*The Efficiency of Commodity Futures Market in Thailand*

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**Abstract**
Two commodity futures markets are organized in Thailand for more than ten years. One is the Thailand Futures Exchange (TFEX) which mainly trades financial assets and non-agricultural commodities (gold and Brent crude oil). Another is the Agricultural Futures Exchange of Thailand (AFET) which only trades agricultural commodities (rubber, rice, tapioca chip, etc.). This paper mainly examines commodity futures in both markets and compares the efficiency in these two markets. Basically, the results reveal the non-stationary in daily spot prices as well as futures prices for all commodities. The Cointegration method confirms the long-run relationship between futures price and spot price in both markets. However, the joint restrictions on the cointegrating regression reveals that futures price is not a good estimator for future spot price and risk premium exists for all commodities. The Error Correction Model is employed for the short-run efficiency testing. The short-run relationship between futures and spot prices is inefficiency. According to the results, producers, hedgers, or investors should be aware in managing their price risk since the futures price is not a good estimator of future spot price. In addition, market regulators should concern about over-speculation from this inefficiency.

Keywords: Thai commodity futures markets, Market efficiency, Unbiasedness hypothesis

## Introduction

In Thailand, two futures exchange markets have been established for more than ten years, where farmers or agricultural producers can use these futures markets in managing their risk or investors can use these markets as an alternative investment or protect their portfolios from unanticipated events. One is Thailand Futures Exchange (TFEX) which is mostly traded financial products such as equity index, interest rate, currency as well as some commodities such as energy and precious metal. Another is The Agricultural Futures Exchange of Thailand (AFET) which mainly traded the agricultural products such as Ribbed Smoked Rubber Sheet No.3 (RSS3), Block Rubber 20 (STR20), White Rice 5% (BWR5, WRF5), Thai Hom Mali 100% Grade B Both Options (BHMR), Tapioca Chip Both Options (TC) and Canned Pineapple Pieces in Light Syrup (CPPL). Both futures markets have been growing in last ten years. The transaction, volumes, including the variety of products traded have significantly increased. However, commodities are separately traded in these two markets where non-agricultural commodities are traded in TFEX and agricultural commodities are traded in AFET, this paper aims to examine and compare the efficiency of these two markets. Understanding the futures market efficiency is important to many stakeholders. Agricultural producers, hedgers, or investors are able to use the futures price as an optimal forecast for future spot price. This could help them effectively manage their price risk if futures price is an unbiased estimator of future spot price. The policy makers also benefit from this study if markets are efficient. The price stabilization and direct market intervention is not required by the government.

Even though the extensive literature on the futures market efficiency has been reviewed, the study of futures market efficiency in Thailand is still limited. This paper strengthens the previous literature by examining the futures market efficiency in Thailand and comparing the efficiency in two futures markets. Since Thailand is the biggest natural rubber producer, the 32% of rubber traded in the world are produced from Thai producers. The ribbed smoked rubber futures, which have been trading in the AFET since 2004, are therefore selected for study in this paper. The gold and Brent crude oil futures are only two commodities, which have been traded in the TFEX since 2009 and 2011, respectively. Gold and Brent crude oil are also examined. Hence, this paper tests the market efficiency of three commodities in two markets which are gold, Brent crude oil, and ribbed smoked rubber.
The remainder of this paper is organized as follows: the next section reviews the literature related to the study of futures market efficiency. The third section discusses the data applied in this paper. The fourth section presents the testing procedure. The empirical results present in the fifth section. A final section concludes.

