taxes suggest that it can increase tax revenues (Kiefer,1990) and reduce speculative trading activities. Stiglitz (1989) argues that the levy of transaction taxes downsizes short-term speculative trading activities, and encourages investors to commit to long-term investments by reducing short-term trades. Some scholars suggest that the levy of transaction taxes shrinks noise trading and futures return volatility (Summer and Summers, 1989). Meanwhile, transaction taxes reduce excess price volatility (Grundfest and Shoven,1991) and issuing volumes of securities (Amihud and Mendelson,1993). However, some scholars hold a different view. They suggest that the levy of transaction taxes increases asset-holding costs (Amihud and Mendelson,1993) and reduces the value of assets. It also lowers the trading volume and expands the bid-ask spreads, and sometimes even drive investors to seek alternative markets overseas (Campbell and Froot, 1994). Lo *et al.* (2004) indicate that the levy of transaction taxes mitigates market liquidity and results in obvious liquidity premium in asset pricing.

Seasonal effects refer to regular phenomena of returns or volatility of financial assets at specific times or days. If there exists a significant seasonal phenomenon in the market, it means there is a form of market inefficiency. In the case of any obvious seasonal effects in financial assets, it means that the returns of the financial assets are predictable. At this juncture, the market tends to be inefficient and there may be arbitrage opportunities. Frequently seen abnormalities include weekday effects and weekend effects. Cross (1973) uses a theoretic model to illustrate weekday effects of share price returns. Jaffe and Westerfield (1985) also support weekday effects. However, other scholars such as Smirlock and Starks (1986) argue otherwise. They do not think weekday effects exist. Also, Milonas (1986) examines the maturity effects of futures and finds that the closer it is to maturity dates, the greater the volatility of future prices is. His study proves that there are maturity effects for futures. However, Chen and Williams (1994) indicate that there are no maturity effects for future.

Some scholars provide explanations for the reasons contributing to seasonal effects. First, Keim and Stambough (1984) indicate that the trading on Fridays and Mondays may be subject to measurement errors and hence they propose the concept of symmetric errors. Some scholars argue that weekend effects are mainly due to measurement errors. Patell and Wolfson (1979) suggest that Monday effects are caused by the announcement of negative news by governments usually after the close of the stock markets on Fridays. More often than not, such negative or positive news are reflected on the trading on Mondays. Miller (1988) argues that weekday effects are subject to the influence of investment decisions. Ritter (1988) explains pre-holiday effects with parking the proceeds hypothesis. Some scholars explain seasonal effects with window dressing and price reversal effects.

Previous studies on transaction taxes in Taiwan mainly focus on the influence of transaction taxes on market quality. Few studies on futures price discovery examine the impact of transaction tax cuts on trading behavior of investors. Meanwhile, most studies do not incorporate the effects of time trends or seasonal effects. In fact, the Taiwanese futures market has grew rapidly in trading volume. As a result, both trading volumes and open interests grow over time with the market and result in time trends (Figure 1). It should be possible to mitigate the interferences of these factors in the study on the reduction of transaction taxes with the time trend factors taken into account.

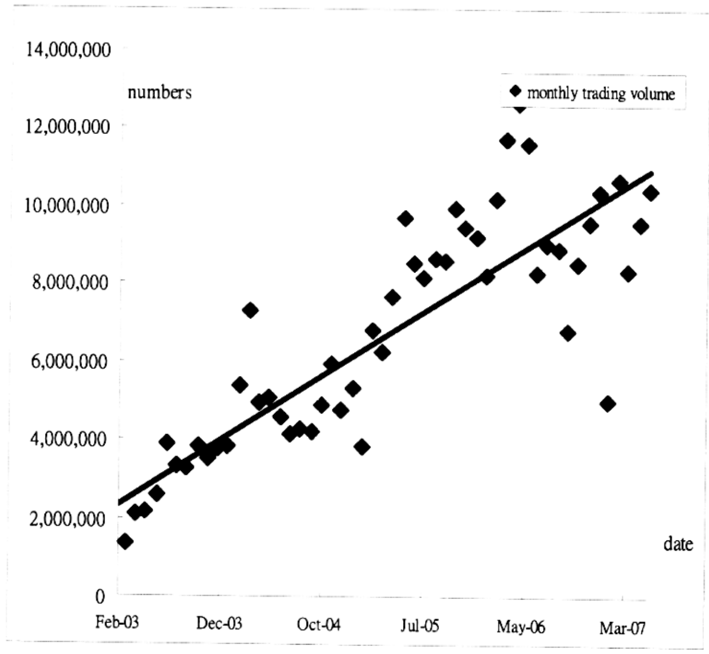
The purposes of this paper are as follows:

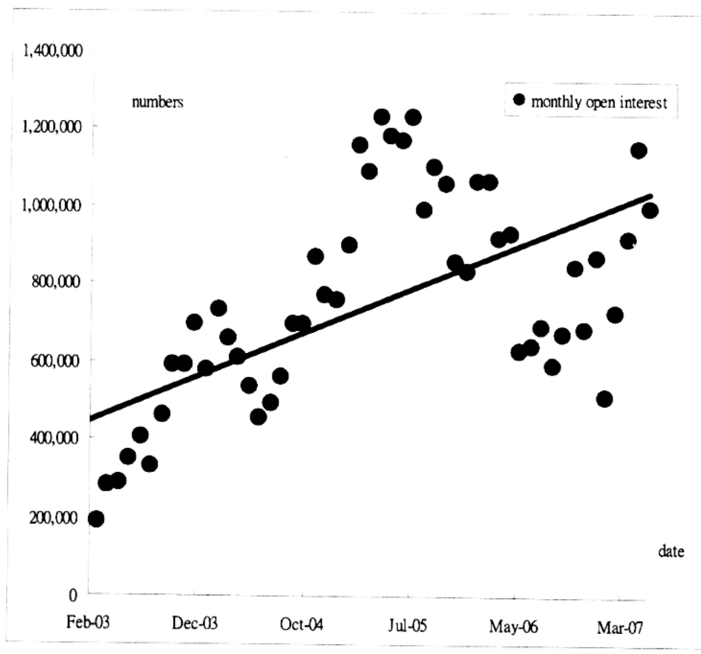
1. It aims to examine the reduction of transaction taxes by Taiwan Futures Exchange and explore the impact of time trends and seasonable factors on the relationship between stock index futures return volatility and trading activities. It intends to gain an understanding of the efficiency of the Taiwan futures market by investigating the seasonal effects of return volatility or trading activities.
2. This paper plans to refer to the return volatility of four different levels of information contents, i.e. the squared return volatility, the high-low price volatility, GK volatility and the sum of intraday return volatility to examine the effects of transaction taxes, time trends and seasonal factors on futures return volatility and compare whether the test results on the volatility of different information contents show any differences.
3. This paper also measures the proxy variables such as trading volume, open interest and speculative trading activities to evaluate trading activities so as to clarify the relationship between transaction taxes, seasonable effects and trading activities. The purpose is to understand how transaction taxes, time trends and seasonal factors affect the breadth, depth and speculative trading activities of the futures market.
4. This paper intends to compare the effects of transaction taxes, time trends and seasonal factors on four different indexes, i.e. TX futures, MTX futures, TE futures and TF futures. Meanwhile, the research finding of this paper serves

as another robustness checks on the empirical effects of the transaction tax cuts on the Taiwan stock index futures market.

Figure 1

Time Series Plots of the Monthly Trading Volume and Open Interest on the Taiwan's Stock Index Futures Market: 2003.1.1.- 2007.6.31.





This paper applies Flexible Fourier Form to test the influence of seasonal factors on index futures return volatility and trading activities, because Flexible

Fourier Form can appropriately capture the smooth wave relationship between time series, time-to-market and time-to-maturity (Luu and Martens, 2003). However, before applying Flexible Fourier Form to examine the impact of seasonal factors on futures return volatility (trading activities), it is necessary to test whether the time series of return volatility (trading activities) are static. The test of seasonal factors with Flexible Fourier Form should be performed whilst the time series of return volatility (trading activities) are static. Meanwhile, assuming the time variables are the endogenous variables of return volatility (trading activities), this paper performs a stepwise regression to identify the optimal explanatory model for the seasonal factors before incorporating the dummy variable regarding tax cuts and examining the tax effects, time trends and seasonal effects. Also, this paper runs the seemingly unrelated regression (SUR) to estimate the two structural equations for volatility and trading volume (speculative trading activities) so as to investigate the dynamic and cross effects of the sum of intraday return volatility and trading volume (speculative trading activities) on the relationship between transaction taxes, time trends and seasonable factors.

This paper consists of five sections. This section explains research motives and purposes. Section Two reviews literature. Section Three describes research methods, samples and empirical models. Section Four outlines the empirical findings and analyzes the key results. Section Five summarizes the conclusions.

2. Literature Review

Stock Index futures, specific to stock markets, are the futures contracts with indexes as the underlying at a future point in time. Generally speaking, index futures serve three functions, i.e. hedging, price discovery and speculation. If the index futures market provides a trading environment of high leverage and high liquidity, it can serve as a good hedging channel for equity investors by transferring the price fluctuation risks they are not willing to take to the speculators who are willing to take such risks. This allows equity investors to be more active. Hence, this paper hopes to gain a deep understanding of the futures market by examining the influence of transaction taxes and seasonal factors on the volatility and trading activities of index futures. Below is a summary of the relevant studies in Taiwan and overseas.

2.1. Transaction Taxes

Umlauf (1993) examines the Swedish stock market in 1980~1987 and finds that after the transaction tax was raised from 1% to 2% in 1986, the volatility of the stock market rose and the trading volume significantly shifted to the London market. Campbell and Froot (1994) also find that the hike of transaction taxes prompts investors to seek alternative markets overseas. Meanwhile, Westerholm (2003) performs an empirical study to prove that the Finn stock market experienced a marked reduction in share price volatility after transaction tax cuts. However, Roll (1989) argues that transaction taxes are irrelevant to volatility. In other words, volatility does not change due to changes in transaction taxes. Hu (1998) investigates the effects of the changes of transaction taxes on the four stock markets in Asia and finds that such changes do not significantly affect price volatility, but do have adverse effects on returns. Ericsson and Lindgren (1992) analyze the impact of transaction taxes on trading volumes and find that an increase in transaction taxes lowers the average turnover of the markets. Baltagi and Li (2006) perform an empirical study and find that in the Shanghai and Shenzhen stock markets, the increase of stamp duties by 1/3 (from 0.3% to 0.5%) reduces the trading volume by 1/3. Meanwhile, tax hikes also increases market volatility. The structural shift indicates a deterioration of the market after tax increases.

