THE UNIVERSITY OF MANITOBA

DEMAND AND SUPPLY OF PALM OIL

by

Kar Sheng Au

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ABSTRACT

In recent years, there has been a rapid rise in Indonesia's palm oil production, resulting in rising exports which compete with Malaysia's palm oil. Coupled with uncertainties in major palm oil importing countries, these two factors could have some serious implications for Malaysia's palm oil production and exports. This study plans to find out the supply and demand prospects of palm oil over the period 1990-2000.

Using an annual equilibrium econometric model, based on data from 1958 to 1987, the production, exports, import demand and domestic consumption of palm oil were predicted for a selected number of countries. It was predicted that palm oil production and exports from Indonesia would increase in absolute amount as well as in terms of market share during 1990-2000 while the market share of Malaysian palm oil would decrease, though production and exports would continue rising. Imports from the 7 major importing countries would also rise but at a slower rate thus raising the importance of the Rest-of-the-world (ROW) as palm oil importers.

This study concluded that competition from Indonesian palm oil would grow in the future and there would be a change in the composition of major palm oil importers.

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INTRODUCTION

Palm oil production, as well as trade, has one of the fastest growth rate among edible oils and fats in the world. Between 1982-88, production grew at an annual rate of 7.9% compared with an average growth rate of 4.6%[1] for the edible vegetable oils and fats industry as a whole (see Table 1.1). During the seven years, only rapeseed and palm kernel oils performed better than palm oil in output growth. Meanwhile, the export average annual growth of 9.1% is above the industry's aggregate growth of 6.6% (see Table 1.2). This rate of export growth places palm oil in the fifth position after rapeseed, sunflower, olive and palm kernel oils. However, palm oil is produced and traded in greater amount than anyone of these oils.

Palm oil came second only to soybean in the total amount produced in 1988. A total of 9,309 thousand tonnes of palm oil were produced which represents over 12% of all oils and fats production. In the same year, it was leading the other oils in world trade. A total of 6,749 thousand tonnes were exported or 75 percent more than the total traded tonnage of the next major oil, soybean oil. This tonnage accounts for 28 percent of all fats and oils traded in 1988.

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[1]The annual rate of growth will be lower if fats from animals and fish are included in the industry's annual growth rate because fats of animal/fish sources grew at a much slower pace than the vegetable oils and fats.

Table 1.1 World Production of Major Oils and Fats, 1982-1988 (in '000 tonnes)

Vegetable Oil	1982	1983	1984	1985	1986	1987	1988
Soybean	13,370	13,658	13,276	13,964	14,320	15,516	15,453
Cottonseed	3,248	2,993	3,346	3,934	3,584	3,211	3,648
Groundnut	3,183	2,898	3,262	3,567	3,335	3,455	3,590
Sunflower	5,367	6,073	5,877	6,574	7,103	7,076	7,635
Rapeseed	4,682	4,982	5,226	6,076	6,463	7,401	7,827
Sesame	535	540	551	594	626	603	613
Olive	1,643	1,911	1,652	1,796	1,826	1,738	1,871
Coconut	2,799	2,605	2,058	2,639	3,358	3,072	2,657
Palm Kernel	710	764	769	882	992	1,018	1,100
Palm	6,314	6,027	7,055	7,614	8,248	8,485	9,309
Linseed	661	708	781	773	768	802	703
Castor Bean	319	336	389	413	390	365	334
Total	42,831	43,495	44,242	48,826	51,013	52,742	54,740
Animal Fat							
Butter	5,912	6,369	6,290	6,315	6,507	6,145	6,102
Lard	4,964	5,112	4,878	4,988	5,142	5,252	5,447
Fish Oil	1,312	1,157	1,550	1,488	1,695	1,431	1,465
Tallow/ Grease	6,215	6,413	6,372	6,518	6,435	6,436	6,739
Total	18,403	19,051	19,090	19,309	19,779	19,264	19,753
Grand Total	61,234	62,546	63,332	68,135	70,792	72,006	74,493

Sources: Oil World Annual, PORLA

Table 1.2 World Exports of Major Oils and Fats, 1982-1988 (in '000 tonnes)

Vegetable Oil	1982	1983	1984	1985	1986	1987	1988
Soybean	3,596	3,636	4,039	3,574	3,023	4,081	3,837
Cottonseed	539	343	337	395	311	253	342
Groundnut	451	502	300	347	355	347	341
Sunflower	1,270	1,635	1,717	1,855	2,139	1,986	2,253
Rapeseed	835	846	1,085	1,344	1,417	1,659	1,980
Sesame	8	9	9	9	9	11	12
Olive	247	412	363	518	491	654	544
Coconut	1,299	1,348	998	1,236	1,641	1,501	1,328
Palm Kernel	460	497	534	631	674	699	773
Palm	4,175	4,304	4,663	5,746	6,992	6,473	6,749
Linseed	254	288	316	248	261	307	201
Castor Bean	149	143	179	204	183	180	153
Total	13,283	13,963	14,540	16,107	17,496	18,151	18,513
Animal Fat							
Butter	1,147	1,037	998	1,236	1,641	1,501	1,328
Lard	498	501	518	519	506	496	557
Fish Oil	766	780	1,018	1,116	853	799	874
Tallow/ Grease	2,480	2,535	2,575	2,574	2,520	2,527	2,760
Total	4,891	4,853	5,109	5,445	5,520	5,323	5,519
Grand Total	18,174	18,816	19,649	21,552	23,016	23,474	24,032

Sources: Oil World Annual, Oil World Statistics Update, PORLA

The top three palm oil producing countries share among themselves over 80% of the world total average output from 1985-87 (see Table 1.3). The leading producer, Malaysia controls 54% of production and it is followed by Indonesia at 17%. A rather similar ordering is observed in the exporting countries (see Table 1.4). Exports of palm oil are dominated by Malaysia, Indonesia, and Papua New Guinea. Again, Malaysia's net exports, averaging 79% annually, is by far the largest. Together with Indonesia, the second largest net exporter, their total net export shares are over 91%. It is therefore obvious that the supply market for palm oil is highly concentrated among the few top producers/exporters.

In contrast, palm oil demand market constitutes a large number of importers with diverse market conditions and consumer preferences (see Table 1.5). Importing countries include countries with developed economies such as the European Community, Japan, and the United States; centrally-planned economies like the Soviet Union and the People's Republic of China; and developing countries which include India, Pakistan and Bangladesh. Petroleum-rich countries in the Middle-east such as Saudi Arabia and Iraq are also large consumers of palm oil. With the exception of the EC and India, no single buyer takes in more than 15% of the palm oil exported every year.

Being both the largest producer and exporter, the future market situations and prices of palm oil are very important to Malaysia. Palm oil exports, since 1974, have consistently contributed about 10% of total export earnings to the Malaysian economy, until the last three years when its share declined to about 8% (IMF International Financial Statistics: Supplement on Trade Statistics). Palm oil also generates an average of 4.8% of the Gross National Product (GNP) annually for Malaysia from 1985-1987 (see Table 1.6). This proportion is relatively high when compared to palm oil's

Table 1.3 World Production of Palm Oil, 1982-88 (in '000 tonnes)

Country	1982	1983	1984	1985	1986	1987	1988
Malaysia	3511	3016	3715	4133	4544	4533	5030
Indonesia	852	921	1147	1243	1351	1506	1690
Nigeria	700	730	750	730	760	730	720
Ivory Coast	160	148	174	164	187	215	235
China	200	200	210	192	195	200	205
Columbia	85	102	118	126	141	148	179
Zaire	155	145	153	160	155	165	165
Thailand	50	56	81	110	105	131	159
PNG	77	103	121	120	132	132	138
Ecuador	58	62	5	100	93	107	121
Cameroon	75	72	82	80	90	98	110
Others	391	472	429	456	495	520	557
World Total	6314	6027	7055	7614	8248	8485	9309

Sources: "Oil Palm Market Review", Dept. of Statistics (Malaysia) and Oil World Statistics Update

Table 1.4 World Net Exports of Palm Oil, 1982-88 (in '000 tonnes)

Country	1982	1983	1984	1985	1986	1987	1988
Malaysia	2841	2950	2972	3269	4511	4175	4264
Indonesia	302	407	189	615	700	568	618
PNG	77	78	132	123	129	123	97
Ivory Coast	61	53	49	56	105	110	86
Cameroon	12	5	5	7	18	27	24
Others	48	61	73	265	172	156	278
World Total	3341	3554	3420	4335	5635	5159	6097

Sources: "Oil Palm Market Review", Oil World Statistics Update, FAO Trade Yearbook

Table 1.5 World Net Imports of Palm Oil, 1982-88 (in '000 tonnes)

Country	1982	1983	1984	1985	1986	1987	1988
EC	586	700	557	654	941	916	967
India	417	647	571	662	952	1154	944
Pakistan	284	379	404	514	522	466	527
China	21	10	16	60	183	250	407
Iraq	191	154	193	174	227	240	241
Japan	148	162	157	161	196	212	238
S. Korea	89	104	66	107	183	171	156
U.S.	108	146	134	213	276	188	152
U.S.S.R	376	316	280	237	206	268	142
Kenya	93	72	75	83	96	124	126
S. Arabia	127	81	125	99	113	118	125
Bangladesh	69	58	116	157	214	158	120
Others	871	762	802	940	1330	792	1072
World Total	3380	3591	3496	4061	5439	5057	5217

Sources: "Oil Palm Market Review" and FAO Trade Yearbook

Table 1.6 Shares of Palm Oil in the GNPs and Exports of Malaysia and Indonesia, 1982-88 (% of Value)

	1982	1983	1984	1985	1986	1987	1988
Malaysia							
% GNP	4.6	4.6	6.1	5.5	4.6	4.3	5.3
% Exports	9.8	9.1	11.8	10.4	8.5	7.2	8.2
Indonesia							
% GNP	0.1	0.2	0.1	0.3	0.2	0.3	n.a.
% Exports	0.5	0.6	0.5	1.3	0.9	1.1	n.a.

Sources: FAO Trade Yearbook, IMF International Financial Statistics contribution to the Indonesian economy. Palm oil contributes less than 0.5% of the Indonesian GNP and about 1% of its foreign exchange earnings. However, it is expected that the share of palm oil in Indonesia's export earnings will increase because of rising production in that country and the continued devaluation of the Indonesian currency with respect to the US dollar, which is used to quote the price of palm oil internationally.

Any future increase and decrease in palm oil production and exports will have far reaching implications on other edible oils as well and consequently on their producing countries. Having such a huge presence in world trade, any change in palm oil supply will affect not only its own price but the prices of other edible oils and their supplies. On top of that, the supply of palm kernel oil, which is obtained from the same oil crop as palm oil, will also be affected by palm oil output. Palm kernel oil in turn will affect the prices and supplies of other oils through its exports.

Therefore, importance of the future market situations of palm oil is not only limited to its major producers but to other edible oil producing countries as well. However, no attempt is made to study the latter and broader topic that involves all major oils that are traded in the world. The present study will only concentrate on the producers/exporters and importers of palm oil.

1.1 Problem Statement

Problems facing palm oil exports and indeed all types of internationally traded oils are basically two folds. However, having more dependence on trade, these problems take on greater significance for palm oil. Many countries are needed to sell the huge amount of palm oil produced every year and all these markets are not homogeneous. Each country has different degrees of openness to edible oil imports and imposes different levels of import taxes or surcharges. Some countries are more free-market oriented, with low or zero import tariffs and many private-traders and processors, while others have only one state agency to engage in trading and impose high import duties. Non-tariff bariers also vary from country to country.

After getting over these institutional barriers, then comes the consumer acceptance and price-competiveness constraints. Here is where this study will put emphasis on. It is in this stage where various edible oils compete in the importing country. Palm oil, being one of the many edible fats and oils traded in the world, will have to compete with other fats and oils for the consumer's disposable income. To be able to compete at all, an edible oil must be acceptable to the consumers in food products or is technically suitable for industrial uses. After being accepted, the price charged for it should be as competitive as possible with respect to the prices of other edible oils because of the increasing ease of substitution among oils.

Not only does Malaysian palm oil have to compete with other edible oils in world trade, it has to overcome the challenge from the lower-priced Indonesian palm oil. Despite holding the dominant position in world output and export of palm oil, lately, Malaysian palm oil has been facing some stiff competition from Indonesian palm oil. With rising levels of production, due to extensive new plantings, Indonesia has a growing need for markets for its exports and hence, cutting into Malaysian palm oil import markets. Coupled with uncertainties in major demand markets for palm oil, a detailed understanding of the conditions in both the supply and demand markets and their growth prospects are needed to accertain their implications for Malaysia.

1.2 Objectives and Scope

This study answers some questions concerning the future prospects for palm oil in international trade. First, it will study the structure of the oil palm industries of the major palm oil producers. Then, it will analyze the economic and technical relationships among edible oils. This will help to explain the complex relationships that exist among all oils of which can affect their respective demands. To get a better insight of the demand side of palm oil trade, it will look at the characteristics of the chief demand markets for palm oil. Beside price, government policies and consumer tastes and preferences can affect the imports of palm oil too. It will then formulate and estimate an econometric model to forecast future demands and supplies of palm oil. The elasticities of these markets will also be estimated. An annual econometric model will be used. Finally, it will draw the implications of the above findings and recommend some policy alternatives that policy-makers in Malaysia can take to maintain or enhance the competitiveness of Malaysia's palm oil.

CHAPTER II

REVIEW OF RELATED STUDIES

2.1 RELATED STUDIES ON WORLD PALM OIL TRADE

Palm oil supply and demand have not been studied as extensive or as often as most other edible oils. Among those limited studies that have been done on palm oil, however, there are a few which are relevant to the present study.

2.1.1 Tan

Tan uses a spatial equilibrium model called Reactive Programming which minimizes transfer costs to forecast trade flows of palm oil in the world. Demand equations in linear form based on annual data from 1959-69 for major importing countries/regions -- the US, UK, Japan, France-Germany, Italy and Belgium-Netherlands -- were estimated. These equations were then fed into the above model, together with fixed export quantities and shipping costs to forecast quantities imported and prices. The results obtained generally predicted a decline in palm oil prices throughout the seventies to 1980 because of excess supplies.

The trade algorithm was later used to simulate the consequences of reduction in palm oil production and the diversion of palm oil away from the commercial market in the main producing country, Malaysia, would have on world palm oil prices. It was concluded that curtailment of Malaysian palm oil production and exports, from the high to the medium projected level, would raise prices by 8.5 percent. Similarly, diversion of palm oil away from commercial sales to concessional sales would increase palm oil prices. The rise in palm oil prices would range from 7 percent to 22 percent, depending on the percentage of palm oil sold at concessionary terms and the export projected level chosen as base level. It was also found that while the former would reduce total foreign exchange earnings, the latter would increase export earnings.

2.1.2 Suryana

This study uses an international trade system model that differentiate a product according to place of origin to study the demand and supply prospects for Indonesian palm oil. The demand model used is the Armington Demand System model and the supply function is based on Nerlove's partial adjustment model. The Almost Ideal Demand System (AIDS) is used to obtain the direct and cross price elasticities of demand for palm oil needed in the Armington Demand System. Estimation of demand equations are based on annual data from 1964 to 1983.

Simulation is used to determine the trade prospects for Indonesian palm oil, first with hypothetical exogenous shocks such as changes in demands, supplies, tariffs, exchange rates and transport costs and then with alternative policies the Indonesian government may exercise such as reduction in domestic consumption, increase exports to Rest-of-the-world (ROW), reduction in export taxes and subsidies to palm oil production.

The study concluded that demand changes in the EEC would have larger effects on the Indonesia's palm oil trade than those changes originating from other endogenous regions (South Asia, US, Japan and Malaysia). Reduction in Indonesia's domestic demand for palm oil, reduction in export taxes on the product shipped to the EEC, and currency devaluation are more effective than increasing exports to the ROW, decreasing the production costs of palm oil, or reducing the export taxes to countries other than the EEC.

2.1.3 Lamm and Dwyer

They use a quarterly simultaneous linear econometric model which is based on data from the first quarter of 1960 to the first quarter of 1976, with instantaneous market clearing, to analyze the impacts of changes in the US import policies and restriction of financial assistance by the World Bank would have on palm oil exports, direction of trade flows and palm oil prices. Three regional import demand functions are included that is for the US, the EEC and Japan plus a crude export supply function for all producing/exporting countries.

The results suggest that either imposition of tariff or curtailing of investment in palm oil production projects by the World Bank would reduce US imports but the effects from the latter would be more severe though slower because of time lag between investment and production. Price level would fall by 1 cent per pound if tariff were imposed but would rise by more than 7 cents per pound if investment financing were stopped. The higher prices are due to huge drop in palm oil exports. Imports by the EEC and Japan would rise in the first case but would decline in the second case.

Though significant in their own ways, all the above studies do not deal with the supply side of palm oil adequately. Emphasis has mainly been on the demand aspects of palm oil trade. Tan ignores the supply side of palm oil altogether, treating it as exogenous. Lamm and Dwyer, on the other hand, model the palm oil supply informally through an aggregated export supply function. Suryana is the only study that actually considers palm oil supply in detail but his choice of variables in the Nerlove-type supply equation is suspect. The equation has such a mix of explanatory variables that it is difficult to determine whether it is a production or export supply equation. Inclusion of mature and planted areas as variables also contribute to the confusion.

2.2 RELATED STUDIES ON THE SUPPLY RESPONSE OF PERENNIAL CROPS

Studies by Chan; Bateman; Labys ("A Lauric"); and Olayemi and Olayide, despite some differences in assumptions and choice of variables in their modelling process, have all modelled supply response in the conventional way, that is using output as the dependent variable. Therefore, planted area and yield responses are only indirectly implied in their models which means some valuable information has been lost. These studies do not distinguish acreage response from production response though there are significant differences between them through changes in yields. Among these studies, only Bateman and also Labys ("A Lauric") had considered new plantings in their models. Removals, however, had not been dealt with in anyone of them. Both Bateman and also Labys ("A Lauric") assumed that their perennial crops had indefinite life cycle.

Another approach in supply response modelling is based upon bearing/mature acreage response rather than output response. This approach has been taken in the reseach works of French, King and Minami; Baritelle and Price; French and Bressler;

and French and Matthews. The first two studies extended and modified the works done earlier by French and Bressler on lemons and French and Matthews on asparagus by incorporating additional information on removals and yields of trees. French and Bressler, though they estimated separate equations for new plantings and removals, did not consider acreage removal by age category. Neither did they consider a yield function. In contrast, French and Matthews dealt with the yield function but they failed to estimate removal and new plantings equations separately. Through substitutions, all factors affecting new plantings and removals were incorporated into the bearing acreage equation.

In a way, the approach taken by studies by French, King and Minami; Baritelle and Price; and French and Bressler are advantageous to the method that French and Matthews took because these studies include additional information thus increases the predictive power of the model. Lengthy lags and loss of degrees of freedom in the bearing acreage response function are also eliminated. However, they require very detailed and elaborate time series data which are not readily available most of the time. French and Matthew's model, on the other hand, suffers from loss of information and degrees of freedom but is less data demanding.

2.3 RELATED STUDIES ON INVENTORIES

The palm oil stocks are also estimated to adjust quantity produced for the amount exported. Studies on stocks can be divided into those that deal with stocks as held by consumers -- such as manufacturers, processors, importers, wholesalers, or dealers -- and those that study stocks as held by producers -- such as source suppliers, exporters, wholesalers or dealers. Most studies on stocks, however, have been on the consumption side of stock-holdings.

Of those studies on consumer-held stocks in the form of raw materials or in the form of goods-in-process[1], the models used have mainly been based on the partial adjustment model with a flexible accelerator effect, as advanced by Goodwin (Lovell). The "flexible accelerator model" assumes that manufacturers only partially adjust their stocks to the desired levels each production period rather than completely.

Lovell, arguing the importance of other factors, expanded the model by including price speculation, changes in output and unfilled orders. Labys (Dynamic), had also specified a stock adjustment model for coconut oil, using Lovell's version of the flexible accelerator model. He redefined the variable for price speculation and dropped the variable for unfilled orders. Expected future prices were assumed made under the extrapolative expectation hypothesis rather than as percentage change from previous period.

Hartman used a modified Lovell's model to study the inventory behavior of the copper industry. He included many variables considered to be important to the copper industry such as a market disequilibrium factor (because the copper industry is oligopolistic), length of strikes, and non-warehousing costs of holding inventories.

A variant of the flexible accelerator model is the "immediate target adjustment model", proposed by Feldstein and Auerbach because they are troubled by the low values usually obtained for the stock adjustment coefficient in the flexible accelerator model. This model, however, is criticized for assuming that inventory adjustment to target level must complete within one quarter for all products (Nguyen and Andrews

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[1]Finished good inventories are usually modelled with the buffer stock model advanced by Lundberg and Metzler or its clones (see Labys (Dynamic) pp. 65-66).

p. 175). Arguing the weaknesses of both approaches because while the immediate target adjustment model assumes instantaneous adjustment of stocks to target levels, the flexible accelerator model (or stock adjustment model) assumes that inventory targets will immediately adjust to changes in fundamental determinants, Nguyen and Andrews combined the two approaches by assuming neither stock nor target levels will adjust completely in a yearly quarter.

On the other side of inventory-holding is the producer-held stocks. Theory on stocks as held by producers, however, has not been as well developed as that for consumers (see Labys (Dynamic) pp. 68-70). The model for wool by Witherell, relating stocks to current and expected future prices, however, provides a good theoretical base for producer-held stocks. With different assumptions, Labys (Dynamic) had also yielded a similar model. He assumes that price expectation follows the extrapolative expectation hypothesis rather than the adaptive expectation hypothesis that Witherell uses and desired stock holdings are only partially adjusted to in a period rather than completely adjusted to.

CHAPTER III

THE SUPPLY OF PALM OIL

Palm oil production is dominated by a handful of countries, namely Malaysia, Indonesia, Nigeria, and Ivory Coast, in that order of importance. However, output from Malaysia constitutes the major share, averaging 54% of total output from 1985-87. A similar pattern is also observed in the export market. Malaysia is by far the dominant exporter, claiming a market share of 79%, while the second largest producer, Indonesia supplies 12% of palm oil net exports. Other important palm oil exporters include Papua New Guinea, Ivory Coast, and Cameroon. An obvious exclusion from the export list is Nigeria, which consumes almost all of its palm oil. In fact, Nigeria is a net importer of palm oil. On the other hand, Papua New Guinea exports most of its palm oil, making it the third largest exporter even though it is not in the list of the top five producers.

Having identified the main producers/exporters, it is fair to say that the top two exporting countries are representative of the supply side of the palm oil trade, supplying roughly 91% of world palm oil. Based on this assumption, the supply side analysis will focus on Malaysia and Indonesia. Producers, other than these two, will only be mentioned in passing. These countries, presently and for the foreseeable future, have very little impacts on the trade of palm oil.

3.1 MALAYSIA

Despite its large share of the palm oil production and trade today, Malaysia has not always been the largest supplier. It has only become the biggest producer of this commodity in the last 20 years. Its production level exceeded that of Indonesia in 1966 before going on to surpass Nigeria's production in 1971 to become the largest producer (FAO Production Yearbook). Although Malaysia's share in the export market for palm oil has been significant for a long time due to low local consumption but more importantly, due to the purpose of the oil palm industry, in 1967, barely 190,000 tonnes were exported (see Table 3.1). Ten years later, the total tonnage traded shot up to 1,427,300 tonnes. In 1987, Malaysia exported 4,260,700 tonnes of palm oil which is 22 times the amount traded in 1967. Its share of the net palm oil trade increased from 37 percent to 81 percent between 1967 and 1987.

