Examining the Long-term Relationships between the Prices of Palm Oil and Soyabean Oil, Palm Oil Production and Export: Cointegration and Causality

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ABSTRACT

The main objective of the article is to investigate whether there are long-run and short-run relationships among natural log of the prices of palm oil price (LPOP) and soyabean oil (LSOP), oil palm production (LPROD) and total export (LEXP). These time series data are annual data from 1988 to 2015. Augmented-Dickey Fuller (ADF) stationary test results show that the time series for LPOP, LSOP, LEXP, and LPROD are stationary at first difference. According to the Engle and Granger method, there is a cointegration relationship between the time series data. Further, the Johansen method shows at least two cointegration vectors between the variables. The Vector Error Correction Model (VECM) was used to test these two cointegration vectors for long-run cointegration relationships. The empirical evidence obtained from the study shows there is no long-run equilibrium between the variables. This is proven by the non-significant and positive values of the Error Correction Term (ECT) parameter. In other words, a change in oil palm price in the long-term is not influenced entirely by soyabean oil price. It may be affected by other important factors such as palm oil supply and extreme weather phenomena. However, the Granger short-run relationship test found that there is a one-way Granger causality relationship from LPROD to LPOP, and from LEXP to LPOP. Thus, it is shown that total export and production of palm oil are expected to influence palm oil price in the short-run.

Keywords: natural log of palm oil price, soyabean oil price, oil palm total export, oil palm total production.

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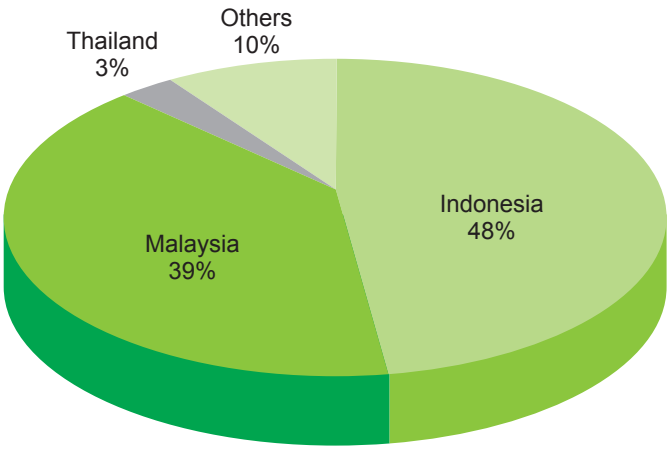
INTRODUCTION

Malaysia is the second largest producer of palm oil in the world after Indonesia (*Figure 1*). Malaysia contributes almost 40% of palm oil globally so it can said to represent an important commodity in the



Source: USDA (2012).

Figure 1. Major palm oil producers in the world in 2015.

Malaysian economy. In 2015, export of palm oil accounted for about RM 779.95 billion, *i.e.* 24.6% of the total Malaysian economic output, with almost 6% of total exports coming from the palm oil industry (MATRADE, 2015). This shows an increase compared with the year 2000 when palm oil export contributed less than 3% of total export value (Bank Negara, 2011).

Based on the Malaysian palm oil export market in 2015, India, the European Union (EU), China, Pakistan and USA are the major importing countries (*Table 1*). India maintained her position as the largest Malaysian palm oil export market in 2015, accounting for 3.69 million tonnes (21.1%), followed by EU at 2.43 million tonnes (13.94%) and China as a third major importer at 2.38 million tonnes (13.64%). These three big importers contributed about RM 20.09 billion (50%) out of the total palm oil export value of RM 40.14 billion.

The main objective of the article is to investigate whether there are long-run relationships between palm oil price (POP) and soyabean oil price (SOP), total palm oil production and export of palm oil (EXP) by applying cointegration techniques. Soyabean oil is palm oil's most important competitor with these two commodities fighting for the same market share mainly in China and India, which together has the highest consumption. Besides, the increases in world population and Gross Domestic Product (GDP), leading to increased demand for food applications, use of these oils for biofuel production brings on a new source of demand for both oils. This creates competition between palm oil and soyabean oil in the international markets. Generally, when the price of soyabean oil rises, demand for palm oil will increase in tandem, with the price of palm oil tending to be weaker (*Figure 2*). A related objective of the article is to investigate causality patterns among these four variables (prices of palm oil and soyabean oil, oil palm total production and total export) using the Granger causality test.

