# The impact of the securities transaction taxes on the Chinese stock market

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**Abstract**

This paper analyzes the impact of changes in the securities transaction tax (STT) rate on the local A-shares market in China. We find that, on average, a 22-base-point- increase in the STT rate is associated with about a 28% drop in trading volume, while a 17-base-point- reduction in the STT rate is associated with about a 89% increase in trading volume in the Chinese A-shares market. Both the increases and reductions in the STT rate result in a significant increase in the market return volatility. Besides, the increases in the STT rate have mixed effects on market efficiency, either improving or curbing it. The reductions usually either make the market less efficient or have not effect on it. The empirical results together show that levying the STT on trading is not an effective tool to regulate stock market, at least in this emerging market.

## 1 Introduction

One of the important functions of financial markets is to transform latent demands of investors into realized financial transactions. The existence of the securities transaction tax (STT hereafter) impacts this transformation. The STT was debated in a number of countries and was a common policy tool in major financial markets including Japan, UK, Italy, France, as well as some OECD economies and emerging markets during the 1990s (Phylaktis and Aristidou, 2007). The idea of assessing the STT on securities transactions has reappeared and has ignited a heated debate since the sub-prime crisis of 2007. For instance, Adair Turner, the chairman of Britain's Financial Services Authority, suggested that financial transactions should be taxed to deter excessive risk-taking and future crisis, while the British Banker's Association rejected such a notion. Based on this, the STT is important because of its policy relevance.

This paper is an empirical examination of the relationship between the STT and the Chinese stock market. The principle objective is to investigate how the market's trading volume, return volatility and market efficiency respond to flucturations in the STT rate.

Theories of the STT can be classified based on their merits. In general, proponents advance that the STT can generate revenues for government, reduce market volatility and enhance market efficiency by curbing short-term noise trading and unproductive speculation activities (Stiglitz,1989; Song and Zhang, 2006). Opponents, however, believe that financial markets have the ability to allocate resources efficiently without direct intervention from public policy. They argue that imposing

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the STT increases transaction costs, which can increase market volatility due to the reduction in market liquidity ( Kupiec, 1996; Habermeier and Kirilenko, 2003).

Given that there is no consensus on theories of the STT, there have been several empirical studies attempting to resolve the debate by examining the impact of the STT on market behavior. Umlauf (1993), for example, reported that an introduction of, or increase in the STT rate in Sweden did not reduce market volatility, although stock prices and market turnover declined; in a similar vein, Saporta and Kan (1997) and Hu (1998) did not find significant effects of the increases in the STT rate on market volatility in U.K, Hong Kong, Japan, Korea, and Taiwan. In contrast to the studies above, the more recent work by Hau (2006) argued that an adjustment in the STT rate is analogous to a change in transaction costs. He, using the French stock market data, concluded that an increase in transaction costs led to a significant increase in market volatility. In line with this, Baltagi et al. (2006) and Phylaktis and Aristidou (2007) found a substantial increase in trading volume and market volatility after the STT rate increased.[1] Overall, these empirical studies provide mixed conclusions regarding the relationship between the STT and volatility.

The aforementioned analyses, however, are not sufficient for either a policy maker or an investor to draw a comprehensive picture of the impact of flucturations in the STT rate on stock market behavior of a country, because they are subject to three potential problems: (i) They were almost exclusively conducted for a single tax change in different markets, instead of all the STT adjustments in a single security market; and (ii) Changes in market efficiency after the STT adjustment have not been widely examined. This paper improves on these earlier efforts by (i) studying all the 14 STT rate adjustments in a single stock market, the Chinese A-shares market; and (ii) examining the effect on market efficiency.

Moreover, relatively few empirical studies to date have attempted to investigate *how* the stock market reacts to reductions in the STT rate. One effort along these lines is by Chou and Wang (2006), who analyzed the impact of a STT rate reduction on trading volume and market volatility in the futures market, rather than in the stock market. This paper will extend existing empirical work through considering the reductions in the STT rate on the stock market, in addition to looking at the increases.

The rest of this paper is organized as follows: section 2 provides a short overview of the Chinese security market and describes the 14 STT rate adjustments; section 3 presents the econometric methodology and data sources; section 4 describes the empirical results; and finally, section 5 concludes the paper.

# 2 The Chinese stock market and STT rate adjustments

## 2.1 Market overview and the STT rate adjustments

The Chinese stock market has two stock exchanges regulated by the China Securities Regulatory Committee (CSRC): the Shanghai Stock Exchange (SHSE hereafter) and the Shenzhen Stock Exchange (SZSE hereafter), which opened in December 1990.[2] Both exchanges list two types of shares,

[1] Baltiga et al studied one single tax increase in China stock market. Our study different from theirs by studying all the tax adjustments in the China stock market, in order to draw more comprehensive conclusions.

[2] The Shanghai Stock Exchange was officially permitted by the People's Bank of China on November 26, 1990 and opened on December, 19, 1990.

The Shenzhen Stock Exchange opened on December 1, 1990. But it was not officially permitted by the People's Bank of China until April 14, 1991.

namely A-shares and B-shares issued by Chinese companies. A-shares, denominated in Yuan, are domestic ordinary shares available only to Chinese citizens.[3] B-shares, denominated in either US or Hong Kong dollars, are ordinary shares designed exclusively for foreign investors. A-shares dominate the stock market in three key regards: the number of listing companies, trading volume and market value. Thus, we only analyze the A-shares market in this paper. A-shares and B-shares carry the same voting rights and dividends, except that they are quoted in different currencies (Chan, Menkveld and Yang, 2008). Several previous studies (Bailey, 1994; Bailey, Chung and Kang, 1999) have found that there is a significant discount on B-shares prices relative to A-shares prices. The main difference between the Shanghai and Shenzhen markets is that the majority of companies listed in Shanghai are large, state-owned enterprises, while the majority in Shenzhen are small, private enterprises.

Prior to 2001, the Chinese stock market was segmented from world financial markets. The A-shares could only be traded by domestic citizens, whereas B-shares could only be traded by foreign investors. Domestic citizens holding foreign currency have been allowed to engage in the B-shares market since 2001. The A-shares market, however, did not open to foreign investors until May 2003, through the Act of Qualified Foreign Institutional Investors (QFII), which stated that only qualified foreign institutional investors are permitted to purchase and sell A-shares.[4] Domestic citizens are allowed to indirectly invest in foreign financial market through the financial planning products provided by Qualified Domestic Institutional Investors (QDII) in February 2007.

The STT, named the stamp duty, is an independent tax on the transfer of a financial instrument from one owner to another (Campbell and Froot, 1995). The STT was imposed on the Shenzhen A-shares market with a rate of 0.6% of trading value since the beginning.[5] The Shanghai market began to charge the STT with 0.3% of trading value on both the purchase and sale of A-shares on October 10, 1991. The rate of the STT has varied over the years. Overall, there have been 14 adjustments in the STT rate in the Chinese stock market since October 1991, among which five are increases in the rate and nine are reductions. More specifically, three of the five increases are levied on the Shanghai A-shares market and the other two on the Shenzhen A-shares market. Four of the nine reductions are levied on the Shanghai A-shares market and the other five on the Shenzhen A-shares market. Table 1 presents the detailed descriptions on each adjustment.

