

# PRODUCTION AND EXPORT MARKETING MODEL

## A Case Study for Malaysian Palm Oil

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*Studi ini bertujuan mengembangkan suatu model pemasaran yang sesuai dengan pemasaran minyak sawit dan mengambil kasus pada produksi dan pemasaran minyak sawit Malaysia.*

*Data yang digunakan dikumpulkan dari berbagai sumber dalam kurun waktu 1960 sampai dengan 1993. Model estimasi terdiri dari 11 persamaan struktur dan 6 identitas serta diestimasi menggunakan 2 SLS (stage least square) dengan metode principle component.*

*Hasil empiris menunjukkan kinerja pemasaran minyak sawit Malaysia dipengaruhi oleh variabel-variabel pemasaran terutama variabel pasar internasional seperti harga sawit dunia dan harga beberapa minyak substitusi, serta instrumen kebijakan pada sisi produksi. Harga minyak sawit Malaysia di pasar internasional secara berarti ditentukan oleh harga dan konsumsi minyak sawit dunia. Dengan demikian meskipun Malaysia sebagai penghasil dan pengekspor utama minyak sawit dunia, namun Malaysia hanya berperan sebagai penerima harga (price-taker) bukan sebagai penentu harga (price-maker).*

**Keywords:** export marketing model; palm oil

### Introduction

During the period 1975-1993 the domestic consumption of palm oil increased gradually in Malaysia. This can be partly attributed to the lowering of yields on coconut plantations and increasing palm oil production. Until 1974, Malaysian exports were in the form of crude oil and the major markets were in the developed countries such as the European Economic Community (EEC), the United States, and Japan. Since 1975, when palm oil began to be refined in Malaysia, processed palm oil (PPO) has begun to dominate Malaysian palm oil exports, and its markets have

diversified to other countries such as India, the Middle East, Africa, Eastern Europe, and Asia. As a result, the palm oil industry has become a major contributor to export earnings, and has become an important provider of employment. This means that the performance of the Malaysian economy in terms of growth rates and stability will also be determined by among other things, the performance of its palm oil sector.

The Malaysian palm oil industry has been plagued by instability as reflected in fluctuations in its exports and export prices as well as in instability indices (Yusoff, 1987). Stiff competition coupled with trade

barriers to Malaysian palm oil exports has exacerbated this instability in the Malaysian palm oil market. Market competition comes from 12 other major sources of oils and fats, including soybean, groundnut, rapeseed, cottonseed, sunflowerseed and coconut. Major oilseeds such as soybean and rapeseed are produced for the feedmeal industry, for the most part under subsidized systems of agriculture prevalent in the developed countries. The prices of these subsidized oilseeds are usually below the world market prices. Consequently, price competition along with instability in expanding the market and in demand, present problems for the Malaysian palm oil industry.

Palm oil has been exported from Malaysia since the 1920, and is taxed as an export crop. Export taxes are levied by the government for two main reasons: *first*, to deliberately depress domestic prices in order to protect internal buyers or consumers from having to pay higher world prices of palm oil; and *second*, to generate revenue for the government. Besides depressing domestic prices which in turn increases domestic consumption, the tax may induce higher export prices which may decrease the production and export volume (Houck, 1986). In this case, the direct losers are domestic producers and possibly foreign buyers of palm oil. This study therefore attempts to model the marketing of Malaysian palm oil and evaluate the impact of policy instruments and market variables on major market participants in the industry. Another objective is to ascertain the market relationship between Malaysian palm oil and competing products on the world market.

## Model Specification, Identification and Estimation

On the supply side, production of palm oil as a perennial crop is characterized by a long production lag between planting and harvesting, and lengthy response to technological and seasonal changes. The establishment stage it takes a period of 3 to 4 years to establish the palms, during which time care is needed to obtain a full stand of healthy palms of a high production potential. This is then followed by the productive stage, from 4<sup>th</sup> or 5<sup>th</sup> to the 25<sup>th</sup> or 30<sup>th</sup> years, varying according to its main yields. The production of palm oil generally tends to increase from the 4<sup>th</sup> year to the 10<sup>th</sup> year, after which production slowly tapers off.

