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Impact of tick size reduction on the volatility components: the case of the Taiwanese stock exchange

Abstract

Using the model proposed by Amihud & Mendelson (1987), this paper discusses the impact of the tick-size reduction implemented in the Taiwanese Stock Exchange on March 1st, 2005, on the volatility components. While previous studies assume that trading information can be fully revealed by the market, this work, which assumes that it is only partially revealed, indicates that the speed of price adjustment plays an important role in volatility-component decomposition. We find that after the tick size reduction, noise variance, intrinsic variance and speed of price adjustment all decrease, and noise reduction is the major source in the volatility reduction. In addition, the changes in the speed of price adjustment are positively related to the changes in noise variance and volatility, but are negatively related to the changes in intrinsic variance.

Keywords: intrinsic variance, noise variance, speed of price adjustment, tick size reduction, volatility component.
JEL Classification: G14, G15.

Introduction

In recent years, in order to enhance market competition, many exchanges have reduced the tick size (e.g., NYSE, NASDAQ), with existing empirical studies all indicating that after such reductions market quality (e.g., spread, volatility and so on) improves (Ronen & Weaver, 2001; Bessembinder, 2003; Chakravarty, Van Ness & Van Ness, 2005). In order to further understand the source of reduced market quality, some studies investigated the effect of tick size reduction on spread components (e.g., Bacidore, 2001; Gibson, Singh & Yerramilli, 2003; Chakravarty et al., 2005). However, as universally understood, volatility plays an important role in evaluating futures hedging, risk management and portfolio allocation. Although considerable attention has been paid in the past to research issues related to volatility decomposition (Harris, 1990; Madhavan, Richardson & Roomans, 1997) and the effect of tick size reduction on volatility (e.g., Bessembinder, 2003), fewer empirical studies focus on the effect of market structure change on volatility components (He & Wu, 2005; Vuorenmaa, 2008).

Using the method proposed by Madhavan et al. (1997), He & Wu (2005) decomposed volatility into three components, namely public information, rounding errors, and market-making frictions (i.e., noise), to examine the effects of decimalization in the New York Stock Exchange (NYSE) on changes in volatility components. Similarly, Vuorenmaa (2008) applied several nonparametric estimators to compare the effect of decimalization on noise variance in the NYSE. Although these studies use different approaches to evaluate volatility components, the consensus is that noise variance decreases after the tick size reduction, with the assumption that the stock price fully reflects the available trading information.

In general, if trading information can be fully disseminated through the market, the observed stock price can be decomposed into two components: intrinsic price and noise (Bandi & Russell, 2006). Hence, volatility can be decomposed into two components: intrinsic variance and noise variance. However, the transmission processes for intrinsic value towards the observed stock price may be affected by the amount and quality of trading information and the extent of market inefficiency. Therefore, the stock price usually over- or under-reacts to the intrinsic price (Daniel, Hirshleifer & Subrahmanyam, 1998), indicating that the stock price cannot fully reflect trading information immediately. Following the method proposed by Amihud & Mendelson (1987), Theobald & Yallup (2005) investigated the FTSE 100 index and found that both noise variance and intrinsic variance are, indeed, affected by the speed of price adjustment. Hence, the speed of price adjustment seems to be considered by the related research concerning volatility decomposition.

Recently, increasing numbers of studies have tried to understand the role of the speed of price adjustment in traders' quoting behavior. For example, Chung, Chuwonganant & Jiang (2008) investigated the effect of decimalization on the speed of quote adjustment in the NYSE and NASDAQ. The empirical results indicated that the speed of quote adjustment increased after decimalization, and that pricing efficiency also increased. Further, Chelley-Steeley (2008) examined the effect of the introduction of a closing call auction in the London Stock Exchange (LSE) on the speed of price adjustment and pricing efficiency, and the empirical results were consistent with Chung et al.'s findings.

This study investigates the influence of the tick size reduction implemented on March 1st, 2005, in the TSEC (Taiwan Stock Exchange Corporation) on changes to volatility components after considering the partial price adjustment. The contributions made by this paper to the existing literature are presented below.