Also, Wang and Yau (2000) examine the four futures contracts in the US market to analyze the relationship among trading volumes, bid-ask spreads and price volatility. The result indicates that transaction taxes and bid-ask spreads move in the same direction. Although tax levies increase tax revenues, they also reduce trading volumes and enhances price volatility. Chou and Lee (2002) compare TX futures listed in Singapore and futures listed in Taiwan and find that in Taiwan, relatively speaking, transaction taxes undermines the efficiency of price discovery. They prove that after the reduction of transaction taxes in the Taiwan futures market, Taiwan index futures lead TX futures listed in Singapore in terms of price discovery. Habermeier and Kirilenko (2003) indicate that transaction taxes significantly affect the demand from investors and such effects are reflected in trading.

To put it differently, transaction taxes delay the process of price discovery, enhance volatility and weaken market liquidity. Edwards (1993) indicates that the levy of taxes in futures market cannot generate equivalent tax revenues, but raises bid-ask spreads and push trading to alternative markets overseas. In other words, it undermines international competitiveness. Transaction taxes cause indirect costs of hedgers because they need to pay higher risk premiums to speculators, and this lowers trading volumes. Finally, Chou and Wang (2006) also validate the effects of transaction tax cuts on May 1, 2000 in the Taiwan futures market. They examine the impact of the tax cut from 0.05% to 0.25% on the market quality and find that tax cuts boost trading volumes and narrow bid-ask spreads. However, there are no significant changes of return volatility. Tax revenues increase in the second and third year, from the level one year before tax cuts.

2.2. Seasonal Effects and Futures Maturity Effects

Many studies indicate that there are seasonal effects on average returns or return volatility in equity or futures markets. Ho and Cheung (1994) perform an empirical study on a number of emerging stock markets in Asia and find that there are weekday effects in most markets, including Taiwan. The return volatility on Monday is significantly higher than other weekdays. Clare et. al. (1997) apply the ARCH model to estimate the conditional variances for the five stock markets in Asia Pacific and find the similar results. Keef and Roush (2005) examine S&P 500 from the 1930s through 1999 in order to validate whether there are significant variances on the pre-holiday returns. The results indicate that in 1987, there were strong pre-holiday effects, but such effects weakened after 1987. Lucey and Tully (2006) sample the futures contracts for gold and silver in 1982~2002 in order to verify whether there are seasonable effects for conditional and unconditional daily means and variances. The study suggests that means are weak but variances are strong, indicating the existence of seasonal effects. Tu (2003) examines the weekday effects of Taiwan index futures and finds that Monday returns are abnormal, indicating Monday and Tuesday effects on futures returns in Taiwan.

Regarding the literature on maturity effects of futures, Walls (1999) examines the maturity effects of electricity futures contracts by estimating volatility with the squares of logarithms of high-low price returns and controlling the effect of trading volumes on volatility. There is strong evidence indicating that volatility increases when maturity dates approach. Milonas (1986) sample agriculture produce futures and TF futures and finds that the closer futures contracts reach maturity, the greater the volatility becomes. However, Moosa and Bollen (2001) argue the otherwise. They examine S&P 500 futures but the research finding does not support maturity effects on TF futures. Stoll and Whaley (1991) investigate the S&P 500 and index futures from January 1985 through June 1989 and find that trading volumes and volatility decline when maturity dates approach. Hence, their study supports maturity effects on trading volumes and volatility. Chen, Duan and Hung (1999) sample Nikkei 225 Index from September 24, 1988 through June 6, 1999 and find that futures volatility goes down when maturity dates are near. Finally, when it comes to empirical studies in Taiwan, Chou, Chen and Chen (2006) examine the Taiwan index futures from 1998 to 2002 and find that maturity effects are not obvious in Taiwan.

2.3. Return Volatility and Trading Activities

There are currently a number of mainstream theories explaining the relationship between return volatility and trading volume (trading activities) in the futures or stock markets. These theories are as follows:

1. Clark (1973) proposes Mixture of Distribution Hypothesis, which assumes daily trading volume is the proxy for the sum of information unobservable flowing into the futures market (Lamoureux and Lastrapes, 1990; Andersen, 1996; Bohl and Henke, 2003). Hence, the volatility of futures price each day can be considered the aggregation of the price volatility within that day. The amount of trading volume is therefore in a positive correlation with the number of information arrivals. To conclude, futures price volatility is

relevant to trading volumes.

2.Copeland (1976) proposes Sequential Information Arrival Model (SIAM). This model assumes information flows are slow and investors pass information to one another. Therefore, new information is gradually generated and reflected. Therefore, prices are adjusted gradually in order to reflect new information and produce the new equilibrium price.

3.Karpoff (1987) proposes asymmetry in price-volume relationship.

4.De Long *et al.* (1990) propose the trading noise hypothesis.

In all, there is extensive literature indicating that there is a certain relationship between trading volumes and volatility.

Kalotychou and Staikouras (2006) argue that trading volumes are a proxy for the amount of information or width of the markets and open interests can be seen as a proxy for market depth. Meanwhile, Kim (2005) refers the ratio of trading volume/open interest as a proxy variable to measure speculative trading activities. If futures volatility is a sure outcome of trading, it happens via the arrival of information in the market where hedgers or speculators respond to the information. Chain of reactions from investors will drive futures prices to the equilibrium after the arrival of information. The expected and subsequent movements will solely reflect on the market liquidity and trading volume of contracts. If the abovementioned adjustment process is proceeded in a continuous time and under the influence of information flows, there should be a triangle relationship among information, liquidity and volatility.

To sum up, most scholars suggest that there is a significant correlation among transaction taxes, market liquidity and bid-ask spreads of the futures market. However, there are no consistent conclusions regarding the relationship between transaction taxes and futures return volatility. Also, scholars have varying views concerning the maturity effect of futures. Finally, this paper finds that most scholars support that there is a positive and significant correlation between price volatility and trading volume in stock or futures markets after they have performed empirical studies.

3. Methodology

3.1. Data and Samples

This paper examines the impact of the transaction tax cuts on the correlation between return volatility and trading activities of Taiwan index futures. (Note: The Taiwan futures transaction tax was lowered from 0.025% to 0.01% on January 1, 2006.) In contrast to existing literature focusing only on TX futures, this paper samples a wider range of trading data by investigating the four nearby contracts, i.e. TX futures, MTX futures, TE futures and TF futures listed on the Taiwan Futures Exchange for a long period and with significant trading volumes. The daily trading data is sourced from the website of the Taiwan Futures Exchange; the intraday trading data is sourced from Taiwan Economic Journal (TEJ). (All the data is confirmed to be accurate). The research period covers from July 1, 2004 through June 31, 2007. This paper selects the 18 months before the tax cut on January 1, 2006 and the 18 months after the tax cut. The daily trading volume and 5-minute intraday trading data over a period of three years are sampled. The 5-minute intraday trading data is used to estimate the sum of intraday return volatility, which is an approximation of the actual return volatility. This paper sources a total of 44,520 entries of 5-minute intraday trading data and 742 entries of daily trading for all the index future contracts.

3.2. Trading Activity Measurement

This paper measures the trading activities of futures with three metrics, i.e. daily trading volumes, open interests and trading volume/open interest. Generally speaking, trading volumes can serve as a proxy for the information flowing into the futures markets or a measurement for the breadth of the futures markets. Open interests can be regarded as a proxy for market depth (Kalotychou and Staikouras , 2006). In addition, this paper refers to trading volume/open interest as a proxy variable for the measurement of speculative trading activities (Kim, 2005). If speculative trading activities rise, trading volumes will increase more than open interests, because speculators tend to close their positions on the same day. If speculative trading activities increase, trading volumes/open interest will go up significantly.

Luu and Martens (2003) also suggest that trading volume/open interest can reflect the impact of speculative and hedge trading activities in the futures market. Assuming that there are two trading days, T_1 and T_2 on the futures market and the trading volume is the same on either day. The trading volume on day T_1 is mainly a result of hedge trading activities; whereas the trading volume on day T_2 is speculative or arbitrage trading activities. As speculators or hedgers tend to close their positions on the same day, the open interest on day T_2 is significantly smaller than that of day T_1. Hence, the trading volume/open interest on day T_2 is greater than that of day T_1. In other words, when there are more speculative trading activities on the futures market, trading volume/open interest will be markedly greater.

3.3. Return Volatility Measurement

Some studies indicate that the test results of the price-volume relationship for futures with squared return volatility and the sum of intraday return volatility are significantly different (Luu and Martens, 2003). Hence, this paper estimates return volatility with the data of four different levels of information contents in order to understand whether the same phenomenon exists in the Taiwan index futures market. These four methods to measure daily return volatility are:

(1) Squared return volatility (r_t^2). This is one of the most frequently used methods. The calculation method is to square the daily return, $r_t = \ln(P_t / P_{t-1}) \times 100$, to measure return volatility. The symbol P_t denotes the closing price on day t.

(2)High-low price volatility. The method to estimate high-low price volatility is based on Parkinson (1980), Chou and Wang (2006) and Webb *et al.* (2007) who perform empirical studies on the index futures markets. Daily high-low price volatility is calculated as $\hat{\sigma}_{HL}^2 = \left(\ln(HP_t / LP_t) \times 100\right)^2 / (4 \cdot \ln 2)$. The symbols HP_t and LP_t denote the highest intraday price and the lowest intraday price.

(3)GK volatility: This is proposed by Garman and Klass (1980), who indicate that the use of daily highest price, lowest price, closing price and opening price to estimate volatility is more efficient than the use of squared return volatility. Meanwhile, Saunders (1986) applies GK volatility to test the maturity effects and the impact of trading volumes on the futures market and argues that closing prices should not be the only description for price paths. Webb *et al.*`(2007) also refer to GK volatility to measure Taiwan index futures return volatility. GK volatility is calculated as follows:

$$\hat{\sigma}_{GK}^2 = 0.511 \cdot (u-d)^2 - 0.019 \cdot \left[c \cdot (u+d) - 2ud\right] - 0.383 \cdot c^2 \quad \textbf{(1)}$$

where $u = \ln(H_t / C_{t-1}) \times 100 - \ln(O_t / C_{t-1}) \times 100$

$d = \ln(L_t / C_{t-1}) \times 100 - \ln(O_t / C_{t-1}) \times 100$

$c = \ln(C_t / C_{t-1}) \times 100 - \ln(O_t / C_{t-1}) \times 100$

Let H_t be the higher intraday price on the t-th trading day; let L_t be the lowest intraday price on the t-th trading day; let O_t be the open price on the t-th trading ďay; let C_t be the closing price on the t-th trading day.

Finally, this paper refers to more detailed data, i.e. 5-minute intraday trading data, to estimate futures return volatility. Andersen and Bollerslev (1998b), Andersen *et al.* (2001) and Luu and Martens (2003) indicate that the use of intraday returns to estimate daily return volatility is more precise than the use of daily average squired return or highest daily bid-ask spread. Chou and Wang (2006) also perform a test on tax cut effects with intraday return volatility, but do not take into consideration overnight volatility.

