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EXTENDED TRADING HOURS AND MARKET MICROSTRUCTURE:
EVIDENCE FROM THE THAI STOCK MARKET

Rosita P. Chang, S. Ghon Rhee, and
Wuttipan Tawarangkoon

ABSTRACT

This study investigates the impact of extended trading hours on market microstructure as measured by market volatility, trading volume, and the speed of price adjustment to new information. On the basis of the daily observations for the SET Index from February 10, 1992 to February 26, 1993, this study finds the Thai stock market to be better off since the trading hours have been extended from three to four and afternoon trading has been introduced. The improvements are observed for the following reasons: first, the market volatility measured by Parkinson's variance has increased at a modest rate of 4.50 percent. The autocorrelation analysis indicates that the Thai stock market is more efficient in processing market-wide information; second, both trading volume and trading value have increased substantially; and third, even though it is not statistically significant, the speed of price adjustment to new information shows improvement.

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INTRODUCTION

On July 2, 1992 the Stock Exchange of Thailand (SET) extended its trading hours of operation from three to four. Prior to this change, the SET's trading time was from 9:00 am to 12:00 noon with no afternoon trading.[1] Also, with this trading extension, the SET now has two trading sessions: a morning session between 10:00 am and 12:30 pm.and an afternoon session between 2:30 pm and 4:00 pm The reason cited by the SET for these changes was to facilitate stock trading of both local and foreign investors to compete with other Asian stock exchanges. With the exception of the Taiwan Stock Exchange Corporation, all Asian stock exchanges utilize a two-session format with a lunch break between sessions on a given trading day. As the popularity of cross-border investment continues in the Asian capital markets, stock exchanges in the region are reluctant to be closed when other competing exchanges are open. For example, to remain competitive, two neighboring stock exchanges, the Stock Exchange of Singapore and the Kuala Lumpur Stock Exchange, also extended their trading hours from a total of four hours to five and one-half hours beginning July 1992.[2]

Although an extension of trading hours or the addition of an afternoon trading session may be considered strictly business decisions by an exchange, there are at least three critical factors the exchange's management must take into account. The three factors are related to market microstructure as measured by volatility, liquidity, and the speed of price adjustment to new information. Regarding these three factors, the following questions arise: First, what effect does the extension of trading hours have on market volatility? Second, what happens to trading volume after the trading hours are extended? Third, do extended trading hours and an added afternoon trading session improve the speed of price adjustment to new information? This study is intended to empirically investigate these questions.

The paper is organized as follows: the next section presents a brief discussion of theory and empirical hypotheses. The third section presents the empirical results. The last section concludes the paper.

THEORY AND HYPOTHESES

Market Volatility

When discussing the issue of market volatility, studies by French and Roll (1986) and Barclay, Litzenberger, and Warner (1990) must first be considered. French and Roll (1986) consider three potential causes of why equity returns are more volatile during trading hours than non-trading hours: (i) public information; (ii) private information; and (iii) trading noise. By examining the behavior of equity returns around exchange holidays (that occur on normal business days), they find that the two-day return variance is only 14.5 percent higher than the variance for normal one-day returns. This finding rejects the public information hypothesis, since the two-day variance is not twice as large as the one-day variance given that public information affects prices whether the exchange is open or closed. This finding, however, supports the private information and trading noise hypotheses because private information affects stock prices only through trading of informed traders and trading noise increases volatility during the trading period. Thus, with the exchange closed for trading, the two hypotheses predict a decline in equity volatility.[3] Barclay, Litzenberger, and Warner (1990) examine the effects of Saturday trading on market volatility at the Tokyo Stock Exchange (TSE).[4] They report that the Friday close-to-Monday close return variance with Saturday trading is approximately twice as large as the variance over the same weekend interval without Saturday trading. Being the opposite case of French and Roll's (1986), it is not surprising that market volatility is increased by extended trading hours through Saturday transactions.

Makhija and Nachtmann (1990, 1991) show that New York Stock Exchange (NYSE)-listed stocks experience a significant increase in volatility following cross-listing either on the TSE or on the London Stock Exchange (LSE). Their findings have a direct implication on this study because trading hours are effectively extended for internationally cross-listed stocks.[5] Cheung, Ho, Pope, and Draper (1993) report that Hong Kong stocks that are traded in London have higher variance over an overnight non-trading period than those stocks traded only in Hong Kong. They also observe that cross-listed Hong Kong stocks exhibit a lower open-to-open return variance and a less negative first-order autocorrelation than those not traded on the LSE. They attribute this result to the effective expansion of stock trading hours.[6] By introducing extended trading hours and an afternoon session, more private information is expected to be released and trading noise is expected to increase as traders face higher frequency of overreaction to the activities of other traders. Consequently, return volatility measured during trading hours is also expected to increase.

