Supply Response of Malaysian Palm Oil Producers: Impact of Interest Rate Variations

Mohammad Alias* and Tuck Cheong Tang**

ABSTRACT

This paper examines the long run relationship between the supply of Malaysian palm oil and its determinants using Johansen multivariate cointegration analysis. The supply response of Malaysian oil palm producers is investigated using annual data from 1967 to 2002. An error correction model is proposed to investigate the short run response of supply to its determinants. Supply of palm oil is postulated to be a function of expected price of palm oil relative to the expected price of rubber (the substitute crop); government expenditure, a proxy for government policy; a time trend variable to represent technological change or preference and interest rate to represent the cost of borrowing. Previous studies have not included the interest rate variable. Naïve expectations model is used to model price expectations. Structural information, in particular, the gestation period for oil palms from first planting is used in the specification of the long run relationship.

INTRODUCTION

The agricultural sector used to dominate the economy in terms of contribution to the Gross Domestic Product (GDP) until 1987, when it was overtaken by the manufacturing sector. Within agriculture, the palm oil sub-sector is the most important perennial agricultural export crop. Palm oil industry has contributed to Malaysian economic development and industrialization in several ways. Firstly, export earnings provided the foreign exchange needed to import critical capital and intermediate goods. Secondly, profits provide the capital resources for the development of manufacturing and service industries, and also for plantation companies to diversify into non-plantation activities. Finally, the industry provides the raw materials for the development of downstream processing activities.

The contribution of the crude palm oil export to the total country's major agriculture exports (in term of value, RM million) has increased remarkably from 9.6% in 1971 to 12.8% in 1980, 21.5% in 1997, 24.2% in 1999, and to 26.7% in 2002. In addition, the total crude palm oil (CPO) production increased from 0.59 million tonnes (in 1971) to 2.57 million tonnes (in 1980), 9.07 million tonnes (in 1997), 10.6

* Kolej Universiti Islam Malaysia, Bandar Baru Nilai, 71800 Negeri Sembilan, Malaysia.

** Monash University Malaysia, No. 2 Jalan College, Bandar Sunway, 46150 Petaling Jaya, Selangor, Malaysia.

million tonnes (in 1999) and 11.9 million tonnes (in 2002) (*Figure 1*). Production grew at an average annual rate of 9.1% over the period 1971-1997. The rapid increase in production has been due to a rapid increase in planted acreage, which grew at an annual average rate of 7.68%. In fact, Malaysia is the world's leading producer of palm oil by contributing 49.5% of world palm oil production in 1998 and 8.2% of world oils and fats production. Meanwhile, Malaysia exported 7.4 million tonnes, contributing 62.8% of world palm oil exports or 22.5% of world exports of oils and fats in 1998 (the figures are calculated from the data reported in *Statistics on Commodities*, Ministry of Primary Industries, various issues).

The rapid growth of the Malaysian palm oil industry is a result of the following factors (Khera, 1976; Pletcher, 1991). Firstly, oil palm production has been found to be more profitable compared to the production of rubber. Secondly, the government supported the development of the industry by allowing the use of rubber replanting grants for replanting with oil palm. The government itself played a significant role in the development by the establishment of federal agencies to facilitate the expansion of the palm oil industry (especially Federal Land Development Authority). Thirdly, the country is well endowed with suitable climatic and soil conditions. As such, there has been a systematic shift out of rubber into oil palm production both by the plantation companies and smallholders. The availability of financing facilities has also been instrumental in promoting the growth of the industry. This latter point is very pertinent in the present context where the government has been exhorting the industry to replant old trees. Bank credit is an important source of financing to expand productive capacity, mainly through replanting with high yielding varieties. The share of commercial bank lending to palm oil of the total credit to agriculture shows an increasing trend from 14.6% in 1970 to 63.2% in 2002 (*Table 1*). According to Mohammad and Tang (2003), commercial financial institutions (commercial banks, finance companies and merchant banks) contributed about 60.6% of the loans for agricultural production (as at 31December 1998).

The main objective of this study is to examine the long run and short run relationship between the supply of palm oil and its determinants using the multivariate cointegration and error correction analysis. The cointegration approach developed by Johansen (1988) and Johansen and Juselius (1990) are used in order to address problems associated with using non-stationary series in OLS estimation. A dynamic error correction model (ECM henceforth) (Engle and Granger, 1987) is proposed to investigate the short run response of supply to its determinants. The specific objective of the study is to investigate the role of interest rate as a determinant of supply response. The interest rate variable is a proxy for cost of borrowing. The inclusion of the interest rate variable is an attempt to improve the specification of the supply response function of palm oil producers. Previous studies have ignored this variable. If the variable were found to be relevant, its

