



**THE INFORMATION AND VOLATILITY IMPACT
FROM INTRODUCTION OF SET50 INDEX FUTURES
ON UNDERLYING INDEX**

DARANEE PONGTOMESUK

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Daranee Pongtomesuk

An Independent Study
Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science (Finance)

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By

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The information and volatility impact from introduction of SET50 index futures on underlying index

ABSTRACT

This paper investigates the impact of the introduction of SET50 index futures on its underlying spot. This study applies Generalized Autoregressive Conditional Heteroskedasticity (GARCH) framework to the prices of SET50 index futures and SET50 index spot. GARCH enables us to analyze the speed of information, the timely response to news and the persistence of volatility of the spot index before and after the futures introduction. The study finds that there is a significant improvement in both speed of and response to information in the post introduction period. So futures is found to benefit the spot index price in that it make the spot market more efficient. Finally, the paper finds that there is no significant change in market volatility in the post introduction period. This final result supports the fact that derivative trading does not destabilize the underlying spot market as evident in some foreign market.

I. INTRODUCTION

Futures is one of the derivatives in which market participants use to hedge, or earn extra return. Generally, we can futures into 3 purposes. (1) Hedging; taking an offsetting position from investing in underlying spot market to protect the risk from adverse movement prices. (2) Arbitrage; taking a profit opportunity from mispricing between futures and underlying prices by taking an opposite site simultaneously. (3) Spread trading; trading to gain a profit from spread of the futures price movement. Hence, the well understanding in futures market is necessary for efficient investing.

According to the arbitrage activity, it is well known as the transaction which leads the convergence of future price to underlying price. However, it may cause the unrelated change from fundamental value. These activities could create the imbalanced order which causes a market destabilize. Similar to occurring of the stock market crash in October 1987, *Miller (1995) & Kuprianov (1995)* concluded that the trading of index futures caused the destabilization effect on the underlying price, the various transactions of futures trading can affect the underlying market. In addition, the price movement of underlying index and futures can not reflect the information appropriately if all participants do not rationally react to information. Such participant is called noise trader who trades on noise not on information (*Black, 1986*). *Shleifer and Summers (1990)* also indicate another type of participants 'feedback trader', who overreact to news because of the less assessment of information, or action tracking on trend.

However, there are suggestions that futures trading and derivative market can help to reduce asymmetric response to information (*Merton, 1995*). Similarly, the introduction of futures may change the way of information due to decreasing of the impact of feedback trader (*Antoniou et al., 2005*). Also, the increasing number of participants in futures market, due to lower transaction costs, could lead to raise the possible channels of information flow (*Cox, 1976*). When the new channels of information have been created, an uninformed trader reduces subsequently. Moreover, when futures market can response

to news faster than underlying spot market, futures could accelerate the speed of price discovery, and market will be efficient subsequently. Therefore, the relationship between underlying index and futures would be benefits for hedging, trading and speculating.

Recently, there are many literatures studying the impact of the introduction of futures impact on the underlying securities. This paper thus investigates the impact of the introduction of futures by examining the changing of volatility before and after the introduction of futures. This paper intends to study in Thai market by using the first derivative; SET50index futures which initially traded on April 28, 2006. The derivative and underlying index are traded in different markets; the derivative market in Thailand Futures Exchange (TFEX) established on May 2004, while the underlying spot market in Stock Exchange of Thailand (SET). Hence, there are still limit of studies about the relationship of underlying index and futures in Thai market.

This literature is in the line of the research of *Bologna and Cavallo* (2002). First, this paper summarizes a brief review of the related literature. Then, we test the hypothesis that the introduction of the index futures effectively reduces underlying volatility based on the GARCH framework. This study intends to investigate the information impact from futures trading on underlying security and to test whether SET50 index futures have affected the underlying volatility.

The empirical result of this study may be beneficial to the market regulator. When the underlying price is already stabilized, there is no need for more regulation. On the other hand, regulator should be careful if issuing the new regulation can change the market dynamic. Moreover, the volatility concerning is an interest for the risk management implication, particularly fund manager.

