An Econometric Analysis of the United States’ Palm Oil Market*

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ABSTRACT

Palm oil imports into the United States have fluctuated drastically over the years. Thus, the objective of this study is to investigate the factors that caused the fluctuations. The results show that palm oil is a substitute for vegetables oils and animal fats. However, it is less responsive to vegetable oils than to animal fats. Thus, palm oil is competitive in the United States market as long as its price remains lower than the overall fats and oils prices and it can be more versatile in terms of end uses. The study also revealed that palm oil is held not only for pipeline purposes but also for other reasons such as speculation, delay in response and error in judgement.

INTRODUCTION

The United States began to import palm oil as early as the fifties. However, since the late sixties the US palm oil imports have increased steeply, reaching 960 million pounds in 1975. The late sixties also marked a change in the source of supply of imported palm oil from western Africa countries, such as Nigeria, to Malaysia. This makes

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the United States one of the important palm oil importing countries especially, for Malaysia. Since then, palm oil import into the United States had been fluctuating. It fluctuated from as low as 6 million pounds in 1964 to as high as 960 million pounds in 1975. However, the United States remain among the ten most important palm oil importing countries in the world. The fluctuations in palm oil imports into the United States was caused by the fluctuations in the supplies of other fats and oils, especially lard and soybean oil, as such other related factors, such as price premium or discount between palm oil price and the price of other fats and oils.

Since the United States is one of the important palm oil importing countries, and that most of the palm oil imported into the country are from Malaysia, it would be desirable to understand the environment surrounding palm oil demand in the US. An understanding of the factors affecting the United States palm oil market is of paramount importance to the exporting countries, especially Malaysia. This is due to the big size of the United States fats and oils market and the influence it has on the world’s fats and oils market. Any change in the factors affecting demand and supply of fats and oils in the United States will ultimately affect the world market.

Many of the studies on palm oil in the US and other countries are descriptive (Kromer 1969, 1972, and Elam and Uko 1977). Empirical studies of palm oil in the United States are limited in number and scope and outdated (Thiam 1973, Senteri 1978). Thiam and Senteri, for example estimated single equation demand functions, for palm oil in the countries they studied. Thiam estimated the demand functions for US, UK, Italy, Belgium – Netherland, France – Germany and Japan while Senteri estimated demand functions for US, Japan, Iraq and EEC countries. Due to an apparently high degree of substitution between fats and oils, and the apparent simultaneous relation among consumption, prices and stock, estimation of a single equation demand function may result in simultaneous equation bias.

Other studies on other types of fats and oils such as soybean oil (Houck et al. 1968, and Vandenborre 1966, 1967, Williams 1977), and lauric oils, (i.e. coconut and palm kernel oils) (Nyberg 1970, and Labys 1973, 1975) failed to include or determine their interactions with palm oil individually. Exclusion of palm oil as a variable or including it with other fats as a weighted variable and oils in their equations reflected the fact that palm oil only became an important component of the United States market in the early seventies. As
such the researchers might not have considered palm oil as an important variable in their equations.

UNITED STATES DEMAND FOR PALM OIL

More than 65 percent of the palm oil consumed in the United States are used as an intermediate input in the manufacture of shortening, and the rest is used in the production of other final products. That is, palm oil is not consumed as a final product but rather as an intermediate product. Thus, the demand function for palm oil in the US will be that of a derived demand. Henderson and Quandt (1980), stated that the producer inputs demand are derived from the underlying demand for the commodity which he produces. Using the following production function:

\[ q = A x_1^\alpha x_2^\beta \]  

with \( \alpha, \beta > 0, \alpha + \beta < 1 \),

they form the profit function

\[ \pi = pA x_1^\alpha x_2^\beta - r_1 x_2 - r_2 x_2 \]

and set its partial derivatives equal to zero:

\[ \frac{\partial \pi}{\partial x_1} = p\alpha A x_1^\alpha - 1 x_2^\beta - r_1 = 0 \]  

\[ \frac{\partial \pi}{\partial x_2} = p\beta A x_1^\alpha x_2^\beta - 1 - r_2 = 0 \]

where

\[ r_1 = \text{price of input } x_1 \]
\[ r_2 = \text{price of input } x_2 \]
\[ P = \text{price of output} \]

