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Structural breaks in stock returns volatility: Evidence from the Stock Exchange of Thailand

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ABSTRACT

This paper examines the time variation in return volatility in the Stock Exchange of Thailand during 1975-2010. Using GARCH-type methodology, together with Bai and Perron's structural break test, we find that there are two structural breaks in the mean of the conditional volatility of both daily and monthly returns. The empirical analysis in this paper reveals that the structural changes in returns volatility are more likely to be a consequence of policy and regulatory change rather than economic crisis.

Keywords: Stock returns volatility, Structural break; Thailand

1. Introduction

Research on stock market volatility has generated increasing public attention, not only for its characteristics but also for the consideration of risk management. Volatility prediction is an important tool for decisions on asset allocation under the modern portfolio theory. In asset pricing theory, market volatility is used for derivative pricing and risk assessment.

In the long-term, volatility also has implications for financial market development, as it represents uncertainty or instability (Kaminsky and Reinhart, 2001). The stock market has an important function in macroeconomy by providing financial assets, in which savers can invest their money effectively. Moreover, businesses can use the stock market as an alternative source of funds for their investment. The stability of the financial market becomes an input to many investment decisions as well as portfolio creation. In particular, increasing volatility could deter investor participation and risk sharing (Allen and Gale, 1994). It could also leads to a higher cost of capital and obstructs firm expansion (Lee et al., 2003). Therefore, high volatility could hinder business growth and financial market development, which play an important role in promoting long-run economic growth (Levine and Zervos, 1998).

There is an abundant amount of literature dealing with volatility issues. Most studies are typically related to predicting stock returns volatility, while a few mention the issue of the possibility of structural change in such volatility1. If there is a structural change in the volatility pattern, prediction of volatility from the model without considering the structural change may no longer be consistent or reliable.

Unlike previous studies, this paper differs in three main aspects. Firstly, while most studies have focused on developed markets, few studies have examined the emerging markets. Secondly, the data used in this paper cover a long span from April, 1975 to August, 2011. Lastly, instead of pre-specifying the break date, we apply the formal structural break test to our data. The results from this paper contribute to the literatures on volatility and the structural break. Moreover, the results also extend the empirical evidence using data from the emerging market.

In sum, this paper examines the time variation in the volatility in the Stock Exchange of Thailand during 1975 - 2010. A GARCH - type model is used to generate the volatility series. Using the Bai-Perron’s (1998, 2003) structural break test, we find that there are shifts in the mean of the conditional volatility in both daily and monthly returns. The timing of breakpoint estimated by Bai-Perron’s methodology reveals that structural changes in returns volatility are more likely to be a consequence of policy and regulatory change rather than economic crisis.

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[1]Among others, Allen and Gale (1999, 2000); Andreou and Ghysels (2002); Chaudhuri and Klaassen (2004); Emmos and Schimid (2000); and Kim et al. (2010) study the structural change in stock returns volatility in the Asian stock markets.

The rest of this paper is outlined as follows. The data and econometric methodology are presented in Section 2. Section 3 reports the empirical results, while Section 4 discusses and concludes the empirical results.

2. Data and econometric methodology

2.1 Data

In this study, we investigate the long-term behavior of returns volatility in the Stock Exchange of Thailand. The main index of the Stock Exchange of Thailand (SET index) is used in the analysis. The daily and monthly data were obtained from Datastream and cover the period from the beginning of the stock market, 30 April 1975, to 31 August 2011.

2.2 Variable construction

2.2.1 The returns

The returns are then calculated from the log-difference of the close price as follows:

$$\mathrm{R_t} = \ln(\mathrm{p_t}) - \ln(\mathrm{p_{t-1}})$$

where $\mathrm{p_t}$ is the daily close index on day t or month-end close index of month t.

2.2.2 The volatilities

Volatility usually refers to the standard deviation of daily price changes; however, since the 1990's using the conditional volatility to represent risk behavior in the stock market has been popular. Therefore, variations of the Generalized Autoregressive Conditional Heteroscedastic (GARCH) model2 were used to characterize the volatility of stock returns. Specifically, apart from standard GARCH model, the Threshold-Generalized Autoregressive Conditional Heteroscedastic (TGARCH), which can capture the asymmetric response of volatility to positive or negative shocks, is also applied in our study. Therefore, we consider both the standard GARCH (1,1) process and the Threshold-Generalized Autoregressive Conditional Heteroscedastic (TGARCH(1,1)) in our paper. These models are defined as follows:

<u>Mean equation</u>

$$\mathrm{r_t} = \sum_{i=1}^{k} \beta_i \, \mathrm{r_{t-i}} + \sum_{j=1}^{5} \gamma_i \, \mathrm{Dw_{j,t}} + \varepsilon_t$$

where $\mathrm{DW_{1,t}} - \mathrm{DW_{5,t}}$ are the dummy variables indicating the day-of-the-week for each observation ($\mathrm{DW_{1,t}} = \text{Monday}, \ldots, \mathrm{DW_{5,t}} = \text{Friday}$). We include the day-of-the-week dummy variables in the return regression with daily data in order to control for the

[2] The GARCH model was originated by Engle (1982) and was extended by Bollerslev (1986).

weekend effect, as mentioned in French (1980). Moreover, we include autoregressive terms to capture the possibility of serial correlation, which is usually found in long - term stock return series (Fama and French, 1988). The number of lagged variables (*k*) was chosen using Box-Jenkins method.

Subsequently, the conditional series, h_t^{GARCH} and h_t^{TGARCH}, are computed using the estimated GARCH (1,1) and TGARCH (1,1) equations, respectively.