$(Insert Table 1 here)$

# 3 Econometric methods and data

## 3.1 Econometric methods

In this section, we discuss the methodology employed to examine *how* the Chinese stock market responds to changes in the STT rate. The conventional event-study approach is taken to conduct the test hypotheses. We define the day of each change in the STT rate as an event day. The procedures for the bootstrapping $t$ test of the equality of average trading volume before and after

[3] Yuan is the domestic official currency of China.

[4] UBS was the first QFII, who got the permission to buy and sell A shares in China stock market on May 26, 2003.

[5] The official first levied on a trial basis with a rate of 0.6% of trading value only on the purchase of the A-shares since the opening of the Shenzhen stock exchange. The Shenzhen stock exchange started to charge STT on the sales of the A-shares on November 23 of the same year. Since then, both the purchase and sales of the A-shares are subject to STT rate of 0.6% of trading value.

the event is described in the first subsection. The modified Levene's test of the equality of market return volatility in the pre-STT and post-STT rate change periods are presented in the second subsection. The Switching Generalized Autoregressive Conditional Heterskedasticity (SGARCH hereafter) model is applied to test whether market efficiency changes after the STT rate changes and the corresponding methodology is discussed in the third subsection. The methodologies taken above are adaptions from Lee and Ohk (1992) and Li et al. (1997) and Baltagi et al. (2006).

### 3.1.1 Bootstrap testing the impact on trading volume

Trading volume contains valuable information about the investor's reaction to equity market changes, for example, trading frequency, expectations and demand. (Blume et al., 1994, Hambermeier and Kirilenko, 2003). In the Chinese A-shares market, the STT accounts for a large portion of transaction costs, to which investors are sensitive.[6] It can thus have a substantial effect on investors' trading decisions, which are later reflected as aggregate trading volume in the market (Habermeier and Kirilenko, 2003). Moreover, Domowitz et al. (2002) found empirical evidence that a higher transaction tax, in terms of transaction cost, can result in lower trading volume in some equity markets. In this paper, we will examine how trading volume changes after adjustments in the STT rate in the Chinese stock market. One should expect that trading volume will fall after an increase in the STT rate, and rise after a reduction in the rate.

The sequence of daily trading volumes for $n$ trading days before and after the event day are defined as $x = (x_1, x_2, x_3, ..., x_i)$ and $y = (y_1, y_2, y_3, ..., y_i)$, respectively. The null hypothesis and test statistic of equal trading volume are then written as:

$$H_0 : \overline{x} = \overline{y}, \tag{1}$$

$$T = \frac{\overline{x} - \overline{y}}{\sqrt{\sigma_x^2/n + \sigma_y^2/n}}, \tag{2}$$

where $\overline{x}$ and $\overline{y}$ are mean trading volume before and after the event day, and $\sigma_x^2$ and $\sigma_y^2$ are corresponding variances, respectively.

In order to avoid non-normality problems, the null hypothesis test is conducted by bootstrapping the distribution of the above test statistic to compute the significance levels. Different subgroup sizes $n$ (number of days before and after the event day), for instance, $n = 10, 15, 20, 30, 40, 50, 60, 75$, are chosen to avoid the possible arbitrariness of any particular value of $n$ (Li,Lin and Li, 1992). To save space, we will not discuss the methodology and detailed description is presented in Efron Tibshiani(1993).

### 3.1.2 Modified Levene's test of changes in market volatility

The volatility of the Chinese stock market is measured by the variance of market returns. According to the STT proponent's argument, one should expect market volatility falls after STT rate is increased. Empirically, we are testing the homogeneity of return variances in the pre-tax and post-tax change periods for each STT adjustment . The null hypothesis then is,

[6] This is proved in section 4.1 of this paper.

$$H_0 : \sigma_1^2 = \sigma_2^2, \tag{3}$$

where $\sigma_1^2$ and $\sigma_2^2$ are the market volatility of the subgroup prior to and post event-day period respectively.

Levene's test (Levene, 1960; Djolov, 2002), without assuming equality of means across $k$ subgroups is used to verify the hypothesis. In our test, we have $k = 2$ subgroups, indexed by $i = 1, 2$. The first subgroup ($i = 1$) consists of $n$ return observations from the pre-STT adjustment period, and the second subgroup ( $i = 2$) contains $n$ return observations from the post-STT adjustment period. The two subgroups together build a sample of market returns with $N = 2n$ observations around the event day, which consists of $k = 2$ subgroups with equal size $n$. Let $r_{ij}$ denotes the $j$th return observation ($j = 1, 2, 3, ...n$) in the $i$th subgroup and $\overline{r_i}$ represents the group mean of the $i$th subgroup . By defining the absolute deviations for each subgroup from its respective group mean, $Z_{ij} = |r_{ij} - \overline{r_i}|$, the Levene's statistic, following the $F$ distribution can now be written as :

$$L = \frac{N-k}{k-1} \cdot \frac{\sum_{i=1}^{2} n(\overline{Z}_i - \overline{Z}^p)^2}{\sum_{i=1}^{2}\sum_{j=1}^{n_i}(Z_{ij} - \overline{Z}_i)^2}, \tag{4}$$

where

$$\overline{r}_i = \frac{\sum_j r_{ij}}{n},\ \overline{Z}_i = \frac{\sum_{j=1}^{n_i} Z_{ij}}{n},\ \overline{Z}^p = \frac{\sum_{i=1}^{2}\sum_{j=1}^{n_i} Z_{ij}}{\sum_{i=1}^{2} n}, \tag{5}$$

$\overline{r_i}$ is the group mean of the $i$th subgroup. $\overline{Z}_i$ is the group mean of the $Z_{ij}$. $\overline{Z}^p$ is the overall mean of $Z_{ij}$.

However, the absolute deviations of stock returns can be skewed and have heavy tails, which violate the normality assumptions of Levene's test. This can be addressed by (i) modifying Levene's test using either the median or the trimmed mean (Brown and Forsythe, 1974). We use the 10% trimmed- mean Levene's test in this study. and (ii) bootstraping the distribution of the test statistic. Different subgroup size $n_i$, for instance, $n_i = 10, 15, 20, 30, 40, 50, 60, 75$ is chosen to avoid the arbitrariness caused by taking any particular value of sample length (Li,Lin and Li, 1992). To reserve space, we will not describble the methodology and details can be found in Efron and Tibshiani(1993), Li et al., (1997) and Baltagi et a., (2006).