### Production Model

The model used to estimate Malaysian palm oil production is based on a model developed by Wickens and Greenfield (1973). For the purposes of this study, some modifications have been made to this model: taking into account the role of the price of rubber as a competing crop, and the policy of re-planting grants for palm oil production. Briefly, the Wickens and Greenfield model consists of three basic structural relationships (vintage production function, investment function and harvesting decision function) reflecting the supply response in both short and long runs, as follows:

$$Q^p_t = \sum_{i=1}^n \delta(i,t) I_{t-i} \quad \delta(i,t) = \delta_i \quad (1)$$

$$I_t = \beta_0 + \beta_1(P_t)\beta_2(I_{t-1}) \quad (2)$$

$$Q_t^p = \alpha_0 + \alpha_1 Q_t^p + \sum_{i=0}^n b_i P_{t-i} \quad (3)$$

where  $Q_t^p$  = potential production at time  $t$

$I_{t,i}$  = the number of trees planted  $i$  years ago and surviving to year  $t$

$\delta(i,t)$  = the average yield of these trees. Technical progress occurs if  $\delta(i,t)$  is a positive function of time. It is assumed that  $\delta(i,t) = \delta i$

$n$  = the maximum length of life of a tree

$P_t$  = palm oil price in time  $t$

$I_t$  = the number of trees in time  $t$

$Q_t$  = actual production in the period  $t$

$P_{t,i}$  = lagged palm oil prices

Because of the length of the lag (25-30 years) and the flatness of the yield pattern after 10 years, a first difference form of the production model was adopted. By combining equations (1), (2), and (3) using the lag operator, the final form of production equations for both estate and smallholder sectors are as follows:

Production model for estate

$$Eq_t = \beta + (1 + \beta_2)Eq_{t-1} - \beta_2 Eq_{t-2} + \sum_{i=0}^n \delta_i^* DP_{t-1} + \alpha_1 \beta_3 \sum_{i=0}^n \delta_i^* NRP_{t-1} + u_t \quad (4)$$

Production model for smallholder

$$Sq_t = \beta + (1 + \beta_2)Sq_{t-1} - \beta_2 Sq_{t-2} + \sum_{i=0}^n \delta_i^* DP_{t-1} + \alpha_1 \beta_3 \sum_{i=0}^n \delta_i^* NRP_{t-1} + \alpha_1 \beta_4 \sum_{i=0}^n \delta_i^* RG_{t-1} + u_t \quad (5)$$

where,

$$\begin{aligned} \delta_i^* &= \delta_i, \delta_i^* = \delta_i && \text{for } i = 0 \\ \delta_i^* &= \delta_i - \delta_{i-1}, \delta_i^* = \delta_i - \delta_{i-1} && \text{for } i = 1, \dots, n \\ \delta_i^* &= -\delta_{i-1}, \delta_i^* = -\delta_{i-1} && \text{for } i = n + 1 \end{aligned}$$

Total production,

$$Q_t = Eq_t + Sq_t \quad (6)$$

where,

$Eq_t$  and  $Sq_t$  = palm oil production on estate and smallholders, respectively, in metric ton

$DP_t$  = domestic price of palm oil

$NRP_t$  = domestic price of natural rubber

$RG_t$  = re-planting grant in hectares (be effective only for smallholders, not for estates)

$U_t$  = disturbance term with zero mean and constant variance

$n$  = the number of lag

Analysis of Demand for Palm Oil

Demand for palm oil is a derived demand. Palm oil is largely used as an input in the manufacture of margarine and compound cooking fat, as well as in the manufacture of soap and candles.

The general structure of Malaysian palm oil demand function can be written as:

$$Q_t = f(P_t, PC_{it}, Y_t, Z_{it}) \quad (7)$$

where,  $Q_t$  = quantity of palm oil demanded

$P_t$  = price of palm oil

$PC_{it}$  = price of some relevant palm oil substitutes

$Y_t$  = economic activity level

$Z_{it}$  = shift factors

Equation (7) presents a static relationship of the demand function. Labys (1973) argued that static relationship suffers from several weaknesses such as the failure to make a distinction of differences in demand response between the short run and the long run, the omission of possible links with inventory adjustment, and the exclusion of the influence of past levels of demand. For these reasons, we turn to the consideration of dynamic relationships. According to the dynamic theory, demand in any period is assumed to adjust only partially towards desired or equilibrium demand. Thus, the long run demand function for palm oil ( $Q^*$ ) can be written as

