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CONTENTS

Effective Cross Hedging: Evidence from Physical Crude Palm Oil and its Inter-Related Agricultural Futures Contracts

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ABSTRACT

Since its establishment, the Crude Palm Oil futures contract (FCPO) has been used to directly hedge its physical crude palm oil (CPO). However, due to the excessive speculation activities on crude palm oil futures market, it has been said to be no longer an effective hedging tool to mitigate the price risk of its underlying physical market. This triggers the need for market players to find possible alternatives to ensure that the hedging role can be executed effectively. Thus this investigation attempts to examine whether other inter-related grains and oil seed futures contracts could serve as effective cross-hedging mechanisms for the CPO. Weekly data of inter-related futures contracts from the Chicago Board of Trade (CBOT) and the Dalian Commodity Exchange (DCE) were employed to cross hedge the physical crude palm oil prices. The study started from 2006 and ended in 2016. Empirical results indicate that FCPO is still the best futures contract for hedging purposes while the Chicago Soybean (CBOTBO) is the second best alternative if cross-hedging is considered.

Keywords: *Crude palm oil, Crude palm oil futures, Cross Hedging, Optimal Hedge Ratio, Effective Hedging*

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INTRODUCTION

The rising of speculation activities has been a major concern among Malaysian crude palm oil planters and refiners in recent years. The crude palm oil futures contract (FCPO) traded in Bursa Malaysia Derivatives showed a deteriorating performance in mitigating price risk for its' underlying physical market (Ong, Tan and Teh, 2012). The speculation activity produced market noise or market swings, which will deviate from the genuine market trend. The market swings resulting from the speculations tend to mislead the hedgers with regard to the indicative price of a particular futures contract.

The theory on cross hedging lies on the Efficient Market Hypothesis (EMH) by Fama (1970). The definition of spot-futures efficiency is when spot and futures prices exhibit a high degree of price association and correlation over a period of time (Naik and Jain, 2002). In the context of the agriculture market, market efficiency depends on location and types of commodity. Di Matteo, Aste, Dacorogna (2005) and Kristoufek and Vosvrda (2013) have suggested that developed markets like the USA and Japan are more efficient than developing ones. Therefore, it is believed that the market efficiency in Malaysia is rather different than in the developed countries considering Malaysia is categorized as an emerging market.

It is previously known that non-related markets become related due to some fundamentals and determinants. In an investigation of causal relationships between soybean oil spot and futures with crude palm oil spot and futures, Sy, Li and Nguyen (2015) showed three main findings with regard to the strength of price association between these two markets: (1) there is a presence of a long-run equilibrium relationship between soybean oil futures and crude palm oil futures markets, but not between soybean oil futures and crude palm oil spot, and between crude palm oil futures and crude palm oil spot prices, (2) there is a convergence between crude palm oil futures and crude palm oil spot prices and a bi-directional causality exists between their prices, and (3) there is a persistence in volatility for soybean oil futures prices, and a significant volatility spill over from soybean oil futures prices to crude palm oil spot and futures prices. This evidence shows that agriculture markets especially oilseed markets is co-integrated, and the connection has become stronger in recent decades after a few cycles of economic downturn and a series of financial markets aftermaths.

Therefore, the hedgers are interested to know whether the Malaysian physical palm oil can be hedged with other grains and oil seeds futures contracts in other commodity exchanges across the globe. The strategy of hedging the physical asset with other futures contract is called cross hedging. Bowman (2004) explained that the cross hedging serves two purposes: (1) there is no futures contract derived from the underlying cash asset; or (2) the pre-existing futures contract did not offset the price risk for its' underlying asset effectively. The cross hedging is proven effective to eliminate price uncertainty in the physical market. Furthermore, empirical studies have shown that cross hedging is able to improve profits in the plantation industry like sorghum, corn and hay (Jackson, Grant and Shafer, 1980; Blake and Catlett, 1984; Wu, Guan and Myers, 2010; Go and Lau, 2014).

Hence, this research tries to go beyond the literature mentioned above by establishing the inter-commodity and cross markets hedging opportunities of Malaysian physical CPO with the abovementioned derivative products which at the time this proposal is written is rarely discussed and studied. It is hoped that findings from this investigation will enhance the body of knowledge related to the hedging mechanism and provide important hedging strategy implications to industry players. The next section of this paper discusses the previous studies on cross hedging and then explains the methodology applied to determine the effectiveness of cross hedging between crude palm oil and other inter related futures contracts.

