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Dynamic Cross-Market Linkages of Commodity Futures Markets: Evidence from FCPO and DCE

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ABSTRACT

The objective of this paper is to examine dynamic cross-market linkages between the crude palm oil futures (FCPO) representing Malaysia commodity futures markets and Dalian RBD Palm Oil (DCE), the proxy for the worlds' commodity futures markets. Daily commodity futures data over the period from November 3, 2008 to April 15, 2013 are used. Applying two-step Engle-Granger cointegration test and Johansen-Juselius technique, the results indicate cointegration between these two markets. The results also show short-run uni-directional dynamics relationship between Malaysia commodity futures market and its world counterpart. The results indicate that, in the long run, global portfolio diversification would produce minimal benefits. However, cross-market hedging and arbitrage are still feasible if temporary mispricing exists.
KEYWORDS: Cointegration, Commodity Futures, VECM, Contingent Pricing.

INTRODUCTION

Futures market development has been the focus of many studies in recent years since it provides two important functions related to price discovery and risk management. Risk management is associated with hedging activity while price discovery refers assimilation price from one market into another market. There are two forms of price discovery that are always been researchers' main interests. First, the return and volatility spillover between spot and futures markets of an asset. Second, the cross-market linkages across different futures markets and across different nations. Hence, the interest on understanding market linkages has its origin in the efficient market hypothesis which states that prices in the market have already incorporates all available information thus leading to lead-lag relationship across markets does not exist [1]. Nevertheless, the presence of transaction costs and information asymmetry may lead to return and volatility spillovers between markets. Additionally, the difference in trading hours between futures markets across the globe may as well impede any instantaneous market efficiency. Understanding information spillover across markets is not only an academic interest but is important as well for global portfolio managers, hedge funds, cross-market hedgers and speculators.

In recent years, two most important events occurred in Malaysian futures market, which lead us to closely examine the objective of the present study. First is the use of automation for futures contracts trade on December 2001. Second, the full migration of the "Matching Engine" on all of Bursa Malaysia Derivatives futures products onto CME GLOBEX trading platform on September 2010. Since then, the domestic commodity futures exchange has experienced a growing trading volume, particularly in its crude palm oil futures (FCPO). In spite of increased exposure towards global investment funds and deeper financial integration with the world, figuratively, there has been no empirical research attempted to shed the light on the international linkages between Malaysia and world equity futures markets. Among the few studies that examine cross-market linkages in Malaysia is only for stock indices and its major trading partners [2, 3, 4]. However, for commodity futures market, surprisingly, there are no prior study investigating cross-linkage between the domestic commodity futures market and other futures markets in parts of the world. The present study examines the relationship between Malaysia commodity futures market (FCPO), and the international futures markets which is RBD Palm Oil futures traded on Dalian Commodity Exchange (DCE). Specifically, the present study will answer the following questions. Firstly, do Malaysian commodity futures markets are cointegrated with the world futures markets. Secondly, is there any short-run relationship between Malaysian commodity futures markets with their global counterparts. Finally, what is the direction and speed of information transmission between this futures market under investigation.

In what follows, in section II, we review previous literature. Section III discusses the data and several methods used in the study. Section IV reports the empirical results. Finally, sections V summarises the main findings and draws some concluding remarks.

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LITERATURE REVIEW

Many empirical researches on price discovery have been focused on investigating relationship between futures and its underlying spot markets. However, studies on the relationship between futures across different markets are scarce. Studying the co-movements of global stock markets is important to understand the benefit of global diversification under portfolio management.

In [5] examines the time series lead or lag linkages between global stock markets of the United States, Latin America region, Europe peripherals and Australasian discover that U.S stock market has been highly positively correlated with other stock markets at different parts of the world. In [6] showed that there is a significant co-movement between stock markets in the CEECs countries with the United Kingdom and Russia stock markets. However, in [7] finds no strong evidence to suggest Shanghai stock market influences New York stock market, and vice versa. In [8] discovered strong evidence on intra-European (Irish, UK and Portuguese) market co-movements with the US market. In [9] finds similar results significant returns spillover and volatility spillover effects from the developed stock market, USA, to the emerging market, Korea.

In [10] finds an asymmetric long-run adjustment between WTI crude oil futures and gold futures and the causality relationship showed that WTI played a dominant role over gold prices. In [11] finds that the world markets have bigger unidirectional impact on Indian markets. In [12] reveals that that the Chinese copper futures prices are cointegrated with their London counterparts where London Metal Exchange (LME) delivered stronger influence on Shanghai Futures Exchange but not otherwise. Almost similar results reported by [13] that show volatility spillover effect existed in COMEX and TOCOM. In [14] finds that, except for wheat futures prices on Zhenghou Commodity Exchange and CBOT, the rest of the futures prices on copper and aluminum (Shanghai Futures Exchange-London Metal Exchange) and soybean (Dalian Commodity Exchange and Chicago Board of Trade) were cointegrated and exhibited highly significant correlation coefficients.