This paper refers to Luu and Martens (2003) for the measurement of intraday return volatility. It is calculated as the sum of intraday return volatility, i.e. the summation of squared overnight return and squared intraday 5-minute returns. It is computed as the following.

$$\hat{\sigma}_{real,t}^2 = r_{C-O,t}^2 + \sum_{i=1}^{N} r_{INTRA\ i,t}^2 \quad \textbf{(2)}$$

In the above equation, the symbol $\hat{\sigma}^2_{real,t}$ denotes the sum of intraday return volatility on the t-th trading day and the symbol $r_{C-O,t}$ denotes the overnight return, i.e. the profit from the difference between the closing price of the day before the t-th trading day and the opening price of the t-th trading day. Therefore, the symbol $r^2_{C-O,t}$ denotes the overnight volatility of the index futures, from the closing price of the day before the t-th trading day and the opening price of the t-th trading day. The symbol $r^2_{INTRA\ i,t}$ denotes the intraday mean squared return of the i-th 5-minute band on the t-th trading day. At this juncture, N is equal to 60. As the trading hours in the Taiwan futures market start on 8:45am and finish on 1:45pm, the daily trading hours can be divided into 60 5-minute bands. The adoption of 5-minute band as the time frequency to capture intraday patterns is mainly based on the recommendations from Luu and Martens (2003), Andersen and Bollerslev (1998b) and Andersen *et al.* (2001) who perform empirical studies on stock markets, forex markets and futures market. This approach avoids market microstructure related issues resultant from bid-ask bounces.

3.4. The Model

Based on the above research motives and purposes, this section provides a detailed description of the empirical methods and steps. At first, this paper tests the impact of transaction taxes, time trends and seasonal factors on futures trading activities or return volatility. This paper applies Flexible Fourier Form and the dummy variable for transaction taxes (D_t^{Tax}). Flexible Fourier Form is proposed by Andersen and Bollerslev (1998a). Martens *et al.* (2002) use it to validate high-frequency (intraday) data because it is a model able to accurately capture time trends. It is also able to test whether the futures market report factors such as time trends, time-to-maturity and Monday effects. Meanwhile, the dummy variable for transaction taxes is incorporated in order to explore the impact of transaction taxes, time trends and seasonal factors on futures return volatility or trading activities. Flexible Fourier Form is described in the following:

$$FFF_t = a_1 \cdot D_{MON} + b_1 \cdot t + b_2 \cdot t^2 + c_1 \cdot ttm_t + c_2 \cdot ttm_t^2 + \sum_{i=0}^{n}\left(\phi_i \cdot \cos(\frac{2\pi \cdot i \cdot ttm_t}{ttm_{\max}}) + \theta_i \cdot \sin(\frac{2\pi \cdot i \cdot ttm_t}{ttm_{\max}})\right) \quad \textbf{(3)}$$

$$TS_t = a_0 + FFF_t + \lambda \cdot D_t^{Tax} + \varepsilon_t \quad \textbf{(4)}$$

In Eq. (4), the symbol TS_t denotes the time series at time t. Such series include futures trading activities, e.g. daily trading volumes, daily open interests and speculative variable, and the four types of return volatility, i.e. squared return volatility, high-low price volatility, GK volatility and total intraday return volatility.

The symbol FFF_t denotes Flexible Fourier Form. This form can be divided into the following in Eq. (3).

1. The symbol D_{MON} denotes the dummy variable for Monday. At the trading time is Monday (i.e. t), $D_{MON} = 1$; otherwise, D_{MON} =0.
2. The trading days t and t^2 are referred to capture the time trends. Generally speaking, the start day of the research period is defined as the initial value t =1, and the number of days is added.
3. The symbol $ttm_{\max}$ denotes the further time (days) to maturity of the futures contract at the nearest month.
4. The symbol n denotes the number of sinusoids. This variable, along with Flexible Fourier series, can capture the smooth wave relationship between time series and days to maturity. When this relationship exists, the trading activities (return volatility) of futures change in a cyclical manner (regularly) according to time-to-maturity. The symbol n denotes the optimal number of sinusoids. This paper chooses to use SIC (Schwarz's Information Criterion) to determine the minimum value.

Finally, in Eq. (4), the symbol D_t^{Tax} denotes the dummy variable for transaction tax cuts. The value is assigned to be zero for time t (before tax cuts on January 1, 2006) and to be one after time t. If the effect of transaction tax cuts is significant, λ value has to be significantly different from zero. If $\lambda > 0$, the time series and transaction taxes are in a reverse relationship. If otherwise, the time series and transaction taxes are in a positive relationship. The symbol ε_{it} denotes errors.

The next step is to examine the cross effects of tax cuts, time trends and seasonable effects on futures return volatility and trading activities. This paper incorporates Flexible Fourier Form (FFF_t) and dummy variable for transaction taxes, D_t^{Tax}, in Eq. (3) into the dynamic two-equation structural model consisting of return volatility and trading activity variables. Meanwhile, this paper uses the SUR method to estimate this structural equation. The SUR estimation is based on the absence of a diagonal relationship in the co-variance matrix of error items in the structural equation. It is applicable when the error items of respective equations are correlated. After the confirmation of such a correlation, this paper uses the SUR estimation to test the impact of tax cuts, time trends and seasonable effects on the Taiwan index futures return volatility and trading activities. The dynamic two-equation structural model is described as follows:

$$\sigma_t^2 = c_{10} + \alpha_{11} \cdot \sigma_{t-1}^2 + \mathrm{K} + \alpha_{1p} \cdot \sigma_{t-p}^2 + \beta_{10} \cdot TAV_t + \mathrm{K} + \beta_{1q} \cdot TAV_{t-q} + FFF_{1t} + \lambda_1 \cdot D_t^{Tax} + \varepsilon_{1t}$$

$$TAV_t = c_{20} + \alpha_{10} \cdot \sigma_t^2 + \mathrm{K} + \alpha_{1r} \cdot \sigma_{t-r}^2 + \beta_{11} \cdot TAV_{t-1} + \mathrm{K} + \beta_{1s} \cdot TAV_{t-s} + FFF_{2t} + \lambda_2 \cdot D_t^{Tax} + \varepsilon_{2t} \quad \textbf{(5)}$$

In Eq. (5), the symbol σ_t^2 denotes the return volatility of the t-th trading day. At this juncture, this paper selects detailed data of the sum of intraday return volatility for measurements. The symbol TAV_t denotes the trading activity variable, measured with daily trading volume (V_t) and speculative trading activities (VO_t). The symbols p, q, r and s denote the four lag lengths, respectively. The number of lengths is determined with stepwise regression. The symbol FFF_t denotes Flexible Fourier Form, which is used to test Monday effects, time trends and time-to-maturity. The symbol D_t^{Tax} denotes the dummy variable for transaction taxes. If λ_i value ($i = 1, 2$) is significantly different from zero, the tax cut effects do exist. It means that tax reductions have significant effects on the volatility or trading activities of futures. The symbols c_{10} and c_{20} denotes drift items whereas the symbols ε_{1t} and ε_{2t} denote error items.

4. Results and Analysis

Below is a summary of test results based on the empirical study performed in the abovementioned method.

4.1. Basic Descriptive Statistics and Unit Root Tests of Futures Trading Activities and Return Volatility

Table 1 summarizes the descriptive statistics and unit root tests of the trading activities of the nearby contracts of four Taiwan stock index futures during the 18 months before the transaction tax cuts on January 1, 2006 and the 18 months after the tax cuts. This paper finds that under the 5% significance level, the *t*-value tests are significantly greater than zero. The average daily trading volume of TX futures, MTX futures and TE futures rose significantly from 25,393, 4,710 and 4308 contracts before tax cuts to 35,665, 6,503 and 4,546 contracts after tax cuts (under the 5% significance level, t-statics significantly more than zero). However, the average daily trading volume of TF futures dropped noticeably from 3,770 contracts before tax cuts to 2,677 contracts after tax cuts (under the 5% significance level, t-statics significantly smaller than zero). Hence, this paper finds that transaction tax cuts cannot enhance the average daily trading volumes for all the index futures contracts on the market.

Secondly, the average daily open interests of MTX futures and TF futures significantly dropped from the before-tax-cut levels of 6,541 and 8,910 contracts to 5,134 and 5,712 contracts, respectively, after tax cuts (under the 5% significance level, the *t*-value significantly smaller than zero). The average daily open interests of TX futures and TE futures significantly dropped from the before-tax-cut levels of 33,357 and 7,752 contracts to 35,142 and 8,242 contracts, respectively, after tax cuts (under the 5% significance level, the *t*-value significantly greater than zero). If open interests are considered a proxy variable

Table 1

Summary Statistics and Unit Root Tests for Daily Futures Trading Activities on the Taiwan Stock Index Futures Market: 2004.7.1-2007.6.31., 742 Trading Days.

Futures	**TX**			**MTX**			**TE**			**TF**		
Study Period	Before	After	Whole	Before	After	Whole	Before	After	Whole	Before	After	Whole
Part I: Daily trading volume												
Mean	25393	35665	30474 ^{U}	4710	6503	5597 ^{U}	4308	4546	4426 ^{U}	3770	2677	3230 ^{D}
Median	25114	35217	29800	4119	6422	5401	4180	4360	4284	3291	2396	2776
Std. Dev.	8365.7	10111.8	10594.1	2312.8	2177.4	2417.8	1477.8	1615.5	1551.0	1941.9	1320.8	1750.4
Skew.	0.7186	0.5548	0.6279	1.1956	0.3263	0.5887	0.7474	0.5175	0.6351	1.4126	2.0184	1.7098
Kurt.	3.7079	4.0780	3.6599	4.6078	2.8750	3.0090	4.2518	2.8783	3.4633	5.5630	9.2783	6.9269
ADF / PP	-4.479* / -28.515*			-4.920* / -22.683*			-5.411* / -25.646*			-3.747* / -18.316*		
Part II: Daily open interest												
Mean	33357	35142	34240 ^{U}	6541	5134	5845 ^{D}	7752	8242	7994 ^{U}	8910	5712	7328 ^{D}
Median	33724	36375	34707	6576	5143	5614	7912	8402	8161	8979	5605	6860
Std. Dev.	8808.2	8209.1	8558.1	1942.8	1349.	1816.3	1889.8	1932.2	1925.3	3049.0	1469.7	2884.4
Skew.	-0.0580	-0.8386	-0.4190	-0.0472	-0.2104	0.2709	-0.4790	-1.0629	-0.7505	0.5035	-0.3789	0.9844
Kurt.	3.2992	4.1819	3.5359	2.9580	3.9001	3.3412	3.7025	4.7897	4.0676	4.2357	3.1112	4.8392
ADF / PP	-8.893* / -8.771*			-6.414* / -6.644*			-10.321* / -9.737*			-6.914* / -6.106*		
Part III: Speculation ratio												
Mean	0.8124	1.0717	0.9406 ^{U}	0.7599	1.3106	1.0323 ^{U}	0.5902	0.6057	0.5979	0.4617	0.4983	0.4798 ^{U}
Median	0.7682	1.0123	0.8854	0.6863	1.2511	0.9830	0.5400	0.5357	0.5385	0.4049	0.4256	0.4136
Std. Dev.	0.3256	0.3785	0.3756	0.3651	0.4309	0.4847	0.2474	0.3397	0.2966	0.2517	0.2689	0.2608
Skew.	0.9364	1.0493	0.9747	1.1126	0.8873	0.7414	1.3645	2.3498	2.1665	1.2180	1.8973	1.5921
Kurt.	4.0129	4.8779	4.5878	4.5793	4.3665	3.6781	7.3591	10.7961	11.1089	4.6568	8.4670	6.9207
ADF / PP	-5.831* / -22.360*			-7.696*/ -7.559*			-16.357* / -16.862*			-11.345* / -14.138*		