Firstly, the specific market structure of the TSEC is different from that of other markets (e.g., NYSE, NASDAQ), as follows:

1. The TSEC is an emerging order-driven market, with retail investors accounting for approximately 70% of trading value and a turnover rate that is significantly higher than nearly all other markets (at the end of 2004, the turnover rate in the TSEC was about 127.27%, second only worldwide to those of the Korea Stock Exchange and NASDAQ). The trading decisions for retail investors in the TSEC are based on rumors, sentiment and news from informal sources. According to previous findings, although retail investors all trade like informed traders, in fact most of them are uninformed (Bange, 2000; Sias, Starks & Titman, 2006), and exhibit overconfidence. Hence, retail investors can be described as noise traders (Barber & Odean, 2000 & 2002), and thus, noise trading in the TSEC is expected to be more significant than in other markets.
2. As the TSEC adopts multiple tick-size regimes, some stocks with the same tick size during the study periods can be used as the control group to examine whether the results are affected by the tick-size reduction or other concurrent changes of stock attributes. Hence, this work can provide more robust results about the effect of tick-size reduction on volatility components.

Secondly, although some studies focus on the effect of tick-size reduction on the volatility components (He & Wu, 2005; Vuorenmaa, 2008), they all assume that the trading information cannot be completely revealed by the market. However, on the basis of the findings of Daniel et al. (1998), a partial speed of price adjustment seems a more reasonable assumption. Furthermore, according to Bandi & Russell (2006), the intrinsic price is the key factor in understanding risk management, while noise is the crucial ingredient in understanding market structure and investors' quoting behavior. However, only some studies have investigated the impact of tick size reduction on noise (e.g., He & Wu, 2005; Vuorenmaa, 2008), but even fewer have examined the role of intrinsic variance. As more information about these issues would be of significant interest to regulators and researchers, this work will conduct an empirical investigation of them.

Summarizing the above discussion, this paper has the following aims: (1) to investigate the effects of tick size reduction on the volatility components, including the speed of price adjustment, noise variance, and intrinsic variance; (2) to examine whether volatility reduction is due to noise reduction, improvements in the speed of price adjustment, or both components.

The findings of this work show that after the tick size reduction the volatility, intrinsic variance and noise variance do indeed reduce. Next, we also find evidence that the speed of price adjustment decreases along with the reduced tick size. Finally, the changes in volatility and noise variance are positively related to the changes in the speed of price adjustment, while a negative relationship exists between the changes in the speed of price adjustment and those in intrinsic variance.

The remainder of this paper is organized as follows. Section 1 will discuss the institutional background of the TSEC. Next, Section 2 provides discussions about data sources and the cross-sectional analysis, with Section 3 discussing the empirical findings. The final section will present the conclusions of this work.

1. Institutional background of the TSEC

The TSEC has one of the highest trading volumes and turnover rates in the Pacific region. At the end of 2004, it had 691 listed firms and the trading value was 18.818 trillion NTD (New Taiwan Dollar). In addition, the TSEC is an order-driven market, without market makers or specialists, and retail investors, who can only submit either market or limit orders, accounted for about 70% of the trading value at the year end of 2004. The priority of the order execution depends first on the price and then on the arrival time of orders.

The TSEC has adopted a multiple tick-size system (six tick size regimes), with the tick size positively related to stock price (see Table 1). Trading on the TSEC is from Monday to Friday, with the orders fed into the computerized trading system at 8:30 a.m., but not executed until trading begins at 9:00 a.m. As for the opening price (closing price), all orders are accumulated in an order book during the pre-opening (pre-closing) period from 8:30 a.m. to 9:00 a.m. (13:25 p.m. to 13:30 p.m.), and it is determined by means of a call auction at 9:00 a.m. (13:30 p.m.). Continuous auctions are adopted during other trading periods, outside of these times. The best five bid and ask prices and the corresponding trading volumes are revealed continuously to the public investors. The minimum trading units are 1,000 shares, and the automated central limit order book accumulates and matches orders against one another. The opening price maximizes the trading volume, and then after this the system matches orders on a periodic basis until the closing. A round of clearing requires about one minute, but the actual time varies slightly based on the trading intensity.