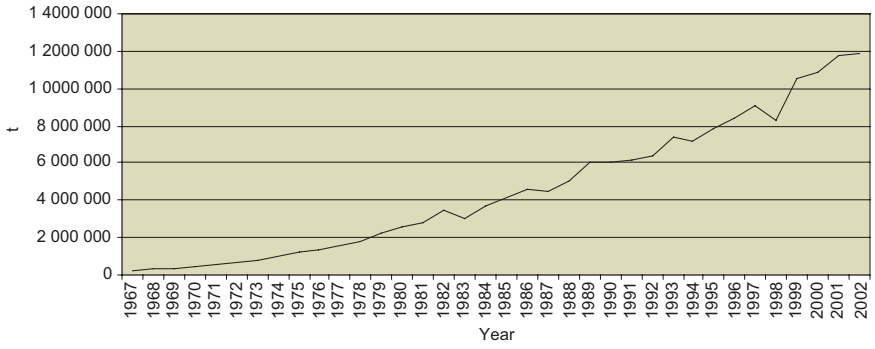


Figure 1. Plot of palm oil production (t) for 1967 to 2002.

TABLE 1. SHARE OF COMMERCIAL BANKS' LENDING TO PALM OIL IN TOTAL AGRICULTURAL CREDIT

Year	Share (%)
1970	14.6
1975	15.4
1980	23.4
1985	19.0
1990	20.6
1995	28.3
1997	34.8
1998	39.4
1999	47.2
2000	56.4
2001	60.0
2002	63.2

Note: CBL refers to commercial bank lending.
Source: Calculated from data in Bank Negara Malaysia, *Quarterly Bulletin*, and Ministry of Primary Industries Malaysia, *Statistics on Commodities* (various issues).

exclusion would lead to misspecification of the supply response function. Ordinary least estimation of a misspecified model due to omission of relevant variables would lead to biased estimation of the least squares estimators (see for example Maddala, 1992). Exclusion of the interest variable also means ignoring an important transmission channel whereby changes in monetary policy can impact on the plantation industry.

THEORETICAL FOUNDATIONS

Theoretical literature offers useful insights on the specification of the supply response function. By model specification, we mean the list of variables, dependent and explanatory variables that should be included, the choice of functional form, and the assumptions on the probability distribution of the stochastic error terms. Empirical supply response of agricultural producers in general, and producers of perennial crops such as palm oil, rubber and cocoa is well studied (Bond, 1983; Askari and Cummings, 1976; 1977). Supply response means the response of producers to market stimuli such as movements in prices (of the commodity and prices of competing/complementary commodities) and costs of input (labour, raw material, as well as working capital). Changes in technology and institutional settings such as government policies may also impact on supply response, usually leading to rightward shifts in the supply function.

In this paper, we want to extend on previous studies of supply response of Malaysian perennial crop producers, in particular oil palm, by incorporating an interest rate variable in the supply function. The rate of interest is a proxy for cost of borrowing. It is expected that this variable is a relevant determinant of palm oil supply response. In most developing countries, the working capital requirements of agricultural producers are covered to some extent by rather short run borrowings, since own savings are usually insufficient to cover the total financing of inputs (Sell, 1988). The role of the banking system in providing working capital to finance production is well documented. Kapur (1986) and Mathieson (1980) specified production function with working capital as one of the inputs. Bank credit is the only fund used to finance all net additions to working capital in production. Galbis' (1980) two-sector model emphasized that input as well as working capital in second sector is operating by own saving plus bank borrowing. Mohammad and Tang (2003) have found a cointegrating relation among Malaysian agricultural output, primary commodity export and commercial bank lending on agricultural category. In addition, causality runs from primary commodities export and agricultural credit to agricultural output.

A study by Sinai and Stokes (1989) examined the effect of the extent of optimality of the financial sector (proxied by the interest rate) on output using Cobb-Douglas production functions. The interest rate variable is found to be significant. Remali *et al*. (1998) incorporated loan interest rates in the specification of their cocoa supply response function. This variable is found to be significant. There are a fair number of empirical studies on the supply response of palm oil producers. Very few considered the cost of borrowing variable though. Basri (1988) used annual data for the period 1961-1985. The long run price elasticity is found to be in the range 0.57 to 1.48, and 0.72-0.53 in the short run. A cross-price effect is found to be insignificant. The study fails to consider certain factors, like technological change, prices of input, and cost of borrowing. The study by Au and Boyd (1992) used annual data for the period 1957-1987 and found that elasticity of own price is 1.686 (long run) and 0.345 (short run). The long run cross-price elasticity (with respect to rubber) is -1.629, and -0.382 for the short run. Mad Nasir and Fatimah (1993) employed the Wickens and Greenfield approach (1973) to examine Malaysian palm oil supply response. The sample period is 1965 to 1990. Using Engle-Granger (1987) cointegration and error correction approach, Mohammad *et al*. (2001) had analysed the Malaysian palm oil supply response. In their model specification, relative price, government expenditure and a time trend variable to represent technological progress or producer preference have been considered.

The inclusion of the government expenditure variable found support in descriptive and empirical studies. According to Pletcher (1991), the involvement of government helps in the rapid development of the Malaysian palm oil industry. Schiff (1987) documented that price and public goods are complements in the sense that, a better public goods base will enhance the effect of price on supply. Thus, government development expenditure on agriculture is used as proxy of government's support.