#### 3.1.3 Examining the changes in market efficiency

The switching GARCH (SGARCH hereafter) model proposed by Lee and Ohk (1992) is employed to examine whether changes in stock market efficiency occurs with changes in the STT rate. SGARCH captures structural change in return volatility by imposing dummy variables on the autoregressive structure of the conditional variance equation. As pointed out by Lee and Ohk, if the coefficients of the dummy variables are significantly different from zero, there is structure change in the conditional variance after the STT rate changed. This in turn, implies that a structural change in market efficiency occurs after the change in the STT rate. The SGARCH model is written as:

$$r_t = \mu_0 + \mu_1 D_t + \varepsilon_t, \tag{6}$$

$$Var(\epsilon|\Omega_{t-1}) = \sigma_t^2 = \omega_0 + \alpha_0\varepsilon_{t-1}^2 + \beta_0\sigma_{t-1}^2 + \omega_1 D_t + \alpha_1\varepsilon_{t-1}^2 D_t + \beta_1\sigma_{t-1}^2 D_t, \tag{7}$$

where

$$D_t = \begin{cases} 0, & \text{when } 1 \le t \le t^* - 1 \\ 1, & \text{when } \ t^* \le t \end{cases}.$$

$r_t$ is the log stock market return on day $t$ and $\sigma_t^2$ is the corresponding conditional variance on the event day (or switching point). $t^*$ is the event day, represents the day of changes in the STT rate in this paper. $\Omega_{t-1}$ represents the set of all relevant and available information at time $t-1$. As said in Lee and Ohk's (1992) paper, the SGARCH model is proposed for the situations, where the autoregressive structure of the conditional volatility of a GARCH model is constant for a period of time and then changes and stays constant at the new level. The Model is estimated using MLE (maximum likelihood estimation) with BHHH algorithm as nonlinear optimization method.

Technically, one can examine whether a change in market efficiency happened (Lee and Ohk, 1992; Li et al.,1997) by analyzing the sign and significance of the coefficients of $\epsilon_{t-1}^2 D_t$ and $\sigma_{t-1}^2 D_t$ (, which are $\alpha_1$ and $\beta_1$, respectively) in the conditional variance function. The $\alpha_1$coefficient indicates the structural change in the effect of the squared residuals $\epsilon_{t-1}^2$ at time $t-1$ on $\sigma_t^2$ at time $t$. The $\beta_1$indicates the structural change in the effect of the lagged conditional volatility $\sigma_{t-1}^2$at time $t-1$ on $\sigma_t^2$ at time $t$. Moreover, negative $\alpha_1$ and positive $\beta_1$ together suggest that, after the STT rate adjusted, the effect of $\epsilon_{t-1}^2$ on $\sigma_t^2$ relatively decreases, while the effect of $\sigma_{t-1}^2$ on $\sigma_t^2$ at time $t$ relatively increases. This implies that the volatility shocks are less quickly assimilated in the stock markets, i.e., the market becomes less efficient (Baltagi et al. (2006)). In a similar way, positive $\alpha_1$and negative $\beta_1$ indicate that the effect of $\epsilon_{t-1}^2$ on $\sigma_t^2$ at time $t$ relatively increases, but the effect of $\sigma_{t-1}^2$ on $\sigma_t^2$ at time $t$ relatively decreases after the STT rate adjusted, which implies that the market is being more efficient. On can illustrates little about market efficiency, when the coefficients of $\epsilon_{t-1}^2 D_t$ and $\sigma_{t-1}^2 D_t$ have the same sign.

### 3.2 Data

Daily data has been obtained from Datastream Advance and Wind databases for the following variables: the dividend-adjusted daily stock price index of the Shanghai and Shenzhen A-shares market and trading volume in value and quantity. The data spans from April 3, 1991 to August 29, 2008. The Shanghai A-shares index and Shenzhen A-shares index are compiled based on the weighted market capitalization method with all the listed A-shares included. Thus, it is a good measurement of the A-share returns. The effective date of the new STT rate was considered as the event day.[7] For each STT rate change, one calendar year daily data was collected, centering around the event day, except the event on April 24, 2008.[8] Transformed data are to be used in the empirical specifications below: stock market returns $r_t$ ($r_t = \ln \frac{p_t + d_t}{p_{t-1}}$), trading volume in billion Yuan (equals original trading volume divided by one million) and variance of stock market returns. The summary statistics of the data as a whole are reported in Table 2, and the descriptive statistics of the data for each STT adjustment event are not displayed to save space and are available upon request. The Jarque-Bera tests show that the return series are not normally distributed.

[7] Fortunately, the announcement date of the stamp tax rate change is either on Friday or just one day ahead of the effective date.

[8] Because our data end on August 29, 2008, we can only collect eight-month data around the event day.

$(Insert Table 2 here)$

# 4 Empirical results

This section reports the impact of the STT rate adjustments on the Chinese A-shares market. The first subsection discusses the effect of changes in the STT rate on trading volume. The return volatility's reaction to the STT rate changes is analyzed in the second subsection. The last subsection summarizes whether market efficiency changes after the STT rate changes.

## 4.1 The impact on trading volume

Tests were performed to investigate whether trading volume changes after the STT rate changed, by comparing the mean trading volume in the pre-tax and post-tax adjustment periods. The tests are based on the methodology presented in section 3.2.1. To avoid arbitrariness, we do the test by choosing eight different sample intervals: ±10, ±15, ±20, ±30, ±40, ±50, ±60, ±75 days around the event day (the date of STT rate adjustment). The empirical results appear in Table 3 and Table 4. For each STT adjustment in the two tables, we first report the ratio of the mean trading volume in the post-tax and pre-tax adjustment periods in the eight sample intervals. The $t$ statistics for all the sample intervals and the corresponding bootstrap $p$ values are then reported. For example, each of the "±10" columns presents the ratio of the mean trading volume in the post-tax and pre-tax adjustment periods, the $t$ statistics and the corresponding $p$ values, respectively.

The empirical results of the reaction of trading volume to increases in the STT rate appear in Table 3. For all the five increases in the STT rate, the ratios of the average trading volume in the post-tax and pre-tax increase periods are less one.[9] This suggests that trading volume declined after the STT rate increased. Most of the $t$ statistics are significant at either 1%, 5% or 10% in the first five sample intervals, which implies that trading volume significantly declined after the STT rate increased in the two Chinese A-shares markets. This finding confirms the STT proponents' argument that market participants react to the increased transaction tax rate by reducing their trading frequencies.

As shown in Table 4, most of the $t$ statistics are significantly negative at either 1%, 5% or 10% levels for six of the nine reductions in STT rate.[10] This indicates that trading volume increases after the STT rate is reduced, which implies that investors respond to the reduced STT rate by trading more actively.

Taken together, the results presented above indicate a strong response of the Chinese stock market to changes in the STT rate. Investors generally reduced their trading activities after the STT rate increased, because, all things being equal, an increase in the STT rate raises transaction costs of stock trading. This in turn discourages rational investors from rebalancing their portfolios because the high transaction costs make the rebalancing trade unprofitable (Lo et al., 2004). The

[9] Except for some intervals of the Shenzhen market in 2007. The mean ratios for the STT increase in 2007 are significantly larger than one in the first three sample intervals, which suggests that the trading volume increased after the STT rate increased. This is not consistent with the theory.