$$Q^*_t = a_0 + a_1 P_t + a_2 PC_{it} + a_3 Y_t + a_4 Z_{it} + u_t \quad (8)$$

Since the long run (desired) quantity demand for palm oil,  $Q^*$ , cannot be observed, equation (8) cannot be estimated directly. Thus, by following the stock adjustment process, it is necessary to introduce a postulate that the change in current quantity demanded will vary in proportion to the difference between long run quantity demanded and past quantity demanded. The adjustment process is approximated by

$$Q_t - Q_{t-1} = \theta(Q^*_t - Q_{t-1}), \quad 0 < \theta < 1 \quad (9)$$

where,  $Q_t$  = current actual quantity of palm oil demanded  
 $Q^*_t$  = current desired quantity of palm oil demanded  
 $Q_{t-1}$  = lagged actual quantity of palm oil demanded  
 $\theta$  = a coefficient describing the speed of adjustment

Equation (9) states that the firms are adjusting from a non-optimal to an optimal situation. If  $\theta = 1$ , the current actual quantity of palm oil demanded is equal to the current desired quantity of palm oil demanded. This implies that the firms are instantaneously adjusted and always in equilibrium. If  $\theta = 0$ , the current actual quantity of palm oil demanded is equal to the preceding actual quantity of palm oil demanded, implying that the firms are not adjusting.

From equation (9),  $Q^*$ , can be expressed in terms of directly observable variables using simple algebraic manipulations as

$$Q^*_t = (1/\theta) Q_t - [(1-\theta)/\theta] Q_{t-1} \quad (10)$$

By substituting the value of  $Q^*$ , in equation (10) into equation (8), we obtain

$$(1/\theta) Q_t - [(1-\theta)/\theta] Q_{t-1} = a_0 + a_1 P_t + a_2 PC_{it} + a_3 Y_t + a_4 Z_{it} + u_t \quad (11)$$

By multiplying both sides of equation (11) by  $\theta$ , we obtain

$$Q_t - (1-\theta)Q_{t-1} = a\theta + a_1\theta P_t + a_2\theta PC_{it} + a_3\theta Y_t + a_4\theta Z_{it} + \theta u_t$$

$$Q_t = a_0 + a_1\theta P_t + a_2\theta PC_{it} + a_3\theta Y_t + a_4\theta Z_{it} + \theta u_t$$

or

$$Q_t = \beta_0 + \beta_1 P_t + \beta_2 PC_{it} + \beta_3 Y_t + \beta_4 Z_{it} + \beta_5 Q_{t-1} + v_t \quad (12)$$

where  $\beta_0 = a_0\theta$        $\beta_4 = a_4\theta$   
 $\beta_1 = a_1\theta$        $\beta_5 = (1-\theta)$   
 $\beta_2 = a_2\theta$        $v_t = \theta u_t$   
 $\beta_3 = a_3\theta$

From equation (12) we can estimate the elasticity of adjustment ( $\alpha$ ) as

$$\alpha = (1 - \beta_1 [Q_t - 1/Q_t]) \quad (13)$$

Equation (12) is the demand equation in its general form for both domestic and export palm oil markets. In order to differentiate the derived demand for these markets, the variables in equation (12) are renamed with relevant variables for domestic demand (DDPO) and export demand (India, XI; Japan, XJ; The United States, XUS; the United Kingdom, XUK; Netherlands, XN; The rest of EEC, XRE and the rest of importing countries, XR). Identities for total export (EDPO<sub>t</sub>), total demand (TCPO<sub>t</sub>) and world consumption of palm oil (WC<sub>t</sub>) respectively, are as follows:

$$EDPO_t = XI_t + XJ_t + XUS_t + XUK_t + XN_t + XRE_t + XR_t \quad (14)$$

$$TCPO_t = DDPO_t + EDPO_t \quad (15)$$

$$WC_t = DDPO_t + EDPO_t + RWC_t \quad (16)$$

RWC<sub>t</sub> is the rest of world consumption

### Price of Palm Oil

The price determination model follows the model developed by Hwa (1979) and Tan (1984). The approach chosen for this model is to begin with a price adjustment model under a dynamic stock disequilibrium system. Equation (17) represents the price equation for Malaysian palm oil on the world market:

$$WPO_t = k_0 + k_1 WC_t + k_2 WPO_{t-1} - k_3 WPO_{t-2} - k_4 SPO_t + U_t \quad (17)$$