II. LITERATURE REVIEW

2.1) The related and relevant issues to this study: Leads and lags between underlying and futures prices

The speed of information flow can be detected by the lead-lag between futures and underlying prices. According to *Chan* (1992), the lead-lag relationship illustrates how fast one market reflects new information relative to the other, and how well the two markets are linked. If one market reacts faster to information, and another market react slower, a lead-lag relationship is observed. *Tse* (1999) found that in reality, futures market could incorporate new information more quickly than cash markets given their inherent leverage, low transaction costs, or the lack of short-sale restrictions. These market restrictions could produce an empirical lead-lag relationship between underlying and futures prices

[Table I is here]

The bulk of literatures have studied a lead-lag relationship. The various conclusions are shown in Table I, which indicate the dissimilar results from different countries. Recently, the lead lag relationship was found in Thai market. for evidence from SET50index and futures, *Paratipchareonchai* (2008) found the relationship between SET50index and futures is the bi-directional based on daily data, while *Thongthip* (2010) found a lead of futures in 5-minutes data.

2.2 The theoretical debate of the impact of the introduction of futures on underlying

The *increase* in the volatility of underlying market has been discussed and proposed in different aspects. The increase in the volatility does not mean an undesirable effect but it leads to the linking of information and volatility. That is the process of more rapid impound of information on price. According to *Cox* (1976), when the newly established futures market can attract more traders to a market, the flow of information will increase and thus

the futures price will reflect all available information and will transmit to underlying price accordingly. Moreover, when the transaction cost of futures is relatively low, the traders will invest in the futures market rather than in the underlying spot market. The information will flow to futures market faster and after that the new information may be transmitted to the underlying price more quickly, which lead to more rapid impound of information on price.

Moreover, the impact of irrational traders, called noise traders, was viewed as a process which causes a price fluctuation (*Kaldor (1960) & Friedman (1953)*), because their activities can increase the underlying price fluctuation. Similar to *Stein (1987)*, the high degree of leverage can attract uninformed traders. Their trading reduce the information content of prices and increase the underlying spot market volatility. In conclusion, the higher volatility occurring in futures market could be due to the increase of information flow and the uninformed trading.

Referring to the lower transaction cost of futures, equity index futures allow the market participant to generate a larger order flow at lower costs to acquire a market-wide exposure and to acquire a larger position due to lower margin requirements.

In contrast, the alternative views for information impact from future trading are finding the *decrease* of the volatility. The result, which found evidence of a decrease of marker volatility consequent to futures introduction, does not further investigate this effect. However, they mostly claimed that Futures trading have a beneficial effect on the underlying spot market by decreasing its volatility. They argue that futures trading increase market depth and enhance efficiency, therefore reduces spot market volatility. *Ross (1976)* found that derivatives improve the efficiency of incomplete capital markets by increasing the investment opportunities set to investors and derivatives may actually reduce the variability of the underlying spot market. As *Cox (1976)*, the additional traders attracting to the futures market could increase the liquidity in the underlying spot market and result in less volatility, unless the futures market is swamped by uninformed speculators who destabilize the underlying spot market. Similarly, *Ross (1976)* suggests that derivatives

may actually reduce the variability of the underlying spot market. *Ross* (1976) argues that derivatives improve the efficiency of incomplete capital markets by increasing the investment opportunities set to investors. Additionally, *Ross* (1989) argues that whether or not derivatives increase or decrease the volatility of the cash market depends on the information flow. *Merton* (1995) maintains that the introduction of futures trading can improve informational efficiency by reducing asymmetric responses to information. According to *Powers* (1970) and *Danthine* (1978), the future existence can increase market depth and informativeness because the cost to informed traders of responding to mispricing is reduced. Also, *Stroll and Whaley* (1988) indicated that futures trading raise the market efficiency. In line with *Kyle* (1985) and *Froot and Perrold* (1991), the introduction of index futures increases the market depth by more rapid dissemination of market-wide information. Additionally, the futures market plays an important role of price discovery in underlying spot market.

In summary, the theoretical debate on how futures trading impact on the underlying spot volatility is still inconclusive. The dissimilar empirical evidences were shown in Table II.