TABLE 1. MALAYSIAN PALM OIL EXPORT MARKET IN 2015

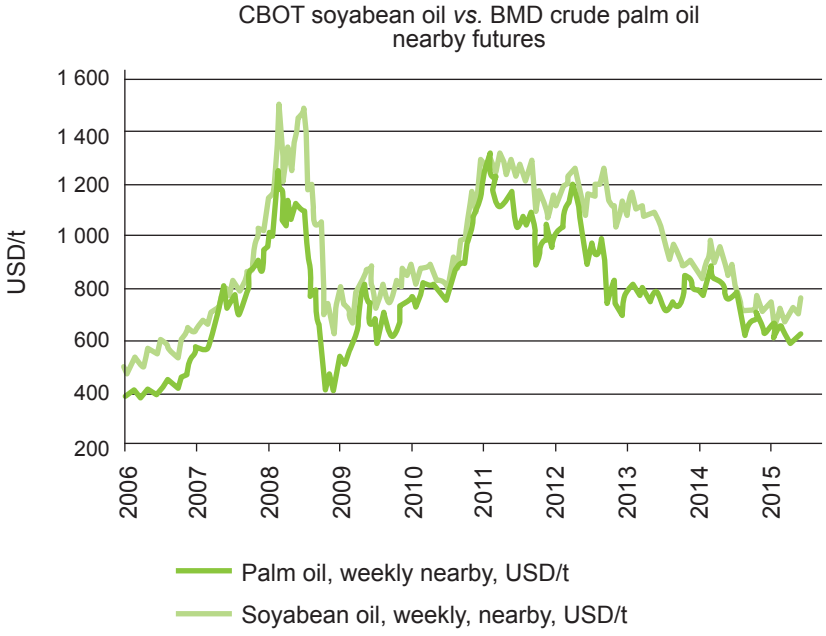
Rank	Country	Export volume (million tonnes)
1	India	3.69
2	European Union (EU)	2.43
3	China, P R	2.38
4	Pakistan	0.73
5	USA	0.70
6	Philippines	0.65
7	Vietnam	0.58

Source: MPOB (2015).

LITERATURE REVIEW

Using annual data from the period 1988 – 2015, Mohammed Yusof (1998) hypothesised a linear relationship between the price of palm oil and the price of its substitute, soyabean oil. The price equation is embedded in a multiple equation model representing the Malaysian palm oil industry. Non-linear Two-stage Least Squares (2SLS) was used to estimate the model. However, in this case, a test for the presence of unit roots in the variables was not performed.

Ghaith and Awad (2011) studied the relationship between crude oil and food commodities prices. They concluded that there is strong proof of a long-term relationship between crude oil and food commodities prices. They also found that there is a one-way causality between the prices of crude oil and some of the food commodities. Campiche *et al*. (2007) examined the covariance between crude oil price and the prices of soyabean, soyabean oil, corn, sorghum, palm oil and sugar using a vector error correction model. They found that soyabean and corn prices were cointegrated with crude oil price. In addition, soyabean price seemed to be more strongly correlated to crude oil price than to corn price. Yu *et al*.



Source: CME Group (2015).

Figure 2. Soyabean oil price vs. *palm oil price.*

(2006) analysed the cointegration and causality pattern of higher crude oil price and demand for vegetable oils. They found that shocks in crude oil price influenced relatively the variation in vegetable oil prices.

Price equations can be estimated by applying a standard technique but may result in spurious regressions. Granger and Newbold (1974) created the phrase 'spurious regressions' to describe regression results that are good in the sense of having high R^2 values and significant t-statistics, but in fact do not have real meaning. Such regression results may be obtained in a regression involving economic time series using y_t as the dependent variable and x_t as the independent variable in a non-stationary random process. In this article, we paid special attention to the problem of non-stationary variables. Cointegration and error-correction techniques were used to help in model specification. Cointegration analysis focused on the issue of spurious regression and gave an idea of the conditions under which the relationships were not spurious.

The Johansen cointegration technique is a better way to find the cointegration vectors between the variables (Gonzalo, 1994) rather than other techniques like those of Engle and Granger (1987) and Stock and Watson (1998). By investigating using the Johansen concept, the result will be based on the Trace statistics value and Maximum Eigen value. In a previous test, POP, SOP, EXP and palm oil production volume (PROD) seemed to be cointegrated, with a long-term or equilibrium relationship among these four variables. It is possible that in the short-run there may be disequilibrium. Therefore, the error term was used to tie the short-run behaviour of POP to its long-run value.

If, and only if, there was a long-run relationship, the study continued with a diagnostic test to make sure that the error correction model that we built in the previous section was free from a heteroskedasticity problem, that the residual had no serial correlation or, in other words, did not have an autocorrelation problem, and lastly that the residual was normally distributed. If all these tests were passed, the model was then considered good for use, and may be able to explain the relationships between the variables very well.