Identity equation for palm oil stock:

$$SPO_t = SPO_{t-1} + Q_t - TCPO_t \quad (18)$$

where: WPO<sub>t</sub> = price of Malaysian palm oil in the world market in US dollar

WC<sub>t</sub> = world consumption of palm oil in metric ton

SPO<sub>t</sub> = palm oil stock in metric ton

U<sub>t</sub> = stochastic disturbance term

In order to link the domestic and the world prices, it is necessary to introduce a price transmission equation as a differential as follows:

$$DP_t = WPO_t (e_t) - XT_t \quad (19)$$

where: DP<sub>t</sub> = domestic price of palm oil in Malaysian ringgit

e<sub>t</sub> = marketing weighted real exchange rate

X<sub>t</sub> = export duty in ringgit per metric ton

### Model Identification, Estimation and Data Source

The estimated model consists of 11 structural equations and 6 differentials. The 11 structural equations are composed of 2 equations for production, 8 for demand function and 1 equation for price determination. The 6 differential equations, differentiate the domestic price of Malaysian palm oil, palm oil stocks, total Malaysian palm oil production, total export demand and total consumption of (demand for) Malaysian palm oil and total world consumption of palm oil. The 11-structural equations satisfy both the order and rank conditions for differentiation. The structural equations consist of 17 and 40

endogenous and predetermined variables respectively and all the equations are cross-differentiated. The structural equations are estimated by means of the two stage least square (2SLS) with principal component (PC) method.

The data used in this study were collected from various sources and cover the period 1960-1993. Malaysian data on palm oil production, consumption, stock, price, policies and others were obtained from Ministry for Primary Industry, PORLA, PORAM, PORIM, RISDA, FELDA, FELCRA and Statistics Department of Malaysia. World data on these components were obtained from Ministry for Primary Industry and various publications related to this study, such as FAO production and trade year books, and World Bank and IMF reports.

### **Empirical Results**

This section presents results of the statistical analysis of the marketing model for Malaysian palm oil and its economic interpretation.

### **Production of Palm Oil by the Estate Sector**

The production function of Malaysian palm oil is estimated separately for estates and smallholders. As such, the role of replanting grant policy on smallholder production can be properly examined.

In the production function for estates as presented in Table 1, the goodness of fit of the equation in term of  $R^2$  is satisfactory. This indicates that the predetermined variables explain well, variations in the dependent variable. Serious serial correlation is not observed as shown by the insignificance of the  $h$  statistic. The result of  $F$  statistic suggests that the Almon lag is not overly restrictive.

The coefficient estimates show the expected signs, except for production lagged by two periods ( $Eq_{t,2}$ ) which is positive but insignificant. According to a priory expectation, the coefficient of  $Eq_{t,2}$  should be negative. However, as cited by Wickens and Greenfield (1973), in practice the expected sign for the  $Eq_{t,2}$  coefficient seldom appears. This is probably due to the botanical and ecological problems of palm oil and the fact that the investment function is not captured exactly by the investment equation.

The coefficient for production lagged by one period is significant at one percent level and the adjustment coefficient is 0.2834. This result indicates that the adjustment to the equilibrium level is quite slow and only about 28 percent of actual production is adjusted to the desired level each year. This is partly due to large fixed investment in the palm oil production and the prolonged biological nature of the production process. The coefficient estimates for the distributed lags of domestic price of Malaysian palm oil follow the expected pattern, consistent with the typical age-yield profile of the palm oil. The price coefficients have negative values from one to three lagged periods and show positive values on current and lagged four to six periods.

A key factor in determining the harvesting decision, current domestic price is an important determinant of palm oil production. The impact of domestic lagged-price of palm oil of four, five and six periods are positive and significant at five, one and five percents respectively. The significance of these variables indicates the time period in which producers decide to invest in response to the price changes.

The coefficient of the price of natural rubber lagged by four periods is negative and significant at the one percent level.