MODEL SPECIFICATION AND DATA

The specification of the supply response function is based on the literature review in Theoretical Foundations section. The general form of the supply response

function used in this study takes the following form:

$$Output = f(HK^{e(+)}, HKS^{e(-)}, G^{e(+)}, IR^{e(-)}, TIME^{(+)}) \quad (1)$$

where Output = output of commodity; HK^e = expected commodity price; HKS^e = expected price of an alternative commodity; G^e = government development expenditure on agriculture; IR^e = interest rate; and TIME = time trend as proxy for technological change or producers' preference.

In this study, we have used the production of palm oil (in tonnes) as proxy variable for output of palm oil instead of average yield per hectare. The yield of a given commodity is defined as the ratio of production to its plantation areas (in hectare), which is more appropriate to measure the effects of technical progress. Converting it into a production function, increased in production will increase the average yield of palm oil. Meanwhile, the palm oil productivity as measured by average yield of CPO per hectare per year has not increased much during the last two decades. Considering these justifications, Mohammad *et al*. (2001) employed total production (in tonnes) for analysing Malaysian agricultural supply response of rubber, palm oil and cocoa.

The interest rate variable is included to proxy the cost of financing planting. Its coefficient is expected to be negative. An increase in the cost of borrowing is expected to have a negative impact on planting. This translates after a lag of three to four years, to a fall in supply. The use of interest rate can also be justified as an opportunity cost to hold money. Given available cash in hand, the palm oil producers have decision either to save or to invest. If the interest rate is higher than the production return, the palm oil producers have been discouraged to increase its production by replanting, and buying land to plant palm oil, for example. Now, this is a motivation to hold money with long- and short-term investment like keeping saving or investment accounts with banks; invest in long-term equity market (government bond), *etc*. Given a low interest rate environment, however, the initiative to hold money is low and it encourages spending. Hence, palm oil producers are expected to take replanting exercises with low level of cost of borrowing.

Price expectations may be modelled in several ways: naïve model, simple lagged model, rational lag or rational expectations. In this study, we chose the naïve expectations to model price expectations because of its simplicity.

Superscripts on each variable with positive or negative sign in ( ) denote the expected relationship between the determinants and output. The relationship between own price and supply is expected to be positive, other things remaining the same. The coefficient of the substitute crop is expected to be positive. If the price of an alternative crop increases, producers are inclined to replace the crop with the alternative crop. In the Malaysian context, oil palm, rubber and cocoa are competitors in terms of land use. An alternative specification for the price variable is to use a relative price variable, *i.e*. the relative price of palm oil with respect to the price of rubber, the main substitute crop.

Next, an increase in government development expenditure on agriculture is expected to shift the supply curve to the right. The shift occurs not immediately but after a lag of several years depending on the gestation period for the perennial crop. The time trend variable is usually used as a proxy for technological change. Its coefficient is expected to be positive, from which we can infer the rate of growth of output due to technological change. This variable may also be used as a proxy for producers' preference to a particular commodity. During the study period, 1971-1997, output per hectare (a measure of productivity) for palm oil did not register a significant increase. As a result, the time trend variable may be used to represent producers' preference for a particular crop. The coefficient of this variable may therefore be positive or negative.

Equation 1 forms the basis of an equilibrium relationship between supply of a commodity and its determinants as identified by economic theory. We will investigate the supply response for the industry as a whole (smallholdings and estates)[1]. If a long run relationship exists, variables that appear in each model will form a cointegrating vector. Consequently, a test of cointegration is a test to determine whether or not there is a long run relationship between the variables as hypothesized by economic theory.

[1] We only examine the palm oil supply response function by using the data in aggregate levels. According to Malaysian Palm Oil Board (MPOB), the crude palm oil (CPO) for estate or stallholders are not available and, the available data for estate is fresh fruit bunches. However, annual figures of CPO for estates can be generated (or approximated) from aggregate CPO based on the ratios of size of estates (in hectares) to the total area of palm oil (in hectares). However, we have a reservation when using data that are derived using approximations such as outlined above. When we use hard data collected by the relevant agencies such as MPOB, there is less criticism on the possibility of measurement errors. Mohammad and Tang (2000) have warned that *but measurement errors may be more serious when data used are constructed data. If measurement errors are correlated with independent variables, use of OLS may lead to biased and inconsistent estates.*

Annual data from 1967 to 2002 are used in this study[2]. The definitions and sources of data are given in *Appendix 1*. *Figures 1* and *2* depict the trend behaviour of the participating series in the study.

The first step is to investigate the stationary properties of the series. For this purpose, the approach developed by Phillip-Perron (1988), PP. PP-test was used, instead of the alternative developed by Dickey and Fuller (1979). The PP-test is more powerful for small samples, while correcting for some serial correlation and heteroskedasticity in the residuals.