DATA AND METHODOLOGY

Secondary data gathered from MPOB were used in the study. The data consisted of POP, SOP, EXP and PROD, and are annual data for the period from 1986 to 2015. POP and SOP variables were measured in USD/t while EXP and PROD were measured in tonnes. This study is an empirical study on the use of econometric methods for analysing time series data to establish the issue of cointegration and causality patterns among the variables. The variables were selected for this study based on the factors that affect palm oil price in Malaysia. As a result, the best improvement method can be integrated with the relevant national policies and strategies, as well as the process of agricultural-economic development of the country.

RESULTS AND DISCUSSION

Unit Root Test

All variables showing the alternative hypothesis were accepted at zero difference. We proceeded next to taking the first differences of all the variables and testing for stationarity. The results are given in *Table 2*.

In all cases, the null hypothesis was rejected at the 1% significance level. In other words, all four variables were stationary after being differenced once.

TABLE 2. RESULTS FOR UNIT ROOT TEST AT FIRST DIFFERENCE

Variable	POP	SOP	EXP	PROD
At level	-2.007483	-1.751030	-1.088721	-1.651136
1st difference	-5.292***	-4.724***	-5.315***	-5.483***

Note: * Significant at 10% probability level.** Significant at 5% probability level.
*** Significant at 1% probability level.
POP - palm oil price.
SOP - soyabean oil price.
EXP - total palm oil export.
PROD - palm oil production.

TABLE 3. OPTIMUM LAG LENGTH SELECTION

Lag	LogL	LR	FPE	AIC	SC
0	41.12237	NA	8.29e-07	-2.651598	-2.461283
1	140.6311	163.4787	2.16e-09	-8.616509	-7.664934
2	171.7758	42.26776***	7.93e-10***	-9.698271***	-7.985437***

Note: *Significant at 10% probability level. **Significant at 5% probability level.
***Significant at 1% probability level.

TABLE 4. JOHANSEN TEST

Null hypothesis Lag1	Statistical test			
	λtrace	α = 5%	λmax	α = 5%
r = 0	71.6299**	47.8561	33.7801**	27.5843
r ≤ 1	37.8498**	29.7971	23.6453**	21.1316
r ≤ 2	14.2046	15.4947	8.4702	14.2646
r ≤ 3	5.7344	3.84147	5.7344	3.8415

Note: * Significant at 10% probability level. ** Significant at 5% probability level.
*** Significant at 1% probability level.

Johansen Cointegration

According to the findings in *Table 4*, and by using 2 lag (*Table 3*), at least two cointegration vectors existed at the significance level of 5%. Both Trace and Max-Eigen statistics values show that the null hypothesis was finally rejected at the 5% significance level after going through three rounds of testing. Thus, at least two cointegrated vectors existed among POP, SOP, EXP and PROD; however, our focus was only on POP as the dependent variable. Thus, in the next section, we present only one Vector Error Correction Model (VECM) model.

Vector Error Correction Model

The vector error correction model (VECM) used is as follows:

$$D(LPOP) = 0.1293ECT + 0.4447D(LPOP_{t-1}) - 0.3892D(LPOP_{t-2}) - 0.8419(LPROD_{t-1}) + 1.9962(LPROD_{t-2}) - 1.1141D(LEXP_{t-1}) + 0.2891D(LEXP_{t-2}) - 0.05743D(LSOP_{t-1}) + 0.0818D(LSOP_{t-2}) - 0.0098$$

The error correction coefficient (ECT) is supposed to be negative and significant. This is because a negative ECT value will show how quickly the adjustment is needed in a short-run disequilibrium towards a long-run equilibrium. In this case, the ECT absolute value showed a positive value but was not statistically significant. It is concluded that there was no long-run relationship among the variables. In other words, the changes in palm oil price were not significantly influenced by SOP, total export of Malaysian palm oil or PROD. It may be influenced by other strong factors such as weather pattern, import policies and palm oil supply.

Short-run Causality

In this section, we report the tests of causality between palm oil price, total production, export and SOP by using the Ganger causality.

The Granger test is based on the sub-set F test. Application of the Granger test is described clearly by Gujarati (1995). *Table 5* gives a summary of the results of the causality test.

The results show that the direction of causality was from PROD to POP and from EXP to POP as the estimated F values were significant at the 1% probability level. Thus, we can conclude that there was a short-run causality from PROD and EXP to POP, meaning that PROD and total export significantly influenced the price of palm oil in the short-run.