note：Before-period: 2004.7.1-2005.12.31., 375 trading days; After-period: 2006.1.1-2007.6.31., 372 trading days. * indicates significance at the 1% level. ADF is the unit root test of Augmented Dickey-Fuller test; PP is the unit root test of Phillips-Perron test. Uindicates significance at the 5% level in the mean increase in after-period with reduced tax ratio; DIndicates significance at the 5% level in the mean decrease in after-period with reduced tax ratio.

Table 2

Summary statistics and unit root tests for daily futures return and volatility on the Taiwan stock index futures market: 2004.7.1-2007.6.31., 742 trading days.

Futures	TX			MTX			TE			TF		
Study Period	Before	After	Whole	Before	After	Whole	Before	After	Whole	Before	After	Whole
Part I: Daily futures return												
Mean	0.0364	0.0792	0.0576	0.0364	0.0792	0.0576	0.0633	0.0734	0.0683	-0.0111	0.0399	0.0141
Median	0.0000	0.1506	0.0685	-0.0164	0.1471	0.0634	0.0000	0.1914	0.1002	0.0199	0.1192	0.0810
Std. Dev.	0.9860	1.1328	1.0607	0.9726	1.1586	1.0681	1.2633	1.3016	1.2815	1.1783	1.2446	1.2110
Skew.	-0.3183	-0.8301	-0.6197	-0.1352	-0.8295	-0.5635	-0.0542	-0.8249	-0.4524	-0.1173	-0.2426	-0.1810
Kurt.	4.9761	6.0484	5.7268	4.6947	6.1538	5.7924	4.8189	6.1707	5.5262	9.6144	4.6711	6.9104
ADF /PP	-28.435* / -28.413*			-28.829* / -28.801*			-29.001* / -29.026*			-28.307* / -28.314*		
Part II: Squared return volatility												
Mean	0.9337	1.2313	1.0809	0.9710	1.2860	1.1268	1.5957	1.6948	1.6447	1.3848	1.5463	1.4647
Median	0.2652	0.4324	0.3327	0.2526	0.4072	0.3132	0.4695	0.5963	0.5220	0.3714	0.4449	0.3968
Std. Dev.	1.7708	2.6681	2.2630	1.9260	2.8179	2.4123	3.1142	3.7817	3.4585	4.0705	2.9529	3.5604
Skew.	4.0901	6.2482	6.1198	4.6226	6.2902	6.2067	4.4861	6.7814	6.0363	8.3836	3.3788	7.2496
Kurt.	25.4164	57.3756	60.6045	31.4757	57.9955	60.7372	29.9327	66.2350	56.7837	91.7134	15.4663	82.1169
ADF /PP	-9.912* / -26.975*			-10.233* / -26.924*			-12.237* / -9.737*			-20.866* / -20.908*		
Part III: High-low price volatility												
Mean	0.6369	0.7456	0.6907	0.6308	0.8049	0.7169^{U}	1.0010	1.0684	1.0343	0.8256	1.0127	0.9181
Median	0.3876	0.4645	0.4258	0.3642	0.4607	0.4255	0.5920	0.6564	0.6301	0.4944	0.6097	0.5459
Std. Dev.	0.7866	1.0236	0.9126	0.7796	1.3624	1.1096	1.2001	1.5891	1.4055	1.3583	1.1582	1.2659
Skew.	3.4101	4.9426	4.5905	3.3632	6.5244	6.6692	3.4996	5.4894	5.0350	8.2058	2.8504	6.1556
Kurt.	17.8757	35.8261	33.5388	18.1854	56.4860	67.3105	20.5612	43.3586	40.7399	100.896	12.3932	70.5528
ADF /PP	-8.953* / -28.194*			-5.935* / -28.470*			-5.678* / -27.735*			-9.770* / -26.488*		
Part IV: GK volatility												
Mean	0.6413	0.7079	0.6742	0.6064	0.7459	0.6754	0.9531	1.0121	0.9823	0.7815	0.9419	0.8608^{U}
Median	0.4004	0.5017	0.4473	0.3707	0.4751	0.4307	0.6495	0.6884	0.6686	0.4898	0.6072	0.5386
Std. Dev.	0.8121	0.7892	0.8010	0.7691	1.3666	1.1072	1.0533	1.4304	1.2536	1.0229	0.9122	0.9724

Study Period	Before	After	Whole	Before	After	Whole	Before	After	Whole	Before	After	Whole
Skew.	4.3910	3.6599	4.0322	4.2330	9.3879	9.5274	3.0025	6.6574	5.8014	4.4972	2.2560	3.5317
Kurt.	29.8557	22.2463	26.1599	29.0257	109.685	131.043	14.6273	70.0657	62.6474	30.3002	9.3815	21.7703
ADF / PP	-10.956* / -26.713*			-12.496* / -27.328*			-10.685* / -26.262*			-11.076* / -25.355*		
Part V: Sum of intraday return volatility												
Mean	0.9142	1.0037	0.9585	0.9368	1.0031	0.9696	1.4288	1.4875	1.4579	1.3761	1.2755	1.3263
Median	0.6151	0.7112	0.6586	0.6208	0.7348	0.6801	1.0322	1.0335	1.03285	0.7220	0.8958	0.8032
Std. Dev.	1.0468	1.1506	1.0995	0.9609	0.9156	0.9387	1.4525	1.8527	1.6617	4.0737	1.0461	2.9865
Skew.	4.7618	6.7563	5.9055	3.1053	2.9306	3.0170	3.8804	6.2600	5.6027	10.5059	2.2415	13.5406
Kurt.	36.4895	75.7891	60.2442	15.1590	13.994	14.6003	24.8957	61.1387	54.1476	124.229	8.9890	217.747
ADF / PP	-10.044* / -27.362*			-9.755* / -23.418*			-9.272* / -26.871*			-13.200* / -17.225*		

note: Before-period: 2004.7.1-2005.12.31., 375 trading days; After-period: 2006.1.1-2007.6.31., 372 trading days. * indicates significance at the 1% level. ADF is the unit root test of Augmented Dickey-Fuller test; PP is the unit root test of Phillips-Perron test. U indicates significance at the 5% level in the mean increase in after-period with reduced tax ratio.

for market depth, the result summarized in Table 1 suggests that the cuts of transaction taxes enhance the market depth for TX futures and TE futures but weaken the market depth for MTX futures and TF futures. The speculative trading activities (trading volume/open interest) of TX futures and MTX futures increased dramatically from 0.8124 and 0.7599 before tax cuts to 0.0717 and 1.3106, respectively, after tax cuts (under the 5% significance level, the *t*-value significantly greater than zero). Hence, this paper infers that the speculative trading activities of TX futures and MTX futures will rise significantly due to tax cuts. However, TE futures exhibit no significant variance. Finally, under the 1% significance level, all the ADF and PP unit root tests on all the series report significant results and reject the unit roots. Hence, this paper infers that the series of the trading activities of the four index futures are all stationary.

Table 2 summarizes the descriptive statistics and unit root tests of the daily log returns and return volatility of the nearby contracts of four Taiwan stock index futures during the 18 months before the transaction tax cuts on January 1, 2006 and the 18 months after the tax cuts. Without considering the transactional costs, this paper finds that under the 5% significance level, the *t*-value tests on the average daily log return of the four index futures cannot support that there are any significant variances before and after tax cuts, although the average daily log return of TX futures and MTX futures increase from 0.0364 % and 0.0364 % before tax cuts to 0.0792 % and 0.0792% after tax cuts. Secondly, the coefficients of skewness of the daily log return of these four index futures are all negative and skewed to the right. All the coefficients of kurtosis are greater than three, consistent with the leptokurtic characteristics of typical financial assets. Meanwhile, this paper also finds that among the four index futures, only the *t*-value tests on the average high-low price volatility of MTX futures and the GK volatility of TF futures are significantly greater than zero under the 5% significance level. Other volatility does not significantly increase or decrease after tax cuts. Finally, under the 1% significance level, the ADF and PP unit root tests of the return volatility series are all significantly different from zero so the unit roots are rejected. Therefore, this paper infers that the series of the return volatility of the four index futures are all stationary.

4.2 Model Fit and Tests on Impacts of Transaction Taxes, Time Trends and Seasonal Factor on Trading Activities and Return Volatility

Table 3 summarizes the effects of transaction taxes, time trends and seasonable factors on the trading activities of the nearby contracts of four stock index futures, i.e. TX futures, MTX futures, TE futures and TF futures. Firstly, this paper considers the influence of time factors, such as Mondays, time trends and time-to-maturity on futures trading activities and return volatility by identifying the optimal explanatory variables with stepwise regression and deriving the optimal explanatory model. Finally, this paper incorporates the dummy variable for tax cuts, D_t^{Tax}, to further test the impact of transaction tax reductions and seasonal factors on the futures trading activities and return volatility. At this juncture, this paper selects the optimal model by choosing the smallest SIC value. Test results are listed in Table 3. The λ coefficients in Table 3 show the relationship of transaction taxes with futures trading activities and the relationship of transaction taxes with return volatility. Secondly, this paper refers to a_1 coefficients to test Monday effects. It refers b_1 and b_2 coefficients to test time trends. It also uses the c_1 and c_2 coefficients to test time-to-maturity and ϕ_i and θ_i coefficients to test the cyclical relationship of smooth waves between futures trading activities (or return volatility) and time-to-maturity.