[Table II is here]

2.3 The empirical evidences of the impact of the introduction of futures on underlying

For an example of the result of the increase in volatility, *Antoniou and Holmes* (1995) studying the impact of trading in the FTSE-100 index futures suggested there has been an increase on spot price volatility due to increased information in the market. Indeed, this increased volatility appears to be the result of futures trading expanding the routes over which information can be conveyed to the market. In the Korea stock exchange (*Ryoo and Smith*, 2004), the results show that futures trading increases the speed of information which is impounded into futures market price firstly and then into spot market prices. Although this volatility might be lead to destabilizing effects, a future trading is viewed as a benefit.

In the Mexico stock exchange (*Zhong et al.*, 2004), futures trading has also been a source of instability for the spot market. They found that short-run innovations originating from market provoke volatility in both markets. Such pronounced volatility spillovers could attribute to certain institutional features of Mexico market. However, the newly established futures market is still useful for a price discovery vehicle.

However, *Bologna & Cavallo* (2002) found that the existence of stock index futures reduce the underlying market volatility for the Italian stock exchange. This can contribute to increase market efficiency. This argument, in theory extensible to any other futures market, is consistent with those theories stating that futures improve the efficiency, enhance the depth and reduce the volatility of the underlying market.

III. DATA & METHODOLOGY

3.1. Data

SET50 index: it is a composite index which is calculated the market capitalization weight of the most 50 liquid and highly capitalized shares traded on Thai market. We apply the daily closed price since September 3, 2002 to December 30, 2009. However, since May 2, 2006 is the cutting point for the post period of futures trading.

$$\text{Set50 Index} = \frac{(\text{Current 50 shares value}) \times 100}{\text{Base 50 shares Value}}$$

SET index: it is a proxy of Thai stock market in order to show the movement of the overall market. We use this data to check whether futures effect is still significant if we isolate the market power.

$$\text{Set Index} = \frac{(\text{Current all shares value}) \times 100}{\text{Base all shares Value}}$$

Converting to the first difference, the prices are adjusted into a form of continuously compounded returns in a following process.

$$R_t = 100 \times \ln \left(\frac{P_t}{P_{t-1}} \right)$$

3.2. GARCH framework

This paper will apply the GARCH framework to investigate the impact of futures trading on price volatility in the underlying spot market index. Many empirical widely used this approach to observe the changes in the coefficient of volatility parameters before and after the introduction of futures.

According to *Bollerslev et al.* (1992), *Hung et al.* (1995) and *Ryoo* (2001), the stock market exists heteroscedasticity where the variance of the error term is inconstant. This leads to the autoregressive conditionally heteroscedastic model. Also, *Holmes* (1996) indicates that the GARCH model would be an appropriate mean by which captures market-wide price volatility.

GARCH (p, q) model suggests that the condition variance of ε at the time t is dependent not only on the size of past squared disturbances but also on past conditional variances. That allows the predictable volatility is dependent on the past news.

The conditional variance h_t can be a function model of the lagged ε 's and the lagged h_t 's, where α_i, β_i and ω_i are constant parameters.

$$h_t = \omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^q \beta_i h_{t-i} \quad (1)$$

Moreover, many financial time series have found that the GARCH (1, 1) framework is the most parsimonious representation of conditional variance (*Bollerslev* 1987). In this paper, we use the GARCH (1, 1).

$$R_t = \beta_0 + \beta_1 R_{t-1} + \varepsilon_t \quad (2)$$

$$\varepsilon_t | \Phi_{t-1} \sim N(0, h_t)$$

$$h = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} \quad (3)$$

For the mean equation, R_t is underlying return in period t , ε_t is an error term indicating an unexplained price change, Φ_{t-1} is the information set available at time t . According to Ross (1989), the positive change from the pre-futures to the post futures would mean the more information transmission to market. For the variance equation, h_t indicates a measure of market-wide price volatility. α_0 represents a speed of information flow. α_1 (a coefficient of the lagged error term) is a dependence of today's spot price change on yesterday's market-specific price change, so it is viewed as "new news". A higher value of α_1 thus implies that recent news have a greater impact on today's price changes. α_2 (a coefficient of the lagged variance term) is a reflection of the variance equation that may affect spot volatility, which is viewed as "old news". It means an uncertainty regarding previous news. $\alpha_1 + \alpha_2$ represent the persistence of volatility shocks.