The increase in trading hours automatically translates into decreased non-trading hours. Naturally, this will have an effect on return volatility during non-trading hours. For example, with afternoon trading, the number of overnight non-trading hours declines from 21 to 18 at the SET. On the theoretical level, this question has not been previously addressed and is a matter to be resolved empirically. As long as the total amount of new private information remains unchanged within a trading day, one may expect return volatility during the non-trading period to decline.[7] Therefore, when the number of trading hours is extended and an afternoon trading session is added, the following hypotheses are proposed: (i) the return variance measured during trading hours increases; while (ii) the return variance measured during non-trading hours decreases.

Trading Volume

A large number of empirical studies confirm that a positive and contemporaneous relationship exists between return volatility and trading volume in a wide range of financial markets.[8] Since extended trading hours cause return volatility to increase, trading volume should also increase. Barclay, Litzenberger, and Warner (1990) report that the average combined Saturday and Monday trading volume exceeds the average Monday volume without Saturday trading by 92 percent They also note that the average weekly volume is 21 percent higher with Saturday trading than without Saturday trading. Chan and Chan (1993) compile evidence that the trading volume of Hong Kong stocks decreases on Wednesdays, when there is no afternoon trading, but increases on Thursdays. Results documented by both studies are consistent with the private information hypothesis. Therefore, when the number of trading hours is extended and an afternoon trading session is added, the following hypothesis is proposed: both trading volume and trading value increase.

Speed of Price Adjustment to New Information

Kyle (1986), Admati and Pfleiderer (1988), and Foster and Viswanathan (1990) provide an important link among private information, market volatility, and trading volume. Lin and Rozeff (1992) derive an empirically testable equation that relates the speed of price adjustment to private information by extending the models of Kyle (1985) and Foster and Viswanathan (1990). Lin and Rozeff report, on the basis of 30 Dow-Jones Industrial Average stocks, that approximately 73 percent of private information informed traders possess at the beginning of each trading day eventually becomes incorporated into stock prices by the end of the day's trading. Thus, extended trading hours and added afternoon trading are expected to increase the speed of price adjustment to new information.

EMPIRICAL ANALYSIS

Data

We have obtained daily observations of opening, closing, high, and low values of the SET Index and daily trading volume and value data for the period from February 10, 1992 to February 26, 1993.[9] The SET Index is a value-weighted index of all common equity shares listed on the SET, but it is not adjusted for dividend payments.[10] The SET Index is supplemented by subindexes for 12 industries.[11] Figure 1 presents a graphical illustration of daily observations of the SET Index closing values plotted against trading days. The study period is partitioned into two subperiods depending on the number of trading hours. During subperiod I,

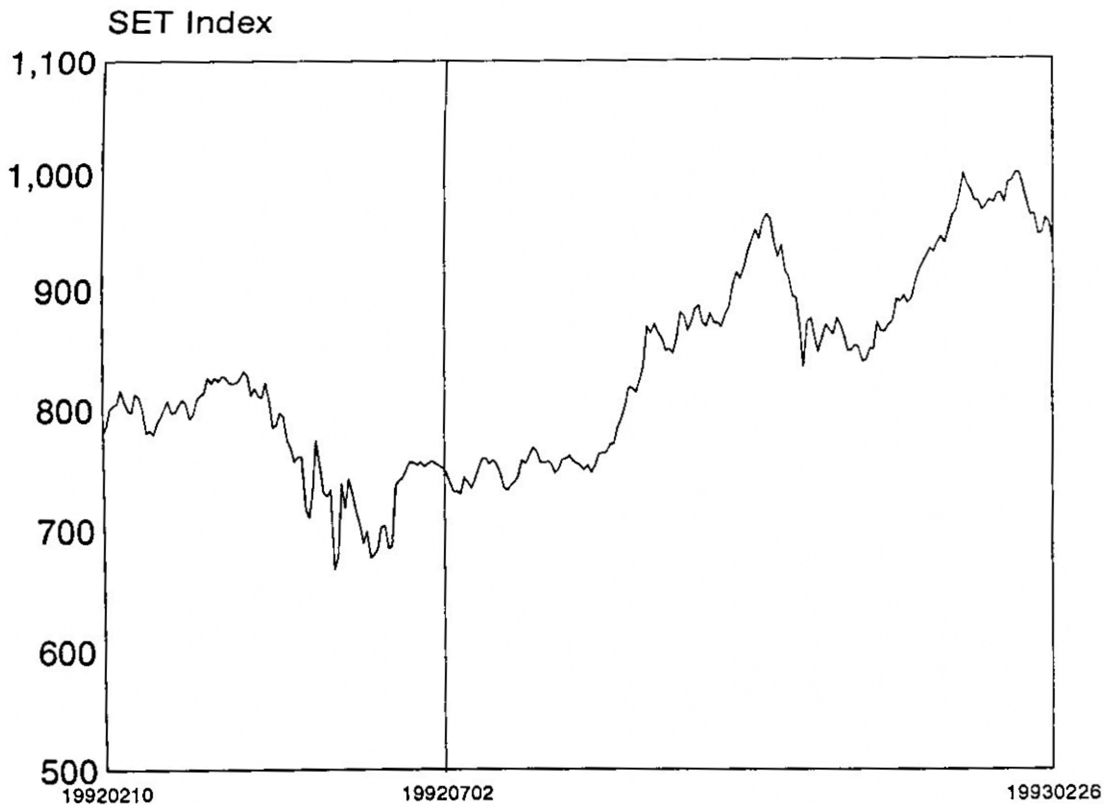

Figure 1. SET Index (February 10, 1992 - February 26, 1993)