Variance equation: GARCH (1,1)

$$h_t = \omega_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}$$

Variance equation: TGARCH (1,1)

$$h_t = \omega_0 + +\alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \lambda_1 d_{t-1} \varepsilon_{t-1}^2$$

where d_{t-1} is a dummy variable accounting for the negative shock. Specifically, it is included to capture the asymmetric effect of shocks, $d_{t-1} = \begin{cases} 1 & \text{if } \hat{\varepsilon}_{t-1} < 0 \\ 0 & \text{otherwise} \end{cases}$.

2.3 Structural break test

Two main methods are used to deal with the structural break. In particular, when the break dates are known *a priori*, the Chow test can be employed. However, it is difficult to determine a certain break date in financial data. Therefore, the formal structural break test with an unknown break date proposed by Bai and Perron (1998) is an obvious candidate. Based on the dynamic programming algorithm, they developed statistics to test for multiple unknown structural breaks. The double maximum statistics are jointly used with the sequential SupF statistic to determine the number of structural breaks.

Specifically, the Bai-Perron test is used to test for the presence of multiple breaks when the breakpoints are determined endogenously. The aim is to identify the number of breakpoints. That is, consider the model with *m* breaks (*m*+1regimes):

$$x_t = \beta_j + \varepsilon_t$$

For j = 1, ..., m+1, where xt is the variable of interest and βj (j = 1, ..., m+1) is the mean level in the *j*th regime. The *m*-partition represents the breakpoints for the different regimes and is treated as unknown. Each regime is estimated by Ordinary least squares method with the estimate of βj (j = 1, ...,m+1) generated by the minimization of the sum of squared residuals. Therefore, we performed the Bai - Perron test on both the conditional series (h_t^{GARCH} and h_t^{TGARCH}) calculated from daily and monthly data in order to find evidence of structural changes.

3. Empirical results

3.1 Descriptive statistics

Table 1 reports the basic descriptive statistics of the stock returns series for the entire sample (2 April 1975 to 31 August 2011). Panel A shows the statistical numbers for the daily data, while Panel B shows the numbers for the monthly data. The mean of the daily returns are 0.00025 or 0.025%, while the mean of the monthly returns are 0.00558 or 0.558%. The minimum daily return is -0.16063 or -16.063% and the maximum daily return is 0.11350 or 11.350%. On 19 December 2006, the SET index sharply dropped from 730.55 to 622.14 points (-16.063%) due to the 30 percent Unremunerated Reserve Requirement (URR) announced by the Bank of Thailand3. This significant plunge also activated the circuit breaker during trading hours.

TABLE 1. Descriptive statistics

	Min	Max	Mean	S.D.	Skewness	Kurtosis	JB.
Panel A: Daily data							
Returns	-0.16063	0.11350	0.00025	0.01443	-0.07590	12.41877	35047.15 (0.000)
h_t^{GARCH}	7.97x10-6	0.00618	0.00024	0.00037	4.70303	38.06487	519738.9 (0.000)
h_t^{TGARCH}	8.21x10-6	0.00662	0.00024	0.00038	4.96522	42.36610	649980.8 (0.000)
Panel B: Monthly data							
Returns	-0.35919	0.28428	0.00558	0.08413	-0.40601	5.83759	157.8925 (0.000)
h_t^{GARCH}	0.00107	0.04189	0.00791	0.00786	1.92210	6.37026	470.4582 (0.000)
h_t^{TGARCH}	0.00098	0.04434	0.00779	0.00753	1.87024	6.48934	471.0003 (0.000)

Notes: Sample period between 2 Apr 1975 and 31 Aug 2011, 9480 and 436 daily and monthly observations, respectively. The Jarque-Bera (JB) test statistics are shown on the first line with the corresponding p-value in the parentheses on the second line. h_t^{GARCH} and h_t^{TGARCH} represent the conditional variance series generated by the GARCH(1,1) and TGARCH(1,1) models.

For the monthly returns, the minimum monthly return is -0.35919 or -35.919% and the maximum monthly return is 0.28428 or 28.428%. The corresponding minimum month is October 2008, when the index sharply dropped from 596.54 to 416.53 (-35.919%), which resulted from the global financial crisis that originated in the United States. A similar decrease occurred in the stock exchanges around the world. Moreover, the magnitude of change was very close to that of the stock market crash in 1987, -35.635% in October 1987 for Thailand.

[3] The Bank of Thailand announced the 30 percent Unremunerated Reserve Requirement (URR) on 18 December 2006 in order to reduce the short term speculative (one-way bet) from foreign investment due to the sharp appreciation of the Thai Baht.

