DISSERTATION

MARKET POWER AND THE DEGREE OF DOMINANCE IN THE WORLD PALM OIL MARKET

Submitted by:

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY ENDAH MURNININGTYAS ENTITLED "MARKET POWER AND THE DEGREE OF DOMINANCE IN THE WORLD PALM OIL MARKET" BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR PHILOSOPHY.

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ABSTRACT OF DISSERTATION

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The thesis measures the degree of market power and trade dominance in the world palm oil market. A new empirical industrial organization model is used to estimate the degree of market power exerted by both exporting and importing countries. Two testable models are developed: i. a leader-follower model (Stackelberg), and ii. a bilateral oligopoly model. A dominance test is also introduced to measure the degree of dominance in market power exertion. The Stackelberg results indicate that both exporting and importing countries exert market power in the world palm oil market. The empirical world market price variations is closer to the triopoly solution, meaning that the exporting countries realize stronger market power in the world market. The welfare effect of these market power exertions and policy implications for exporting countries' are analyzed. This thesis contributes to the formulation of a complete framework to analyze the exertion of market power on both supply and demand sides of the market sides, which is followed by a test on the degree of dominance to measure the strength of those market power impositions.

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Imperfect Competition in the World Market of Palm Oil

1. 1. Introduction

Imperfect competition commonly exists in agricultural commodity markets. Certain commodities are produced in certain countries due to natural conditions. Consumption is usually spread all over the world This situation enables a small number of countries to have large export shares in the world market. This large market share could cause a country to not behave as a price taker in the world market. In the world market of palm oil, there is a very limited number of producing countries. For decades, Indonesia and Malaysia have maintained large export shares. Both countries have shared about 50-80 percent of exports in the world palm oil market. Importing countries in the 1970s were concentrated on the European Union, the United States and Japan. The three of them have shared about 60 percent of palm oil imports.

Several previous studies have examined world palm oil and related vegetable oils. None of them, however, examine the possibility that those large trade shares may influence countries' trade behavior in the world market. Suryana (1986) studied the world demand for fats and oils to observe the prospect of palm oil exports from Indonesia. He estimated a fats and oils demand system, using the AIDS (Almost Ideal Demand System) model, for Malaysia, Indonesia, the United States, European Union and

Japan. He found that demand elasticities vary among these trading countries, and there are complementary relationships between these fats and oils sources. In relation to Indonesia's palm oil, he found that exogenous changes in the European Union trade behavior affected Indonesia's palm oil exports more than other countries' trade behavior.

Sumartini (1990) estimated the Indonesian palm oil export supply function and the import demand function from the European Union during the period of 1968-1987. She found a high relationship between production and export of palm oil from Indonesia. Export, however, was not responsive to the changes in world price. She also found that import demand from the European Union was inelastic to its own price. Income and time trend positively influence palm oil demand from European Union.

Alwi (1997) studied the impact of trade liberalization on palm oil exports from Indonesia. He used the Static World Policy Simulation Model (SWOPSIM) developed by the USDA to observe the impact of trade liberalization on quantity and prices of vegetable oils, including palm oil export from Indonesia. He found that internal policies in trading countries still have a major effect on trade patterns in the world fats and oils markets.

Indonesia's palm oil industry was studied by Larson (1996) and Marks et.al. (1998). They investigated the impact of palm oil's export tariff on domestic welfare. They found that the export tariff, intended to protect consumers' welfare by keeping a low price for cooking oil, was not accomplishing the intended purpose. There has been success in stabilizing cooking oil prices, but the consumer's gain is small.

Those studies contribute significant information regarding the world fats and oils markets and Indonesia's palm oil industries. Suryana's and Alwi's studies related the world fats and oil market with Indonesia's palm oil exports and recognized that several trading countries such as Malaysia, Indonesia and the European Union maintain large trade shares. Sumartini's study provides further information on the European Union market. Their study however, did not specifically measure market power and market interactions between large trading countries. Sumartini estimated export supply and import demand independently. Therefore, she ignored the possibility of a simultaneous relationship between export supply and import demand on palm oil. Larson's and Marks' studies provided information on Indonesia's pricing policy on palm oil, but did not relate it to the world palm oil market.