from February 10, 1992 to June 30, 1992, the SET only had a three-hour morning trading session, while the SET during subperiod II, from July 2, 1992 to February 26, 1993, had both a morning trading session, for two and a half hours, and an afternoon session, for one and a half hours.

Change in Market Volatility

In measuring market volatility, two methods are proposed. First, using Parkinson's (1980) extreme-value method, daily variances are estimated: $\text{Var}_t = [\ln(DH_t/DL_t)]^2/(4\text{x}\ln 2)$, where Var_t denote Parkinson's variance, and DH_t and DL_t are daily high and low values of the SET Index on trading day t. Second, the traditional statistical variance measures are computed for four return series:

Figure 2 plots daily estimates of Parkinson's variance over the study period. A quick glance at the graph indicates that no significant shift of Parkinson's variance is shown from subperiod I to subperiod II, with the exception of some volatile trading days. However, extreme volatility observed on those trading days had very little to do with the extension of trading hours at the SET. Rather, the extreme volatility is attributed to many events the Thai stock market experienced during the study period. Two noteworthy events are: (i) a series of violent confrontations between army troops and pro-democracy demonstrators in May 1992 of subperiod I; and (ii) a series of joint investigations by the Securities and Exchange Commission and the SET into stock manipulation charges against large-scale local investors in November 1992 of subperiod II. The Thai stock market plunged in reaction to the political turmoil and, as a result, the SET Index dropped almost 9 percent on May 19 alone. Also, on November 20 the SET Index recorded the largest difference (79.21) between the high and low values to close at 871.72. Additionally, price fluctuations in major foreign stock markets, including the TSE, did not help the Thai stock market reduce market volatility during subperiod I.[12]

In order to compare the change in market volatility resulting from the extension of trading hours, the effects of such events as discussed above must be taken into account. Two adjustment methods are used. First, daily Parkinson's variance is adjusted using R_{oc}, intraday returns during trading period, as measured by morning opening and daily closing prices. The adjustment is done using a simple regression: $(\text{Var}_t)^{1/2} = \alpha R_{oc,t} + \mu_t$, where μ_t is a random error term from a time-series regression. An intercept term is not used so that the market volatility net of external influence can be captured in the residuals. The selection of R_{oc} as an independent variable is justified since it is an intraday return during the trading period while Parkinson's variance is an effective intraday volatility measure. Squared residuals from this regression are *adjusted* Parkinson's variance, Var^*_t, and the equality of means test is conducted using a dummy regression model: $\text{Var}^*_t = \beta_1 D_1 + \beta_2 D_2 + \varepsilon_t$, where $D_1 = 1$ for subperiod I and 0 otherwise, $D_2 = 1$ for subperiod II and 0 otherwise, and ε_t is a random error term.