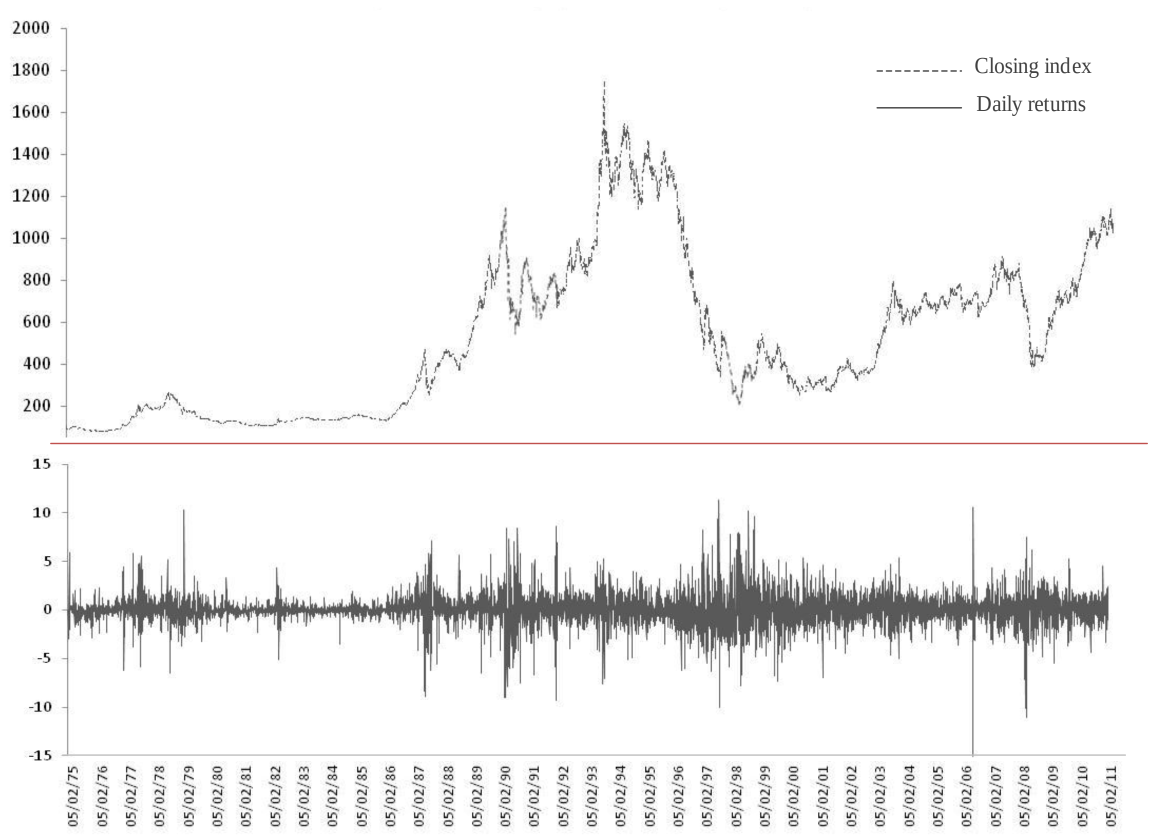

Figure 1A**.** Daily closing SET index and daily returns (2 April 1975 - 31 August 2011)

Furthermore, the skewness and kurtosis figures reveal the departure from normality in data, confirmed by the Jarque-Bera test. In addition, the dynamics of stock returns are provided in Figure 1A and Figure 1B. These figures show the movement of the closing SET index and the corresponding returns over time. Looking at Figure 1A and 1B, we find that when changes in returns are small, they tend to remain small for some time, and vice versa. There are also some “outliners” which occur more frequently than would be the case if returns were normally distributed. Therefore, in other words, the unconditional distribution of returns has “fat-tails.” In addition, we find that the volatility of returns is time-varying and that volatility clustering exists for a considerable time. Hence, these motivated us to use the ARCH model to capture such autoregressive and persistent properties.

Next, the unit root tests were conducted to investigate the stationary property of the series. We performed the Augmented Dicker Fuller (ADF test) and Phillips Perron (PP test) tests for this purpose. The results of the unit root tests, together with the Ljung-box (LB) Q-Statistics, are provided in Table 2.

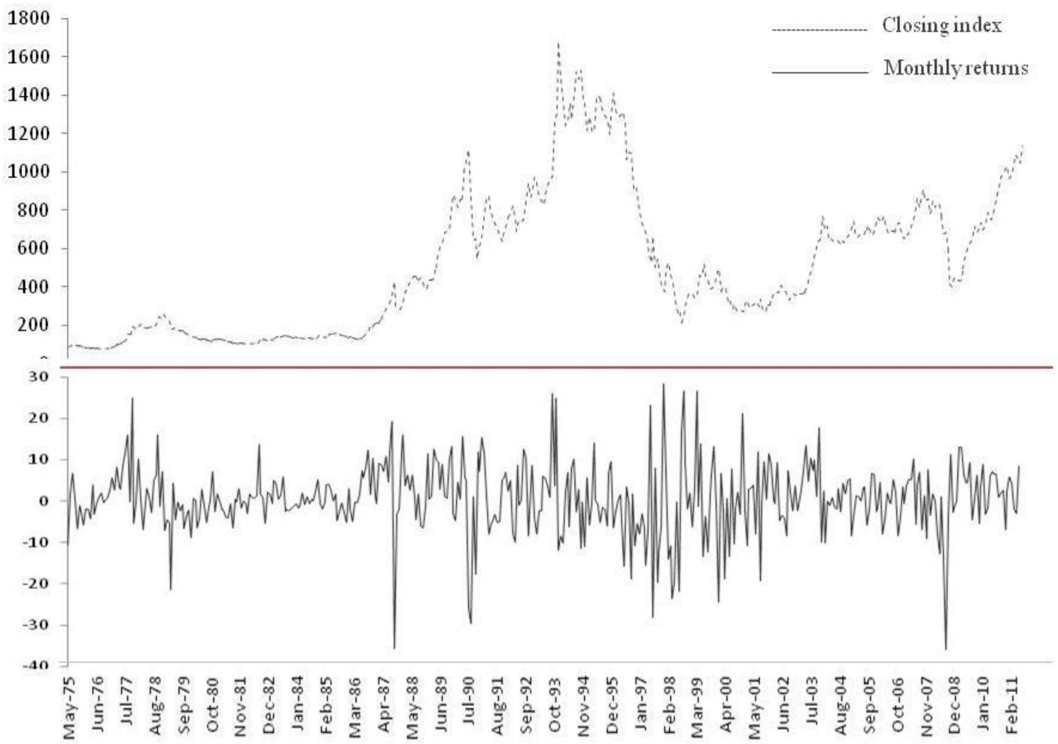

Figure 1B. Monthly closing SET index and daily returns (April 1975 - August 2011)

