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# Transaction tax and market volatility: Evidence from the Taiwan futures market

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## Abstract

This paper employs an asymmetric component generalized autoregressive conditional heteroskedasticity (AC-GARCH) model to test the relation between securities transaction tax (STT) and market volatility. Proponents of an STT argue that such a tax will reduce market volatility by discouraging the trading activity of destabilizing short-term traders. In contrast, Song and Zhang (2005) hypothesize that in the markets with relatively higher volatility and larger noise trader participation, an increase in STT will lead to an increase in market volatility. This paper uses daily data on TAIEX futures to test the Song and Zhang (2005) hypothesis. The results reveal that the volatility in high tax periods is larger than that in low tax periods, especially for the part of short-term volatility.

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# 1 Introduction

The relation between securities transaction tax (STT) for various financial assets and asset return volatility has been widely investigated (see, e.g., Aliber *et al*., 2003; Baltagi *et al*., 2006; Sanger *et al*., 1990). Proponents of an STT have suggested that such a tax may reduce asset return volatility. The argument is that the trading activity of short-term noise traders is the source of excess volatility and an increase in an STT will reduce market volatility by discouraging such trading activity. In contrast to this partial equilibrium model, Kupiec (1996) develops a general equilibrium model and classifies market participants into rational investors and noise traders. He shows that, the reduction in price volatility due to transactions tax is accompanied by a fall in the asset's price as agents discount the future tax liability associated with risky asset ownership. Since the fall in equilibrium prices is more than compensates, the volatility of risky asset returns unambiguously increases with the level of the transactions tax. Umlauf (1993), Jones and Seguin (1997), and Westerholm (2003) also find that an increase in STT will lead to an increase in asset return volatility. Yet, other researchers report that is there is no relationship between an STT and market volatility (e.g., Chou and Wang, 2006; Hu, 1998; Phylaktis and Aristidou, 2007).

Volatility asymmetry is referred to that the volatility of stock returns is larger when stock prices down than when stock prices up[4] (see, e.g., Christie, 1982; Koutmos, 1999; Blasco et al., 2002; Leeves, 2007). Pindyck (1984) and Campbell and Hentschel (1992) argue that, if market risk premium is an increasing function of expected volatility, then volatility will increase and lead to the fall of asset

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[4] Brooks and Henry (2002) and Koutmos and Knif (2002) find that there exists asymmetry in the response conditional beta to positive and negative shocks.

prices, resulting in asymmetric volatility.[5] Seida and Wempe (2000) point out that an increase in transaction tax is equivalent to an increase in transaction cost and will lead the investors to make a decision of selling stocks. Hau (2006) further shows at high levels of statistical significance that the hourly range volatility of individual stocks increases by more than 30% for a 20% exogenous increase in transaction costs due to tick size variations in the French trading system.

Except a few rigorous investigation of the relation between an STT and market volatility such as Kupiec (1996) and Song and Zhang (2005), most studies regarding this issue emphasize empirical tests. Song and Zhang (2005) develop a general equilibrium model to encompass the trader composition effect and the liquidity effect of an STT on market volatility.[6] The net impact of an STT on financial market volatility will depend on the relative magnitude and interaction of the two effects. Song and Zhang (2005) find that in markets with higher volatility and larger participation of noise traders, an increase in an STT may result in higher market volatility. In contrast, in markets with lower volatility and smaller noise traders, an STT and market volatility is negatively related. Since the introduction of the TAIEX futures listed in the Taiwan Futures Exchange on July 21, 1998, the transaction tax is reduced twice in 2000 and 2006 respectively. In contrast to the developing markets, the Taiwan futures market is characterized by

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[5] Another interpretation to the volatility asymmetry is attributed to the leverage effect (Black, 1982), which postulates that stock price declines increase the debt/equity ratio and consequently, the volatility of a stock.