IV. THE EMPIRICAL RESULT

Data Analysis

[Table III is here]

At the result of the Jarque-Bera test, the normality of residuals is not normality at 99% confidence level, which may occur from, autocorrelation, heteroscedasticity or volatility clustering. For the p-value of the Ljung-Box Q-statistics for return is high even at the lag of 20 for the return series, we thus cannot reject the hypothesis there is no serial

correlation in the level of return. Hence, to test the volatility clustering or Chi-square distribution, we then apply the ARCH effect test. From the result of the ARCH effect test, the first differences of SET50 index cash and futures prices, and SET price, we found that the coefficient values of squared residuals are significant different from zero at 99% confidence interval. Therefore, residual exists the ARCH effect, confirming presence of volatility clustering and heteroscedasticity and autocorrelation.

[Table IV is here]

From the result of the ADF test for level and first difference of level and first differences of SET50 index cash and futures prices, SET prices, we found that all three prices levels are not statistically stationary at 99% confidence interval. While, all three first differences (Return) are statistically stationary at 99% confidence interval. Therefore, we should use the first difference in the time series analysis to avoid spurious problem.

We divided the descriptive statistics for the full sample period and for periods before and after in the introduction of futures.

[Table V in here]

Considering the change only in SET50 index series, the standard deviation shows an increase from the pre-futures (1.339059) to the post-futures (1.954950).

[Table VI is here]

During October, 2007, there was the subprime situation which causes the underlying more volatile. We thus separate the data analysis into 2 more sub period; the first sub period is the before-crisis in the post futures period and the second sub period is

for the after-crisis in the post futures period. Although we cut the sample of after crisis period off, the standard deviation remains increase for all three returns. By the way, the subprime strongly affects in all returns which cause the mean return changing from positive to negative and standard deviation is obviously higher (from 1.668745 to 2.128957).

According to our two research questions, the empirical design will process into 3 parts. First, testing does future trading impact to underlying volatile? Second, testing whether futures dummy is the only cause in the volatility changing? Third, testing whether the introduction of futures changes the index volatility during the introduction period?

The empirical result

For the first step that to test the pre and post impact of the introduction of futures, we adjust the variance equation of the GARCH by adding a dummy variable which value equal to 0 for the pre-futures period and value equal to 1 for the post-futures period. For mean equation, we select AR (1) in all tests using the Schwarz Bayesian Criterion (SBC) and Hannan–Quinn Criterion (HQC) (Table VII).

$$R_t = \beta_0 + \beta_1 R_{t-1} + \varepsilon_t \quad (4)$$

$$\varepsilon_t | \Phi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \gamma D_F \quad (5)$$

[Table VIII is here]

According to the increase value of parameter ' α_0 ' (from 0.0608 to 0.5496) and ' α_1 ' (from 0.0061 to 0.1439), it shows that the speed of information in following of futures trading run to the market faster, also the *new* information is more significant effect to the return of underlying price.

Consistent to the increase of information process, we find the role of *old* new significant decrease in the post-futures period (α_1 : from 0.9012 to 0.7032) and the persistence of volatility subsequently reduces ($\alpha_1 + \alpha_2$: from 0.9673 to 0.8471)

The evidence also suggests that there has been an increase in underlying price volatility due to the positive value of futures dummy ' γ '. Therefore, this increased volatility appears to be the result of futures trading expanding the routes of information.

However, we should consider whether there are other factors affecting to the volatility because during the sample data in the post period the subprime crisis is the negative phenomenon that may cause the volatility in this sample. Hence, in the next section, we will add a market proxy into mean equation to isolate the market effect from futures effect.

For the second step, we examine whether the introduction of futures trading is not the only factor responsible for the increasing in the spot market volatility. Thus, we now consider the market effect in the mean equation, which may affect spot market volatility. This study applies 'SET' as economic indicator which can capture the overall marker wide volatility. This is typically to isolate "market-wide" movement. Thus, we test the hypothesis that futures introduction lead to increase in volatility. In this case, we adjust the mean equation by adding the market proxy 'SET index return'.

$$R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 SET_t + \varepsilon_t \quad (6)$$

$$\varepsilon_t | \Phi_{t-1} \sim N(0, \sigma_t^2)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \gamma D_F \quad (7)$$

[Table IX is here]

The result of this step maintain finding a reduction of the old news impact on today's price change ' α_2 ' which can be regarded as an increase in the rate of information flow ' α_0 '. Thus market reflects information rapidly, the persistence of volatility shocks ' $\alpha_1 + \alpha_2$ ' decreases, which is consistence to the first testing.