Table 1. Estimated Production Equations for Estate and Smallholder

Variable	Estate (Eq)		Smallholder (Sq)	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	-20407	-0.2697	-268720	-0.9718
Eq (-1)	0.7166	3.9584***	-	-
Eq (-2)	0.3173	1.6561	-	-
Sq (-1)	-	-	0.8076	4.6211***
Sq (-2)	-	-	0.0702	0.1849
DP	285.03	3.5847***	64.803	0.2482
DP(-1)	-121.46	-2.2919**	-7.9486	-0.0487
DP(-2)	-195.77	-4.2371***	-24.929	-0.1519
DP(-3)	-67.091	-1.1890	7.3001	0.0468
DP(-4)	135.39	2.1846**	82.177	1.3678
DP(-5)	282.47	3.2063***	193.14	2.7039**
DP(-6)	244.99	2.1167***	333.63	2.9097***
NRP(-4)	-176.62	-2.9761***	-95.615	-0.4777
RG(-3)	-	-	31.893	3.8708***
R2	0.9896		0.9639	
F	142.7307***		48.5469***	
h	-1.2788		-1.0701	

\*\* significant at 5% level

\*\*\* significant at 1% level

note : This equation is estimated using a polynomial distributed lag structural of degree 3 without endpoint restriction.

This indicates that rubber, a competing crop for palm oil, is also an important determinant for estate palm oil producers in making investment decisions. The cross price elasticity of palm oil supply with respect to price of natural rubber lagged by four periods is low and inelastic at -0.2275. This result suggests that variations in the price of natural rubber as competing crop for palm oil have a relatively small effect on palm oil production

### Production of Palm Oil by the Smallholder Sector

The production function for the smallholder sector takes into consideration the role of re-planting grant program. As shown in Table 1, the fit of the equation is good as depicted by the high value of R<sup>2</sup> at 0.96. Serious serial correlation is not observed in the model, as indicated by the insignificant h statistic. Consistent with

the results for estate supply, the value of  $F$  statistic for smallholders reflects that the Almon lag is not overly restrictive compared to ordinary least square without restrictions. The signs of coefficient estimates are generally good, with the exception of production by lagged two periods ( $Sq_{t,2}$ ), which is not as expected. As mentioned earlier, this is common in practice because obtaining the expected sign for the coefficient is very difficult.

The coefficient of production lagged by one period is significant at the one percent level, and the adjustment coefficient of 0.1924 is lower than that of estate supply. This implies that only about 19 percent of actual production is adjusted to the desired level per year. This is partly due to large fixed investment in the palm oil production and the prolonged biological nature of the production process.

The coefficient estimates for the distributed lag prices approximate expectations. The positive and negative portions are consistent with the typical age-yield profile of the oil palm. The price coefficients have positive values over the periods at the tail-ends and are negative in value over the interim lagged periods. The coefficient for current price, which represents the harvesting decisions, is positive but not an important factor of palm oil production. This is probably attributed to the rapid development of the palm oil industry in Malaysia in the last 18 years. Being a perennial crop, once oil palm is planted, it becomes a fixed input and is quite costly to replace. The distributed lag prices then fall off rapidly, becoming negative at lag one and two. The coefficients then become positive at lag three to six, but only lag five and six are significant at five and one percent respectively. The significant effect of the prices lagged five and six periods on smallholder production reflects

the investment decision made by producers at the time. It can be seen that the investment decisions in the smallholder sector are made more slowly than that in estate sector, which begins at lag four. This is probably due to the more systematic and manageable production planning systems on estates. Also, advanced technology has shortened the gestation period of oil palm production on estates.

The coefficient of the price of natural rubber lagged four periods is negative, unlike the estate sector, this is not an important factor for palm oil production in the smallholder sector. The cross price elasticity of palm oil supply and the price of natural rubber lagged four periods is low and inelastic at 0.1817. This indicates that the effect of variations in the price of this competing crop on palm oil production by smallholders is relatively small.

The production of palm oil by smallholders is also determined by the re-planting grant variable, as indicated by the significance of that variable at one percent level. During the period of estimation, an additional one hectare cultivated with oil palms under the re-planting grant program would increase palm oil production by about 32 tons. This result implies that the average productivity of palm oil production under this program is about 1.14 ton per hectare, lower than the average productivity of palm oil production on estates which is about 3.5 tons per hectare.

