Spillover Effects in the Malaysian Palm Oil Futures and Cash Markets

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Abstract: This paper examines the intertemporal information transmission mechanism between the palm oil futures market and the physical cash market in Malaysia. It is shown that as an important feature in the emerging futures market, the spillover effects between the two markets are bi-directional and the role of the price leader is not identifiable. The results from standard GARCH model estimation, vector error correction modeling, Granger causality test and superexogeneity test are consistent with the finding.

1. Introduction

Organised world commodity futures markets have been around since the end of the last century. Despite their longevity, they have been criticised as relatively less transparent, more inefficient and more difficult to interpret than more recently established financial futures markets. Agricultural commodity futures have been the prime focus of most research. In this paper, the informational spillover effects, the direction of information flows and the information transmission mechanism are examined in the Malaysian palm oil markets.

Despite its 20-year short existence, Malaysia has been the largest palm oil producer and trader in the world. There are two dominant markets for palm oil transactions: the futures market and the physical cash market. The futures market provides futures contracts expiring in one month to eight months; the cash market allows traders to transact physical palm oil at a spot price with immediate delivery or at a negotiated spot price with delivery in one to three months. The futures price is matched with realised cash price via the contract during its delivery month. Participants in the two markets can take positions in both markets. It is of interest, therefore, to investigate the information transmission mechanism by looking at the spillover effects on the contracts with the same expiration period but in two different palm oil markets and identify which is the true price leader in the Malaysian palm oil market.

To date, considerable work has been done to scrutinise the informational dissemination or the spillover effects for the world's major futures markets, particularly, the financial futures market. This paper is a first attempt to look at such issues in the Malaysian agricultural futures market, a new emerging developing market, by using the daily palm oil closing prices. The main contribution of this paper is to provide direct evidence on the relationship between mean and volatility in the Malaysian palm oil futures and cash markets. An understanding of intra-market volatility is important for the pricing of securities within and across the markets, for trading strategies, for hedging strategies, and for regulatory policy.

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The methodology used in this study involves modeling volatility within the context of time-varying volatility captured in GARCH (1, 1) models incorporating the spillover effects from another market. Both univariate and bivariate GARCH have been estimated. Vector error correction approach (VECM), Granger-causality and superexogeneity tests were implemented to further explore the relationship of the two markets.

This article is organised as follows. Section 2 presents the literature review and theoretical considerations regarding pricing leadership and spillover effects in the futures markets. Section 3 investigates the statistical properties of return distributions and identifies the class of return-generating stochastic processes that are consistent with these properties. In Section 4, the detection of sudden changes in variances and the existence of leverage effects are discussed. The section further presents the VECM results as well as the Granger-causality test and super-exogeneity test on the return series. A summary of empirical findings along with concluding remarks and suggestions for future research are presented in the final section of the paper.

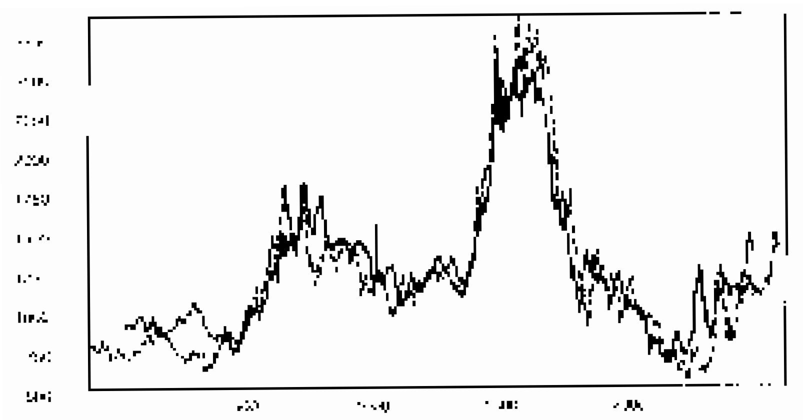
2. Literature Review

Considerable work has been concentrated on the subject of linkage between geographically separated markets where research has been mainly restricted to the financial markets, in particular, to well developed stock markets. This paper is the first attempt to examine the relationship between two palm oil markets within one emerging economy – Malaysia. The nature of the relationship between two markets that we are interested in are futures and spot markets.