3.1.1 Historical Developments and Trends

Oil palm entered Malaya (now Peninsular Malaysia) in 1875 but it was primarily used for ornamental purposes. Commercial development of oil palm only began in 1911 and the first oil palm plantation was established in 1917, using planting materials from East Sumatra, Indonesia (Khoo pp. 2-3). Although this cash crop was introduced into Southeast Asia earlier than rubber tree, its commercial plantings were delayed largely due to profitability in the production of rubber and the more limited availability of lands suitable for oil palm cultivation. The same factors have also stunted the growth of oil palm industry until after World War II (Fryer p. 250).

Following World War II, despite severe damage and deterioration of estates and factories and the low prices paid for palm oil by Britain, which was then the colonial

Table 3.1 Malaysia: Annual Exports of Palm Oil, 1960-88 (in '000 Tonnes)

Calender Year	Palm Oil		
	Crude	Processed	Total
1960	97.6	--	97.6
1961	94.9	--	94.9
1962	107.4	--	107.4
1963	116.7	--	116.7
1964	125.2	--	125.2
1965	141.5	--	141.5
1966	181.3	--	181.3
1967	188.9	--	188.9
1968	286.0	--	286.0
1969	356.7	--	356.7
1970	401.9	--	401.9
1971	573.4	--	573.4
1972	697.0	--	697.0
1973	797.8	--	797.8
1974	901.6	--	901.6
1975	957.4	215.6	1,173.0
1976	882.3	457.8	1,340.1
1977	701.1	726.2	1,427.3
1978	574.0	941.8	1,515.8
1979	358.1	1,560.0	1,918.1
1980	197.7	2,073.6	2,271.3
1981	138.8	2,346.7	2,485.5
1982	67.7	2,809.2	2,876.9
1983	90.7	3,073.8	3,164.5
1984	59.3	3,124.1	3,183.4
1985	13.1	3,421.0	3,434.1
1986	117.5	4,440.6	4,558.1
1987	170.7	4,090.0	4,260.7
1988	27.2	4,331.6	4,458.8

Source: Dept. of Statistics(Malaysia), PORLA, and Oil World Annual power, planted area in Malaya grew steadily. Instability in the rubber sector greatly helped the growth of the oil palm industry. Persistent low prices for rubber, besides the occasional wide swings in prices, had given estate management incentives to convert plantations under rubber to alternative crops. A study done by the World Bank Mission in 1955 suggested many crops in place of rubber tree and oil palm was one of the suggested alternatives. In spite of the recommendation, not much interest was shown by the government at that time because of the requirements of large initial capital investment and long-term commitment. There are no returns from investment in oil palm for the first two or three years after planting. Furthermore, the investor has to wait for a long period of time to recover his capital and any returns that come with it because oil palm has an economic lifespan of 25 to 30 years. Development of the industry, thus, was mainly left to the privately-owned plantations. Moreover, the price of rubber was on the rise again at that time after some periods of depressed prices following the break of the Korean War.

Later in 1963, another study was done by the Ford Foundation and again it came up with the same recommendation. This time, the response from the government was highly favourable[1]. Outlook for natural rubber was cloudy and the potential profitability of palm oil was well demonstrated. In addition to high yields per acre and relative high returns to investment, oil palm reaches maturity earlier than rubber. Oil palm takes about 3-4 years to reach maturity (oil bearing age) while rubber tree takes 6-7 years to reach maturity (tappable age). Palm oil prices at that time were also

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[1]Government involvement started as early as 1960 when the first oil palm land development scheme was established, but the Ford Report gave further impetus to go ahead with such schemes.

relatively stable and the industry requires less labour than the rubber industry[2] (Khoo pp. 1-4). One worker on average can take care of 14 acres of oil palm area while a similar size rubber area requires 2 workers (Khera p. 36).

There were some years with very low prices but overall, prices received for palm oil were high enough to encourage expansion. Total hectareages increased from 153,600 hectares in 1967 to 1,640,300 hectares in 1987 or equivalent to an annual growth of almost 80 percent (see Table 3.2). In the same time period, crude palm oil production level went up by 20 times (see Table 3.3). Output of palm oil broke over the first thousand tonne benchmark in 1974 and it reached the second thousand tonne level 5 years later. The third and fourth thousand tonne marks were achieved in 1982 and 1985 respectively. In 1988, more than 5000 thousand tonnes of palm oil were produced.

Involvement of the Federal Government, using FELDA (Federal Land Development Authority) as its main agent, is perhaps the most important structural change in the oil palm industry. Under various land development and settlement

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[2]Although Khoo in his later comments, did not consider the lower labour intensity of the oil palm industry as an advantage because lower labour requirement would contribute to labour unemployment, it has become obvious now that this characteristic is one of the many positive features of oil palm industry. Instead of generating insufficient jobs, there is an ongoing need to bring in labour from neighbouring countries to work in estates in Malaysia. Labour squeece is so chronic that future competitiveness of Malaysian palm oil is said to be at stake because management has to pay higher wages and salaries.

Malaysia, despite abundant in labour, is having difficulty finding workers because workers are reluctant to work in plantations. They prefer the comfort and excitement of urban life and the less demanding works in the manufacturing sector. Wages, however, may or may not be a factor contributing to the urban migration process. Although Malaysian workers refuse to work at the going wage rate in estates, foreign workers are more than satisfied with it and have been pouring in to fill the gap in labour supply.

Table 3.2 Malaysia: Oil Palm Planted Area, 1960-1987 (in '000 hectares)

Year	P. Malaysia	Sabah	Sarawak	Total
1960	n.a.	n.a.	n.a.	54.6
1961	n.a.	n.a.	n.a.	57.1
1962	n.a.	n.a.	n.a.	62.1
1963	n.a.	n.a.	n.a.	75.0
1964	n.a.	n.a.	n.a.	83.2
1965	n.a.	n.a.	n.a.	97.0
1966	n.a.	n.a.	n.a.	122.7
1967	n.a.	n.a.	n.a.	153.6
1968	n.a.	n.a.	n.a.	190.8
1969	n.a.	n.a.	n.a.	231.2
1970	221.8	38.4	1.0	261.2
1971	248.6	43.1	2.5	294.2
1972	296.0	48.0	4.6	348.6
1973	352.9	51.9	7.1	411.9
1974	500.0	54.8	10.9	565.7
1975	568.6	59.1	14.1	641.8
1976	629.6	69.7	15.3	714.6
1977	691.7	73.3	16.8	781.8
1978	755.5	78.2	19.2	852.9
1979	830.5	86.7	21.6	938.8
1980	906.6	94.0	22.8	1023.4
1981	996.5	100.6	24.1	1121.2
1982	1,048.0	110.7	24.1	1182.8
1983	1,099.7	128.2	25.1	1253.0
1984	1,143.5	160.5	26.2	1330.2
1985	1,232.1	187.2	28.1	1447.4
1986	1,324.2	207.3	28.9	1560.4
1987	1,380.0	228.2	32.1	1640.3

Sources: Dept. of Statistics (Malaysia) and PORLA

n.a. -- not available

Table 3.3 Malaysia: Production of Crude Palm Oil and Palm Kernel, 1960-88 (in '000 tonnes)

Year	Crude Palm Oil			Palm Kernel
	P. Malaysia	Sabah & Sarawak	Total	Total
1960	91.8	-	91.8	-
1961	94.8	-	94.8	-
1962	108.2	-	108.2	-
1963	125.6	0.1	125.7	-
1964	122.0	0.9	122.9	-
1965	148.7	1.7	150.4	-
1966	186.3	3.4	189.7	-
1967	216.8	8.9	225.7	-
1968	264.9	18.1	283.0	-
1969	326.1	26.0	352.1	-
1970	402.3	28.8	431.1	n.a.
1971	550.8	38.2	589.0	n.a.
1972	657.0	72.0	729.0	134.8
1973	739.3	73.3	812.6	152.4
1974	942.3	103.7	1046.0	194.7
1975	1,136.8	120.7	1257.5	232.8
1976	1,260.6	131.4	1392.0	256.0
1977	1,483.6	129.1	1612.7	334.8
1978	1,640.3	145.2	1785.5	367.5
1979	2,033.0	156.7	2188.7	475.0
1980	2,396.8	176.4	2573.2	557.1
1981	2,645.2	176.9	2822.1	588.8
1982	3,252.9	258.0	3510.9	909.9
1983	2,783.0	233.5	3016.5	834.6
1984	3,407.6	307.2	3714.8	1,045.6
1985	3,799.3	334.1	4133.4	1,213.0
1986	4,119.3	424.5	4543.8	1,337.0
1987	4,079.6	453.5	4533.1	1,314.4
1988	4,513.3	517.0	5030.0	1,580.0

Sources: Dept. of Statistics (Malaysia), PORLA, and Oil World Annual

- Nil or insignificant
n.a. not available

schemes of both Federal and state governments, areas under forest were cleared to make way for smallholding[3] oil palm cultivation. Existing smallholdings planted with rubber trees were also given grants to replace old rubber trees with oil palms. Finally, some coconut land areas were also involved in the conversion process. In fact, a large percentage of the hectarage increase after 1960, is due to the emergence of these land schemes and crop-converted smallholdings. There were no smallholders in the oil palm industry before 1960[4]. All palm oil produced came from the privately-owned estates. At present, large plantations only makeup about 54% of total area covered with oil palms (see Table 3.4).

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[3]Smallholdings are based upon small units of land, each unit usually run by the farmer and his family without hired labour. Meanwhile, plantations or estates are usually organized on a large scale, that is, the scale of operation, the area per unit holding and the labour force per hectare. In Peninsular Malaysia, the minimum size of an estate is 100 acres (40.5 ha).

[4]Smallholders did not grow this cash crop on their own initiatives because of the heavy capital investment outlays required in the handling and extraction of oil palm fruits in addition to the complex chemical properties of harvested fruits (Selvadurai p. 85). Oil palm fruits harvested must be processed within twenty-four hours because the fruits contain an enzyme that breaks down oil into free fatty acids. Oil containing high levels of free fatty acids is difficult to process and has lower market value. Therefore, processing factories must be located near the site of production to shorten transportation distance. Furthermore, oil palms are more prone to disease and require greater care (Selvadurai p. 85).

Palm oil processing factories are expensive to build and operate. Smallholders not only did not have the means to construct them , they could not have operated these factories profitably because palm oil processing has economies of scale (Fryer p. 85). Under government land development and settlement schemes, eventually it was possible for smallholders to exist. These smallholders, with the help of government agencies, have made some arrangements with the larger plantations to send their oil palm fruits for processing. Some smallholders in the landschemes have also combined their limited resources to establish their own processing factories, extracting oil from fruits from their respective smallholdings.

3.1.2 Palm Oil Production

The growth in the area under oil palm, though spectacular, does not directly translate into a corresponding growth in palm oil production. Area expansion is only one of the many ways that has contributed to the rising production[5]. The actual amount of palm oil produced annually and its rate of growth depend on many other factors and they can be divided into two stages. The first stage is the agronomic stage which relies on the availability of higher fruit-producing planting materials, total planted area, the amount of fertilizer used, rainfall, soil conditions, and agricultural practices such as planting distance and frequency of harvesting, to influence the total production of fresh fruits. Most of the output growth in Malaysia in the earlier years were chiefly in this stage but in the last decade or so, the second stage is more prominent. The second stage exphasizes on the use of higher oil-yielding materials and advancements made in the extraction of fruits for their oil and the refining process. With better technology and knowledge, seed varieties that produces higher oil-yielding fruits, in addition to more fruits, are used. These fruits give more palm oil per unit of fresh fruit bunches, which means some improvement in the extraction rate. Developments and improvements in processing methods, of course, have also helped in raising yields and production.

3.1.2.1 Regional Production and Productivity

Production of fresh fruit bunches (ffb) and palm oil in Malaysia (Peninsular

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[5]Oil palm , being a perennial crop, takes 3-4 years to mature and to produce fruits, so the actual producing hectareage is always smaller than the total planted area. Sometimes, some of the producing areas are not harvested during the year because of low market prices for palm oil. These areas are usually occupied by low-yielding young stands or oil palms that are falling in production.

Malaysia plus Sabah and Sarawak) is not uniform across its two regions. Having an earlier historical development in palm oil production, the bulk of palm oil produced by Malaysia comes from the Peninsula. Between 1985 and 1987, production in Peninsular Malaysia accounted for 91% of total production and the balance comes from Sabah and Sarawak. Most of the oil palm hectareages - 85% of total area - are also concentrated in the Peninsula.

Hectareage productivity is also differed between the two regions. Peninsular Malaysia tends to have higher yields than its sister states in the east. During 1985, 1986, and 1987, the estates in the Peninsula had average ffb yields of 18.0, 19.0, and 18.0 compared with ffb yields of 16.3, 18.3, and 17.1 for estates in Sabah and Sarawak. Furthermore, the combined ffb productivity of the two Borneo states fluctuates more violently than is the case in the Peninsula, reflecting the young palms and the relative smaller harvested area, especially in Sarawak. In the last 8 years, from 1980-87, the yield of ffb per hectare harvested by estates in Sarawak varies from a high or 22.3 to a low of 11.8 (Dept. of Statistics, Malaysia).

In spite of poorer records on ffb yield per hectare, the average combined yield of crude palm oil of estates in Sabah and Sarawak are much closer to those of the Peninsula (see Table 3.5). This characteristic seems to suggest that the extracting mills in Sabah and Sarawak are more productive than those in the Peninsula. A look at the average extraction rates of crude palm oil of the two regions confirmed the suspicion. During 1986, all the monthly extraction rates in Sabah and Sarawak are greater than those recorded in the Peninsula, averaging 20.63 tonnes of crude palm oil per 100 tonnes of fresh fruit bunches as against the rate of 19.52 for Peninsular Malaysia (PORLA).

Table 3.4 Malaysia: Oil Palm Planted Area Under Estates and Non-estates, 1985-87 (in '000 hectares)

Sector	1985	1986	1987	Average 85-87	%
Estates	782.1	837.9	876.6	832.2	53.7
Landschemes	555.8	604.6	648.3	602.9	38.9
Smallholdings	109.6	117.9	115.3	114.3	7.3
Total	1447.5	1560.4	1640.2	1549.4	100.0

Source: Dept. of Statistics (Malaysia)

Table 3.5 Malaysia: Average Hectareage Harvested, Production[a] and Yield of Crude Palm Oil (cpo) in Estates, 1965-1987

Year	Peninsular Malaysia			Sabah and Sarawak		
	Average harvested area ('000 ha)	Prodtn of cpo ('000 MT)	Yield (MT/ha)	Average harvested area ('000 ha)	Prodtn of cpo ('000 MT)	Yield (MT/ha)
1965	59.5	148.7	2.5	n.a.	1.7	-
1968	84.8	264.9	3.1	n.a.	18.1	-
1971	170.4	550.8	3.2	n.a.	38.2	-
1974	269.4	942.3	3.5	n.a.	103.7	-
1977	418.9	1483.6	3.5	n.a	129.1	-
1980	634.5	2396.8	3.8	35.6	176.4	5.0
1985	572.0	3799.3	6.6	53.7	334.1	6.2
1986	608.5	4119.3	6.8	62.9	424.5	6.7
1987	630.4	4079.6	6.5	72.0	453.5	6.3

Source: Dept. of Statistics (Malaysia)

a includes production from non-estate sources

3.1.2.2 Systems of Production

With the exclusion of smallholdings, other than those in landschemes, estates' share of oil palm hectareages will increase from 54% to 58% as compared with a share of 42% for landscheme smallholdings. However, the share of estates in fresh fruit bunches (ffb) production will rise even higher - at 65% of total ffb production (Dept. of Statistics, Malaysia). This shows that estates are more efficient in their production process than the landscheme smallholdings. Their efficiency is mainly due to better management and capability to experience economies of scale. In addition, estates have sufficient capital to equip themselves with the latest machinery and technical knowhow.

In 1987, estates had an average ffb yield per hectare of 17.9 while landschemes only managed to attain a yield of 15.3[6] (see Table 3.6). This differences in yield applies to the systems of production in both the Peninsula and the states of Sabah and Sarawak. In both regions, productivity of estates are far much higher than yields of landscheme smallholdings, but with a slight advantage for Peninsular Malaysian estates over those in Sabah and Sarawak.

3.1.3 Exports

Palm oil production in Malaysia is not directed towards the domestic population for self-sufficiency but towards other countries as a means to earn foreign exchange. Therefore, large amounts of palm oil are produced and exported annually. However, Malaysia's small population has also contributed to the availability of palm oil for

[6]If nonlandschemes smallholdings are included, this figure is expected to go down further because landschemes smallholdings are generally better run than the nonlandschemes smallholdings.

Table 3.6 Malaysia: Average Hectareage Harvested, Production, and Yield of Fresh Fruit Bunches(ffb) by Estates and Landschemes, 1987

Region	Estates			Landschemes		
	Average Harvested Area ('000 ha)	Prodtn of ffb ('000 MT)	Yield (MT/ha)	Average Harvested Area ('000 ha)	Prodtn of ffb ('000 MT)	Yield (MT/ha)
Pen. Malaysia	630.4	11,344.4	18.0	363.8	5,926.3	16.3
Sabah & Sarawak	72.0	1,234.0	17.1	77.5	810.3	10.5
Total Malaysia	702.4	12,578.4	17.9	441.2	6,736.6	15.3

Source: Dept. of Statistics (Malaysia)

export. The local economy consumes less than 10% of the total palm oil produced every year.

3.1.3.1 Markets for Palm Oil

As the largest net exporter of palm oil in the world, controlling three-quarter of the trade, it is not surprising that the list of major importers of Malaysian palm oil mirrors the list of principal importing countries of palm oil in world trade (see Table 3.7). India, Pakistan and the EC are the three largest importers of Malaysian palm oil. Between 1985-1987, on average, Malaysia supplied 91% of India's palm oil imports and 79% of Pakistan's palm oil needs every year[7] (Oil World Annual). These two countries also represent 31% of the palm oil exported by Malaysia. Despite having decreased its palm oil imports in 1988 after importing an unprecedented amount of palm oil in the previous year, India is still by far the most important market. Pakistan comes in second place while the EC is the third biggest importer of Malaysian palm oil. The EC, although accounts for 17% of the world net imports during the period, its imports only made up 10% of Malaysian palm oil exports, which reflects its more diverse sources of palm oil. Exports to Japan has been rising steadily reaching 223.8 thousand tonnes in 1988, and it is the fourth largest outlet for Malaysian palm oil.

The United States, after importing 231.8 thousand tonnes in 1986, had since reduced its palm oil consumption levels. Declining consumption in the US are mainly

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[7]These import percentages do not include Malaysian palm oil that are exported indirectly via Singapore to these two countries. Inclusion of these quantities will swell the percentages further because palm oil exported by Singapore originates almost exclusively from Malaysia.

Table 3.7 Malaysia: Palm Oil Exports, 1983-88 (in '000 tonnes)

	1983	1984	1985	1986	1987	1988
EC	346.2	315.6	311.8	487.7	428.4	390.8
USSR	256.4	162.6	160.2	178.4	162.7	96.5
Egypt	5.5	26.0	31.9	28.6	36.0	107.0
Kenya	4.0	2.9	6.9	16.5	46.4	11.3
Nigeria	62.4	7.4	11.5	56.9	-	-
USA	146.8	107.2	141.0	231.8	182.0	158.2
Bangladesh	13.1	15.9	32.2	33.3	19.5	15.6
China	7.7	14.8	39.0	37.6	85.7	214.6
India	609.9	610.6	619.9	855.9	1076.8	752.9
Iraq	92.2	73.4	66.1	151.8	155.5	159.0
Japan	183.2	171.0	198.4	220.6	218.6	223.8
South Korea	84.6	52.0	95.9	171.6	132.4	142.9
Pakistan	344.6	227.3	213.2	641.1	436.2	474.3
Saudi Arabia	53.9	102.6	99.6	102.6	111.0	111.3
Singapore	407.2	791.0	975.8	776.4	580.0	603.8
Turkey	52.1	48.4	32.9	100.0	69.2	79.6
Mozambique	9.9	5.5	5.5	13.2	31.4	32.0
Sudan	7.4	12.5	18.9	41.5	20.6	22.9
Canada	15.2	14.4	21.1	13.0	12.1	15.2
Indonesia	--	74.0	25.3	5.0	153.5	248.8
Jordan	49.5	4.5	26.4	58.6	87.3	111.8
Australia	54.6	40.7	53.7	56.3	64.4	69.4
Others	358.1	303.1	246.9	279.7	65.5	317.1
Total	3164.5	3183.4	3434.1	4558.1	4260.7	4358.8

Source: Oil World Annual

due to the effect of an adverse campaign against tropical oils uses[8] and the recovery in palm oil prices after record low price levels in 1986. The US, although taking in less than 5% of Malaysian palm oil exported annually, is important because being able to maintain a presence in the market means impacts of the anti-tropical oils campaign have been partially contained.

Both Iraq and South Korea have increased their respective demand levels substantially - above 100 thousand tonnes - since 1986. While the USSR palm oil imports fell below 100 thousand tonnes in 1988 for the first time since 1980. Other important palm oil importers for Malaysia are Saudi Arabia, China, Egypt, Bangladesh, Turkey, Kenya and Australia. Both Bangladesh and Kenya import Malaysian palm oil primarily indirectly via Singapore. Occasionally, Indonesia also imports substantial amounts of Malaysian palm oil for domestic consumption. China will be an interesting market to watch for in the future considering the 2.5 times jump in exports to this

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[8]Many special interest groups were involved in a campaign to discourage the consumption of tropical oils by pointing out that they contain high levels of saturated fatty acids of which have been associated with elevated blood cholesterol levels. At the forefront of the pack was the American Soybean Association (ASA). The issue reached its height when a bill which only labels tropical oils as saturated fats was introduced in the US Congress after much lobbying by the ASA. The main producers of tropical oils which include Malaysia and the Philippines were alarmed and in response, they launched their counter-campaign in the US, coupled with some lobbying efforts in the US Congress. The situation became so intense that a report which appeared in the Wall Street Journal called it a trade issue, hiding under the name "health", and questioned the sincerity of the ASA in promoting health rather than the superiority of soybean oil, at a time when the market share of soybean oil is declining in the US and the potential threats from oils such as rapeseed oil are strong (Freeman and Waldholz).

The bill, eventually, was rejected due to its trade-protectionist elements. A substantial revised version replaced the original bill. The new bill does not single out tropical oils as saturated fats but requires food manufacturers to explicitly and specifically mention the types of oil they use in their products. In the past, manufacturers were allowed to put several oils on their package labelling without pointing out precisely the ones used (Graves).

country between 1987-88.

3.1.3.2 Composition of Palm Oil Exported

In terms of composition of palm oil exported, there has been a tendency to move towards the export of processed palm oil products. Before 1975, all the palm oil exported was unprocessed. Starting from 1975, however, 215.5 thousand tonnes or 18% of total palm oil exports were categorized as processed. The percentage has been rising since and it reached 99.6% in 1985 before dropping to 96% in 1987 due to larger exports of crude palm oil. Most of the processed palm oil exported are either crude palm olein or palm olein and palm oil that has been processed in one of these ways: neutralize, bleach, deodorize, or refine (see Table 3.8).

3.1.4 Institutional and Marketing Structures

Palm oil exports from Malaysia are subject to a variable export duty. The duty changes according to average world market prices for palm oil in the previous months on a sliding scale. However, exemptions are given to some processed palm oil exports, depending on their stages of processing. The further the oil is processed, the higher will the level of exemptions be available to it. However, the level of exemptions is reduced in times when the market price of the product is high (Anuwar p. 12). The revenue collected from export duty by the government, therefore, fluctuates violently from year to year, depending on the composition and market prices of palm oil and products. For example, in 1977, M$346 million were collected from export duty while only M$18 million were received in 1970 (PORLA).