## **Domestic Demand for Malaysian Palm Oil**

The estimated result for domestic demand function is presented in Table 2. The results are satisfactory in terms of the goodness of fit and significance of the variables. All the estimated coefficients have the expected signs. Serious serial



Table 2. Estimated Demand Equation for Domestic Market

Variable	Coefficient	t-ratio
Constant	-76732	-2.8180***
DP	-3.8118	-0.2040
PSO	2.4016	0.0977
PGO	74.225	6.6850***
MPI	2032.6	15.012***
DDPO (-1)	0.5128	14.877***
R2		0.9217
F		58.8569***
H		-1.3559

\*\*\* significant at 1% level

correlation is not observed, as shown by the insignificance of the *h* statistic.

The results indicate that the price of palm oil and price of soyabean oil as a substitute for palm oil are not important determinants of the demand for palm oil on the domestic market. The important determinants are the price of groundnut oil, the level of economic activity (which is proxied by Malaysian industrial production index), and domestic demand lagged by one period. All the important determinant coefficients are significant at one percent level.

The elasticities of the domestic demand for palm oil with respect to the price of palm oil itself, and the prices of soyabean and groundnut oils are low and inelastic at -0.0184, 0.0058 and 0.2681 respectively. These elasticities indicate that domestic demand is not responsive to changes in the price of palm oil or its substitutes. The price of groundnut oil is significant, since this product is indeed a substitute for palm oil on the domestic market. In the earlier estimation, the price of coconut oil was also incorporated and run in the equation as one of the substitutes for palm oil,

however the result did not provide any significant relationship and hence it was excluded from the equation.

The coefficient for domestic demand lagged one period is also significant at the one percent level and the adjustment coefficient is 0.4872. This indicates that the adjustment to optimal level is relatively slow and only about 48 percent of actual domestic demand is adjusted to the desired level per year. The lag in the adjustment may be due to the fact that manufacturers or users take time to change from using of one type of fat or oil to another, in response to changes in the determining factors.

### Export Demand for Malaysian Palm Oil

Table 3 presents the results of estimated export demand equations for Malaysian palm oil. It can be seen that the results for all equations are satisfactory in terms of the goodness of fit as depicted by the high  $R^2$  values. Serial correlation is not observed in any of the equations, as shown by the insignificance of the *h* statistic, and all the estimated coefficients have the expected signs.

Table 3. Estimated Export Demand Equations

Export to	Variable												
	Constant	WFO	PSO	PGO	PRO	PCSO	PSFO	PCO	INPH	XI(-j)	RZ	f	h
India (XI)	-144030 (-2.056**)	-181.01 (-3.03***)	13.047 (0.289)	81.804 (3.44***)	85.729 (1.98*)	-	-	-	3991.8 (8.978***)	0.4418	0.7695	13.3535*** (8.762***)	0.7323
Japan XJ	-4624.4 (-0.759)	-104.61 (-3.001***)	35.401 (0.658)	-	108.51 (2.058**)	-	-	-	41.435 (0.2944)	0.9562	0.9860	352.143*** (21.303***)	0.2955
USA (XUS)	-83745 (-2.728**)	-30.425 (0.9001)	18.398 (2.089**)	-	-	62.066 (3.912***)	38.052 (2.466**)	-	1475.6 (4.56***)	0.3387	0.9001	36.04*** (4.621***)	-0.025
U. Kingdom (XUK)	-101770 (-2.972***)	-79575 (-2.411**)	24.532 (2.219**)	-	43.00 (4.76***)	-	-	0.759 (0.0638)	1651.5 (3.755***)	0.2626	0.8627	25.133*** (4.573***)	0.149
Netherlands (XN)	-9552 (-6.529***)	-83.831 (-3.593***)	-	41.134 (9.74***)	35.634 (3.484***)	-	27.165 (2.84***)	-	1932.4 (10.009***)	0.4095	0.8973	34.948*** (10.744***)	0.334
The res of EEC(XRE)	-37556 (-3.928***)	-14.499 (-1.4728)	5.8825 (1.1981)	11.995 (6.78***)	11.968 (2.994***)	-	8.5249 (2.171**)	-	605.54 (4.467***)	0.2901	0.8778	23.602*** (5.171***)	0.627
The rest of importing Countries(XR)	-93190 (-5.644***)	-1571.3 (-10.16***)	-	335.2 (7.07***)	22.696 (0.2403)	147.3 (1.5475)	-	-	23747 (20.08***)	0.6245	0.9381	60.620*** (18.717***)	0.556