The reason for the presence of any relationship between futures and spot markets is generally considered to be explained by the price maintenance of the cost-of-carry relation for any pair of continuous trading and efficient futures and stock markets. However, there is a wide body of research which has shown that a departure from the cost-of-carry relation between spot and futures markets is not uncommon. It is indicated that the futures market leads spot markets and futures markets act as a vehicle for price discovery within the corresponding financial markets.

Reasons as to why futures prices seem to lead spot prices are numerous. They include the fact that futures markets tend to have less constraints than the primary markets, leading to futures markets being more informational efficient as the marginal costs from trading will be less than in the primary markets. This is further compounded by the fact that futures markets tend to have lower transaction costs and higher liquidity. Stoll and Whaley (1990), Chan (1992) and Miller (1990) found similar results from their studies.

Most of the studies in this area have primarily focused on examining causality in mean returns. Interest on the impact of volatility spillovers from one market to another has primarily arisen due to the realisation of speculative price changes being interwoven with higher moment dependencies (Bollerslev *et al.* 1992) as volatility interaction can be a good measure for the quantity of informational flow between markets (Ross 1989; Kyle 1985). Studies by Hamao *et al.* (1990), Cheung and Ho (1991) and Wei *et al.* (1995) have provided evidence that markets are related through volatility dynamics rather than just causality in mean returns. Both returns and volatility spillover effects between two palm oil markets in Malaysia are examined. Any relationship that exists may portray a better picture of how these two markets are linked within the country.



Dashed line - futures price; solid line - cash price

Figure 1: *Time plot of closing prices in futures and cash markets*

3. The Data

The closing price for the first, second and third month futures contracts and cash contracts taken from Malaysia Derivatives Exchange and Malaysian Palm Oil Board respectively were examined for the period between 2 January 1992 to 8 June 2002. While the fundamental results derived are based on the third month contract data, the first and second month contracts have also been examined in this study in order to test the robustness of the results.

The trading hours for the futures market are divided into two sections – the morning section starts at 10:30pm and ends at 12:30pm; the afternoon section starts at 3:00pm and ends at 5:00pm. The trading hours for the cash market starts at 10:00am and ends at 1:00pm and starts again at 2:00pm and ends at 6:00pm following regular office hours in Malaysia.[1] As tick-by-tick data is not recorded by the exchange, we assume the non-synchronising hours to be ignorable at this stage.

The time plot of cash and futures prices is presented in Figure 1. It shows that the two series tend to move together due to the cost-of-carry relationship and arbitrage effects. We have also applied the unit root testing methodology of the Phillips (1987) and Phillips-Perron (1988) and failed to reject the null hypothesis of a unit root in the logarithm of two closing price series. The results of the Phillips-Perron unit root test for levels and first difference are reported in Table 1. In the light of this preliminary analysis, we shall only subsequently consider the first differences for the two time series: $R_t = 100 (\log P_t - \log P_{t-1})$.

1 There is no officially fixed trading hours according to Malaysian Palm Oil Board; companies trade with each other within the regular office hours.

Table 1: Summary statistics on daily return series

	Futures	Cash
Mean	0.00032	0.00031
Variance	0.00036	0.00038
Skewness	0.34547	0.74672
Kurtosis	2.27893	9.20984
Jarque-Bera	134.91004	2071.09323
Ljung-Box Q(8)	11.36725	37.87051*
Ljung-Box Q(16)	30.33436*	58.83271*
PP test statistics (level)	-4.82631	-4.71309
PP test statistics (difference)	-2548.51266*	-2515.77176*

Note: The numbers with superscript asterisks are statistically significant; the critical values of PP unit roots test with a constant are from Hamilton (1994:762).

Summary statistics describing the data are provided in Table 1. On the whole there is high kurtosis in the two markets. This indicates that the daily returns have a fat tail distribution. Table 1 shows the Ljung and Box portmanteau test statistics Q(8) and Q(16) for up to 16th order serial correlation. The high values for *Q*-statistics suggest the presence of conditional heteroscedasticity. These findings suggest the use of GARCH modeling which recognises the temporal dependence in the second moment of the return series.