Solving these equations for \( x_1 \) and \( x_2 \), the corresponding input demand functions are:

\[ x_1 = \left( \frac{\alpha}{r_1} \right)^{(1-\beta)/\gamma} \left( \frac{\beta}{r_2} \right)^{\beta/\gamma} (AP)^{1/\gamma} \]  

\[ = g_1(r_1, r_2, P) \]  

\[ x_2 = \left( \frac{\alpha}{r_1} \right)^{\alpha/\gamma} \left( \frac{\beta}{r_2} \right)^{(1-\alpha)/\gamma} (AP)^{1/\gamma} \]
Equations (6) and (8) thus explained that the demand for an input is the function of its price, prices of other inputs and the price of output. Based on equations (6) and (8) and understanding of the demand for palm oil in the US, the general structure of palm oil demand function for the US could be as follows,

\[ CPO_t = f(PO_t, PSI_{it}, W_t, PMF_t) \quad (9) \]

where:

- \( CPO_t \) = quantity of palm oil consumed.
- \( PO_t \) = price of palm oil.
- \( PSI_{it} \) = prices of some of palm oil substitutes.
- \( W_t \) = average wage in fats and oils manufacturing.
- \( PMF_t \) = price of manufactured fats and oils.

The above demand function assumes a static relationship. Labys (1973, p.10) pointed out that estimation of a demand function assuming a static relationship suffers from several weaknesses.

... static relationships suffer 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.

Consumers in general do not respond immediately, but rather delay their responses to changes in factors affecting demand. They spread their responses over some period of time. For example, palm oil is an input in the manufacture of shortening. The physical and chemical characteristics of palm oil and other fats and oils are different even though minor, and different processing stages are needed for different fats and oils before they are finally used in the production of shortening or other end products. These differences often prevent demand for these fats and oils from adjusting immediately to changes in their determining factors. That is, technical processes have to be changed before various fats and oils possess similar qualities to that of the final products. Changes in the prices of fats and oils, there-
fore, influence consumption not only in the short run but also in the long run.

The distance between the manufacturing plants of the end products and the port of entry for palm oil could also dictate the speed of substitution of other fats and oils to palm oil in their manufacturing processes if there is a decrease in palm oil price or an increase in the price of substitute. This is because of the transportation cost incurred in moving the palm oil from the port to the manufacturing plants might be more than the change in the price as such the incentives might not be enough for the substitution of one fats and oil to another.

Such behaviour of delayed response is explained by Nerlove (1958), that is, demand in any period is assumed to adjust only partially towards the desired or equilibrium demand. He made a marked distinction between short-run and long-run demand. Nerlove first considered a long-run demand function as,

\[ \bar{C}_t = a_0 + a_1 P_t + a_2 Y_t \]  

(10)

where,

\( \bar{C}_t \) = the long-run quantity demanded.

\( P_t \) = current price.

\( Y_t \) = current income.

Since the long-run equilibrium quantity demanded, \( \bar{C}_t \), is not observable, equation (10) cannot be estimated directly. He then assumed that the relationship between the observable quantity and the long-run quantity demanded in time \( t \), that is, \( C_t \) and \( \bar{C}_t \), respectively is given by the following difference equation.

\[ C_t - C_{t-1} = \tau \left[ \bar{C}_t - C_{t-1} \right] \]  

(11)

0 < \( \tau < 1 \)

where \( \tau \) is a coefficient describing the speed of adjustment. By substituting equation (10) for \( \bar{C}_t \) into (11) he obtained:

\[ C_t = a_0 \tau + a_1 \tau P_t + a_2 \tau Y_t + (1 - \tau)C_{t-1} + u_t \]  

(12)

where \( u_t \) is the required stochastic disturbance term.

\[ C_t = b_0 + b_1 P_t + b_2 Y_t + b_3 C_{t-1} + u_t \]  

(13)
From equation (13) he estimated the elasticity of adjustment as,

\[ \eta = \left[ 1 - b_1 C_{t-1} + \frac{C_t - 1}{C_t} \right] \]

and thus the long run elasticity was estimated as,

\[ \text{short run elasticity} \]

\[ \eta \]

PALM OIL PRICE RELATIONSHIPS

Relative to the total world palm oil imports, the size of the United States' palm oil imports is still small to have an influence on the price of palm oil. Further more palm oil is competing in the fats and oils market and not a market of its own. Therefore, this indicates that palm oil price is determined in the world market. Prices of fats and oils, shown by Figure 1, fluctuate together in the same direction. That is, as the supply of one of the fats and oils increases (decreases) its price decreases (increases), assuming other things remain the same, and eventually causing the price of other fats and oils to decrease (increase).

