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Asymmetric adjustments in the Thai palm oil market

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ABSTRACT

Drastic movements of global commodity prices and their impact on the Thai palm oil market is a major concern due to Thailand being the third largest producer of crude palm oil (CPO). Although the country is not a net importer, global price changes of the commodity can transmit to domestic markets for palm oil products. This paper analyzed the transmission of Malaysian CPO and world crude oil price changes to the changes in the Thai CPO price using an asymmetric error correction model. The price data used in this paper covers the period from January 1996 to September 2015. The findings showed that the speed of adjustments towards long-run equilibrium were asymmetric and the effects of the world prices on Thai CPO price were significant in both positive and negative deviations. This result calls for policy measures to mitigate the impact of global price movements because CPO is an essential intermediate input in various products and any changes in the Thai CPO price definitely affects the welfare of domestic consumers.

Introduction

The impact of oil prices on agricultural commodities has become a major concern, especially when there are erratic movements in the global oil markets. Numerous studies have examined the linkages between prices of crude oil and agricultural commodities (Campiche, Bryant, Richardson, & Outlaw, 2007; Yu, Bessler, & Fuller, 2006). Studies have also looked at asymmetric transmission of oil price changes to prices of selected agricultural commodities. For example, Abdulai (2002), Kim and Ward (2013), Peri and Baldi (2010), and Sanogo and Amadou (2010) examined the presence of asymmetric price transmission between markets. Interestingly, they found that prices of agricultural commodities are quite sensitive to shocks from price increases rather than to price reductions.

This issue affects the Thai palm oil market and concerns the national government because oil palm is one of the economic crops they promote and support. The oil palm market produces hundreds of millions of dollars in revenue for the country annually. Currently, Thailand is the third-ranked palm-oil-producing country, accounting for approximately four percent of global palm oil production. This production may be small compared to leading-countries, but it is sufficient for national consumption and also allows surplus export to neighboring countries. Although the country is not a net importer of palm oil, global price changes of this commodity can transmit to the

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domestic market for palm products (McLaren, 2015). Moreover, domestic policies cannot prevent the co-movements of domestic product prices with global prices in the long-run (Mundlak & Larson, 1992). While this seems to be an important problem that needs addressing, no specific studies on it have been conducted for Thailand. Thus, we analyzed the transmission of changes in global prices (particularly Malaysian crude palm oil (CPO) and world crude oil) to changes in the Thai CPO price. Our study utilized data from January 1996 to September 2015.

There are various econometric models and techniques available to capture the dynamic relationships between commodity prices (Campenhout, 2007; Chavas & Mehta, 2004), but the most appropriate would be threshold models, which have good power and size properties over symmetric models (Enders & Siklos, 2001). This estimation strategy is flexible enough to allow for the accommodation of possible differences in price adjustments that may have deep or sharp movements in a series. Moreover, this methodological procedure has been widely used to examine the asymmetric adjustment process (Abdulai, 2002; McLaren, 2015; Nakajima, 2012; Peri & Baldi, 2010). Our study used the asymmetric threshold autoregressive model proposed by Enders and Siklos (2001); the findings revealed that the adjustments process in the Thai CPO market is asymmetric in nature. Furthermore, we also provided a perspective on how a developing country adjusts to global price changes, which adds to the existing literature in this area.

Literature Review

Numerous studies investigated the relationship among vegetable oil prices as well as the relationship between oil price and food prices (Campiche et al., 2007; Hadi, Yahya, Shaari, & Huridi, 2011; Mundlak & Larson, 1992; Nazlioglu & Soytas, 2012; Owen, Chowdhury, & Garrido, 1997). Their findings showed that world oil prices were transmitted to other products. In contrast, some studies found no relationships between crude oil and vegetable oils prices, and only a few studies have addressed the asymmetric adjustment process that is critically important from a policy formulation point of view. Moreover, the paucity of literature that has analyzed asymmetric price transmission mainly focused on examining the linkages between farm, wholesale, and retail prices (Abdulai, 2002; Vavra & Goodwin, 2005).

The issue of asymmetric price transmission in the palm oil sector of the Thai economy has not been thoroughly studied. Previous studies on asymmetric price transmission in the Thai economy were regarding the livestock industry (Barahona, Trejos, Lee, Chulaphan, & Jatuporn, 2014), aquaculture products (Singh, Dey, Laowapong, & Bastola, 2015), rice export prices (Ghoshray, 2008), and macroeconomic indicators (Rafiq, Salim, & Bloch, 2009). Importantly, a study by Barahona et al. (2014) identified asymmetric price transmission in the pork industry, but price transmission appeared to be symmetric in the poultry industry. In contrast, Singh et al. (2015) did not find any evidence of asymmetric price transmission in fish markets. Nonetheless, Ghoshray (2008) found that adjustment to the long-run equilibrium is relatively faster when the price differential is negative in rice markets.