2. Data, variable measures, and cross-sectional analysis

2.1. Data. The data on the TSEC common stocks are collected from the *TEJ* (Taiwan Economic Journal) database, and consists of the best bidding and asking prices. In order to analyze the impact of the tick size reduction on the volatility components, the study period, covering one year from September 2004 to August 2005, is divided into two periods of from September 1st, 2004 to February 28th, 2005, including 120 trading days (denoted as the "pre-period"), and from March 7th, 2005 to August 31st, 2005, including 124 trading days (denoted as the "post-period"), yielding a total of 244 trading days. The periods extending from March 1st, 2005 to March 6th, 2005 are excluded to eliminate irregular trading behaviors.

Table 1. Tick size rule before and after tick size reduction

Regime		1	2	3	4	5	6
Price range	Pre-period	[0,5)	[5,15)	[15,50)	[50,150)	[150,1000)	[1000, ∞)
	Post-period	[0,10)	[10,50)	[50,100)	[100,500)	[500,1000)	[1000, ∞)
Tick size		0.01	0.05	0.1	0.5	1	5

Notes: * The tick size was reduced on March 1st, 2005. The unit is the New Taiwan Dollar (NT$).

Furthermore, we omit the following data to minimize data errors: common shares that experienced delisting, stock splits, temporary trading halts or underwent different tick size regimes during the study periods; trades with price or trading volume less than or equal to zero; stocks with the speed of price adjustment outside the range between [0,2]; stocks with negative noise or negative intrinsic variance and issues with less than ten transactions per day (He & Wu, 2005). In addition, as the TSEC adopts a multiple tick size regime, the stocks can be classified into various event groups, with the tick size changing from NT$ 0.05 to NT$ 0.01 (group 1), NT$ 0.1 to NT$ 0.05 (group 2), and in the control group (group 3) the tick size is NT$ 0.05 in both the pre- and post-periods. The sample sizes are 28, 82 and 11 respectively, yielding a total of 121 firms.

2.2. Variable measures. *2.2.1. Partial adjustment with noise model.* In this study, the partial adjustment with noise model proposed by Amihud & Mendelson (1987) is used to assess the effects of tick size reduction on the volatility components, including the noise variance (σ^2), intrinsic variance (v^2) and the speed of price adjustment (g). The variables are defined as follows:

1. Speed of price adjustment (g). Amihud & Mendelson (1987) initially proposed the concept of speed of price adjustment, and various studies (e.g., Amihud & Mendelson, 1989; Damodaran, 1993; Brisley & Theobald, 1996; Theobald & Yallup, 1998) have developed ways to estimate this. However, Theobald & Yallup (2004) indicated that all these methods have some weaknesses, and thus, proposed two other approaches, Autocovariance Ratios and ARMA estimators. The simulation results show that the performance of the ARMA estimators is better than that of Autocovariance Ratios. Although high-order MA terms proposed by Theobald & Yallup (2004) can be used to consider the stocks with thin trading or non-trading, the majority of studies (e.g., Chelley-Steeley (2005)) still use ARMA (1,1) to estimate the speed of price adjustment. According to Bandi & Russell (2006), even though the high-order coefficients are significantly different from 0 they are still much smaller than the first-order coefficients. Consequently, this work uses ARMA (1,1) to evaluate the speed of price adjustment. The ARMA estimator proposed by Theobald & Yallup (2004) is used to estimate the coefficient of the speed of price adjustment. The model, ARMA (1,1), is as follows:

$$R_t = g\mu + (1-g)R_{t-1} + ge_t + u_t - u_{t-1}, \quad (1)$$

where g is the price-adjustment coefficient reflecting the speed of trading price towards the intrinsic price. Further, R_t is the day-t logarithmic stock return ($\ln(MP_t / MP_{t-1})$); MP_t is the midpoints of closing bidding and asking prices on day t; e_t is the innovation; u_t is the white noise, and its variance is σ^2. The above equation will be stationary provided that $0 < g < 2$.