4. Empirical Results

4.1. Univariate Models

4.1.1. Univariate GARCH Models

In this paper, we estimated the standard basic GARCH (1, 1) model for each of the palm oil markets as follows:

$$R_t = R_0 + \sum_{i=1}^{P} \alpha_i R_{t-i} + \sum_{j=1}^{q} \beta_j \varepsilon_{t-j} + \varepsilon_t$$

where $\varepsilon_t \mid \Omega_{t-1} \sim D(0, h_t)$

$$h_t = \nu + \gamma_1 h_{t-1} + \gamma_2 \varepsilon_{t-1}^2 \quad (1)$$

where $\nu \geq 0$ and $\gamma_1, \gamma_2 \geq 0$ to ensure $h_t > 0$.

In model (1), R_t represents the return series at time t; ε_t is residuals at time t; $\varepsilon_t \mid \Omega_{t-1} \sim D(0, h_t)$ denotes residual ε_t at time t given information set Ω at $t-1$, which follows the distribution $D(0, h_t)$; h_t denotes the conditional variance and α, β and γ are parameters.

Table 2: Estimation of GARCH model - Equation 1

	Futures	Cash
Model specification	ARMA(1,4)-GARCH(1,1)	ARMA(1,(1,6))-GARCH(1,1)
R_0	-0.00093	-2.6714-04
	(-1.1845)	(-0.3461)
α	0.9959*	0.9977*
	(237.47)	(315.81)
β_1	0.0075	0.1232*
	(0.1472)	(2.5175)
β_2	0.0381	
	(0.8607)	
β_3	0.0727	
	(1.7283)	
β_4	-0.0105	
	(-0.22633)	
β_5		0.1018*
		(2.5687)
v	0.00002	2.0368e-05*
	(1.9029)	(3.5350)
γ_1	0.1697*	0.2413*
	(4.3773)	(11.4966)
γ_2	0.7891*	0.7267*
	(15.0870)	(55.0494)
LL	1984	2023
SK	0.0648	0.5226
KU	1.1759	2.6833
AIC	-861.970	-890.802
SBC	-842.970	-889.760
Ljung-Box Q(8)	8.3864	15.4927
Ljung-Box Q(16)	22.8821	30.8787

Note: LL, the values of log likelihood functions; SK, skewness of the standardised residuals; KU, kurtosis of the standardised residuals; Ljung-Box Q(8) and Ljung-Box Q(16) are serial correlation tests on standardised residuals with 8 and 16 lags respectively; AIC, Akaike information criterion; SBC, Schwarz Bayesian information criterion; numbers in brackets are *t*-statistics. Numbers with superscript asterisks are statistically significant.

Box-Jenkins ARMA model methodology is applied to estimate the individual time series. Spillover effects from the other market are incorporated in the mean and variance equations of the returns of crude palm oil futures and cash contracts to test the significance of these effects.

Box-Jenkins methodology is first used to identify the order of ARMA model in the mean return equation, following the principle of parsimony. The AIC and SBC criteria reported in Table 2 have also been applied for model selection. GARCH(1,1) is selected on the criterion of which model has the best fit. It is estimated by BFGS method provided in

RATs. The results are shown in Table 2. Futures return series follows ARMA(1,4) - GARCH(1,1), whereas cash return series follows ARMA(1,|1,6|)- GARCH(1,1). There is no serious mis-specification. Higher order serial correlation on standardised residuals and squared standardised residuals are tested by Ljung-Box *Q*-statistics with 8 and 16 lags and both are not significant.

4.1.2. GARCH Model with Changes in Variance

The methodology used in this study to detect discrete changes in the variance is based on the ICSS algorithm by Inclan and Tian (1993). Three mild changes in the variance as identified by ICSS algorithm have been found in both cash and future series. However the maximum values of these three changes specified by a designed statistics in Inclan and Tian (1993) have not exceeded the asymptotic critical values from the same source. Therefore there exists no significant sudden changes in variance.[2] The timing and duration of these three mild changes are as follows: January 1994 to January 1995, due to the increased reserved requirement; November 1997 to December 1998, due to the Asian financial crisis; September 1998 to October 1999, due to the capital control policy of Bank Negara Malaysia. The three periods of increased volatility tend to correspond to country specific and world-wide economic events.