Peri and Baldi (2010) used a threshold cointegration approach in examining the asymmetric adjustment processes between prices of rapeseed oil, sunflower oil, and soybean oil and the price of diesel. They revealed that only the rapeseed oil price was co-integrated with the diesel price and adjusted quickly when the deviation from equilibrium exceeded the threshold value. Moreover, Nakajima (2012) revealed asymmetric price transmission for exporting crude palm oil from Indonesia to Malaysia, but the price transmission for refined palm oil from Malaysia to Indonesia was symmetric. These results may imply that Malaysia enjoyed excess profits from importing crude palm oil from Indonesia and exported refined palm oil back to Indonesia. Moreover, the results indicate that palm oil holds some advantages over the other vegetable oils in terms of its price, Therefore, maintaining competitiveness in terms of price is crucial for countries exporting palm oil.

The existence of asymmetric price transmission is viewed as evidence of market failure. Although the number of studies on price transmission in agricultural commodities has increased recently, evidence from developing countries is relatively limited. The contribution of this study is therefore to uncover the asymmetric price transmission in the palm oil market, which hopefully will provide new insights into the asymmetric price adjustment mechanism in developing countries.

Methodology

This paper used monthly data covering the period of January 1996 to September 2015 with 237 observations of prices for Thai CPO, Malaysian CPO, and world crude oil. The Thai CPO prices were obtained from Thailand's Department of Internal Trade, Ministry of Commerce. Prices were transformed to US dollars per metric ton using a nominal exchange rate sourced from the Bank of Thailand. The Malaysian CPO price was based on the Malaysian crude palm oil future prices expressed in US dollars per metric ton. The world crude oil price was based on the Europe Brent spot price FOB and expressed in US dollars per barrel. All prices used in the analysis were transformed into natural logarithmic form prior to analysis.

The empirical procedures of this study involved three steps. First, we examined the stationarity of the data using the frequently used Augmented Dickey–Fuller (ADF) and Phillips-Perron (PP) unit root tests. The purpose of using these unit root tests was to check whether the series contained a unit root in order to avoid spurious regression. The ADF was extended from the Dickey–Fuller test by adding lagged difference variables, in which serial correlation was addressed, whereas the PP is a non-parametric test that is robust to general forms of heteroscedasticity and serial correlation. Second, we applied the variables that were stationary at the first difference level or integrated at order 1, $I(1)$ to test whether they shared a long-run relation using the threshold cointegration test proposed by Enders and Siklos (2001). The threshold cointegration test was divided into two main models: Threshold Autoregressive

(TAR) and Momentum Threshold Autoregressive (MTAR), which are based on the following regression:

$$\Delta\mu_t = I_t\delta_1\mu_{t-1} + (1-I_t)\delta_2\mu_{t-1} + \sum_{i=1}^{k}\gamma_i\Delta\mu_{t-i} + \nu_t \qquad (1)$$

where μ_t is the residuals obtained from the long-run equation, that is $\mu_t = LTHCPO_t - [\alpha_0 + \beta_1 LMYCPO_t + \beta_2 LWCO_t]$ It should be noted that cointegration requires the residuals to be stationary at level. I_t is the Heaviside indicator which is defined according to the level or changes of the residuals as below:

$$\text{TAR model:}\quad I_t = \begin{cases} 1 & if\ \mu_{t-1} \geq \tau \\ 0 & if\ \mu_{t-1} < \tau \end{cases}, \quad \text{MTAR model:}\quad I_t = \begin{cases} 1 & if\ \Delta\mu_{t-1} \geq \tau \\ 0 & if\ \Delta\mu_{t-1} < \tau \end{cases}$$

where τ is the threshold value, which can be zero or non-zero. For τ being non-zero, the threshold value was estimated using a procedure proposed by Chan (1993), which provides the consistent threshold value by minimizing the residual sum of squares (RSS).

The TAR model considers the last period of deviation from the long-run, while the MTAR model captures the changes of the deviation, which is more appropriate to use if the deviation or shock has a greater movement in one direction rather than the other in relation to present momentum (Enders & Dibooglu, 2001).

