The Impact of Futures Market on Spot Price Volatility, and Market Efficiency: Evidence from Thai Stock Index Futures

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Abstract
This research examines the impact of Thai securities futures on the underlying spot market. Specifically, the study investigates whether (1) Thai securities futures market reduces spot price volatility or stabilizes the underlying spot market, (2) the futures market helps facilitating the transmission of information to spot market, and enhancing market efficiency. The Generalized Autoregressive Conditional Heteroskedastic (GARCH) Model is employed, using three sets of daily SET50 stock index data, ranging from January 2000 to April 2018. The results reveal that Thai futures market does not induce spot price volatility, or destabilizes the underlying spot market. Due to the existence of futures market in Thailand, new information has been transmitted to the underlying spot market faster and the persistence of past information reduces, resulting in a reduction in spot price volatility. Thus, market efficiency is improved.
Keywords: Futures Market, Spot Market, Information Transmission, Volatility, GARCH

Introduction
Futures contracts are a kind of derivatives that its price interacts to the underlying cash price. Then, the roles of futures contracts are hedging risks arising from spot price volatility of respective assets, as well as speculating. A key of success to hedging attributes to market efficiency in a view of stabilizing the prices of such assets as equities and commodities (Gupta & Mayer, 1981). A market is said to be efficient if futures price fully reflects available information (Fama, 1970), and the price would not be affected if all market participants are informed (Malkiel, 2003). A number of studies mainly focus on market efficiency and the relationship between spot and futures prices, which efficiency is mostly revealed in developed markets. That is due to the ability to generate high liquidity and advanced development of financial systems (Awang et al., 2012). However, risk management is extremely important in emerging markets with unforeseen volatilities. Low liquidity in trading and experiences in the use of derivatives could be issues of huge losses, so related studies could be extended in this scope. Some previous studies conducted on developed markets show that futures markets improve the efficiency of spot markets due to rapid information transmission to cash price, while in developing countries, it is less efficient.
As Thailand is appealed as an emerging market for foreign investors, Thai Futures Exchange (TFEX) has to play an important role in stabilizing the financial market. Many futures contracts were launched, including Stock Index Futures (SET50), Single Stock Futures, Gold Futures, Silver Futures, USD Futures, Oil Futures, and so on. Interestingly, this research therefore attempts to observe whether Thai futures market has any impacts on improving efficiency of spot markets. Particularly, the objective is to investigate whether the existence of Thai stock index futures (SET50 index futures) accelerates the rate at which new information is passed on to its underlying spot prices. And, the persistence effect of old information on price discovery in Thai spot market is also tested after launching future

trading. Moreover, to make decision on some policy implications, if the market is less efficient, is crucial.

Literature Review

Previous literature debates whether the establishment of futures markets has an impact on the volatility of spot markets. Most of research examined the impact by conducting financial assets and commodities data to obtain the results. Yilgor and Mebounou (2016) studied the impact of derivatives markets on the Turkish spot markets volatility and liquidity, using EGARCH and ARMA model. They found that derivatives markets reduce the spot markets volatility but do not significantly affect the volume of the spot markets. Another evidence from the Turkish market, Baklaci and Tutek (2006) examined the impact of future trading on spot price volatility, using the Istanbul Stock Exchange 30 (ISE 30) index future data and employing the GARCH model for testing. Their results showed that the Turkish futures market increase the speed of new information transmitting to spot prices and reduce the persistence of information and volatility in the underlying spot market. More on GARCH model, the listed real estate markets in Europe were tested for the impact of futures trading on the European real estate securities markets by Lee, Stevenson & Lee (2014), using the approach of Bessembinder & Seguin (1992) and the Gray's (1996) Markov-switching-GARCH model. Their results showed that futures trading stabilizes the underlying listed real estate markets and improves the speed and quality of information flowing to the spot markets. Chauhan, Singh and Arora (2013) analyzed market efficiency of the Indian commodity and volatility spillover effects between the spot and futures market for agricultural commodities. The results indicated that there is a flow of information from futures to spot commodity markets.