This study adds a new dimension by recognizing that trade concentrations in several countries may affect the world market structure. The long export domination by Malaysia and Indonesia may influence their export behavior and affect the world palm oil market structure. On the import side, the European Union's domination of imports and the increased availability of other vegetable oils could also affect their buying power. This study conducts a hypothesis test on the possibility of market power imposition by both sides in the world market of palm oil. Then, a degree of dominance test is conducted to measure which side has the stronger influence on the world market price of palm oil.

1. 2. Problem Statement

Palm oil is the biggest vegetable oil traded in the world market. In 1997, world production of palm oil was 17.5 million tons, of which 12.2 million tons (70 percent) was traded. Palm oil export is also highly concentrated. The export market has been dominated by Malaysia and Indonesia. In 1997, Malaysia and Indonesia had 64 percent and 22 percent of total world exports, respectively. The import side is less concentrated. Until the seventies, import was dominated by European Union, the United States and Japan. These three importing countries shared about 65 percent of the total world imports. In the eighties, India and Pakistan shared about 22 percent of the total world imports. While the United States' and Japan's import were stagnant, India's and Pakistan's imports steadily increased. In the late 1980s, China joined the import market. The three countries' imports outweigh the United States and Japan. In fact, in 1997, China's palm oil import share was almost as large as the European Union's (Table 1). This trade composition indicates that those big trading countries may use their share to influence their trade behavior in the world market. In addition, governments in those big countries implement policy on palm oil or other vegetable oils.

Governments in those trading countries have various policies on vegetable oils, such as production subsidies, tariffs and quantitative restrictions. For example, Malaysia and Indonesia provide subsidies to increase palm oil production. An export tariff is applied in Malaysia to encourage export of high-valued palm oil product. Indonesia uses export tariff and quantity restrictions to secure a supply of palm oil for domestic consumption. The European Union applies support prices for rapeseed,

Table 1. World Palm Oil Production and Trade, Selected Years 1970-1997

Year	1970		1980		1990		1997	
	1000 ton	%	1000 ton	%	1000 ton	%	1000 ton	%
Production								
Malaysia	431	25	2,576	56	6,095	56	9,057	51
Indonesia	216	12	691	15	2,413	22	5,150	29
Nigeria	449	26	433	10	580	5	615	4
Others[1]	645	37	887	19	1,888	17	2,794	16
Total	*1,741*	*100*	*4,587*	*100*	*10,976*	*100*	*17,616*	*100*
Export								
Malaysia	400	43	2,260	61	5,949	69	7,747	63
Indonesia	159	18	511	14	1,163	14	2,982	25
Others[1]	364	39	904	25	1,480	17	1,530	12
Total	*923*	*100*	*3,675*	*100*	*8,592*	*100*	*12,259*	*100*
Import								
EU	486	53	792	22	1,556	18	2,038	17
USA	64	7	117	3	130	2	135	1
Japan	40	4	148	4	276	3	369	3
Australia	-	-	-	-	-	-	113	1
W. Europe	36	4	40	1	66	1	25	0
Eastern Eu.	-	-	101	3	202	2	208	2
Canada	12	1	20	0.5	16	0	8	0
China	-	-	57	1.5	1,133	13	1,860	15
India	-	-	534	15	668	8	1,465	12
Pakistan	2	0	249	7	683	8	1,120	9
Other Asian[2]	-	-	-	-	-	-	2,855	23
S. America[3]	-	-	-	-	-	-	314	3
African[4]	-	-	-	-	-	-	1,264	11
Others[1]	283	31	1,617	43	3,862	45	485	4
Total	*923*	*100*	*3,675*	*100*	*8,592*	*100*	*12,259*	*100*

[1] Data on individual country (1970-1993) is not available. For 1995 and 1997:
a. Other major producing countries (100-500 thousand tons) are: Nigeria, Ghana, Ivory Coast, Cameroon, and Papua N.G., Ecuador and Colombia
b. Other major exporting countries (100-300 thousand tons) are: Singapore, HongKong, Papua NG, and Ivory Coast

[2] Major countries (100-400 thousand tons) are Bangladesh, Myanmar, Iran, Iraq, Jordan, S. Korea, Saudi Arabia, Turkey and Yemen.