[10] Except for the two reductions on both markets in 1998 and the reduction in the Shenzhen market in 2001. The size of the mean ratio for some intervals and years show some interesting phenomenons in the Shenzhen market. For instance, the after and before mean ratios in the 1998 and 2001 STT rate reductions are significantly less than one, which implies the shrink in the trading volume after STT rate reduced.

noise trading activities and destabilizing speculative trading are possibly discouraged in a similar way. Alternatively, reductions in the STT rate, resulting in a reduction in the transaction costs, can be a sign of deregulation and can encourage investment in stock market. Investors are likely to be more active in trading due to the lowered transaction costs caused by the reduced the STT rate and thus bring in more liquidity.

However, *how* strong the negative relationship between changes in SST rate and trading volume is depends on the weight to the STT in total transaction costs. Transaction costs in the Chinese A-shares markets consist of the commission fees and the STT. The commission fees are around a flat rate of 0.35% of the trading value. If, for example, the STT rate increases from 0.1% to 0.3%, the transaction cost of an investor will increase above 44% ($\frac{0.35\%+0.3\%}{0.35+0.1\%}-1$), which is not a small burden. Thus, even a small adjustment in the level of the STT rate can cause a large change in the transaction costs, which can result in a significant shift in trading volume. Actually in our sample period, trading volume in the Chinese stock market generally fell by 10%-53%, and the total tax revenues increased by 14%-172%, after the STT rate increased. On average, the STT rate increased by around 133% (from an average rate of 0.16% to 0.38%), and trading volume fell by about 26%. Given that the commission fee is 0.35% of the transaction value, the percentage change in average transaction costs is about 47% ($\frac{0.35\%+0.38\%}{0.35\%+0.16\%}-1$). So, the elasticity of average trading volume with respect to transaction costs is roughly $\frac{26\%}{47\%} \approx -0.55$, which is large, although it is small relative to the corresponding elasticity found in other equity markets.[11] The average tax revenue went up by only 76%, which is much less than in the ideal case, where no changes happen in the tax bases. From the view of public finance, this suggests that investors responded to increases in the STT rate by heavily reducing their trading volume, which leads to large shrink in the tax bases.

On the other hand, trading volume generally increased by 37%-346% after reductions in the STT rate and the total tax revenues fell by 0.4% to 205%. On average, the STT rate reduced by about 56% (from an average rate of 0.33% to 0.15%), and transaction costs changed by around $\frac{0.35\%+0.15\%}{0.35\%+0.33\%}-1 \approx -26\%$. The average trading volume raised by about 105% and average tax revenue fell by around 9%. Thus, the elasticity of average trading volume with respect to transaction costs is about $-4$. This indicates that lower transaction costs can cause substantial increases in trading volume but do not reduce the government's tax revenues in this specific market.

$(Insert\ Table\ 3\ and\ Table 4\ here)$

### 4.2 The impact on market volatility

This subsection examines the volatility effect associated with changes in the level of the STT rate. We tested the equality of the variances of returns in the pre-tax and post-tax change periods, based on the methodology discussed in section 3.1.2. As in the last subsection, we also chose eight different sample intervals: ±10, ±15, ±20, ±30, ±40, ±50, ±60, ±75 days around the event day to avoid arbitrariness. The empirical results are shown in Table 5 and Table 6. For each STT adjustment in the two tables, we first report the standard deviations of returns in the pre-tax and post-tax change periods. The modified Levene's statistics and the corresponding bootstrapping p values are then reported. For example, each of the "±10" columns presents the standard deviation of returns in the pre-tax change period, the standard deviation of returns in the post-tax change period, the $L$ statistics and the corresponding $p$ values, respectively.

[11] For instance, Lindgren and Westlund (1990) find the elasticity in Swedish market ranges from -85% to -135%.

Table 5 reports the results of the impact of increases in the STT rate on return volatility. As shown, the standard deviations of returns in the post-STT increase period are larger than the corresponding standard deviations in the pre-STT increases period. Most of the modified Levene's statistics $L$ are significant at either the 0.05 or 0.1 level in all the eight sample intervals for the five increases, except for the one in 1991.[12] This suggests that market volatility significantly increased after increases in the STT rate. Together with the findings in the previous the subsection 4.1, this paper shows that the declined trading volume is associated with increased market volatility, after the STT rate increased. It is well recognized that higher STT rate signals an increased transaction cost. Investors trade less frequently and trading volume significantly declines. Moreover, the market becomes more illiquidity and the bid-ask spread will generally increase, causing higher market volatility. The empirical evidence here, like many previous findings, also contradicts the proponent's view that the STT can help reduce stock return volatility by reducing short-term destabilizing trading activities.

Table 6 presents the results of the effect of reductions in the STT rate on return volatility. As in the above case, the standard deviations of the returns in the post-STT reductions period are also larger than the corresponding standard deviations in the pre-STT reductions period for the nine STT reductions, except for the two reductions in 2001. Most of the modified Levene's statistics are significant at the conventional levels for the early STT reductions (before 2005), but, not for the more recent ones.[13] This indicates that markets generally become more volatile after the STT rate is reduced; however, the volatility impact seems to be stronger in the early STT reductions. Together with findings in the previous subsection, the empirical results show that a reduction in the STT rate resulted in higher trading volume and higher market volatility. This is typically consistent with the empirical finance literature that there is a positive relationship between trading volume and market volatility. By taking trading volume as a proxy for information flow, the significantly increased trading volume after the STT rate reduced could be interpreted as a higher rate of information flow after the event. The higher the intensity of information flow, the greater the market volatility (Karpoff, J. M., 1987). In addition, a reduction in the STT means a large decline in transaction costs. This results in more noise trading and destabilizing speculations, which are important sources of short-term market volatility. Our findings provide empirical evidence to the existing literature that market volatility increases after reductions in the level of the STT rate. Our results also provide a supplement to Hu's (1998) empirical tests on Asian markets.

Thus, the return volatility in the Chinese A-shares market significantly increased after the STT rated increased. The reductions in the STT rate, instead of reducing return volatility, often increased it. Furthermore, the STT, as a policy tool has a significant impact on return volatility, but not as the proponents stated. It seems that this tax should be removed from the Chinese stock market, if people expect a lower return volatility.

(*Insert Table* 5 *and Table* 6 *here*)

### 4.3 The impact on market efficiency

The SGARCH model is used to test whether there is a structural change in the time-varying volatility after the STT rate is changed. This is because the change in the conditional volatility

[12] The increase in STT rate in the Shanghai A-shares market in 1991 is the introduction of STT into the market.

[13] The modified Levene's statistics are not significant in many sample intervals for STT reductions after 2005.

can imply a change in market efficiency ( Lee and Ohk, 1992). One can determine whether the market efficiency changes by analyzing the sign and significance of the coefficient of $\epsilon_{t-1}^2 D_t$ and $\sigma_{t-1}^2 D_t$ in the conditional variance function. Table 7 reports the results of the effect of increases in the STT rate on market efficiency. Table 8 presents the impact of the STT rate reductions on market efficiency.