2. Noise variance and intrinsic variance. The methodology proposed by Amihud & Mendelson (1987) is used to decompose the volatility ($Var(R_t)$) into two components, intrinsic variance (v^2) and noise variance (σ^2), which are defined as follows:

$$Var(R_t) = (gv^2 + 2\sigma^2)/(2-g), \quad (2)$$

$$\sigma^2 = (1-g)Var(R_t) - Cov(R_t, R_{t-1}), \quad (3)$$

$$v^2 = Var(R_t) + 2Cov(R_t, R_{t-1})/g, \quad (4)$$

where the $Cov(R_t, R_{t-1})$ represents the covariance between R_t and R_{t-1}.

Further, in order to eliminate the effect of market trends, the noise-to-volatility ratio (*NV*) and intrinsic-variance-to-volatility ratio (*IV*) can be defined as follows:

$$NV = \sigma^2 / Var(R_t), \text{ and} \quad (5)$$

$$IV = v^2 / Var(R_t). \quad (6)$$

The above variables are derived via the following processes. First, the stock return is obtained as $\ln(MP_t / MP_{t-1})$. Furthermore, the daily estimate of speed of price adjustment is estimated using equitation (1), while the variance, including volatility, intrinsic variance and noise variance, are estimated using equitations (2) through (4). Next, the pre-period mean (post-period mean) for each stock is obtained by averaging the daily estimates across the trading days. Finally, the results are averaged across stocks to obtain a final market mean (pre- or post-mean).

After the tick size reduction, because the degree of price discreteness decreases and trading information is revealed easily due to smaller binding constraints (Chung, Charoenwong & Ding, 2004), the speed of price adjustment of the stock price toward the intrinsic value is expected to increase. However, the smaller tick size will also increase the number of ticks with which the stock price achieves the intrinsic value, slowing the speed of price adjustment towards it. Hence, the impact of tick size reduction on the speed of price adjustment is still an empirical question. Further, according to the definitions provided by Bandi & Rusell (2006), the source of noise is market-friction, including discreteness and bid-ask bounce. As the degree of price discreteness and bid-ask bounce decrease after the tick size reduction, noise is expected to decrease. Similarly, the noise-to-variance ratio is also expected to decrease.

2.2.2. Control variables. The speed of price (quote) adjustment is not uniform across all firms (Theobald & Yallup, 2004; Chung et al., 2008). For example, according to the findings by Chung et al. (2008), stocks with more frequent trading, higher stock price, smaller market capitalization, and smaller trade sizes exhibit faster quote adjustments. Theobald and Yallup (2004) also indicate that firms with large market capitalization exhibit faster price adjustment, even after adjusting for thin trading. However, some studies (Lo & MacKinlay, 1990; Jegadeesh & Titman, 1995) reached the opposite conclusion, finding that stocks with smaller market capitalization exhibit faster price adjustment. Consequently, summarizing the above, the variables of market capitalization, trade size and stock price, are included into the regression analysis to avoid the confounding effects.

The control variables are derived via a two stage process. First, the pre-period (post-period) means for each stock are obtained by averaging the daily estimates. Secondly, the pre- (post-) means are obtained by averaging the pre-period (post-period) means across the stocks.

2.3. Cross-sectional analysis. In order to compare whether the difference is significantly less (or greater) than 0, the change measure (*DR*, Difference Ratio) of Stock *i* is defined as the difference between post-period measure ($\overline{X}_{i,post}$) and pre-period measure ($\overline{X}_{i,pre}$). The definition is as follows:

$$DR_i = \overline{X}_{i,post} - \overline{X}_{i,pre}. \quad (7)$$

It is assumed that the tick-size reduction can efficiently reduce the volatility components if both the following two results exist. First, *DR* in group 1 is significantly less (or greater) than that of group 3 using the two-sample t-test. Next, *DR* in group 2 is less (or greater) than 0 using the one-sample t-test. Such a comparison enables us to focus on the effects of tick size reduction on the volatility components per se, assuming all other things being equal.