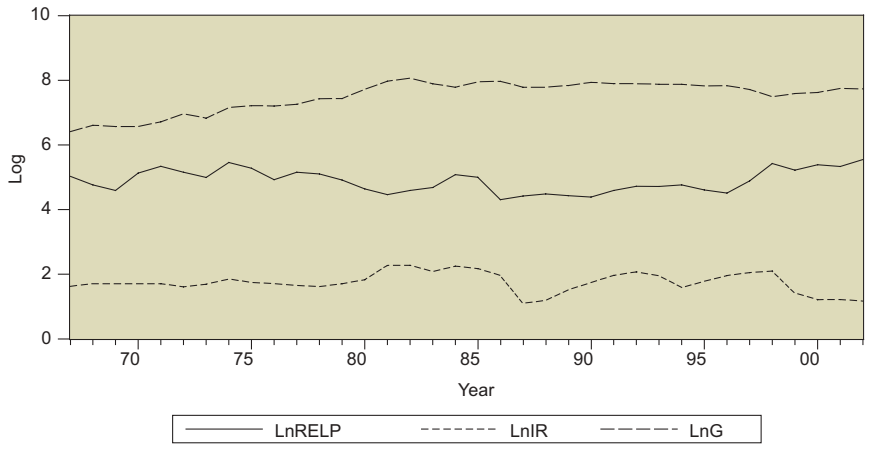
Table 2 shows that all the involved series are non-stationary or integrated of order one, *I*(1) at 1% significant level. We therefore proceeded with the cointegration analysis in order to avoid the risk of OLS estimation associated with non-stationary series.

We used the cointegration methodology developed by Johansen and Juselius, which is based on maximum-likelihood estimation procedure and then allow for testing of feedback effects among a set of variables. This is an advantage over the Engle and Granger residual based methodology (Engle and Granger, 1987) as the number of cointegrating vectors as well as their estimates can be estimated. According to Hakkio and Rush (1991), in carrying out a cointegration analysis, what matters is the length of the sample period and not so much the number of observations. Increasing the number of observations by using monthly or quarterly data does not add any robustness to the results in tests of cointegration. This study covers the sample period 1967-2002, which is found to be sufficient for cointegration analysis. In fact, the ECM provides additional test for cointegration given the sample size is small - if the error correction term is statistically significant (Bahmani-Oskooee and Brooks, 1999). The cointegrating regression for aggregate supply responses is:

$$LnPO_t = b_1 LnIR_{t-3} + b_2 LnG_{t-3} + b_3 LnRELP_{t-3} + b_4 Time + Constant + e_t \quad (2)$$

where *Ln* PO_t is aggregate palm oil production.

The shift from the general functional form in Equation 1 to the log-linear specifications as in Equation 2 require an elaboration. Firstly, a log-linear specification is adopted because it is often used in supply response studies and that the coefficients are direct estimates of elasticities. Secondly, as the gestation period between planting and first commercial production is about three years, we specify the lag length on each explanatory variable (except Time) as three. Thirdly, we used relative price of palm oil to the price of rubber to represent the price effect. This specification imposes the constraint that the coefficients on price are the same but opposite in signs. Finally, under the naïve expectations hypothesis, current price is used as the predictor for future expected price. As the gestation period is three years, the lag length on the price variables (interest rate and relative price) is set at three.



Notes: *Ln*RELP = relative price of palm oil (that is palm oil price index divided with rubber price index); *Ln*IR = interest rate (deposit rate); *Ln*G = government expenditure on agriculture.

*Figure 2. Plot of log of relative price of palm oil (Ln*RELP*), interest rate (Ln*IR*) and government expenditure on agriculture (Ln*G*) for 1967-2002.*

TABLE 2. PHILLIP-PERRON UNIT ROOT TEST

Variable:	Level	First difference
Ln PO	-3.190(3)	-5.678(3)*
Ln RELP	-1.720(3)	-5.925(3)*
Ln IR	-2.368(3)	-4.491(3)*
Ln G	-1.281(3)	-5.537(3)*

Note: * denotes significant at 1% level based on MacKinnon critical values.

[2] This sample span is essentially based on the data availability. Deposit rate (proxy for interest rate) which is only started in 1967 from the *International Financial Statistics*, International Monetary Fund. In addition, the Bank Negara Malaysia's *Monthly Statistical Bulletin* (February 2004) has reported that the actual figures of government expenditure are up to 2002, and the figure for the year of 2003 is a preliminary value.

If the series are found to be cointegrated or there exists a long run relationship (at least one cointegrating vector), then a dynamic structural ECM can be estimated as Equation 3.

$$DLnPO_t = -b_0 EC_{t-1} + \sum_{i=1}^{n} b_{2i} DLnIR_{t-i} + \sum_{i=0}^{n} b_{3i} DLnG_{t-i} + \sum_{i=0}^{n} b_{4i} DLnRELP_{t-i} + C + e'_t \quad (3)$$

where C is a constant term, D is first difference of X_t and, EC_{t-1} is error correction term that is the residual derived from normalized cointegrating Equation 2 by using Johansen approach. The e'_t is assumed to be white noise and normally distributed errors. All variables are differenced one level in order to ensure that they are stationary.