\* Significant at 10% level

\*\* Significant at 5% level

\*\*\* Significant at 1% level

Note: Numbers in parentheses are t values

Palm oil exports to India are influenced significantly at one percent by the price of Malaysian palm oil on the world market, the market price of groundnut oil, the industrial production index of India, exports lagged one period, and at ten percent by the market price of rapeseed oil. Soyabean oil—another substitute for palm oil India—has the expected sign, but is not significant in determining the performance of palm oil exports to India. Cross-price elasticities with soyabean, groundnut and rapeseed oils are low and inelastic at 0.0227, 0.2103 and 0.1520 respectively. These indicate that export demand to India is not responsive to substitute oil prices, but the significance of groundnut oil and rapeseed oil prices shows that they are substitutes for palm oil exports to India. Export demand for palm oil to India is also significantly dependent on palm oil exports lagged one period. The adjustment coefficient is 0.5582, indicating that the adjustment to optimal level of palm oil export to India is relatively slow at about 56 percent per year. This may be due to the importers taking time to change from the importing of one type of fats and oils to another.

Palm oil export to Japan is significantly influenced by the price of palm oil itself and the price of and rapeseed oil. Similar to the results for exports to India and rest of EEC, palm oil exports to Japan are not significantly determined by price of soyabean oil, although it has the expected sign. The other insignificant variable in determining exports to Japan is the industrial production index of Japan. The performance of palm oil exports to Japan is also influenced by palm oil exports to Japan lagged one period. The resultant adjustment coefficient is 0.0438, showing that adjustment to optimal level is quite slow.

Palm oil exports to the United States are significantly influenced at the five percent level by soyabean and sunflowerseed oil prices. The other important variables determining the palm oil export to the country are the price of cottonseed oil, the industrial production index of the United States, and palm oil exports lagged one period. All these variables are significant at one percent level. The adjustments coefficient which is reflected by export demand lagged one period is 0.6613, suggesting that adjustment to the desired level of palm oil export to the United States is rapid at about 66 percent per year. Unlike the results for exports to India, Japan, the United Kingdom, Netherlands and the other importing countries, palm oil exports to the United States are not significantly influenced by the price of Malaysian palm oil in the world market, although it has the expected sign. This may be associated with the consumption pattern of palm oil in the United States which is used heavily to supplement the shortage of land for the production of manufactured fats, especially shortening (Senteri, 1988).

Palm oil exports to the United Kingdom are significantly influenced by the price of palm oil itself and the price of soyabean oil at five percents level, and at the one percent by the price of rapeseed oil, the industrial production index of the United Kingdom, and palm oil exports to the UK lagged one period. This result indicates that the price of palm oil and the prices of both palm oil substitutes are important variables in determining the performance of palm oil exports to the United Kingdom. The significance of rapeseed and soyabean oil prices confirms the belief that both commodities are indeed a substitute for palm oil in the United Kingdom. The result also shows that coconut oil has the expected sign, but this is not

significant in influencing the performance of palm oil exports to the United Kingdom. Export demand for palm oil to the United Kingdom is also significantly determined by palm oil export to this country lagged one period. The adjustment coefficient is 0.7374, implying that adjustment to optimal level is rapid at about 74 percent per year.

Export demand for palm oil to the Netherlands is significantly (at one percent) determined by the price of palm oil itself, the prices of groundnut, rapeseed and sunflowerseed oils, and the industrial production index of the Netherlands. The result also shows that the coefficient for lagged palm oil exports is significant at one percent level. This result is consistent with the results for exports to India, Japan, the United States, the United Kingdom, other EEC countries and the other importing countries. The adjustment coefficient is 0.5905, indicating that adjustment to the desired level of palm oil exports to the Netherlands is about 60 percent per year.