The null hypothesis of this threshold cointegration test is no cointegration: $H_0: \delta_1 = \delta_2 = 0$, which can be tested using *F*-statistics. Where the null of no cointegration is rejected, the test of the presence of asymmetric adjustment is applied. The null hypothesis of this step is symmetric adjustment, which is $H_0: \delta_1 = \delta_2$, and can also be tested using *F*-statistics. If both null hypotheses are rejected, it can be concluded that there is a long-run relation among the variables and the adjustment process to equilibrium is asymmetric.

In the final analytic step, residuals were extracted from the long-run relation and used to estimate the asymmetric error correction model. The asymmetric error correction model was estimated based on the following equation:

$$\Delta LTHCPO_t = \theta_1 + \sum_{i=1}^{k}\beta_i\Delta LTHCPO_{t-i} + \sum_{i=0}^{m}\gamma_i\Delta LMYCPO_{t-i} + \sum_{i=0}^{r}\varnothing_i\Delta LWCO_{t-i} + \lambda_1 Z\_plus_{t-1} + \lambda_2 Z\_minus_{t-1} + \varepsilon_t \qquad (2)$$

where Δ is the first difference operator, $Z\_plus_{t-1} = I_t\mu_{t-1}$, $Z\_minus_{t-1} = (1-I_t)\mu_{t-1}$, and ε_t is the disturbance term.

In this model, we expect the absolute value of coefficient λ_2 to be higher than the absolute value of coefficient λ_1, which means that the adjustment speeds to a long-run relation are asymmetric and the higher value of λ_2 implies a faster adjustment of the Thai CPO price to negative shocks.

Results and Discussion

The results of unit root tests are presented in Table 1. The ADF and PP tests indicated that all variables, namely, Thai CPO (LTHCPO), Malaysian CPO (LMYCPO), and world crude oil (LWCO), are integrated of order 1, I (1). The null hypothesis of the unit root cannot be rejected for all prices of series in their level, but it is rejected at the 1% level of significance after taking a first difference of all series. Accordingly, we proceeded to conduct the Enders and Siklos (2001) threshold cointegration test.

Table 2 provides the Enders and Siklos co-integration test. The results revealed three-lag changes in residuals. Moreover, the null of no co-integration could be rejected at the 5% level of significance for every case. The F-joint statistics in all models were greater than the critical values calculated using a Monte Carlo experiment approach, which suggests that there is a long-run relationship among the variables. However, the null of symmetric adjustments cannot be rejected in all cases except for the MTAR model. The F-equal of the MTAR-consistent model was 8.6783, which was higher than the critical value of 8.3384 at the 5% significance level. The unknown threshold value of the model was −0.0303, which suggests that the Thai palm oil market will only adjust to the long-run equilibrium when the absolute price deviation exceeds 3.03 percent. These results help to conclude that the variables in the model are co-integrated and there is an asymmetric adjustment process in the Thai CPO price. Therefore, the Thai CPO price can be modeled using the MTAR asymmetric error correction model.

Ordinary least squares (OLS) was employed to estimate the long-run co-integration model and the model coefficients are presented below. The coefficient for the Malaysian CPO price was positive and significant at the 1%

Table 1
ADF and PP unit root tests

Variable	ADF Test		PP Test	
	Level	First difference	Level	First difference
Intercept:				
LTHCPO	−1.9913	−11.2055***	−2.0858	−11.4300***
LMYCPO	−1.8280	−6.2619***	−1.7277	−10.4985***
LWCO	−1.3724	−12.4865***	−1.5477	−12.4805***
Intercept and trend:				
LTHCPO	−2.7208	−11.1772***	−2.8780	−11.3963***
LMYCPO	−2.1658	−6.2504***	−2.0816	−10.4766***
LWCO	−1.3678	−4.6517***	−1.7079	−12.5058***

Note: *** denotes rejection of the null hypothesis at the 1% significance level. The chosen lag lengths in the ADF test are based on the Akaike Information Criterion and in the PP test are based on the Newey−West Bandwidth

Table 2
Co-integration results of threshold autoregressive modeling

	TAR	TAR-consistent	MTAR	MTAR-consistent
δ_1	−0.2480	−0.2726	−0.2196	−0.1554
	(−4.2337)	(−4.5503)	(−3.6137)	(−2.9347)
δ_2	−0.1906	−0.1648	−0.2308	−0.4245
	(−2.7822)	(−2.5087)	(−3.5264)	(−5.1304)
τ	0.0000	0.1096	0.0000	−0.0303
$\delta_1 = \delta_2 = 0$	11.0895**	11.8048**	10.8312**	15.5717**
(F-joint)	[7.1661]	[8.2479]	[7.6647]	[9.5494]
T-max value	−2.7822**	−2.5087**	−3.5264**	−2.9347**
	[−2.4568]	[−2.1834]	[−2.2789]	[−2.1886]
$\delta_1 = \delta_2$	0.4910	1.7976	0.0191	8.6783**
(F-equal)	[2.1896]	[6.0527]	[3.7860]	[8.3384]
Lags	3	3	3	3