Marketing of Malaysian palm oil for the purpose of export was first made under

Table 3.8 Malaysia: Annual Exports of Palm Oil by Product, 1984-1986 (in '000 tonnes)

Products	1984	1985	1986
Crude Palm Oil	59.3	13.1	117.5
N, NB,NBD, and RBD Palm Oil	853.9	708.5	1647.5
Crude, N, NB, NBD, and RBD Olein	1443.8	1745.4	1848.9
Crude, N, NB, NBD, and RBD Stearin	600.4	748.0	691.2
Palm Acid Oil	22.0	17.1	30.3
Palm Fatty Acid	204.0	202.0	223.5
Total	3183.4	3434.1	4558.9

Source: PORLA

Note: N - Neutralized
R - Refined
B - Bleached
D - Deodorized

a foreign-controlled pool system and later a local-controlled pool system whereby prices are set by a committee from 1954 to 1974[9]. Palm oil was collected from all producers by the installation/shipping parties, some of whom were also producers, for shipment and sale. The rigid arrangement was terminated in 1974 and competition among producers was allowed as a result of rising production and exports. The pool system was replaced by an open market selling system.

In 1980, the Kuala Lumpur Commodity Exchange (KLCE) was established. It provides protection to traders, processors and producers against price fluatuations and also aides the price discovery process and trade of palm oil. Crude palm oil is the first commodity traded on the exchange. Most recently, refined palm oil has also been traded.

3.2 INDONESIA

As mentioned earlier, before 1966, Indonesia produced more palm oil than Malaysia. At the same time, Indonesia also exported more palm oil than Malaysia until 1962, when Malaysian palm oil exports overtook exports from Indonesia for the first time. However, exports from Indonesia regained its lead in 1964 after two years and it was the last time that Indonesian exports ever exceeded that of Malaysia. Since then, exports from Malaysia have always been greater than the quantities of palm oil exported from Indonesia.

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[9]For a detailed historical developments of the marketing arrangement for palm oil, refer to Khera.

3.2.1 Palm Oil Production

Palm oil production in Indonesia stagnated throughout the late fifties and most of the sixties as a result of political instability and restrictive government policies with regards to land tenureship for foreign-owned estate companies. Many estates were abandoned or produced way below capacity (see Fryer pp. 350-356). Production grew slowly but started recovering in the late sixties after a new government took over. Recovery in production, however, became obvious only after 1970 when production, on average, grew at an annual rate of 17.8% in constrast to the 3.4% growth rate throughout the sixties (Oil World, 1958-2007).

Palm oil produced in Indonesia still mainly comes from estates which are either owned by private companies or by the government. This characteristic is opposite to the situation in Malaysia where smallholders -- landschemes or nonlandschemes -- already have had a significant stake in the planted area and production. However, more recently, attempts have been made to redistribute ownerships to the peasant's cooperatives. An innovative programme, started in the early 1980s, that involves the participation of smallholders is the Nucleus Estate Schemes (NES) in which investors are required to accept oil palm fruits produced by neighbouring smallholders for extraction in their mills, located at the centre.

Majority of the oil palm estates in Indonesia are confined to the northern region of Sumatra, the land mass closest to the major producing areas in Peninsular Malaysia. Those newly established NES which are increasingly important because of their rising share in mature hectareage, however are mostly located in Kalimantan and Sulawesi.

3.2.2 Exports

Palm oil exports from Indonesia change from year to year, depending on its domestic needs for oils and fats. For example, between 1982 and 1988, despite yearly growth in production, palm oil net export levels had not been on a continuous rise. Instead net exports fell by 220 thousand tonnes between 1983-84, as a consequent of poor coconut harvest in 1983. Coconut oil is a major source of edible oil in Indonesia. Shortages in supply, therefore, partly had to be filled by palm oil. Palm oil exports rebounded in 1985 after a better harvest was recorded in 1984 for coconut. Another reason is that, copra, the raw material for coconut oil, and coconut oil have higher market prices than palm oil. Palm oil is therefore used as a means to increase the availability of copra and coconut oil for export.

3.2.2.1 Markets for Palm Oil

The European Community is the largest market for Indonesian palm oil. This single economic unit accounts for more than half its total exports (see Table 3.9). Since 1983, the Soviet Union has also taken in a substantial amount of palm oil from Indonesia, peaking in 1987 -- 81.1 thousand tonnes -- but dropped to 43 thousand tonnes in 1988. Imports from Kenya and Bangladesh had also risen markedly in 1988. The most alarming trend, for Malaysian oil palm producers, is perhaps the growing palm oil exports to India. India took in 99.9 thousand tonnes of Indonesian palm oil in 1988 compared with a mere 3 thousand tonnes in 1984. As noted earlier, India is currently the most important market for Malaysian palm oil. Other important importers for Indonesia are South Korea, the US, and Japan.

Table 3.9 Indonesia: Palm Oil Exports, 1984-88 (in '000 Tonnes)

Country	1984	1985	1986	1987	1988
EC-12	123.7	388.1	452.3	374.8	517.4
USSR	33.7	51.3	41.4	81.1	43.0
Kenya	14.7	25.5	35.3	55.0	107.2
USA	3.1	10.0	15.5	25.2	12.9
Bangledesh	-	-	14.1	6.2	24.4
India	3.0	43.5	53.0	97.5	99.9
Japan	9.0	8.6	7.4	7.1	9.6
Pakistan	-	50.3	22.4	-	-
Saudi Arabia	-	5.1	4.1	8.0	2.0
South Korea	4.9	18.3	13.3	11.2	11.2
Singapore	11.5	5.1	6.9	10.2	6.9
Others	27.3	46.1	16.9	20.7	37.3
Total	240.9	651.9	982.6	697.6	871.7

Sources: Oil World Statistics Update, Oil World Annual

3.3 OTHER PRODUCERS/EXPORTERS

The most important net exporter of palm oil after Malaysia and Indonesia is Papua New Guinea (PNG), controlling about 3% of the trade. Export growth in this country is phenomenal -- increased by more than 20 times between 1972 and 1982 -- despite being a relative new comer to the industry. Similar to the Malaysian oil palm industry, palm oil produced in Papua New Guinea is mainly for export. This country will likely become a significant player in palm oil trade in years to come.

Ivory Coast, although is a much larger producer than Papua New Guinea, exported less palm oil than the former. Following Ivory Coast in the list of major palm oil exporters is Cameroon. Production in Cameroon, though rising steadily, has fallen behind that of PNG since the early 1980's. However, it is still the fifth largest exporter of palm oil.

CHAPTER IV

RELATIONSHIPS AMONG EDIBLE OILS

Many edible oils are produced and traded in the world. The amount of each oil produced and traded, however, is not independent of the market conditions of the other oils. All oils have become related in their chemical and physical characteristics due to the improvements attained in processing technology. Oils with different chemical and physical properties can now readily substitute one another in many end uses and therefore their prices have become closely related as well. Through these price relationships or more specifically through their price spreads, quantities of an oil produced and demanded partly depend on the supply and demand conditions of the other oils.

4.1 Technical Relationships

Edible oils can be categorized under different groups on the basis of their iodine numbers[1] and their main commercial uses. There are three such major groups. The first group is the drying oils which consists of oils with the highest iodine numbers. These

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[1]Iodine numbers are the measurement unit for the amounts of unsaturated fatty acids in the oils. If an oil contains a high level of unsaturated fatty acids, it will need large quantities of iodine to fully react with it. (Specifically, large number of grams of iodine to fully react with 100 grams of the oil.) Therefore, this oil will have a high iodine number. In contrast, an oil with a low level of unsaturated fatty acids will need a low amount of iodine to fully react with it.

oils are also the most chemically active and as their name suggests, are used as drying agent. Oils with intermediate iodine numbers which include both the semidrying and nondrying oils represent the second group and there are used in food as well as industrial products. The third group is made up of tropical oils and animal fats of which are also used for food and industrial purposes (see Table 4.1).

The limits of each group or sometimes subgroup define the natural substitutability of the oils. For example, under normal circumstances soybean oil would substitute peanut oil. The reverse, however, is only partly true because though peanut oil can substitute soybean oil in food uses, it is not suitable for industrial uses while soybean oil is suitable. Thus, its natural substitution possibilities are more limited than soybean oil. With developements in processing methods, however, natural substitution possibilities now have become less relevant. There are technologies to enable nondrying oils to substitute semidrying oils as well. More importantly, however, the hydrogenation and fractionation processes[2] have enable the soft oils (such as soybean and rapeseed oils) to cross over to the hard oil end uses and for the hard oils (such as palm oil and tallow) to enter the soft oil market. As a result, nowadays, it has become common to see palm oil competing with soybean oil in many markets in the world.

Although technically, all edible oils are interchangeable, commercially, the degree of substitution is more limited because of the high costs involved in the processing process. For example, in margarine manufacturing, it is more expensive to use an oil with high iodine number, compared with one that has low iodine number,

[2]The hydrogenation process modifies the unsaturated fatty acids in an oil to make them more saturated while the fractionation process separates the liquid portion from the solid portion of an oil, especially those oils which have low iodine numbers.

Table 4.1 Technical Classification of Fats and Oils

Fats and Oils	Iodine Number	Fatty Acids[1]		
		Saturated[2]	Unsaturated	
			Oleic[3]	Linoleic[4]
			percent	
A) Fluid				
1) Drying oils				
Linseed	173-201	--	--	--
Tung	166-170	--	--	--
2) Semidrying oils				
Soybean	121-142	14	25	50
Sunflowerseed	115-135	11	14	70
Corn	111-128	13	26	55
Marine	110-180	--	--	--
Cottonseed	102-107	23	17	54
Rapeseed	94-105	7	53	22
3) Nondrying Oils				
Sesame	100-108	14	38	42
Peanut	84-105	18	47	29
Olive	78- 95	11	76	7
B) Solid or Semisolid				
1) Palm & Animal				
Palm	45- 56	45	40	8
Lard	53- 77	38	46	10
Tallow	45- 55	48	36	4
2) Lauric Oils				
Coconut	7- 10	88	6	2
Palm Kernel	16-23	80	14	1

Sources: Tan ,Boutwell et al and FAO

1 Total is not expected to equal 100 percent
2 Includes fatty acids with chains from 8 through 18 carbon atoms
3 Monounsaturated
4 Polyunsaturated

because of the huge amounts of hydrogen needed in the hydrogenation process to harden the oil. Consumer habits, tastes, and beliefs and the requirement for some specific fatty acids can also restrict the substitution between oils in many cases. An example is the continued use of coconut and palm kernel oils in some end-products despite their relatively higher prices, primarily because they provide a high degree of stability to the product and their taste is unique. These oils consequently are not easily replaced with alternatives without some loss in product quality. Another example of restriction to technical substitution is the issue concerning the use of higher saturated oils in food products in North America. Rising awareness that consumption of oils with high saturated fatty acids may contribute to elevated blood cholesterol levels[3] has resulted in consumers presuring food manufacturers to substitute away from tropical oils despite their physical or price advantage.

4.2 Price Relationships

Owing to the technical relationships among oils and their capability to interchange, prices of all oils have become closely interdependent. A relative constant price gap is always being maintained among the oils. When the price differential between two oils which are easily interchanged grows wider, food manufacturers will start to substitute away from the more expensive oil with the cheaper one. In due time, their combined actions will drive down the higher priced oil and cause a rise in the price of the cheaper oil. Eventually, the two prices will return to their normal price

[3]It has also been recognized that changing fat quality intake has very little effect on blood cholesterol levels and that the response level varies widely from person to person ("Diet" ; Moore pp. 42-57).

gap and it becomes less economical to continue substituting. Edible oil prices, therefore, tend to move together so that their price differences do not become too wide. Exceptions, however, are not uncommon for short time periods. When the supply of an oil is tight, the price relationships will deviate from the trend and the higher priced oil becomes less competitive in the market. Demand conditions can also affect the movement of prices though less frequently than supply factors.

Various studies have analyzed the price relationship among oils (see Griffith and Meilke ("Relationships"); Griffith; Kwang; Fryar and Hoskin; Tan; and Wendland). They range from using simple correlation coefficient and coherency coefficient to using the more complex technique of spectral and cross-spectral analysis. Some of these studies use annual data while others use quarterly or monthly data. The years under consideration are also different. Consequently, all of these studies ended up with different values attached to the strength of the price relationships. Despite variations in the price strengh values, the conclusions arrived at are similar. Oils in the same group or different groups are found to have strong price relationships and the price relationships have increased over time, that is, they are stronger now than in the past. The interdependence is also stronger in longer time intervals than in shorter time intervals. All these conclusions therefore suggest an increasing possibility for substitution among oils. With respects to palm oil, generally, soybean oil, rapeseed oil, sunflowerseed oil, edible tallow and marine oil are regarded as competitors for palm oil uses. Palm oil does not have specific demands, unlike the lauric oils or olive oil, and therefore does not have any technical advantages over the other oils to claim a market.

4.3 Summary

The ultimate choice of oils and fats to use in an end-product, therefore, depends on its price relative to that of its close competitors because of processing costs and the consumer's edible oil preference in the end-product. If the demand for an oil in an end-product is very specific in which the consumer attaches great importance to the oil's natural characteristics and is prepared to pay higher prices, substitution possibilities are very limited. On the other hand, if a weaker significance is attached to the type of oil used in the processed product, interchangeability is very strong and it depends on the relative price levels of all oils. Most of the time, however, manufacturers have a wide range of oils to choose from and the choice is based on the law of least-cost.

CHAPTER V

MARKETS FOR PALM OIL

In the sixties and earlier, demand for palm oil mainly concentrated in a few markets. These markets were the EC, the US, and Japan. The significance of these markets, however, started to decline in the late seventies and it continues to the present. For example, in 1969, these markets accounted for as much as 78 percent of the palm oil net imports (Tan p. 17), however, between 1985 and 1987, the average total net absorption by these outlets were 1253 thousand tonnes or only about 26 percent (Table 1.5). Dilution of the demand market dominance of these countries is primarily due to the growing importance of other importing countries and the entry of new ones in the palm oil trade. Not only has the composition of importers of palm oil changed, the stage of development of most of these importing countries is also different. Demand markets for palm oil gradually shifted towards those less developed or developing countries from the developed ones.

Rising demands for edible oils in these less developed countries, mainly due to growing population and rising income per capita, have prompted greater imports of various edible oils, not just palm oil. However, owing to its price competitiveness, palm oil is able to capture the lion share of the growing market. Among these palm oil markets, India and Pakistan are two of the most notable among them. Since 1980, these two countries account for almost 30 percent of all palm oil imported. At the same time, they also import a large proportion of the palm oil exported by Malaysia. Other important palm oil importers include Iraq, South Korea, the USSR, Kenya, Saudi Arabia, Bangladesh, and increasingly the People's Republic of China. Therefore, markets for palm oil predominantly lie in those countries with less developed economies and still have very low levels of per capita consumption of fats and oils. Imports from the EC, Japan and US, however, cannot be overlooked because they still take in very large amounts of palm oil in absolute terms every year.

5.1 INDIA

Although India has long been a market for palm oil, large scale imports did not start until 1977, after restrictions on vegetable oil imports, were relaxed following some internal demand pressures. After the relaxation in the restrictions on vegetable oil imports into India, imports of oils rose dramatically . Imported oils came to constitute approximately 25% of domestic vegetable oil supply and the per capita availability of vegetable oils increased by more than one kilogram, from 5 kg to 6 kg, between the period 1974 to 1976 and 1977 to 1980 (Harrison, Hichings, and Wall p. 71). In the mean time, palm oil imports shot up by almost 19 times over the year 1977. Since then, large quantities of palm oil have been purchased, though with no perceptible trend. India, in 1984, after only seven years of the lifting of import retrictions, became the biggest net importer of palm oil in the world, pushing the E.C. into second spot.

5.1.1 Domestic Supplies

Edible oil needs in India are met by many oilseeds and tree crops (see Table 5.1). However, two oilseeds are dominant in supplying oils to the domestic market:

Table 5.1 India: Oilseeds and Vegetable Oils Production by Source, Average of 1982/83-83/84 (in Percentage)

Oilseeds	% of Oilseed Cropped Area	% of Oilseed Production	% of Oil Production
Groundnut	26.5	44.9	45.2
Rape/Mustard	15.4	18.1	21.2
Sesame	9.8	3.7	5.3
Safflower	2.7	2.8	3.0
Niger	1.9	0.9	1.4
Soybean	2.8	3.8	2.7
Sunflower	1.8	1.8	2.8
Cottonseed	28.9	18.5	8.1
Coconut	3.9	2.0	6.3
Linseed	6.4	3.4	3.7
Castor	n.a.	n.a.	n.a.
Rice Bran	n.a.	n.a.	n.a.
Tree Crops	n.a.	n.a.	n.a.

Sources: Harrison, Hitchings and Wall, Landes and Nehring and South Asia: Situation and Outlook Report

n.a. -- not available

Note: Percentage excludes area planted to castor, rice bran and tree crops (except coconut), and their productions groundnut and rapeseed. Groundnut oil on average constitutes 45% of the domestic oil production and rapeseed comes in second with 21% of the share. These two crops also account for 42% of the total oilseed area.

There are two principal tree sources of edible oils. One of them is oil palm from which palm oil is obtained and the other is coconut tree. Palm oil is produced in small amount in the state of Kerala, at the southern tip of India. This is one of the two regions in India that has the necessary conditions for palm oil cultivation. However, the industry is still in its infancy and is not important in supplying palm oil. In 1986, there were 3705 hectares of oil palm area and only 560 hectares of it were covered with mature oil palms as of June 1986 (Meenakshi, Sharma, and Poleman p. 69). Furthermore, less than optimal climatic conditions and quality planting materials have dampened the rise in fruit production and yields as shown in one of the largest plantations in Kerala (Meenakshi, Sharma, and Poleman pp. 72-77).

5.1.2 Demand Conditions

Palm oil imported into India are primarily channelled into two uses: vanaspati manufacturing and as refined cooking oil. Vanaspati is a hydrogenated mix of various vegetable oils used for the purpose of cooking. Those edible oils used in its making are mainly imported oils such as soybean, palm and rapeseed oils although some less important domestically produced edible oils from rice bran, cottonseed, soybeans and sesame are also utilized[1] (see Table 5.2).

[1]Groundnut oil and rapeseed oil produced locally are the the two traditionally preferred vegetable oils. They are discouraged from use in the vanaspati industry in order to maximize domestic supplies of these oils for direct consumption in food.

Table 5.2 India: Estimated Use of Edible Oils in Vanaspati and the Public Distribution System (PDS), Oct/Sept, 1977-87 (in '000 Tonnes)

Year	Vanaspati			PDS[1]
	Total	Domestic	Imported[2]	
1977	601	60	541	58
1978	681	68	613	52
1979	678	231	447	93
1980	720	85	635	355
1981	878	225	653	437
1982	949	355	594	404
1983	941	320	621	505
1984	912	224	688	707
1985	960	334	626	730
1986	972	474	498	670
1987	964	459	505	840

Source: Landes and Nehring, South Asia: Situation and Outlook Report and World Oilseed: Situation and Market Highlights

1 imported oils only

2 government allocations only

Owing to the structural nature of the market, palm oil must be competitive in price in relation to other imported vegetable oils, namely soybean oil and rapeseed oil and to a lesser extent sunflowerseed oil internationally in order to maintain its market share in India. However, relative price competitiveness in the international market is not the only determinant of the amount of palm oil demanded. The production condition of oilseeds in India is also important because imported vegetable oils are allocated to the vanaspati industry and to the Public Distribution System (PDS), which distributes palm oil and other imported oils, according to the availability of domestically produced vegetable oils. Since the imports of oils are virtually controlled by the State Corporation of India (Meenakshi, Sharma, and Poleman p. 11) and additional imported oils are available to vanaspati manufacturers and the PDS only in years when domestic oilseed supplies are short, the amount of edible oil imported each year indirectly depends on the oilseed production condition.

Between these two factors, domestic oilseed crop harvest has a more important role in determining the amount of palm oil imported. In light of the continuing efforts of the Indian Government to reduce India's dependence on imported edible oil in order to save scarce foreign exchange, this factor has taken additional weight.

Imported oils in India are priced below domestic market prices but above import costs. While availability of oils to vanaspati manufacturers are controlled directly by allocation, the PDS works under a different mechanism. In years when domestic oilseed production is abundant, the price differences between domestic oils and imported oils will narrow and consumers will shift their consumption towards the preferred domestic oils, thus decreasing the demand for imported oils. The reverse happens when domestic supplies are tight and prices are high. More imported oils are then available for distribution.

Competition for palm oil for use in vanaspati manufacturing comes from both soybean and rapeseed oils but for the purpose of consumption in food directly, the main competitor is rapeseed oil. Soybean oil is still not readily accepted by consumers as cooking oil and therefore it is not widely consumed in this manner in India (South Asia: Outlook and Situation Report p. 38). Another reason is that soybean oil is less competitive-priced when compared to palm oil and rapeseed oil. Sunflowerseed oil is also imported but only occasionally because it is a premium oil, so its use for cooking or vanaspati manufacturing is negligible.

Despite the presence of imported oils in India, domestic prices of all vegetable oils are generally still above world market prices. Oilseed meals, however, are generally sold at a discount when compared to their respective equivalences in the international markets. The market structure for oils and meals in India is therefore the opposite of the normal market conditions as seen in developed countries. The paradox can be partially explained by the market demand in India which favours vegetable oils. Owing to religious beliefs and low per capita income, demand for animal products is low when compared to demand for vegetable oils for consumption in food . Consequently, the demand for oilmeals, which are used for animal feeding, is low and therefore contributes to low oilmeals local prices (Harrison, Hitchings, and Wall p. 80; Landes and Nehring pp. 20-21).

5.2 PAKISTAN

Large scale imports of palm oil came much earlier in Pakistan than in India. However, Pakistan has traditionally been a huge importer of edible oils due to its smaller production base for oilseeds. In spite of this, the first recorded numerically significant palm oil imports were only made during 1965. After many years of uncertain direction in the amount of palm oil imported, palm oil imports finally shot up over the year 1974-75 and its imports have since been on the rise despite some swings in the amount imported from time to time.

5.2.1 Domestic Supplies

Oilseed production in Pakistan is dominated by cottonseed. Cottonseed oil accounts for about 74 percent of the edible oil supplies during 1984/85 - 1986/87. Meanwhile rapeseed, the second most important oilseed crop, accounts for about 23 percent of domestic oils produced. The remaining sources of edible oils are oilseeds which include groundnuts, sesameseed, soybeans, sunflowerseed, and safflower.

5.2.2 Demand Conditions

Pakistan's dependence on imported oils to fulfill domestic edible oil requirements has traditionally been high, however, the share of imported oils in the domestic oil consumption has grown even larger lately. As a proportion of total domestic consumption, imported oils had 55 percent of the share during 1975-77 (Landes and Nehring p. 28) but during the period 1985-87, the proportion of imported oils jumped to 70 percent (see Table 5.3). Accordingly, the share of palm oil in the market rose and Pakistan became the third largest importer of palm oil in the world.

Similar to product usage in India, palm oil is also used to make hydrogenated vegetable oil, called vegetable ghee. The type of edible oils used, which are usually cottonseed, soybean, and crude palm oils, depends on the seasonal availability of

Table 5.3 Pakistan: Supply and Use of Vegetable Oils, 1980/81-87/88 (in '000 Tonnes)

	Prodtn	Imports				Use	
		Soybean		Palm	Other	Total	Veg. Ghee
		Total	U.S.				
1980/81	225	214	126	226	15	707	505
1981/82	240	291	260	273	9	777	531
1982/83	256	306	237	349	8	894	513
1983/84	190	301	216	328	1	863	530
1084/85	289	189	168	487	4	n.a.	n.a.
1985/86	344	314	275	692	1	n.a.	n.a.
1986/87	363	200	147	378	45	n.a.	n.a.
1987/88	353	400	400	350	25	n.a.	n.a.