The error correction term (EC_{t-1}) should be significant and have a negative sign. Initially, a general ECM is estimated with three years lag structure from ordinary least squares (OLS) estimator. Then, a general to specific modelling strategy (Hendry and Ericsson, 1991) is used to obtain the parsimonious (preferred) model. The general model was tested downwards sequentially to arrive at a specific short run data consistent equation. The strategy is to drop variables that have relatively small t-values (absolute values less than one) sequentially.

THE FINDINGS

Cointegration Analysis

Table 3 reports the results of Johansen cointegration procedure (*trace* test) that indicate one cointegrating relation for aggregate palm oil supply at 10% significant level[3]. We selected the lag length for Johansen specification based on justifications of economy that is, starting with a three-year lag length and observing that the results did not alter appreciably as lag length was reduced. Lag length was kept as short as possible (Atesoglu, 1997).

Table 4 is the results of normalized cointegrating vectors based on Equation 2. Coefficients on *Ln*IR_{t-3}, *Ln*G, and *Ln*RELP, which are interpreted as long run elasticities, have the correct signs consistent with a priori expectations. The palm oil producers are found to be responsive to interest rate variations and government expenditure. The estimated long run supply elasticities with respect to these variables are -0.96 and 1.00 respectively. A 1% increase in the rate of interest leads to 0.96% decrease in supply three periods ahead. An increase in the interest rate affects negatively on working capital financing, and hence, discourage planting. This finding is consistent with the finding in Remali *et al.*'s (1998) study on Malaysian cocoa supply response. For the government expenditure variable, a 1% increase in expenditure leads to a 1% increase in supply three periods ahead.

The coefficient on the relative price variable is found to be insignificant. This result is rather counter-intuitive. Given that the observed shift of rubber into oil palm that started particularly from the 1970s has been due to better palm oil prices compared to rubber, the result must be accepted with reservation. The coefficient of the time trend variable is significant at the 1% level. This can be

TABLE 3. COINTEGRATION ANALYSIS OF AGGREGATE PALM OIL SUPPLY RESPONSE

Sample: 1967-2002
Test assumption: linear deterministic trend in the data
Series: *Ln* PO_t *Ln* IR_{t-3} *Ln* G_{t-3} *Ln* $RELP_{t-3}$

Eigenvalue	Likelihood ratio	10% Critical value (1)	Adjusted 10% critical value (2)	Hypothesized No. of CE(s)
0.7752	90.669	59.14	88.71	None *
0.6045	47.388	39.06	58.59	At most 1
0.3517	20.486	22.76	34.14	At most 2
0.2389	7.916	10.49	15.74	At most 3

Notes: Lags interval: 1 to 3.
*Denotes rejection of the hypothesis at 10% significance level based on the *adjusted* critical values.
(1) The critical values are from Osterwald-Lenum (1992, Table 2*).
(2) Following the method developed in Cheung and Lai (1993).

TABLE 4. NORMALIZED COINTEGRATING VECTOR FOR AGGREGATE PALM OIL SUPPLY RESPONSE

LnPO_t	*Ln*IR_{t-3}	*Ln*G_{t-3}	*Ln*$RELP_{t-3}$	Time	Constant
-1.000	-0.471	1.266	0.405	0.075	2.948
(standard error)	(0.059)	(0.081)	(0.051)	(0.003)	-
(t-ratios)	(-7.942)	(15.610)	(7.989)	(22.401)	-

[3] We consider the 10% level of significance in order to minimize the possible bias of not rejecting the null hypothesis - number of cointegrating vector(s), since the study involves small sample size, 36 observations.

interpreted as evidence for a strong preference for oil palm cultivation among producers compared to rubber cultivation. Usually the time trend variable is included to represent technological progress. However, palm oil productivity as measured by average yield of CPO per hectare per year has not increased much during the last two decades. We therefore used the time trend variable to proxy for producer preference (Mohammad *et al*., 2001).

Error Correction Models

Table 5 illustrates the estimated structural ECM, which capture the short run response of palm oil supply to its determinants. The results indicate that, in the short run, palm oil supply is found to be responsive to the interest rate, government support and relative prices. The significance of both error correction terms confirms that there exists a long run relationship between palm oil supply and its determinants. This additional evidence of cointegration is approximate for small sample study (Bahmani-Oskooee and Brooks, 1999). The coefficient on the error correction term measures the speed of adjustment at which the discrepancy between the short run disequilibrium to the long run equilibrium is closed in the first period. For the aggregate supply response, the rate of adjustment is 14.6% per annum. In addition, the significant of both error correction terms shows that interest rate, government expenditure, relative prices do jointly *Granger* cause supply of palm oil in the short run at the aggregate level.

Most of the diagnosis tests fit the ECM well. The CUSUM analysis in *Figure 3* indicates parameter stability over the sample period both for short run (first-differenced regressor) and long run parameter (error correction term).