On a different econometric approach, Laws and Thompson (2004) tested the forecasting efficiency of financial futures contracts. They examined whether the interest rates implied by the futures price for eurodollar and short sterling contracts are cointegrated, also using a vector error correction model (VECM) and ARIMA model. The relative efficiency of the markets is carried out. Behera (2015) examined price discovery and market efficiency in the Indian metal and energy futures, using co-integration and error correction method. The researcher found the fair price discovery in the futures market and the gold market is not efficient as it fails to incorporate all the information available in the market. Go and Lau (2017) used variance ratio to examine the investor demand affecting commodity prices. They found that spot and futures prices are highly correlated during backwardation period. The investor demand on the futures market is highly correlated with spot and futures prices during backwardation. High efficient information transmission in the futures market is linked to a high correlation between spot and futures markets.

There is also evidence from Thai derivatives markets on market efficiency and predictability of futures prices. Tharavanij (2017) tested market efficiency and unbiasedness of futures price hypothesis, using SET50 index futures. The researcher investigated whether long-run or short-run inefficiencies or pricing biases exist by identifying and estimating a risk premium. The finding is that futures and cash prices are cointegrated. The results could not detect a constant or a time-varying risk premium, market is efficient, and all results supported the unbiasedness hypothesis. Ouppathumchua (2015) examined market efficiency in Thailand Futures Exchange (TFEX) specified in SET50 index futures, and explained the speed of adjustment of future spot prices utilizing the Cointegration and Error Correction Model (ECM) Model. This study concluded that the market is inefficient. Short-term futures price is better in predicting future spot price than that of long-term, and the speed of adjustment of future spot price in the long-term has higher volatility. Termprasertsakul (2016) compared the efficiency between Thailand Futures Exchange (TFEX) and Agricultural Futures Exchange of

Thailand (AFET), using the Cointegration and Error Correction Model (ECM) Model. The results confirmed that there is a long-run relationship between futures price and spot price in both markets, but futures price is not a good estimator for future spot price due to risk premium for all commodities. While, the short-run relationship between futures and spot prices is inefficiency. The researcher suggested managing price risk since the futures price is not a good estimator of future spot price.

Research Methodology

To examine the impact of the introduction of Thai futures market on spot price volatility of the underlying securities, the Generalized Autoregressive Conditional Heteroskedastic (GARCH) Model developed by Bollerslev (1986) is employed. The behavior of volatility of securities returns over time is captured by the GARCH (1,1) model, estimated by the following equations:

$$R_t = a_0 + a_1 R_{t-1} + \varepsilon_t \, , \varepsilon_t \sim N(0, \sigma_t^2) \quad (1)$$

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \lambda_1 D_F \quad (2)$$

Equation (1) and (2) are mean and conditional variance equation respectively. Daily log index returns and 1-day lagged values are denoted as R_t and R_{t-1} in equation (1), while ε_t is the normally distributed error term. In equation (2), σ_t^2 represents conditional variance at time t, dependent on the relevant information from ε_{t-1}^2 (the ARCH term), along with its own lag (the GARCH term). Additionally, following Lee, Stevenson & Lee (2014), a dummy variable of futures trading period (D_F) is also added in the variance equation to examine the effect of futures market on the volatility of spot market. D_F is equal to 1 since the time futures contracts of Thai stock index were introduced and 0 otherwise. A positive dummy coefficient (λ_1) indicates that the futures market increases the underlying spot price volatility. That is, the futures market destabilizes the spot market.