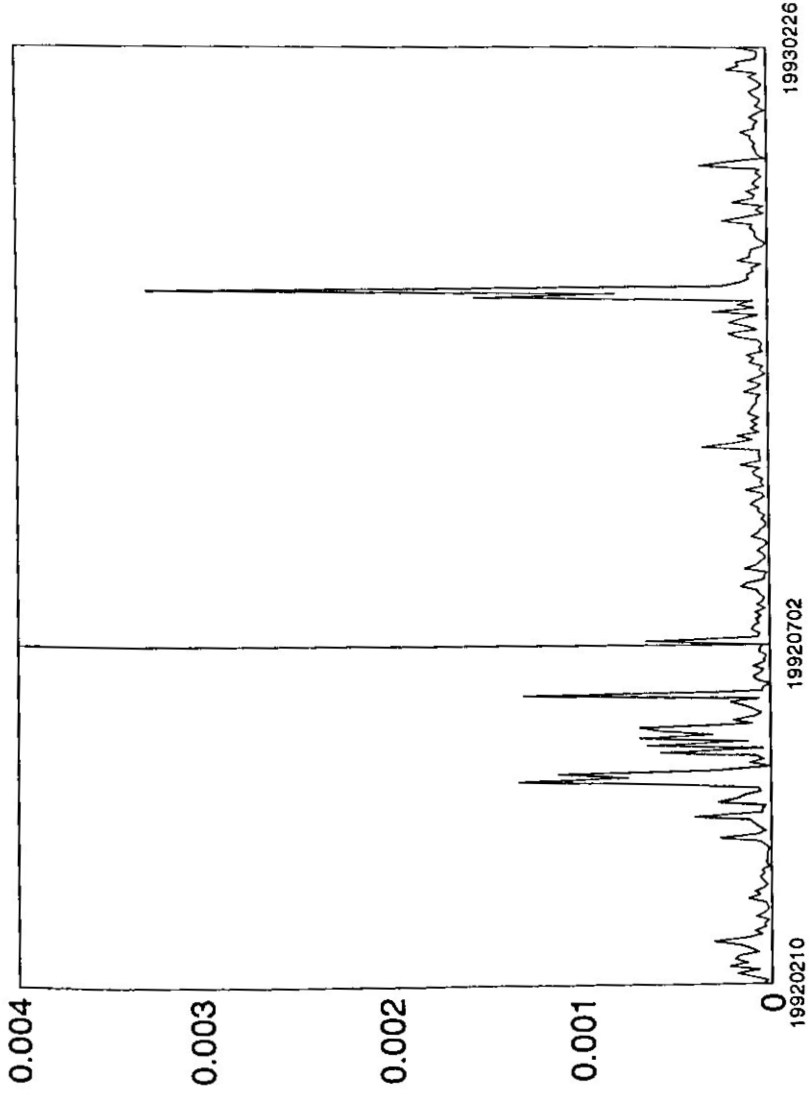

Figure 2. Parkinson's Variance

In addition to the above adjustment for Parkinson's variance, an adjustment is also needed to make a meaningful comparison of the traditional variance measures between the two subperiods. First, the variances of *hourly* returns are estimated for daily trading period, overnight non-trading period, 24-hour period between market close and market close, and 24-hour period between market open and market open.[13] Per hour variance will facilitate the comparison of variances measured over time intervals with different lengths. Second, variance ratios are computed using the variance of daily close-to-daily close returns as the denominator. Unlike Parkinson's variance measures, traditional variance measures are not available on a daily basis. Rather, one variance measure for each of the four return series will be computed for each of the two subperiods. As a result, the Bartlett test is used to examine whether variance ratios are equal.[14]

Table 1 summarizes market volatility test results. As shown in Panel A, Parkinson's variances are, on average, 1.65 in subperiod I and 1.13 in subperiod II prior to the appropriate adjustment, indicating that unadjusted volatility declined by approximately 30 percent. *Adjusted* Parkinson's variances are 2.23 and 2.33 in subperiod I and II, respectively.[15] The hypothesis of equal variances across two subperiods is rejected at a 6.49 percent level. Also, as predicted, market volatility has increased at a modest rate of 4.50 percent with the extended trading hours and the added afternoon trading.

Panel B reports the results of the per hour variance ratio test. During the trading period, average variance ratio increased from 30.69 to 52.41, which is consistent with previously mentioned prediction. The hypothesis of equal variance across two subperiods is rejected at a 5 percent level. During the overnight non-trading period, average variance ratio declined from 0.62 to 0.20, which is also consistent with the hypothesis. The null hypothesis is rejected at a 1 percent level.

Table 1 also notes a potentially interesting observation; in subperiod II, when the SET is open, the hourly variance is roughly 260 times larger than when it is closed.[16] During subperiod I, however, the hourly variance is only approximately 50 times greater during trading period than non-trading period. An in-depth analysis on this drastic increase from one subperiod to another will not be offered here because of the lack of transaction data of the SET Index component stocks.

Finally, to complete the analysis of market volatility, autocorrelation coefficients for four return series are estimated. Large and significant portfolio return autocorrelations imply market inefficiency. Various market imperfection factors, such as transaction costs and stale prices resulting from thin trading, cause autocorrelation.[17] Froot, Gammill, and Perold (1990) report that the predictability of short-term stock returns has declined markedly as inefficiencies in processing market-wide information are reduced by index arbitrage in the U.S. market. Table 2 presents autocorrelations for lags between one and four. From this table, there is one notable observation. None of the coefficients estimated for R_{oo}, R_{cc}, R_{oc}, and R_{co} are significant in subperiod II whereas the estimated coefficients at lag 2 are significant in subperiod I. It is not clear as to why the coefficient at lag 2 is negative