## Literature review

The study of market efficiency has been heavily influenced by Fama (1970), who proposed the Efficient Market Hypothesis (EMH). According to the EMH, the prices are fully reflected all publicly available information in the market. Investors therefore are unable to gain abnormal returns from their investment. This hypothesis is also applied to the test of futures market efficiency. The futures market efficiency implies that no investors obtain the abnormal returns because the futures price is an unbiased estimator of future spot price. Therefore, Gulen (1998) and Zivot (2000) state that the futures price at time t-1 ($F_{t-1}$) should be equal to the future spot price at time t ($E(S_t)$) for any underlying assets. Even though the literature examining the futures market efficiency is very extensive, a number of previous studies has revealed the mixed results of this efficient market testing for commodities. For example, Gulen (1998) examines 'simple efficiency of futures market' by testing monthly ahead contracts of crude oil futures for 1-month, 3-month, and 6-month at NYMEX by the cointegration analysis. The results show that futures price is an unbiased estimator of the spot price as both prices are cointegrated in the long-run. Kellard et al. (1999) study the efficiency of futures market by examining variety of futures commodities such as Brent crude oil, gasoil, soybeans, live hogs, live cattle, and DM/$ with the forecast horizons of 28 and 56 days. They test both long-run and short-run market efficiency by using the cointegration method. The model is also extended in order to measure the relative efficiency, which is able to compare the performance of different markets. The results show the cointegration between futures and spot price, implying the existence of long-run efficiency for all commodity futures. However, the empirical evidence in the short-run exhibits inefficiency in many markets, implying the existence of risk premia. Crowder and Hamed (1993) explain the existence of risk premia as a compensation for the risky assets according to the non-zero speculative returns in the futures market. The results also indicate a degree of inefficiency which cattle market has a greater degree inefficiency, following by Brent crude market, live hogs market, DM/$ market, and gasoil market, respectively. Mckenzie and Holt (2002) apply the two-stage Engle-Granger and Johansen cointegration approach to test the long-run market efficiency as well as the unbiased estimator of future spot price. Five futures commodities, which are live cattle, live hogs, corn, soybean meal and iced broilers are tested with the forecast horizons of 2 months. The empirical results reveal that four out of five markets (live cattle, live hogs, corn, and soybean meal) are efficient as well as unbiased in the long-run, suggesting that the risk premia do not exist in these four markets. Only iced broilers market exhibits biasedness in the long-run. When short-run efficiency is studied, the error correction model (ECM) is allowed for the constant risk premia while the ECM-GARCH in mean is applied for the time-varying risk premia. The inefficiency exists for all market in the short-run. Chin et al. (2005) examine the efficiency of energy commodities market, which are crude oil, gasoline, heating oil, and natural gas. Using the OLS technique, the change in the spot rate is regressed on its relation to the basis in order to analyse the long-run dynamics. In addition, the predictive abilities of futures price are tested. The results reveal that futures prices of crude oil, gasoline and heating oil are unbiased estimators. The futures prices of natural gas and gasoline are good estimators, with smallest forecast errors. Wang and Ke (2005) examine the efficiency of two futures market in China. Two commodities-wheat and soybean-are studied. The results based on the Johansen cointegration technique suggest that long-run efficiency exists only in soybean futures market. The wheat futures market shows inefficiency according to the market manipulation.

According to substantial studies on futures market efficiency, the analysis of the efficiency is fruitful. However, the empirical results have been controversial in terms of market efficiency or inefficiency. Besides, the study of commodity markets in Thailand is scant. This paper contributes to the literature by extensively comparing the efficiency in two futures markets in Thailand and strengthening the concepts of market efficiency.

## Data

To compare the futures market efficiency in TFEX and AFET, the futures price ($F_{t-1}$) and spot price ($S_t$) of commodities (Brent crude oil, gold, and rubber) are required to test for both long-run and short-run efficiency. Following the martingale definition of efficiency by Samuelson (1965), Crowder and Hamed (1993) suggest that the futures price should be the closing price 30-day prior to the last trading day of the futures contract. Kellard et al. (1999) confirm that the choice of a date close to contract maturity helps to minimize inefficiency arising from a risk premium. Kristoufek and Vosvrda (2014) analyze the efficiency of commodities futures by using daily futures price with the earliest delivery. Therefore, this paper analyses only nearby contract of all commodities futures, which mostly traded and much more liquid. The detail of each commodity is as follows:

*RSS3* is a futures contract of Natural Rubber Ribbed Smoked Sheet No.3 traded in AFET. Most Thai rubber production is RSS3 is popular for Thai rubber production according to its properties which are easily transport, storage and its standard. There are seven consecutive months from the nearest contract month traded in AFET. The series of RSS3 cover the period from January 2009 to December 2015. The futures price of RSS3 is obtained from AFET.

*GF* and *GF10* are futures contracts of gold traded in TFEX. The underlying asset of both contracts are gold bullion with 96.5% purity. The contract size of GF is 50 Thai Gold baht (762.20 grams) whereas the contract size of GF10 is 10 Thai Gold baht (152.44 grams).[1] Three nearest even month contracts are traded. Since GF and GF10 expires every even month, the GF and GF10 prices of 2-month contract before expiration are examined, which covers the period from January 2010 to December 2015. The futures prices of GF and GF10 are obtained from TFEX.