For the value of futures dummy, it is different from the first testing. As this paper is aware of the volatility impact from the sub-prime crisis in October 2007, after we isolate the market wide effect ' β_2 ', the futures dummy ' γ ' becomes negative but insignificant. Thus the increase of volatility of the first testing is not the direct consequence of future trading.

For this final step, we analyze in more detail of the volatility behavior over the whole time period by examining whether the change occur exactly during the futures trading introduction. Hence, we consider the behavior of the conditional variance in figure 1 from the first step under the GARCH (1, 1) framework by equation (4) and (5) with $\gamma = 0$.

[Figure 1 is here]

The graph comprises of two series of the conditional variance for the pre and post-futures period. As SET50 index futures was introduced on April 28, 2006, we can see that the condition variance likely change during the beginning of the post futures period in Figure 1 However, according to the second step testing, the volatility shift was occurred by the market influences. Hence, there is no evidence for volatility shift from the introduction of futures.

V. CONCLUSION

Futures is viewed as the important role to improve the efficient market. However, futures trading can affect to the underlying volatility differently, which may increase or decrease, or unchange. This is thus inconclusive and has a long debate in many studies.

This study examines the impact on SET50 index price volatility after the introduction of its futures on 28 April 2006 with applying the GARCH model which allow us to determine the relationship between information and index price volatility. Firstly, the results is similar to *Bologna and Cavallo* (2002) that futures trading increase the impound of information into spot market prices which has had substantial improvement on (a) the increase in information speed; (b) the quickly response to news; and (c) the reduction of volatility persistence. The lagged uncertainty of yesterday's price is more significant in explaining the today return volatility which increases market efficiency in term of reflection of new information in share price. Thus, futures is useful for the prediction of spot's volatility and return for tracking and monitoring purpose. However this study finds that there is no evidence of returns becoming more volatility after futures introduction. This result is consistent with *Kan* (1999) who suggests that the change in previous studies occurred by the bull and bear market effect instead of the index futures trading effect. *Lee and Tong* (1998) who find no increase in volatility suggests that the trading of stock futures offers many of the benefits associated with derivative trading without the specter of raising volatility. Specifically, it offers some reassurance that derivative trading does not destabilize the market.

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Table I: Related literature reviews of cointegration and lead-lag relationship between stock index cash and futures price.

Year	Authors	Lead-lag (minutes)		Country	Product (Stock Index)
		Cash	Futures		
1990	Stoll, Whaley	Lag	Lead	USA	MMI, S&P 500
1992	Chan	Lag	Lead	USA	MMI
1995	Tse	Lag	Lead	Japan	NIKKEI 225
1998	Pizzi, Ec., O'Neill	Bi-direction		USA	S&P 500
1998	Abhyankar	Bi-direction		UK	FTSE 100
1999	Booth, So, Tse	Bi-direction		Germany	DAX
1999	Min, Najand	Lag	Lead	Korea	KOSPI 200
1999	Turkington, Walsh	Bi-direction		Australia	SPI
2000	Green, Joujon	Bi-direction		France	CAC-40
2004	Zhong, Darrat, Otero	Lag	Lead	Mexico	IPC
2005	Mukherjee	Bi-direction		India	NIFTY
2007	Floros, Vougas	Lag	Lead	Greece	ASE-20, ASE Mid 40

Note: Table 1 represents the related literature reviews of cointegration and lead-lag relationship between stock index cash and futures in different countries. This is a good support of the long-run relationship between stock index cash and futures market.

For lead-lag relationship, the empirical results seemed to disagree. Some studies found that futures returns significantly lead cash index returns, while the others found the bi-directional causality between them. However, the evidence that the cash index returns led futures returns was weak. However, each country seemed to face its own specific features and reasons of lead-lag relationship.

Resource: Thongtip (2010)

Table II: Related literature reviews of volatility impact of futures on underlying cash market.