[6] According to literature, the STT affects market volatility can be through two effects: an STT may not only discourage the trading activity of destabilizing traders but also discourage rational and stabilizing traders from trading. The net effect will depend on the change of trader composition, which is referred to as the trader composition effect. Moreover, Heaton and Lo (1995) point out that an STT may reduce the trading volume significantly and may exhibit greater volatility to shocks in the market, which is referred to as the liquidity effect.

higher volatility and large percentage of individual participants.[7] Black (1986) argues that individual traders have disadvantage in information and capital. Therefore, most individual traders, whose trading is not based on fundaments, are noise traders. Furthermore, Subrahmanyam (1991) finds that the trading in futures markets will reduce the adverse selection cost of noise traders, making them more likely to enter into futures markets. Accordingly, the Taiwan futures market provides a unique opportunity to test the relation between an STT and return volatility.

This paper differs from previous literature in several ways: First, previous studies (e.g., Baltagi *et al*., 2006; Hu, 1998; Umlauf, 1993) investigate the relation between an STT and return volatility in stock markets. This paper, however, emphasizes the effects of changes in an STT on both short- and long- term return volatilities of futures contracts,[8] especially the effects of the two reductions of futures transaction tax on the asymmetric volatility in the Taiwan futures market.[9] Moreover, the use of an asymmetric component generalized autoregressive conditional heteroskedasticity (AC-GARCH) model allows us to examine the effects of futures transaction tax on both short- and long-term return volatilities. The results reveal that volatility in the high-tax period is larger than that in the low-tax period, especially for the short-term volatility. The findings support the Song and Zhang's (2005) hypothesis -- in markets with higher volatility and larger participation of noise traders, market volatility and transaction tax is positively correlated, implying that the policy maker cannot eliminate the excess volatility

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[7] According to the statistics published by the TAIFEX, the percentage of participation of individual traders is higher than 70% (See website: www.taifex.com.tw).

[8] So far as authors know, examinations of the impacts of futures transaction tax on return volatility of futures contracts are only provided by Edwards (1993) and Chou and Wang (2006).

[9] In the literature, the asymmetric volatility of futures contracts is attributed to the volatility feedback. See, for example, Mcmillan and Speight (2003) and Carvalho *et al*. (2006).

through an increase in an STT.

The rest of this paper is organized as follows. Section II describes the data and methodology. Section III reports and compares the results for the whole period and four subperiods for two transaction reductions in the Taiwan futures market. Finally, Section IV concludes and outlines future research directions.

## 2 Data and Research Design

This study uses the settlement prices of the nearby contracts for the TAIEX futures listed in the Taiwan Futures Exchange. The daily data has been retrieved from the Datastream and covers the period from July 21, 1998 to December 31, 2007. Since the Taiwan government reduced the transaction tax for futures twice, from 5 to 2.5 basis points on May 1, 2000 and from 2.5 to 1 basis point on January 1, 2006, respectively, the changes in the transaction tax offers a unique opportunity to assess empirically the impact of transaction taxes on the futures volatility. The whole period is partitioned into four subperiods, i.e., two pre- and two post-tax reduction periods. The first (second) pre-tax reduction period begins on July 21, 1998 (January 1, 2004) and ends on April 30, 2000 (December 31, 2005), while the post-tax reduction period runs from May 1, 2000 (January 1, 2006) to December 31, 2001 (December 31, 2007).

The Component-GARCH (C-GARCH) model developed by Engle and Lee (1993) is employed to decompose volatility into short- and long-run components. To observe whether there is any volatility change after the tax reduction resulting from the short- or long-run behavior, we connect the C-GARCH with the threshold GARCH (T-GARCH) of Glosten *et al*. (1993) collectively, which allows for asymmetric news shock. Hence, the asymmetric C-GARCH (AC-GARCH) can be formulated as follows:

$$R_t = \mu + \phi R_{t-1} + \varepsilon_t \tag{1}$$

$$h_t = q_t + \alpha(\varepsilon_{t-1}^2 - q_{t-1}) + \gamma(\varepsilon_{t-1}^2 - q_{t-1})d_{t-1} + \beta(h_{t-1} - q_{t-1}) \tag{2}$$

$$q_t = \omega + \rho q_{t-1} + \delta(\varepsilon_{t-1}^2 - h_{t-1}) \tag{3}$$

where $R_t$ and $R_{t-1}$ are the market return at time $t$ and $t$-1, respectively. $\varepsilon_t$ denotes a new market shock at time $t$ and $\varepsilon_t \sim N(0, \sqrt{h_t})$. $d_{t-1}$ stands for the dummy variable with a value of unity if $\varepsilon_{t-1} < 0$ and zero otherwise.

Eq. (1) describes the first order autoregressive process for stock returns, with $\phi R_{t-1}$ capturing the autocorrelation. Eq. (2) expresses the process of conditional variance and allows mean reversion to a time-varying level $q_t$. It also describes conditional variance process to respond asymmetrically to rise and fall in stock price. Specifically, positive return shocks have an impact of $\alpha$, while negative return shocks have an impact of $\alpha + \gamma$. If $\gamma > 0$, it indicates the process of transitory leverage effects in the conditional variance. Moreover, Hadsell (2006) indicates that the volatility move halfway back to its mean following a given deviation, which is defined as $\alpha + 0.5\gamma + \beta$ in the T-GARCH model. A value less than one suggests a mean-reverting conditional volatility and shocks are transitory in nature. Eq. (3) describes the permanent component of variance, $q_t$, which converges to $\omega$ with the speed of $\rho$. If $1 > \rho > \alpha + 0.5\gamma + \beta$, $q_t$ represents the component of variance with the longest persistence, i.e., the permanent volatility will dominate the conditional variance. Note that the AC-GARCH model reduces to the T-GARCH if either $\alpha = \beta = 0$, or $\rho = \delta = 0$.

## 3 Empirical Results

Table 1 lists the estimation results by applying the AC-GARCH model to the full period and the four subperiods. It is interesting to note that in the Taiwan futures market, $\phi < 0$ and is statistically significant at the 5% level, indicating a negative first order serial correlation. This result could be induced by the bid-ask bounce effect, as posited by Roll (1984). The conditional variance shows the existence of both the transitory and permanent components. The transitory asymmetric volatility is captured by $\gamma$ and the asymmetric response of volatility to return shocks holds, i.e., negative return shocks tend to influence future volatility more than positive return shocks do. The volatility persistence measure of $\alpha + 0.5\gamma + \beta$ amounts to 0.749 and is less than one, exhibiting that shocks are largely transitory. Furthermore, the speed of mean reversion for the permanent volatility is verified by a larger $\rho$ (= 0.998), indicating that a slower mean reversion for the permanent volatility. In sum, the condition $1 > \rho > \alpha + 0.5\gamma + \beta$ is applicable to the Taiwan futures market, implying that the long-run stock return conditional variance will decay more slowly than the transitory component of variance. This result further suggests that the permanent volatility controls the conditional variance. Diagnostic tests for model appropriateness are performed on

Table 1. Maximum likelihood estimates of the AC-GARCH model for the full and the pre- and post-tax reduction subperiods

$$R_t = \mu + \phi R_{t-1} + \varepsilon_t$$

$$h_t = q_t + \alpha(\varepsilon_{t-1}^2 - q_{t-1}) + \gamma(\varepsilon_{t-1}^2 - q_{t-1})d_{t-1} + \beta(h_{t-1} - q_{t-1})$$

$$q_t = \omega + \rho q_{t-1} + \delta(\varepsilon_{t-1}^2 - h_{t-1})$$

the standardized and squared standardized residuals via Ljung-Box tests. We also use the sign bias, negative size bias, positive size bias, and joint tests to capture the robustness of the asymmetric volatility effect, all of which are proposed by Engle and Ng (1993) and the relevant supporting statistics are listed in the bottom panel of Table 1.