Impulse Response Function

The impulse response function (IRF) shows the response of a variable resulting from the impulse of the endogenous variables. A shock in a dependent variable brings about a positive or negative direction in the independent variables. The response lines are represented by the straight lines. The dotted lines were calculated by the analytical method. Responses in EXP, SOP and PROD fluctuated

TABLE 5. SHORT-RUN CAUSALITY TEST

Null hypothesis:	F-statistic	Prob.
LPROD does not Granger cause LPOP	12.0434	0.0003***
LPOP does not Granger cause LPROD	1.84088	0.1813
LEXP does not Granger cause LPOP	9.84123	0.0008***
LPOP does not Granger cause LEXP	0.56789	0.5745
LSOP does not Granger cause LPOP	1.20759	0.3172
LPOP does not Granger cause LSOP	1.80904	0.1864
LEXP does not Granger cause LPROD	2.16507	0.1376
LPROD does not Granger cause LEXP	2.07754	0.1481
LSOP does not Granger cause LPROD	1.44213	0.2570
LPROD does not Granger cause LSOP	1.86403	0.1777
LSOP does not Granger cause LEXP	1.86583	0.1774
LEXP does not Granger cause LSOP	2.44173	0.1092

Note: * Significant at 10% probability level. ** Significant at 5% probability level.
*** Significant at 1% probability level.
LPOP - log of the prices of palm oil price.
LPROD - log of the price of oil palm production.
LEXA - log of the prices of palm oil total export.
LSOP - log of the prices of soyabean oil.