As for Malaysia, in [4] finds that during the pre-Asian financial crisis period, stocks markets of Malaysia major trading partners (USA, Singapore, Japan, China and Thailand) did influence the Malaysian stock market. In [15] results show that there is large and positive contemporaneous cross-correlation between CAC40 and FTSE100 spot markets hence cross-country hedging strategy is feasible. Similar findings reported by [16] who find that crude palm oil spot and futures prices were cointegrated.

METHODOLOGY

The present study uses the futures contract on crude palm oil (FCPO) representing Malaysian commodity futures market and the China's Dalian Commodity Exchange (RBD Palm Oil futures contract) representing the world commodity futures market (palm oil). The daily closing prices on 3-month futures contract are employed since it is the most actively traded contract on Bursa Malaysia Derivatives Berhad (BMD) while for Palm Oil futures contracts traded on China's Dalian Commodity Exchange, the daily closing prices on 3-month, 6-month and 9-month futures contracts are used intermittently. We use this approach because Dalian Commodity Exchange is very volatile, where the most actively traded palm oil futures contracts in a month could be any of those three different-horizon contracts. Thus, one needs to closely observe on the volume of the responding futures contracts in order to avoid any inaccuracy in the construction of continuous futures price series. Upon expiry, all the futures contracts would be rolled over to next active month contracts.

The daily commodity futures spans over the period from November 3, 2008 to April 15, 2013, producing total observations of 1034. Any non-matching data caused by holidays and non-trading dates is deleted so that the pairs of futures price series for commodity futures are comparable across different markets. For consistency, all data is converted into MYR or unit by using daily exchange rates. All data are obtained from Bloomberg Terminal.

Johansen-Juselius Cointegrating Test

Johansen-Juselius methods is used since it is more robust approach of cointegration test based on maximum likelihood estimation in order to determine the number of cointegrating vectors in the analysis. Johansen-Juselius cointegration test can be conducted through the k^{th} order vector correction model (VECM) represented as:

$$\Delta Y_t = \pi Y_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta Y_{t-1} + v + \varepsilon_t \quad (1)$$

where Y_t is (n x 1) vector to be examined for cointegration, v is the vector of deterministic term or trend, π and Γ are coefficient matrix. The lag length k is selected using Aikake's Information Criterion. Here, the rank of long run impact matrix π is examined to determine any existence of cointegration between endogenous variable. If the rank of matrix π is r, then there is r cointegrating relationships among the elements of Y_t. When r = 0, there is no long run relationship among the futures price series. If the rank π is full, then any linear combination of Y_t will be stationary. In the case the rank lies between zero and p, where p is the number of variables in the system, there exist one or more cointegrating relationship among the variables under investigation. Two likelihood ratio tests are used to test the long run relationship.

Firstly, with p = 2, the null hypothesis of rank, r = 0 is tested against the alternate hypothesis of $r \leq 1, \ldots, r \leq p$ by trace statistics. Trace statistics is given by:

$$(\lambda \text{ - trace}) = -T \sum_{i=r+1} \ln(1- \lambda)_i \quad (2)$$

where T is the number of observations and λ is the eigenvalues. Besides, Maximum Eigenvalues statistics is also used to test the null hypothesis of r cointegrating vector against the alternative or r + 1. Maximum Eigenvalues is given by:

$$(\lambda \text{ - max}) = -T \ln (1 - \lambda_{r+1}) \quad (3)$$

Table 4 shows that FCPO and DCE commodity futures are cointegrated at r =1, and there is long run equilibrium between Malaysian and China palm oil futures markets. The result supports those studies in [11, 12, 13, 14, 18], where they had found strong evidence for cointegration across different commodity futures markets in different nations.

RESULTS AND DISCUSSION

Table 1 shows the correlation of coefficients between FCPO and DCE prices. It is found that there is very high correlation between FCPO and DCE with a coefficient value stands at 0.9643. Hence, it may be suggested that any attempt on portfolio diversification across markets, such as between Malaysian and China palm oil futures markets, would not be beneficial.

Table 1: Correlation coefficients

Futures Contracts	**Correlation Coefficients**
FCPO and DCE	0.9643

Following [17] approach in testing for cointegration, it involves a two-step process. Firstly, a regression of an endogenous variable on its exogenous variable must be performed. After residuals or error terms from the regression have been obtained, then a unit root test must be carried out on the residuals. If the residuals estimated from each bi-variate model are stationary at level, or I(0), then the bi-variate model is said to be cointegrated. Table 2 clearly shows that the commodity futures (FCPO and DCE) are cointegrated and share common stochastic trends in long run.