*BR* is a futures contract of Brent crude oil traded in TFEX. Since Brent crude oil is one of the world major's benchmark, the BR has started trading in TFEX since 2011 to help the investors manage their portfolio risk. The nearest 3 consecutive-month contracts are traded. The BR series cover the period from November 2011 to December 2015. The futures prices of BR are obtained from TFEX.

Regarding to Crowder and Homed (1993) suggestions, the spot price is the cash price on the last day of trading of the corresponding futures contract. The spot prices for ribbed smoked rubber sheet No.3 are obtained from the Rubber Research Institute (RRI) of Thailand. The spot prices for gold bullion with 96.5% purity are obtained from Gold Trader Association, Thailand. The spot prices for Brent Crude oil are obtained from TFEX. All dataset is daily closing price.

## Methodology

It is clearly presented in section 2 that the method of cointegration is employed in much previous literature to test the market efficiency. The analysis of unit root for all

[1] 1 Thai gold Baht equals to 15.244 grams

data series is required before the cointegration testing. The augmented Dickey-Fuller (ADF) and the KPSS techniques are account for the order of integration. The unit root test of all series are estimated as follows

$$\Delta y_t = b_0 y_{t-1} + \sum_{i=1}^{T} b_i \Delta y_{t-i} + \varepsilon_t \qquad \text{Eq. (1)}$$

where $y_t$ represents the log level of futures or spot price for all commodities. For the ADF technique, the null hypothesis is that $y_t$ is non-stationary. For the KPSS technique, the null hypothesis for the KPSS is that $y_t$ is stationary. Following Lai and Lai (1991) and Kellard et al. (1999), the model for testing commodity market efficiency is as follows

$$S_t = \alpha + \beta F_{(t-1)} + u_t \qquad \text{Eq. (2)}$$

where $F_{t-1}$ is the natural logarithm of futures price before the contract matures at time t-1, $S_t$ is the natural logarithm of spot price at time t, and $u_t$ is an error term with mean zero and finite variance. The Eq. (2) can be rearranged as follows

$$u_t = S_t - \alpha - \beta F_{(t-1)} \qquad \text{Eq. (3)}$$

According to Engle and Granger (1987), the residual series ($u_t$) in Eq. (3) are required to test for stationary. $S_t$ and $F_{t-1}$ are cointegrated if both futures price ($F_{t-1}$) and spot price ($S_t$) for all commodities are integrated at the same order of I(1). In addition, the Johansen's cointegration method is further explored the long-run relation between both prices. Eq. (2) also accommodates for testing the unbiased estimators of future spot price. Under the hypothesis of market efficiency, if the futures price is an unbiased estimator of future spot price and no risk premium exists, the $\beta$ and $\alpha$ in Eq. (2) should be equal to 1 and 0, respectively. The $\alpha$ and $\beta$ should be tested independently and jointly. Following Wang and Ke (2005), the likelihood ratio test (LR test) is employed for testing joint null hypothesis of $\alpha = 0$ and $\beta = 1$. Using canonical correlation proposed by Johansen and Juselius (1990), the likelihood ratio test follows an asymptotic chi-square distribution.

For the short-run efficiency, the Error Correction Model (ECM) is employed. This model allows for the long-run relationship as well as short-run adjustments. The ECM with 1 cointgrating vector is as follows

$$\Delta S_t = \rho_0 + \rho_1 \Delta F_{t-1} + \rho_2 ECM_t + \nu_t \qquad \text{Eq. (4)}$$

where

$$ECM_t = S_{t-1} - \alpha + \beta F_{t-1} \qquad \text{Eq. (5)}$$

The coefficient $\rho_1$ indicates the short-run relationship between change in $F_{t-1}$ and change in $S_t$. The coefficient $\rho_2$ indicates the speed of adjustment back to equilibrium. Conventionally, the sign of $\rho_2$ is expected to be negative, implying that $S_t$ finally converges to the long-run equilibrium relationship.

**Empirical results**

Table 1 provides the unit root test for the levels of log prices of all commodities, which is the first step of testing cointegration. The augmented Dickey-Fuller (ADF) and the KPSS techniques are account for the order of integration. The results indicate that the unit root exists for all data series. When the first difference of all price series is applied, it can be confirmed that the futures and spot price have integrated at the same order of I(1). Table 2 shows the t-statistics of the ADF test on the residual series from Eq. (3). The t-statistics are more negative than the critical values at all levels. It can be concluded that the residual series are stationary, implying that the futures price and spot price are cointegrated for all series data.