METHOD

The variables involved in this study are average weekly settlement prices of crude palm oil (CPO) and for the futures contracts. This research uses the nearest contract month of crude palm oil futures (FCPO) from the Bursa Malaysia Derivatives, soybean (CSOY), soybean oil (CBO) and corn futures (CCORN) from Chicago Board of Trade, and also corn (DCORN), soybean No. 1 (DSOY1), soybean No. 2 (DSOY2), soybean oil (DBO) from the Dalian Commodity Exchange. The inclusion of FCPO is to serve as a benchmark to compare the effectiveness of hedging of the inter-related futures contracts. The period of study was from 6th January 2006 to 25th November 2016.

Several steps are involved in determining cross hedging effectiveness between the CPO and the other interrelated futures contracts. The first step is to determine the optimal hedge ratio. The estimation of optimal hedge ratio is carried out using the Ordinary Least Square (OLS) model, the VAR model and the VECM model.

Optimal hedge ratio using the OLS model is derived through the equation (1). OLS is known to be the simplest method (Gupta and Singh, 2009).

$$rst= + \beta rft + t \quad (1)$$

Where rstthe physical spot return at time, t, is, rft is the futures return at time *t*, α and are coefficients of the regression and t is the error term. in this equation is also used to represent the optimal hedge ratio between the CPO and the interrelated futures contract. Ong, Tan and Teh (2012) explained that the R2 of the estimated regression represents the hedging effectiveness between the two products. Larger R2 shows better minimum variance of hedging effectiveness.

According to Brooks (2014), VAR is frequently adopted by many researchers to conduct a large-scale simultaneous equations structural model. The sample of traditional bivariate VAR illustrated by Brooks (2014) can be specified in the following form:

rst = s + i=1msirst-i + j = 1nsirft-i + st
rft = f + i=1mfirst-i + j = 1nfirft-i + ft (2)

Where and stands for the physical spot and futures return at time *t*; , are the coefficients to be estimated, *n* number of lag length as proposed by SIC, *i* denotes stationary order while and is the residual series of spot and futures and time *t*.

If the spot and futures are found cointegrated, then the Vector Error Correction Model (VECM) is needed to capture the long run relationship. Otherwise, the flow will proceed to finding the optimal hedge ratio and finally cross hedging effectiveness.

rst = s + i = 1msirst-i + j = 1nsirft-i + sZt-1+ st
rft = f + i = 1msirst-i + j = 1nfirft-i + fZt-1+ft (3)

Clearly, the VECM has the additional regression line which is the error correction term, sZt-1 and fZt-1. When Zt-1= St-1- δFt-1 is error correction term with 1 – δ as the co-integration vector and s, f will function as the adjustment speed parameters.

The residual series or error term in VAR and VECM model for both spot and futures are important in order to extract out the optimal hedge ratio. From the residuals, covariance between spot and futures and variance of futures are taken in order to obtain the minimum variance hedge ratio. Hence, variance for spot return, st =Δs, variance for futures return, ft = 2Δf and covariance, st , ft = ΔsΔf; therefore, the minimum variance hedge ratio is hf*= ΔsΔf2Δf, where hf* represents the futures contract of hedge pair for CPO.

Hedging effectiveness is computed by the variance reduction in the hedged portfolio compared to that unhedged position, which is using the Minimum Variance Hedge Ratio (MVHR). Johnson (1960) and Ederington (1979) developed the procedure to measure hedging effectiveness (HE) as follows:

HE=VarianceUnhedged- VarianceHedgedVarianceUnhedged (4)

Ong, Tan and Teh (2012) stated that the MVHR approach is more accurate and supersedes the R2 in OLS model estimation results since it accounted for the variance of hedged and unhedged ratio.

RESULTS AND DISCUSSION

The standard unit root test establishes that both of the return series of spot and futures are stationary. Table 1 provides the unit root test results.

Table 1: Unit Root Test

Variable	ADF	Variable	ADF
CPO	-9.9105***	DCORN	-17.347***
FCPO	-10.551***	DSOY1	-17.326***
CSOY	-17.805***	DSOY2	-16.345***
CCORN	-17.816***	DBO	-17.922***
CBO	-11.715***		

***denote significant at 1% level

The results above show the data series are stationary at level and therefore the data series require no differencing (Brook, 2014)

Table 2: Johansen Cointegration Analysis Results

Variable	Hypothesis	Eigenvalue	trace	95% Critical Value
CPO & FCPO	H0: r = 0*,	0.3244	289.4753	15.4947
	H1: r 0*	0.1536	86.3775	3.8415
CPO & CSOY	H0: r = 0*	0.1716	182.8611	15.4947
	H1: r 0*	0.1485	84.2414	3.8415
CPO & CCORN	H0: r = 0*	0.1819	189.2194	15.4947
	H1: r 0*	0.1481	84.0125	3.8415
CPO & CBO	H0: r = 0*	0.2244	214.7227	15.4947
	H1: r 0*	0.1442	81.5968	3.8415
CPO & DCORN	H0: r = 0*	0.2459	230.8931	15.4947
	H1: r 0*	0.1465	82.9937	3.8415
CPO & DSOY1	H0: r = 0*	0.1636	172.2055	15.4947
	H1: r 0*	0.1393	78.6051	3.8415
CPO & DSOY2	H0: r = 0*	0.2164	205.8418	15.4947
	H1: r 0*	0.1384	78.0406	3.8415
CPO & DBO	H0: r = 0*	0.2118	205.4069	15.4947
	H1: r 0*	0.1427	80.6823	3.8415