2.4. Preliminary statistics – volatility components. Before analyzing the impact of tick size reduction on the volatility components, we first compare the changes of volatility components from pre- to post-period. According to Table 2, in each event group the values of the volatility components, namely volatility, intrinsic variance, and noise variance, reduce from the pre- to post-period, while the changes in the control group exhibit the opposite results. In addition, from the pre- to the post-period, the speed of price adjustment in group 1 (group 2) changes from 133% (130%) to 126% (127%), while the value in the control group changes from 118% to 126%. Summarizing the above, the value of each volatility component reduces after tick-size reduction.

In order to examine the major source of volatility reduction, we further divide the noise or intrinsic variance by the volatility as the ratio of *NV* or *IV*. The value of *NV* decreases from 7.79% (7.29%) to 6.62% (5.70%) in group 1 (group 2), while the value of *NV* in group 3, the control group, increases. Furthermore, the changes in IV exhibit the opposite results, showing an insignificant increase after the tick size reduction. The above findings indicate that the noise-variance reduction seems to be the major reduction in volatility. In Section 4, we further use the t-test and sign-rank test to obtain robust results about the impact of tick size reduction on the volatility components.

Table 2. Preliminary statistics of volatility components and stock characteristics

	Group 1		Group 2		Group 3	
	Pre-period	Post-period	Pre-period	Post-period	Pre-period	Post-period
Panel A. Volatility components (%)						
Variance (V)	2.21	1.66	1.73	1.49	0.54	2.16
Noise (N)	0.19	0.14	0.15	0.11	0.04	0.15
Intrinsic (I)	0.69	0.56	0.58	0.50	0.18	0.78
Intrinsic to variance (IV)	39.36	54.80	44.76	53.23	66.49	53.26
Noise to variance (NV)	7.79	6.62	7.29	5.70	4.04	6.22
Speed of price adjustment (g)	133.97	125.73	130.77	127.03	118.10	126.64
Panel B: Stock characteristics						
Number of trades (NT) (trades)	874.56	524.04	1463.68	1105.88	370.96	692.69
Market value (MV) (NT$ 1000000)	14234.76	10791.51	28049.88	27977.28	6789.45	5625.15
Sample size	36	33	106	103	23	13

Notes: This table shows the descriptive statistics of volatility components and stock characteristics in the event and control groups. The volatility-component decomposition is measured using the model proposed by Amihud & Mendelson (1987). The pre-period is from September 1st, 2004 to February 28th, 2005, and the post-period is from March 7th, 2005 to August 31st, 2005. Group 1 indicates the stocks for which the tick size changed from 0.05 to 0.01. Group 2 indicates the stocks for which the tick size changed from 0.1 to 0.05. Finally, group 3 indicates the stocks with the same tick size (0.05) during the study period.

3. Empirical findings

Using the Shapiro-Wilk test (or Kolomogorov-Simirnov test) to examine whether or not the changes in these variables, including changes in the speed of price adjustment, noise variance and intrinsic variance, follow the normal distribution, the empirical results show that the normality assumption only exists in some changes, no matter which groups (the results are omitted for the sake of brevity but are available upon request). Hence, the results of the t-test and those of the sign-rank test are used simultaneously. In addition, after deleting the stocks with the values of speed of price adjustment outside [0, 2] or equal to 1, the stocks with negative noise variance, or the stocks with negative intrinsic variance, the sample sizes are 28, 82, and 11, respectively.