Source: South Asia: Situation and Outlook Report and Landes and Nehring

n.a. -- not available

cottonseed oil and the relative prices of soybean and palm oils in the international marketplace (Landes and Nehring p. 31). At times, the availability of soybean oil on concessions or credit terms can be the deciding factor determining the amount of soybean used. Imports of soybean oil from the US mainly fall in this category.

With the fast rising consumption of refined and unrefined cooking oil, palm oil use for this purpose has also increased. The relative prices of palm oil and soybean oil determines the total amount of palm oil used as cooking oil and so does the domestic produced cottonseed oil.

Pakistan is also facing the problem of tight foreign exchange reserves. Any continued future imports for palm oil will therefore partly depend on the future conditions of its foreign exchange. Domestic supply of edible oils and fats is a less significant factor affecting palm oil imports because Pakistan has a smaller production base for oilseed production and its government's present commitment to low consumer edible oil prices will likely to continue.

5.3 THE UNITED STATES

The United States has traditionally been and continues to be a net exporter of vegetable oils, either in the form of crude oil or oilseed. Despite its surplus vegetable oils, the United States does import some oilseeds and vegetable oils. Imported oilseeds and vegetable oils make up approximately 10 percent of domestic edible oils used in food products. Palm oil is one of the many edible oils imported (others include coconut oil, olive oil, rapeseed oil, palm kernel oil and castor oil). Demand for palm oil has been erratic from year to year, with no obvious trend. Its imports peaked in 1975 when over 440000 metric tonnes of palm oil were imported following periods of poor domestic edible oils production and high prices[2]. Palm oil imports, however, have never come near that level again since then. Palm oil has been allowed into the US duty-free since 1969 (Griffith and Meike (A Description) p. 80) and there is no quantitative restriction on its imports (Graham p. 8).

5.3.1 Domestic Supplies

Various oilseed crops are cultivated in the United States and these oilseeds are extracted for their oils and oilmeals. Soybeans, however, are the largest oilseed crop produced, consumed and exported. It has taken over from cottonseed as the most important oilseed since the 1950's and is now the largest source of edible oil in all three major food products - margarine, salad and cooking oil and shortening - in the US (see Table 5.4 and Hoskin and Putnam). Soybean oil accounts for 50 percent of all edible fats and oils consumed, either in food products or industrial products (calculated from data in USDA Agricultural Statistics). Cottonseed oil is the second most important edible oil after soybean oil. Other oilseed crops that are produced in significant quantities are corn, peanuts, flaxseed and sunflowerseed.

[2]Large quantities of palm oil were imported starting from 1972, at first mainly because of shortages of edible oils in the domestic market, later it was due to the price advantage of palm oil over other oils. The decline in soybean oil and animal fats (butter, lard, and edible tallow) production in the US which stretches two consecutive crop years from 1971/72 to 1972/73, contributed to rising domestic edible oil prices. Restrictions imposed on exports of oils and oilseeds during 1972-73 did not dampen the price hikes for long after another poor oilseed harvest and animal fats production occurred in 1974/75. Imports of palm oil, thus , were needed to slow down price increase and to meet the domestic demand (McGuire p. 4; Doty and Hacklander pp. 17-18). However, the increased palm oil imports has also stirred up some political uproars in the US that eventually led to various considerations to curb the amounts imported and overall palm oil prodution in exporting countries (see Graham pp. 8-9 ; "Asst. Secretary", for example).

Table 5.4 Soybean Oil Uses in the United States: Margarine and Shortening, 1973 - 87 (in million pounds)

Year	Margarine			Shortening		
	Soybean	Total	%	Soybean	Total	%
1973	1,491	1,889	78.9	2,268	3,696	61.4
1974	1,457	1,905	76.5	2,177	3,725	58.4
1975	1,568	1,917	81.8	2,025	3,728	54.3
1976	1,671	2,091	79.9	2,322	3,938	59.0
1977	1,585	2,026	78.2	2,279	3,855	59.1
1978	1,593	1,997	79.8	2,480	4,059	61.1
1979	1,643	1,985	82.8	2,680	4,213	63.6
1980	1,653	2,016	82.0	2,651	4,200	63.1
1981	1,685	2,012	83.7	2,767	4,304	64.3
1982	1,718	1,997	86.0	2,948	4,391	67.1
1983	1,549	1,850	83.7	2,914	4,381	66.5
1984	1,544	1,842	83.8	3,465	5,108	67.8
1985	1,628	1,946	83.7	3,625	5,564	65.2
1986	1,741	2,041	85.3	3,375	5,453	61.9
1987	1,615	1,931	83.6	3,434	5,303	64.8

Source: USDA Agricultural Statistics

5.3.2 Demand Conditions

Over half of all the palm oil imported into the US has gone into shortening manufacturing with the exception of 1980 (see Table 5.5). The rest is used in other food products such as margarine, salad dressing, and confectionary. As can be seen from Table 5.5, there is a rising use of palm oil in products other than shortening. Share of palm oil used in baking and frying (the main uses of shortening) has declined gradually from over 60% to the current roughly fifty-fifty split with other food product uses despite maintaining its share of about 4-5 percent in shortening manufacturing.

Most palm oil imports are used in food products. Use of palm oil for industrial purposes is only about 10 percent of total palm oil consumed in the US and has been stagnant due to the encroachment of synthetic substitutes. Palm oil can be used in cosmetics, soaps, candles, inks, detergents and paints. However, its share in industrial products rose to 18 percent while its share in edible products fell to 82 percent in 1987/88 (World Oilseed: Situation and Market Highlights).

Growing health consciousness among consumers on the posssible effects of saturated fatty acids on blood cholesterol levels and the subsequent increased risks of heart disease, has been affecting the consumption of palm oil in the US. Although coming from a plant, palm oil has a higher proportion of saturated fatty acids than most oils and fats.

5.4 THE EUROPEAN COMMUNITY

Since domestic production is still insufficient to meet internal demands, many oilseeds and vegetable oils are imported into the EC for consumption. Palm oil net imports have been quite stable around the 600-700 thousand metric tons mark

Table 5.5 United States: Palm Oil Used in Shortening (as Percentages of Total Fats and Oils Used in Shortening and Palm Oil Consumption), 1976 - 87

Calender Year	Palm Oil (Mill. Ibs)	Total Fats and Oils (Mill. lbs)	%	Total Palm Oil Consumption (Mill. lbs)	%
1976	532	3,938	13.5	723	73.6
1977	371	3,855	9.6	588	63.1
1978	266	4,059	6.6	325	81.8
1979	222	4,213	5.3	285	77.9
1980	88	4,200	2.1	233	37.8
1981	217	4,304	5.0	286	75.9
1982	190	4,391	4.3	240	79.2
1983	213	4,381	4.9	286	74.5
1984	216	5,108	4.2	336	64.3
1985	230	5,564	4.1	408	56.4
1986	320	5,453	5.9	634	50.5
1987	215	5,303	4.0	408	52.7

Sources: USDA Agricultural Statistics, Oil World Annual and Oil World Statistics Update throughout these years, although total imports change more pronouncedly from year to year due to the huge internal trade among member states. Lately, in 1986, 1987 and 1988, imports have soared because of the large decline in palm oil prices during that time. The sudden jump in the quantity of palm oil imported demonstrates the sensitivity of relative prices of edible oils to demand because of interchange possibilities.

All oilseeds and meals enter the EC are free of import tariff but an *ad valorem* tariff is applied to edible oil imports. Palm oil imports from producers that are associated with the EC through the Lome Convention such as Cameroon, Ivory Coast and Papua New Guinea are exempted from the excise duty. However, palm oil imports from Malaysia and Indonesia both of which are not members of EC's ACP countries are not given this privilege. Different tariff rates are set for palm oil, depending on its degree of processing (with higher rates imposed on refined oil than crude unprocessed oil) and its intended end uses (with higher rates applied to oil used in food products than for industrial purposes).

5.4.1 Domestic Supplies

The main oilseed produced in the EC is rapeseed but sunflowerseed production is increasingly important following the accession of Greece, Spain and Portugal to the EC in the 1980s. These three member-states produce almost one half of the sunflowerseed in the EC. Other major producers of sunflowerseed are France and Italy. Rapeseed, on the other hand, is mainly produced in France, West Germany, Denmark and the United Kingdom. There are a few other important oilseeds such as olives, flaxseed, cottonseed and soybeans. The most important among them is olives. However, olive oil does not compete in the usual edible oil market due to its specific demand.

Olives are produced in significant quantities in Italy, Spain and Greece though some smaller amounts also come from Portugal and Southern France. Large amounts of soybeans -- average 13463 thousand tonnes during 1985/86-86/87 (EC's Agricultural Situation in the Community: 1988 Report) -- are also imported into EC annually for crushing to produce oil (and meal). These imported soybeans are in addition to the domestically produced soybeans. Soybeans are mainly imported into West Germany, the Benelux, Spain and Italy. Beside soybean, some other oilseeds such as sunflowerseed, groundnuts and copra are also imported for crushing.

5.4.2 Demand Conditions

EC is not a single homogeneous market where consumer preferences are relatively identical across. The EC is made up of many submarkets with diverse preferences and tastes. Take for example, the main edible oil consumed in Italy is olive oil while sunflowerseed oil is more important in France.

Among the 12 members of the EC, the largest net importers of palm oil are West Germany and United Kingdom. These two member-states represent one half of EC's annual imports (see Table 5.6). However, palm oil does not dominate these two submarkets or anyone of the other submarkets though it has significant market shares in United Kingdom, West Germany and Netherlands.

Palm oil is consumed in the forms of shortening, margarine, and cooking and salad oil. The level of demand for palm oil, therefore, is reflected in these three major food products, as long as its price is competitive. As shown in Table 5.7, consumption of these three major food products in Belgium-Luxembourg, West Germany, France, Netherlands, and United Kingdom are still below that of the Community's average of

Table 5.6 European Community: Breakdown of Palm Oil Net Imports by Member-state, 1984-87 ('000 Tonnes)

Members	1984	1985	1986	1987	1988
Belgium-Lux	38.4	42.7	71.5	72.2	50.5
Denmark	8.8	11.2	19.9	23.5	32.1
France	55.9	60.8	73.2	69.4	72.2
Germany, FR	121.8	140.4	242.4	210.4	221.0
Greece	0.1	0.3	7.8	13.1	14.4
Ireland	3.2	2.3	6.1	3.7	5.6
Italy	74.6	96.8	95.4	105.2	116.7
Netherlands	83.3	90.0	79.9	85.5	91.0
Portugal	15.3	10.6	18.8	22.3	29.6
Spain	9.4	11.5	27.3	23.4	28.4
U. Kingdom	161.5	216.0	272.1	281.5	279.6
Total	572.3	682.6	914.4	913.2	941.1

Source: Oil World Annual

Table 5.7 European Community: Apparent Human Consumption of Fats Subdivided by Processed Products Consumed (Pure Fat), 1986 (in '000 Tonnes)

Members	Margarine	Edible Oils	Others[1]	Subtotal	Total[2]	Per Capita
Belgium-Lux	103	53	64	220	372	36
Denmark	55	108	3	166	201	39
W. Germany	384	341	108	833	1573	26
Greece	20	242	13	275	316	32
Spain	53	860*	67	980	1065	27
France	167	672	20	859	1546	28
Ireland	17	46	6	69	96	27
Italy	41	1206	25	1272	1627	28
Netherlands	148	98	69	315	568	39
Portugal	45*	125*	8*	178	196	19
U. Kingdom	387	786	110	1283	2045	36
EC-12	1420	4537	493	6450	9605	31

Source: EC Agricultural Situation in the Community

* Eurostat Estimate

1 Other prepared oils and fats (shortening)

2 Include oils and fats of both land and marine animals and butter

67 percent. However, on per capita total fats and oils consumption, among these member-countries, only West Germany and France are below the Community's average level. Therefore, rising consumption of palm oil through higher demand for food products like margarine, shortening, and edible oils is most likely to come from West Germany and France since their consumption of these three products and per capita total fats and oils have not reached the average levels of the Community. Opportunities for palm oil in the other markets of the Community will have to come mainly from replacing other edible oils because per capita consumption levels are already very high so that they will not rise much.

5.5 JAPAN

Having produced too small a quantity of oilseeds to satisfy its domestic edible oil requirements, Japan relies on foreign sources to fulfill its demand. Large quantities of various oilseeds are imported for crushing and to supply edible oils. Palm oil is one of the very few oils that are imported exclusively in the form of oil, rather than oilseed, because of the necessity to extract the fruits immediately after harvesting.

Japan has long imported palm oil but the quantities were not significant until 1973 when the quantity of palm oil imported almost doubled the quantity imported a year earlier, rising from 55 thousand tonnes to 100 thousand tonnes. Similar to other palm oil importing countries, there is no apparent trend in Japan's imports of palm oil. The degree of fluctuation in imports, however, is much smaller when compared to those of India and United States, for instance.

Palm oil imported into Japan has been granted a Generalized System of Preferences (GSP) privilege since 1971 and so has a much lower import duty -- 4 percent -- than most other vegetable oils. However, this privilege was not available to all countries and it was subject to volume controls (McGuire p. 11 ; Griffith and Meilke (A Description) pp. 40-41). In 1986, duty on palm oil was finally reduced to zero (East Asia and Oceania: Situation and Outlook Report p. 20).

5.5.1 Domestic Supplies

Japan produces soybeans, rapeseed and peanuts but the quantities produced are small and do not change very much from year to year. Since these soybeans and peanuts produced locally are also directly consumed in the dried state as food and other food products such as beancurd, bean paste and soysauce, domestic oilseeds production is not able to satisfy domestic edible oil requirements. These needs are therefore have to be met by foreign oil sources. Soybean and rapeseed oils obtained from imported oilseeds are the two primary foreign sources of edible oils in Japan (see Griffith and Meilke (A Description)). Other imported oilseeds are less significant in providing oils and meeting Japan's edible oil needs. They include peanuts, cottonseed, sesameseed, safflowerseed, copra, flaxseed and palm kernels. Japan also produces butter, tallow, and lard, and large quantities of marine oils, but they generally insufficient to satisfy domestic requirements. Only small quantities of oils are imported for consumption because high import tariffs are imposed on most vegetable oils while the tariff levels on oilseeds are typically low or zero.

5.5.2 Demand Conditions

Vegetable oils and fats represent approximately 80 percent of all oils and fats, including butter, consumed in Japan (see Table 5.8). Of this market share for vegetable oils and fats, 10 percent of it belongs to palm oil. Therefore, palm oil is not as important as soybean oil or rapeseed oil in providing oil to Japanese consumers. However, its share of the market and the quantities consumed have been rising.

Refined vegetable oils in Japan are channelled into three places: the consumer market for brand name salad oil, the institutional market for wholesalers, and the secondary-processing of margarine, shortening, and other products. Given that both soybean and rapeseed oils are mainly used as salad and cooking oil (Griffith and Meilke (A Description) p. 31), it is expected that palm oil mainly goes into shortening and margarine manufacturing.

5.6 OTHER IMPORTING COUNTRIES

There are many other important importers of palm oil but detailed information about their institutional and market structures and consumer diets are more limited. As a result, these markets are discussed more briefly. Among these countries, there are those in the Middle-east of which include Saudi Arabia, Turkey, Iraq, Egypt, Arab Republic of Yemen and most recently Iran. Other importers are Kenya, Bangladesh, South Korea, China, Soviet Union and Australia.

Palm oil is the most important edible oil in both Iraq and Saudi Arabia. Consumption of palm oil averaged 74 percent and 60 percent respectively of total oils and fats consumed in these two countries during 1986-88. Competitor of palm oil in Iraq is sunflowerseed oil of which constitutes about 11 percent of the market and corn oil is the second most important oil consumed in Saudi Arabia. Corn oil represents 20 percent of total domestic consumption. Potentials for palm oil in these two markets are huge because per capita edible oil consumption is still below 20 kg per year and

Table 5.8 Japan: Domestic Disappearance According to Type of Oils and Fats, 1984 - 88 (in '000 Tonnes)

Fats and Oils	1984	1985	1986	1987	1988
Soybean	699.8	697.2	720.1	673.2	699.6
Rapeseed	533.1	594.2	625.2	664.6	697.7
Corn	83.4	84.2	85.1	90.5	106.5
Palm	155.0	158.5	197.6	210.5	240.1
Cotton	29.6	41.4	45.0	42.6	36.3
Coconut	68.2	69.9	73.2	72.0	70.3
Sunflower	16.8	17.8	20.4	19.0	31.3
Sesame	20.9	22.6	23.5	25.8	28.3
Palm Kernel	20.9	20.5	20.8	35.0	37.7
Others	55.0	56.9	53.2	53.4	54.6
Subtotal	1,682.7	1,763.2	1,864.1	1,886.6	2,002.4
Lard	92.7	99.2	95.9	82.3	87.1
Fish	102.3	128.5	266.7	255.4	161.9
Tallow & Grease	140.9	146.8	142.2	136.8	157.4
Butter	65.1	74.4	73.3	58.1	75.5
Total	2,083.7	2,212.1	2,442.2	2.419.2	2,484.3

Source: Oil World Annual

therefore palm oil consumption will rise hand in hand with total oil consumption. In addition, having had such a strong market presence in these two countries, means palm oil does not need to face the uncertainty of consumer acceptance that is usually happened to an oil when it is first introduced.

Palm oil should also continue to dominate Yemen's edible oil consumption. This country only started importing palm oil in the late 1970's but imports grew very fast and it reached about 50 thousand tonnes in 1985.

Markets such as Turkey and Egypt, however provide some uncertainties because there are many types of oil imported and consumed. Palm oil is only one of them. Palm oil is placed in the 4th position after sunflower, soybean, and cottonseed oils, among vegetable oils consumed in Turkey, and the 3rd place in Egypt after sunflower and cottonseed oils. These countries also consume large quantities of butter and animal fats. Beside the diverse sources of edible oils, Egypt also suffers from lack of foreign exchange. Similarly, there are many competitors of palm oil in Australia. Almost 30 percent of the edible oils and fats needs in Australia are satisfied by tallow and grease while the rest are fulfilled by oils which include rapeseed, palm oil, soybean oil and sunflowerseed oil.

In both South Korea and Bangladesh, palm oil competes with soybean oil for consumption. While both soybean and palm oils are imported into Bangladesh, South Korea produces most of its own soybean oil from soybeans that are locally produced or imported. Only palm oil is imported in significant quantities. In addition to consuming palm oil and soybean oil, rapeseed oil consumption has also been rising in Bangladesh because of rising domestic rapeseed production and imports. Tallow and grease is the other important competitor of palm oil in South Korea.

Kenya has imported large quantities of palm oil for consumption for many years. Palm oil is by far the most important source of edible oil. Considering the low per head edible oil consumption of 5 kg, palm oil has a great potential to raise its presence in this market, that is either by means of higher per capita consumption or to a lesser degree through substitution.

Palm oil only represents a small proportion of total edible oil consumed in both China and Soviet Union. While imports from the Soviet Union have declined lately, the rise of palm oil imports into China have more than offset the decrease. Beside palm oil, both of these countries import large quantities of other edible oils such as sunflowerseed as in the case of Soviet Union. Relative market prices and concessional sales determine the amounts of each type of oil demanded.

Iran is another market that palm oil has successfully broken into. The traditionally oil which is consumed in the largest quantity in Iran is soybean oil, holding more than 60 percent of the market share. Since 1985, large quantities of palm oil have been imported.

CHAPTER VI

MODEL SPECIFICATION

World trade of palm oil is relatively close to a competitive market-price situation. Country restrictions on palm oil movements do not affect quantity traded in any significant way and there is no commodity agreement to manage supply. Coupled with the fact that palm oil has many close substitutes and there are many importing countries, its price competitiveness primarily dictates the quantity supplied and demanded. Given the nature of its marketplace, equilibrium econometric model, based on supply, demand, stock adjustment and market-clearing price, is believed to be a reasonable approximation of the actual marketplace for palm oil.

The model to be used to forecast palm oil production, exports, import demand and consumption will consist of three blocks -- a supply block, a demand block, and a block for both price and stocks. The market is not assumed to clear instantaneously through production and consumption changes in the short run (that is within the time unit of observation which is a year) but through inventory and price adjustments. The quantity produced in the current year has been partially determined 3-4 years ago and thus does not respond very well to current prices[1]. Consumption also shows lag in

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[1]Oni, studying palm oil output response to current producer prices in Nigeria, has found the supply elasticities to be about 0.202 and 0.346 (Askari and Cummings pp. 267).

response because of shipping time, foreign exchange restrictions, manufacturer's decision to adjust composition of edible oil used and consumer's taste adjustment[2]. Since both the supply and demand of palm oil are inelastic in the short-run, equations in the supply block and demand block are expected to be determined recursively. Meanwhile, the price and stock equations for palm oil are believed to be determined simultaneously because as the supply and demand of palm oil are inelastic, the market has to be cleared through changes in stocks and price. Adjustments in stocks and price are believed to be much faster than adjustments in the supply and demand of palm oil and therefore equilibrate the market in the short run (less than a year).

The supply side will have a total of 4 behavioral equations, 2 each for Malaysia and Indonesia. On the other hand, the demand block will have a total of 7 equations, that is for each of the largest and most important importers of palm oil. There will be 7 stock equations and 1 price equation. As many identities and definition equations as needed are included to make the system full rank and to close it.

6.1 EMPIRICAL MODEL

6.1.1 SUPPLY BLOCK

The supply response model hypothesized by French and Matthews offers the best model framework for palm oil supply relations. Choice of this model is made after a careful weighing of its behavioral assumptions, the amount of information that it

[2]Both Wendland and Fryar and Hoskin, using monthly prices in US, have shown that the coherency coefficients between palm oil price and other oil prices improve as the length of time increases which suggests that the substitution possibility of an oil with palm oil is more likely after a certain time period rather than immediately in the event of a price advantage for palm oil.

incorporates and the requirements of quantitative data for estimation. The model consists of two behavioural equations, a hectareage change function and a yield function. An identity will be added to the model to make the supply side trade oriented.

6.1.1.1 Hectareage Change Functions

One of the two behavioural equations in the supply block is the hectareage change response equation. It is used to estimate the adjustment in the palm oil areas of Malaysia and Indonesia.

Definition of some variables in the hectareage change function is modified and some of them are dropped because of lack of data. Rather than using expected long-run profitability (assuming that it is the same as the equilibrium long-run profitability as French and Matthews did), expected long-run price is used. This modification seems reasonable because producers can better control their production costs than the market price of palm oil (and its competitor which as in this case is rubber). Therefore, input costs change little from year to year when compared to the price of palm oil (and rubber). This modification is similar to the one French and Matthews made to the profitability variables in their empirical application, except that the variables are not deflated with the farm wage rate index of which is not available (p. 487). Decisions on new plantings or removals will primarily be based upon future price expectations. A similar change is also made to the expected short-run profitability variables.

Variables to account for disease and insect losses are deleted right from the begining because their effects would ordinarily be quite small and their presence might cause multicollinearity problems because of the large number of variables (French and

Matthews p. 483). The variable for nonbearing hectareages is also dropped because no quality data are available. Like French and Matthews, it is assumed that its effect is included in the disturbance term (p. 487). No attempts are made to explicitly incorporate institutional or physical factor changes into the hectareage change response model because the dependent variable will only cover the period after the institutional or physical changes in Malaysia and Indonesia had already occurred. The hectareage change equation estimated for Malaysia will cover the period after 1960 while that for Indonesia will begin after 1970. Therefore, the use of dummy variables variables to denote these changes will be redundant.