Moreover, this research also analyzes the impact of futures trading on market efficiency by comparing the GARCH separately estimated results between pre and post-futures period. This method investigates the change in spot volatility and how information has been transmitted after the establishment of Thai futures market. According to the interpretation of Lee, Stevenson & Lee (2014), Baklaci & Tutek (2006), and Antoniou & Holmes (1995), the ARCH term is lagged values of the squared error term, so the coefficient of ARCH term (α_1) describes the effect of new information, while the coefficient of GARCH term (β_1) explains the impact of old news as the GARCH term is lagged values of variance. In particular, a higher α_1 means new information is transmitted to spot price faster, but a lower α_1 means the transmission is slower. On the other hand, an increase in β_1 implies that past information is still persistent to effect spot price movement, whereas a decrease in β_1 indicates a lower effect of that persistence of the old news. As such, market efficiency is considered to be improved by futures trading if the coefficient of ARCH term rises and the coefficient of GARCH term declines in the post-futures period. In other words, when more recent news is enhanced and the old news becomes a smaller extent, the market is efficient.

The daily SET50 stock index data was collected from the Stock Exchange of Thailand's database called SETSMART. Then, the daily SET50 index returns were calculated using the continuously compounding return method as follows:

$$R_t = 100*\log (P_t / P_{t-1}) \quad (3)$$

where R_t is the daily log returns of SET50 index. P_t denotes the daily SET50 index data, and P_{t-1} is its 1-day lag. Under the GARCH estimation with a dummy variable of SET50 index futures trading period, three sets of data samples are classified to assure the impact of futures market on spot price volatility. First, a 7-year sample of SET50 index data spans from January 2003 to December 2009, covering 1,715 observations. Second, a 13-year sample

includes data from January 2000 to December 2012 with 3,181 observations. The third sample is a collection of data from January 2000 to April 2018, approximately 18 years and 4 months. All samples cover the period of SET50 index futures trading (period of the dummy variable, D_F), starting from April 28, 2006 onward.
In the case of separate GARCH estimations of the two sub-samples (to compare the estimated coefficients between pre and post-futures trading period), each of the above mentioned 3 samples are divided into pre and post-futures trading sub-sample. The starting point of the post-futures period is from April 28, 2006.

Empirical Results

The descriptive statistics of SET50 index returns are presented in Table 1. The results show that the daily average returns of SET50 are positive for all time spans. The skewness and the significance of Jarque-Bera statistics indicates that the daily returns are not normally distributed. The ARCH effect is detected by the significant Lagrange multiplier (LM) test at conventional levels, implying that the index returns data is heteroskedastic, and there is a volatility clustering effect on the returns data. Thus, it is proper to use the GARCH model in our analysis. The daily returns for all periods are concluded to be stationary by 3 tests of unit root for an unbiased estimation. The Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test are strongly significant at 1% level, so the null hypotheses of a unit root are rejected. Likewise, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test does not reject a stationary null hypothesis.

Table 1 Summary statistics of daily SET50 index (log) returns

	Daily SET50 index returns					
	7 years		**13 years**		**18 years +**	
Mean	0.0481		0.0326		0.0279	
Median	0.0309		0.0327		0.0331	
Maximum	11.4312		11.4312		11.4312	
Minimum	-17.2309		-17.2309		-17.2309	
Skewness	-0.8319		-0.5490		-0.5468	
Kurtosis	14.5846		11.0155		12.1230	
Jarque-Bera	9,787.70	***	8,675.43	***	15,731.26	***
ADF	-40.9957	***	-36.8748	***	-44.2727	***
PP	-41.0007	***	-55.5223	***	-65.7435	***
KPSS	0.2764		0.1458		0.0794	
LM test (prob.)	0.0329	**	0.0004	***	0.0005	***

Note. *,**,*** indicate 10%, 5%, and 1% level of significance respectively.

The Impact of Futures Market on Spot Price Volatility

The results of GARCH estimation with a dummy variable of futures trading period (D_F) are shown in Table 2. The coefficients of the dummy variable (λ_1) are negative and statistically significant for the period of 13 years (-0.0312) and 18 years (-0.0315). The results reveal that the presence of SET50 index futures reduces the volatility of the underlying stock price in spot market for the particular periods. In contradiction, the coefficient in the 7-year sample is positive which should indicate higher volatility in spot market after futures market started, but it is not statistically significant. Thus, the overall results can be interpreted that the existence of Thai stock index futures does not induce the spot price volatility. In other words, the trading of Thai stock index futures does not destabilize its underlying spot market.