According to Table 7, for two of the five increases in the STT rate, the $\alpha_1$ coefficient, indicating a structural change in the squared residuals of the autoregressive structure, is significantly negative.[14] The $\beta_1$ coefficient , indicating a structural change in the effect of the lagged conditional volatility on the current volatility in the autoregressive structure, is significantly positive. As suggested by Lee and Ohk (1992), a negative $\alpha_1$ and a positive $\beta_1$ indicate that the effect of $\sigma_{t-1}^2$ on $\sigma_t^2$ at time $t$ increases, but the effect of $\epsilon_{t-1}^2$ on $\sigma_t^2$ at time $t$ decreases after the STT rate increased. This implies that the volatility shocks are less quickly digested and reflected in the stock market in the post-STT period. Therefore, the two increase in the STT rate makes the Chinese A-shares market less efficient because the volatility shocks are less quickly assimilated in that market. For the other two of the five increases, however, the $\alpha_1$ coefficient is positive, while the $\beta_1$ coefficient is negative. That is, the effect of $\epsilon_{t-1}^2$ on $\sigma_t^2$ relatively increase while the effect of $\sigma_{t-1}^2$ on $\sigma_t^2$ at time $t$ relatively decrease after the STT rate increased. According to Lee and Ohk (1992) in subsection 3.1.3, this implies that the volatility shocks are more quickly digested and reflected in the stock market after the STT rate increased, i.e., the market becomes more efficient. Altogether, the impact of the increases in the STT rate is mixed.

As shown in Table 8, among seven of the nine reductions in the STT rate, the $\alpha_1$ coefficient and $\beta_1$ coefficient in the SGARCH models have the same sign, either negative or positive. According to Lee and Ohk (1992) in subsection 3.1.3, no effect on market efficiency can be found if $\alpha_1$ coefficient and $\beta_1$ coefficient have the same sign. For the other two reductions, the $\alpha_1$ coefficient is negative while the $\beta_1$ coefficient is positive, which suggests that the effect of $\epsilon_{t-1}^2$ on $\sigma_t^2$ relatively declines while the effect of $\sigma_{t-1}^2$ on $\sigma_t^2$ relatively increases. As suggested above, this indicates that the volatility shocks are less quickly digested and reflected in the market in the post-STT reductions period, i.e., the market becomes less efficient.

Overall, the market became less efficient after the STT rate increased. The reductions in the STT rate sometimes made the market less efficient while having no effect on market efficiency in other times. Our findings are consistent with Pollin, Baker and Schaberg (2003) that adjustments in the STT in an illiquid market have the potential to raise volatility and reduce efficiency. However, this destabilizing effect is uncertain, given that traders hold heterogeneous beliefs on market fundamentals. This divergence in investors' beliefs can counterbalance each other and make the net effect unclear (Xiong and Yan, 2010). This may partly explain why some adjustments in the STT rate have little impact on market efficiency. In general, STT rate adjustments did not improve the

[14] The $\alpha_1$ coefficient and $\beta_1$ coefficient in the SGARCH models for increase in the STT rate in the Shenzhen market in 2007 have the same sign, both positive. According to Lee and Ohk (1992) in subsection 3.3, one can illustrate little about the market efficiency, if $\alpha_1$ coefficient and $\beta_1$ coefficient have the same sign. Thus, No effects on market efficiency can be found after the STT rate reduced in the Shanghai A-shares market.

market efficiency in both markets.[15]

(*Insert Table* 7 *and Table* 8 *here*)

## 5 Conclusions

This study investigated the impact of the STT rate adjustments on trading volume, return volatility and market efficiency, using the daily Chinese stock market data to gauge policy implications. The empirical results suggest that trading volume significantly increases after the STT rate is reduced and significantly declines after the rate is increased. On average, an increase of STT rate by around 133% (from an average rate of 0.16% to 0.38%) would lead to a fall of trading volume by 26 percent. A reduction in the STT rate by 56% (from an average rate of 0.33% to 0.15%) would result an increase in trading volume by 105 percent.

Like many other empirical studies, we also found that market volatility increased after the STT rate increased, which contradicts the argument by the STT proponents. We also contributed to literature by providing empirical evidence that market volatility generally increases after the STT rate reduced. This implies that imposing taxes on stock trading cannot help stabilize the market by discouraging destabilizing trading activities.

The impact of the increases in the STT rate on the Chinese stock market efficiency is mixed, either improving or curbing it. We did not find strong evidence that reductions in the STT rate have an effect on market efficiency, although some of them make the market less efficient.

In general, the empirical results show that the effect of the STT on the stock market is not as what policy makers expect, at least in this emerging market. Our study provides some valuable evidence in the ongoing debates of whether to impose a STT in the United States, U.K. and other main equity markets.

The event-study methods in this paper, however, rely on the assumption that no other structural or policy changes simultaneously occur. It is, thus, hard to disentangle the effect of the STT on stock markets from the effect of other factors if any and makes the estimated results potentially biased. But we did not find any factors that lead to an upward bias in the estimated market impact. We did not quantitatively analyze the reasons for the stock market's response in this study, because of lacking either enough observations of the STT adjustments or micro-structure type data, for example, bid-ask data. Given the availability of bid-ask data in the future, further attempts to gain some insights into reasons why the stock market reacts to the STT adjustments would be an intriguing topic.

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**Table 1: The STT rate Adjustments in the Chinese Stock Market**

| Adjustment date | STT rate before adjustment | STT rate after adjustment |
|---|---|---|
| October 10, 1991 | 0.0% (0.6%)* | 0.3% |
| May 12, 1997 | 0.3% | 0.5% |
| June 12, 1998 | 0.5% | 0.4% |
| November 16, 2001 | 0.4% | 0.2% |
| January 24, 2005 | 0.2% | 0.1% |
| May 30, 2007 | 0.1% | 0.3% |
| April 24, 2008 | 0.3% | 0.1% |

*Notes*: This table displays the events of adjustments in the STT rate in the two A-shares market of China. Column one displays the date on which the changes in the STT rate occured. Column two presents the STT rate before the adjustment. The third column presents the STT rate after the adjustment. All the other six pre-adjustment and post-adjustment STT rate are the same in the Shanghai and the Shenzhen market, except for 1991. *The number in the parenthesis is the pre-adjustment STT rate in the Shenzhen market in 1991.