SUPPLY OF PALM OIL IN THE UNITED STATES

United States' palm oil market supply comes from imports and the carry over or beginning stock. Palm oil is imported in its oil form. Price was earlier assumed to be determined in the world market and the demand function posits an inverse relationship between quantity demanded and price. Therefore, the supply curve can be considered as perfectly elastic.

STOCK OF PALM OIL IN THE UNITED STATES

In conceptualizing the demand for soybean oil for the United States, Houck, Ryan and Subotnik (1972) treated soybean stock as a part
FIGURE 1. Selected U.S fats and oils prices
of the United States' demand function. Palm oil is thus treated in a similar manner in this study.

Stock adjustment represents an important mechanism whereby short-run price equilibrium is reached for commodities where consumption or supply or both are price inelastic. For example, if there is an increase in palm oil price, the short run behaviour of palm oil stockholder would be to release the stock and vice versa.

Most of the palm oil imported into the United States is already refined and can be held up to a year. Due to the high storage costs and the possibility of quality deterioration over time, one may assume that palm oil is held for a short time period, that is for transaction purpose. However Figure 2 shows that palm oil stocks have been fluctuating and that the percentage of stocks over domestic consumption have fluctuated from a high of 65 percent in 1966 to a low of 14 percent in 1973 and 1977, suggesting that there are other reasons for holding palm oil. In addition to holding palm oil for pipeline purposes that is for replacement purposes, stocks may also be held for speculation purpose. Stock accumulation could also be the result of errors in estimating the demand for the final products.

An accelerator theory was presented by Clark (1917) and later developed by Abramovitz (1950) to explain commodity inventory behaviour. The accelerator can be stated in two different forms: inventories (STK_t) should rise or fall with sales or manufacturing activity (Q_t), and the rate of change of stock holding should vary directly with the rate of change in activity.

\[ STK_t = aQ_t \]  

and,

\[ \frac{dSTK_t}{dt} = \beta a \frac{dQ_t}{dt} \]  

(15)

Goodwin (1947), Lundberg (1937), Metzler (1941), and Mack (1967) criticized the accelerator theory for ignoring other reasons for stock accumulation such as errors made in forecasting the future sales of output. Using the Nerlovian partial adjustment model Goodwin developed the flexible accelerator theory to explain stock behaviour.

That is:

\[ STK_t = \sigma a_0 + \sigma a_1 Q_t + (1 - \sigma) STK_{t-1} \]  

(16)
FIGURE 2. United States Palm Oil Stock

- stock
- (stock/consumption) x 100
or,

\[ STK_t = b_o + b_1Q_t + b_2STK_{t-1} + u_t \]  \hspace{1cm} (17)

Using the same premise as Goodwin, Houck, Ryan and Subotnik (1972) developed the following stock function:

\[ STK_{it} = \lambda_ia_o + \lambda_ia_1STK_{it} + \lambda_ia_2STK_{jt} + \lambda_ia_2K_{it} + (1 - \lambda_i) STK_{t-1} \]  \hspace{1cm} (18)

where,

- \( i \neq j \)
- \( STK_{it} \) = stocks of commodity \( i \) at the end of period \( t \),
- \( STK_{jt} \) = actual level of stocks of commodity \( j \) at the end of period \( t \),
- \( K_{it} \) = other factors influencing the level of stocks of commodity \( i \).