Note: ** denotes significance at 5% levels. Numbers in parentheses are t-statistics. Numbers in brackets are simulated critical values obtained from a Monte Carlo experiment approach. τ is the threshold value. The optimal lag order of the equation is based on the Akaike Information Criterion

Table 3
Asymmetric error correction model

		ΔLTHCPO	
Constant		−0.0026 (−0.5171)	
$\Delta LTHCPO_{t-1}$		0.1974 (3.9380)***	
$\Delta LTHCPO_{t-2}$		−0.1091 (−2.2003)**	
$\Delta LMYCPO_t$		0.7644 (10.9738)***	
$\Delta LWCO_t$		−0.0843 (−1.4827)	
$\Delta LWCO_{t-2}$		−0.0757 (−1.3400)	
$\Delta LWCO_{t-9}$		0.1167 (2.0300)**	
Z_plus_{t-1}		−0.1757 (−3.8209)***	
Z_minus_{t-1}		−0.4058 (−4.9278)***	
R-squared	= 0.5348	AIC	= −2.2811
Adjusted R-squared	= 0.5177	BIC	= −2.1453
F-statistic	= 31.3278***	HQ	= −2.2263
Diagnostic tests:			
Q (4)	= 3.0737 [0.5460]	ARCH(1)	= 2.0826 [0.1490]
Q (8)	= 7.2335 [0.5120]	Jarque-Bera	= 6.7108 [0.0349]
LM (4)	= 6.0158 [0.1980]	RESET(1)	= 1.6668 [0.1981]

Note: *** and ** denote significance at 1% and 5% levels, respectively. Z_plus_{t-1} and Z_minus_{t-1} are the error correction terms showing adjustments to increasing and decreasing deviations from the long-run equilibrium, respectively. Numbers in parentheses are t-statistics. Numbers in brackets indicate the significance level of the statistics. The *Q*-statistic denotes the Ljung–Box statistic that the first four and eight of the residual autocorrelations are jointly equal to zero. LM is LM test for serial correlation up to order four. ARCH is autoregressive conditional heteroscedasticity test up to order one. Jarque-Bera is Jargue–Bera test for normality. RESET is Ramsey's misspecification test with the fitted terms set to one

$$LTHCPO_t = \underset{(1.6683)}{0.2191^{*}} + \underset{(38.1182)}{0.9921}\, LMYCPO_t^{***} - \underset{(-1.2087)}{0.0195}\, LWCO_t + \mu_t$$

Adjusted R-squared = 0.9126, F-statistic = 1232.90***

level, whereas for the world crude oil price it was not significant. This suggests that an increase in the Malaysian CPO by 1% will increase the Thai CPO price by approximately 0.99% in the long-run, the magnitude of which strongly shows the pass-through effect of the world CPO price to the Thai domestic market. This finding is in line with the results of McLaren (2015), who found an asymmetric pass-through effect for world agricultural prices to domestic prices. This result should be useful for policymakers in planning proper policies for the reduction of the pass-through effect of the Malaysian CPO on the Thai crude palm oil price.

The results of the asymmetric error correction model are provided in Table 3. The model was estimated based on the threshold value in the MTAR-consistent model. Lagged variables of dependent and explanatory variables were included as the response of the dependent variable to the changes in the explanatory variables was commonly scattered over time rather than instantaneous. The optimal lag length used in the study was selected based on the Akaike Information Criterion value. The general-to-specific procedure was also applied to trim nonsignificant, first-differenced, right-hand-side variables. However, this study considered the white noise of the residuals in the model as well.

Table 3 provides the estimation results of the momentum threshold error correction model for the Thai CPO price. The performance of the model was satisfactory. The F-statistic of the model was significant at the 1% level, indicating that the relationships among the variables in this model were statistically significant and the coefficients were jointly not all equal to zero. Therefore, at least one of the explanatory variables helped in explaining the model. The adjusted R-squared value was 0.5177, indicating that 51.77 percent of the variation in the dependent variable can be explained by the variations of explanatory variables in the model.