Table 2 Impact of SET50 index futures on the volatility of the underlying spot market

Variance Equation		**Time Span**					
Variables	**Coefficient**	**7 years**		**13 years**		**18 years**	
Intercept	ω_0	0.0781	***	0.0949	***	0.0442	***
		0.0007		0.0000		0.0002	
ε_{t-1}^2	α_1	0.1105	***	0.1214	***	0.1077	***
		0.0000		0.0000		0.0000	
h_{t-1}	β_1	0.8599	***	0.8506	***	0.8886	***
		0.0000		0.0000		0.0000	
D_F	λ_1	0.0046		-0.0312	**	-0.0315	***
		0.8255		0.0439		0.0028	

Note. *,**,*** indicate 10%, 5%, and 1% level of significance respectively. P-values are included in parentheses.

This research further investigates, especially for the 7-year sample, the effect of financial crisis in 2007 to 2009 which may distort our results because it took place and covered almost all the post-futures period in this sample. Therefore, a dummy variable of financial crisis is introduced into the model. The dummy variable is equal to 1 from September 2007 to June 2009 to represent the financial crisis period, and 0 otherwise (Lee, Stevenson, & Lee, 2014). With regard to this extent, the variance equation in the GARCH model becomes as follows:

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \lambda_1 D_F + \lambda_2 D_C \quad (4)$$

where D_C is the dummy variable of financial crisis, and λ_2 is the respective coefficient. Table 3 provides the results of this modification.

Table 3 Impact of SET50 index futures and financial crisis on the volatility of the underlying spot market

Variance Equation		**Time Span**					
Variables	**Coefficient**	**7 years**		**13 years**		**18 years**	
Intercept	ω	0.0938	***	0.1146	***	0.0542	***
		0.0005		0.0000		0.0000	
ε_{t-1}^2	α_1	0.1059	***	0.1198	***	0.1072	***
		0.0000		0.0000		0.0000	
h_{t-1}	β_1	0.8528	***	0.8409	***	0.8833	***
		0.0000		0.0000		0.0000	
D_F	λ_1	-0.0195		-0.0474	***	-0.0389	***
		0.3863		0.0078		0.0008	
D_C	λ_2	0.0947	**	0.1027	**	0.0661	**
		0.0388		0.0159		0.0248	

Note. *, **, *** indicate 10%, 5%, and 1% level of significance respectively. P-values are included in parentheses.

As seen from Table 3, the estimated coefficients λ_2 are all positive and statistically significant at 5% level for all time spans, indicating that the financial crisis obviously causes higher volatility of the stock price in spot market. After capturing the effect of financial crisis, the coefficient of futures trading dummy variable (λ_1) turns out to be negative (-0.0195) for the 7-year sample (in line with the results of 13 years (-0.0474) and 18 years (-0.0389) period), but it is still insignificant. The new estimated results insist that Thai futures market still have no

destabilizing impact on the spot market, but the more volatile market is instead derived from the financial crisis for all tested time spans. This finding is consistent with the previous work of Lee, Stevenson & Lee (2014) and Darrat & Rahman (1995).

The Information Transmission: The Estimation of Pre and Post-Futures Period

Table 4 contains the GARCH estimated results from both pre and post-futures period. A comparison of such results helps us see the change in spot price volatility and explains how information has been transmitted after SET50 index futures were launched. For all time spans, the estimated coefficients α_1, which represent the effect of recent news, are all strongly significant at 1% level. The magnitudes of these coefficients are all greater in the post-futures period than that of pre-futures period. These greater ARCH effects show that the spot price volatility increases and also imply that new information has been transmitted to spot market more quickly after the introduction of stock index futures. The changes in spot price are more influenced by recent news when the futures market exists. The trading of futures provides more relevant information to market participants.