Labys (1973) modified the form of the flexible accelerator in estimating the inventories of lauric oils held by manufacturers and dealers in the importing countries by combining the partial adjustment model with the price expectation.

\[ STK^*_t = a_o + a_1Q_t + a_2\Delta Q_t + a_3P_t^* \]  \hspace{1cm} (19)

where,

\[ P_t^* = P_{t-1} + B(P_{t-1} - P_{t-2}) \]  \hspace{1cm} (20)

Combining equation (20) with (19) together with the partial adjustment hypothesis he gets

\[ STK_t = \mu a_o + \mu a_1Q_t + \mu a_2\Delta Q_t + \mu a_3P_{t-1} + \mu a_4B\Delta P_{t-1} + (1 - \mu) STK_{t-1} + u_t \]  \hspace{1cm} (21)

Because data were reported in the form of ending stocks, he adjusted the variable to reflect activity in the following period.

\[ STK_t = \mu a_o + \mu a_1Q_{t+1} + \mu a_2\Delta Q_{t+1} + \mu a_3P_t + \mu a_4B\Delta P_t + (1 - \mu) STK_{t-1} + u_t \]  \hspace{1cm} (22)

THE MODEL

Based on the theoretical background discussed and the assumption described earlier the model for the United States palm oil market
could take the following form containing three behavioural equations and four identities.

**Functional Equation:**

\[
WPO_t = f(PSW_{it}, \ldots, PSW_{nt})
\]

(23)

\[
CPO_t = f(WPO_t, PSI_{it}, W_t, CPO_{t-1}, PMF_t)
\]

(24)

\[
SPO_t = f(WPO_t, \Delta WPO_t, SPO_{t-1}, QMF_t, \Delta QMF_t)
\]

(25)

**Identities**

\[
QPM_t = CPO_t + SPO_t - SPO_{t-1}
\]

(26)

\[
QPD_t = CPO_t + SPO_t
\]

(27)

\[
QPS_t = QPM_t + SPO_{t-1}
\]

(28)

\[
\Delta WPO_t = WPO_t - WPO_{t-1}
\]

(29)

where,

- \(CPO_t\) = quantity of palm oil consumed.
- \(QPM_t\) = quantity of palm oil imported.
- \(QPD_t\) = quantity of palm oil demanded.
- \(QPS_t\) = quantity of palm oil supplied.
- \(WPO_t\) = world palm oil price.
- \(SPO_t\) = quantity of palm oil in stock, or ending stock.
- \(\Delta WPO_t\) = change in the world price of palm oil.
- \(CPO_{t-1}\) = lagged value of quantity of palm oil consumed.
- \(PMF_t\) = price of manufactured fats and oils.
- \(PSI_{it}\) = prices of substitutes in the United States.
- \(PSW_{it}\) = world prices of substitutes.
- \(QMF_t\) = quantity of manufactured fats produced in time \(t\).
- \(\Delta QMF_t\) = change in the quantity of manufactured fats in time \(t\).
- \(SPO_{t-1}\) = lagged value of quantity of palm oil in stock or beginning stock.
- \(W_t\) = average hourly wages in fats and oils manufacturing industry.
Price Relationship

The movements of fats and oils prices could be shown by estimating equation (23), where world price of palm oil is the dependent variable and the independent variables are the individual world prices of the substitutes. This is in line with the relationships of fats and oils described earlier.

Demand Function

Equation (24), which is similar to that of Nerlove, will be estimated to define the relationship between variables of the palm oil demand function. It is a derived demand function, thus it will include wages (W) and price of the manufactured fat (PMF) as the independent variables. The equation assumes that the demand for palm oil adjusts only partially toward the desired or equilibrium demand. Thus the lagged value of the dependent variable (CPO_{t-1}) is included to see how fast is the speed of adjustment.

Stock Function

Equation (25) will be estimated to explain the behaviour of palm oil stock holding. The function takes into consideration the speculative reason of stock holding by including price variable (WPO) and includes output variable (QMF) to see the effect of output change on stock holding.

Import Relationship

Estimating import and consumption functions in the same system of equations is redundant (Labys 1973). The quantity of palm oil imported into the United States will be described using equation (26) which is an identity. The relationship suggests that if there is no change in stocks, that is, if,

\[ SPO_t = SPO_{t-1} \]

then the quantity of palm oil imported will be the same as quantity consumed.

Quantity Of Palm Oil Demanded

The quantity of palm oil demanded comes from consumption and replenishing the stocks. Thus the total quantity of palm oil demanded is given by identity (27).
Supply

With the United States palm oil supply being assumed to be perfectly elastic, supply is then explained by equation (28) which is an identity. Equation (29) is an identity to show how the change in the world price of palm oil is derived. Thus the system of equations for palm oil contains 3 functional and 4 definitional equations.