The significance of the positive and negative findings of speed adjustments in the MTAR model showed that there are asymmetric adjustments in the short-run dynamics and it is incorrect use a symmetric error correction model (Abdulai, 2002). The Z_minus_{t-1} value indicated that the Thai CPO price reacts strongly and faster to negative shocks than positive shocks. Moreover, the changes in the Malaysian CPO price seem to have the largest impact on the changes in the Thai CPO price. In contrast, the lagged Thai CPO prices seem to lead to oscillating fluctuations, but they were significant at conventional levels and their coefficients' sum was positive. Furthermore, both the Malaysian CPO and world crude oil prices had immediate impacts on the Thai CPO price, but only the impact of the Malaysian CPO price was positive and statistically significant. Despite this immediate impact observed from the data, the short-run effect of the world crude oil price (the sum of changes in the world crude oil price coefficients) was negative and only the positive effect counted.

The coefficient of Z_plus_{t-1} in the error correction model showed that within a month, the Thai CPO price adjusted to eliminate the positive deviation by approximately 17.57

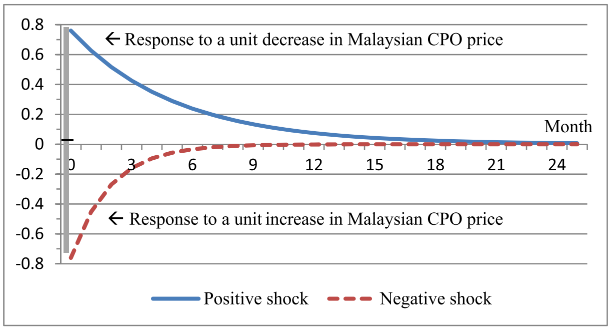

Figure 1 Asymmetric adjustment of Thai CPO price to unit shocks in Malaysian CPO price
Source: Authors' calculation

percent. In contrast, the Thai CPO price adjusted by 40.58 percent of the negative deviation from the equilibrium created by changes in the Malaysian CPO and world crude oil prices. This information indicated that the Thai CPO price adjusted toward the long-run equilibrium relationship between the Thai CPO and global prices much faster when negative deviations existed rather than positive deviations.

The results of the asymmetric error correction model also indicated that negative shock in the Malaysian CPO price led to an increase of 0.76 units in the Thai CPO price. This negative deviation tends to be corrected by an adjustment factor of 40.58 percent per period in the following months. The asymmetric adjustment responses to one unit of positive and negative deviations are presented in Figure 1.

Figure 1 shows that a unit increase in the Malaysian CPO price results in an increase of 0.76 units in the Thai CPO price. This deviation is corrected by a factor of 40.58 percent per period and it will revert back to its long-run equilibrium within 6 months (correct 95%). On the other hand, a reduction in the Malaysian CPO price was corrected by a factor of 17.57 percent per period which would take nearly 15 months (correct 95%) to return to the equilibrium. These results are consistent with Abdulai (2002), Kim and Ward (2013), Ibrahim and Chancharoenchai (2014), and Sanogo and Amadou (2010), where the adjustment of prices was more rapid in the upward direction than the downward. Therefore, the findings suggest that the government should be focusing on policies regarding the consequences of the Malaysian CPO and world crude oil prices shocks.

Conclusion and Recommendation

This paper presented a comprehensive study on price transmission between the Thai CPO, Malaysian CPO, and world crude oil prices. The empirical estimation employed a threshold autoregressive model to analyze the dynamics of the Thai CPO price. The results showed the existence of co-integration and an asymmetric adjustment process in the momentum threshold autoregressive model with a non-zero threshold value (MTAR-consistence). The increase in the Malaysian CPO and world crude oil prices had significant impacts on the Thai CPO price and the impacts were no less when there were price reductions. However, the speed of adjustment to higher world prices was much faster than the speed of adjustment to lower prices. This result was expected because processors would slowly pass on the effect of declining global prices to the domestic market. On the other hand, the processors would quickly pass on the increasing effect of world prices by raising the domestic price.

These revealing results suggest that the government should have a distinctive policy reaction toward increasing and decreasing Malaysian CPO and world crude oil prices. This could be achieved, for example, by setting daily price change ceilings to prevent a rapid price increase and maintaining a balance of the domestic stock as well as providing alternative sources to supply when there is an excess of CPO. It is essential for policy makers to monitor changes in global prices, especially in upward trends. Because the CPO is an important raw material in various industries, changes in its pricing could definitely affect the welfare of domestic consumers. Empirical studies into similar commodities in other countries with different market structures would link these results with market power and international trade policy.

Conflict of Interest

There is no conflict of interest.

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