**Table 2: Descriptive Statistics for Index Returns**

| | Shanghai A-shares market | Shenzhen A-shares market |
|---|---|---|
| Mean | 0.00067 | 0.000493 |
| Median | 0.000678 | -0.000224 |
| Maximum | 0.719 | 0.233 |
| Minimum | -0.179 | -0.220 |
| Standard Deviation | 0.0264 | 0.024 |
| Skewness | 5.567 | 0.498 |
| Kurtosis | 141.942 | 17.177 |
| Jarque-Bera Test | 3506106[0.000] | 35765.51[0.000] |

*Notes*: This table reports the descriptive statistics for the return series on the Shanghai and Shenzhen A shares market. The returns for the Shanghai market span from January 7th, 1991 to August 29th, 2008. The returns for the Shenzhen market span from April 5th, 1991 to August 29th, 2008. The last row presents the p values for the Jarque-Bera test

**Table 3: Bootstrapping $t$ Test of Trading Volume's ( in billion Yuan) Response to Increases in the STT Rate**

| Year | | Sample intervals | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ±10 | ±15 | ±20 | ±30 | ±40 | ±50 | ±60 | ±75 |
| 1991 | Mean ratio | 0.05 | 0.60 | 0.45 | 0.53 | 0.71 | 0.70 | 0.70 | 0.63 |
| | $t$ statistic | 1.89 | 1.80 | 3.26 | 2.37 | 1.31 | 1.42 | 1.52 | 2.18 |
| | $p$ value | [0.072] | [0.097] | [0.001] | [0.024] | [0.214] | [0.156] | [0.134] | [0.042] |
| 1997 | Mean ratio | 0.75 | 0.71 | 0.72 | 0.66 | 0.65 | 0.65 | 0.64 | 0.69 |
| | $t$ statistic | 2.74 | 3.85 | 4.34 | 5.44 | 6.72 | 7.00 | 6.60 | 4.74 |
| | $p$ value | [0.025] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 1997 | Mean ratio | 0.67 | 0.65 | 0.71 | 0.68 | 0.70 | 0.70 | 0.70 | 0.71 |
| | $t$ statistic | 3.20 | 3.35 | 2.93 | 4.06 | 4.73 | 5.18 | 5.23 | 4.72 |
| | $p$ value | [0.006] | [0.003] | [0.005] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 2007 | Mean ratio | 0.91 | 0.90 | 0.90 | 0.81 | 0.79 | 0.88 | 0.96 | 1.10 |
| | $t$ statistic | 1.25 | 1.78 | 1.84 | 3.33 | 3.28 | 1.86 | 0.64 | -1.59 |
| | $p$ value | [0.247] | [0.085] | [0.079] | [0.000] | [0.000] | [0.070] | [0.516] | [0.117] |
| 2007 | Mean ratio | 1.17 | 1.09 | 1.02 | 0.88 | 0.86 | 0.98 | 1.08 | 1.21 |
| | $t$ statistic | -2.05 | -1.17 | -0.21 | 1.72 | 1.95 | 0.34 | -1.24 | -3.33 |
| | $p$ value | [0.051] | [0.267] | [0.831] | [0.097] | [0.059] | [0.738] | [0.230] | [0.003] |

*Notes*: This table reports the results for the bootstrapping t test of how trading volume changes after increases in the STT rate. Except for 1991, all other years have two increases in the STT rate. Therefore, there are totally 5 increases in the STT rate. Mean ratio is the ratio of average trading volume in the post-STT and pre-STT increase periods.

**Table 4: Trading Volume's ( in billion Yuan)**
**Response to Reductions in the STT Rate**

| Year | | Sample intervals | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ±10 | ±15 | ±20 | ±30 | ±40 | ±50 | ±60 | ±75 |
| 1991 | Mean ratio | 1.99 | 2.49 | 3.35 | 5.02 | 5.47 | 5.64 | 5.82 | 5.88 |
| | $t$ statistic | -2.01 | -3.41 | -5.02 | -8.04 | -9.64 | -9.65 | -10.40 | -11.10 |
| | $p$ value | [0.069] | [0.001] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 1998 | Mean ratio | 0.81 | 7.12 | 0.68 | 0.61 | 0.57 | 0.53 | 0.55 | 0.67 |
| | $t$ statistic | 2.332 | 4.61 | 5.36 | 8.54 | 11.33 | 13.64 | 11.47 | 6.69 |
| | $p$ value | [0.032] | [0.001] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 1998 | Mean ratio | 0.73 | 0.63 | 0.60 | 0.52 | 0.51 | 0.48 | 0.54 | 0.61 |
| | $t$ statistic | 3.63 | 6.34 | 7.70 | 11.38 | 13.89 | 16.90 | 12.07 | 8.21 |
| | $p$ value | [0.003] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 2001 | Mean ratio | 1.77 | 1.66 | 1.14 | 1.14 | 1.12 | 1.12 | 1.16 | 1.30 |
| | $t$ statistic | -3.96 | -4.91 | -0.78 | -0.96 | -1.00 | -1.19 | -1.81 | -3.08 |
| | $p$ value | [0.001] | [0.000] | [0.449] | [0.378] | [0.338] | [0.226] | [0.071] | [0.003] |
| 2001 | Mean ratio | 0.36 | 0.31 | 0.19 | 0.17 | 0.16 | 0.16 | 0.17 | 0.20 |
| | $t$ statistic | 2.58 | 4.51 | 3.86 | 5.47 | 7.34 | 8.98 | 10.54 | 12.43 |
| | $p$ value | [0.030] | [0.001] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 2005 | Mean ratio | 1.36 | 1.46 | 1.71 | 1.75 | 1.53 | 1.38 | 1.26 | 1.05 |
| | $t$ statistic | -1.95 | -3.07 | -4.70 | -6.66 | -6.03 | -4.98 | -3.64 | -0.88 |
| | $p$ value | [0.087] | [0.005] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.399] |
| 2005 | Mean ratio | 2.09 | 2.02 | 2.30 | 2.21 | 2.09 | 2.01 | 1.82 | 1.40 |
| | $t$ statistic | -3.49 | -4.59 | -6.59 | -8.67 | -9.24 | -9.40 | -8.79 | -4.90 |
| | $p$ value | [0.005] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 2008 | Mean ratio | 2.20 | 1.88 | 1.68 | 1.31 | 1.08 | 0.99 | 0.93 | 0.75 |
| | $t$ statistic | -7.42 | -7.39 | -6.11 | -3.14 | -0.92 | 0.13 | 1.16 | 4.52 |
| | $p$ value | [0.000] | [0.000] | [0.000] | [0.002] | [0.365] | [0.899] | [0.264] | [0.000] |
| 2008 | Mean ratio | 1.71 | 1.44 | 1.32 | 1.08 | 0.95 | 0.91 | 0.84 | 0.66 |
| | $t$ statistic | -4.25 | -3.70 | -3.11 | -0.89 | 0.61 | 1.40 | 2.71 | 6.03 |
| | $p$ value | [0.000] | [0.000] | [0.002] | [0.374] | [0.553] | [0.158] | [0.007] | [0.000] |

*Notes*: This table reports the results for the bootstrapping t test of how trading volume changes after reductions in the STT rate. Except for 1991, all other years have two reductions in the STT rate. Therefore, there are totally 9 reductions in the STT rate. Mean ratio is the ratio of average trading volume in the post-STT and pre-STT reductions periods.