TABLE 2. Unit Root Tests and Ljung-box Q-Statistics (LB)

Panel A: Daily data				
Variable	ADF test	PP test	Q(10)	Q(20)
Returns	-15.805***	-87.517***	221.73***	276.11***
h_t^{GARCH}	-12.869***	-12.665***	56018***	78566***
h_t^{TGARCH}	-13.103***	-13.334***	53950***	74595***
Panel B: Monthly data				
Variable	ADF test	PP test	Q(6)	Q(12)
Returns	-12.624***	-18.789***	12.799***	23.176***
h_t^{GARCH}	-12.869***	-12.665***	1388.0***	1838.3***
h_t^{TGARCH}	-13.103***	-13.334***	1493.9***	2056.7***

Note: *,**,*** denotes a 10%, 5%, and 1% significant level, respectively.

We first considered the stock return series. The results from Table 2 show that the stock return series is stationary. Specifically, the ADF and PP figures are all larger than the critical value under a 1% significance level. Hence, we were able to reject the null hypothesis of the unit root process. The Ljung-box (LB) Q-Statistics of return series was significant at the 1% level for both daily and monthly data, which indicates the existence of a serial-correlation pattern in the stock return series.Therefore, the ARIMA models with day-of-week dummies were used in the estimation of the mean equation.

3.2 Estimation of conditional volatility

Table 3A and 3B shows the GARCH (1,1) and TGARCH (1,1) estimation results for both daily and monthly returns series. The significances of α_1 and α_2 indicate that the conditional volatility of Thai stock returns is affected by both the ARCH effect (α_1) and the GARCH effect (α_2).

TABLE 3A. Model for conditional volatility of Thai stock returns, April 1975 - August 2011 (Mean equation)

	Daily volatility		**Monthly volatility**	
	GARCH (1,1)1	**TGARCH (1,1)**2	**GARCH (1,1)**3	**TGARCH (1,1)**4
Mean equation				
β0			0.003 (0.003)	0.006* (0.003)
β1	0.166*** (0.011)	0.166*** (0.011)	0.105** (0.051)	0.135** (0.053)
β2	-0.190** (0.095)	0.037*** (0.011)		
β3	0.036* (0.020)		0.113** (0.048)	0.122** (0.048)
β4	0.036*** (0.011)	0.036*** (0.011)		
β5	0.039*** (0.011)	0.037*** (0.010)		
β6	0.061*** (0.009)	0.060*** (0.009)		

	Daily volatility		**Monthly volatility**	
	GARCH (1,1)1	**TGARCH (1,1)**2	**GARCH (1,1)**3	**TGARCH (1,1)**4
β7	0.045***	0.035***		
	(0.009)	(0.008)		
β8	-0.001**	-4.99x10-4***		
	(0.000)	(1.59x10-4)		
β9	3x10-5	-2.98x10-4*		
	(0.000)	(1.64x10-4)		
β10	1.81x10-4	2.28x10-4		
	(0.000)	(1.70x10-4)		
β11	2.85x10-4*	2.19x10-4		
	(0.000)	(1.70x10-4)		
β12	0.001***	9.14x10-4***		
	(0.000)	(1.87x10-4)		
β13	0.226**			
	(0.095)			

TABLE 3B. Model for conditional volatility of Thai stock returns, April 1975 - August 2011 (Variance equation)

	Daily volatility		**Monthly volatility**	
	GARCH (1,1)1	**TGARCH (1,1)**2	**GARCH (1,1)**3	**TGARCH (1,1)**4
Variance equation				
ω_0	8.54x10-7***	9.49x10-7***	2.03x10-4***	1.66x10-4***
	(6.67x10-8)	(7.04x10-8)	(5.95x10-5)	(4.85x10-5)
α_1	0.155***	0.141***	0.224***	0.289***
	(0.005)	(0.005)	(0.034)	(0.059)
α_2	0.844***	0.859***	0.776***	0.791***
	(0.003)	(0.003)	(0.030)	(0.029)
λ_1		0.049***		-0.150***
		(0.008)		(0.058)

Note: *,**,*** denotes a 10%, 5%, and 1% significant level, respectively.

In estimation of the GARCH-type model, the mean and variance equations are specified as follows:

1) GARCH(1,1); $r_t = \beta_1 r_{t-1} + \beta_2 r_{t-2} + \beta_3 r_{t-3} + \beta_4 r_{t-8} + \beta_5 r_{t-10} + \beta_6 r_{t-13} + \beta_7 r_{t-15} + \beta_8 DW_{1,t} + \beta_9 DW_{2,t} + \beta_{10} DW_{3,t} + \beta_{11} DW_{4,t} + \beta_{12} DW_{5,t} + \varepsilon_t + \beta_{13}\varepsilon_{t-2}$

and $h_t = \omega_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}$

where $DW_{1,t}, \ldots, DW_{5,t}$ are the day-of-week dummy variables.

2) TGARCH(1,1);$r_t = \beta_1 r_{t-1} + \beta_2 r_{t-2} + \beta_4 r_{t-8} + \beta_5 r_{t-10} + \beta_6 r_{t-13} + \beta_7 r_{t-15} + \beta_8 DW_{1,t} + \beta_9 DW_{2,t} + \beta_{10} DW_{3,t} + \beta_{11} DW_{4,t} + \beta_{12} DW_{5,t} + \varepsilon_t$

and $h_t = \omega_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \lambda_1 d_{t-1} \varepsilon_{t-1}^2$

where $DW_{1,t}, \ldots, DW_{5,t}$ are the day-of-week dummy variables,

while d_{t-1} is a dummy variable which equals one if a negative shock occurs ($\varepsilon_t < 0$) and zero otherwise.