TABLE 5. ESTIMATED SPECIFIC ERROR CORRECTION MODEL (ECM) FOR AGGREGATE PALM OIL SUPPLY FUNCTION

Least square: dependent variable is $D\mathit{Ln}\ PO_t$
Sample (adjusted): 1971 to 2002

Variable	Coefficient	Std. error	t-Statistic
EC_{t-1}	-0.146	0.024	-6.160*
$D\mathit{Ln}\ IR_t$	-0.069	0.038	-1.803***
$D\mathit{Ln}\ IR_{t-2}$	-0.087	0.036	-2.415**
$D\mathit{Ln}\ G_t$	0.351	0.076	4.612*
$D\mathit{Ln}\ G_{t-1}$	0.289	0.097	2.978*
$D\mathit{Ln}\ RELP_t$	0.117	0.049	2.399**
$D\mathit{Ln}\ RELP_{t-2}$	0.058	0.037	1.555
$D\mathit{Ln}\ RELP_{t-3}$	-0.049	0.033	-1.487
$D\mathit{Ln}\ PO_{t-1}$	-1.174	0.186	-6.325*
$D\mathit{Ln}\ PO_{t-2}$	-0.714	0.195	-3.671*
$D\mathit{Ln}\ PO_{t-3}$	-0.465	0.149	-3.127*
Constant	2.530	0.402	6.294*

*, **, *** Denote significance at 1%, 5%, and 10% (two-sided test)

R-squared	0.880	Mean dependent var.	0.104
Adjusted R-sq	0.804	S.D. dependent var.	0.101
S.E. of regression	0.045	Akaike info criterion	-3.088
Sum squared residuals	0.038	Schwarz criterion	-2.492
Log likelihood	62.405	F-statistic	11.573
Durbin-Watson	1.907	Prob(F-statistic)	0.000

Notes: Diagnostic tests: Ramsey RESET test (4): 7.135 (0.129); Breusch-Godfrey LM test (2): 1.212 (0.546); Jarque-Bera: 0.033 (0.984); ARCH test (2): 0.527 (0.768).

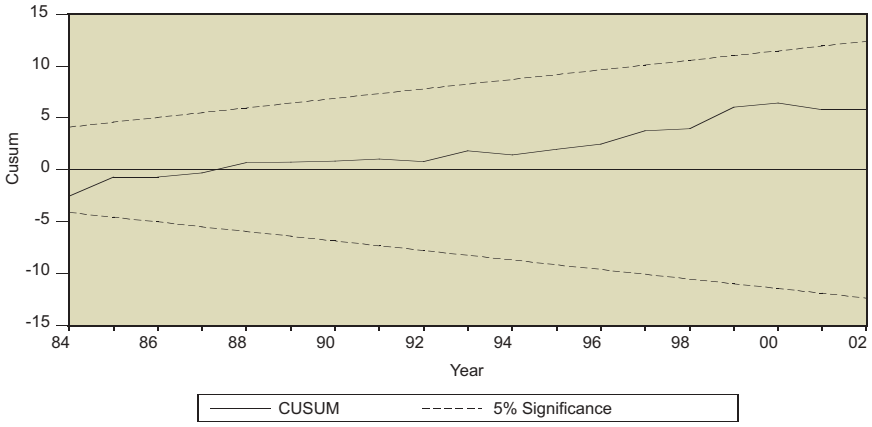


Figure 3. Plot of CUSUM of estimated specific error correction model (Table 5).

CONCLUSION AND POLICY IMPLICATIONS

Using recent time series techniques of cointegration and error correction model, the present study has examined the major determinants of Malaysian palm oil supply response function. The analysis involves the palm oil production in aggregate levels. The findings of this study are significant in terms of model specification and policy implications. The inclusion of the interest rate variable, a proxy for the cost of borrowing, improves model specification. Earlier studies have ignored this variable leading to misspecification error.

The two major findings are monetary policy does has an impact on the planting (investment) decisions. A lower cost of borrowing would encourage

planters to replant old trees or to replace rubber trees with oil palm. This is relevant within the current context of government exhortations to the plantation sector to speed up replanting of old tree stands with higher yielding clones in order to remain competitive. Cost reduction and improvements in efficiency in the application of fertilizers have been suggested, as fertilizers constitute on average about 30% of operational costs. One more approach is to narrow the gap between potential yield and realized yield. The national average yield is about 1.3 t of palm oil per hectare less than that achieved by a well managed plantation. But a more effective long run strategy now, is to increase the rate of replanting. A large proportion of trees planted 25 to 30 years ago are yet to be replanted. Two major findings can be drawn from this study. Firstly, the results of cointegration tests (Johansen, 1988) support a long run equilibrium relationship among palm oil production and its response variables *viz*. interest rate, government's support, relative price. Secondly, as results showed in the Findings section, the palm oil production is responsive to its relative price, government's support, and interest rate, both in the long and short runs.