Table 1. Change in Market Volatility

Subperiod I is from February 10, 1992 to June 30, 1992 when the SET's trading was from 9:00 a.m. to 12:00 noon and subperiod II is from July 2, 1992 to February 26, 1993 when the SET's introduced two trading sessions, a morning session between 10:00 a.m. and 12:30 p.m. and an afternoon session between 2:30 p.m. and 4:00 p.m. Parkinson's variance is calculated using $Var_t = [\ln(DH_t/DL_t)]^2/(4x\ln 2)$, where Var_t denote Parkinson's variance, and DH_t and DL_t are daily high and low values of the SET Index on trading day t. To compute *adjusted* Parkinson's variance, a simple regression is used $(Var_t)^{1/2} = \alpha R_{oc,t} + \mu_t$, where μ_t, is a random error term from a time-series regression. Squared residuals from this regression are *adjusted* Parkinson's variance, Var^*_t, and the equality of means test is conducted using a dummy regression model: $Var^*_t = \beta_1 D_1 + \beta_2 D_2 + \varepsilon_t$, where $D_1 = 1$ for subperiod I and 0 otherwise, $D_2 = 1$ for subperiod II and 0 otherwise, and ε_t is a random error term. Traditional statistical variance measures are computed for four return series: (i) daily open-to-open returns (R_{oo}); (ii) daily close-to-close return (R_{cc}); (iii) intraday return during trading period returns (R_{oc}); and (iv) intraday return during non-trading period (R_{co}). The returns are calculated as the natural logarithm of the index relatives per hour. The hypothesis of equal variances across the two subperiods is tested using the Bartlett test. Bartlett's B statistic is approximately distributed as χ^2 with r-1 degree of freedom where r is the number of populations. If B-value $\leq \chi^2(1-\alpha;r-1)$, then the null hypothesis can not be rejected. The critical χ^2 values are 13.28 at the 0.01 level, 3.84 at the 0.05 level, and 2.71 at the 0.10 level. Statistical significance is noted by ** at the 0.01 level and * at the 0.05 level. Figures in the parentheses are the probability levels

	Subperiod I	*Subperiod II*	*F-Value*
A. *Test Using Parkinson's Variance* ($x10^{-4}$)			
1. Before Adjustment	1.65	1.13	30.51
	(0.0001)	(0.0001)	(0.0001)
2. After Adjustment	2.23	2.33	2.76
	(0.1705)	(0.0576)	(0.0649)
	Subperiod I	*Subperiod II*	*B-Value*
B. *Per Hour Variance Ratio*			
1. Trading Period (R_{oc})	30.69	52.41	7.98*
2. Overnight Non-trading Period (R_{co})	0.62	0.20	40.44**
3. Morning Open-to-Morning-Open (R_{oo})	1.003	1.328	2.26
4. Daily Close-to-Daily Close (R_{cc})	1.000	1.000	—

and significant. Nevertheless, one important conclusion is that the lower predictability of stock returns indicates an improvement in market efficiency after the SET extended its trading hours.

Change in Trading Volume and Value

Figure 3 plots the SET's daily trading volume (in million board lots) and its trading value (in billion baht).[18] As shown in this figure, both volume and value show an increasing trend over time. The daily trading volume, on average, is 2.56 times

Table 2. Change in Autocorrelation Coefficients

Subperiod I is from February 10, 1992 to June 30, 1992 when the SET's trading was from 9·00 a.m. to 12:00 noon and subperiod II is from July 2, 1992 to February 26, 1993 when the SET's introduced two trading sessions: a morning session between 10:00 a.m. and 12.30 p.m. and an afternoon session between 2:30 p.m. and 4:00 p.m. R_{oo}, R_{cc}, R_{oc}, and R_{co} denote daily open-to-open returns, daily close-to-close returns, intraday returns during trading period, and intraday returns during non-trading period. The returns are calculated as the natural logarithm of the index relatives. Statistical significance is noted by ** at the 0.01 level and * at the 0.05 level.

		Subperiod I				Subperiod II			
		Lag 1	*Lag 2*	*Lag 3*	*Lag 4*	*Lag 1*	*Lag 2*	*Lag 3*	*Lag 4*
1.	R_{oo}	0 0160	−0.2939**	−0.0712	0.1233	−0.0498	−0.0234	0 0644	0.0618
2.	R_{cc}	−0.0339	−0.3027**	0.0205	0.0585	0.1038	−0.0517	0 0631	0.1572
3.	R_{oc}	0.0821	−0.2729**	−0.0210	0.1937	−0.0418	−0 0510	0.0557	0.0840
4.	R_{co}	−0.0265	−0.1893*	−0.0849	0.0700	0.1417	0.0910	0.0622	0.0559