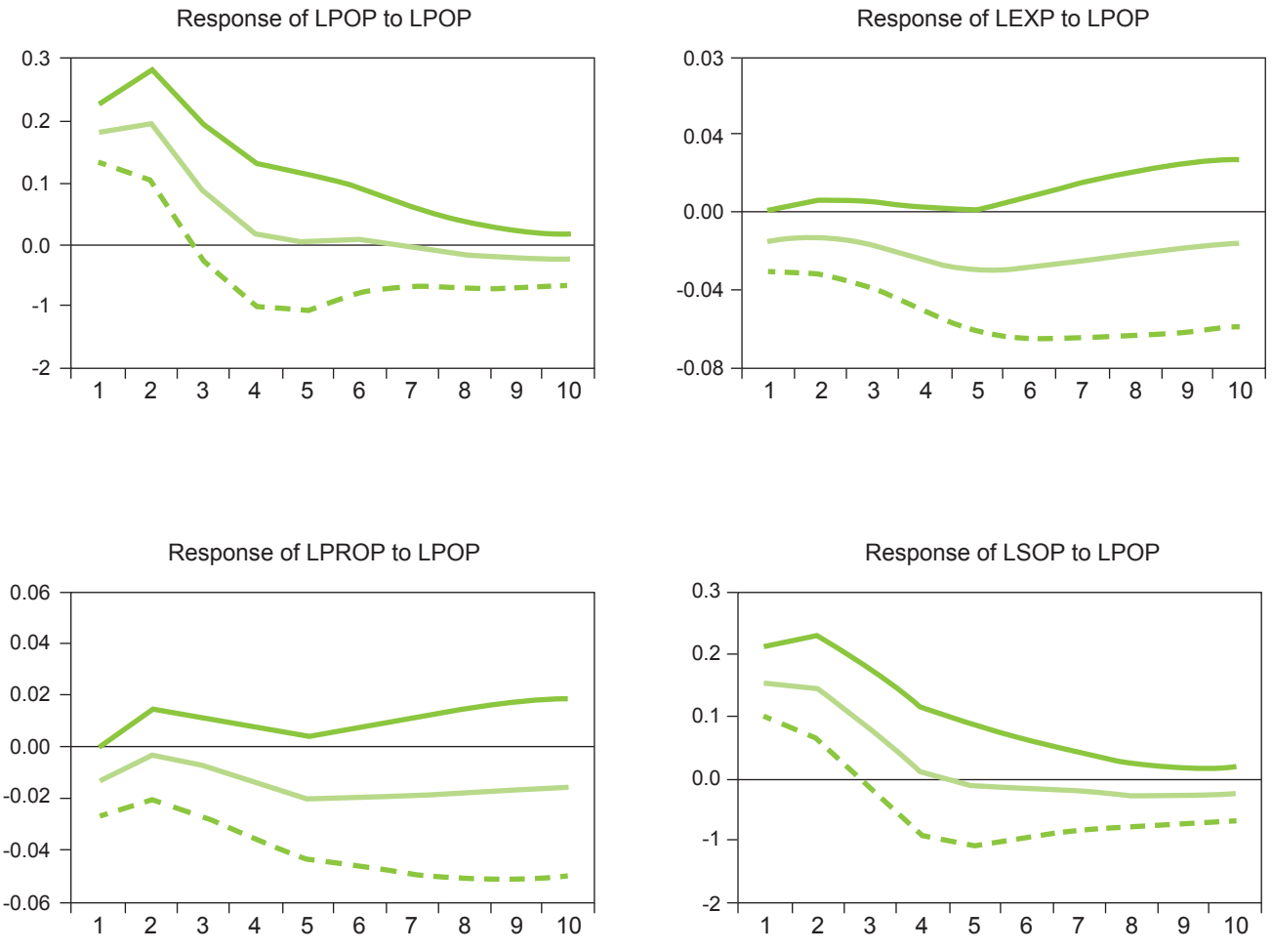


Figure 3. Responses of exogenous variables towards the endogenous variable.

between two and 10 months after the actual month. The responses of EXP, SOP and PROD had negative trends because of POP. It appears that an increase in POP led to decreases in total export.

CONCLUSION

The study established that the time series on POP, SOP, PROD and export were cointegrated, even though separately each time series was not stationary at level. This means that there were relationships between these four variables. There was therefore no tendency for the variables to drift widely apart.

The results for short-run causality show that the direction of causality was from PROD to POP and from EXP to POP. Thus, we can conclude that there were short-run causalities from PROD and EXP to POP, meaning that total production and total export of palm oil significantly influenced the price of palm oil in the short-run. According to the test, all the independent variables gave negative trends towards POP. An increase in POP will produce negative responses in SOP, total export and PROD in the short-term. This finding is interesting as it suggests that in the POP determination process, we cannot ignore information on the trends of total production and total export of palm oil.

POP behaviour is crucially dependent on many factors. On top of the listed variables which theoretically influence the price of palm oil, there are some other factors that are more important in explaining the volatility in price. More studies are needed to improve the information reported in this article. Firstly, this article focused on only three variables that affect POP. There are more important factors such as changes in taxation and import duty structure, import policies, weather pattern, and the supply and demand of palm oil that need to be studied in detail. Secondly, future studies should take into consideration monthly data so that the variation in price can be seen clearly.

REFERENCES

BANK NEGARA MALAYSIA (2011), Chapter 1: Economic development in 2011. The changing structure of Malaysia's export. *Annual Report*. p. 32-35.

CAMPICHE, J L; BRYANT, H L; RICHARDSON, J W and OUTLAW, J L (2007). Examining the evolving correspondence between petroleum prices and agricultural commodity prices. Paper presented at the American Agricultural Economics Association Annual Meeting. Portland, OR.

CME GROUP (2015). Spread trading in CBOT soybean oil and BMD crude palm oil. https://www.cmegroup.com/trading/agricultural/files/spreading-cbot-soybean-oil-and-bmd-crude-palm-oil.pdf

GUJARATI, D N (1995). *Basic Econometrics*. 3rd edn. New York: McGraw-Hill.

ENGLE, R F and GRANGER, W J (1987). Co-integration and error correction: representation, estimation and testing. *Econometrics, 55*: 251-276.

GHAITH, Z and AWAD, I M (2011). Examining the long term relationship between crude oil and food commodity prices: co-integration and causality. *International J. Economics and Management Sciences, 5(1)*: 62-72.

GONZALO, J (1994). Five alternative methods of estimating long-run equilibrium relationship. *J. Econometrics, 60(1)*: 203-233.

GRANGER, C W J and NEWBOLD, P (1974). Spurious regressions in econometrics. *J. Econometrics, 2(2)*: 111-120.

MATRADE (2015). Top 10 major export products, 2015. Malaysian External Trade Development Corporation (MATRADE).

MOHAMMED BIN YUSOFF (1988). Production and trade model for the Malaysian palm oil industry. *ASEAN Economic Bulletin, 5.2*:169-177.

MPOB (2015). *Malaysian Oil Palm Statistics 2015*. 35th Edition. MPOB, Bangi.

STOCK, J H, and WATSON, M W (1998). *A Comparison of Linear and Nonlinear Univariate Models for Forecasting Macroeconomic Time Series*. No. w6607. National Bureau of Economic Research, Cambridge.

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA) (2012). *Oilseeds: World Market and Trade*.

YU, T H; BESSLER, D A and FULLER, S (2006). Cointegration and causality analysis of world vegetable oil and crude oil prices. Paper presented at the American Agricultural Economics Association Annual Meeting. Long Beach, California. p. 23-26.