3) GARCH (1,1); $r_t = \beta_0 + \beta_1 r_{t-1} + \beta_2 r_{t-3} + \varepsilon_t$

and $h_t = \omega_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}$.

4) TGARCH (1,1); $r_t = \beta_0 + \beta_1 r_{t-1} + \beta_2 r_{t-3} + \varepsilon_t$

and $h_t = \omega_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \lambda_1 d_{t-1} \varepsilon_{t-1}^2$

where d_{t-1} is a dummy variable which equals one if a negative shock occurs ($\varepsilon_t < 0$) and zero otherwise.

The conditional return volatility series for both daily and monthly data were computed from the GARCH (1,1) (h_t^{GARCH}) and TGARCH (1,1) (h_t^{TGARCH}) models. As can be seen from Table 1 and 2, both the h_t^{GARCH} and h_t^{TGARCH} series exhibit a stationary property as the null hypothesis of the unit root is rejected using the ADF and PP tests at a 1% significance level. The *LB* Q-statistics results are also significant, which indicates a persistent volatility pattern. The graphical illustrations of these conditional volatility series are plotted and shown in Figures 2 - 3.

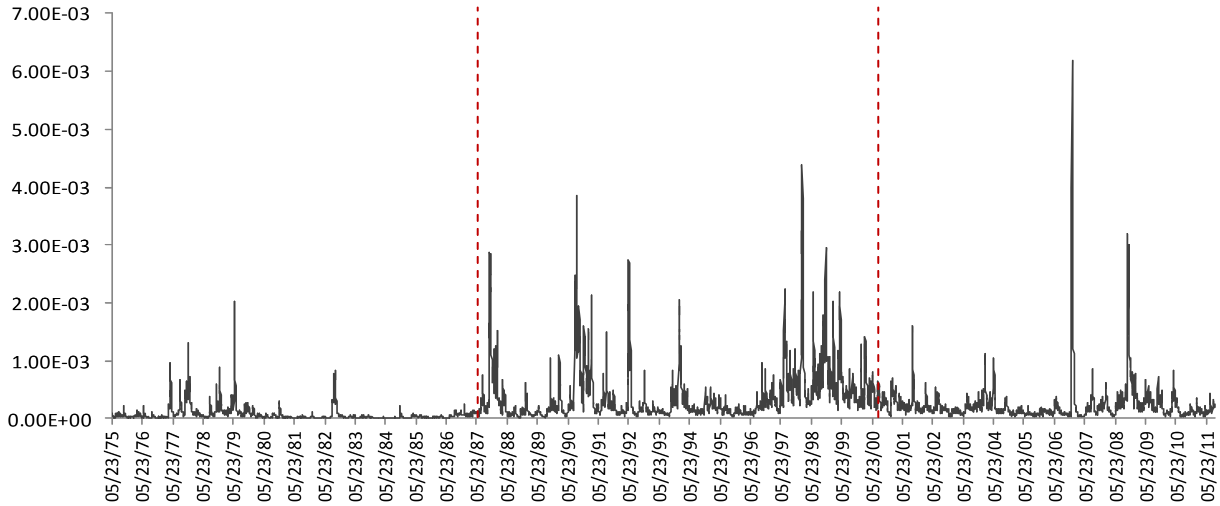

Figure 2A. Plot of daily conditional volatility estimated from GARCH (1,1)

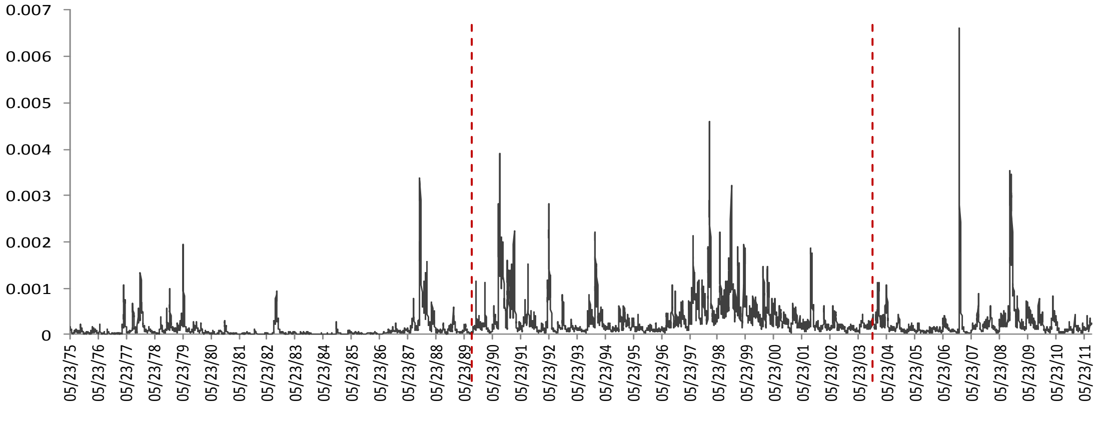

Figure 2B. Plot of daily conditional volatility estimated from TGARCH (1,1)