The mild changes in variance are incorporated directly into a GARCH model to test the relative strengths of each type of changes in variance. If the changes in variance were significant, the values of the GARCH coefficients should be reduced and most of them should be no longer significant. A model that combines the shifts in variance with GARCH is considered. The approach is to introduce the dummy variables into the variance equation of GARCH model to account for the changes. The model is given by:

$$R_t = R_0 + \sum_{i=1}^{P} \alpha_i R_{t-i} + \sum_{j=1}^{q} \beta_j \varepsilon_{t-j} + \varepsilon_t$$

where $\varepsilon_t \mid \Omega_{t-1} \sim D(0, h_t)$

$$h_t = \nu + d_1 D_1 + \ldots + d_n D_n + \gamma_1 h_{t-1} + \gamma_2 \varepsilon^2_{t-1} \qquad (2)$$

where $\nu \geq 0$ and $\gamma_1, \gamma_2 \geq 0$ to ensure $h_t > 0$, $D_{1\ldots}D_n$ are dummy variables taking a value of 1 from each point of sudden change of variance onwards, 0 otherwise.

The model is estimated for both cash and futures markets. The results for the futures market are reported in Table 3. The conclusions from the cash market are similar. Neither the significant reduction in the magnitude of most coefficients nor the reduction of the significance levels of most coefficients was detected. Like what has been found by the ICSS algorithm, there were therefore three insignificant changes in the variance. The finding of mild changes, however, is consistent with one of the observations in practice that the

[2] The results are available from the authors on request.

Table 3: GARCH(1,1) model with and without dummy variables for changes in variance for the futures market – Equation 2

	Without dummy variables	With dummy variables
Model specification	ARMA(1,4)-GARCH(1,1)	ARMA(1,4)-GARCH(1,1)
R_0	-0.00093	0.00001
	(-1.18450)	(0.96346)
α	0.99592*	2.20875*
	(237.47135)	(8.14165)
β_1	0.00751	-1.20885*
	(0.14723)	(-4.46572)
β_2	0.03814	0.98308*
	(0.86072)	(-3.59669)
β_3	0.07273	0.051532*
	(1.72834)	(2.08280)
β_4	-0.01052	-0.031576
	(-0.22633)	(-0.38437)
v	0.00002	0.00002
	(1.90293)	(1.58613)
γ_1	0.16973*	0.17100*
	(4.37731)	(4.29362)
γ_2	0.78912*	0.793049*
	(15.08704)	(14.92261)
LL	1984	3082.58873
Ljung-Box Q(8)	8.38642	12.32810
Ljung-Box Q(16)	22.88219	21.81483

Note: LL, the values of log likelihood functions; Ljung-Box Q(8) and Ljung-Box Q(16) are serial correlation tests on standardised residuals with 8 and 16 lags respectively; numbers in brackets are *t*-statistics. Numbers with superscript asterisks are statistically significant.

demand for palm oil from major importers such as China, EU, Pakistan and India has not changed dramatically, taking into account the domestic and world economic events during the sample period.

4.1.3. Test for a Leverage Effects

Asymmetric or leverage volatility models, in which bad news has different effects on volatility from good news, has been widely applied in the literature. Since cash and futures prices are categorised as financial time series, they might have a tendency to display an asymmetry effect. Therefore, the size and sign bias tests proposed by Engle and Ng (1993) were applied for detecting the presence of asymmetry.

To conduct the sign bias test, the negative size bias test and the positive size bias test jointly, the following regression is considered.

$$v_t^2 = a + b_1 S_{t-1}^- + b_2 S_{t-1}^- \varepsilon_{t-1} + b_3 S_{t-1}^+ \varepsilon_{t-1} + cZ_t + e_t \quad (3)$$

Table 4: Sign and size test for a leverage effect – Equation 3

Test	Futures	Cash
Sign bias	-0.00556	-0.28933
	(-0.06547)	(-1.40773)
Negative size bias	356.34641*	-22.26617
	(2.03303)	(-0.10216)
Positive size bias	363.86988	-11.86666
	(1.56447)	(-0.05453)
Joint test	16.99378	11.36545

Note: Numbers with superscript asterisks are statistically significant.

where V_t is standardized residual, variables S^-_{t-1}, $S^-_{t-1}\varepsilon_{t-1}$ and $S^+_{t-1}\ \varepsilon_{t-1}$ are constructed for sign bias, negative and positive size bias tests respectively, and Z_t for the rest of the explanatory variables included in the original GARCH(1,1) model.