Year	Authors	Result			Country	Product (Stock Index)
		Increase	Decrease	No impact		
1989	Harris	x			USA	S&P500
1995	Antoniou and Holmes	x			UK	FTSE
1995	Darrat and Rahman			x	USA	S&P500
1998	Lee and Tong			x	Australia	
1998	Chang et al.	x			Japan	NIKKEI
1999	Kan			x	HongKong	HIS
2002	Bologna et al.		x		Italian	MIB
2002	Pilar and Rafael		x		Spain	Ibex35
2004	Wee Ching Pok et al.	x			Malaysia	KLSE
2004	Ryoo et al.	x			Korea	KOSPI 200
2004	Zhong et al.	x			Mexico	IPC
2006	Baklaci et al.		x		Turkish	
						FTSE/ASE
2007	Drimbetas et al.		x		Greece	20
2008	Kasman et al.		x		Turkish	ISE-30

Note: Table 2 represent the related literature reviews of the volatility impact from introduction of futures in different countries.

Table III: Ljung Box test, ARCH Effect test and Jarque-Bera test

	SET50	SET	SET50 futures
Ljung Box			
Q(20)			
Test Statistic	42.4370	41.1690	71.9600
P-value	***0.002	***0.004	***0.00000
ARCH effect			
Test Statistic	55.00598	53.32508	20.52626
P-value	***0.00000	***0.00000	***0.00000
Jarque-Bera			
Test Statistic	10258.53	12936.75	1287.86
P-value	***0.00000	***0.00000	***0.00000

Note: Significance levels: * =10%, ** =5%, *** =1%, while Ljung Box test is for autocorrelation test, ARCH effect is based on the null hypothesis that all 20 lags of the squared residuals have the coefficient values that are not significantly different from zero and Jarque-Bera is based on the null hypothesis of normality

Table IV: Augmented Dickey-Fuller tests

	Price level		
	SET50	SET	SET50 futures
t-Statistic	-2.079202	-2.087207	-1.453333
Prob	0.2533	0.2500	0.5570
	Return		
	SET50	SET	SET50 futures
t-Statistic	-41.99511	-41.77570	-31.31069
Prob	***0.0000	***0.0000	***0.0000

Note: Significance levels: * =10%, ** =5%, *** =1%. : Unit root test for price and return

Table V: Descriptive statistics for daily SET50 index cash and futures returns and SET return without crisis period

Statistic	Entire Period		Pre-futures		Post-futures		
	SET50	SET	SET50	SET	SET50	SET	SET50 futures
Mean	0.046011	0.040139	0.094858	0.085322	-0.002782	-0.005003	-0.004321
Median	0.035584	0.045179	0.070218	0.054218	0.003385	0.022984	0.052728
Maximum	11.43119	10.57703	5.692063	5.425965	11.43119	10.57703	11.46421
Minimum	-17.23093	-16.06325	-5.143049	-5.020291	-17.23093	-16.06325	-14.18736
Standard deviation	1.675509	1.490318	1.339059	1.214409	1.954950	1.72188	2.207695
Skewness	-0.818246	-0.97315	0.020437	-0.044951	-0.992345	-1.206989	-0.444168
Kurtosis	14.59669	16.00701	3.920997	4.375494	14.72691	16.76316	8.799161
Jarque-Bera Prob	10258.53 ***0.00000	12936.75 ***0.00000	31.76524 ***0.00000	71.01495 ***0.00000	5298.838 ***0.00000	7305.672 ***0.00000	1287.86 ***0.00000
No. of observation	1,795	1,795	897	897	898	898	898

Significance levels: * =10%, ** =5%, *** =1%,

Table VI: Descriptive statistics for daily SET50 index cash and futures returns and SET return with crisis period