Table 2: Engle-Granger cointegration test

		Commodity Futures (FCPO-DCE)
OLS Regression Results	N	1034
	R^2	0.9299
	Adj. R^2	0.9298
	Root MSE	0.05352
	Exogenous Variable	1.07945 (0.0092)**
	Constants	-0.926212 (0.0754)**
Unit Root Test on Estimated Residuals (ADF)	N	1033
	T-stats	-5.135
	P-value	0.0000

** Denotes acceptance at 5% critical value, parenthesis = standard error

Table 3 depicts the results of Augmented Dickey-Fuller and Phillips-Perron unit root tests on FCPO and DCE, before and after first differencing. Before Johansen-Juselius cointegration test being performed, all price series must first undergo unit roots test to examine any existence of unit root at level and to check for order of integration. As clearly shown, all the price series contain unit root at level, or non-stationary at level. The null hypothesis before differencing is accepted. After first differencing, all the price series are again tested and the results strongly reject null hypothesis. Hence, it can be concluded that all of the FCPO and DCE futures prices series are I(1), or integrated at order one. The prerequisite for Johansen-Juselius cointegration test is that all the variables, or price series must be integrated at same order, at least I(1).

Table 3: Unit Root tests

Before Difference				
	Augmented Dickey-Fuller		**Phillips-Perron**	
	T-statistics	P-value	T-statistic (rho)	P-value
FCPO	-2.276	0.1799	-6.535	0.1770
DCE	-2.039	0.2696	-5.352	0.2750
After First Difference				
ΔFCPO	-32.404	0.0000	-1059.014	0.0000
ΔDCE	-31.232	0.0000	-959.492	0.0000

Table 4: Johansen Cointegration test

Futures Contract	**Lag**	**Cointegration Rank Test Using Max Eigenvalue**		**Cointegration Rank Test Using Trace Statistics**	
		H_0: rank = 0 vs H_1: rank = 1	H_0: rank = 1 vs H_1: rank = 2	H_0: rank = 0 vs H_1: rank = 1	H_0: rank = 1 vs H_1: rank = 2
Commodity	4	0.01375**	0.00513	19.5545**	5.2942

**Denotes rejection of null hypothesis at 5% critical value

There are several observations can be inferred from the above findings. Under the theory of global portfolio management, the long run benefits of diversification would greatly be reduced when the diversification involves cointegrated markets or assets. Nonetheless, cross-market hedging and statistical arbitraging activities are possible. Investors or traders may hedge their exposure in Malaysian commodity futures market by taking position in China futures market. However, it is beyond the scope of this paper to determine the optimal hedge ratio and magnitude of the horizon involved. Furthermore, although those futures markets are located in different nations, the existence of cointegration suggests that both markets are informationally linked where they incorporate similar information contents. Furthermore, the cointegrating relationship also supports the notion that the world's financial markets have greatly benefited from technological advancements and the abolishing of trade barrier.

Weak Exogeneity Test

As cointegration has been found to exist among the investigated price series, this paper further proceeds with the adjustment speed of prices towards long run equilibrium. Here, the α from the coefficient matrix π as in equation (1) are examined.

Table 5: Weak Exogeneity test

Futures Contracts	**Malaysia Prices**	**World Prices**
	Chi-square, χ^2	Chi-square, χ^2
Commodity	1.871174	4.882283**

**Denotes acceptance at 5% critical value

Table 5 shows that Malaysian commodity futures price do not react to any shock or discrepancies in long run equilibrium, where it is weakly exogenous to the system whereas China commodity (palm oil) futures price will respond to any shock or discrepancies in long run equilibrium at moderate speed. We may also infer, based on the weak exogeneity test, that in case of palm oil commodity futures, it is Malaysian commodity futures market that plays the leading role in price discovery, and China commodity futures market is a natural satellite market, where unidirectional flow of information exists, from Malaysia to China.

Vector Error Correction Model (VECM)

Since Malaysia commodity futures markets are cointegrated with their worlds' counterparts, this paper proceeds with VECM test to estimate the short-run parameters or error correcting terms in the presence of deviation from long run equilibrium. From the equation (1), it can be further represented by:

$$\Delta P_{WF,t} = C_{WF} + \zeta_{MY,EC} P_{MY,t-1} + \sum_{i=2} \chi_{WF,i} \Delta P_{WF,\,t-I} + \sum_{j=2} \zeta_{MY,j} \Delta P_{MY,t-j} + \varepsilon_{WF,\,t} \quad (4)$$

$$\Delta P_{MY,t} = C_{MY} + \zeta_{WF,EC} P_{WF,t-1} + \sum_{i=2} \chi_{MY,i} \Delta P_{MY,\,t-I} + \sum_{j=2} \zeta_{WF,j} \Delta P_{WF,t-j} + \varepsilon_{MY,\,t} \quad (5)$$