The tests were conducted for both cash and futures markets and the results are reported in Table 4. As far as the cash market is concerned, the coefficients for individual variables as well as the joint tests were not significant; for the futures market, the coefficient for the negative size bias variable was significant while the rest were not. We therefore concluded that the leverage effect was not significant and that the exponential GARCH model would not be applied consequently.

4.1.4. Spillover Effects on the Conditional Mean and Variance

In the context of mean and volatility spillover effect, the effect of mean and volatility surprise in one market on the mean and volatility of the other market can be examined by the addition of the mean and volatility surprise as an explanatory variable in the conditional mean and variance equation of the other market.

$$R_t = R_0 + \sum_{i=1}^{P} \alpha_i R_{t-1} + \sum_{j=1}^{q} \beta_j\ \varepsilon_{t-j} + \Psi_i \text{ spillovers} + \varepsilon_t$$

where $\varepsilon_t \mid \Omega_{t-1} \sim D(0, h_t)$

$$h_t = \nu + \gamma_1 h_{t-1} + \gamma_2 \varepsilon^2_{t-1} + \Psi_2 \text{ spillovers} \qquad (4)$$

In the case of futures market, p=1, q=4; while in the case of cash market, p=1, q=1. The spillover surprises are given by Ψ_1, Ψ_2 respectively and were measured by estimating ε^2_t and h_t. The mean and volatility spillover from cash market to the futures market were therefore measured by $\Psi_{1,1}$ and $\Psi_{1,2}$; the mean and volatility spillover from the futures market to the cash market were measured by $\Psi_{2,1}$ and $\Psi_{2,2}$.

Table 5 shows that the spillover effects in the mean equation are not significant in all the cases. It implies that both markets are efficient in terms of incorporating the other market's information. This can be true as the two markets trade in almost contemporaneous trading hours and both are exposed to more or less same market information.[3]

There were mixed results of spillover effects in the volatility equation. The coefficients of the volatility spillover effects were all significant, indicating that the conditional volatility of the cash market is a significant influence on the conditional volatility of the futures market. The same conclusion can be drawn for the cash market. The spillover effect from the cash market to the futures market was larger in magnitude. This may be consistent with the current institutional establishment in the Malaysia Derivatives Exchange for futures and Palm Oil Exchange Board for cash.[4] The empirical result is interesting and quite unlike the conventional futures price leadership role; rather it shows a bi-directional effect between the futures and cash markets. This could be a feature of the futures market in an emerging economy such as Malaysia.

A word of caution, however, is in order when interpreting these results. By using simultaneous trading variables in the system, we inevitably introduced bias. One way to address this problem is to examine the exogeneity of spillovers from the other market.

4.2. Spillover Effects – Bivariate Model

A bivariate vector autoregressive (VAR) system was set up in order to further investigate the spillover effects between cash and futures markets, in particular allowing recursive effects in the system. Two sets of models were estimated. Bivariate BEKK specification of GARCH proposed by Engle and Kroner (1995) was used. This model takes into account simultaneous trading effects, in particular the covariance and correlation covariance.

The estimation results of the bivariate GARCH(1,1) were generally consistent with the results from the univariate equation.[5] The significant spillover effect from the cash market to the futures was indicated by a coefficient of 0.533, and from the futures to the cash market by a coefficient of 0.8207. In the variance equations, there are significant spillovers in both directions as reported in the univariate model.

4.3. Exogeneity Tests

4.3.1 Vector Error Correction Model

Engle and Hendry (1993) introduced the concept of weak exogeneity, strong exogeneity and superexogeneity. Weak exogeneity provides a sufficient condition for conducting

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3 In another paper, we looked at how information flows from foreign markets (such as Chicago Board of Trade) to Malaysia market. In this paper, we focused on domestic markets.