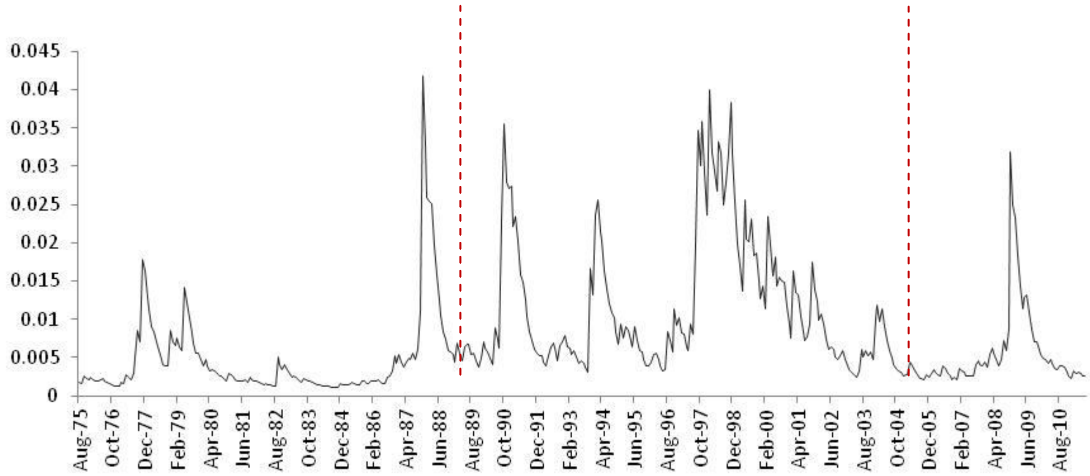

Figure 3A. Monthly conditional volatility estimated from GARCH (1,1)

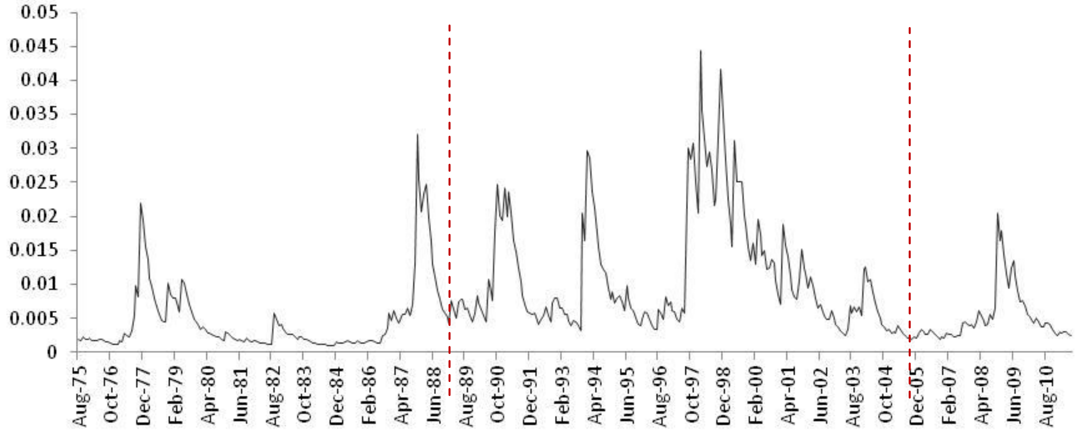

Figure 3B. Monthly conditional volatility estimated from TGARCH (1,1)

TABLE 4. Tests for change in mean of conditional returns volatility

	Daily volatility		Monthly volatility	
	GARCH (1,1)	TGARCH (1,1)	GARCH (1,1)	TGARCH (1,1)
Panel A: Test of structural breaks				
SupFT(1)	1001.336***	952.671***	82.828***	81.954***
SupFT(2)	675.217***	637.660***	97.559***	104.876***
SupFT(3)	467.577***	438.014***	72.581***	80.938***
UDmax	1001.336***	952.671***	97.559***	104.876***
WDmax	1001.336***	952.671***	122.807***	132.018***
Panel B: Number of breaks selection				
$SupF_T(2\|1)$	222.229***	204.203***	67.181***	78.940***
$SupF_T(3\|2)$	N/A	N/A	7.689	8.132*
BIC	3	3	3	3
LWZ	2	2	2	2
Sequential	2	2	2	2

where *,**,*** denotes a 10%, 5%, and 1% significant level, respectively.

3.3 Structural break test

In this section, we performed the formal structural break test as suggested by Bai and Perron (1998, 2003). Bai and Perron (1998) introduced the two statistical tests of the null of no break against an unknown number of breaks. These two tests are called the *double maximum tests* (UDmax and WDmax) and the SupF tests. These Bai-Perron tests provide an advantage over the tradition test, e.g. the Chow test, because they do not require number and points of breaks to be pre-specified.

Panel A of Table 3 reports that both *double maximum statistics* are significant at conventional levels. Moreover, the SupFT(m) tests of null of no break against the alternative of *m* break(s) are rejected at the 1% significance level. In sum, the data seem to strongly favor structural break(s) in the mean of the h_t^{GARCH} and h_t^{TGARCH} series rather than the case of no break.

In order to select the number of breaks, a common procedure is to consider the information criterion. However, the BIC always chooses a much higher value than the true one in the presence of a serial correlation case, as documented by Bai and Perron (2003). Consequently, they suggest a method based on the sequential application of the $SupF_T(\ell + 1|\ell)$ test, which is superior to information criterion. Table 3 Panel B reports that the $SupF_T(2|1)$ are significant for both daily and monthly data, which imply that there are two breakpoints rather than one breakpoint. Next, considering the $\mathrm{SupF_T}(3|2)$ test statistics, we find that the null of two breakpoints is failed to reject. In sum, the test statistics provide evidence in favor of the two breakpoints in the conditional return volatility series. Notably, the number of breaks selected by the LWZ information criteria and the sequential procedure are similar.