The final model to be estimated takes on the following form[3]:

$$A_t - A_{t-1} = f(\ XPPO_{t-k}^{e},\ XRUB_{t-k}^{e},\ DY_{t-k}^{e},\ A_{t-1}^{o},\ A_{t-k-1}^{o},\ A_{t-1}^{o}XPPO_{t-1}^{s},\ A_{t-1}^{o}XRUB_{t-1}^{s},\ e_t\ ) \tag{1}$$

where

A_t is the oil palm bearing hectareage for year t
A_{t-1} is the oil palm bearing hectareage for year t-1
f is a linear function
$XPPO_{t-k}^{e}$ is the expected price per unit of palm oil held in year t-k
$XRUB_{t-k}^{e}$ is the expected price per unit of rubber (a competing crop) held in year t-k
DY_{t-k}^{e} is the change in the expected oil palm yield between year t-k and year t-k-1
A_{t-1}^{o} is the area of "old age" palms in year t-1
A_{t-k-1}^{o} is the area of "old age" palms in year t-k-1
$A_{t-1}^{o}XPPO_{t-1}^{s}$ is the weighted expected price per unit of palm oil held in year t-1
$A_{t-1}^{o}XRUB_{t-1}^{s}$ is the weighted expected price per unit of rubber (a competing crop) held in year t-1
e_t is a random disturbance term for year t
t is the year under consideration such as 1965, 1966, etc.
k is the number of years it takes to reach the age the oil palm is first harvested or is classified as ready for harvesting

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[3]For the complete model, reader is advised to refer to French and Matthews.

The expected palm oil prices will have a positive sign while the expected rubber (a competing crop) prices and change in expected yield will have a negative sign. The sign for the "old age" oil palm area variable for the year t-1 is expected to have a negative sign but is expected to be positive for the year t-k-1.

6.1.1.2 Yield Functions

The second behavioural equation in the French and Matthews model is the yield response equation which is needed to calculate total production, by using the identity:

$$Q_t = A_t \; Y_t \qquad (2)$$

where

Q_t is the quantity of palm oil produced for year t
A_t is the oil palm bearing hectareage for year t
Y_t is the average yield of bearing oil palm area for year t

Two alternate models for yield response are suggested by French and Matthews. However, owing to lack of data, the first alternative and its modifications are not applicable to oil palm yield response. The second model recommended which does not require data on oil palm area segregated according to age is as follows:

$$Y_t = f(\; A_t - A_{t-h}, \text{YEAR}, e_t \;) \qquad (3)$$

where

Y_t is the average yield of bearing oil palm area for year t
f is a linear function
A_t is the oil palm bearing hectareage for year t
A_{t-h} is the oil palm bearing hectareage for year t-h
YEAR is a proxy for trend which is to account for technological changes
e_t is a random disturbance term in year t
h is some small numbers such as 2, 3, 4

The trend variable is positive correlated with yield and therefore will have a positive sign. On the other hand, newly producing oil palm area is expected to have a negative sign because plants in the younger age category typically have lower yields, thus reducing the industry average yield.

6.1.1.3 Identity for Amounts Exported

The identity to be used to put the supply model in a trade context is :

$$EXP_t = Q_t + IMP_t - DSTOCK_t - CON_t \qquad (4)$$

where

Q_t is the quantity of palm oil produced for year t
EXP_t is the quantity of palm oil exported for year t
IMP_t is the quantity of palm oil imported for year t
$DSTOCK_t$ is the difference between the ending stock of palm oil in year t and the ending stock in year t-1
CON_t is the domestic utilization of palm oil for year t

The total quantity of palm oil produced will be obtained from the identity $Q_t = A_t\ Y_t$ of which A_t and Y_t are the values predicted using the hectareage change and yield functions. The predicted value for changes in stock will be obtained from stock equations to be estimated later. Since the amount of palm oil imported into Indonesia each year is unpredictable, because of government licensing control, and is rather small as a proportion of total domestic production, it will be dropped. Similarly, the import variable for Malaysia will be deleted from the above identity because no consistent quality data are available and the amount is quite negligible. Expected quantities of palm oil consumed domestically in both the producing countries are assumed to be some percentage of production. No attempts will be made to estimate separate palm oil demand equations in these countries because there is no data for consumption. Its crude approximate, domestic disappearance[4] is seen not appropriate because it accounts not only for palm oil actually consumed in the country, palm oil for export, but not categorized as such, of which is used in manufactured food and industrial products is also included. This is very important in the case of Malaysia because much of the palm oil used domestically are exported in the form of manufactured products. Domestic consumption would be overstated in data of such countries.

6.1.2 PRICE AND STOCKS BLOCK

6.1.2.1 Price Equation

The variables in the price equation are chosen with the stocks of palm oil in mind. Since supply and demand of palm oil are inelastic, market imbalances mainly show up in the stock and price levels. Therefore, adjustments in these two variables are expected to equilibrate the market in the short-run. The price equation for palm oil is stated as follows:

$$PPO_t = f(\ PPO_{t-1},\ S_t,\ DS_{t-1},\ T,\ e_t\ ) \qquad (5)$$

where

PPO_t is the average price per unit of palm oil in year t
PPO_{t-1} is the average price per unit of palm oil in year t-1
f is a linear function
S_t is the world palm oil ending stocks for year t
DS_{t-1} is the change in the palm oil ending stocks between year t-1 and t-2
T is the trend for general rise in nominal palm oil prices

The sign of PPO_{t-1} is expected to be positive because current price level is

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[4]Domestic disappearance is defined as the difference between the actual visible ending stocks of a year and the accounting ending stocks of which are obtained from adjusting the actual visible beginning stocks, production, imports, and exports during the year.

partially determined by the immediate past price level while S_t and DS_{t-1} should have a negative sign. S_t should have a negative sign because larger stock levels means excess supply while smaller stock levels means shortages, both of which need an opposite adjustment in price to clear the marketplace. DS_{t-1} which is the change in ending stocks of previous year should have a negative sign because a positive change means accumulation of stocks and it will put pressure on price and cause it to fall during the following year while a negative change means the drawing down of stocks which will cause a rise in prices, so that the market will return to equilibrium, without excess stocks or shortages.

6.1.2.2 Stock Equations

Two different models will be used to estimate the equations for stocks, depending on whether the equation is for an importing or an exporting country. The importing countries considered are the EC, the US, Japan, India and an aggregate stock equation for Rest-of-the-world (ROW). The exporting countries are represented by Malaysia and Indonesia. Choice of countries to consider are subject to the availability of data.

The consumer stock equations will be based on the stock partial adjustment model which Labys (Dynamic) modified from Lovell's inventory model for raw materials. This model seems most appropriate because it is theoretically sound and data for its variables are readily available. This model assumes that price speculation is formed under the extrapolative price expectation hypothesis[5] and that adjustment to the

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[5]This hypothesis assumes that expected price is a function of previous price level and changes in the previous price level, that is:

desired stock level in each period is only partial. Although the model could be easily expanded by assuming the desired stock level adjusts slowly to changes in exogenous variables rather than immediately, the use of annual data as observation is considered long enough for this adjustment to complete. In structural form, this model will be a function of the variables as shown[6]:

$$S_t = f(\ S_{t-1},\ PPO_t,\ DPPO_t,\ PROD_{t+1},\ DPROD_{t+1},\ e_t\ ) \qquad (6)$$

where

S_t is the palm oil ending stocks for year t
f is a linear function
S_{t-1} is the palm oil ending stocks for year t-1
PPO_t is the average palm oil price per unit in year t
$DPPO_t$ is the change in the average palm oil price per unit in year t
$PROD_{t+1}$ is the production activities of industries using palm oil for year t+1
$DPROD_{t+1}$ is the change in the production activities of industries using palm oil for year t+1
e_t is a random disturbance term

The model for the producer-held stocks is very similar to the stock model for consumers except that it excludes the accelerator effect (production activities). One version of the model is developed by Witherell (see Labys (Dynamic) pp. 68-70) and a modification of it which is based on different assumptions, is developed by Labys. The two models appear as follow:

$$S_t = f(\ S_{t-1},\ PPO_t,\ PPO_{t-1},\ e_t\ ) \qquad (7)$$

$$S_t = f(\ S_{t-1},\ PPO_t,\ DPPO_t,\ e_t\ ) \qquad (8)$$

where

S_t is the palm oil ending stocks for year t

$$P^*_t = P_{t-1} + \beta(P_{t-1} - P_{t-2})$$

[6]For derivation of relationships, see Appendix 1.1

f is a linear function
S_{t-1} is the palm oil ending stocks for year t-1
PPO_t is the average price per unit of palm oil in year t
PPO_{t-1} is the average price per unit of palm oil in year t-1
$DPPO_t$ is the change in the price per unit of palm oil in year t
e_t is a random disturbance term

Except for the signs of $DPROD_{t+1}$ and $DPPO_t$ which are indeterminate and the sign of PPO_{t-1} which is negative, all variables in both producer and consumer stock equations should be positive. PPO_t is expected to have a positive sign because price speculation, under the extrapolative expectation and of which partly determines the amount of stocks held, is partly based on the previous price level. Higher previous price level means higher current price expectation and therefore higher stock levels are held. $PROD_{t+1}$ is positive because higher production activities in the following year means the needs for holding more stocks to accertain supplies.

6.1.3 DEMAND BLOCK

6.1.3.1 Import Demand Equations

The import demand equation for each country is hypothesized with regards to demand theory and attributes of the market concerned. Consumer demand theory states that the quantity demanded for a product is a function of its own price, the price of substitutes or complements, consumer income, population and tastes. However, models with only these variables are not dynamic and sometimes do not reflect market reality. To render the demand equation for a country dynamic, a variable for lagged quantity demanded is also included, in accordance with the "habit formation principle[7]." Other

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[7]This principle, which has its origin in the partial adjustment hypothesis, says that " the quantity demanded in any one period depends, among others, on the quantity

variables deemed to be important in specific markets will also be included. Therefore the import demand equation, in general, will look as follows:

$$IMP_t = f(IMP_{t-1}, O_t, C_t, INC_t, POP_t, R_t, e_t) \qquad (9)$$

where:

IMP_t is the quantity demanded for year t
IMP_{t-1} is the quantity demanded for year t-1
O_t is the own price in year t
C_t is the cross price in year t
INC_t is the income of a country in year t
POP_t is the population of a country in year t
R_t is other relevant variables in year t
e_t is a random disturbance term

As usual, income and cross price (for substitutes) are expected to have a positive sign while own price will have a negative sign. The lagged dependent variable will have a positive sign because palm oil is a nondurable good. The sign of the remaining variables will be determined accordingly, depending on what they are.

The choice of countries to include in the demand side of the market is a bit difficult because no single country dominates the palm oil trade. After some careful considerations, it is decided that 7 countries or economic units will be included. They are chosen largely on the basis of the quantities of palm oil imported, the length of time palm oil has been present in them and the availability of data. These countries/economic units are India, Pakistan, the European Community, the United States, Japan, Kenya, and South Korea. Together these markets represent between 51.0 percent to 63.9 percent of palm oil imports from 1982 to 1988. As can be seen, these markets are short of representative of the demand side of palm oil trade. This fact will

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demanded in previous periods due to a habit formation process which is characteristics of human behaviour."(Koutsoyiannis p. 312).

be taken into account in the identity used to close the equilibrium econometric model.

6.1.3.2 Identity for Amounts Consumed

An identity will be used to get the estimated palm oil consumption level in each importing country. This identity is similar to the one used for quantity exported and it appears as follows:

$$CON_t = Q_t + IMP_t - DSTOCK_t - EXP_t \tag{10}$$

where

Q_t is the quantity of palm oil produced for year t
EXP_t is the quantity of palm oil exported for year t
IMP_t is the quantity of palm oil imported for year t
$DSTOCK_t$ is the difference between the ending stock of palm oil in year t and the ending stock in year t-1
CON_t is the domestic utilization of palm oil for year t

The variables Q_t and EXP_t will be dropped because, other than India, all the importing countries do not produce palm oil. Production of palm oil in India, however, is not likely to contribute much to the domestic edible oil supplies because of less than optimal climatic conditions and the lack of good planting materials. All the importing contries, therefore, export very little palm oil and will still be net importers of palm oil. The values for import quantity and changes in stock will be obtained from the import demand equations and the stock equations.

6.1.4 IDENTITIES FOR EQUILIBRIUM

Three identities are needed to complete the system model. They are as shown below:

$$S^{W}_t = S^{M}_t + S^{IN}_t + S^{EC}_t + S^{US}_t + S^{JP}_t + S^{ID}_t + S^{RW}_t \tag{11}$$

$$EXP^{W}_{t} = EXP^{M}_{t} + EXP^{IN}_{t} \quad (12)$$

$$IMP^{ROW}_{t} = EXP^{W}_{t} - (IMP^{EC}_{t} + IMP^{ID}_{t} + IMP^{PK}_{t} + IMP^{JP}_{t} + IMP^{US}_{t} + IMP^{KN}_{t} + IMP^{SK}_{t}) \quad (13)$$

where

W = World
M = Malaysia
IN = Indonesia
EC = European Community
PK = Pakistan
JP = Japan
US = United States
KN = Kenya
SK = South Korea
ID = India
ROW= Rest-of-the-world

Identity (11) is the world palm oil stock equation and it is needed in the simultaneous estimation of price and stock equations. This identity says that the summation of stocks held by individual countries and the Rest-of-the-world are equal to world palm oil stocks. Equation (12) says that world exports of palm oil are equal to the exports of Malaysia and Indonesia. Together, these two producing countries export over 90 percent of the world's palm oil. The last identity, which is needed to equilibrate the supply and demand of palm oil, states that palm oil imports of the Rest-of-the-world(ROW) are the residuals of the world's palm oil exports and imports of the largest palm oil consuming countries. It accounts for the imports of countries that the import demand equations are unable to deal with explicitly.

6.2 VARIABLE DEFINITION, UNIT MEASUREMENT, AND DATA SOURCES

6.2.1 SUPPLY EQUATIONS

Observations for the dependent variables of hectareage change and yield equations of Malaysia extend from the year 1958 to 1987 inclusive while that of Indonesia cover the period from 1970 to 1987. There are 30 observations for the independent variables, covering the period from 1958 to 1987, but owing to the large number of lags required for some of them in parameter estimation, the paramater estimates for Malaysia and Indonesia will be based on a shorter time period.

6.2.1.1 Oil Palm Bearing Hectareages (A_t and A_{t-1})

Areas under oil palms will be defined as hectares of mature oil palm, regardless of whether these land areas are harvested for palm oil or not. The difference between areas in year t and year t-1 will give the new oil palm hectareages. The mature hectareages for Peninsular Malaysia will be used to represent the producing area for Malaysia as a whole. Although not all oil palms are grown in the Peninsula, its share of 85 percent or more justifies its use. This share in planted area is not likely to change much in the near future.

The data for Malaysia are obtained from both the Dept. of Statistics (Malaysia) and Oil World. On the other hand, data for Indonesia exlusively come from Oil World.

6.2.1.2 Expected Prices of Palm Oil ($XPPO_{t-k}^{e}$ and $A_{t-1}^{o}XPPO_{t-1}^{a}$)

The price of palm oil is obtained from Oil World, 1958-2007, and Annual, and PORLA, of which is quoted at Northwest European ports. It is later adjusted with the domestic exchange rate. Therefore, prices are expressed in ringgits per tonne in

Malaysia's hectareage change equation and prices are in rupiahs per tonne for Indonesia's hectareage change function. The figures for exchange rates are obtained from IMF's International Financial Statistics.

The expected price of palm oil held in t-k is the average price of palm oil in t-k and the preceding years. The number of years to include in the average price depends on its effects on the goodness of fit of the model. Similarly, the expected price of palm oil held in t-1 is its average price in that year and the preceding years. However, these prices are further weighted by the area for "old age" palms so as to put a limit on the extent removals are possible when prices are low. These oil palms which are over a certain age and have become less productive or have declined in productivity significantly, are estimated as a proportion of total mature oil palm area because there are no data for them. These oil palms are most likely to be removed every year. They are expressed in unit hectare. The data for mature oil palm hectareages are obtained from the Dept. of Statistics (Malaysia) and Oil World.

6.2.1.3 Expected Prices of Rubber ($XRUB_{t-k}^e$ and $A_{t-1}^o XRUB_{t-1}^s$)

Rubber tree is the main competitor of oil palm in both Malaysia and Indonesia for planted area and other input factors. Expected rubber price relative to that of palm oil will influence producers' decision on area allocation for each crop, after their respective costs of production are accounted for.

The price of rubber is defined as its wholesale price per tonne at United Kingdom converted to local currency. The expected rubber price in t-k therefore is expressed in ringgits per tonne for Malaysia while rupiahs per tonne is used for the expected rubber price of Indonesia. The expected short-run rubber price,

$A_{t-1}{}^{o}XRUB_{t-1}{}^{e}$, is similarly defined but it is further weighted by "old age" palms. The number of years needed to form price expectations and to approximate aging oil palms are determined through empirical investigation.

The data for rubber prices are obtained from FAO's Production Yearbook while that for exchange rates come from IMF's International Financial Statistics. The data for "old age" palms are expressed in unit hectare and are collected from the Dept. of Statistics (Malaysia) and Oil World.

6.2.1.4 Yield and Change in Expected Yield (Y_t and $DY_{t-k}{}^{e}$)

Yield of palm oil is found using the identity: $Y_t = Q_t/A_t$ and expressed in unit tonnes per hectare. The change in expected yield is assumed to be the difference between the actual yields of year t-k and year t-k-1. The data for quantity of palm oil produced (Q_t) and total mature area under oil palm (A_t) for Malaysia are obtained from the Department of Statistics (Malaysia) and Oil World while data for Indonesia are obtained solely from Oil World.

6.2.1.5 Old Oil Palm Hectareages ($A_{t-1}{}^{o}$ and $A_{t-k-1}{}^{o}$)

Since there are no data available for oil palm hectareages which are over a certain age and are falling in productive capacity, following French and Matthews (p. 488), these variables are approximated as some proportion of all bearing oil palm hectareages. To account for years of fast rising or declining hectareage, the average bearing hectareage for a few years is used. The data for mature oil palm area are obtained from the Dept. of Statistics (Malaysia) and Oil World.

6.2.1.6 Trend (YEAR)

The trend in the yield is proxied by the actual years covered during the period of estimation. It accounts for technological changes in the production process such as higher oil yielding seed variety or improved cultural practice.

6.2.2 PRICE AND STOCK EQUATIONS

Estimation of functions are based on annual data from 1960 to 1987 for the dependent variables. Data for price, stocks, and industrial production activities (represented by palm oil disappearance) are all obtained from Oil World.

The variable price(PPO_t) is defined as the world price of palm oil, expressed in US dollars per tonne and is the cif price of palm oil at Northwest European ports. The other quantity variables are all expressed in metric tons for each country.

Palm oil disappearance in a country is used to represent the production activities of industries using palm oil as an input factor. The choice of this variable is considered most accurate because data on actual production activities which are usually given in index, are highly aggregated, without a separate category for edible-oil based industries. Furthermore, even if such information were available, it would not be a good measure of the demand for palm oil inventories because palm oil might be only one of the many types of edible oils used.

6.2.3 IMPORT DEMAND EQUATIONS

6.2.3.1 The European Community (EC)

The quantities of palm oil imported by the EC are the summation of amounts imported by each member-state, including internal trade. The data for total quantities, undoubtedly, inflate the actual amounts imported but since no continuous data for trade between member-states are available, no attempts are made to adjust them to account for internal trade.

It is hypothesized that the EC palm oil import demand function is as follows:

$IMP_t = f(IMP_{t-1}, PPO_t, PSO_t, CINC_t, e_t)$

where

IMP_t is the quantity of palm oil imported for year t(in tonnes)
IMP_{t-1} is the quantity of palm oil imported for year t-1 (in tonnes)
PPO_t is the real average price of palm oil in year t(in US dollars per tonne)
PSO_t is the real average price of soybean oil in year t(in US dollars per tonne)
$CINC_t$ is the real income per capita for year t (in million ECUs)
e_t is a random disturbance term for year t

Soybean oil is chosen as the substitute of palm oil because soybean oil is still the largest consumed edible oil in EC despite losing some grounds to other lower-priced oils such as rapeseed oil. The soybean oil nominal price as well as the nominal income are deflated with the weighted consumer price index (CPI) of EC to get the real price and real income to which consumers respond to their relative change. The CPI is base on the year 1980=100. To get a more accurate measure of the average well-being of consumers, the real income of the EC is further deflated by population. Population is not included separately because it is believed to be highly correlated with income.

It is noted here that in the other demand equations to follow, all of them will also use prices in real terms of which based on price index of 1980. Similarly, incomes for all demand equations are deflated to get the real income level.

Income is expressed in unit currency ECU in the million rather than in US dollar in the million to eliminate the inconsistent growth pattern in income because of the huge depreciation and later the appreciation of the US dollar against the currencies of many EC's member-countries in the late 1970s and the early 1980s. The population used to deflate it is also in the million. Except for the sign of palm oil price which is expected to be negative, other variables are expected to have positive signs. Both linear and logarithmic functional forms are use to fit the model.

6.2.3.2 India

The import demand equation for India is hypothesized to be a function of the following variables:

$$IMP_t = f(IMP_{t-1}, XPPO_t, XPSO_t, QG_{t-1}, FR_t, e_t)$$

where

IMP_t is the quantity of palm oil imported for year t (in tonnes)
IMP_{t-1} is the quantity of palm oil imported for year t-1 (in tonnes)
$XPPO_t$ is the real average price of palm oil in year t (in Indian rupees per tonne)
$XPSO_t$ is the real average price of soybean oil in year t (in Indian rupees per tonne)
QG_{t-1} is the domestic production of groundnuts for year t-1 (in thousands of tonne)
FR_t is the quantity of foreign exchange reserves for year t (in millions of US dollar)

Instead of using the income level, the foreign exchange position of India, of which is expressed in US dollars, is used because it seems to be a more likely determinant factor for the amount of palm oil imported. Edible oil import demand in India is heavily managed by means of foreign exchange allocation to the state-owned's trading agencies. It is believed that improvements in foreign reserve holdings will contribute to higher palm oil imports and the opposite holds if foreign reserves deteriorate. This variable, thus should have a positive sign.

At the same time, India has been trying to achieve self-sufficiency in its edible oil requirements, like what it has managed to do in grain production. Although its efforts to induce domestic oilseed production have been quite successful, annual oilseed production still fluctuates widely in unpredictable manners. Being the largest oilseed produced, groundnut production level appears to be a reasonable prediction of the amount of palm oil to be imported. There is a one year lag between production level and palm oil imports because it takes time for the lower groundnut oil supply to be felt throughout the market and for decisions to be made on whether to purchase additional palm oil from overseas market or not. A few months are also needed for the shipments to arrive. Again, both linear and logarithmic functional forms are use to fit the import demand model.

6.2.3.3 Pakistan

The import demand equation for Pakistan is hypothesized to be more or less similar to the one for India:

$$IMP_t = f(\ IMP_{t-1},\ XPPO_t,\ XPSO_t,\ FR_t,\ POP_t,\ e_t\ )$$

All the variables are as previously defined for the import demand equation of India, except that the real prices are expressed in Pakistani rupees. No attempts are made to incorporate local oilseed production because oilseed production has not been detrimental to edible oil imports in Pakistan. However, since Pakistan's foreign exchange reserve is tight, it might affect the types of edible oils imported, if not the total quantity imported. It is expressed in millions of US dollar. Fast rising population and government's policy to keep edible oils and fats prices down so that they are accessible by the general public means the population of Pakistan, POP_t, is also an important factor. This variable will be in millions of people.

6.2.3.4 Japan

The palm oil import demand for Japan appears as shown:

$IMP_t = f(IMP_{t-1}, XPPO_t, XTALLOW_t, CINC_t, e_t)$

The first two variables and e_t are as previously defined and the others are defined in the following way:

$XPPO_t$ is the real average price of palm oil in year t (in Japanese yens)
$XTALLOW_t$ is the real average price of tallow in year t (in Japanese yens)
$CINC_t$ is the real income per capita for year t (in million Japanese yens)

6.2.3.5 The United States (US)

The model hypothesized for US is exactly the same as the equation for EC, that is:

$IMP_t = f(IMP_{t-1}, PPO_t, PSO_t, CINC_t, D_t, e_t)$

All variables are as previously defined for EC, except that the unit for $CINC_t$ is in millions of US dollar, rather than millions of ECU, and a dummy variable is added to account for the impact of bad publicity palm oil has received in US. Before 1986, this variable will assume the value "1" but from 1986 onwards, it will take on the number "0" to reflect the continuous efforts of manufacturers to substitute away from palm oil, thus reducing its imports.