4 Malaysia developed its futures exchange in 1980s while the physical palm oil trading started one century ago. The trading volume is thin in the Exchange: 4,091,403 tons in 2000 and 3,205,937 tons in 2001; in the cash market: 9,553,918 tons 10,803,788 tons in 2001 (calculation based on information published by the two markets). As there are still many restrictions on trading in the futures exchange, it causes higher transaction costs and lower liquidity.

5 Detailed results are available from the authors by request.

Table 5: Estimation of spillover effects (3rd-month contract)-Equation 4

	Futures		Cash	
Model specification	ARMA(1,4)-GARCH(1,1) Spillover 1: $\Psi_{1,1}=\varepsilon^2_{t-1}$	Spillover 2: $\Psi_{1,2} = h_{t-1}$	ARMA(1,(1,6))-GARCH(1,1) Spillover 1: $\Psi_{2,1} = \varepsilon^2_{t-1}$	Spillover 2: $\Psi_{2,2} = h_{t-1}$
R_0	-0.00082	-0.00065	-0.00091	-0.00146
	(-1.08340)	(-0.69876)	(-1.21702)	(-1.17923)
α	0.99694*	0.99668*	0.99733*	0.99773*
	(276.11257)	(245.11022)	(355.250431)	(311.56732)
β_1	-0.11902*	0.01856	0.08704	0.12104*
	(-2.21130)	(0.44373)	(1.95557)	(2.45092)
β_2	0.04953	0.02754		
	(1.18492)	(0.63929)		
β_3	0.04516	0.07523		
	(1.18493)	(1.77165)		
β_4	0.00758	-0.01200		
	(0.22002)	(-0.29069)		
β_5			0.05660	0.14402*
			(1.61083)	(3.56028)
ν	0.00014*	0.00012*	0.00001	-0.00003
	(4.05180)	(2.61733)	(1.32824)	(-1.06982)
γ_1	0.059927	0.00013*	0.08933*	0.14343*
	(1.20229)	(2.61732)	(3.10167)	(2.66975)
γ_2	0.27334*	-0.38873	0.47503*	-0.16813
	(4.27361)	(-1.72902)	(10.18010)	(-0.97639)
Ψ_1	1.78293	1.50116	1.09702	4.44561
	(0.82985)	(0.51462)	(0.52937)	(1.21014)
Ψ_2	0.6505*	1.0445*	0.4102*	0.98560*
	(6.0199)	(4.0245)	(6.6761)	(4.25031)
LL	2021.33214	1983.83214	2356.32312	2042.13258
SK	0.05521	0.10491	0.26551	0.22400
KU	-0.02712	0.81082	2.09491	1.48581
Ljung-Box Q(8)	10.38431	5.14085	19.89622	12.11487
Ljung-Box Q(16)	23.42020	18.68127	32.02893	26.60724

Note: LL , the values of log likelihood functions ; SK, skewness of the standardised residuals; KU, kurtosis of the standardised residuals; Ljung-Box Q(8) and Ljung-Box Q(16) are serial correlation tests on standardised residuals with 8 and 16 lags respectively; numbers in brackets are *t*-statistics. Numbers with superscript asterisks are statistically significant.

inference conditionally on variables (x_t) without loss of relevant sample information. If, in addition, x_t is not Granger caused by the endogenous variables in the system, then x_t is said to be strongly exogenous to the parameters of interest. If the conditional model is structurally invariant to structural changes in marginal distribution of x_t, then x_t is said to be superexogenenous for the parameters of interest. In this paper, we tested whether inferences about one market were conditional on the other market and were affected by the marginal

Table 6: Pairwise granger causality tests

Hypothesis	F-statistic	Probability
Futures does not Granger cause cash market	21.5251*	0.000000
Cash market does not Granger cause futures market	4.6123*	0.000018

Note: Numbers with superscript asterisks are statistically significant.

distribution of the other market. If two markets are mutually exogenous, risk diversification has a role to play.