DATA TO BE USED

Monthly data are available for most of the variables except for price and quantity of manufactured fats which are given on an annual basis. While using the monthly or quarterly data will give more observations for the study, their usage is not without problems. In many cases, when quarterly or monthly data are used, the dependent variable in a distributed-lag model may frequently exhibit a pronounced seasonal pattern that cannot be explained by the seasonal changes of the independent variables. For the purpose of this study, the annual data covering the period from 1951 to 1981 from various publications of the United States Department of Agriculture (USDA) and that of the Food and Agriculture Organization of the United Nations (FAO) will be used.

METHOD OF ESTIMATION

The world price relationship with palm oil price as the dependent variable and the world prices of the substitutes as the independent variables will first be estimated using the ordinary least square (OLS) method of estimation and recursively introduced into the estimation of the demand and stock functions. Labys (1973) cited two problems that may violate one or more assumptions of the OLS estimations; the problem of simultaneous equation bias and the problem that will arise when a lagged value of the dependent variable appears as a regressor in the regression.

As for the simultaneous equation bias, Fox (1958) suggested that the nature of the demand for certain agricultural products is such that the estimation of a small model using OLS may still be meaningful. Klein (1960) suggested the suitability of OLS estimation for international trade models where a country's imports may be relatively minor. This is especially true with respect to palm oil imports into the United States which are relatively small.

With regard to the lagged dependent variable problems, Rao and Miller (1971, p. 176), indicated that OLS can still provide a mea-
ningful result when the corresponding errors are not correlated, especially for the case of small sample size.

RESULT

A preliminary estimate of the price relationship equation that is equation (23) gave a negative sign for the coefficient of lard that was not significant at the 10 percent level. This is contrary to the consumption pattern observed within the study period and also to the similarity of the chemical and physical characteristics of lard and palm oil. The negative sign of the lard coefficient in the price relationship equation indicates that there are problems in specifying the equation or problem of multicollinearity. Thus it will be difficult to get a meaningful result when we estimate the relationship between palm oil price against individual fats and oils prices. Equation (23) was thus modified, whereby the fats and oils prices were grouped based on their common sources, that is vegetables oils (coconut, cottonseed and soybean oil) and animal fats (lard and beef fats). The result of the modified equation is presented in Table 1.

Since fats and oils have similar physical and chemical characteristics, they are expected to substitute for each other. The positive signs of the world vegetable oils and animal fats variables in the price equation indicate that world palm oil price fluctuated or varied directly with other world fats and oils prices.

<table>
<thead>
<tr>
<th>TABLE 1. Estimate of the world price relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variables</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Vegetable oils price</td>
</tr>
<tr>
<td>Animal fats price</td>
</tr>
<tr>
<td>R-square</td>
</tr>
<tr>
<td>F-ratio</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>Durbin-Watson</td>
</tr>
</tbody>
</table>

PALM OIL DEMAND FUNCTION OF THE UNITED STATES

Earlier it was stated that the United States is a price taker with respect to palm oil. Thus, the world price variable in the demand function was recursively introduced into the demand function from the price relationship equation estimated earlier.
As stated earlier, individual fats and oils prices cannot be included separately in the estimation of price relationship and demand function because their inclusion individually lead to some problems such as problems of multicollinearity. As in the estimation of price relationship, the fats and oils prices are grouped into vegetable oils and animal fats.

Table 2 shows the estimated value of the demand function. Several of the coefficients obtained are not statistically different from zero. From a statistical standpoint, it is not possible to place much confidence in the values of some of those coefficients. However, those variables that are not significant at least at the 10 percent level are still retained in the model since they have the appropriate signs which are consistent with a priori restrictions. Furthermore, their inclusion will help to explain their relationship with quantity of palm oil consumed and the consumption behaviour of palm oil by the end products manufacturers.