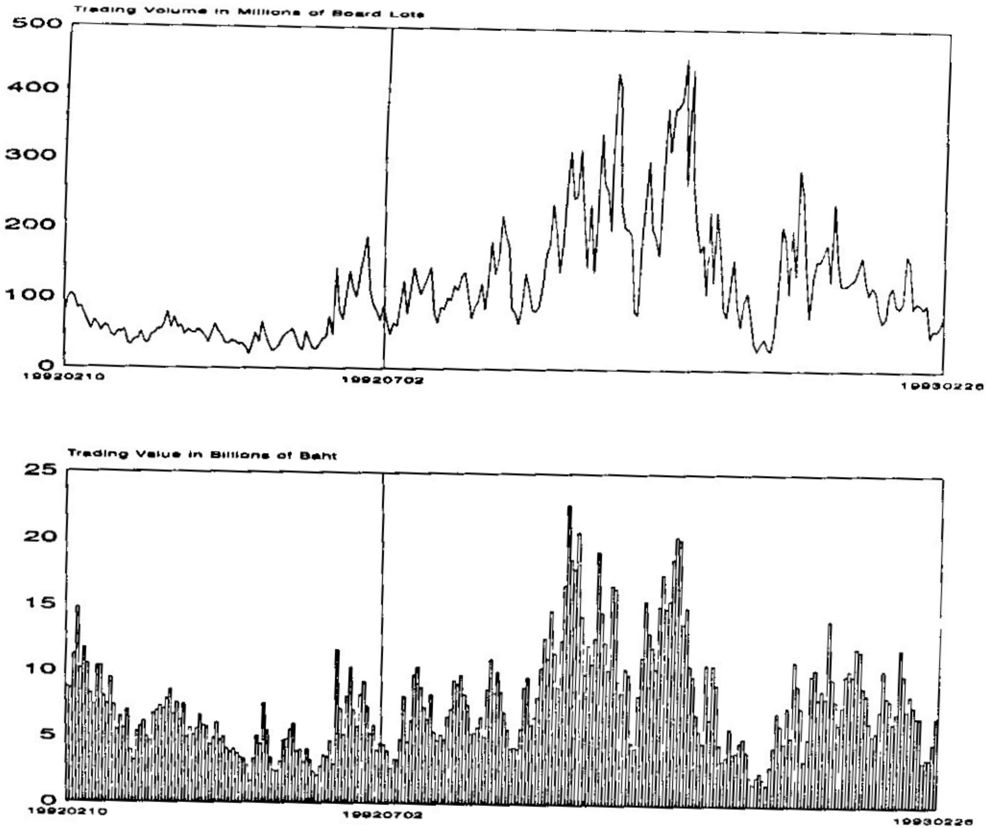

Figure 3. Trading Volume and Trading Value

greater in subperiod II than in subperiod I while the daily trading value, on average, is 1.45 times greater in subperiod II than in subperiod I.

In order to capture the increasing trend of the trading volume and value over time, the following simple regressions are used in which daily trading volume or value are regressed on daily observations of the SET Index: $\text{Volume}_t = \alpha I_t + \mu_t$ and $\text{Value}_t = \delta I_t + \varepsilon_t$, where I_t denotes SET Index value on day t, and μ_t and ε_t are random error terms.[19] Once residual volume and residual value are estimated, dummy regression models are used to test the equality of trading volume and value in the two subperiods: $\text{Volume*}_t = \beta_1 D_1 + \beta_2 D_2 + \xi_t$ and $\text{Value*}_t = \beta_1 D_1 + \beta_2 D_2 + \nu_t$, where Volume* and Value* denote residual volume and residual value, respectively, and ξ_t and ν_t are random error terms. Table 3 presents the results.

The differences in trading volume (value) between the two subperiods are observed as expected. The averages of adjusted volume are -53.20 million and 26.20 million board lots for subperiods I and II, respectively.[20] The null hypothesis of equal means across the two subperiods is rejected at the 0.0001 level. Similar results are obtained for trading value. The average adjusted trading value is -1,270.89 billion baht in subperiod I as opposed to 588.43 billion in subperiod II. Consistent with the prediction, both trading volume and value increase substantially after the SET extended trading hours and introduced afternoon trading.[21]

Table 3. Change in Trading Volume and Value

Subperiod I is from February 10, 1992 to June 30, 1992 when the SET's trading was from 9:00 a.m. to 12.00 noon and subperiod II is from July 2, 1992 to February 26, 1993 when the SET's introduced two trading sessions: a morning session between 10:00 a.m. and 12:30 p.m. and an afternoon session between 2:30 p.m. and 4:00 p.m. To estimate *adjusted* trading volume and trading value, two simple regressions are run: $\text{Volume}_t = \alpha I_t + \mu_t$ and $\text{Value}_t = \delta I_t + \varepsilon_t$, where I_t denote SET Index value on day t, and μ_t and ε_t are random error terms. Once residual volume and residual value are estimated, dummy regression models are used to test the equality of trading volume and value in the two subperiods: $\text{Volume*}_t = \beta_1 D_1 + \beta_2 D_2 + \xi_t$ and $\text{Value*}_t = \beta_1 D_1 + \beta_2 D_2 + \nu_t$, where Volume* and Value* denote residual volume and residual value, respectively, and ξ_t and ν_t are random error terms. Figures in the parentheses are the probability levels.