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level

The Table 2 below shows the tested null and alternative hypothesis. Overall the null hypothesis or $H0$: $r = 0$ isrejected for the hypothesis of no co-integration between the bivariate of CPO and its pair of CSOY, FCPO, CCORN, CSOY, DCORN, DSOY1, DSOY2 and DBO. Further, the trace test and maximum eigenvalue of all CPO pairs are found to have exceeded its respective critical values and it concludes that the alternative hypothesis or $H0 : r \leq 1$ of CPO and its' pair of CSOY, FCPO, CCORN, CSOY, DCORN, DSOY1, DSOY2 and DBO to be cointegrated at most 1 cointegrating vectors also rejected. Briefly, CPO and its pairs have at least two cointegrating vectors and all the co-integration tests are significant at the 5 percent significant level.

Table 3: Estimated OLS Regression Model

	α	β	R2
FCPO	0.0006	0.7226***	0.4998
	(-0.0312)	(-0.001)	
CSOY	0.0012	0.3746***	0.1148
	(-0.001)	(-0.0312)	
CCORN	0.0016	0.1552***	0.0326
	(-0.0014)	(-0.0365)	
CBO	0.001	0.614***	0.2610
	(-0.0012)	(-0.0446)	
DCORN	0.002	-0.055***	0.0017
	(-0.0014)	(-0.0577)	
DSOY1	0.0016	0.2485***	0.0243
	(-0.0014)	(-0.068)	
DSOY2	0.0017	0.1661***	0.0191
	(-0.0014)	(-0.0513)	
DBO	0.0013	0.3851***	0.1288
	(-0.0013)	(-0.0432)	

Standard errors are in the parentheses.
*** denotes 1% significance level.

With OLS calculation, based on Table 3, FCPO could hedge 72 percent of the physical stocks which is the best hedge pair with Malaysian palm oil. The rank is followed by the Chicago and Dalian soybean oil futures; which are 60 percent and 38 percent respectively. Grain futures in the US is the best pairwise for CPO, where soybean could protect 37 percent of the physical palm oil compared to both of Chinese soybeans No.1 and No.2; 24 percent and 16 percent respectively. Cross hedge with corn futures only applies 15 percent of the whole portfolio that can be hedged. As the corn futures in China and CPO has a negative correlation of returns, it produced a negative hedge ratio which is in this case is not advisable to be paired with Malaysian crude palm oil.

Table 4: Optimal Hedge Ratio from the Bivariate VAR Model

	Cov (s f)	**Var (εf)**	**h***
FCPO	0.000616	0.00086	0.7163
CBOTSOY	0.000255	0.000791	0.3224
CBOTCORN	0.000154	0.001303	0.1182
CBOTBO	0.000367	0.00064	0.5738
DCECORN	-0.00002	0.000542	-0.0362
DCESOY1	0.000087	0.000374	0.2324
DCESOY2	0.00007	0.000644	0.1092
DBO	0.000302	0.000818	0.3692

The results of the optimal hedge (h*) using the Bivariate VAR model illustrated in Table 4 indicate that the benchmark FCPO has an optimal hedge ration of 0.7163 with CPO. This implies that CPO traders can protect at least 71 percent of their physical feed stock with FCPO. While cross hedge strategy using oilseed futures contracts like CBOTBO and DBO have optimal hedge ratios of 57 percent and 36 percent respectively. On the other hand, cross hedge strategy using Chicago soybean (CBOTSOY) and Dalian soybean (DCESOY1 and DCESOY2) are able to offer a hedge ratio of 23 percent and 10 percent respectively. Apparently, the cross-hedge strategy between Dalian corns (DCECORN) appears to be not suitable since the optimal ratio is negative 3.62 percent when paired with crude palm oil.