Table 4 GARCH estimated results from both pre and post-futures period

Variance Equation		**Sub-Sample**			
Variables	**Coefficient**	**Pre-Futures**		**Post-Futures**	
7-year time span					
ε_{t-1}^2	α_1	0.0591	***	0.1174	***
		0.0007		0.0000	
h_{t-1}	β_1	0.9115	***	0.7576	***
		0.0000		0.0000	
13-year time span					
ε_{t-1}^2	α_1	0.1120	***	0.1224	***
		0.0000		0.0000	
h_{t-1}	β_1	0.8306	***	0.8105	***
		0.0000		0.0000	
18-year time span					
ε_{t-1}^2	α_1	0.1120	***	0.1255	***
		0.0000		0.0000	
h_{t-1}	β_1	0.8306	***	0.8679	***
		0.0000		0.0000	

Note. *, **, *** indicate 10%, 5%, and 1% level of significance respectively. P-values are included in parentheses.

In the opposite, the coefficients of GARCH term (β_1) significantly decrease in the post-futures period of 7-year and 13-year time span. The lower GARCH effects inform that the spot volatility falls and the impact of past information become smaller after the trading of SET50 index futures. The persistence of old news declines, so it has less effect on spot price movements. The 18-year time span shows a different result as the coefficients β_1 increases significantly. That means the persistence of past information still induces the spot price volatility, or it has more influences on today's price movements. However, the latter result could be explained by the effect of unequally separated sub-sample. The pre-futures period takes 7 years long but the post futures period is over 11 years, while the other time spans are almost equally divided. Overall, the results suggest that market efficiency is improved by Thai stock index futures in the sense that the speed of information transmission from futures to spot market increases but it does not stimulate the volatility, leading to stability in Thai

stock market. This finding supports previous work that the existing of futures market has a stabilizing effect and enhances the efficiency of spot market (Lee, Stevenson & Lee, 2014; Bohl, 2011; Baklaci & Tutek, 2006; Holmes, 1995, and more).

Conclusion

The important roles of futures contracts are hedging risks associated to spot price volatility of respective assets. For a successful performance of futures trading, the efficiency of markets should be enhanced. Theoretically, according to Fama (1970), a market is considered to be efficient if futures price fully reflects all available information. Then the information is publicly revealed to all market participants. As witnessed by much of literature which focuses on market efficiency and the interaction between spot and futures prices in developed markets, futures markets improve the efficiency of spot markets due to rapid information transmission to cash price. The same sense is asked, in this research, for Thailand where the stock index futures (SET50) is outstanding in terms of liquidity. Specifically, the objective is to test whether Thai futures market has any effect on improving the efficiency of spot markets. Does the securities futures market reduce spot price volatility and helps facilitating the transmission of information to spot market? The Generalized Autoregressive Conditional Heteroskedastic (GARCH) Model is used to obtain estimated results. Dummy variables of futures trading period and financial crisis are also incorporated in the model to study the impact. Three time horizons of daily SET50 index data are classified to assure the impact of futures market on spot price volatility; 7 years, 13 years and 18 years. All samples cover the period of SET50 index futures trading starting from April 28, 2006 onward. Another approach used in this research is a separate GARCH estimations of the two sub-samples (pre and post-futures trading sub-sample). The results show that the existence of Thai stock index futures does not induce the spot price volatility. In other words, the trading of Thai stock index futures does not destabilize its underlying spot market. To investigate further, after capturing the effect of financial crisis, the new estimated results insist that Thai futures market still have no destabilizing impact on the spot market. Instead, the more volatile market is caused by the financial crisis. Additionally, from the GARCH estimated results of pre and post-futures period, greater ARCH effects show that the spot price volatility increases, implying that new information transmission to spot market is more rapid after the introduction of stock index futures. The changes in spot price are more influenced by recent news when the futures market exists. The trading of futures provides more relevant information to market participants, while the lower GARCH effects indicate that the spot volatility falls and the impact of past information become smaller after the trading of SET50 index futures. The persistence of old news declines, so it has less effect on spot price movements. In conclusion, the results suggest that market efficiency is improved by Thai stock index futures in the sense that the speed of information transmission from futures to spot market increases but it does not stimulate the volatility, leading to stability in Thai stock market. The finding is consistent with the previously reviewed work.

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