6.2.3.6 Kenya

Palm oil dominates the Kenyan edible oil market. There is no apparent substitute of palm oil. Therefore, the import demand equation for Kenya is hypothesized as follows:

$IMP_t = f(\ IMP_{t-1},\ XPPO_t,\ XINC_t,\ e_t\ )$

Again, all the variables are as previously defined, except that the measurement unit used for palm oil price is in Kenyan shillings per tonne and it is deflated by the CPI to get the real price. $XINC_t$ is the real income of Kenya, not deflated by population and is expressed in millions of shilling.

6.2.3.7 South Korea

The demand equation for South Korea will assume the following form:

$IMP_t = f(\ IMP_{t-1},\ XPPO_t,\ XPSO_t,\ CINC_t,\ e_t\ )$

All the variables are as previously defined for other equations except that the units are in Korean won for $XPPO_t$, and $XPSO_t$, and millions of won for $CINC_t$.

The number of years used for estimation are constrained by data availability for import quantity. Some of the selected importers did not start importing palm oil until the seventies which means there are fewer observations for these countries. The years to be covered in estimating the parameters are therefore different among countries but whenever possible, the first observation will begin in 1960 for the dependent variable and end in 1987.

Data for incomes of all countries, except for the EC, are obtained from various IMF's International Financial Statistics publications. The data for foreign exchange reserves and exchange rates also come from the same source. The data used to represent the income for countries such as the US, Japan, India, Pakistan and South

Korea are the National Incomes of these countries. The Gross Domestic Product (GDP) is used for the other importing countries because no data are available for the National Incomes of these countries. Data for GDP of EC are collected from EC's Eurostat Review and Eurostatistics while older data series are converted from data obtained from the United Nations' Yearbook of National Accounts Statistics for EC's member-countries.

IMF's International Financial Statistics also provides the data for Consumer Price Index (CPI) and population. Older time series data for population are collected from United Nation's Demographic Yearbook: Historical Supplement. Data for CPI and population of EC, again, are obtained from Eurostat's publications -- called Consumer Price Index and Demographic Statistics.

All prices are obtained from Oil World. Data for imports and production come from FAO's Production Yearbook and Trade Yearbook.

6.2.4 ESTIMATION PROCEDURE

Every equation in the supply and demand blocks is estimated using OLS because it is believed that the supply and demand of palm oil are determined recursively, thus simultaneous equation bias does not arise. All variables on the right hand side of an equation are assumed determined outside the model or in previous time periods.

However, price and stocks of palm oil are believed to be determined simultaneously and therefore their equations are estimated using 2SLS. A system simultaneous estimation method (such as 3SLS of FIML) is not used because it is believed that the error terms of all equations are not seriously correlated. Furthermore, system estimation methods have the disadvantage of spreading specification errors from one equation to other equations in the simultaneous system and they need a large amount of data. The single-equation estimation method such as 2SLS uses a sample over and over again to estimate each equation. In contrast, a system method estimates all parameters at the same time and so the number of observations must be greater than the number of parameters in the system, rather than in an equation.

CHAPTER VII

RESULTS AND MODEL VERIFICATION

The results of estimation will be reported according to blocks of equations. The supply block results will be reported first and it will be followed by the results obtained for price and stocks and finally, the demand block results will be reported. The results obtained for the supply and demand blocks will be compared to elasticities obtained by other studies.

All the equations, when applicable, will then be validated for their forecasting performance by testing the significance of the difference between a predicted value and the actual observation of the dependent variable beyond the sample data used for regression. Other tests used to accertain their forecasting power are the Theil's inequality coefficient(U), the root mean square error (RMSE) and the mean absolute error (MAE).

7.1 RESULTS, INTERPRETATION AND VERIFICATION

7.1.1 Supply Block

A total of 4 behavioral equations are estimated in the supply block. Two of them are hectareage change equations and the other two are yield functions. These equations are as shown in Table 7.1 and Table 7.2.

Although initially, there were 7 explanatory variables in the hectareage change

Table 7.1 Results of OLS Estimation for Palm Oil Supply: Change in Bearing Hectareage, $A_t - A_{t-1}$[a] (in hectares)

	Malaysia	Indonesia
Constant	46160	-6077
$XPPO_{t-k}^{e}$	93.95[b***] (4.21)	0.06990[c***] (3.85)
$XRUB_{t-k}^{e}$	-47.39[b***] (-5.90)	-0.02733[c*] (-2.23)
A_{t-k-1}^{o}	0.07166[b] (1.61)	0.1359[c**] (2.30)
DY_{t-k}^{e}	-39130[b**] (-2.72)	--
$A_{t-1}^{o}XPPO_{t-1}^{s}$	$3.046X10^{-5}$[b] (1.62)	--
$A_{t-1}^{o}XRUB_{t-1}^{s}$	$-2.573X10^{-5}$[b*] (-1.87)	--
<u>Statistics</u>		
F-ratio	15.08	21.95
$ADJ\text{-}R^2$	0.79	0.84
DW d	2.257	1.618
n	24	13

a Based on annual data covering the period 1958 to 1987 and figures in parentheses are t-values for H_o: parameter= 0

b $XPPO_{t-5}^{e} = 1/2(XPPO_{t-5} + XPPO_{t-6})$
$XRUB_{t-5}^{e} = 1/2(XRUB_{t-5} + XRUB_{t-6})$

$A_{t-6}^{o} = A_{t-6}$; $DY_{t-5}^{e} = Y_{t-5} - Y_{t-6}$

$A_{t-1}^{o}XPPO_{t-1}^{s} = XPPO_{t-1} * 1/2(A_{t-1} + A_{t-2})$
$A_{t-1}^{o}XRUB_{t-1}^{s} = XRUB_{t-1} * 1/2(A_{t-1} + A_{t-2})$

c $XPPO_{t-3}^{e} = XPPO_{t-3}$; $XRUB_{t-3}^{e} = XRUB_{t-3}$

$A_{t-4}^{o} = 1/2(A_{t-4} + A_{t-5})$

***, **, and * are respectively 1, 5, and 10 percent levels of significance

Table 7.2 Results of OLS Estimation for Palm Oil Supply: Yield, Y_t (in tonnes per hectare)

	Malaysia	Indonesia
Constant	-155.7	-89.90
$A_t - A_{t-1}$	-4.278×10^{-6}* (-1.81)	-8.639×10^{-6}** (-2.19)
YEAR	0.08065*** (9.46)	0.04694** (2.53)
$FERT_{t-1}$	--	4.264×10^{-4}** (2.64)
Statistics		
F-ratio	86.84	78.01
ADJ-R^2	0.86	0.94
DW d	1.541	2.191
n	28	17

a Based on annual data covering the period 1959 to 1987 and figures in parentheses are t-values for H_o: parameter = 0
*** significant at the 1-percent level
** significant at the 5-percent level
* significant at the 10-percent level

Table 7.3 Variable Definitions for Palm Oil Supply Equations for Malaysia and Indonesia

Variable	Description and Unit of Measurement
$XPPO_{t-5}^{e}$	Expected palm oil price held in year t-5 (ringgits per tonne)
$XPPO_{t-3}^{e}$	Expected palm oil price held in year t-3 (rupiahs per tonne)
$XRUB_{t-5}^{e}$	Expected rubber price held in year t-5 (ringgits per tonne)
$XRUB_{t-3}^{e}$	Expected rubber price held in year t-3 (rupiahs per tonne)
A^{o}_{t-6}	"Old age" oil palms in year t-6 (hectares)
A^{o}_{t-4}	"Old age" oil palms in year t-4 (hectares)
DY_{t-5}^{e}	Change in expected yield held in year t-5 (tonnes per hectare)
$A_{t-1}^{o}XPPO_{t-1}^{s}$	Expected palm oil price held in year t-1 (ringgits or rupiahs per tonne)
$A_{t-1}^{o}XRUB_{t-1}^{s}$	Expected rubber price held in year t-1 (ringgits or rupiahs per tonne)
$A_t - A_{t-1}$	Change in bearing hectareage in year t (hectares)
YEAR	Trend variable for technological advances, represented by actual time period i.e. 1980, 1981, 1982,...
$FERT_{t-1}$	Total fertilizer consumption in year t-1 (tonnes)
Y_t	Yield of oil palm bearing area (tonnes per hectare)

Note: The average exchange rates for Malaysian ringgit and Indonesian rupiah against the US dollar for 1988 are:
2.6 ringgits = 1 US dollar
1686 rupiahs = 1 US dollar

equations, some were eventually dropped because of less than satisfactory statistical results, sign problems and bad predicted values. In the hectareage change equation of Malaysia, the previous year's old oil palm hectareages, A_{t-1}^{o}, was not included because it has the wrong sign. Similarly, the variables DY_{t-k}^{e} and $A_{t-1}^{o}XRUB_{t-1}^{e}$ for Indonesia were dropped because of their signs while the others were excluded partly because of their lower significance level (see Appendix 1.2). All these symptoms seem to suggest strong intercorrelation between variables, making coefficient estimates indeterminate and having large standard errors. Perhaps if data were available for those variables that need approximation and longer and better time series data were available, the problem would decrease. Another reason for the decision not to use alternative models for Indonesia is that these models were later found to give negative predicted values in hectareage change forecasting which would suggest declining hectareage when in reality, area expansion is expected. All of those variables dropped from the hectareage change equation of Indonesia are used to explain removal and since most oil palms were planted in the early 1980s and are not expected to be removed until after the year 2005, forecasting using the estimated hectareage change equation is deemed to be sufficiently accurate.

Using the remaining variables, the equations obtained are quite good. All the equations have reasonably good fit as shown by the relative high adj-R^2. Most of the coefficient estimates are significant at the 10 percent level. All of them do not have correlation problems in the residuals. They all fall within the 5 percent significance level of the Durbin-Watson statistics or are in the inconclusive zone. The signs of coefficient estimates are also as expected. The value of k chosen for Malaysia is 5 while k is 3 for Indonesia after some empirical testing. The longer time lag for

Malaysia could be due to producers' decision to delay harvesting until yields are higher. With larger areas under oil palms, more intensive harvesting in existing areas could easily offset production delay in these newly producing areas.

The coefficients estimated for the independent variables of palm oil and rubber prices suggest prices are very important determinant factors for hectareage expansion. An average of one ringgit increase in palm oil price will induce mature oil palm area expansion by 94.0 hectares five years later while a reduction in the price of rubber by one ringgit per tonne will increase oil palm area by 47.4 hectares in Malaysia five years down the road. In Indonesia, an average of one rupiah per tonne increase in palm oil price will induce producers to expand planted area by 0.07 hectare and will increase planted area by 0.03 hectare if the price of rubber declines by one rupiah. In terms of elasticities[1] (see Table 7.4), calculated at the means of the respective variables, the own price and cross price elasticities of mature hectareage change for Malaysia are 1.94 and -2.07 which suggests that for each percent change in either palm oil or rubber price, producers will response by increasing new hectareage by about 2 percents. However, Suryana, using a Nerlove-type supply model, found the long-run palm oil own price response in Malaysia to be inelastic (0.14) and so is the long-run own price elasticity of supply for Indonesia (0.27). The long-run own price and cross price elasticities for hectareage change response in Indonesia obtained in this study are 0.98 and -0.71 respectively which again are more elastic than the own price elasticity of palm oil

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[1]Elasticities are calculated as follows:

$$E = \frac{dQ}{dP} * \frac{P}{Q}$$

where Price(P) and Quantity(Q) are calculated at their respective means supply obtained by Suryana[2]. It is however difficult to accertain which sets of elasticities are "true" because while the present study excludes some variables which may cause specification bias, Suryana's model may be theoretically less sound and some of the variables included may not be clear. Suryana's postulated that quantity supplied is a function of previous year's quantity supplied, previous year's stock level, existing mature area, previous year's palm oil price and planted area 5 years ago.

Although prices are important in influencing producers' decision on whether to increase planted area or not, thus giving rise to mature area, in Malaysia, they are less effective in influencing producers in the terms of removals. The inelastic hectareage removal response to recent year average prices and its subsequent impact on total mature hectareage (0.32 for own price and -0.53 for cross price) supports earlier findings such as Oni (as cited in Askari and Cummings) and Suryana that palm oil production is not responsive to recent prices. The short-run own price elasticities of palm oil output supply for Nigeria were found to be 0.202 and 0.346 and the equivalence for both Malaysia and Indonesia is 0.09 which is very inelastic.

The change in expected normal yield in the investment year is also influential in determing mature area expansion in Malaysia but the response is very inelastic. A one percent change in the expected yield will only cause 0.10 pecent change in the mature hectareage in the opposite direction.

The rise in mature hectareage over the previous year appears to have played an important role in affecting yield fluctuations in both Malaysia and Indonesia while the

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[2]Using the alternative models for Indonesia in Appendix 1.2, it was similarly concluded that the price elasticities are more elastic than those of Suryana's. The own price elasticities obtained for Model B is 1.20 and it is 1.14 for Model C. The cross price elasticities are -0.561 and -0.679 respectively for models B and C.

trend variables seems to have captured the long run trend in palm oil yields. Inclusion of factors such as rainfall and fertilizer applications, both of which oil palm yields are sensitive to, in Malaysia's yield equation earlier had not given any satisfactory results, primarily because of sign problems. The yield equation for Indonesia, however, managed to incorporate the impacts of fertilizer applications. This variable is expressed in thousands of tonne and the data for it are obtained from FAO's Fertilizer Yearbook.

7.1.2 Price and Stocks Block

Results of estimation for the price and stock equations are as shown in Table 7.5 and Table 7.6. Variables in some equations were changed and dropped to give a better statistical fit and to correct for sign problems. The adjusted coefficients of determination obtained are moderately high ranging from 0.51 to 0.91 for the stock equations and the adjusted R^2 for price is 0.71.

Price speculation seems to have played a significant role in influencing the amount of stocks held by both exporting and importing countries. Palm oil prices in one form or another are mostly significant at the 5 percent level in all equations. Palm oil stocks held for the purpose of consumption (by means of production activities), are significant in the EC, Japan and India but not in the US and the Rest-of-the-World (ROW). Therefore, it can be said that stocks are held for both speculation and consumption purposes in the EC countries, India and Japan but mainly for price speculation in the US, Malaysia, Indonesia, and ROW. Both exporting countries, Malaysia and Indonesia, will only hold higher levels of stocks if they expect price level to increase so that they will receive a higher price for their products. In the US, higher stocks are held to take advantage of the lower current prices while expecting price

Table 7.4 Long-run and Short-run Price Elasticities of Palm Oil Supply

	Long-run Own Price	Long-run Cross Price	Short-run Own Price	Short-run Cross Price
Malaysia	1.945	-2.066	0.3230	-0.5329
Indonesia	0.9840	-0.7132	--	--

Table 7.5 Results of 2SLS Estimation for Palm Oil Price Equation[a] (in US dollars per tonne)

	PPO_t	
constant	-27900	
PPO_{t-1}	0.7680*** (4.75)	n = 28
YEAR	14.26** (2.74)	F-ratio = 1726
DS_{t-1}	-3.882×10^{-4}*** (-3.32)	$ADJ\text{-}R^2 = 0.71$
S_t	-1.685×10^{-4}** (-2.23)	DW = 1.877

a Based on annual data covering the period 1959 to 1988 and figures in parentheses are t-values for H_o : parameter = 0
*** significant at the 1-percent level
** significant at the 5-percent level

Table 7.6 Results of 2SLS Estimation for Palm Oil Stock Equations[a] (in tonnes)

	M'sia	Ind'sia	EC	US	Japan	India	ROW
Const	-125400	-66160	-9956	6872	-551.0	7069	-26300
PPO_t	616.6*** (3.54)	172.7** (2.13)	31.85* (2.01)	39.54*** (3.61)	2.565*** (2.83)	132.0** (2.38)	169.0** (2.45)
PPO_{t-1}	--	-148.0 (-1.59)	--	--	--	-165.4** (-2.71)	--
$DPPO_t$	-512.9** (-2.16)	--	-55.12** (-2.78)	-34.82** (-2.64)	--	--	-397.1*** (-4.33)
$PROD_{t+1}$	--	--	0.06089*** (3.29)	--	--	0.1562*** (4.43)	--
$DPROD_{t+1}$	--	--	--	--	0.02456** (2.56)	-0.1665** (-2.15)	--
$COPRA_{t-1}$	--	0.1105* (2.06)	--	--	--	--	--
D	--	--	--	44100*** (6.77)	--	--	--
S_{t-1}	0.5472*** (4.19)	0.4364** (2.26)	0.3455** (2.73)	0.07514 (0.643)	0.7413*** (7.03)	0.3974 (1.64)	0.9226*** (13.6)
Statistics							
F-value	24.45	7.950	28.98	30.36	44.56	20.59	93.17
ADJ-R^2	0.72	0.51	0.81	0.81	0.83	0.78	0.91
DW	2.28	2.60	1.79	2.34	2.34	1.71	2.86
n	28	28	28	28	28	28	28
θ^b	0.453	0.564	0.654	0.925	0.259	0.603	0.077

a Based on annual data covering the period 1959 to 1988 and figures in parentheses are t-values for H_o: parameter = 0

b The coefficient of adjustment (obtained from subtracting the estimates of S_{t-1} form 1)

* significant at the 10-percent level

** significant at the 5-percent level

*** significant at the 1-percent level

Table 7.7 Variable Definitions for Palm Oil Price and Stock Equations

Variable	Description and Unit of Measurement
PPO_t	Price of palm oil in year t (US dollars per tonne)
PPO_{t-1}	Price of palm oil in year t-1 (US dollars per tonne)
$DPPO_t$	Change in palm oil price in year t (US dollars per tonne)
YEAR	Trend variable for general rise in nominal price
DS_{t-1}	Change in ending stock level of year t-1 (tonnes)
S_t	Ending stock level of year t (tonnes)
S_{t-1}	Ending stock level of year t-1 (tonnes)
$PROD_{t+1}$	Production activities using palm oil in year t+1 (tonnes)
$DPROD_{t+1}$	Change in production activities that use palm oil in year t+1 (tonnes)
$COPRA_{t-1}$	Copra production in year t-1 (tonnes)
D	Dummy variable for exceptional high stock holding years in which 1972, 1974, and 1977 are "0.5", 1975 and 1976 are "1" and "0" for other years

level to rise so that input costs can be reduced. A dummy variable to account for the exceptional high stock levels held during the early to mid 70's are also included in the stock equation of the US. The dummy variable assumes the value of "0.5" for 1972, 1974 and 1977, the value of "1" for 1975 and 1976 and "0" for the other years.

The production of copra has been included in the stock equation of Indonesia because palm oil stock level is correlated with copra production. In years of poor coconut harvest, palm oil stocks are drawn down to make up for the lower availability of domestic-produced coconut oil. This variable is in unit tonne and data are collected from FAO's Production Yearbook.

Signs for most of the coefficient estimates are as expected. Exceptions are the signs of those variables considered to be ambiguous such as $DPPO_t$ and $DPROD_{t+1}$. The negative sign of the coefficient of $DPPO_t$ is difficult to explain but Labys (Dynamic) suggested that it can be interpreted in the following way: the consumer expects the change in the price of palm oil recently to be reversed, that is a positive change (increase) in price will be followed by a negative change (decrease), consequently, the consumer decreases his holdings of palm oil stocks. When the price has a negative change (decrease), palm oil price is expected to rise soon, so he raises his stock levels (pp. 81-81).

Two opposite signs are obtained for the coefficent of $DPROD_{t+1}$. Both of them have economic interpretation. A positive sign means that an increase in economic activities using palm oil over the previous year will require higher amounts of palm oil for input, thus a higher stock level is needed to guarantee the supply. Orders placed with suppliers to build up stocks, however, arrive earlier than anticipated thus raising stock level above the desired level. Conversely, a negative sign has the interpretation that when output is rising, orders are placed with suppliers but there is a delay in delivery, thus stock level falls below the desired level. A positive sign is obtained for $DPROD_{t+1}$ in the stock equation of Japan while India has a negative sign for the variable. The sign obtained for each country appears to be consistent with the marketing and transportation system efficiency in each country.

All of the stock equations have no serial correlation at the 5 percent level or stay within the inconclusive zone, except for the stock equation of ROW which has autocorrelation. This is partly due to exclusion of the remaining variables from the equation which have the wrong signs. Their effects thus were included in the disturbance term. It is assumed that the trend in the disturbance term will continue during the forecast period. The price equation is also in the inconclusive zone of the DW test at the 5 percent level. All the variables in the price equation have the correct signs and are significant at the 5 percent level.

There is one additional information that can be extracted from the stock equations. The difference between 1 and the coefficient of the lagged stock variable will give the stock coefficient of adjustment. This coefficient gives the speed stocks are adjusted towards the desired level in each country.

7.1.3 Demand Block

Almost all of the equations in the demand block have adjusted-R^2 over 90 percent which means that much of the variation in the dependent variables can be explained by the explanatory variables (see Table 7.8 and Table 7.9). The Durbin-Watson statistics shows that all equations are either significant at the 5 percent level or are inconclusive. Coefficient estimates are generally significant at the 5 percent level

Table 7.8 Results of OLS Estimation for Palm Oil Import Demand Equations[a] (in tonnes)

	EC	JAPAN	US
Constant	3.858	-2.827	-7.287
$QIMP^{b}_{t-1}$	0.6171*** (5.87)	0.8106*** (14.0)	0.5455*** (5.08)
PPO_t	-0.8076*** (-4.19)	--	-3.951*** (-3.83)
PSO_t	0.6805*** (3.62)	--	3.621*** (3.78)
$XPPO_t$	--	-0.7798** (-2.67)	--
$XTALLOW_t$	--	0.9011** (2.51)	--
$CINC_t$	0.3567** (2.73)	0.4485*** (2.96)	2.643*** (3.44)
D	--	--	0.3446 (1.60)
Statistics			
F-value	74.49	396.7	41.44
Adj-R^2	0.919	0.983	0.882
DW	2.34	1.89	1.74
n	27	28	28

a Based on annual data covering the period 1959 to 1987 and figures in parentheses are t-values for H_o: parameter = 0
b All variables are expressed in logarithmic form.
* significant at the 10-percent level
** significant at the 5-percent level
*** significant at the 1-percent level

Table 7.9 Results of OLS Estimation for Palm Oil Import Demand Equations[a] (in tonnes)

	S. Korea	Kenya	India	Pakistan
Constant	24900	1619	391000	-284400
$QIMP^{b}_{t-1}$	0.6508*** (4.50)	0.7416*** (6.63)	0.8480*** (7.54)	0.4711** (2.41)
$XPPO_t$	-34.27** (-2.74)	-337.8** (-2.37)	-12000** (-2.68)	-4542** (-2.49)
$XPSO_t$	21.05** (2.12)	--	7665* (2.02)	3327** (2.16)
$CINC_t$	4.815** (2.74)	--	--	--
$XINC_t$	--	17.01*** (2.90)	--	--
QG_{t-1}	--	--	-52.31** (-2.39)	--
FR_t	--	--	53.77*** (3.96)	53.55 (1.66)
POP_t	--	--	--	5425** (2.34)
F-value	53.99	116.8	76.37	74.46
Adj-R^2	0.927	0.928	0.933	0.944
DW	1.74	1.71	2.16	1.51
n	22	28	28	23

a Based on annual data covering the period 1959 to 1987 and figures parentheses are t-values for H_o : parameter = 0
b All variables are expressed in linear form
* significant at the 10-percent level
** significant at the 5-percent level
*** significant at the 1-percent level

Table 7.10 Variable Definitions for Palm Oil Demand Equations

Variables	Description and Unit of Measurement
IMP_t	Quantity of palm oil imported for year t (tonnes)
IMP_{t-1}	Quantity of palm oil imported for year t-1 (tonnes)
PPO_t	The real average price of palm oil in year t (US dollars per tonne)
PSO_t	The real average price of soybean oil in year t (US dollars per tonne)
$XPPO_t$	The real average price of palm oil in year t (local currency per tonne)
$XPSO_t$	The real average price of soybean oil in year t (local currency per tonne)
$XTALLOW_t$	The real average price of tallow in year t (Japanese yens per tonne)
$CINC_t$	Real income per capita in year t (millions of local currency)
$XINC_t$	Real income in year t, not deflated by population (millions of Kenyan shillings)
QG_{t-1}	Quantity of groundnuts produced in year t-1 (thousand tonnes)
FR_t	Foreign reserves at the end of year t (millions of US dollar)
POP_t	Average mid-year population of year t (millions)
D	Dummy variable for negative publicity palm oil received (before 1986 = 1, 1986 and after = 0)

Note: In 1988, the average local currency exchange rates against the US dollar are as follows:

1.18 EC ECUs = 1 US dollar
128 Japanese yens = 1 US dollar
671 S. Korean won = 1 US dollar
18 Kenyan shillings = 1 US dollar
14 Indian rupees = 1 US dollar
18 Pakistan rupees = 1 US dollar

and the signs are all as expected.