[3] Major country (about 100 thousand tons) is Mexico.

[4] Major countries (100 -400 thousand tons) are Egypt, Kenya, and S. Africa.

Source: Oil World Annual 1984, 1993 and 1998. The Oilworld, Hamburg sunflower, and soybeans, which are closely related to palm oil. The United States and Japan have price support policies on soybeans too. The higher the availability of these vegetable oil sources in the domestic market, the smaller the amount of palm oil which might be imported by those importing countries.

So, exporting countries with large export shares supported by their domestic policy can potentially control exports to maximize profits. Importing countries with their significant import share, coupled with a high availability of other vegetable oils, can potentially react to exporting countries' behavior. In addition, vegetable oil industries in developed countries are increasingly concentrated, while in developing countries imports are handled by state trading. Both sides then, have potential factors that can influence their trading behavior in the world market. Therefore, it would be interesting to examine whether those factors significantly influence their trading behavior and affect the world market structure. Findings will be very important for both Malaysia and Indonesia, since palm oil exports are important sources of export revenue in both countries.

1. 3. Objectives

To investigate the above market situations, this study has three objectives:

1. To examine factors that influence behavior in major trading countries in the world market for palm oil;

2. To conduct:

    a. hypothesis tests whether factors examined in (1) make those major trading countries capable of influencing the world market, i.e., whether those trading countries have market power;

    b. dominance tests to measure which trading country has stronger market power in the world market;

3. To analyze the welfare impact of the estimated market structures on the palm oil trade and its implications for exporting countries.

The first objective is accomplished by studying the domestic market situation for palm oil and other vegetable oils, including government policies in the large trading countries. The second objective is conducted by formulating models that allow a hypothesis test on a market power parameter. The estimated world prices from both sides then are used to find out which one is more dominant in influencing world price. A simulation on the estimated model by restricting the values of the market power parameter is conducted to observe price changes with and without assumptions of market power.

1.4. The Thesis

Following this introduction, Chapter 2 describes the world market situation by examining the vegetable oils market situation and government policies in each trading country. Chapter 3 reviews the relevant theories and examines various models used to analyze market power in previous studies. Chapter 4 describes model formulations.

Chapter 5 explains the empirical data used in the model, data sources, the econometric estimations and the methods used for welfare analysis. Chapter 6 presents results and interpretations of the triopoly and triopsony models and the possibility of market power imposition from other trading countries. Chapter 7 summarizes the empirical findings and discusses possible implications for exporting countries' policies.

CHAPTER 2

Palm Oil Market Situations and the Source of Market Power

This chapter describes the relationship of palm oil to other fats and oils, and government policies in major trading countries. It also provides an understanding of how vegetable oils are related to each other and how policies on palm oil and other vegetable oils in each trading country may affect the country's trade behavior. First, the chapter describes palm oil as part of the other vegetable oils. Second, it describes vegetable oil situations and government policies in major trading countries. Third, the chapter identifies potential sources of market power in the trading countries and their possible interactions in the world market.

2. 1. Palm Oil and other Vegetable Oils

In the world market, palm oil is included in the fats and oils group. Fats and oils consist of vegetable oils, fish oils and fats. These fats and oils are related to each other because they are used in combination for various purposes. Vegetable oils are the biggest component in fats and oils, contributing about 80 percent of the total fats and oils produced. Major sources of vegetable oils are soybean oil, palm oil, rapeseed oil, and sunflower oil. They alone supply about 60 percent of the total of fats and oils.

Soybean oil is the largest vegetable oil produced in the world followed by palm oil. Palm oil however is the biggest vegetable oil traded in the world market. In 1997, 17.6 million tons of palm oil were produced and 70 percent was traded in the world market. In the same year, 21 million tons of soybean oil was produced, but only 32 percent of it was traded. Thus, about 40 percent of the vegetable oil traded in the world is palm oil (Table 2). Sunflower oil is the third biggest vegetable oil traded, followed by rapeseed and coconut oil. While soybean, sunflower and rapeseed oil are commonly consumed in developed countries, palm oil and coconut oil are more common in developing countries. Other sources of fats and oils are tallow and grease, fish oil, and lard.