Part 1 of Table 3 indicates the test results of daily trading volumes. It shows that λ coefficients of the four index futures are all significantly greater than zero (p=0.000) and supports the significant reverse relationship between daily trading volumes and transaction tax rates for all the four index futures. In other words, transaction tax cuts markedly enhance daily trading volumes of the four Taiwan index futures. However, the trading volume of TF futures is greater before tax cuts if time trends are not taken into account (Table 1). After time trends are taken into the equation, the influence of transaction taxes on the trading volume of TF futures is the same as the influence on the other three index futures. Meanwhile, test results indicate that the a_1 coefficients for TX futures and TE futures are -2232.18 and -436.899, respectively and their p values are 0.006 and 0.001. These numbers are statistically significant and hence support the conclusion that Monday trading volumes of TX futures and TE futures are significantly smaller than those on other trading days. In other words, Monday effects do exist. This paper then continues to perform a test on b_1 or b_2 coefficients to validate whether Monday effects are relevant to the correlation of TX futures and TE futures with international equity markets (as Mondays in Taiwan are Sundays in Europe and the US).

Except for the b_2 coefficient of TX futures, the trading volumes of these four futures are significantly correlated with time or time squares. Hence, this paper infers that there are time trends in the trading volumes of Taiwan index futures. Meanwhile, this paper also finds that the test results on c_1, c_2, ϕ_1 and θ_1 coefficients of TX futures and MTX futures are significantly different from zero (p values all smaller than 0.01). Therefore, this paper infers that the trading volumes of TX futures and MTX futures are significantly correlated with time-to-maturity. Meanwhile, it is also in a cyclical (regular) relationship of a smooth sine wave with time-to-maturity.

According to the test results on daily open interests shown in Section 2 of Table 3, the λ coefficients of these four index futures are all significantly smaller than zero (p=0.000). Therefore, this paper there is a significantly positive correlation between daily open interests and transaction taxes. In other words, the reduction of transaction taxes lowers daily open interests. Meanwhile, this paper also finds that only the a_1 coefficient of the open interests for TX futures is significantly smaller than zero (a_1 = -0.0978; p-values = 0.000). This shows that the open interest of TX futures is significantly smaller on Mondays and hence Monday effects do exist. As far as the b_1 or b_2 time trend coefficients are concerned, the b_1 coefficient of TX futures is 27.4189 and the b_2 coefficient is -0.0107; the b_1 coefficient of MTX futures is -5.7667 and the b_2 coefficient is 0.0043; the b_1 coefficient of TF futures is -5.1211 and b_2 coefficient is 0.0031. All these coefficients are significantly different from zero.

Table 3

Tax, Time Trend and Seasonal Factors for the Effect of Futures Trading Activities on the Nearby Contracts of Four Stock Index Futures in the Taiwan Futures Market: 2004.7.1-2007.6.31., 742 Trading Days.

$$Variable = a_0 + a_1 \cdot D_{MON} + b_1 \cdot t + b_2 \cdot t^2 + c_1 \cdot ttm_t + c_2 \cdot ttm_t^2 + \sum_{i=0}^{n}\left(\phi_i \cdot \cos\left(\frac{2\pi \cdot i \cdot ttm_t}{ttm_{\max}}\right) + \theta_i \cdot \sin\left(\frac{2\pi \cdot i \cdot ttm_t}{ttm_{\max}}\right)\right) + \lambda \cdot D_t^{Tax} + \varepsilon_t$$

Coeff.	n	**SIC**	a_0	a_1	b_1	b_2	c_1	c_2	ϕ_1	θ_1	ϕ_2	θ_2	λ
Part I: Daily trading volume													
TX	1	21.0363	-	-2232.18 (0.006)	-7.8679 (0.000)	-	4223.31 (0.000)	-102.879 (0.000)	14648.3 (0.000)	-4429.41 (0.007)	-	-	14686.2 (0.000)
MTX	1	17.8676	-	-	-13.2552 (0.000)	0.0092 (0.000)	1050.75 (0.000)	-24.7187 (0.000)	3376.32 (0.000)	-734.440 (0.030)	-	-	3553.21 (0.000)
TE	0	17.3055	4505.11 (0.000)	-436.899 (0.001)	1.3156 (0.054)	-0.0047 (0.000)	-	-	-	-	-	-	2331.11 (0.000)
TF	0	17.4880	5717.54 (0.000)	-	-8.6602 (0.000)	0.0044 (0.000)	-	-	-	-	-	-	1014.44 (0.000)
Part II: Daily open interest													
TX	2	20.1948	-27975.7 (0.001)	-0.0978 (0.003)	27.4189 (0.000)	-0.0107 (0.000)	7069.62 (0.000)	-157.176 (0.000)	25257.9 (0.007)	2020.50 (0.586)	3813.62 (0.000)	478.598 (0.653)	-6782.24 (0.000)
MTX	2	17.1656	-	-	-5.7667 (0.000)	0.0043 (0.000)	977.267 (0.000)	-21.7171 (0.000)	3060.29 (0.000)	357.266 (0.465)	509.529 (0.000)	115.297 (0.365)	-820.431 (0.000)
TE	2	17.2831	-9600.39 (0.000)	-	-	-	2457.55 (0.000)	-57.5425 (0.000)	9477.79 (0.000)	-987.218 (0.258)	1226.00 (0.000)	-328.876 (0.189)	-499.883 (0.000)
TF	2	17.9899	-	-	-5.1211 (0.000)	0.0031 (0.000)	1080.01 (0.000)	-20.9737 (0.000)	3494.71 (0.000)	1907.48 (0.010)	595.041 (0.000)	394.534 0.040)	-2273.53 (0.000)
Part III: Speculation ratio													
TX	1	0.6135	1.6571 (0.000)	-0.1017 (0.001)	-	-4.53E-07 (0.000)	-0.1070 (0.000)	0.0025 (0.001)	-0.3201 (0.001)	0.0186 (0.809)	-	-	0.5301 (0.000)
MTX	0	1.0161	0.9051 (0.000)	-0.0957 (0.009)	-	-1.79E-07 (0.017)	-0.0197 (0.001)	0.0006 (0.000)	-	-	-	-	0.6559 (0.000)
TE	2	0.0467	3.2982 (0.000)	-0.0936 (0.000)	0.0004 (0.010)	-6.14E-07 (0.000)	-0.4065 (0.000)	0.0097 (0.000)	-1.6434 (0.000)	0.3097 (0.048)	-0.2355 (0.000)	0.0890 (0.047)	0.1429 (0.000)
TF	1	-0.2973	1.6615 (0.000)	-0.0567 (0.003)	-0.0008 (0.000)	3.32E-07 (0.000)	-0.1384 (0.000)	0.0032 (0.000)	-0.4294 (0.000)	0.0428 (0.379)	-	-	0.2668 (0.000)

note: The selection factor of the model is the minimum SIC value; Numbers in parentheses are z-values.

Table 4

Tax, Time Trend and Seasonal Factors for the Effect of Futures Return and Volatility on the Nearby Contracts of Four Stock Index Futures in the Taiwan Futures Market: 2004.7.1-2007.6.31., 742 Trading Days.

$$Variable = a_0 + a_1 \cdot D_{MON} + b_1 \cdot t + b_2 \cdot t^2 + c_1 \cdot ttm_t + c_2 \cdot ttm_t^2 + \sum_{i=0}^{n}\left(\phi_i \cdot \cos\left(\frac{2\pi \cdot i \cdot ttm_t}{ttm_{max}}\right) + \theta_i \cdot \sin\left(\frac{2\pi \cdot i \cdot ttm_t}{ttm_{max}}\right) \right) + \lambda \cdot D_t^{Tax} + \varepsilon_t$$

Coeff.	n	SIC	a_0	a_1	b_1	b_2	c_1	c_2	ϕ_1	θ_1	λ
Part I: Squared return volatility											
TX	0	4.4847	0.8385 (0.000)	0.4961 (0.018)	-	-	-	-	-	-	0.2955 (0.074)
MTX	0	4.6125	0.8691 (0.000)	0.5308 (0.018)	-	-	-	-	-	-	0.3127 (0.077)
TE	0	5.3372	1.4506 (0.000)	0.7558 (0.019)	-	-	-	-	-	-	0.0960 (0.705)
TF	0	5.3935	1.3848 (0.000)	-	-	-	-	-	-	-	0.1616 (0.537)
Part II: High-low price volatility											
TX	0	2.6682	0.7774 (0.000)	-	-0.0089 (0.012)	-	-	-	-	-	0.1109 (0.097)
MTX	0	3.0584	0.7749 (0.000)	0.2003 (0.050)	-	-	-0.0116 (0.007)	-	-	-	0.1762 (0.029)
TE	0	3.4906	1.5586 (0.000)	-	-0.0020 (0.000)	-	-	-	-	-	1.1709 (0.000)
TF	0	3.3205	0.8256 (0.000)	-	-	-	-	-	-	-	0.1870 (0.044)
Part III: GK volatility											
TX	0	2.3627	1.0633 (0.000)	-	-0.0012 (0.000)	-	-0.0059 (0.053)	-	-	-	0.7194 (0.000)
MTX	0	3.0547	0.7751 (0.000)	-	-	-	-0.0107 (0.013)	-	-	-	0.1422 (0.079)
TE	0	3.2542	1.6294 (0.000)	-	-0.0020 (0.000)	-	-0.0085 (0.075)	-	-	-	1.1347 (0.000)
TF	0	2.7916	0.7815 (0.000)	-	-	-	-	-	-	-	0.1605 (0.025)
Part IV: Sum of intraday return volatility											
TX	0	2.9942	1.3673 (0.000)	-	-0.0016 (0.025)	-	-	-	-	-	0.9863 (0.000)
MTX	0	2.6753	1.3335 (0.000)	-	-0.0014 (0.014)	-	-	-	-	-	0.8513 (0.000)
TE	0	3.8112	2.1712 (0.000)	-	-0.0027 (0.000)	-	-	-	-	-	1.5277 (0.000)
TF	0	5.0422	1.3761 (0.000)	-	-	-	-	-	-	-	-0.1007 (0.647)
Part V: Squared overnight return											
TX	0	2.6765	0.7081 (0.000)	-	-0.0016 (0.000)	8.16E-07 (0.029)	-	-	-	-	0.3940 (0.003)
MTX	0	1.9225	0.5356 (0.000)	-	-0.0011 (0.000)	6.19E-07 (0.016)	-	-	-	-	0.2420 (0.008)

Coeff.	n	SIC	a_0	a_1	b_1	b_2	c_1	c_2	ϕ_1	θ_1	λ
TE	0	3.3799	0.4753 (0.000)	-	-	-	-	-	-	-	0.0399 (0.677)
TF	0	4.5062	0.4697 (0.0001)	-	-	-	-	-	-	-	-0.1891 (0.260)
Part VI: Squared intraday 5-minute returns											
TX	0	1.4185	0.8199 (0.000)	-	-0.0009 (0.000)	-	-	-	-	-	0.5849 (0.000)
MTX	0	1.9051	0.9199 (0.000)	-	-0.0010 (0.000)	-	-	-	-	-	0.6037 (0.000)
TE	0	2.4873	1.4068 (0.000)	-	-0.0016 (0.000)	-	-	-	-	-	0.9157 (0.000)
TF	0	4.0553	0.9064 (0.000)	-	-	-	-	-	-	-	0.0884 (0.509)

note: The selection factor of the model is the minimum SIC value; Numbers in parentheses are p-values.