The policy implications are as follows. The major players of the palm oil industry need to address the challenges facing the industry in a comprehensive manner so that Malaysia is able to maintain competitiveness and profitability (Mohammad, 2000). Firstly, the inclusion of interest rate variable as proxy of opportunity cost or cost of borrowing does improve the supply response specification, in particular the bias of omitted important variables. The interest rate variable is found to be statistically significant in the long and short run specifications, and has the expected sign. It indicates that monetary policy does impact on the planting (investment) decisions. A lower cost of borrowing would encourage planters to replant old trees or to replace rubber trees with oil palm. This is relevant within the current context of government exhortations to the plantation sector to speed up replanting of old tree stands with higher yielding crosses in order to remain competitive. One more approach is to narrow the gap between potential yield and realized yield. But a more effective long run strategy now, is to increase the rate of replanting.

Secondly, the relative price variable is found to be significant for the supply response function, both for the long and short runs, but inelastic. The significance of the relative price level lends empirical support for some form of price policy. Even though price determination is left to the forces of supply and demand with minimal government intervention, an instance of the effect of price policy, even though through an indirect channel, can be seen from the response of the industry to the pegging of the ringgit to the US dollar in September 1998. However, a policy to maintain a minimum price level of palm oil is necessary since decrease of palm oil price will significantly shift the producer's interest to another alternative (like rubber) or to reduce their palm oil production because of low profitability. The crude palm oil prices have been on a down trend from around RM 22 000 in January 1999 to RM 1200 in January 2000, and currently below RM 850/t (Mohammad, 2001). The lower price now appears to discourage replanting as the plantation companies need the cash. But replanting of old trees with high yielding varieties would reduce the average age of trees, and increase the national average yield of CPO produced per hectare. As a major world exporter of palm oil, the exchange rate fluctuation has important implication on country's palm oil industry.

Thirdly, the significance of the government expenditure variable, a proxy for government support, which mainly benefits the smallholding sector, may be interpreted as having a positive effect on palm oil supply response. The significance of the government expenditure variable gives empirical support for government intervention and support in agriculture. A bigger involvement by the government is supported by findings of Schiff (1987). Schiff has shown that price and public goods are complements in the sense that, a better public goods base will enhance the effect of price on supply. What this means is that a higher agricultural price, increases the impact of investment in public goods on output (quoted from Schiff and Montenegro, 1999). The converse is also true. Finally, the significance of the time trend variable (positive sign) indicates the shift of producer's preference to palm oil. It reveals a more optimistic future trend in palm oil price held by producers and pessimism toward future rubber price trend, a lower labour requirement for oil palm compared to rubber, helps to hasten the shift.

ACKNOWLEDGMENTS

We would like to thank MPOB for assisting us the palm oil data collection and an anonymous reviewer for comments. The early version of this paper had been presented at the First International Conference on Banking and Finance: Issues and Strategies, organized by School of Finance and Banking, Universiti Utara Malaysia, Hotel Nikko, Kuala Lumpur, 18-20 August 2000.

REFERENCES

ATESOGLU, H S (1997). Balance-of-payments-constrained growth model and its implications for the United States. *J. Post Keynesian Economics, 19(3)*: 327-335.

ASKARI, H and CUMMINGS, J T (1976). *Agricultural Supply Response*. Praeger, New York.

ASKARI, H and CUMMINGS, J T (1977). Estimating agricultural supply response with the Nerlove model: a survey. *International Economic Review, 18*: 257-92.

AU, KARSHENG and BOYD, M S (1992). An analysis of supply response, export demand and stocks for Malaysian palm oil. *The Malaysian Journal of Agricultural Economics, 9*: 47-58.

BASRI ABDUL TALIB (1988). Supply response analysis of palm oil in Malaysia 1961-1985. *Jurnal Ekonomi Malaysia, 18*: 43-55.

BAHMANI-OSKOOEE, M and BROOKS, T J (1999). Bilateral J-curve between US and her trading partners. *Weltwirtschaftliches Archiv (Review of World Economics), 135*: 156-165.

BOND, MARIAN E (1983). Agricultural response to prices in Sub-Saharan Africa. *International Monetary Fund Staff Papers, 30(4)*: 703-26.

CHEUNG, Y-W and LAI, K S (1993). Finite sample sizes of Johansen's likelihood ratio tests for cointegration. *Oxford Bulletin of Economics & Statistics, 55*: 313-328.

DICKEY, D A and FULLER, W A (1979). Distribution of the estimators for autoregressive time series with a unit root. *J. American Statistical Association, 74*: 427-431.

ENGLE, R F and GRANGER, C W J (1987). Cointegration and error correction: representation, estimation and testing. *Econometrica, 55(2)*: 251-276.

GALBIS, V (1980). Financial intermediation and economic growth in less developing countries: a theoretical approach. *Money and Monetary Policy in Less Developed Countries: A Survey of Issues and Evidence* (Warren, L C and Deena, R K eds.). Pergamon Press, London.

HAKKIO, C S and RUSH, M (1991). Cointegration: how short is the long run? *J. International Money and Finance, 10*: 571-581.

HENDRY, D F and ERICSSON, N R (1991). Modelling the demand for narrow money in the United Kingdom and the United States. *European Economic Review, 35(4)*: 833-886.