Table 5: Optimal Hedge Ratio from the Bivariate VEC Model

	Cov (s f)	Var (εf)	h*
FCPO	0.000734	0.000976	0.7521
CBOTSOY	0.00042	0.000912	0.4605
CBOTCORN	0.000334	0.001454	0.2297
CBOTBO	0.00046	0.00069	0.6585

DCECORN	-0.000034	0.000523	-0.0644
DCESOY1	0.00013	0.000377	0.3448
DCESOY2	0.000115	0.000623	0.1846
DCEBO	0.000372	0.000854	0.4356

Table 5 shows the optimal hedge ratios using the Bivariate VECM model. When the model is applied, the hedge ratios are higher than those in Table 4. Once again FCPO could protect around 75 percent of physical underlying CPO, while CBO and DBO offers 65 percent and 43 percent of the protection. In the grains futures market, CSOY protects almost half of the physical asset, which is 46 percent compared to Chinese soybean futures which have optimal hedge ratios of 34 percent and 18 percent respectively.

Table 6: Hedging Effectiveness using OLS, Bivariate VAR and Bivariate VECM Models

	FCPO	CSOY	CCORN	CBO	DCORN	DSOY1	DSOY2	DBO
				OLS				
H2	0.00052	0.00091	0.001	0.00076	0.00103	0.00101	0.00101	0.0009
U2	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103
h*	0.4996	0.1148	0.0326	0.2609	0.0017	0.0243	0.019	0.1286
HE	0.4951	0.1165	0.0291	0.2621	0.0000	0.0194	0.0194	0.1262
				Bivariate VAR				
H2	0.0004	0.00085	0.00014	0.00069	0.00095	0.00101	0.00094	0.00084
U2	0.00084	0.00093	0.00015	0.0009	0.00095	0.00095	0.00095	0.00095
h*	0.5278	0.0883	0.1182	0.2331	0.0007	-0.0637	0.0081	0.1179
HE	0.5238	0.0860	0.0667	0.2333	0.0000	-0.0632	0.0105	0.1158
				Bivariate VECM				
H2	0.0004	0.00096	0.00107	0.00074	0.00127	0.00122	0.00124	0.00094
U2	0.00095	0.00116	0.00114	0.00104	0.00127	0.00127	0.00126	0.0011
h*	0.5817	0.1675	0.0671	0.2888	0.0017	0.0354	0.0168	0.1476
HE	0.5789	0.1724	0.0614	0.2885	0.0000	0.0394	0.0159	0.1455

The cross-hedging effectiveness of CPO and inter-related futures contracts using OLS, VAR and VECM models are reported in Table 6. Crude palm oil futures (FCPO) have a higher hedging effectiveness than those inter-related futures based on results of the three estimated regression models. The bivariate VECM produces the highest hedging effectiveness relative to the other two models where a reduction in variance of at least 58 percent is attained. Hedging effectiveness based on the cross-hedging strategy revealed smaller variance reduction relative to the direct hedging strategy.

A hedging strategy only can be called effective if the mean return from the strategy is higher than the competing strategies and it has reduced a significant portion of the variance with respect to its unhedged strategy. In most cases, the bivariate VECM model has the highest cross hedging effectiveness of CPO and other inter related futures contracts. It seems that the cross hedge with CBOTBO has the highest reduction in variance (28%) relative to the other inter-related futures contracts. This is followed by cross hedging using CSOY and DBO which have a variance reduction of 17 percent and 15 percent respectively. In the grain futures market, it is revealed that VAR model produces a negative hedging effectiveness for DSOY1. Brooks, Henry and Persand (2002) concluded that a weak co-integration between the two products could lead to negative hedge ratio that result in a negative hedging effectiveness. A weak co-integraion is due to the lack of trading volume for DSOY1. In short, hedgers and traders should not use DSOY1 to cross hedge physical crude palm oil.

CONCLUSION

In conclusion, although the price risk is not fully eliminated, FCPO is still the best instrument to offset the price risk in CPO markets given the empirical evidence above. For the optimal hedge ratios, it is recommended to hedge the CPO using the VECM model due to its ability to protect 75 percent of the physical feed stocks. Where grain futures consist of CSOY, CCORN, DCORN, DSOY1 and DSOY2, Chicago soybean has the highest optimal hedge ratio while Dalian soybean seems not to have a preferable cross hedge ratio for CPO as it has a negative optimal hedge ratio. In the illustrations of hedging effectiveness, despite the weak strength of hedging effectiveness, FCPO is still reliable to offset the price risk in the physical asset by almost 58 percent by using VECM. This indicates that any attempts to cross hedge with other types of vegetable oil futures like soybean oil will only yield mostly 28 percent with Chicago soybean oil futures. Grains futures promised 16 percent of hedging effectiveness if VECM is used to cross hedge FCPO with CSOY. However, by using BVAR to cross hedge CPO with DSOY1 will result negatively. Hence, this paper shows the other options for palm oil traders have for their hedging strategy in case they prefer to mitigate their physical price risk with other agricultural commodities futures.

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