Table 1

| | Full sample period | 1st pre-tax reduction period | 1st post-tax reduction period | 2nd pre-tax reduction period | 2nd post-tax reduction period |
|---|---|---|---|---|---|
| μ | 0.0544** | -0.0576 | -0.1411** | 0.0481 | 0.1487*** |
| | (0.0244) | (0.0698) | (0.0704) | (0.0374) | (0.0442) |
| ψ | -0.0587** | -0.0944** | -0.0681** | -0.0128 | -0.0700* |
| | (0.0195) | (0.0444) | (0.0317) | (0.0386) | (0.0404) |
| α | -0.0730*** | 0.0261 | -0.2254*** | -0.1538** | -0.1876*** |
| | (0.0243) | (0.0802) | (0.0485) | (0.0774) | (0.0694) |
| γ | 0.1060*** | 0.2015* | 0.0896* | 0.2461** | 0.1417** |
| | (0.0351) | (0.1199) | (0.0551) | (0.1022) | (0.0780) |
| β | 0.7692*** | 0.5666** | 0.6421*** | 0.7909*** | 0.5553* |
| | (0.1310) | (0.2482) | (0.2461) | (0.1625) | (0.3528) |
| ω | 0.0254 | 0.2076*** | 0.2864** | 0.0395 | 0.0587*** |
| | (0.0577) | (0.0706) | (0.1289) | (0.0351) | (0.0137) |
| ρ | 0.9975*** | 0.9523*** | 0.9517*** | 0.9888*** | 0.9583*** |
| | (0.0061) | (0.0467) | (0.0335) | (0.0138) | (0.0247) |
| δ | 0.0709*** | 0.0223 | 0.1692*** | 0.0517** | 0.0792*** |
| | (0.0110) | (0.0352) | (0.0453) | (0.0269) | (0.0286) |
| Log L | -4479.567 | -907.400 | -1495.160 | -775.559 | -815.259 |
| α+0.5γ+β | 0.7492 | 0.6935 | 0.4615 | 0.7602 | 0.4386 |
| Diagnostics for *AC-GARCH* model | | | | | |
| LB(20) | 25.4830 | 13.3000 | 21.8240 | 23.8320 | 14.7650 |
| $LB^2(20)$ | 22.2830 | 12.4180 | 16.8440 | 25.2880 | 18.8440 |
| Sign bias | 1.7165 | -0.9241 | -0.7216 | 1.4851 | 2.2974** |
| Negative size | 0.5955 | 0.6983 | 0.8298 | -0.7435 | -1.9588** |
| Positive size | -1.4370 | -0.0122 | -0.4554 | -1.0702 | -1.3664 |
| Joint test | 2.0940 | 0.4068 | 0.6739 | 0.5202 | 2.0364 |

*Notes*: *, ** and *** denote significance at 10%, 5% and 1% level, respectively. Numbers in parentheses are standard errors. LB(12) and $LB^2(12)$ are the Ljung-Box test statistics testing for autocorrelation in the standardized residuals and standardized squared residuals of AC-GARCH model up to the twelfth lags.

The regressions for the asymmetric volatility tests are as follow:

Sign bias test: $Z_t^2 = a + bS_t + e_t$ (i)

Negative size bias test: $Z_t^2 = a + bS_t\varepsilon_{t-1} + e_t$ (ii)

Positive size bias test: $Z_t^2 = a + b(1 - S_t)\varepsilon_{t-1} + e_t$ (iii)

Joint test: $Z_t^2 = a + b_1 S_t + b_2 S_t\varepsilon_{t-1} + b_3(1 - S_t)\varepsilon_{t-1} + e_t$ (iv)

where $z_t^2$ is squared standardized residuals and $S_t$ is a dummy that takes the value of unity if $\varepsilon_t < 0$ and zero otherwise. Asymmetric volatility tests are t-tests for coefficient *b* in (i), (ii), and (iii). The joint test is an F-test for regression (iv).