**Table 5: Modified Levene's Test of Return Volatility's Reaction to Increases in the STT Rate**

| Year | | Sample intervals | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ±10 | ±15 | ±20 | ±30 | ±40 | ±50 | ±60 | ±75 |
| 1991 | *Std* before $t$ | 0.007 | 0.006 | 0.007 | 0.007 | 0.007 | 0.006 | 0.006 | 0.007 |
| | *Std*after $t$ | 0.001 | 0.003 | 0.002 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 |
| | $L$ statistic | 533.0 | 50.46 | 92.78 | 238.8 | 112.3 | 43.77 | 36.61 | 96.12 |
| | $p$ value | [0.003] | [0.002] | [0.001] | [0.000] | [0.002] | [0.002] | [0.000] | [0.000] |
| 1997 | *Std* before $t$ | 0.030 | 0.025 | 0.022 | 0.020 | 0.020 | 0.019 | 0.024 | 0.022 |
| | *Std*after $t$ | 0.046 | 0.039 | 0.038 | 0.033 | 0.031 | 0.029 | 0.027 | 0.026 |
| | $L$ statistic | 3.38 | 3.37 | 5.63 | 4.81 | 6.02 | 6.33 | 1.68 | 3.75 |
| | $p$ value | [0.179] | [0.174] | [0.073] | [0.051] | [0.028] | [0.024] | [0.204] | [0.069] |
| 1997 | *Std* before $t$ | 0.036 | 0.030 | 0.027 | 0.024 | 0.023 | 0.021 | 0.025 | 0.023 |
| | *Std*after $t$ | 0.051 | 0.044 | 0.042 | 0.038 | 0.040 | 0.037 | 0.034 | 0.032 |
| | $L$ statistic | 2.43 | 3.33 | 4.73 | 4.94 | 6.06 | 6.77 | 3.21 | 5.32 |
| | $p$ value | [0.294] | [0.21] | [0.077] | [0.04] | [0.04] | [0.028] | [0.086] | [0.04] |
| 2007 | *Std* before $t$ | 0.01 | 0.015 | 0.014 | 0.018 | 0.016 | 0.015 | 0.016 | 0.021 |
| | *Std*after $t$ | 0.041 | 0.035 | 0.032 | 0.032 | 0.029 | 0.028 | 0.027 | 0.025 |
| | $L$ statistic | 11.93 | 5.38 | 10.63 | 12.02 | 12.25 | 12.81 | 10.91 | 3.12 |
| | $p$ value | [0.052] | [0.134] | [0.030] | [0.007] | [0.004] | [0.005] | [0.003] | [0.155] |
| 2007 | *Std* before $t$ | 0.012 | 0.016 | 0.017 | 0.020 | 0.018 | 0.018 | 0.018 | 0.024 |
| | *Std* after $t$ | 0.045 | 0.037 | 0.035 | 0.036 | 0.034 | 0.032 | 0.031 | 0.029 |
| | $L$ statistic | 15.81 | 6.69 | 10.06 | 13.06 | 13.73 | 14.44 | 16.27 | 4.51 |
| | $p$ value | [0.058] | [0.086] | [0.012] | [0.006] | [0.003] | [0.001] | [0.000] | [0.065] |

*Notes*: This table presents the results of how return volatility changes after increases in the STT rate. Except for 1991, all other years have two increases in the STT rate. Therefore, there are totally 9 increases in the STT rate. *Std* before t and *Std* after t are the standard deviations in the pre-STT and post-STT increase periods. $L$ Statistic is the modified Levene's statistic.

**Table 6: Modified Levene's Test of Return Volatility's Reaction to Reductions in the STT Rate**

| Year | | Sample intervals | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ±10 | ±15 | ±20 | ±30 | ±40 | ±50 | ±60 | ±75 |
| 1991 | *Std* before *t* | 0.063 | 0.056 | 0.049 | 0.043 | 0.051 | 0.046 | 0.042 | 0.038 |
| | *Std*after *t* | 0.037 | 0.032 | 0.040 | 0.068 | 0.063 | 0.056 | 0.052 | 0.047 |
| | *L* statistic | 4.89 | 4.44 | 0.46 | 2.05 | 3.19 | 3.88 | 4.07 | 4.30 |
| | *p* value | [0.125] | [0.145] | [0.623] | [0.214] | [0.084] | [0.055] | [0.06] | [0.045] |
| 1998 | *Std* before *t* | 0.010 | 0.009 | 0.008 | 0.009 | 0.009 | 0.010 | 0.010 | 0.010 |
| | *Std*after *t* | 0.014 | 0.014 | 0.013 | 0.013 | 0.012 | 0.019 | 0.018 | 0.018 |
| | *L* statistic | 0.78 | 3.52 | 5.23 | 6.21 | 3.21 | 6.90 | 6.46 | 11.08 |
| | *p* value | [0.391] | [0.078] | [0.022] | [0.018] | [0.076] | [0.003] | [0.008] | [0.000] |
| 1998 | *Std* before *t* | 0.010 | 0.009 | 0.009 | 0.010 | 0.011 | 0.010 | 0.011 | 0.011 |
| | *Std*after *t* | 0.016 | 0.017 | 0.016 | 0.017 | 0.016 | 0.021 | 0.020 | 0.019 |
| | *L* statistic | 2.89 | 6.17 | 8.75 | 7.57 | 3.63 | 7.14 | 7.24 | 6.91 |
| | *p* value | [0.107] | [0.017] | [0.005] | [0.011] | [0.06] | [0.01] | [0.004] | [0.005] |
| 2001 | *Std* before *t* | 0.017 | 0.015 | 0.028 | 0.026 | 0.023 | 0.021 | 0.020 | 0.020 |
| | *Std*after *t* | 0.008 | 0.008 | 0.010 | 0.010 | 0.012 | 0.019 | 0.020 | 0.019 |
| | *L* statistic | 0.69 | 1.26 | 3.85 | 7.13 | 3.34 | 0.29 | 0.01 | 0.04 |
| | *p* value | [0.616] | [0.418] | [0.025] | [0.003] | [0.053] | [0.598] | [0.929] | [0.848] |
| 2001 | *Std* before *t* | 0.019 | 0.017 | 0.028 | 0.026 | 0.023 | 0.022 | 0.021 | 0.021 |
| | *Std*after *t* | 0.009 | 0.01 | 0.011 | 0.011 | 0.014 | 0.021 | 0.022 | 0.021 |
| | *L* statistic | 1.11 | 1.28 | 2.66 | 4.73 | 2.58 | 0.007 | 0.000 | 0.005 |
| | *p* value | [0.406] | [0.412] | [0.087] | [0.017] | [0.084] | [0.777] | [0.975] | [0.938] |
| 2005 | *Std* before *t* | 0.013 | 0.012 | 0.010 | 0.011 | 0.010 | 0.010 | 0.011 | 0.012 |
| | *Std*after *t* | 0.021 | 0.019 | 0.016 | 0.015 | 0.014 | 0.015 | 0.014 | 0.014 |
| | *L* statistic | 2.23 | 3.24 | 2.68 | 1.40 | 1.52 | 5.16 | 3.71 | 2.08 |
| | *p* value | [0.298] | [0.128] | [0.174] | [0.300] | [0.259] | [0.038] | [0.006] | [0.152] |
| 2005 | *Std* before *t* | 0.013 | 0.012 | 0.01 | 0.011 | 0.01 | 0.01 | 0.011 | 0.013 |
| | *Std* after *t* | 0.019 | 0.017 | 0.016 | 0.015 | 0.014 | 0.015 | 0.014 | 0.015 |
| | *L* statistic | 1.14 | 1.78 | 2.84 | 2.86 | 3.18 | 7.40 | 3.47 | 2.21 |
| | *p* value | [0.418] | [0.258] | [0.198] | [0.153] | [0.103] | [0.013] | [0.07] | [0.145] |
| 2008 | *Std* before *t* | 0.030 | 0.032 | 0.034 | 0.031 | 0.028 | 0.027 | 0.029 | 0.028 |
| | *Std*after *t* | 0.038 | 0.032 | 0.031 | 0.027 | 0.031 | 0.031 | 0.030 | 0.028 |
| | *L* statistic | 0.22 | 0.05 | 0.88 | 2.36 | 0.10 | 0.006 | 0.06 | 0.14 |
| | *p* value | [0.630] | [0.831] | [0.351] | [0.13] | [0.739] | [0.941] | [0.79] | [0.717] |
| 2008 | *Std* before *t* | 0.035 | 0.036 | 0.036 | 0.036 | 0.033 | 0.031 | 0.032 | 0.031 |
| | *Std* after *t* | 0.041 | 0.035 | 0.034 | 0.029 | 0.034 | 0.034 | 0.033 | 0.031 |
| | *L* statistic | 0.12 | 0.10 | 0.33 | 3.35 | 0.31 | 0.000 | 0.042 | 0.23 |
| | *p* value | [0.710] | [0.761] | [0.619] | [0.064] | [0.587] | [0.974] | [0.853] | [0.641] |