**Table 1 Unit root tests for all data series**

| | ADF | KPSS |
|---|---|---|
| RSS3 | | |
| Spot | -1.071 | 1.717*** |
| Futures | -0.605 | 2.108*** |
| GF | | |
| Spot | -2.069 | 1.251*** |
| Futures | -2.088 | 1.251*** |
| GF10 | | |
| Spot | -1.696 | 1.872*** |
| Futures | -1.595 | 1.865*** |
| BR | | |
| Spot | 1.213 | 2.658*** |
| Futures | 0.818 | 2.671*** |

Notes: Both spot and futures price are presented in log level. The t-statistics are shown for the ADF test. The lag length is automatic selection by SIC. The LM-statistics are presented for the KPSS test. *, **, *** denote 10%, 5%, and 1% significant level, respectively.

**Table 2 The ADF test on the residual series**

| | AFET | TFEX | | |
|---|---|---|---|---|
| | RSS3 | GF | GF10 | BR |
| T-statisitcs | -3.709414 | -14.70139 | -34.07882 | -15.46485 |
| Test critical values: | | | | |
| 1% level | -3.433986 | -3.434147 | -3.435211 | -3.436625 |
| 5% level | -2.863033 | -2.863104 | -2.863574 | -2.864199 |
| 10% level | -2.567612 | -2.567650 | -2.567903 | -2.568238 |

Notes: The lag selection is based on SIC, with the maximum of 24. The constant but no trend are employed in a regression on the levels of the series.

Using the Johansen's cointegration testing, the trace test ($\lambda_{trace}$) in Table 3 shows that the null hypothesis of the zero rank (r=0) is rejected at 1% significant level for all commodities. Meanwhile, the null hypothesis of one cointegrating regression ($r \leq 1$) cannot be rejected. This is confirmed by the maximum eigenvalue test ($\lambda_{max}$). The maximum eigenvalue and trace test identify one cointegrating vector. Thus, the results from Johansen approach are consistent with the Engle-Granger approach in Table 2, indicating the futures price and spot price of all commodities are cointegrated. Therefore, the long-run efficiency exists in both markets. The results emphasize previous literature such as Gulen (1998), Kellard et al. (1999), Mckenzie and Holt (2002), that the long-run relationship between futures price and future spot price exists.

Furthermore, Eq. (2) is account for testing the unbiased estimators of future spot price. The estimated cointegrating vector of Eq. (2) is presented in Table 4 with the value of normalized intercept ($\alpha$) and futures prices coefficients ($\beta$). Under the hypothesis of market efficiency, the null hypothesis of $\alpha = 0$ and $\beta = 1$ is investigated. For the individual null hypothesis test of $\alpha = 0$ or $\beta = 1$, the $\alpha$ of RSS3 and GF is not rejected at 5% significant level, suggesting that no risk premium exists for RSS3 and GF market.

**Table 3 Johansen's Conitegration testing for long-run efficiency**

| | AFET | TFEX | | |
|---|---|---|---|---|
| | RSS3 | GF | GF10 | BR |
| $\lambda_{trace}$<br>r = 0 | 42.79911***<br>(20.26184) | 107.3849***<br>(20.26184) | 112.0185***<br>(20.26184) | 187.9689***<br>(20.26184) |
| r ≤ 1 | 0.772526<br>(9.164546) | 4.532285<br>(9.164546) | 2.327329<br>(9.164546) | 3.011063<br>(9.164546) |
| $\lambda_{max}$<br>r = 0 | 42.02658***<br>(15.89210) | 102.8526***<br>(15.89210) | 109.6911***<br>(15.89210) | 184.9578***<br>(15.89210) |
| r ≤ 1 | 0.772526<br>(9.164546) | 4.532285<br>(9.164546) | 2.327329<br>(9.164546) | 3.011063<br>(9.164546) |

Notes: The deterministic test specification allows for no linear trends and the cointegrating equations have intercepts. The critical value at 0.05 level is shown in parentheses. *, **, *** denote 10%, 5%, and 1% significant level, respectively.