This indicates that the daily open interests of these three index futures are relevant to time and time squares so time trends do exist. Meanwhile, c_1, c_2, ϕ_1 and ϕ_2 coefficients of these four index futures are all significantly different from zero. It suggests that the daily open interests are relevant to time-to-maturity or time squares. There is also a cyclical relationship of a smooth sine wave. According to the test results on speculative trading activities listed in Section 3 of Table 3, this paper finds that the λ coefficients of the four index futures are all significantly greater than zero and the p values are all smaller than 0.05. Hence, this paper infers that there is a significantly reverse relationship between transaction taxes and speculative trading activities. In other words, tax cuts noticeably enhance the speculative trading activities in the futures market. Meanwhile, this paper finds that the a_1 coefficients of the speculative trading activities of the four futures are all significantly smaller than zero. This indicates that the speculative trading activities in the Taiwan index futures market are significantly reduced on Monday and Monday effects do exist. Similarly, this paper finds that speculative trading activities report in part or in all a significant correlation with time trends (a_1 and a_2) and time-to-maturity (c_1, c_2, ϕ_1, θ_1, ϕ_2 and θ_2) for these four futures.

Secondly, Part I to IV of Table 4 summarize the test results of the squared return volatility, the high-low price volatility, GK volatility and the sum of intraday return volatility based on the four degrees of information contents. According to Part I, the effect of tax cuts on the squared return volatility is not obvious, because all the p values of the λ coefficients of these four index futures are greater than 0.05. Meanwhile, Part II and Part III list the test results on λ coefficients. They show that the λ coefficients of the high-low price volatility of MTX futures, TE futures and TF futures and the λ coefficients of the GK volatility of TX futures, TE futures and TF futures are significantly greater than zero (with p values all smaller than 0.05). The above results indicate that for most index future contracts, there is a significantly reverse relationship between return volatility and transaction taxes. The test results of detailed data, i.e. 5-minute intraday trading data and the estimation of the volatility (Part IV of Table 4) also suggest that the λ coefficients of the sum of intraday return volatility for TX futures, MTX futures and TE futures are all significantly greater than zero (with p values all smaller than 0.05). Therefore, this paper infers that there is a significantly reverse relationship between the sum of intraday return volatility and transaction taxes for TX futures, MTX futures and TE futures.

This paper continues to examine whether the enhanced sum of intraday return volatility stems from the squared intraday return volatility or overnight volatility during trading hours. This paper applies the method listed in Table 4 to test overnight volatility and the squared intraday return volatility. The results are summarized in Part V and Part VI of Table 4. This paper finds that the intraday volatility and transaction taxes are in a significantly reverse relationship as far as the overnight volatility and the squared intraday return volatility of TX futures and MTX futures are concerned. However, in the case of TE futures, only the squared intraday return volatility and transaction taxes are in a significantly reverse relationship. To sum up the results shown in Table 4, the impacts of transaction taxes on the return volatility estimated with information of different levels of contents are different. This paper does not find any significant tax effects on volatility if daily trading data is used to perform tests. However, if intraday trading data is used for empirical tests, this paper finds that the sum of intraday return volatility is subject to significant tax effects.

According to the test results on c_1, c_2, ϕ_1, θ_1, ϕ_2 and θ_2 coefficients shown in Table 4, only the high-low price volatility of MTX futures (c_1 = -0.0116) and its GK volatility (c_1 = -0.0107, $p<0.05$) report a significant negative relationship, all the other coefficients are significantly different from zero. Hence, this paper infers that the return volatility and time-to-maturity for these four index futures are not heavily related. So, the research finding tends to support that there is no time-to-maturity effect on futures return volatility. The test results on b_1 coefficients shown in Table 4 suggest that the high-low price volatility, GK volatility and the sum of intraday return volatility of TX futures and TE futures and the sum of intraday return volatility of MTX futures are significantly smaller than zero ($p<0.05$). Therefore, this paper tends to support that the return volatility and market timing are in a reverse relationship for TX futures, MTX futures and TE futures. Time trends for the volatility do exist. Meanwhile, the test results on time trends with mean squared return and the sum of intraday return volatility show significant variances. Time trends do not exist for the squared return volatility of these four futures. However, there is a significant reverse relationship between the sum of intraday return volatility and market timing for FX futures, MTX futures and TE futures.

The test results on a_1 coefficients reported in Table 4 suggest that the a_1 coefficients of TX futures (a_1=0.4961), MTX futures (a_1=0.5308) and TE futures (a_1=0.7558) are significantly greater than zero. The research finding tends to support that there are Monday effects for Taiwan stock index futures because the mean square volatility on Mondays is obviously greater than that on other weekdays. This conclusion is similar with Ho and Cheung (1994) and Clare *et al.* (1997) whose empirical results support Monday effects in the Taiwanese stock market. However, this paper performs a test with detailed data, i.e. the sum of intraday return volatility, but finds that all the a_1 coefficients of these four index futures are all significantly different from zero. Hence, this paper infers that there is no Monday effect on the sum of intraday return volatility for all these four index futures.

4.3 Tests of Transaction Taxes and Seasonal Effects in a Dynamic Structure of Cross Effects from Futures Return Volatility and Trading Activities

After the confirmation of the correlation between the two error items in Eq. (5), this paper applies the SUR method to estimate the dynamic structured model of the sum of intraday return volatility and trading volume for the four Taiwan stock index futures. The test results on time factors, such as transaction taxes, time trends, Mondays and time-to-maturity, are summarized in Table 5. The results indicate that the λ_i coefficients of TX futures, MTX futures and TE futures are 8,058.07, 2,028.63 and 1,018.09 respectively and their t-statics are 6.1890, 7.9841 and 4.7277, respectively. Under the 1% significance level, the λ_i values of these three futures are significantly greater than zero. This shows that the trading volumes and transaction taxes of these three futures are in a significantly reverse relationship. The finding supports that tax cuts enhance trading volumes. Secondly, under the 5% significance level, only the λ_i coefficient of the sum of intraday return volatility of TX futures is significantly smaller than zero, at -0.3068 (t statics of -2.0304). Therefore, after the consideration of the cross effects of the sum of intraday return volatility and trading volumes, this paper finds that only the sum of intraday return volatility of TX futures exhibits a significantly positive correlation with transaction taxes. However, in the case of the other three futures, the sum of intraday return volatility is not correlated with transaction taxes. Hence, this paper finds that in fact, futures return volatility is irrelevant to transaction taxes for most futures contracts, when the impact of trading volumes on return volatility is taken into account.

According to the test results on seasonal effects, the a_{i1} coefficients of trading volumes for TX futures and TE futures are -2,342.53 and -495.887 (*t*-value = -3.3366 and -4.2950) under the 1% significance level. Therefore, the trading volumes of these two futures on Monday are significantly smaller than the levels on other weekdays. Hence, Monday effects exist for the trading volumes of TX futures and TE futures. Based on the test results on time trends (i.e. b_{i1} and

b_{i2} coefficients), Table 5 shows that the b_{i1} coefficient of the sum of intraday return volatility of TX futures and the b_{i1} or b_{i2} coefficient for the trading volumes of MTX futures, TE futures and TF futures are significantly different from zero. All these results indicate the significant presence of time trends. Finally, according to the test results on the c_{i1}, c_{i2} and ϕ_{i1} coefficients, this paper finds that the trading volumes and time-to-maturity of TX futures and MTX futures are significantly and positively correlated (TX futures: c_{i1} = 2306.02; *t*-value = 5.0444, MTX futures: c_{i1} = 579.354; *t*-value = 6.6162). However, it is in a significantly reverse relationship with the time square of time-to-maturity (TX futures: c_{i2} = 54.2669, *t*-value = -4.2761; MTX futures: c_{i2} = -12.9036, t value=-5.3094). Hence, it is in a significant sine wave relationship with time-to-maturity (TX futures: ϕ_{i1} = 7036.91, *t*-value = 3.9801; MTX futures: ϕ_{i1} = 4.5142, *t*-value = 4.5142). Hence, this paper infers that the relationship between trading volumes and time-to-maturity is regular.

Similar with Table 5, Table 6 is the SUR estimation of the dynamic structured model of the sum of intraday return volatility and speculative trading activities for the four Taiwan index futures. This paper takes into consideration of the cross effects of the sum of intraday return volatility and speculative trading activities in the examination of the impact of transaction taxes and seasonal factors. According to Table 6, the λ_i coefficients of TX futures, MTX futures and TF futures are 0.1969, 0.2067 and 0.1392, respectively and their t values are 4.8756, 4.3261 and 4.9932, respectively. Under the 1% significance level, the λ_i values of these three futures are significantly greater than zero. This suggests that the speculative trading activities increased markedly after the reduction of transaction taxes. Meanwhile, according to the test results on the λ_i coefficients of the sum of intraday return volatility, this paper finds that the λ_i coefficients of TX futures and MTX futures are -0.3514 and -0.3130 and their *t*-values are -2.2737 and -2.4198, respectively. Under the 5% significance level, the λ_i coefficients are significantly smaller than zero. Hence, the research finding supports that there is a significant positive relationship between the sum of intraday return volatility and transaction taxes for TX futures and MTX futures.

However, the λ_i coefficient of TE futures is 0.5360, and its t value is 2.4455; therefore, the finding supports that there is a significant reverse relationship between the sum of intraday return volatility and transaction taxes. These results suggest that when speculative trading activities and return volatility are taken into the equation, the relationship between transaction taxes and return volatility is different from one futures contract to another.