where P_{MY} is the log prices in the Malaysian futures markets and P_{WF} is the log futures prices in their world counterparts' futures markets. The error correction terms (ECTs) $\zeta_{WF,EC}$ $P_{WF,t-1}$ or $\zeta_{MY,EC}$ $P_{MY,t-1}$ (π = $\alpha\beta'$ representation) represents the adjustment speed towards long-run equilibrium. The short-run integration or return spillover can be measured through the short-run parameter of χ_{MY} , χ_{WF} , ζ_{MY} and ζ_{WF}. Both $\varepsilon_{WF,\,t}$ and $\varepsilon_{MY,\,t}$ are joint white noise. Table 6 shows the short run parameters estimates on the commodity futures markets. There exists a unidirectional relationship between Malaysia commodity futures market and world commodity futures market where Malaysia commodity futures market plays the leading role in price discovery process.

Table 6: Short run parameters from VECM

Malaysian Futures Prices, $\Delta P_{MY,t}$								
Futures	C_{MY}	$\zeta_{WF,EC} P_{WF,t-1}$	$\chi_{MY,1}$	$\chi_{MY,2}$	$\chi_{MY,3}$	$\zeta_{WF,1}$	$\zeta_{WF,2}$	$\zeta_{WF,3}$
Commodity	.00028	-.01445	.04894	.408	.04488	-.0873	-.0011	.0003
World Futures Prices, $\Delta P_{WF,t}$								
Futures	C_{WF}	$\zeta_{MY,EC} P_{MY,t-1}$	$\chi_{WF,1}$	$\chi_{WF,2}$	$\chi_{WF,3}$	$\zeta_{MY,1}$	$\zeta_{MY,2}$	$\zeta_{MY,3}$
Commodity	.00021	.01896*	-.17506*	-.05788	-.07756*	.29442*	.08701*	.0542

*Denotes acceptance at 10% critical values

Granger Non-Causality Test

The study further proceeds with Granger non-causality test on each pair of futures prices series to determine the direction of cointegrating relationship. A general specification of the Granger causality test in a bivariate (X, Y) context is represented by:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \ldots + \alpha_i Y_{t-I} + \beta_1 X_{t-1} + \ldots + \beta_i X_{t-I} + \mu \quad (6)$$

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \ldots + \alpha_i X_{t-I} + \beta_1 Y_{t-1} + \ldots + \beta_i Y_{t-I} + \mu \quad (7)$$

In the above equations, the subscripts t and μ respectively denote time periods and white noise error. In order to understand the causal relationship between variables X and Y, two tests are performed. Firstly, the null hypothesis that X does not Granger-cause Y and secondly, the null hypothesis that Y does not Granger-cause X. Unidirectional causality would be concluded if one of the null hypotheses in the above equations were not rejected. If both of the null hypotheses are rejected, the bivariate causality exists between these variables.

Table 7: Granger Non-Causality test results

	Malaysia → World	World → Malaysia
Commodity Futures	94.60**	3.78

** Denotes acceptance at 5% critical values

Table 7 shows that a unidirectional relationship exist between Malaysian commodity futures market and world commodity futures market, where FCPO Granger-cause DCE, and not otherwise. This result also further refirms the previous results obtained through VECM parameters estimation and the weak exogeneity test. This interesting finding also further strengthens the previous results from VECM parameters estimation. It is plausible to point out that such causation might be due to information flows that follows a clockwise movement.

CONCLUSION

This present study examines the dynamic cross-market linkage between Malaysia commodity futures markets and Dalian Palm Oil futures (DCE) in China. First, we apply [17] method to provide a preliminary idea cointegration, followed by [19] cointegration testing approach. Both tests show that Malaysia commodity futures markets are cointegrated with the world futures markets. Hence, the proofs on cointegration indicate that the any global portfolio diversification involving the any futures markets would merely generate limited gains in the long run.

The study also shows the existence short-run dynamics between Malaysia and world's commodity futures markets. As for the direction and speed of information transmission between Malaysia and world's commodity futures markets, it is found out that the information flows is uni-directionally from Malaysia commodity futures market onto the world commodity futures market. This further suggests that Malaysia commodity (palm oil) futures market plays a leading role in price discovery process. However, the speed of information flow is weak.

The study reveals the evidence of Malaysia commodity futures markets are closely connected to the world's commodity futures markets perhaps due to technological advancement in financial exchange and trading system. Moreover, under shorter period, it is further proven that there exist a unidirectional relationship from Malaysia to world's commodity futures market, supporting the believe that Malaysia plays a major role in influencing global price discovery process.

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