The β of RSS3 is not rejected at 10% significant level, implying that futures price of RSS3 is a good predictor for its spot price in the long-run. However, the results for unbiasedness in TFEX contradict the findings in AFET. The α and β of GF10 and BR is rejected at 1% significant level, implying that the risk premium exists and the futures price of GF10 and BR is a poor predictor for their spot price. Then, the joint null hypothesis of $\alpha = 0$ and $\beta = 1$ in cointegrating equation is imposed. The $\chi^2$ statistic expresses the LR statistic for joint restrictions. The null hypothesis is rejected for all commodities at 1% significant level, suggesting that risk premium exists and futures price is not a good estimator of future spot price for all commodities.

**Table 4 Test of unbiasedness estimators**

| | AFET | TFEX | | |
|---|---|---|---|---|
| | RSS3 | GF | GF10 | BR |
| α | 0.354920*<br>(0.21291) | 0.026635<br>(0.02787) | 0.061602***<br>(0.01993) | -0.311666***<br>(0.02728) |
| β | 0.932785<br>(0.04785) | 0.996493***<br>(0.00281) | 0.992994***<br>(0.00200) | 1.038002***<br>(0.00342) |
| $\chi^2$ | 607.4128*** | 763.1264*** | 776.5589*** | 140.0598*** |

Notes: Standard errors are shown in parentheses. *, **, *** denote 10%, 5%, and 1% significant level, respectively.

Since only one cointegrating vector is estimated, the Error Correction Model (ECM) is testing for the short-run efficiency. Table 5 presents the empirical results of short-run efficiency. The speed of adjustment ($\rho_2$) for all commodities shows the expected sign and is significant at 5% level. The futures prices of all commodities will eventually adjust to a long-run relationship. The adjustment of RSS3, GF, GF10, and BR is about 1.61%, 12.94%, 6.53%, and 32.41% of the deviation of their spot prices, respectively. The commodities in TFEX have a greater speed in adjustment to a long-run relationship than commodity in AFET. However, the short-run multiplier coefficient ($\rho_1$) for RSS3 and GF10 is not significant, suggesting that the change in futures price of RSS3 and GF10 is not correlated with the spot price in the short-run.

Hence, the short-run relationship between futures and spot prices in RSS3 and GF10 is inefficiency.

**Table 5 Short-run efficiency**

| | AFET | TFEX | | |
|---|---|---|---|---|
| | RSS3 | GF | GF10 | BR |
| $\rho_0$ | 0.0000518<br>(0.00024) | 0.000101<br>(0.000267) | 0.034231<br>(0.025310) | -0.000840**<br>(0.000421) |
| $\rho_1$ | 0.000870<br>(0.012837) | 0.131438**<br>(0.063531) | -0.003438<br>(0.002542) | 0.131728***<br>(0.024729) |
| $\rho_2$ | -0.016097***<br>(0.002038) | -0.129379**<br>(0.054436) | -0.065324**<br>(0.027794) | -0.324093***<br>(0.016364) |

Notes: Standard errors are shown in parentheses. *, **, *** denote 10%, 5%, and 1% significant level, respectively.

## Conclusion

This paper investigates the efficiency of commodity futures market in Thailand – AFET and TFEX. The variety of commodities are selected from both markets to examine. Since Thailand is the biggest natural rubber, the ribbed smoked rubber (RSS3) from AFET are selected. Gold (GF and GF10) and Brent crude oil (BR) are selected as they are only two commodities which have been traded in TFEX among various financial assets. Concerning about the liquidity and trading volume, only series of nearby contract for all commodity futures are obtained. The Engle-Granger approach and Johansen technique confirm the long-run equilibrium in both AFET and TFEX. This strengthens the much previous literature in terms of long-run equilibrium. When the unbiased estimators of future spot prices are investigated, the joint null hypothesis of $\alpha = 0$ and $\beta = 1$ is rejected, suggesting that the risk premium exists and futures price is not a good estimator for future spot price for all commodities. Using the ECM to investigate the short-run efficiency, the short-run relationship between futures and spot price is only found in GF and BR. However, the futures price of all commodities will eventually adjust to a long-run relationship. According to the results, even though the long-run equilibrium exists in both commodity markets, producers, hedgers, or investors should be aware in predicting the future spot price as the futures price is not a good estimator. In addition, market regulators should concern about over-speculation from this inefficiency, particularly in the shot-run.

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