Table 5

SUR Estimates of the Two-Equation Structural Model for the Sum of Intraday Return Volatility and Trading Volume and Tests the Impact of Tax, Time Trend and Seasonal Effects on the Nearby Contracts of Taiwan's Four Stock Index Futures: 2004.7.1-2007.6.31., 742 Trading Days.

$$\sigma_t^2 = c_{10} + \sum_{k=1}^{p} \alpha_{1k} \cdot \sigma_{t-k}^2 + \sum_{k=0}^{q} \beta_{1k} \cdot Vol_{t-k} + FFF_{1t} + \lambda_1 \cdot D_t^{Tax} + \varepsilon_{1t}$$

$$Vol_t = c_{20} + \sum_{k=0}^{r} \alpha_{2k} \cdot \sigma_{t-k}^2 + \sum_{k=1}^{s} \beta_{2k} \cdot Vol_{t-k} + FFF_{2t} + \lambda_2 \cdot D_t^{Tax} + \varepsilon_{2t}$$

Coeff.	TX futures		MTX futures		TE futures		TF futures	
	σ_t^2	Vol_t	σ_t^2	Vol_t	σ_t^2	Vol_t	σ_t^2	Vol_t
c_{i0}	-0.8848 (-6.5437)*	503.595 (0.1663)	-0.1790 (-1.6058)	-132.412 (-0.2195)	-0.8073 (-2.9663)*	2302.86 (8.9162)*	-0.0652 (-0.2239)	1364.85 (5.0586)*
α_{i0}	-	5063.10 (18.7147)*	-	1414.31 (22.5951)*	-	354.126 (12.3559)*	-	108.370 (7.2504)*
α_{i1}	0.0633 (1.9755)**	-	0.2728 (7.5545)*	-261.067 (-3.9584)*	0.1298 (3.7138)*	-	0.4868 (13.3918)*	-
α_{i2}	0.1266 (4.0465)*	-	0.0930 (2.8644)*	-	0.2038 (6.0640)*	-	-0.2164 (-5.4988)*	-
α_{i3}	0.1325 (4.1725)*	-	0.0625 (1.9335)	-	0.1073 (3.0564)*	-	0.0884 (2.4877)*	-
α_{i4}	-	-	-	152.243 (2.5322)**	-	-	-	-
α_{i5}	-	-	-	-	0.0685 (2.0467)**	-	-	-
β_{i0}	6.36E-05 (17.6401)*	-	0.0002 (17.7589)*	-	0.0005 (12.5569)*	-	0.0005 (7.1942)*	-
β_{i1}	-	-	-7.90E-05 (-5.4527)*	-	-0.0001 (-3.4302)*	-	-0.0003 (-4.4051)*	0.2478 (6.8367)*
β_{i2}	-	0.0705 (2.2563)**	-	0.0670 (2.3466)**	-	0.1720 (4.9029)*	4.91E-05 (0.6442)	0.1750 (4.7033)*

Coeff.	TX futures		MTX futures		TE futures		TF futures	
	σ_t^2	Vol_t	σ_t^2	Vol_t	σ_t^2	Vol_t	σ_t^2	Vol_t
β_{i3}	-	0.0723 (2.3715)*	-	0.0728 (2.5741)**	-	0.1029 (2.9873)*	-	0.1493 (4.0250)*
β_{i4}	-	-	-	-	-	0.0739 (2.1467)**	-	0.0846 (2.2923)**
β_{i5}	-	-	-	-	-	-	-	0.0754 (2.0912)**
a_{i1}	-	-2342.53 (-3.3366)*	-	-	-	-495.887 (-4.2950)*	-	-
b_{i1}	-0.0005 (-2.1001)**	0.3891 (0.2058)	-0.0002 (-1.2473)	-8.4871 (-9.6688)*	0.0001 (0.3287)	1.4477 (2.2823)**	-	-2.3005 (-3.2645)*
b_{i2}	-	-	-	0.0068 (9.8968)*	-	-0.0028 (-5.1255)*	-	0.0013 (2.3749)**
c_{i1}	-	2306.02 (5.0444)*	-	579.354 (6.6162)*	-	-	-	-
c_{i2}	-	-54.2669 (-4.2761)*	-	-12.9036 (-5.3094)*	-	-	-	-
ϕ_{i1}	-	7036.91 (3.9801)*	-	1523.93 (4.5142)*	-	-	-	-
θ_{i1}	-	972.337 (1.0368)	-	431.066 (2.4104)	-	-	-	-
λ_i	-0.3068 (-2.0304)**	8058.07 (6.1890)*	-0.1213 (-0.9551)	2028.63 (7.9841)*	-0.0788 (-0.3360)	1018.09 (4.7277)*	0.2193 (1.0630)	236.557 (1.3053)
R^2	0.2078	0.4171	0.2871	0.5910	0.2385	0.3369	0.2190	0.5203

note: Numbers in parentheses are *t*-values; * indicates significance at the 1% level; ** indicates significance at the 5% level.

Table 6

SUR Estimates of the Two-Equation Structural Model for the Sum of Intraday Return Volatility and Speculation Ratio and Tests the Impact of Tax, Time Trend and Seasonal Effects on the Nearby Contracts of Taiwan's Four Stock Index Futures: 2004.7.1-2007.6.31., 742 Trading Days.

$$\sigma_t^2 = c_{10} + \sum_{k=1}^{p} \alpha_{1k} \cdot \sigma_{t-k}^2 + \sum_{k=0}^{q} \beta_{1k} \cdot VO_{t-k} + FFF_{1t} + \lambda_1 \cdot D_t^{Tax} + \varepsilon_{1t}$$

$$VO_t = c_{20} + \sum_{k=0}^{r} \alpha_{2k} \cdot \sigma_{t-k}^2 + \sum_{k=1}^{s} \beta_{2k} \cdot VO_{t-k} + FFF_{2t} + \lambda_2 \cdot D_t^{Tax} + \varepsilon_{2t}$$

Coeff.	TX futures		MTX futures		TE futures		TF futures	
	σ_t^2	VO_t	σ_t^2	VO_t	σ_t^2	VO_t	σ_t^2	VO_t
c_{i0}	-0.6950 (-5.2242)*	0.8002 (8.0111)*	-0.1157 (-1.1494)	0.2654 (5.9405)*	0.0216 (0.1177)	1.5651 (7.9260)*	-0.3126 (-1.2692)	0.9756 (12.3483)*
α_{i0}	-	0.1608 (17.1906)*	-	0.2901 (23.2903)*	-	0.0577 (11.0999)*	-	0.0104 (4.6404)*
α_{i1}	0.0753 (2.2233)**	-0.0353 (-3.5102)*	0.3174 (8.9334)*	-0.1107 (-7.7007)*	0.0944 (2.6979)*	-0.0126 (-2.3529)**	0.4726 (13.0755)*	-
α_{i2}	-	0.0272 (2.7794)*	0.0666 (2.1846)**	-	0.2044 (5.8284)*	0.0103 (2.0252)**	-0.2291 (-5.8438)*	-
α_{i3}	0.1053 (3.2339)*	-	-	-	0.0879 (2.3954)**	0.0117 (2.2581)**	0.0977 (2.7384)*	-
α_{i4}	-	-	-	-	-	-	-	-
α_{i5}	-	-	-	-	0.0730 (2.1292)**	-	-	-
β_{i0}	1.7665 (17.1540)*	-	1.6393 (22.5117)*	-	1.6296 (9.0081)*	-	1.9319 (4.8127)*	-
β_{i1}	-	0.1292 (3.9245)*	-0.5934 (-7.0648)*	0.2835 (8.1461)*	-	0.2683 (8.7785)*	-	0.2699 (7.7742)*
β_{i2}	-	0.0865 (2.5899)*	-	0.1068 (3.5075)*	-	-	0.6710 (1.6424)	0.1721 (5.0456)*
β_{i3}	-	0.1264 (4.0065)*	-	0.0790 (2.5978)*	-	-	-	-
β_{i4}	-	-	-	-	-	-	-	-
β_{i5}	-	0.0943 (3.1554)*	-	0.0686 (2.3727)**	-	-	-	-
a_{i1}	-	-0.1031 (-4.3931)*	-	-0.0928 (-3.5051)*	-	-0.0840 (-4.3685)*	-	-0.0338 (-2.0342)**
b_{i1}	-2.93E-05 (-0.1248)	-	-0.0004 (-2.1586)**	-	-0.0009 (-2.5532)**	0.0005 (4.8053)*	-	-0.0004 (-4.4185)*
b_{i2}	-	-1.04E-07 (-2.0041)**	-	6.11E-08 (1.0405)	-	-4.65E-07 (-5.3368)*	-	1.84E-07 (2.4791)**

Coeff.	TX futures		MTX futures		TE futures		TF futures	
	σ_t^2	VO_t	σ_t^2	VO_t	σ_t^2	VO_t	σ_t^2	VO_t
c_{i1}	-	-0.0553 (-3.6059)*	-	-0.0106 (-2.6336)*	-	-0.1760 (-5.5405)*	-	-0.0771 (-6.7883)*
c_{i2}	-	0.0012 (2.8334)*	-	0.0003 (2.4347)*	-	0.0042 (4.9076)*	-	0.0017 (5.3356)*
ϕ_{i1}	-	-0.1303 (-2.2137)**	-	-	-	-0.5748 (-4.4623)*	-	-0.2098 (-4.8678)*
θ_{i1}	-	-0.0435 (-1.3951)	-	-	-	-0.1154 (-2.7860)*	-	-0.0651 (-2.8900)
ϕ_{i2}	-	-	-	-	-	-0.0904 (-3.1922)*	-	-
θ_{i2}	-	-	-	-	-	-0.0513 (-2.7754)*	-	-
λ_i	-0.3514 (-2.2737)**	0.1969 (4.8756)*	-0.3130 (-2.4198)**	0.2067 (4.3261)*	0.5360 (2.4455)**	0.0012 (0.0384)	-0.1432 (-0.7423)	0.1392 (4.9932)*
R^2	0.1956	0.4922	0.2708	0.5601	0.2317	0.5028	0.2252	0.5303

note: Numbers in parentheses are t-values; * indicates significance at the 1% level; ** indicates significance at the 5% level.

The test results on seasonal effects shown in Table 6 suggest that under the 5% significance level, the a_{i1} coefficients of the speculative trading activities for all the four index futures are all significantly smaller than zero. Therefore, this paper infers that the percentage of speculative trading activities on Monday is lower than other weekdays in the Taiwan index futures market. Hence, the finding supports Monday effects on the speculative trading activities in the Taiwan index futures market. One possible reason for this phenomenon may be the close of the stock markets in Europe and the US. Similarly, the test results on the a_{i1} coefficients of the sum of intraday return volatility for all the four index futures find no Monday effects. Secondly, the test results on the b_{i1} and b_{i2} coefficients in Table 6 demonstrate that under the 5% significance level, the b_{i1} or b_{i2} coefficients of these futures are significantly different from zero. This shows that time trends exist in the speculative trading activities of TX futures, TE futures and TF futures, as well as the intraday return volatility of MTX futures and TE futures.