*Notes*: This table presents the results of how return volatility changes after reductions in the STT rate. Except for 1991, all other years have two reductions in the STT rate. Therefore, there are totally 9 reductions in the STT rate. *Std* before t and *Std* after t are the standard deviations in the pre-STT and post-STT reduction periods. *L* Statistic is the modified Levene's statistic.

**Table 7: Switch GARCH Examination of Market Efficiency's Response to Increases in the STT Rate**

| Year | $\mu_0$ $\times 10^{-3}$ | $\mu_1$ $\times 10^{-3}$ | $\omega_0$ $\times 10^{-4}$ | $\alpha_0$ | $\beta_0$ | $\omega_1$ $\times 10^{-4}$ | $\alpha_1$ | $\beta_1$ |
|---|---|---|---|---|---|---|---|---|
| 1991 | 6.821 | 0.341 | 0.055 | 0.442 | 0.464 | -0.049 | 0.761 | -0.200 |
| | [0.000] | [0.726] | [0.314] | [0.139] | [0.001] | [0.432] | [0.038] | [0.278] |
| 1997 | 3.340 | -4.195 | 3.261 | 0.437 | 0.259 | -2.880 | -0.417 | 0.627 |
| | [0.213] | [0.211] | [0.002] | [0.005] | [0.088] | [0.007] | [0.008] | [0.000] |
| 1997 | 5.709 | -5.888 | 4.804 | 0.385 | 0.176 | -4.568 | -0.511 | 0.890 |
| | [0.043] | [0.081] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| 2007 | 6.269 | -5.385 | 2.003 | 0.494 | 0.045 | 7.380 | 0.037 | -1.247 |
| | [0.014] | [0.118] | [0.749] | [0.746] | [0.729] | [0.254] | [0.802] | [0.416] |
| 2007 | 8.023 | -7.143 | 10.520 | -0.020 | -0.960 | -4.895 | 0.313 | 0.820 |
| | [0.000] | [0.025] | [0.000] | [0.011] | [0.000] | [0.066] | [0.088] | [0.011] |

*Notes*: This table presents the result of SGARCH examination of how market efficiency changes after increases in the STT rate. Except for 1991, all other years have two increases in the STT rate. The explanation to the coefficients in this table are in equation (7) of Section 3.1.3.

**Table 8: Switch GARCH Examination of Market Efficiency's Response to Reductions in the STT Rate**

| Year | $\mu_0$ $\times 10^{-3}$ | $\mu_1$ $\times 10^{-3}$ | $\omega_0$ $\times 10^{-4}$ | $\alpha_0$ | $\beta_0$ | $\omega_1$ $\times 10^{-4}$ | $\alpha_1$ | $\beta_1$ |
|---|---|---|---|---|---|---|---|---|
| 1991 | -6.047 | 7.042 | 0.028 | 10.912 | 0.031 | 0.273 | -10.176 | 0.516 |
| | [0.000] | [0.001] | [0.545] | [0.000] | [0.001] | [0.019] | [0.000] | [0.000] |
| 1998 | 1.201 | -1.793 | 1.496 | -0.153 | -0.413 | -0.895 | 0.318 | 0.685 |
| | [0.275] | [0.257] | [0.009] | [0.181] | [0.311] | [0.158] | [0.037] | [0.137] |
| 1998 | -0.616 | -0.563 | 2.063 | 0.037 | -0.521 | -1.160 | 0.364 | 0.786 |
| | [0.592] | [0.733] | [0.219] | [0.685] | [0.639] | [0.498] | [0.006] | [0.485] |
| 2001 | -1.233 | -0.071 | 0.200 | 0.768 | 0.119 | 3.968 | -0.142 | -0.142 |
| | [0.290] | [0.974] | [0.214] | [0.000] | [0.053] | [0.018] | [0.028] | [0.033] |
| 2001 | -0.878 | -0.364 | 0.016 | 0.258 | 0.819 | 3.917 | -0.299 | -0.904 |
| | [0.411] | [0.868] | [0.707] | [0.000] | [0.000] | [0.216] | [0.000] | [0.306] |
| 2005 | -1.233 | -0.071 | 0.200 | 0.119 | 0.768 | 3.968 | -0.142 | -1.441 |
| | [0.290] | [0.974] | [0.214] | [0.053] | [0.000] | [0.018] | [0.028] | [0.033] |
| 2005 | -0.098 | 0.475 | 0.142 | 0.162 | 0.773 | 4.608 | -0.196 | -1.495 |
| | [0.374] | [0.805] | [0.210] | [0.034] | [0.000] | [0.000] | [0.012] | [0.000] |
| 2008 | -6.232 | 2.602 | 11.757 | 0.133 | -0.898 | 5.093 | -0.157 | -0.018 |
| | [0.003] | [0.522] | [0.000] | [0.002] | [0.000] | [0.040] | [0.049] | [0.954] |
| 2008 | -0.005 | 0.0002 | 0.002 | 0.127 | -0.777 | -0.0006 | -0.007 | 0.679 |
| | [0.130] | [0.973] | [0.001] | [0.377] | [0.040] | [0.519] | [0.969] | [0.501] |

*Notes*: This table presents the result of SGARCH examination of how market efficiency changes after reductions in the STT rate. Except for 1991, all other years have two reductions in STT rate. Therefore, there are totally 9 reductions. The explanation to the coefficients in this table are in equation (7) of Section 3.1.3.