Next, we consider the estimated break dates in the data specified by the Bai - Perron procedure. Table 5 shows the estimated mean of the conditional volatility in each regime. In addition, the estimated break date is also reported with a 95% confidence interval. The results from the monthly $\mathrm{h_t^{GARCH}}$ series show that the first structural shift was found between June 1986 and June1987 (the point estimate was May 1987) and the second breaks was located between the date of July 2001 and April 2003 (the point estimate was October 2001). Furthermore, for the monthly $\mathrm{h_t^{TGARCH}}$ series, the locations of the breakpoints selected were analogous to those of the monthly $\mathrm{h_t^{GARCH}}$ series. Specifically, the point estimates were located on April 1987 and November 2001 for the first and second breakpoints, respectively.

Considering the daily $\mathrm{h_t^{GARCH}}$ and $\mathrm{h_t^{TGARCH}}$ series, the break dates are also detected around the same period as those of the monthly data. Therefore, we can conclude that there is evidence of two breakpoints in the conditional return volatility of the SET index, which occurred around 1987 and 2001. Interestingly, there was no structural break in volatility during the Asian financial crisis in 1997, as we might expect.

TABLE 5. Conditional volatility and breakpoint properties (two - break case)

	Daily volatility		Monthly volatility	
	GARCH (1,1)	TGARCH (1,1)	GARCH (1,1)	TGARCH (1,1)
regime 1	0.00008 (0.000006)	0.00008 (0.000006)	0.00350 (0.000540)	0.00356 (0.000514)
	10Jul 87 [4Jun 87 - 13 Jul 87]	10Jul 87 [3Jun 87 - 13 Jul 87]	May87 [Jun 86- Jun 87]	Apr 87 [May 86 - May 87]
regime 2	0.00040 (0.000006)	0.00040 (0.000006)	0.01319 (0.000496)	0.01296 (0.000468)
	28Aug 00 [14Jun 00-15Jan 01]	28Aug 00 [1Jun 00-22Jan 01]	Oct 01 [Jul 01 - Apr 03]	Nov 01 [Sep 01 - Mar 03]
regime 3	0.00024 (0.000006)	0.00024 (0.000007)	0.00553 (0.000614)	0.00521 (0.000585)

Notes: The first number in each cell is the estimated mean for such regime; standard error is reported in parentheses. The break date (end date of the regime) is on the second line with 95% confidence intervals reported in brackets. The first regime begins on 2 Apr 1975 and the last regime ends on 31 Aug 2011.

The means of the $\mathrm{h_t^{GARCH}}$ and $\mathrm{h_t^{TGARCH}}$ series in each regime are computed and reported in Table 5. For the monthly data, the average conditional volatility ($\mathrm{h_t^{GARCH}}$) during the first (April 1975 to May 1987), the second (June, 1987 to October 2001), and the third regimes (November, 2001 to August, 2011) are 0.356, 1.319 and 0.553 percent, respectively. From 1987 to 2011, the conditional return volatility significantly increased. The estimated conditional return volatility during the second regime was four times higher than that of the first regime, in particular. Even though the market volatility rose sharply during 1997 - 1998, caused by the Asian financial crisis, these fluctuations quickly dropped to a long - run average level. Later on, in the next regime, the market volatility began to decline in 2001. Although there are several events of large shocks that occurred in the market, i.e. the Unremunerated Reserve Requirement (URR) in 2006 and the Global financial crisis in 2008, the market volatility during the third regime (2001 to 2011) was significantly smaller than that of the period between 1987 and 2001. In sum, the empirical results provide supportive evidence that the structural changes in Thai conditional return volatility from 1975 to 2010 were not likely a consequence of economic crisis.

4. Conclusion

In this paper, the time variation in volatility in the Stock Exchange of Thailand during 1975-2010 was investigated using both daily and monthly data. Using GARCH - type methodology, together with structural change analysis, we found that there were shifts in the mean of the conditional volatility of both daily and monthly returns. Thailand has experienced two structural breaks in returns volatility since 1975. The first break date was detected from April to July 1987, while the second break date was detected from August 2000 to November 2001, in particular.

A possible economic explanation of the first structural change concerns two main issues. One is the increasing role of the foreign investor, while another is the growing numbers of listed firms. The Stock Exchange of Thailand was set up in 1975 and was in "the developing period" during the first decade, 1975 - 1986. At that time, the Thai economy was very volatile, as oil prices and interest rates were high. Private savings were less than the demand for investment; moreover, the political situation was unstable due to the political situation of the neighboring countries'. Even through the primary objective of the stock market was to facilitate capital allocation and enhance capital fund flows; the investment environment was not attractive and did not promote trading activities from foreign investors as expected.

However, after this period, the Stock Exchange of Thailand developed and set up standard trading regulations and started promoting an open economy. In 1987, the Thai government under the General Chatchai Choonhavan supported a policy of changing the battle to the trade field. Since then, the Thai economy had started a boom period. Together with the stability of the political situation, the flows of foreign investment had begun to rise according to the stock market liberalization in September, 1987[4]. Figure 4 obviously shows the soaring of foreign portfolio investment from less than a thousand million dollars to more than 2,000 million dollars since 1987. This also made the ratio of foreign investment in the stock market swell from 4 - 5 percent in 1986 to 14.40

[4] As reported in Bekaert and Harvey (2000).

percent in 1990[5]. In addition, Figure 5 discloses the numbers of listed firms, which has continuously increased from 98 firms in 1986 to hundreds later on. Moreover, according to the government policy to promote investment, Figure 6 also shows that the trading values have increased 4 - 5 times and the SET index doubled over the year.