	Pre-futures		Post Futures (Pre-crisis)			Post Futures (Post-crisis)		
	SET50	SET	SET50	SET	SET50 futures	SET50	SET	SET50 futures
Mean	0.094858	0.085322	0.059975	0.043296	0.064118	-0.044387	-0.037023	-0.049693
Median	0.070218	0.054218	0.044629	0.057536	0.096445	-0.022613	-0.002915	0
Maximum	5.692063	5.425965	11.43119	10.57703	7.360036	8.916483	7.548747	11.46421
Minimum	-5.143049	-5.020291	-17.23093	-16.06325	-13.03347	-12.56347	-11.09023	-14.18736
Standard deviation	1.339059	1.214409	1.668745	1.509669	1.628103	2.128957	1.84867	2.519979
Skewness	0.020437	-0.044951	-2.303007	-2.563738	-1.256342	-0.527905	-0.680624	-0.241393
Kurtosis	3.920997	4.375494	39.80285	44.35768	16.20661	7.633090	7.98295	6.767739
Jarque-Bera	31.76524	71.01495	20520.34	25906.50	2695.861	508.05570	600.3628	324.6511
Prob	***0.0000	***0.0000	***0.0000	***0.0000	***0.00000	***0.0000	***0.0000	***0.00000
No. of observation	897	897	358	358	358	540	540	540

Significance levels: * =10%, ** =5%, *** =1%,

Table VII Analysis of mean equation with different number of lags for the dependent variable 'SET50 Index'

Number of lags	AIC	HQIC	SBIC
1	3.872351	3.875741	3.881535
2	3.871652	3.877306	3.886966
3	3.87145	3.879369	3.892899

Table VIII: Maximum likelihood estimate of the GARCH (1,1) with the SET50 index in the mean equation

β_0	β_1	α_0	α_1	α_2	γ
Estimate for the whole period					
0.088475	0.150354	0.0152138	0.093605	0.823789	0.0050
** <i>(0.0144)</i>	*** <i>(0.0001)</i>	*** <i>(0.0001)</i>	*** <i>(0.0001)</i>	*** <i>(0.0001)</i>	** <i>(0.0123)</i>
Before the introduction of SET50index futures					
0.0929	-0.0985	0.0608	0.0661	0.9012	
** <i>(0.0336)</i>	*** <i>(0.0029)</i>	** <i>(0.0149)</i>	*** <i>(0.0001)</i>	*** <i>(0.0001)</i>	
After the introduction of SET50index futures					
0.0823	-0.0644	0.5496	0.1439	0.7032	
<i>(0.2343)</i>	<i>(0.1076)</i>	*** <i>(0.0001)</i>	*** <i>(0.0001)</i>	*** <i>(0.0001)</i>	

Notes: Significance levels: * =10%, ** =5%, *** =1%. P-value are presented in parentheses.

$$R_t = \beta_0 + \beta_1 R_{t-1} + \varepsilon_t \quad (4)$$

$$\varepsilon_t | \Phi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \gamma D_F \quad (5)$$

Table IX: Maximum likelihood estimate of the GARCH (1,1) with the SET50 index and the SET index in the mean equation

β_0	β_1	β_2	α_0	α_1	α_2	γ
Estimate for the whole period						
-0.00138 (0.6883)	1.12921 ***(0.0001)	0.035959 (0.1434)	0.000503 ***(0.0032)	0.079891 ***(0.0001)	0.906452 ***(0.0001)	-0.0004 (0.7702)
Before the introduction of SET50index futures						
-	-	-	-	-	-	-
0.003162 (0.8462)	-0.0359 (0.1133)	1.1176 ***(0.0001)	0.000245 ***(0.0001)	0.0637 ***(0.0001)	0.9311 ***(0.0001)	
After the introduction of SET50index futures						
-	-	-	-	-	-	-
0.001012 (0.5514)	-0.0610 (0.2628)	1.1383 ***(0.0001)	0.001868 **(0.0155)	0.1067 ***(0.0001)	0.8077 ***(0.0001)	

Notes: Significance levels: * =10%, ** =5%, *** =1%. P-value are presented in parentheses.

$$R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 \text{SET}_t + \varepsilon_t \quad (6)$$

$$\varepsilon_t | \Phi_{t-1} \sim N(0, \square_t)$$

$$\square_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \square_{t-1} + \gamma D_F \quad (7)$$

Figure 1

This analyze in more detail of the volatility behavior over the whole time period by examining whether the change occur exactly during the futures trading introduction. Hence, we consider the behavior of the conditional variance under the GARCH (1, 1) framework by equation (4) and (5) with $\gamma = 0$.

$$R_t = \beta_0 + \beta_1 R_{t-1} + \varepsilon_t$$

(4)

$$\varepsilon_t | \Phi_{t-1} \sim N(0, h_t)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \gamma D_F \quad (5)$$