Vegetable oil consumption is classified into edible and non-edible (industrial) use. Edible use is mostly for cooking oil, margarine, salad oil, lard, coating and shortening. Industrial (non-edible) uses are for soap, fatty acids, animal feeds and other industrial products (paint, varnish, resin, plastic, lubricants) (USDA, 1998). Developing countries mostly use vegetable oil mostly for cooking oil. Developed countries use it mostly as an industrial input.

Vegetable oil consumption in the last two decades has increased steadily. In 1970, per capita consumption on average was 10.8 kilograms per capita per year. By 1990, it had increased by 50 percent, and, in 1997, consumption reached 17.2 kilograms per capita per year. The highest per capita consumption is in the developed countries. Countries with a high per capita consumption are the United States (47.3 kg), the European Union (43.7 kg) and Canada (42.5). Countries with the lowest per capita consumption are Bangladesh (5.0), the Philippines (5.9 kg), and Sudan (6.9 kg). Indonesia has a per capita consumption of 15.6 kilograms per year.

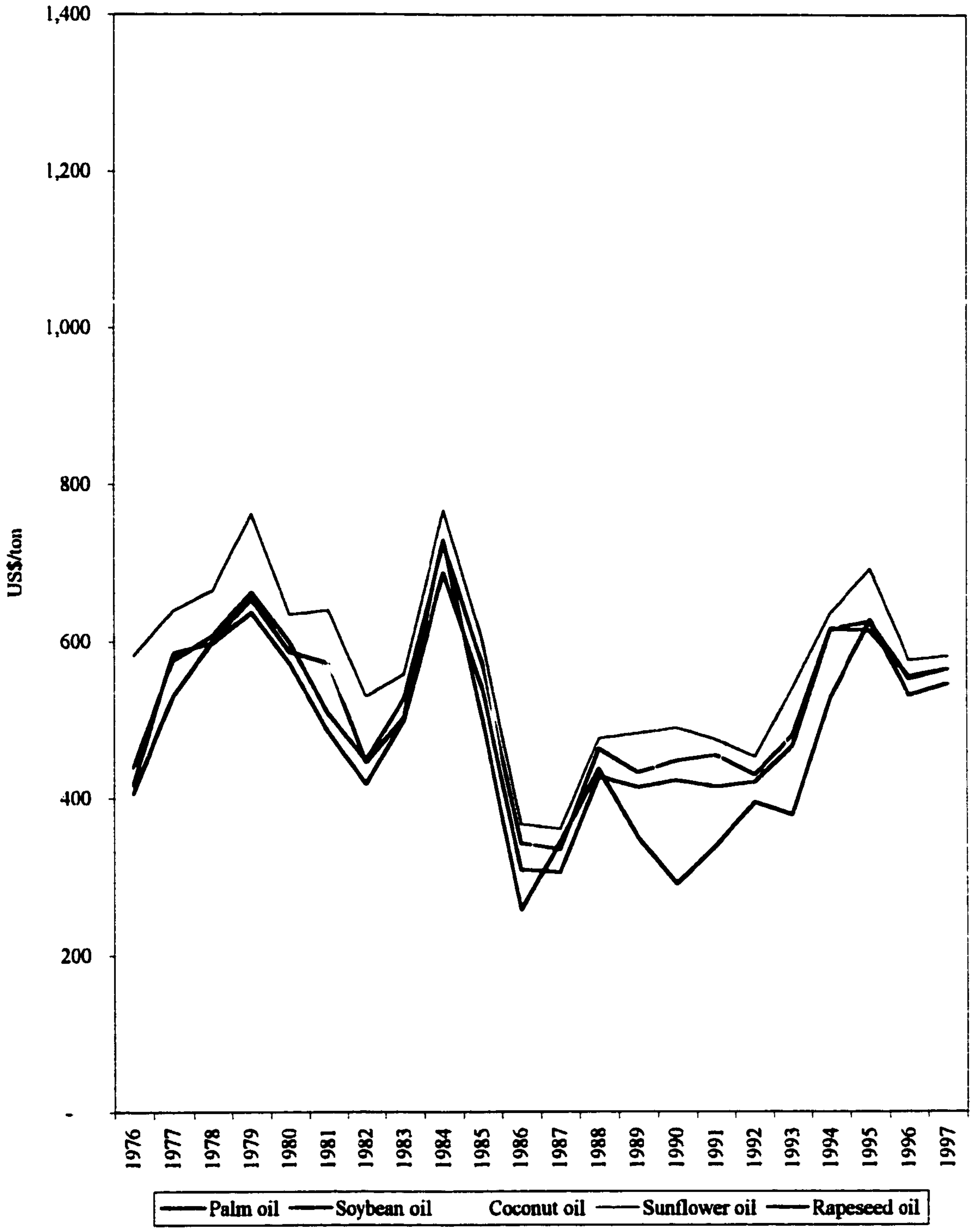
Table 2. World Fats and Oils Production and Trade, by Type of Oil, 1997