Among the importing countries, India, South Korea, Pakistan, and the US are found to be highly responsive to prices (see Table 7.11). The own price elasticities range from -1.6 (Pakistan) to -4.0 (United States) while the low and high for cross price elasticities are 1.3 (Pakistan) and 3.6 (US). On the other hand, the own price elasticities of demand for EC, Japan and Kenya are found to be inelastic. Except for the income elasticity of US which is 2.6, all other countries (when applicable), are also inelastic in income. The foreign exchange reserve elasticities of demand are not elastic for both India (0.53) and Pakistan (0.15). However, India's domestic oilseed production is elastic (-1.2) and so is population in Pakistan (2.6).

The palm oil's own price elasticity of demand obtained for the US is quite consistent with the elasticities found by Tan, Senteri (in Goddard and Glance), Goddard and Glance, and Suryana but inconsistent with the elasticity found by Ghaffar (in Goddard and Glance). Those former studies all concluded that palm oil's own price elasticity is very elastic in the US, though the actual number varies among them. Tan put the number at -31.4, Senteri had it at -4.14/-11.67, Goddard and Glance got -1.47 for it and Suryana concluded that the values are -1.46/-1.14/-1.57, depending on whether there is any adjustment made to the AIDS model used. Ghaffar, however, found that palm oil's own price elasticity is inelastic (-0.109) in the US.

For Japan, the own price elasticity of demand (-0.78) is quite close to the elasticity values of -0.89 and -0.90 obtained by Suryana using the AIDS model with no restriction imposed and correction made for autocorrelation. However, Suryana's AIDS model with homogeneity imposed gives an elastic own price demand in Japan (-1.16). Tan found the own price elasticity of demand to be -16.7 and Goddard and

Table 7.11 Elasticities of Palm Oil Import Demand

	Own Price	Cross Price	Income	Foreign Exchange	Domestic Groundnuts	Pop'n
EC	-0.8076	0.6805	0.3567	--	--	--
Japan	-0.7780	0.9011	0.4485	--	--	--
Kenya	-0.5057	--	0.8107	--	--	--
India	-2.103	1.438	--	0.5313	-1.182	--
Korea	-3.320	2.225	0.9246	--	--	--
Pakistan	-1.585	1.260	--	0.1540	--	2.551
US	-3.951	3.621	2.643	--	--	--

Glance put Japan's own price elasticity at -0.34.

The own price elasticity of demand of -0.81 obtained for the EC in this study is slightly higher than the -0.53/-0.54/-0.54 obtained by Suryana using the AIDS model with no restriction, with homogeneity imposed and correction for autocorrelation. However, it very close to the -0.83 income elasticity obtained by Labys ("Multicommodity").

On the cross price elasticity of palm oil demand with respect to soybean oil price in the US of 3.6, not only is it inconsistent with those of Ghaffar (-0.28) and Suryana(-0.27) its sign is also the opposite. In these two studies, soybean oil is found to be a complement rather than a substitute of palm oil in the US. Goddard and Glance, however, obtained a cross price elasticity *vis-a-vis* soybean oil of -1.14 for the US which is elastic but still has the opposite sign. Their cross price elasticities for Japan *vis-a-vis* tallow is -0.02. Suryana obtained a cross price elasticity *vis-a-vis* soybean oil of -0.03 for the EC.

It is noted that all the above studies used for cross price elasticity comparison, except Ghaffar, are based on a system demand approach while the present study is based on the usual consumer demand theory for a good and other variables considered to be important in specific countries. Another difference is that the parameter estimates used to calculate cross price elasticities in all of the above studies are mostly insignificant at the 5% level or even 10% level while all the parameter estimates in this study are significant at the 5% level, except one. The insignificance of the parameter estimates in those studies appears to suggest strong multicollinearity among the different price variables, all of which are highly correlated because of substitution possibilities, which in turn means parameter estimates may be unstable and inaccurate and may sometimes even change sign (Koutsoyiannis p. 236).

Suryana's palm oil expenditure elasticities for EC and US of 0.96 and 4.2 are much higher than the income elasticities of 0.36 and 2.6 found in the present study. Both Suryana and also Goddard and Glance found that the palm oil expenditure elasticity for Japan of 1.8 and 1.09 respectively, to be highly elastic which contradicts the present study for income elasticity of Japan of 0.45 which is inelastic. Ghaffar concluded that palm oil is an inferior good in the US (-0.40) and so did Goddard and Glance (-0.74). However, these income elasticities compare favourably with those of Lamm and Dwyer of 0.49 and 0.57 for the EC, and Japan though not for the US(0.62).

It is obvious that the elasticities obtained compare favourably with some studies while inconsistent with others. Some of the differences may be traced back to sample period considered, model type and model specification, and estimation technique. However, it is not the purpose of this study to pinpoint the advantages and disadvantages of the different approaches or studies and the subsequent impacts on results obtained. Besides, the main purpose of the demand equations estimated in this study is for forecasting rather than for estimating elasticities. Therefore, what is more important is for these equations to be able to reproduce historical observations as close as possible.

7.2 EVALUATION OF FORECASTING POWER

Before using the system model for forecasting, it is instructive to evaluate its predictive power. The reason is that the model may be not suitable for forecasting, even when the model is economically meaningful and statistically and econometrically satisfactory, if, for example, there is a rapid change in the structural parameters of the relationship (Koutsoyiannis p. 28). Four of such tests will be used to evaluate the model's forecasting capability. Three of them are based on the results of historical simulation and the last one is an *ex post* prediction test. The last test will only be conducted for those single-equation models in the demand and supply blocks because the standard error of forecast cannot be computed for the multi-equation model of price and stocks (Pindyck and Rubinfeld p. 366).

7.2.1 Mean Absolute Error (MAE)

This measure of prediction accuracy is defined as:

$MAE = 1/n \, \Sigma|Y_S - Y_A|$ where:

Y_S = simulated dependent value
Y_A = actual dependent value
n = sample size of simulation

It is desired that the value for the absolute mean error (MAE) be as small as possible. The MAE for each equation is as shown in Table 7.12 and Table 7.13.

7.2.2 Root Mean Square Error (RMSE)

The formula for the root mean square error (RMSE) is:

$RMSE = (1/n \, \Sigma(Y_S - Y_A)^2)^{1/2}$

It is again desired that its value be as small as possible. For comparison purposes, the RMSE for each equation will be evaluated at the mean of the dependent variable. Comparing the RMSE at the means of endogenous variables, the percentages are lowest for the yield equations of Malaysia and Indonesia (see Table 7.12 and Table 7.13), and the demand equations of the EC, the US and Japan. The percentages are less than 10 percent for these equations. The equation that has the next lowest RMSE, as

Table 7.12 Forecasting Validation Statistics for Endogenous Variables of Palm Oil Supply and Demand

	U	MAE	RMSE	RMSE / Dependent	t^*
SUPPLY BLOCK					
1) CHANGE IN MATURE AREA					
Malaysia	0.209	7740	12900	29.3%	2.00[a]
Indonesia	0.165	2887	4934	22.6%	-2.34
2) YIELD					
Malaysia	0.0633	0.165	0.224	7.42%	0.488[a]
Indonesia	0.0281	0.0588	0.105	3.24%	2.26
DEMAND BLOCK					
Kenya	0.182	7350	10000	28.3%	1.29[a]
EC[b]	0.00620	0.0680	0.0917	0.69%	-0.987[a]
Pakistan	0.154	26700	41900	26.4%	-2.01[a]
US[b]	0.0358	0.271	0.457	4.06%	-0.0545[a]
S. Korea	0.224	13400	17300	45.3%	3.18
India	0.185	52100	83700	34.4%	2.45
Japan[b]	0.105	0.0841	0.129	1.17%	-1.12[a]

a not significant at the 5-percent level
b in logarithmic-linear form

Table 7.13 Forecasting Validation Statistics for Endogenous Variables of Palm Oil Price and Stocks

	U	MAE	RMSE	RMSE / dependent	Forecast error / Actual obs
Malaysia	0.179	73600	109000	51.9%	54.2%
Indonesia	0.240	29800	39600	67.8%	32.2%
EC	0.0860	7840	10400	18.6%	7.30%
US	0.124	6950	8470	28.9%	33.1%
Japan	0.140	482	677	37.0%	128%
India	0.176	18100	28300	59.7%	40.0%
ROW	0.0861	39100	52800	21.1%	27.1%
World	0.0850	102000	141000	21.6%	30.4%
Price	0.0939	62.5	76.9	20.4%	10.1%

evaluated at the mean, is the stock equation of the EC. The equations with the highest RMSE is the stock equations of Indonesia which is over 60 percent.

7.2.3 Theil's Inequality Coefficient (U)

A related test to the RMSE is the Theil's inequality coefficient (U) which is defined by the expression:

$$U = \left(\frac{\Sigma(Y_S - Y_A)^2}{E\ Y_A^2} \right)^{1/2}$$

where:
Y_A = actual dependent value
Y_S = simulated dependent value
n = number of observations in sample

If U is 0, this means $Y_A = Y_S$ and the prediction is perfect. On the other hand if U is 1, the predictive performance of the model is poor because it is no better than using the previous year's dependent value as the predicted value. Finally, when U is greater than 1, model prediction would be worse than using the previous year's value as prediction. It would be better off to use the previous year's dependent value.

Using the Theil's inequality coefficient (U) to compare the historical simulated values with actual observations, it is found that all the equations in the system model have values between 0 and 1, which means that all of them are acceptable for forecasting. Prediction using the models is better than using the previous year's value but is less than perfect. The best results appear to have come from the price equation, both the yield equations, the demand equations for the EC and the US, and the stock equations for the EC, the ROW, and the World. All of them have values less than 0.1.

7.2.4 Test of Significance of the Difference Between a Single Prediction and the Actual Observation

The formula to be used to test whether there is any difference between the actual observation (Y_A) outside the estimation sample data and the predicted value (Y_F) is:

$$t^* = \frac{Y_F - Y_A}{S.E_f}$$

where:
$S.E_f$ = standard error of forecast

The difference between the predicted and actual values (which gives the forecast error) for 1988 is insignificant for most of the equations at the 5 percent level except for both the supply equations of Indonesia, and the demand equations of India and South Korea. Thus, it appears that the predictive power of equations for 1988 is mixed. Some equations predict very well while others do not. However, it is too soon to discard those equations that performed badly in 1988 because the year 1988, the out of sample year, could be an exceptional year. For example, in India, domestic oilseeds production were above normal in that year and an unprecedented amounts of palm oil were bought the previous year resulting in lower imports.

A crude evaluation of the predicted endogenous values in the price and stocks block, expressing those values as percentages of observed values, are also shown. This is called an *ex post* rms forecast error test. The best forecast is obtained for the stock equation of EC while the stock equation of Japan gives the worst forecast. The poor result obtained for the stock equation of Japan is due to the small amounts of palm oil it holds every year. Consequently, any change in stock holdings as a percentage of total stock holdings would be very large.

CHAPTER VIII

FORECASTING

The system model estimated will be used to predict production, exports, imports and consumption of palm oil over the period 1990-2000. Since the related equations are function of predetermined variables which have no known values to the year 2000, some assumed values are needed for them. However, for those earlier years, whenever available, the actual observations will be used to do the forecasting.

Having to depend on some assumed values of the exogenous variables, predictions made will only be as good as the values chosen for the exogenous variables[1]. Therefore, these predicted values should not be taken at face value but as indication of the direction they are most likely to follow, given the values for the exogenous variables. To partially offset the uncertainty, a few alternate forecasts will be made for some of the endogenous variables, based on different assumptions about the exogenous variables.

To forecast the future supply of and demand for palm oil with the relevant equations, some values are needed for the price and stock exogenous variables. These values will be supplied by the price and stock equations, of which predicted values are determined by their own exogenous variables. It is assumed that these variables in the

[1]Of course, at the same time it is assumed that the parameter estimates for sample period are sufficiently accurate and do not change during the forecast period. The same shall also hold for the *ceteris paribus* claus.

price and stock equations follow some past trends. In the stock equation of Indonesia, copra production is assumed to stabilize at 125000 tonnes which is quite realistic because output has stagnated around this amount for the last few years. Variables for production activities in the coming year, $PROD_{t+1}$ and $DPROD_{t+1}$, will take on the 5-year average values as predicted by Oil World.

The most difficult assumptions to make are the values for $DPPO_t$ which is the adjustment in the price of palm oil because its values cannot be extrapolated from immediate past values. However, it is very likely that palm oil prices will rise again throughout the 1990s because prices have fallen to levels not seen since the early 1970s. Although prices have picked up slightly recently, they are still way below the price levels before 1986. On the basis of past trends, the variable $DPPO_t$ is assumed to change in a way similar to that as occurred between 1973 and 1982. This will be the first scenario. An alternate scenario will be that $DPPO_t$ is half of those values from 1973 to 1982 because severe shortages as seen between 1973 and 1976 and the huge year-to-year price changes are not likely to be repeated. This will be the second scenario. The values for the remaining variables in the price and stock equations will be internally generated.

The predicted palm oil prices and stock levels obtained under the first and second scenarios are as shown in Table 8.1 and Table 8.2. In both instances, prices are expected to rise throughout the 1990s. Since they show almost the same trend, only one set of prices will be used for further analysis.

Using the first set of projected palm oil prices, the production of palm oil is forecasted for Malaysia and Indonesia, under 3 alternate rubber prices (see Tables 8.3, 8.4, 8.5). In all cases, it is predicted that total palm oil output in 1990 would be 8366

Table 8.1 Predicted Palm Oil Price and Stock Levels, 1990 -2000: Scenario I

Year	Price	Stocks ('000 MT)							
		World	M'sia	Ind'sia	EC	US	Jpn	India	ROW
1990	336	1780.5	565.3	231.0	83.8	14.8	3.3	155.6	726.7
1991	682	1687.5	450.3	240.9	82.8	24.5	3.6	245.5	639.9
1992	694	2070.5	688.3	196.1	122.6	45.6	5.1	223.7	789.0
1993	556	1935.5	601.8	150.9	117.8	32.8	4.7	225.9	801.6
1994	669	1912.8	552.4	171.1	112.0	31.4	4.6	264.5	776.6
1995	718	1961.6	583.8	171.7	114.7	35.2	4.7	267.7	783.4
1996	734	2007.9	619.4	167.6	117.0	36.7	4.8	263.0	799.5
1997	737	2161.2	702.7	163.7	128.0	41.1	6.2	256.8	862.7
1998	704	2202.9	700.8	156.0	127.9	38.3	5.8	279.5	894.5
1999	709	2363.9	760.1	158.4	134.1	42.2	5.6	294.7	968.9
2000	696	2274.5	690.6	156.5	125.8	35.6	5.4	298.1	962.6

Table 8.2 Predicted Palm Oil Price and Stock Levels, 1990 -2000: Scenario II

Year	Price	Stocks ('000 MT)							
		World	M'sia	Ind'sia	EC	US	Jpn	India	ROW
1990	324	1854.9	603.2	228.9	88.3	17.4	3.2	153.9	759.9
1991	621	1822.6	510.7	231.2	90.7	27.5	3.4	238.8	720.2
1992	637	1991.1	616.8	191.1	116.1	38.9	4.9	223.6	799.8
1993	592	1954.2	581.4	163.4	116.3	33.5	4.6	240.1	814.8
1994	651	1955.7	562.7	168.2	114.4	33.0	4.5	261.9	810.9
1995	688	2003.1	589.0	167.9	116.5	35.3	4.6	265.6	824.2
1996	705	2048.4	618.1	165.3	118.1	36.5	4.6	263.2	842.6
1997	716	2151.1	672.0	163.5	125.9	39.1	6.0	259.1	885.6
1998	706	2209.7	682.2	159.4	126.8	38.0	5.7	284.2	913.3
1999	713	2314.6	720.0	160.2	130.4	40.1	5.5	296.6	961.8
2000	717	2298.1	696.4	160.2	126.7	37.3	5.4	301.0	971.1

Table 8.3 Projected Output Supplies of Palm Oil, 1990-2000 ('000 MT): Medium Rubber Prices (US$1100 per tonne)

Year	Price	Malaysia	Indonesia	Total
1990	336	5867.0	2499.3	8366.3
1991	682	6363.7	2720.8	9084.5
1992	694	6629.5	2998.6	9628.1
1993	556	7033.9	3280.5	10314.4
1994	669	7389.8	3544.7	10934.5
1995	718	7476.9	4159.9	11636.8
1996	734	7838.7	4929.8	12768.5
1997	737	8280.3	5564.3	13844.6
1998	704	9211.9	6361.5	15573.4
1999	709	10056.8	7305.8	17362.6
2000	696	10696.6	8431.1	19127.7

Table 8.4 Projected Output Supplies of Palm Oil, 1990-2000 ('000 MT): High Rubber Prices (US$1200 per tonne)

Year	Price	Malaysia	Indonesia	Total
1990	336	5867.0	2499.3	8366.3
1991	682	6373.3	2720.8	9094.1
1992	694	6599.1	2998.6	9597.7
1993	556	6957.9	3287.4	10245.3
1994	669	7260.6	3535.2	10795.8
1995	718	7318.6	4130.5	11449.1
1996	734	7626.0	4875.0	12501.0
1997	737	7980.8	5489.5	13470.3
1998	704	8798.5	6267.1	15065.6
1999	709	9521.7	7188.3	16710.0
2000	696	10070.2	8283.8	18354.0

Table 8.5 Projected Output Supplies of Palm Oil, 1990-2000 ('000 MT): Low Rubber Prices (US$1000 per tonne)

Year	Price	Malaysia	Indonesia	Total
1990	336	5867.0	2499.3	8366.3
1991	682	6354.0	2720.8	9074.8
1992	694	6658.1	2998.6	9656.7
1993	556	7108.0	3272.7	10380.7
1994	669	7517.2	3553.2	11070.4
1995	718	7630.3	4187.6	11817.9
1996	734	8039.6	4982.7	13022.3
1997	737	8565.0	5636.2	14201.2
1998	704	9607.4	6452.6	16060.0
1999	709	10572.7	7419.3	17992.0
2000	696	11298.1	8571.1	19869.2

thousand tonnes of which 5867 thousand tonnes originate from Malaysia and the rest come from Indonesia. Under the medium rubber price projection of US$1100 per tonne[2], it is predicted that world palm oil output would increase to 11637 thousand tonnes in 1995 and by the year 2000, the amount would reach 19128 thousand tonnes. Palm oil production in Indonesia would more than triple while output in Malaysia would almost double the amounts in 1990. However, if rubber prices were to increase to US$1200 tonnes, production would decline by 188 thousand tonnes in 1995 and by 774 thousand tonnes in 2000 largely because of reduction in Malaysia. Under the low rubber price level of US$1000 per tonne, palm oil production would rise in both Malaysia and Indonesia but most of the increase (80%) would come from Malaysia. Therefore, it is obvious that rubber price is a very important factor determining production levels in both countries, especially palm oil production in Malaysia. This is not surprising considering its lower land availability and thus oil palm has to compete with rubber for land and other inputs.

In the above predictions, some assumed values were needed for the predetermined variables. It was assumed that the exchange rates for Malaysia and Indonesia would remain at 2.7 ringgits and 1850 rupiahs per US dollar throughout the 10 years. Fertilizer consumption in Indonesia is assumed to rise at a rate of 10 % annually. These values are extrapolated from the recent trends of each variable.

Using output levels arrived at with the first set of palm oil prices and rubber price of US$1100 per tonne, the amounts exported will be derived using an identity. The respective export levels for Malaysia and Indonesia are as shown in Tables 8.6 and

[2]The most recent average price from Jan-September, 1989 is US$1078 per tonne.

Table 8.6 Predicted Palm Oil Output and Exports[a] for Malaysia, 1990-2000 ('000 MT)

Year	Output	- DStock	- Consumption[b]	= Exports
1990	5867.0	-485.9	586.7	5766.2
1991	6363.7	-115.0	636.4	5842.3
1992	6629.5	238.0	663.0	5728.5
1993	7033.9	-86.5	703.4	6417.0
1994	7389.8	-49.4	739.0	6700.2
1995	7476.9	31.4	747.7	6697.8
1996	7838.7	35.6	783.9	7019.2
1997	8280.3	83.3	828.0	7369.0
1998	9211.9	-1.9	921.2	8292.6
1999	10056.8	59.3	1005.7	8991.8
2000	10696.6	-69.5	1069.7	9696.4

a Assuming rubber prices remain at US$1100 per tonne
b Assuming domestic consumption is 10 percent of production

Table 8.7 Predicted Palm Oil Output and Exports[a] for Indonesia, 1990-2000 ('000 MT)

Year	Output	- DStock	- Consumption[b]	= Exports
1990	2499.3	-119.0	1499.6	1118.7
1991	2720.8	9.9	1632.5	1078.4
1992	2998.6	-44.8	1799.2	1244.2
1993	3280.5	-45.2	1968.3	1357.4
1994	3544.7	20.2	2126.8	1397.7
1995	4159.9	0.6	2495.9	1663.4
1996	4929.8	-4.1	2957.9	1976.0
1997	5564.3	-3.9	3338.6	2229.6
1998	6361.5	-7.7	3816.9	2552.3
1999	7305.8	2.4	4383.5	2919.9
2000	8431.1	-1.9	5058.7	3374.3

a Assuming rubber prices remain at US$1100 per tonne
b Assuming domestic consumption is 60 percent of production

8.7[3]. Total world exports would be 6885 thousand tonnes in 1990 and they would reach 8361 thousand tonnes in 1995 and 13071 thousand tonnes in 2000. World market share for Malaysian palm oil would decline from 84% to 74% while Indonesia would increase its market share from 16% to 26%. If rubber prices were to decrease to US$1000, *ceteris paribus*, world availabilities would increase even more because of larger production, but exports would drop if rubber prices were to increase to US$1200.

On the demand side, shares of palm oil imports of the existing 7 largest importing countries are expected to continue rising (see Tables 8.8 and 8.9). In the first scenario, using the first set of palm oil prices and assuming that prices of competitors of palm oil --soybean oil and tallow-- are US$100 higher and lower, total imports are predicted to rise to 4262 thousand tonnes in 1995 and 6349 thousand tonnes in 2000. A second scenario that assumes the prices for substitutes of palm oil are $50 higher or lower, predicted that amounts imported for 1995 would be 3973 thousand tonnes and 5910 thousand tonnes in the year 2000. Their palm oil disappearance levels, obtained after adjusting imports for changes in stock levels, are also shown (see Tables 8.10 and 8.11).