According to the test results of c_{i1}, c_{i2}, ϕ_{i1}, θ_{i1}, ϕ_{i2} and θ_{i2} coefficients, under the 1% significance level, this paper finds that the speculative trading activities of the four types of futures contracts are all significantly correlated to time-to-maturity (TX futures: c_{i1}=-0.0553, *t*-value = -3.6059; MTX futures: c_{i1}=-0.0106, *t*-value = -2.6336; TE futures: c_{i1}= -0.1760, *t*-value= -5.5405; TF futures: c_{i1}= -0.0771, *t*-value = -6.7883) and the square of time-to-maturity (TX futures: c_{i2}= 0.0012, *t*-value = 2.8334; MTX futures: c_{i2}= 0.0003, *t*-value = 2.4347; TE futures: c_{i2}= 0.0042, *t*-value = 4.9076; TF futures: c_{i2}= 0.0017, *t*-value = 5.3356). This means that the speculative trading activities of Taiwan index futures are significantly and positively correlated with time-to-maturity, but significantly and negatively correlated with the square of time-to-maturity. Finally, under the 5% significance level, the ϕ_{i1} coefficients of TX futures, TE futures and TF futures are significantly different from zero (TX futures: ϕ_{i1}= -0.1303, *t*-value = -2.2137; TE futures: ϕ_{i1}= -0.5748, *t*-value = -4.4623; TF futures: ϕ_{i1}= -0.5748, *t*-value = -4.4623). Hence, this paper infers that there is a smooth sine wave relationship between speculative trading activities and time-to-maturity for Taiwan index futures. It is worth noting that ϕ_{i1}, θ_{i1}, ϕ_{i2} and θ_{i2} coefficients (indicative of the speculative trading activities of TE futures) are all significantly different from zero. There are two sine waves in the relationship between speculative trading activities and time-to-maturity. This number of sine waves is consistent with the finding of Luu and Martens (2003) who examine the US market. It is worth following whether this is because the electronics sector in Taiwan is highly relevant to the US.

4.4 Comparison of Overall Futures Market before and after Tax Reductions

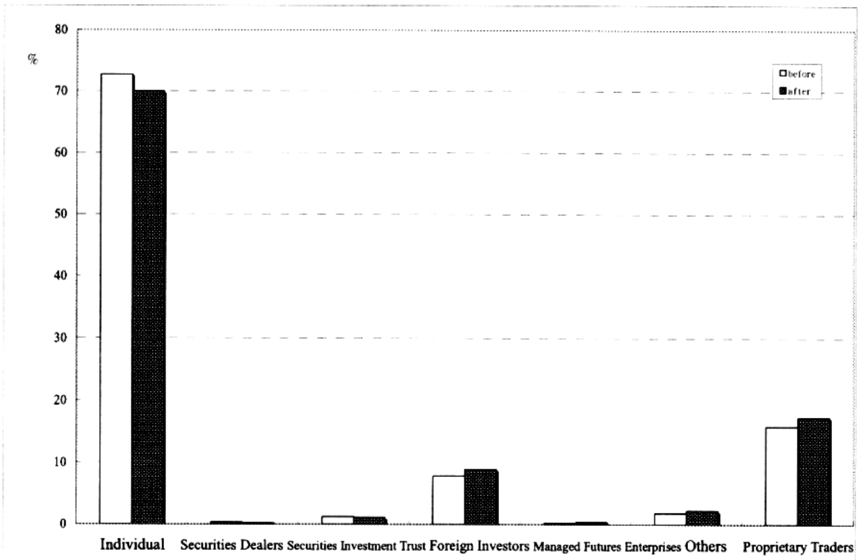
According to the tax revenue statistics released by the Ministry of Finance, the annual transaction tax revenues in 2004 (two years before the tax reduction on January 1, 2006) and in 2005 (one year before the tax reduction) totalled NT$8,272 million and NT$6,342 million, respectively. The tax revenues in 2006 (the first year after tax cuts), 2007 (the second year) and 2008 (the third year) amounted to NT$4,072 million, NT$5,758 million and NT$6,692 million, respectively for the futures market. These numbers are not consistent with Chou and Wang (2006), who find that after the tax cut in May 2000, the futures transaction tax revenue in the second year increased (Table 5, Page 1,213, Chou and Wang, 2006). Although the tax reduction percentage in 2006 was greater than the cut in 2000, the effects of transaction tax cuts on trading volumes in 2006 were milder, compared to the previous effects. It requires further observation to validate that whether it takes longer for the market to respond. Meanwhile, another possible reason is that although tax cuts lower transaction costs and stimulate trading, the traders become more rational in a more market so the effects are limited.

Meanwhile, Figure 2 illustrates the trading data provided by Taiwan Futures Exchange. It shows that retail investors are the biggest player (approximately 70%), followed by futures dealers (c. 16%), foreign institutional investors (c. 8%) and domestic institutional investors (c. 2%) in the Taiwan futures market. Meanwhile, it also indicates no noticeable changes during the 18 months before the tax cuts on January 1, 2006 and the 18 months after the tax cuts, as far as the structural breakdown is concerned. The percentage of trading by retail investors dropped from 72.71% before the tax cut to 69.92% after tax cuts; the percentage of trading by foreign institutional investors rose from 7.85% before tax cuts to 8.92% after tax cuts; the percentage of trading from futures dealers increased from 15.89 % before the tax cuts to 17.32 % after the tax cuts. Figure 2 suggests limited changes to the market structure as a result of the futures transaction tax cuts on January 1, 2006.

Table 7 lists the daily trading data of the nearby contracts of SGX-DT MSCI TX futures. The data indicates that the log return, the squared return volatility and the average value of trading activities (trading volumes, open interests and speculative trading activities) are greater after tax cuts than the levels before tax cuts. This is particularly true with TX futures listed in Singapore. The average daily trading volume before tax cuts was 20,863.8 contracts (with open interests of 106,348.8 contracts), and it increased to 34,438.7 contracts (with open interests of 162,188.2 contracts) after tax cuts, up 49% and 52.5%, respectively. The average daily trading volume and average open interests of TX futures also

Figure 2

The Taiwan Futures Market Trading Statistics From 2003.1.1. to 2005.12.31. and From 2006.1.1. to 2007.6.31.



Source: Taiwan Futures Exchange Website

Table 7

Comparison of the Impact of the Taiwan's Reduction Transaction Tax for the Mean Daily Futures Return, Volatility and Trading Activities on the Nearby Contracts of MSCI Taiwan Index Futures at the Singapore Exchange Derivatives Trading Limited: 2004.7.1-2007.6.31., 742 Trading Days.

Reduction tax	Trading volume	Open interest	Speculation ratio	Futures return	Squared return volatility
Before	20863.8	106348.8	0.2242	0.0339	1.2953
After	34438.7	162188.2	0.2693	0.0575	1.5673
t-values	2.94E-26	1.14E-77	0.0115	0.7875	0.1733

note: Before-period: 2004.7.1-2005.12.31., 375 trading days; After-period: 2006.1.1-2007.6.31., 372 trading days.

grew by 40% and 7.95%, respectively, after tax cuts. In terms of both trading volumes and open interests, TX futures listed in Singapore see a higher growth compared to TX futures listed in Taiwan. Meanwhile, this paper also applies

t-values to test whether there are any variances in the average values of the return volatility and trading activities of TX futures before and after tax cuts. At this juncture, the null hypothesis is $H_{0i}: \mu_{i\_before} = \mu_{i\_after}$. The symbol I denotes return volatility or trading activities. According to Table 7, none of the t-values for trading volume, open interests, speculative trading activities, log return and the squared return volatility reaches any statistical significance. Hence, it is not possible to prove that the reduction of futures transaction taxes in Taiwan changes the log return, squared return volatility or trading activities of SGX-DT MSCI TX futures.

However, the conclusion shown in Table 7 does not take into account any changes to the trading environment or systems in Singapore. The conclusion may be due to the fact that tax reductions do not affect the Singapore futures market. It may also due to the swift of foreign institutional investors to the Taiwanese stock market. They mainly invest in the Taiwanese constituents of MSCI so tend to use TX futures listed in Singapore for the hedging of their equity positions. Meanwhile, it is worth considering that TX futures are denominated in NT dollars but TX futures in Singapore are denominated in the US dollars. The difference in currency causes exchange risks and possibly affects the willingness of foreign institutional investors to trade. Of curse, it is also worth exploring the trading patterns of these investors and the responses of the Singaporean authorities in the trading system.

5. Conclusions

This paper aims to explore the effects of futures transaction tax cuts on the return, volatility and trading activities of Taiwan stock index futures. It also compares the effects of such tax cuts on different types of index futures contracts. Time variables such as time trends and seasonal factors, which may affect futures trading activities and return volatility are taken into account for empirical studies. Meanwhile, this paper compares the similarities and differences of tax cut effects based on different levels of data details. The results offer the following conclusions.

If the effects of time trends and seasonable factors on return volatility or trading activities are not taken into consideration in the examination of tax cut effects on Taiwan stock index futures, the conclusion may be biased. Meanwhile, there are variances in terms of effects of time trends or seasonal factors on different types of stock index futures.

With time trends and seasonal factors taken into account, there is a significantly reverse relationship between futures transaction tax rates and trading volume (speculative trading activities). However, tax rates and open interests are positively correlated. Meanwhile, this paper finds that futures transaction tax rates seem to be irrelevant to return or the squared return volatility. However, detailed trading data seem to indicate that the high-low price volatility, GK volatility and the sum of 5-minute intraday volatility are in a significantly reverse relationship.

Although the reduction of transaction tax rates enhance speculative behavior in the futures market, the increased speculative behavior seems to exhibit some preferences for specific contracts, particularly TX futures or MTX futures which are representative of the overall market. The interest in sector-specific products, e.g. TE futures and TF futures, seems to be weak.

The result of this paper tends to support that there are time trends and seasonal effects in the trading activities of the Taiwan futures market. In particular, the speculative trading activities (trading volumes) of the four stock index futures (TX futures and TE futures) are significantly smaller on Mondays. This may be related to the market closes in the US and Europe. It is worthy of follow-up studies.

This paper also finds that the level of data details also affects the conclusion regarding the impact of time trends and Monday effects on futures volatility. The test result based on the daily squared return volatility supports Monday effects but not time trends. However, the test based on the data of more details supports time trends, but not Monday effects.

Finally, tax cuts can increase the percentage of market participation by institutional investors, a goal desired by the competent authorities. However, as the mix of the Taiwan futures market has only changed slightly, the impact seems rather limited.

Meanwhile, as the trading volumes of futures contract grow over time and the sum of intraday return volatility and speculative trading activities for most futures contracts drop gradually over time, all the above numbers indicate that the Taiwan stock index futures market is maturing. However, the empirical study of this paper shows that after the transaction tax cuts on January 1, 2006, the average daily trading volume of TX futures and MTX futures has gone up significantly. However, speculative trading activities also increased drastically. Whilst the transaction tax reduction enhances liquidity, the rise of speculative trading activities may in fact enhances futures volatility.

6.References

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