TABLE 2. The estimation of the palm oil consumption demand function in the United States

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Coefficient value</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-274.428</td>
<td>-1.869</td>
</tr>
<tr>
<td>Predicted value of the world palm oil prices</td>
<td>-53.809</td>
<td>-2.099</td>
</tr>
<tr>
<td>The United States vegetable oils prices</td>
<td>5.875</td>
<td>0.209</td>
</tr>
<tr>
<td>The United States animal fats prices</td>
<td>25.705</td>
<td>1.956</td>
</tr>
<tr>
<td>Price of manufactured fats(^a)</td>
<td>22.385</td>
<td>1.471</td>
</tr>
<tr>
<td>Wages(^b)</td>
<td>.093</td>
<td>0.345</td>
</tr>
<tr>
<td>Lag value of palm oil consumption</td>
<td>.671</td>
<td>4.243</td>
</tr>
<tr>
<td>R-square</td>
<td>.80</td>
<td></td>
</tr>
<tr>
<td>F-ratio</td>
<td>15.83</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>2.0843</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
\(^a\) the values are the weighted average prices of shortening and margarine
\(^b\) wages in the food and kindred products manufacturing.

ELASTICITIES OF DEMAND

From the demand function various short and long run elasticities were calculated as shown in Table 3. The own-price elasticity is elastic in the short and long run. This result is consistent with previous studies done by Thiam (1973) and Senteri (1978). Thiam calculated
the own-price elasticity of palm oil to be $-31.4$ and Senteri calculated the value as $-2.13$ and $-23.67$ for the short and long run respectively.

The cross-price elasticity with respect to vegetable oils is inelastic in the short run but elastic in the long run, with a value of $0.488$ and $1.375$ respectively. However, the cross-price elasticity with respect to animal fats is elastic both in the short and long run. The difference in the cross-price elasticities is consistent with the consumption pattern of palm oil over the years. Palm oil was used heavily to supplement the shortage of lard in the production of manufactured fats especially shortening. The concern for cholesterol resulted in the switch away from lard thus benefited palm oil.

<table>
<thead>
<tr>
<th>Type of elasticities</th>
<th>Short-run</th>
<th>Long-run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own-price</td>
<td>$-4.144$</td>
<td>$-11.673$</td>
</tr>
<tr>
<td>Cross-price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Vegetable oil</td>
<td>$0.488$</td>
<td>$1.375$</td>
</tr>
<tr>
<td>b. Animal fats</td>
<td>$1.899$</td>
<td>$5.349$</td>
</tr>
</tbody>
</table>

The elastic nature of the long run elasticities are expected because of the longer time period enable consumers and users to change their habits. The long run elasticities are calculated by finding the short-run elasticities with the elasticity of adjustment calculated from the coefficient of adjustment. The coefficient of adjustment, that is, the coefficient of the lag dependent variable give an indication as to how long the adjustment of demand take place. With respect to US palm oil demand, the adjustment takes more than one time period. In this case only about 67 percent of the adjustment take place in one period.

The lag in the adjustment may be due to the fact that manufacturers take time to change from the use of one type of fats and oils to another in response to changes in the determining factors. The use of a new fat and oil in a manufacturing process may require the manufacturer to change some of its processes to adapt to the conditions of the new fat and oil. Manufacturers may also take time to change from one type of fats and oils to another due to preference of the former over the other in the manufacturing process based on taste, colour or other physical appearance even though it might be cheaper to use the new fats and oils. Manufacturers may also be un-
aware of the existence of a more suitable fats and oils even though it might be cheaper and/or possess better quality.

STOCK FUNCTION OF PALM OIL

The estimates of the parameters of the stock function are given in Table 4. The price variable is significant at the 5 percent level implying that price strongly affects the behaviour of palm oil stock holders. In other words, palm oil was also held for the purpose of speculation.

The variable changes in fat production in time t is also significant at the 10 percent levels and has a negative sign. The negative sign of the coefficient is consistent with Lovell's (1961) observation that there was a tendency for stocks to fall below the desired level when output was increasing, due to delays in delivery to meet the manufacturers demand. Conversely, a decrease in output production could cause stocks to accumulate. This is also consistent with the reason that stocks were accumulated as a result of error in the forecasting of the demand for the final products.

The estimated coefficient of the lagged dependent variable indicates that palm oil stock takes more than one time period to adjust. It also implies that palm oil was held for more than 1 time period which is more than a year.