Export demand to the rest of EEC countries is not significantly influenced the price of palm oil itself, or by the price of soyabean oil. The insignificance of the price of palm oil is partly due the fact that palm oil in these countries is used mainly to supplement shortages of vegetable oil. Export demand for palm oil to these countries is determined significantly at the one percent level by the prices of groundnut and rapeseed oil, industrial production indices, and the export of palm oil to other EEC countries lagged one period, and at five percent by the price of sunflowerseed oil. The significance of the prices of rapeseed, sunflowerseed and groundnut oils confirm the belief that the three oils are indeed substitutes for palm oil in the rest of EEC. It should be noted that among the rest of EEC countries, rapeseed oil is mainly

produced by France, Federal Republic of Germany and Denmark; sunflowerseed oil by France and Spain; and that coconut oil is mainly imported by Federal Republic of Germany, France, Italy, Spain and Denmark. The adjustment coefficient as shown by the coefficient of lagged period of palm oil exports to the rest of EEC countries is low at 0.3755. This implies that adjustment to optimal level is slow as importers need time to change from one type of fats and oils to another.

Palm oil exports to the other importing countries is significantly determined at the one per cent level by the price of palm oil itself, the price of groundnut oil, the industrial production indices and palm oil exports to these countries lagged one period. The adjustment coefficient is 0.3755, indicating that adjustment to optimal level is relatively slow. This result is also consistent with the results for exports to India, Japan, the United States, the United Kingdom, the Netherlands and the rest of the EEC.

These results clearly indicate that the price elasticities of export demand to all the countries with respect to the price of palm oil are inelastic. This indicates that export demand to all the countries is not responsive to the price of palm oil. However, the significance of the price of palm oil itself in determining palm oil exports to India, Japan, the United Kingdom, the Netherlands and other importing countries shows that the price of palm oil is one of the important market variables determining the performance of Malaysian palm oil exports to these countries.

The cross elasticities of export demand to all the countries with respect to the substitute oils are also inelastic. This indicates that export demand to all the countries is not responsive to prices of substitute oils. However, the significance

of most of the substitutes oil prices indicate that these oils are indeed substitutes for palm oil on the world market. This implies that the Malaysian palm oil industry faces price competition with soyabean, groundnut, rapeseed, and sunflowerseed oils on the world market. With the exception of Japan, variations in industrial production indexes have large effect on the export demand. In other words, export demand for Malaysian palm oil also depends on the economic conditions of the importing countries.

### Price of Malaysian Palm Oil in the World Market

The results of the estimated equation of Malaysian palm oil on the world market

are presented in Table 4. They are satisfactory in terms of the goodness of fit as depicted by  $R^2$  and significance of the variables. The coefficients of the variables have the expected signs, serious serial correlation is not observed as shown by the insignificant  $h$  statistic. The results indicate that the model is capable of explaining the Malaysian palm oil price behavior on the world market.

The main determinants influencing the price of Malaysian palm oil on the world market are world consumption of palm oil and the price of Malaysian palm oil on the world market lagged one period. These variables are significant at five and one percent respectively. The price lagged by two periods and palm oil stocks are not significant although they have the expected signs.

Table 4. Estimated Price Equation of Malaysian Palm Oil in the World Market

Variable	Coefficient	t-ratio
Constant	101.940	1.2119
WC	0.000033	2.4994**
SPO	-0.0005	-0.4448
WPO (-1)	0.7459	3.4280***
WPO (-2)	-0.1407	-0.6023
$R^2$	0.8274	
F	31.1593***	
H	0.2690	

\*\* Significant at 5% level

\*\*\* Significant at 1% level

## Conclusion and Policy Implications

Theoretical and empirical analyses show that current and future prices of Malaysian palm oil and the prices of its substitutes have a substantial impact on palm oil producers in making harvesting and investment decisions, and on marketing performance. In the case of smallholders, replanting grants are a further variable determining the investment decision; and in the case of estates, the price of natural rubber. Thus, the authorities concerned should further enhance the transmission of information on prices to palm oil producers or exporters, enabling them

to make better decisions and improve performance. The Malaysian palm oil industry should also be able to adopt a proactive stance and develop new forms of marketing and production arrangements through joint ventures, counter-trading, off-shore investment and integrated production processes to expand its market share in the world palm oil market.

The re-planting grant program needs to be continued and developed as it has a positive effects on smallholder production and also encourages private sector participation in the palm oil industry. This program should be aim at producing high yielding palms.

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