3.1.1. Impact on the volatility components. Panel A of Table 3 shows the mean difference of volatility for the two sub-periods. The results show that the value in group 1 is -0.66%, which is significantly different from 0 at the 0.05 level, and similar results are also obtained in group 2, although the coefficients are insignificant. However, the difference in group 3 shows significant increases at the 0.01 level. Further, using the two-sample t-test, we found that the difference in changes between groups 1 and 3 is significant at the 0.01 level. Similarly, the tick size reduction can efficiently reduce the noise variance and intrinsic variance at the 0.05 level (results are omitted for the sake of brevity but are available upon request). Further, in Panel B, ΔNV in group 1 and the difference in ΔNV between groups 1 and 3 is significantly less than 0 at the 0.01 level. Similar results for ΔIV are also obtained, but the changes are in the opposite direction (See Panel C of Table 3). Summarizing the above, we find that the tick size reduction can reduce the noise variance and intrinsic variance, and that most declines in volatility are due to the declines in the former.

3.1.2. Impact on the speed of price adjustment. Panel D of Table 3 shows the effect of tick size reduction on the speed of price adjustment (g). In group 1, of the 28 values, it can be seen that seven are positive and twenty-one are negative. Further, the two mean changes in groups 1 and 3 are related but in opposite directions. The differences are as large as -18.77%, indicating that the differences between two sub-periods are significantly different from 0 at the 0.05 level. Similarly, the difference in group 2 is -2.86% although the coefficients are negative but insignificant. The above results indicate that the smaller tick size will slow the speed of price adjustment toward the intrinsic value.

Table 3. Descriptive statistics of changes in volatility components

Panel A: $\Delta Var(R_t)$ (%)						
Group	Max	Min	Median	Mean	(+/-)	Sample Size
1	2.12	-5.13	-0.28	-0.66*	9/19	28
2	8.40	-5.73	-0.03	-0.16	36/46	82
3	4.46	-0.69	1.84**	1.77**	10/1	11
1 vs. 3				-2.44**		
Panel B: ΔNV (%)						
1	3.92	-8.52	-0.42	-1.19*	9/19	28
2	10.07	-13.93	0.84	-1.74**	31/51	82
3	8.72	-9.72	2.45	2.26	8/3	11
1 vs. 3				-3.46*		
Panel C: ΔIV (%)						
1	120.16	-21.14	2.96	17.51*	20/8	28
2	94.34	-68.80	1.14	7.74	47/35	82
3	79.14	-71.97	0.23	-14.16	6/5	11
1 vs. 3				31.68*		
Panel D: Δg (%)						
1	21.37	-60.32	-2.43**	-9.56*	7/21	28
2	39.16	-52.37	0.26	-2.86	43/39	82
3	49.23	-44.05	-2.28	9.20	5/6	11
1 vs. 3				-18.77*		

Notes: 1.* and ** indicate significance at the 0.05 and 0.01 levels, respectively. 2. This table shows the descriptive statistics of the changes of volatility components in the event and control groups. The volatility component decomposition is measured using the model proposed by Amihud & Mendelson (1987). The difference is defined as the difference between post-period mean and pre-period mean. The t-test is used to examine the alternative hypothesis that the mean difference is different from 0. Group 1 indicates the stocks for which the tick size changing from 0.05 to 0.01. Group 2 indicates the stocks for which the tick size changing from 0.1 to 0.05. Finally, group 3 indicates the stocks with the same tick size (0.05) during the study period.

3.1.3. Impact of changes in the speed of price adjustment on the changes in volatility components. In this section, we use the analysis of variance to examine whether or not the changes in the volatility components are affected by the stock characteristics. Based on the pre-period number of trades and market value, the samples in group 2 are partitioned into three sub-samples, containing 27, 27, and 28 samples, respectively. (Because the sample size in group 1 is only 28 and is thus too small, the sample in group 2 is investigated in the analysis of variance (ANOVA) and regression analyses. The results are omitted for the sake of brevity but are available upon request). The results show an insignificant effect of the tick size rule type, even at the 0.10 level. Further, using the analysis of variance to examine the hypothesis, it is found that the change in each volatility components is affected by the change in the speed of price adjustment, and thus, the results are supported.