	Subperiod I	*Subperiod II*	*F-Value*
A. *Trading Volume (in Million Board Lots)*			
1. Before Adjustment	59.10	151.20	392.68
	(0.0001)	(0.0001)	(0.0001)
2. After Adjustment	–53.20	26.20	37.99
	(0.0001)	(0.0001)	(0.0001)
B. Trading Value (in Billion Baht)			
1. Before Adjustment	5.94	8.62	554.78
	(0.0001)	(0.0001)	(0.0001)
2. After Adjustment	–1 27	0.59	8.06
	(0.0007)	(0.0368)	(0.0004)

Change in Speed of Price Adjustment to New Information

Following Lin and Rozeff (1992), the speed of price adjustment is measured using a regression model: $\Delta \text{Var}_t = \alpha + \beta \text{Var}_{t-1} + \varepsilon_t$, where $\Delta \text{Var}_t = \text{Var}_t - \text{Var}_{t-1}$, β denotes the speed of price adjustment coefficient, and ε_t is the random error term. To make empirical estimation feasible, Lin and Rozeff assume that $0 \leq |\beta| \leq 1$, where if $\beta = -1$, then all private information released on day t-1 is incorporated into stock prices on day t. The magnitude of β indicates the speed of price adjustment to new information.

Table 4 summarizes the regressions results. In subperiod II, approximately 72 percent of private information that informed traders have at the beginning of day t-1 is incorporated into stock prices by the end of the day, whereas the comparable figures are 65 percent and 69 percent for subperiod I and the whole period, respectively. These estimates are in the same range as findings by Lin and Rozeff (1992) and Damodaran (1993). Lin and Rozeff report 78 percent for the Standard & Poor's 500 Index, while the mean β for 30 Dow-Jones Industrial Average stocks is 73%. In a different framework which is built on Amihud and Mendelson (1987), Damodaran reports that approximately 67 percent of new information is reflected in prices by the end of the day.

Table 4. Change in the Speed of Price Adjustment

Subperiod I is from February 10, 1992 to June 30, 1992 when the SET's trading was from 9:00 a.m. to 12:00 noon and subperiod II is from July 2, 1992 to February 26, 1993 when the SET's introduced two trading sessions: a morning session between 10:00 a.m. and 12:30 p m. and an afternoon session between 2:30 p.m. and 4:00 p m. The speed of price adjustment is measured using a regression model. $\Delta \text{Var}_t = \alpha + \beta \text{Var}_{t-1} + \varepsilon_t$, where $\Delta \text{Var}_t = \text{Var}_t - \text{Var}_{t-1}$, Var_t denotes Parkinson's variance, β denotes the speed of price adjustment coefficient, and ε_t is the random error term. To test the equality of the estimated β coefficients in the two subperiods, a dummy regression is run for the whole period: $\Delta \text{Var}_t = \alpha + \beta \text{Var}_{t-1} + \gamma D_2 + \delta (D_2 {*} \text{Var}_{t-1}) + \varepsilon_t$, where D_2 = 1 if subperiod II and 0 otherwise. Figures in the parentheses are the probability levels.

Regression Coefficient	Subperiod I	Subperiod II	Whole Period	Whole Period
α	0.0001	0.0001	0.0001	0.0001
	(0.0005)	(0.0005)	(0.0001)	(0.0001)
β	−0.6509	−0 7211	−0 6933	−0.6509
	(0.0001)	(0 0001)	(0 0001)	(0.0001)
γ	—	—	—	−0.00003
				(0 5086)
δ	—	—	—	−0 0703
				(0.5858)
R^2	0.3255	0.3606	0.3467	0.3504
F-Value	44.39	91.92	136.41	45.845
	(0.0001)	(0.0001)	(0 0001)	(0.0001)

To test the equality of the estimated β coefficients in the two subperiods, a dummy regression is run for the whole period: $\Delta \text{Var}_t = \alpha + \beta \text{Var}_{t-1} + \gamma D_2 + \delta(D_2 * \text{Var}_{t-1}) + \varepsilon_t$, where $D_2 = 1$ if subperiod II and 0 otherwise. As reported in the last column of Table 4, the estimated coefficients for γ and δ are insignificant. Particularly, statistically insignificant δ implies that the speed of price adjustment is the same for the two subperiods, even though there is approximately a 7 percent difference.

CONCLUSION

This study investigates the impact of extended trading hours on market microstructure as measured by market volatility, trading volume, and the speed of price adjustment to new information at the SET. On the basis of the daily observations for the SET Index from February 10, 1992 to February 26, 1993, this study finds the Thai stock market to be better off since the trading hours have been extended from three to four and afternoon trading has been introduced. The improvements are observed for the following reasons: first, the amount of increase in market volatility is modest. The autocorrelation analysis indicates that the Thai stock market is more efficient in processing market-wide information; second, both trading volume and trading value increase substantially; and third, even though it is not statistically significant, the speed of price adjustment to new information shows improvement.

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NOTES

1. The three-hour trading session was adopted on June 1, 1990. Prior to this date, the SET's trading time was from 9:30 am to 11:30 am.

2. New trading hours at both exchanges are: 9:30 am-12:30 pm and 2:30 pm-5:00 pm Prior to the recent change, trading hours were. 10:00 am-12:30 pm in the morning and 2:30 pm-4 00 pm in the afternoon.

3. Chan and Chan (1993) examine equity volatility surrounding exchange holidays for Hong Kong stocks. Their findings are consistent with the private information hypothesis.