In order to examine whether the short- and long-run volatility have changed after the 1st and 2nd tax reductions, Table 1 also illustrates the estimates of the AC-GARCH model for the four subperiods. $\gamma$ is positive for the four subperiods, meaning that the transitory asymmetric volatility exists before and after the tax reductions. All the $\gamma$ are smaller during the post-tax reduction periods, showing that investors are less sensitive to past negative return shocks during the post-tax reduction periods. Moreover, the values of $\alpha + 0.5\gamma + \beta$ are smaller in the post-tax reduction periods. In the two tax reductions, the average value of $\alpha + 0.5\gamma + \beta$ is 0.727 for the pre-tax reduction period and 0.450 for the post-tax reduction periods. This result is similar to that of Hau (2006), i.e., the transitory volatility is larger in the high-tax regime than in the low-tax regime.

Theoretically, a high value of $\rho$ means the permanent volatility is more persistent by nature. It can readily be noted that all the coefficients of $\rho$ are smaller in the post-tax reduction periods. For instance, the average value of $\rho$ is 0.971 for the pre-tax reduction subperiods, while it is 0.955 for the post-tax reduction subperiods, suggesting that in the post-tax reduction period the Taiwan futures market is substantially less volatile and less asymmetric. Furthermore, the values of $\rho$ are larger than $\alpha + 0.5\gamma + \beta$ in the four subperiods. This result shows that even though the permanent component of volatility has slightly changed after the tax reduction, the permanent volatility still dominates the conditional variance.

According to the AC-GARCH model, $\alpha + 0.5\gamma + \beta$ ($\rho$) measures the varying transitory (permanent) volatility. The empirical results exhibit that the values of $\alpha + 0.5\gamma + \beta$ ($\rho$) are smaller in the post-tax reduction subperiods. Furthermore, the decrement of $\alpha + 0.5\gamma + \beta$ ranges from 0.232 for the 1st tax reduction period to 0.322 for the 2nd tax reduction period, while the decrement of $\rho$ is from 0.001 for the 1st tax reduction period to 0.031 for the 2nd tax reduction period, i.e., the decrement of $\alpha + 0.5\gamma + \beta$ is larger than the decrement of $\rho$ after the 1st and 2nd tax reduction subperiods. Apparently, a lower volatility following the tax reduction is due primarily to short-run but not to long-run volatility decrease.

Umlauf (1993) and others indicated that volatility is higher in the high-tax regime than in the low-tax regime. The reason is that an STT may not help reduce return volatility by discouraging short-term destabilizing speculation. Supporting prior findings, we further decompose volatility into transitory and permanent components and the empirical results show that futures market volatility decreases after the policy maker cuts the transaction tax, with this effect being displayed in relation to both transitory and permanent components of volatility. In essence, both a lower degree of transitory and permanent volatility after the two tax reductions has been recognized. Moreover, the effect of short-run volatility decrease is larger than that of long-run volatility after the two tax reductions, exhibiting that the lower volatility following the tax reductions is primarily attributable to short-run volatility decrease.

## 4 Conclusions and Implications

The paper utilizes an AC-GARCH model to investigate the relation between an STT and return volatility in the Taiwan futures market. The results support the asymmetric volatility hypothesis, i.e., the impact of negative returns on volatility is higher than that of positive volatilities. Moreover, this paper also support the Song and Zhang (2005) hypothesis that in markets with higher volatility and larger participation of noise traders, market volatility and an STT are positively correlated, implying that the policy maker cannot eliminate the excess volatility through an increase in an STT. This paper contributes to the literature by providing evidence of the impacts of an STT on the return volatility in the futures markets. However, there are some issues unresolved for the future researches. For example, does the transaction tax have the same effects on conditional betas as on market volatility? We hope the findings of this paper can stimulate more future research on the futures price behavior in emerging markets.

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