TABLE 4. Estimates of the stock function of palm oil in the United States

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Coefficient values</th>
<th>t values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-46.490</td>
<td>-2.326</td>
</tr>
<tr>
<td>Predicted value of the world price of palm oil</td>
<td>2.319</td>
<td>2.457</td>
</tr>
<tr>
<td>Change in the world palm oil prices</td>
<td>-3.301</td>
<td>-2.850</td>
</tr>
<tr>
<td>Fat production in time t</td>
<td>0.009</td>
<td>1.875</td>
</tr>
<tr>
<td>Change in fat production in time t</td>
<td>-0.010</td>
<td>-1.963</td>
</tr>
<tr>
<td>Lag value of palm oil stock</td>
<td>0.432</td>
<td>2.759</td>
</tr>
<tr>
<td>R-square</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>F-ratio</td>
<td>14.97</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>2.065</td>
<td></td>
</tr>
</tbody>
</table>

Note:
*total amount of shortening and margarine production.
CONCLUSION

Looking at the empirical results of this study, one would find that in the short run the use of palm oil in the production of manufactured fats in the United States is not sensitive to the changes in the vegetable oil prices as a whole. It is however, very sensitive to the changes in the animal fats prices and its own price.

The cross-price elasticity with respect to vegetable oils which is inelastic at least in the short run indicates that any changes in the prices of the vegetable oils will have little effect on palm oil used in the short run. However, in the long run any change in the vegetable oils prices will have an effect on the use of palm oil.

The palm oil producing and exporting countries will have to monitor the long term trend in the production of fats and oils in the United States and understand the United States government’s agricultural and trade policies and their implications to the fats and oils market. For example, an agricultural policy that discourages production of agricultural products may result in the reduction in the fats and oils supply in the United States, thus there will be a need for more imports of palm oil. On the other hand, a grain embargo such as that during the Carter administration will result in an increase in the supply of fats and oils in the United States and hence less demand for palm oil imports.

The estimated elasticities provide some guidelines for the producers and exporters of palm oil in order to respond to the changes in the condition of palm oil market in the United States either in the short or long run. The elasticities show the degree of responsiveness of the consumers of palm oil in the United States to the changes in the price of palm oil and its substitutes.

The coefficients of the vegetable oils and animal fats prices in the demand function and the value of the respective cross-price elasticities should be of interest to the palm oil producers and exporters. They indicate that palm oil is a better substitute for animal fats than for vegetable oils. As such, palm oil can only compete favourably in the production of manufactured fats and oils that also use a large amount of animal fats.

A study of the period of the seventies, which is the period of the emergence of the concern for cholesterol consumption, shows that the per capita margarine consumption is constant. On the other hand, the per capita consumption of shortening and salad or cooking oils increased at an average annual increase of about 0.1 pound and 0.5 pound respectively.
Prior to 1970 palm oil has not been used in the production of margarine and salad or cooking oil because of its characteristics. However since the seventies some palm oil has been used in their production. This is because of the fractionation process that enabled palm oil to be divided into solid and liquid portions.

With the consumption of shortening and salad or cooking oil still rising and the consumption of food fats and oils as a whole are still growing, palm oil can still compete with other fats and oils in the United States market.

IMPLICATIONS OF THE STUDY FOR MALAYSIA

United States is one of the more important markets for Malaysian palm oil. This is especially so when US imported most of its palm oil from Malaysia. In 1975 the United States fats and oils market was able to absorb more than 960 million pounds of palm oil. This was due to the shortage of domestically produced fats and oils, especially the animal fats, in the United States market and the readily available palm oil in the world market at a favourable price. However, when the supply of domestically produced fats and oils in the United States improved in the early eighties, the quantity of palm oil imported dwindled to around 300 million pounds. This indicates that given the right conditions and strategies, the United States can consume more than what they are consuming now. Any increase in the demand for palm oil in the United States will directly benefit Malaysia since Malaysia is the major exporter of palm oil to the United States. Conversely, any decrease in demand for palm oil in the United States would adversely affect Malaysia. Recent events in the fats and oils market in the United States, such as campaigns by various groups including the American Soybean Association (ASA), show that there were concerted efforts to reduce the demand for palm oil in the United States for various reasons. This will seriously affect the Malaysian palm oil in the United States' fats and oils market.

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