Finally, we use regression analysis to investigate the relationship between the changes in each volatility component and the changes in the speed of price adjustment. With the results shown in Table 4, Chung et al. (2004) suggest that the pre-period variables should be included into the regression analysis to avoid the endogenous problems. Hence, only the pre-period variables are included into the regression analysis in this work to control the effect of stock characteristics. The empirical results show that the changes in the volatility components, including volatility, intrinsic variance and noise variance are significantly and positively related to the changes in the speed of price adjustment at the 1% level, with the coefficients being 3.23%, -163.82%, and 16.68%, respectively. The *VIF* for the *MV* and *NT* is less than 2, so the multi-collinearity problems will be ignored in the regression analysis. Further, White's correction is used to correct the heteroscedasticity of variance in this work. The above results support previous findings, which the speed of price adjustment will affect the changes in each volatility components, and hence, should be included in the volatility-component decomposition.

Table 4. Regression analysis

Y	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	R^2
$Var(R_t)$	0.07 %	3.23 %**	-0.75 %**	0.52 %*	14.52 %

Table 4 (cont.). Regression analysis

Y	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	R^2
IV	5.86 %	-163.82 %**	-0.12 %	-0.21 %	95.23 %
NV	-2.36 %	16.68 %**	0.04 %	0.08 %	49.95 %

Notes: 1.* and ** indicate significance at the 0.05 and 0.01 levels, respectively. 2. This table provides the regression analyses for the changes in speed of price adjustment on the changes in volatility components after considering the stock characteristics, including pre-period daily number of trades (NT_{pre}) and pre-period daily market value (MV_{pre}). The dependent variables are the changes in volatility components, including the variance ($Var(R_t)$), noise-to-variance (*NV*), and intrinsic-to-variance (*IV*). The regression equation is as follows:

$$\Delta\hat{Y} = \hat{\alpha}_0 + \hat{\alpha}_1 \Delta g + \hat{\alpha}_2 \ln(NT_{pre}) + \hat{\alpha}_3 \ln(MV_{pre}).$$

Conclusions

This paper examines how the tick size reduction implemented on March 1, 2005 in the TSEC affected the volatility components. Using data from the *TEJ*, this paper compares the changes of each volatility component between the first sample period from September 1, 2004 to February 28, 2005 and the second sample period from March 7, 2005 to August 31, 2005. Although some studies have focused on the impact of the tick size reduction on the volatility components (He & Wu, 2005; Vuorenmaa, 2008), they all assume that the speed of price adjustment is constant. This institutional change gives us a unique opportunity to examine how the volatility components change with the tick size reduction and are affected by the speed of price adjustment. The empirical results show that the volatility decreases after the tick size reduction. Most of the reduction in volatility is due to the noise reduction, while the changes in volatility components are also affected by the changes in the speed of price adjustment. This is a new finding, different to previous studies, which assume that the reaction to trading information is complete (He & Wu, 2005), and this provides support for the methodology used in this work, which considers the speed of price adjustment along with the volatility-component decomposition. These results can provide a valuable insight into the impact of market-mechanism changes on the related volatility components.