JOHANSEN, S (1988). Statistical analysis of cointegration vectors. *J. Economic Dynamics and Control, 12*: 231-254.

JOHANSEN, S and JUSELIUS, K (1990). Maximum likelihood estimation and inference on cointegration - with application to the demand for money. *Oxford Bulletin of Economics and Statistics, 52*: 169-210.

KAPUR, BASANT (1986). *Studies in Inflationary Dynamics: Financial Repression and Financial Liberalization in Less Developed Countries*. Singapore University Press, Singapore.

KHERA, HARCHARAN SINGH (1976). *The Oil Palm Industry of Malaysia: An Economic Study.* Penerbit Universiti Malaya. Kuala Lumpur.

MATHIESON, D J (1980). Financial reform and stabilization policy in a developing economy. *J. Development Economics, 7(3)*: 359-395.

MAD NASIR SHAMSUDIN and FATIMAH MOHD ARSHAD (1993). Malaysian palm oil market model. *Malaysian Agricultural Commodity Forecasting and Policy Modelling* (Fatimah Mohd Arshad; Mad Nasir Shamsudin and Mohd Shahwahid Hj Othman eds.). Centre for Agricultural Policy Studies, Universiti Pertanian Malaysia.

MADDALA, G S (1992). *Introduction to Econometrics.* Second edition. MacMillan, New York.

NERLOVE, M (1958a). Distributed lags and estimation of long run supply and demand elasticities: theoretical considerations. *J. Farm Economics, 40*: 301-310.

NERLOVE, M (1958b). *The Dynamics of Supply: Estimation of Farmers' Response to Price*. John Hopkins University Press, Baltimore, Md.

MOHAMMAD HAJI ALIAS and TANG, T C (2003). *Sumber pertumbuhan sektor pertanian di Malaysia: satu analisis penyebab-akibat*. *Utara Management Review, 4(1)*: 85-103.

MOHAMMAD HAJI ALIAS; ANIZAH MD ALI and MARIA ABDUL RAHMAN (2001). The impact of government policy on the supply response of Malaysian palm oil, rubber and cocoa producers. *Utara Management Review, 2(1)*: 41-64.

MOHAMMAD HAJI ALIAS and TANG, T C (2000). Aggregate imports and expenditure components in Malaysia: a cointegration and error correction analysis. *ASEAN Economic Bulletin, 17(3)*: 257-269.

MOHAMMAD HAJI ALIAS (2000). Penanaman semula kelapa sawit wajar diutamakan. *Berita Harian.* 22 Mach 2000.

OBTERWALD-LENUM, M (1992). A note with quantiles of the asymptotic distributing of the ML cointegration rank test statistics. *Oxford Bulletin of Economics & Statistics, 54*: 461-472.

PHILLIPS and PERRON (1988). Testing for a unit root in time series regression. *Biometrika, 75(2)*: 335-346.

PLETCHER, J (1991). Regulation with growth: the political economy of palm oil in Malaysia. *World Development, 19(6)*: 623-636.

REMALI YUSOFF; MARGARET CHEE and ZULKIFLI SENTERI (1998). Supply and demand model of the Malaysian cocoa industry. *Borneo Review, 9(1*): 67-86.

SCHIFF, M (1987). A structural view of policy issues in African agricultural development: comment. *American Journal of Agricultural Economics, 69(2)*: 384-388.

SCHIFF, M and MONTENEGRO, C E (1997). Aggregate agricultural supply response in developing countries: a survey of selected issues. *Economic Development and Cultural Change, 45(2)*: 393-410.

SELL, F L (1988). Credit as a factor of production in agriculture: evidence from Thailand. *Malaysian Journal of Economic Studies, 25(2)*: 35-43.

SINAI, A and STOKES, H H (1989). Money balances in the production function: a retrospective look. *Eastern Economic Journal, 15*: 349-363.

WICKENS, M R and GREENFIELD, F W (1973). The econometrics of agricultural supply: an application to the world coffee market. *Review of Economics and Statistics, 55*: 433-440.

Appendix 1

DATA DEFINITIONS AND SOURCES

The annual data used in analysis covers the period from 1967 to 2002. All series are in natural logarithmic form (*Ln*). The definitions of involved variables are given below:

1. *Ln*PO is total production of palm oil (crude palm oil) from estates and smallholdings measured in tonnes. Data are obtained from PORLA, *Palmoil Statistics* (various issues) and MPOB (http://www.mpob.gov.my).

2. Bank interest rate (*Ln*IR) is proxied by deposit rate since the lending rate data are only available in 1987 from the *International Financial Statistics* CD-ROM.

3. *Ln*RELP refers to relative price of palm oil to rubber price (1990=100). The source of palm oil price data is PORLA. Local delivery and rubber price are from the Ministry of Primary Industries, Malaysia, *Statistics on Commodities* (various issues). Both measured in RM/t.

4. Government expenditure (Ln G) is the sum of Federal Government development expenditure and current expenditures. The series are deflated by Consumer Price Index (1990=100). Data are from Bank Negara Malaysia, *Monthly Statistical Bulletin* (various issues).