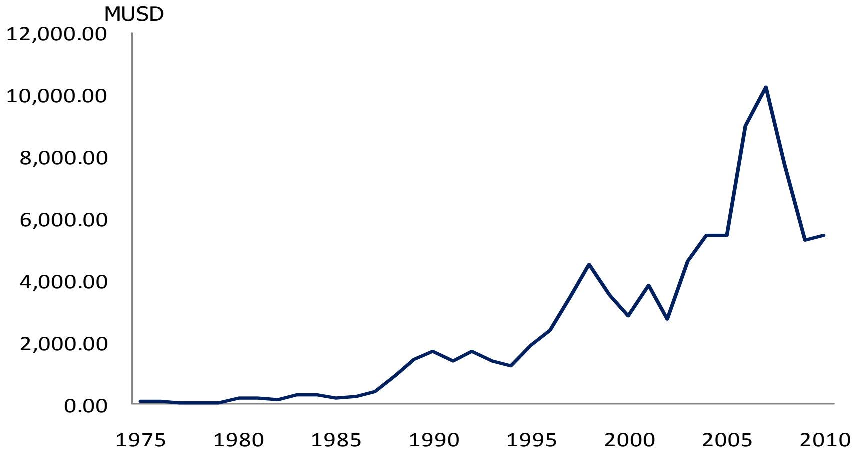

Figure 4. Foreign portfolio investment in Thailand (1975 - 2010), unit: Million USD

Source: Bank of Thailand

The second structural change, dated around 2000 to 2001, corresponding to the recovery period from the Asian financial crisis. During that time, the economic figures began to show a sign of recovery. At the same time, the pressure in the stock market was relieved. As can be seen in Figure 4, the foreign investment portfolios have risen continuously since 2000s. Figure 5 shows that the number of listed firms has increased due to the tax incentive for newly listed firms, corporate tax reduction in particular, together with the privatization of state-enterprise firms, PTT groups specifically. Furthermore, trading values have been boosted (shown in Figure 6) according to the reduction of brokerage commission fees, from 0.50 percent to 0.25 percent.

Interestingly, the test results show that there was no structural break in volatility in 1997. Even though it is widely accepted that the Asian financial crisis originated in Thailand and created a ripple effect throughout the region, the Bai and Perron test statistics do not provide any evidence of a structural break in volatility during that time. Our findings are similar to those reported by Kim *et al.* (2010). Specifically, Kim *et al.* (2010) investigate a possible structural break in volatility using data from five Asian financial markets: Korea, Japan, Hong Kong, Singapore and Thailand. They found that over the sample period, 1 Jan 1990 - 31 December 2005, all financial markets except Thailand exhibited structural changes.

[5] Translated from "The Journey of Life" (in Thai), the Stock Exchange of Thailand

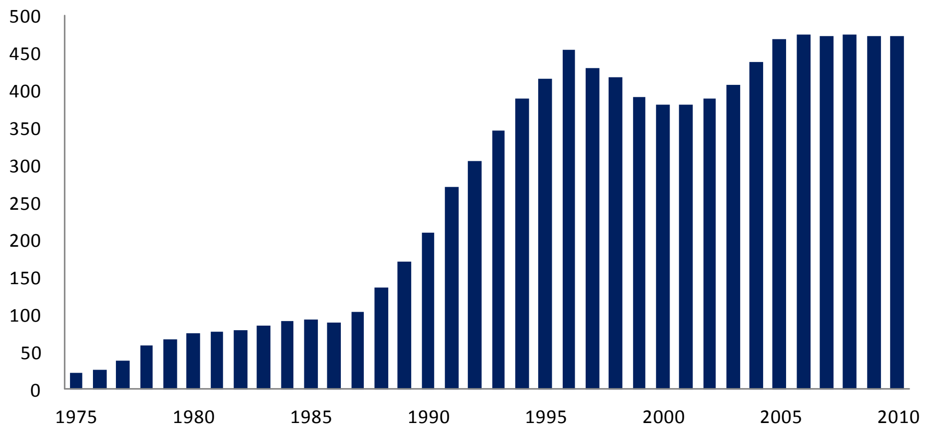

Figure 5. Number of listed firms on the Stock Exchange of Thailand (1975 - 2010)

Source: Stock Exchange of Thailand

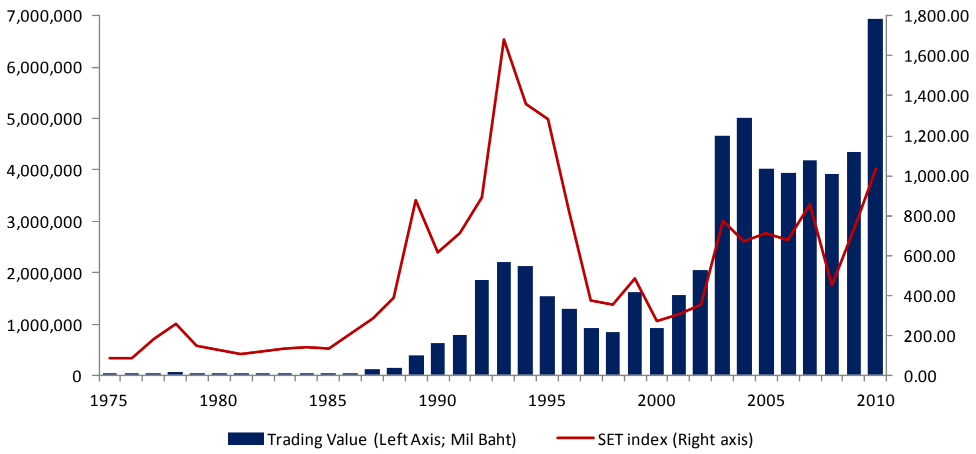

Figure 6. SET index and annual trading value (1975 - 2010), unit: Million Baht

Source: Stock Exchange of Thailand

In conclusion, the empirical analysis in this paper reveals that, over the sample period of April 1975 to August 2011, the structural changes in stock return volatility in Thailand were more likely to be a consequence of policy and regulatory change rather than economic crisis.

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