It should be pointed out that values for most of the exogenous variables in these import demand equations are chosen quite arbitrarily, being extrapolated from immediate past actual values. For population, the growth rate is obtained from the World Bank's World Development Report, 1989. Economic growth rate for some earlier years for the US, the EC and Japan are provided by OECD's Economic Outlook predictions. The growth rate for the remaining years are given some fixed values seem

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[3]It is assumed that palm oil domestic consumption in Malaysia and Indonesia would remain at 10 percent and 60 percent of production respectively.

Table 8.8 Predicted Palm Oil Import Demand, 1990-2000[a] ('000 MT)

Year	India	Pakistan	US	Kenya	S.Korea	Japan	EC	Total
1990	595.8	597.9	287.7	135.8	217.7	200.9	1441.4	3477.2
1991	621.7	602.4	270.3	148.0	246.1	216.1	1334.0	3438.6
1992	647.7	626.2	281.8	163.4	275.9	234.7	1289.8	3519.5
1993	721.5	677.4	380.0	185.9	314.8	239.6	1351.0	3870.2
1994	754.4	712.7	420.0	207.6	349.6	262.4	1358.4	4065.1
1995	773.9	748.7	461.3	231.4	386.4	293.6	1367.2	4262.5
1996	792.0	789.8	525.8	258.5	427.8	330.0	1391.6	4515.5
1997	812.4	835.1	621.3	289.4	474.7	370.2	1432.2	4835.3
1998	843.7	886.7	779.4	325.1	529.0	409.5	1499.4	5272.8
1999	873.9	938.1	971.4	364.8	589.1	454.1	1569.1	5760.5
2000	907.2	991.9	1231.6	409.4	656.5	501.3	1650.8	6348.7

a Assuming prices of competitors are US$100 higher or lower

Table 8.9 Predicted Palm Oil Import Demand, 1990-2000[a] ('000 MT)

Year	India	Pakistan	US	Kenya	S.Korea	Japan	EC	Total
1990	589.3	579.6	185.1	135.8	213.8	238.9	1326.7	3269.2
1991	585.1	576.4	167.3	148.0	239.7	267.8	1211.8	3196.1
1992	613.2	597.3	171.4	163.4	268.1	300.4	1163.0	3276.8
1993	689.5	647.6	216.1	185.9	306.0	320.8	1199.5	3565.4
1994	726.3	683.4	242.0	207.6	340.4	358.7	1205.7	3764.1
1995	750.2	720.4	271.7	231.4	377.0	405.8	1216.8	3973.3
1996	773.0	762.5	314.9	258.5	418.3	459.4	1241.8	4228.4
1997	798.3	808.8	375.8	289.4	465.3	518.2	1280.2	4536.0
1998	834.8	861.4	469.6	325.1	636.8	577.7	1339.2	5044.6
1999	870.1	913.7	584.8	364.8	656.1	644.4	1401.3	5435.2
2000	908.4	968.4	738.2	409.4	697.1	715.8	1473.0	5910.3

a Assuming prices of competitors are US$50 higher or lower

Table 8.10 Predicted Palm Oil Disappearance, 1990-2000[a] ('000 MT)

Year	India	Pakistan[b]	US	Kenya[b]	S.Korea[b]	Japan	EC	Total
1990	490.2	597.9	283.9	135.8	217.7	201.6	1456.8	3383.9
1991	531.8	603.4	260.6	148.0	246.1	215.8	1335.0	3339.7
1992	669.5	626.2	260.7	163.4	275.9	233.2	1250.0	3478.9
1993	719.3	677.4	392.8	185.9	314.8	240.0	1356.0	3886.2
1994	715.8	712.7	421.4	207.6	349.6	262.5	1363.5	4033.1
1995	770.7	748.7	457.5	231.4	386.4	293.5	1364.5	4252.7
1996	796.7	789.8	524.3	258.5	427.8	329.9	1389.3	4516.3
1997	818.6	835.1	616.9	289.4	474.7	368.8	1421.2	4824.7
1998	821.0	886.7	782.2	325.1	529.0	409.9	1499.5	5253.4
1999	858.7	938.1	967.5	364.8	589.1	454.3	1562.9	5735.4
2000	903.8	991.9	1238.2	409.4	656.5	501.5	1659.1	6360.4

a Assuming prices of competitors are US$100 higher or lower
b Assume to be the same as imports

Table 8.11 Predicted Palm Oil Disappearance, 1990-2000[a] ('000 MT)

Year	India	Pakistan[b]	US	Kenya[b]	S.Korea[b]	Japan	EC	Total
1990	483.7	597.9	585.5	135.8	217.7	239.6	1342.1	3602.3
1991	495.2	602.4	575.4	148.0	246.1	267.5	1212.8	3547.4
1992	635.0	626.2	592.1	163.4	275.9	298.9	1123.2	3714.7
1993	687.3	677.4	702.3	185.9	314.8	321.2	1204.5	4093.4
1994	687.7	712.7	727.7	207.6	349.6	358.8	1210.8	4254.9
1995	747.0	748.7	746.4	231.4	386.4	405.7	1214.1	4479.7
1996	777.7	789.8	771.5	258.5	427.8	459.3	1239.5	4724.1
1997	804.5	835.1	793.9	289.4	474.7	516.8	1269.2	4983.6
1998	812.1	886.7	837.6	325.1	529.0	578.1	1339.3	5307.9
1999	854.9	938.1	866.2	364.8	589.1	644.6	1395.1	5652.8
2000	905.0	991.9	915.0	409.4	656.5	716.0	1481.3	6075.1

a Assuming prices of competitors are US$50 higher or lower
b Assume to be the same as imports

most likely. The other exogenous variables are also similarly assigned some values considered most appropriate given past movements about them (see Appendix 1.3).

Most of the predictions obtained are quite reasonable on the basis of past import levels and expected future values of explanatory variables. There are, however, a few uncertainties. Most recently, more rigorous attempts of the Indian government to control edible oil imports despite high domestic prices have made palm oil imports quite unpredictable because this move could have some implications on the coefficient estimates. Similarly, efforts to substitute away from palm oil uses in the US could be stronger than predicted. Inclusion of a dummy variable to take this development into account has not given very strong influence on quantity imported. One reason could be that there were too few observations because it is a recent development. This variable is also found not significant at the 5 percent level. Further revisions, therefore are probably needed to these equations when additional information about these markets are available. However, should the existing information hold and the past trends persist, the import demands in these countries should be as predicted.

In both import demand predictions, shares of the existing palm oil importers between 1990 and 2000 would only drop from 50.5% to 48.6% in the scenario where prices of substitutes are $100 higher or lower and from 47.5% to 45.2% in the case where prices of substitutes are $50 higher or lower. However, if their average share during 1986-1988 is used as the initial amount, the decline in market share would be much greater, being 12% in the first scenario and 15% in the second scenario. Their smaller share predicted for 1990 is largely due to huge cutbacks in import by India in the last two years. In any case, this implies imports from countries other than these 7 would have to increase to clear the market and to prevent a downward pressure on prices. Imports from the Rest-of-the World (ROW) would have to increase to 4099 thousand tonnes in 1995 and 6722 thousand tonnes in 2000 under the first scenario and to 4388 thousand tonnes in 1995 and 7160 thousand tonnes in 2000 under the second scenario (see Table 8.12). These amounts imported are a doubling and more than tripling of amounts imported before 1990. Obviously, their import levels and market shares would rise even higher should export availabilities increase as a result of lower than expected rubber prices, *ceteris paribus*.

Table 8.12 Predicted Palm Oil Import Demand from Rest-of-the-World (ROW), 1990-2000 ('000 MT)

Year	Scenario I[a]	Scenario II[b]
1990	3407.7	3615.7
1991	3482.1	3724.6
1992	3453.2	3695.9
1993	3904.2	4209.0
1994	4032.8	4333.8
1995	4098.7	4387.9
1996	4449.7	4766.8
1997	4763.3	5062.6
1998	5572.1	5800.3
1999	6151.2	6476.5
2000	6722.0	7160.4

a Assuming prices of substitutes are US$100 higher or lower
b Assuming prices of substitutes are US$50 higher or lower

CHAPTER IX

CONCLUSIONS, POLICY IMPLICATIONS, AND LIMITATIONS OF STUDY

9.1 CONCLUSIONS AND POLICY IMPLICATIONS

Two results were reached in the analyses of previous chapter and they are:

a) Palm oil production and exports from Indonesia are expected to rise during 1990-2000 and so are its market shares in both production and export but *only if* the coefficient estimates in the supply equations and other assumed values for explanatory variables hold.

b) It is predicted that the share of the existing seven largest palm oil importing countries would drop despite rising imports during the 1900s while imports and market share of the Rest-of-the-World (ROW) would increase but *only if* assumptions made about the conditions in each market hold.

From these results, it is concluded that competition for Malaysian palm oil, coming form Indonesian palm oil, will continue to increase. Furthermore, it is concluded that there will be a change in the composition of major palm oil importers that is towards those nontraditional palm oil importers. These two conclusions basically suggest that some fundamental changes are needed in the Malaysian oil palm industry for it to remain competitive and for palm oil production and exports to continue rising[1]. These improvements to enable a continued growth in the oil palm industry can be divided into three areas.

9.1.1 Production Costs Reduction

The first improvement necessary is to reduce the costs of production. To meet this objective, there are two possibilities:

9.1.1.1 Lowering Labour Cost

Seaward has pointed out that Malaysia is less advantageous in terms of labour abundancy and labour cost, though this limitation is partially offset by better management and adequate infrastructure facilities (pp. 88 and 91). Since inadequate labour and more expensive labour is the source of its uncompetitiveness, one way to alleviate the labour tightness in Malaysia is to bring in more labour from neighbouring countries to work in plantations. Existing restrictions on foreign labour recruitment should be relaxed. This move will not only reduce labour shortages but also help to ease rising real wages and therefore, lowering production costs. With lower production

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[1]Implicitly, it has been assume that palm oil prices are high enough for production to remain profitable so that it will continue rising. There are at least three reasons why prices will not fall too much despite rising production. First of all, edible oils are easily interchanged and therefore their price differences will not deviate too much from one another which means movement of palm oil prices will depend more on the overall market conditions rather than its own supply and demand conditions. Furthermore, being a perennial crop of which supply is price inelastic in the short run, palm oil production cannot change very much should there be excess supplies. Therefore, most of the supply adjustments will likely come from annual oilseed crops. Thirdly, among oil-bearing crops, oil palm is the highest oil yielding thus giving it the lowest cost per unit. When prices are low, its production will still cover variable cost when most other oilseeds are not able to .

costs, producers in Malaysia can then afford to sell at lower prices. Since this will only apply to large estates that use paid-labour and they are the most efficiently-run operation, lower wage rate will help to increase the competitiveness and enhance profitability of the oil palm industry as a whole.

Although such a move will have some undesirable social consequences, their impacts can be reduced with the use of workers on contract. The presence and whereabouts of these foreign workers, can therefore be more easily controlled and adjusted, depending on the seasonal needs of the industry. It is also deemed far better than the *status quo* where foreigners come in illegally to work in some of these estates. Some estimates put the number of illegal foreign workers in plantations as high as 60,000 or about 26 percent of the overall labour force and in Sabah and Sarawak, the percentage rises to 70 percent (Azham p. 22 and Tsuruoko p. 44). Beside meeting the labour needs of the oil palm estates, it will also help to ease chronic unemployment situation in neighbouring countries such as Indonesia and the Philippines and therefore is mutually beneficial. In Indonesia, each year 2.5 million people join the labour force (Vatikiotis p. 22) and many of these are unable to find works.

Without doubt, bringing in foreign workers will only partly reduce the labour shortage problem and can be seen only as a short-term solution. Some other more self-sustaining methods are needed to address this situation in the longer run. Therefore, efforts to reduce labour requirement and to increase labour productivity such as mechanization in area upkeep and harvesting will need to continue. Other means to spread out production costs, like extracting oil palm mill effluence to be used as livestock feed and fertilizer, raising animals, and intercropping with other commodities should also be further developed (Seaward p. 89 and p. 92).

9.1.1.2 Increasing Yields

Another way to decrease production costs is to raise the yields of oil palms per hectare. It was pointed out that yields of fresh fruit bunches (ffb) of the privately-owned oil palm estates are much higher than those of smallholding under landschemes. Therefore yields in these smallholdings, under existing planting materials and cultural practices, can be raised if given the right management. Similarly, Sabah and Sarawak are found to have lower average yields than the Peninsula which again can be traced back to their smallholding system of production. Improvements in yields of these landscheme smallholdings (and non-landscheme smallholdings as well), such as from 15 to the currently observed level of 18 tonnes ffb per ha for estates, would help to lower production costs because more ffb can be obtained from the same amounts of inputs or lower amounts of inputs can still produce the same levels of ffb.

Two related areas that can also be improved on are the crude palm oil yields and extraction rates. The current national average crude palm oil yield level of about 4 tonnes per ha. is still below the potential maximum yield of 6-7 tonnes thought possible for existing strains or the theoretical high of 8-10 tonnes per ha. under optimal climatic and soil conditions (Seaward p. 91). The average extraction rate of milling plants in Peninsular Malaysia is found to be lower than those in Sabah and Sarawak thus raising extraction rate will be important for Peninsular Malaysia's producers.

Yield improvements can only be made with more research and development (R & D) in seed varieties, cultural practices and better management skills. Therefore, one way to achieve the goals is to increase public funding for research and development in the oil palm sector. It was reported that in 1986, a mere M$24 million were spent on R & D by the government (Seaward p. 89) while the industry brought in M$3 billion in export revenue or less than 1% of export revenue was spent on the industry. Since the private sector also engages in its own R & D, to maximize benefits of R & D spendings, cooperation between the public-funded and private research laboratories should be encouraged by all means. This will avoid unnecessary duplication of expensive experiments and new findings can be shared and put into application as quickly as possible.

In the area of management, efforts should be put on accelerating the transfer of expertise and knowhow of managers of plantations to smallholding producers. With the share of smallholdings in mature hectareage rising, because of their rapid area expansion and the need for replanting in many plantations and more limited availability of additional land for them, productivity in these smallholdings will have strong impacts on overall yield of palm oil production during the 1990s. Some of the options to consider include government-sponsored management seminars and workshops and on-the-job training. It is essential that productivity does not suffer because it is one of the few areas that has helped the Malaysian oil palm industry to stay competitive.

Meanwhile, better extraction rate can be achieved by plant modernization and upgrading in those mills in the Peninsula, especially those older ones. The government could provide incentives to these mills by offering discount loan charges or allowing faster tax right-off.

9.1.2 Market Development

Although there have been continuing efforts to develop new outlets and to expand existing markets for Malaysian palm oil through various trade seminars, trade shows, and end-use technical assistance, further enhancement of current promotional activities are deemed needed because of growing domestic production and the increasingly competitive world marketplace for edible oils. Not only are higher production expected from other edible oils, fast oil palm area expansion in Indonesia as part of its efforts to diversify the economy presently means growing competition from Indonesia palm oil as well.

One of the methods worth considering and exploring of which Tan had described and studied is concessional sales. Although its capability to influence world palm oil prices and earnings of exporting countries are debatable due the wide range of substitutes and the close price relationship between palm oil and other edible oil prices, concessional sales have the potential to retain and raise market shares for Malaysian palm oil. It is projected that more than 50 percent of future world markets for palm oil will be in markets other than the EC, the US, Pakistan, India, Kenya, Japan, and South Korea. These markets will largely consist of countries to be broadly categorized as developing countries. Although most of them will still low in per capita fats and oils consumption and have the needs for imported oils, many of these countries will also short in foreign exchange. Palm oil imports, therefore, will be unpredictable and smaller, depending on the availability of hard currencies. Furthermore, consumption in existing countries like India and Pakistan may also be lower, thus contributes to world availabilities and lower prices should foreign exchange position be worse than anticipated. The foreign exchange elasticities of import demand for Pakistan and India obtained are 0.154 and 0.531 respectively. Therefore, some kind of sales on a concessional basis will play an important role in determining the accesibility of many countries to palm oil imports.

The U.S. Public Law 480 which governs the sales of surplus farm commodities and food aid can provide the foundation for such a programme. Three kinds of concessional sale methods are worth further looking into and they are:

1) sales for local currency
2) sales on long-term credit of which are repaid by the recipient countries in convertible currency
3) barter trade

The benefits and costs of each type of agreements and their suitability for application in specific bilateral trades can only be known with further studies. However, some of the major problems foreseen is with administering such a programme. Although such a programme is found to cost very littlle[2], the marketing strategy will deviate substantially from traditional methods. It will require the participation of governments of both sides or their agencies. Therefore, creation of state corporations such as the US's Commodity Credit Corporation (C.C.C) to provide administration and credits are probably needed. Furthermore, when dealing with non-convertible local currency and barter trade, it is necessary to agree on the type of goods of which Malaysia needs and wants. Aside from prices, sometimes quality could be a deterent to such a trade because many of these countries are still developing and thus have trouble guaranteeing goods with high and consistent quality. Option 2 seems to be more attractive because it does not require reciprocal trade but it would require the extension of credits which Malaysia might have trouble with.

One of the major advantages of such an agreement is, of course, it provides a

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[2]Pinstrup-Anderson and Tweeten put the net cost of P.L. 480 sales to the United Stated at less than 1 percent of food shipment market values when the cost of production control through land retirement is taken into account.

market to Malaysian palm oil which otherwise will have to go through the usual commercial channel. Prices may be depressed to some extent due to larger availabilities and may fluctuate more violently thus affecting growth of palm oil production. Government efforts to elevate standards of living of rural population through various land development schemes would also be affected because of the low and unstable prices. Beside offering more stable prices, such an agreement would also provide a wider market for palm oil because some of these importing countries would not have imported such a large volume or would have imported other edible oils. Furthermore, it secures markets for Malaysian palm oil which otherwise would have to compete with Indonesian palm oil in these markets.

9.1.3 Domestic Consumption and Utilization

Another outlet for palm oil produced is the domestic market. Although Malaysia does not have the population to absorb rising production, with rapid industrialization, food-based and industry-based manufacturing companies should be encouraged to use palm oil as their input material. Increasing domestic utilization of palm oil produced will reduce both export supply availabilities and dependency on foreign markets. Fallouts from the marketplace such as price fluctuations and economic conditions of importing countries can therefore be reduced. Perhaps some kind of discounts could be offered to local manufacturers who use palm oil.

9.2 LIMITATIONS OF STUDY

This study has a few limitations. These limitations come from the model used for forecasting. The first weakness of this study is the need to change the definition or to drop some variables in the supply equations because no data were available for them. Consequently, quality of these estimated equations was affected. However, it is difficult to accertain the degree their coefficient estimates were affected because very few studies have been done on palm oil supply, thus few estimates were available for comparison. The same also applies to some of the demand equations in terms of variable definition, but overall the problem is less severe.

The second limitation of this study originates from the forecasted values. When the estimated equations are used for forecasting, it was necessary to make many assumptions. It has to be assumed that all the parameter estimates are correct and do not change during the period of forecast. Other things not in the model are also assumed to stay the same as during the estimation period. In addition to these assumptions about the model, some assumed values are also needed for the explanatory variables of the model. Therefore, if any one of these assumptions were not true, the predicted values would not be realized during the period of the forecast and the conclusion reached in this study would be wrong. As a result of the weaknesses mentioned, when interpreting the predicted values, assumptions about them should always be kept in mind.

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Appendix 1.1 Derivation of Demand Stock Equation

$$s_t - s_{t-1} = \delta(s_t^* - s_{t-1}) \qquad (1)$$

$$s_t^* = a_0 + a_1y_t + a_2dy_t + a_3p_t^* + e_t \qquad (2)$$

$$p_t^* = p_{t-1} + \beta(p_{t-1} - p_{t-2}) \qquad (3)$$

where:

s_t^* = desired stock level in t
y_t = output level in t
dy_t = changes in output level in t
p_t^* = expected price level in t
p_t = actual price level in t
p_{t-1} = actual price level in t-1
p_{t-2} = actual price level in t-2
s_t = actual stock level in t
s_{t-1} = actual stock level in t-1

substitute (3) into (2) yields:

$$s_t^* = a_0 + a_1y_t + a_2dy_t + a_3p_{t-1} - a_3\beta dp_{t-1} + e_t \qquad (4)$$

substitute (4) into (1) will give:

$$s_t = \delta a_0 + (1-\delta)s_{t-1} + \delta a_1y_t + \delta a_2dy_t + \delta a_3p_{t-1} + \delta a_3\beta dp_{t-1} + \delta e_t \qquad (5)$$

since stocks are recorded at the end of the year:

$$s_t = \delta a_0 + (1-\delta)s_{t-1} + \delta a_1y_{t+1} + \delta a_2dy_{t+1} + \delta a_3p_t + \delta a_3\beta dp_t + \delta e_t \qquad (6)$$

alternatively,

substitute (3) into (2) yields:

$$s_t^* = a_0 + a_1y_t + a_2dy_t + a_3(1+\beta)p_{t-1} - a_3\beta p_{t-2} \qquad (7)$$

substitute (7) into (1) will give:

$$s_t = \delta a_0 + (1-\delta)s_{t-1} + \delta a_1y_t + \delta a_2dy_t + \delta a_3(1+\beta)p_{t-1} - \delta a_3\beta p_{t-2} + \delta e_t \qquad (8)$$

since stocks are recorded at the end of the year

$$s_t = \delta a_0 + (1-\delta)s_{t-1} + \delta a_1y_{t+1} + \delta a_2dy_{t+1} + \delta a_3(1+\beta)p_t - \delta a_3p_{t-1} + \delta e_t \qquad (9)$$

Appendix 1.2 Selected Results of OLS Estimation for Hectareage Change Equation of Indonesia

	Model A	Model B	Model C	Model D
Constant	-6077	1700	17650	31610
$XPPO_{t-3}^{e}$	0.06990*** (3.85)	0.08521*** (4.77)	0.08414*** (4.66)	0.06890** (3.32)
$XRUB_{t-3}^{e}$	-0.02733* (-2.23)	-0.02486* (-2.29)	-0.02149* (-2.00)	-0.02217* (-2.08)
A_{t-4}^{o}	0.1359** (2.30)	0.8046* (2.27)	0.8707** (2.53)	0.7431* (2.06)
A_{t-1}^{o}	--	-0.5782* (-1.91)	-0.7736** (-2.36)	-0.7885* (-2.43)
DY_{t-3}^{e}	--	--	--	--
$A_{t-1}^{o}XPPO_{t-1}^{s}$	--	--	1.865×10^{-7} (1.30)	8.059×10^{-8} (0.464)
$A_{t-1}^{o}XRUB_{t-1}^{s}$	--	--	--	1.529x10-7[a] (1.06)
<u>Statistics</u>				
F-ratio	21.95	22.20	16.30	16.85
ADJ-R^2	0.84	0.88	0.86	0.89
DW "d"	1.618	1.575	1.821	2.018
n	13	13	13	13

***, **, and * are respectively 1, 5 and 10 percent levels of significance
a sign problem

Appendix 1.3 Assumed Values of Some Exogenous Variables of Demand Equations, 1990-2000

	EC	US	Japan	S.Korea	Kenya	India	Pakistan
Nominal Income Growth Rate (%)	7.1	7.1	6.9	15.0	15.0	--	--
Foreign Reserves (million US dollars)	--	--	--	--	--	5000	500
CPI Growth Rate	5	5	2	5	15	10	10
Exchange Rates (per US dollar)	1.0	1.0	142.0	650.0	22.0	17.0	27.0
Groundnut Production (thousand tonnes)	--	--	--	--	--	7000	--