The vector error correction model was applied to analyse the long–run relationship between two time series before the short–run Granger causality test and superexogeneity tests were conducted. The following VECM was estimated:

$$F_{t+2} = F_{t+1} - \nu\,(F_{t+1} - C_t) + \varepsilon_{ft+2}$$
$$C_{t+2} = C_{t+1} - \mu\,(F_{t+1} - C_t) + \varepsilon_{ct+2} \qquad (5)$$

where $\nu > 0, \mu > 0$, denote the adjustment speed of coefficients. Both $\varepsilon_{ft+2}, \varepsilon_{ct+2}$ have mean zero. The estimation results (with *t* statistics in parentheses) are as follows:

$$\hat{F}_{t+2} = 0.06395 + 0.07812\,(F_{t+1} - C_t)$$
$$(2.27877) \quad (–3.77436)$$
$$\hat{C}_{t+2} = –0.02920 + 0.03305\,(F_{t+1} - C_t)$$
$$(–0.54229) \quad (–2.67651)$$

It shows that there exists a long–run equilibrium relationship between the cash and futures markets, though the magnitude of the speed of adjustment coefficients is not very large, indicating the presence of Granger causality for two cointegrated time series.

4.3.2. Granger Causality Tests

The two series were tested for Granger causality. The results are shown in Table 6. The hypothesis that futures market does not Granger-cause cash market was rejected, and the same results were obtained for the futures market. This result supports our spillover effect of the previous section that the two series are mutually interacted.

4.3.3. Superexogeneity Test

Engle and Hendry (1993) introduced tests of superexogeneity and invariance. Following their structure and the applied work of Francis and Leachman (1998), we experimented with the superexogeneity tests on spillover from the other market.

Firstly, marginal distributions for each return series were estimated. The specification of the marginal distribution was based on the previous analysis. The results (with *t*-statistics in parentheses) on the distributions are as follows:

Table 7: Superexogeneity test results

Superexogeneity	Futures markets to the parameters of cash	Cash markets to the parameters of futures
Residual	0.0607*	0.0933*
Variance	0.0020*	0.0494*
Residual* variance	0.0020*	0.0161*
Mean squared	0.0030*	0.00099
Mean* variance	0.0040*	0.0099

Note: Numbers with superscript asterisks are statistically significant.

Futures market:

$$\hat{R}_t = \underset{(0.4460)}{0.00039} - \underset{(-3.3012)}{0.00088} R_{t-1} + \varepsilon_t + \underset{(3.3156)}{0.9412}\varepsilon_{t-1} + \underset{(0.2593)}{0.0149}\varepsilon_{t-2} + \underset{(1.7998)}{0.1037}\varepsilon_{t-3} + \underset{(2.0104)}{0.0961}\varepsilon_{t-4}$$

Cash market:

$$\hat{R}_t = \underset{(0.2248)}{0.00023} + \underset{(1.6844)}{0.3583} R_{t-1} + \varepsilon_t - \underset{(-1.5720)}{0.3322}\varepsilon_{t-1} + \underset{(3.8637)}{0.1609}\varepsilon_{t-6} \qquad (6)$$

Five variables were constructed from each of the above distributions for superexogeneity tests. In the case of the superexogeneity test on the mean spillover of cash market on the futures, residual (ε_{future}) and variance (σ^2_{future}) were saved. The difference between each of the return series and its residual (M_{future}) was used as proxy of conditional mean. The residual (ε_{future}) was used to test for weak exogeneity. Variance (σ^2_{future}), conditional mean squared (M^2_{future}) and a newly constructed variable M_{future} ($\sigma^2_{future} * M_{future}$) were used as parameter invariance. Another constructed variable ($\sigma^2_{future} * \varepsilon_{future}$) was used for parameter constancy. Each of the above five variables were included in the futures return series, as specified by equation (2) one by one. The likelihood ratio test was applied to test for significance. The same procedures were run for the return series in the cash market.

The results are displayed in Table 7. The rejection of the superexogeneity implies that in the market place, traders in the futures market have adjusted their perspective with the information from the cash market. The same results hold for the cash market. The bi-directional result is consistent with what we have found in the previous sections. Therefore, there is a strong possibility that the two markets are indeed components of one large palm oil trading place.