4. Beginning in February 1989, the TSE stopped trading on Saturdays.

5. Barclay, Litzenberger, and Warner also examine the case of the New York Stock Exchange (NYSE) stocks that are cross-listed on the TSE. They report, however, that longer trading hours do not increase the return variances in New York. In interpreting this result, they suggest that the addition of exchange trading hours would have little impact on equity volatility when liquidity traders are inactive

One should be cautious about drawing strong conclusions based on the results reported by Barclay, Litzenberger, and Warner for three reasons: first, the number of stocks examined by them is only 16; second, the TSE volume for cross-listed stocks is less than 10 percent of the average NYSE volume; and third, without appropriate adjustment for overall market trend, the return variance tend to be under- or overstated

6. Cheung, Ho, Pope, and Draper (1993) report that trading of Hong Kong stocks on the LSE occur at 5 30 pm-11 30 pm (Hong Kong time) during the U.K. summer hours or 4:30 pm-10:30 pm during the U K. winter hours.

7 This argument is analogous to the interpretation offered by Barclay, Litzenberger, and Warner (1990) to explain no discernable difference between return variances for weeks with and without Saturday trading. They suggest that their finding on weekly return variance is consistent with rational trading models such as Kyle's (1985). They reject French and Roll's (1986) hypothesis that irrational trading noise is permanent.

8 See Karpoff (1987) for an extensive review of relevant literature

9 Prior to February 10, only daily closing values of the SET Index and trading volume are available from the SET.

10 The PACAP Research Center at the University of Rhode Island compiles and releases both value- and equally weighted daily market portfolio returns for the SET-listed stocks. The PACAP Thai Index returns are computed with and without dividend reinvestment with April 30, 1975 as the beginning date of the return series. Trading at the SET started on April 30, 1975.

11 Subindexes are compiled for: agribusiness; banking, building and furnishing; commerce; electrical products, finance and service; food and beverage; hotels and travel; insurance; printing and publication, property development; and textile and clothing.

12. Ng, Chang, and Chou (1991) report that cross-country stock investing is a very important channel in the transmission of volatility from one national market to another and that volatility spillover from the U.S. market to the Thai market has increased substantially after the introduction of the Alien Board in September 1989.

13. Due to a lunch break between the morning and afternoon sessions, the estimation of return during trading period in subperiod II is done as follows: first, the return during the morning trading session (R_m) and the return during the afternoon trading session (R_a) are computed, and second, the hourly return during trading period is calculated using $[(1+R_m)(1+R_a)-1]/4$.

14. Given sample variances of $s_1^2, s_2^2, \ldots, s_r^2$ from r normal populations, the mean square error (MSE) of s_j^2 is equal to the geometric average (GMSE) of s_j^2 if all s_j^2 are equal; as the variation between the s_j^2 becomes greater, the GMSE becomes smaller than the MSE. A function of log(MSE/GMSE) follows approximately a χ^2 distribution with r-1 degrees of freedom for large sample sizes when the population variances are equal See Neter, Wasserman, and Kutner (1985, pp. 618-622) for a discussion on the Bartlett test.

15. The regression at the first step of adjustment is:

$$(Var_t)^{1/2} = 0.0020 R_{oc,t}, \quad R^2 = 0.0264 \text{ and } F\text{-value} = 6.94$$
$$(0\ 009) \qquad\qquad\qquad\qquad (0\ 009)$$

where figures in parentheses are the probability levels.

16. This figure is quite large when compared with 72 computed for the U.S. market by French and Roll (1986) and 28 computed for the Tokyo Stock Exchange by Chang, Fukuda, Rhee, and Takano (1993).

17. For an empirical investigation of determinants of portfolio return autocorrelation, see Mech (1993).

18. One board lot represents 100 shares for all securities traded on the SET main board. The minimum size of transaction at the SET main board is at least one lot and the maximum size for a single transaction is 100 board lots. An odd lot (which is less than one board lot), special lot (which is more than one board lot but not a complete board lot), and big lot (which exceed 10 million baht in market value or 10 percent of the paid-up capital, whichever is lower) are traded on the special board.

19. Two regression results are:

$$\text{Volume}_t = 145{,}362 I_t, \quad R^2 = 0.695 \text{ and } F\text{-value} = 590.35$$
$$(0.0001) \qquad\qquad\qquad (0\ 0001)$$

$$\text{Value}_t = 9{,}344{,}678 I_t, \quad R^2 = 0\ 815 \text{ and } F\text{-value} = 1{,}139.57$$
$$(0\ 0001) \qquad\qquad\qquad (0\ 0001)$$

where figures in parentheses are the probability levels.

20 One should not be alarmed by a negative figure for the adjusted volume in subperiod I since the main purpose here is to compare the *adjusted* trading volume in the two subperiods

21. We also conducted the analysis with the trading volume on the alien board included. The results, however, remain unchanged because the trading volume on SET's alien board is too small to make any difference. For example, the alien board trading volume during the study period is less than one percent of the main board trading volume

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