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References

1. Amihud, Y., Mendelson, H. (1987). Trading mechanism and stock returns: an empirical investigation, *Journal of Finance*, 42 (3), 533-553.
2. Amihud, Y., Mendelson, H. (1989). Index and index-future returns, *Journal of Accounting*, *Auditing and Finance*, 4 (4), 415-431.
3. Bacidore, J.M., (2001). Decimalization, adverse selection, and market maker rents, *Journal of Banking and Finance*, 25 (5), 829-855.
4. Bandi, F.M., Russell, J.R. (2006). Separating microstructure noise from volatility, *Journal of Financial Economics*, 79 (3), 655-692.
5. Bange, M.M. (2000). Do the portfolios of small investors reflect positive feedback trading? *Journal of Financial and Quantitative Analysis*, 35 (2), 239-255.
6. Barber, B.M., Odean, T. (2000). Trading is hazardous to your wealth: the common stock investment performance of individual investors, *Journal of Finance*, 55 (2), 773-806.
7. Barber, B.M., Odean, T. (2002). Online investors: do the slow die first? *Review of Financial Studies*, 15 (2), 455-488.
8. Bessembinder, H. (2003). Trade execution costs and market quality after decimalization, *Journal of Financial and Quantitative Analysis*, 38 (4), 747-777.
9. Brisley, N., Theobald, M. (1996). A simple measure of price adjustment coefficients: a correction, *Journal of Finance*, 51(1), 381-382.
10. Chakravarty, S., Van Ness, B.F., Van Ness, R.A. (2005). The effect of decimalization on trade size and adverse selection costs, *Journal of Business Finance and Accounting*, 32 (5), 1063-1081.
11. Chelley-Steeley, P.L. (2005). Explaining volatility and serial correlation in opening and closing returns: a study of the FT-30 components, *Global Finance Journal*, 16 (1), 1-15.
12. Chelley-Steeley, P.L. (2008), Market quality changes in the London Stock Market, *Journal of Banking and Finance*, 32 (10), 2248-2253.
13. Chung, K.H., Charoenwong, C., Ding, D.K. (2004). Penny pricing and the components of spread and depth changes, *Journal of Banking and Finance*, 28 (12), 2981-3007.
14. Chung, K.H., Chuwonganant, C., Jiang, J. (2008). The dynamics of quote adjustments, *Journal of Banking and Finance*, 32 (11), 2390-2400.

15. Damodaran, A. (1993). A simple measure of price adjustment coefficients, *Journal of Finance*, 48 (1), 387-400.
16. Daniel, K., Hirshleifer, D., Subrahmanyam, A. (1998). Investor psychology and security market under and overreactions, *Journal of Finance*, 53 (6), 1839-1885.
17. Gerety, M.S., Mulherin, J.H. (1994). Price formation on stock exchanges: the evolution of trading within the day, *Review of Financial Studies*, 7 (3), 609-629.
18. Gibson, S., Singh, R., Yerramilli, V. (2003). The effect of decimalization on the components of the bid-ask spread, *Journal of Financial Intermediation*, 12 (2), 121-148.
19. Harris, L. (1990). Estimation of stock price variances and serial correlations from discrete observations, *Journal of Financial and Quantitative Analysis*, 25 (3), 291-306.
20. He, Y., Wu, C. (2005). The effects of decimalization on return volatility components, serial correlation, and trading costs, *Journal of Financial Research*, XXVIII (1), 77-96.
21. Jegadeesh, N., Titman, S. (1995). Overreaction, delayed reaction and contrarian profits, *Review of Financial Studies*, 8 (4), 973-993.
22. Lo, A.W., MacKinlay, A.C. (1990). When are contrarian profits due to stock market overreaction? *Review of Financial Studies*, 3 (2), 175-205.
23. Madhavan, A., Richardson, M., Roomans, M. (1997). Why do security prices change? A transaction-level analysis of NYSE stocks, *Review of Financial Studies*, 10 (4), 1035-1064.
24. Rhee, S.G., Wang, C.J. (1997). The bid-ask bounce effect and the spread size effect: evidence from the Taiwan stock market, *Pacific-Basin Finance Journal*, 5 (2), 231-258.
25. Ronen, T., Weaver, D.G. (2001). 'Teenies' anyone? *Journal of Financial Markets*, 4 (3), 231-260.
26. Sias, R. Starks, L.T., Titman, S. (2006). Changes in institutional ownership and stock returns: assessment and methodology, *Journal of Business*, 79 (6), 2869-2910.
27. Theobald, M., Yallup, P. (1998). Measuring cash-futures temporal effects in the U.K. using partial adjustment factors, *Journal of Banking and Finance*, 22 (2), 221-243.
28. Theobald, M., Yallup, P. (2004). Determining security speed of adjustment coefficients, *Journal of Financial Markets*, 7 (1), 75-96.
29. Theobald, M., Yallup, P. (2005). Intradaily volatility and adjustment, *Journal of International Financial Markets, Institutions, and Money*, 15 (5), 407-424.
30. Vuorenmaa, T.A. (2008). Decimalization, realized volatility, and market microstructure noise, Working paper.