From the previous empirical results, it is shown that as an important feature in emerging futures market, the spillover effects between two markets are bi-directional and the role of the price leader is not identifiable. The results, however, have been based on the third month contract that is most actively traded in the futures market. It might be of interest to estimate Equation (4) to see if the conclusion will still hold for the first month contracts. The results are shown in Table 8. While the results were generally consistent with the third month contract data, the significant spillover effects were found not only in the variance equations

Table 8: Estimation of spillover effects (1st month contract) – Equation 4

	Futures		Cash	
Model specification	ARMA(1,4)-GARCH(1,1) Spillover1: $\Psi_{1,1}=\varepsilon^2_{t-1}$	Spillover2: $\Psi_{1,2} = h_{t-1}$	ARMA(1,(1,6))-GARCH(1,1) Spillover1: $\Psi_{2,1} = \varepsilon^2_{t-1}$	Spillover 2: $\Psi_{2,2} = h_{t-1}$
R_0	–0.00082	–0.00069	–0.00083	–0.00060
	(–1.08340)	(–0.43007)	(–1.79585)	(–0.98672)
α	–2.87843*	–2.12980	0.41370*	0.12109
	(–2.86981)	(–1.90554)	(13.52973)	(1.07834)
β_1	1.29136	0.03800	0.78727*	1.06120*
	(1.71859)	(0.61187)	(27.37920)	(8.76231)
β_2	3.10164*	0.47642		
	(3.10004)	(0.08121)		
β_3	1.27940	0.66542*		
	(1.72770)	(3.09081)		
β_4	0.15225*	0.07831		
	(3.84236)	(0.60063)		
β_6			0.02322	–0.82130
			(0.89627)	(–1.78099)
ν	0.00001*	0.00002*	0.00938	0.00213
	(8.41530)	(4.200633)	(0.38529)	(0.00811)
γ_1	0.20962*	0.801280	0.21471*	0.40041*
	(15.31740)	(0.12739)	(29.90750)	(61.07056)
γ_2	0.79236*	0.08939	0.40778*	0.01209
	(5.54219)	(0.02092)	(24.02130)	(0.60138)
Ψ_{i1}	0.61764	0.80116*	1.09702*	8.54601
	(0.25041)	(2.16020)	(3.52937)	(0.01134)
Ψ_{i2}	0.08340*	0.10565*	0.41000*	1.86052
	(5.01123)	(2.21145)	(6.6761)	(0.50034)
ß	3083.18344	1983.83214	4710. 0267	2042.13258
Ljung-Box Q(8)	5.40796	5.14085	5.3553	12.11487
Ljung-Box Q(16)	14.29742	18.68127	29.4202	26.60724

Note: LL , the values of log likelihood functions; Ψ_{i1}, Ψ_{i2} are spillover effects on mean and variance from the other market, i = 1 denotes the futures market, i = 2 denotes the cash market. Ljung-Box Q(8) and Ljung-Box Q(16) are serial correlation tests on standardised residuals with 8 and 16 lags respectively; numbers in brackets are t-statistics. Numbers with superscript asterisks are statistically significant.

but also from the mean equations. The magnitude of the coefficients, however, was different among different contracts.

5. Summary and Conclusion

Investigation of the Malaysian palm oil futures and cash markets with univariate time series model indicates evidence of spillover effects between both markets. The two markets were efficient in incorporating past information from each other. Variance spillovers, however, were transmitted in both directions. When both markets were open, substantial spillover effects in the conditional variance took place bi-directionally. This is different from the conventional future-spot market relationship where the futures always plays the leading role and the spot follows, i.e. a uni-directional relationship. This finding might be of interest for potential cross-hedge relationship between two markets and the role of expectation in influencing the pricing process in two markets. Any new information arriving in one market and absorbed in the pricing process tends to be reflected in the pricing of the other market, and vise versa.

The results were also robust in relation to vector error correction modeling, Granger-causality test and the superexogeneity test. They may indicate the existence of a common trading market place, which needs to be further investigated. The next step in this line of research should be to use high frequency data in order to establish the relationship of the two markets. Moreover, as this paper mainly focused on the domestic market, it is of interest, therefore, to investigate the palm oil markets relationship within a much broader scenario by including the Indonesian palm oil futures, and soybean oil futures in the Chicago Board of Trade – to examine the cross correlation between the palm oil and other major international crude oil futures markets.[6]

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