Fats and Oil	Production		Trade	
	1000 tons	%	1000 tons	%
Soybean oil	20,819	21	6,666	20
Palm oil	17,616	18	12,259	38
Rapeseed oil	11,832	12	1,808	5.5
Sunflower oil	9,315	9	3,133	10
Groundnut oil	4,208	4	238	1
Coconut oil	3,432	3	1,892	6
Others[1]	12,144	12	2,620	8
Total Vegetable oils	*79,366*	*79*	*28,616*	*88.5*
Butter as fat	5,703	6	619	2
Lard	6,186	6	142	0.5
Fish oil	1,131	1	740	2
Tallow and grease, and castor oil	7,941	8	2,241	7
Total Fats and Oils	*100,327*	*100*	*32,358*	*100*

Note: [1] Consists of sesame, corn, olive, lineseed and cottonseed oils. Each produces <2500 thousand tons.

Source : Oil World Annual 1998, The Oilworld, Hamburg.

There is a high degree of interdependence among the main source of vegetable oils. World prices of these major vegetable oils fluctuate very closely (Figure 1). Some of these vegetable oils are complements (Suryana, 1986 and Larson, 1996).



Source: Oil World Annual 1983, 1994 and 1998. The Oilworld, Hamburg

Figure 1. Vegetable Oil Prices in the European Union Market, 1976-1997

Relative price, physical and chemical properties of these vegetable oils are important factors that determined their substitutability (Griffith and Meilke, 1979). Perception of the relative health attributes of each oil is also an important factor in determining the market share for vegetable oils (Owen, 1996). The production pattern also influences consumption of vegetable oils in a country. Palm and coconut oils are mostly consumed in tropical countries, while soybean, rapeseed, and sunflower oil are mostly consumed in the four season countries.

Palm oil has a competing characteristic compared to other vegetable oils. It is the highest yielding vegetable oil crop per unit area. On average, a hectare of palm trees produces more than ten times the vegetable oils produced by soybeans (Bek-Nielsen, 1999). Palm oil is the main output of palm crushing industries (and so is coconut oil). Other vegetable oils, such as soybean, sunflower, and rapeseed, are by-products of meal production. Therefore, soybean oil and other vegetable oils productions are highly related to meal/feed demand, which is a derived demand of the beef and poultry market. Palm oil also is the richest source of natural vitamins such as vitamin A and E that possess a strong antioxidant, an important factor to counteract the formation of cancerous tumors. The drawback of palm oil is its high content of saturated fats (51 percent), second after coconut oil (77-92 percent). The percentage of saturated fats on other vegetable oils are: cottonseed oil, 27 percent; soybean oil, 15 percent; olive oil, 14 percent; peanut or corn oil, 13 percent; and sunflower oil, 11 percent (Buschena and Perloff, 1991).

The following paragraphs describe the patterns of production and consumption of these vegetable oils in major trading countries.

2. 2. Major Trading Countries and their Policies

Natural conditions limit palm oil production to the tropical countries. Other vegetable oil production sites are spread all over the world, except for olive oil, which is mostly produced in Italy. Palm oil production and exports are concentrated in Malaysia and Indonesia. About 80 percent of palm oil production is concentrated in Malaysia and Indonesia, and the remaining 20 percent is shared among Nigeria, Ghana, Ivory Coast, Cameroon, Papua New Guinea, Ecuador, and Colombia. Nearly 90 percent of palm exports are from Malaysia and Indonesia. Other exporting countries ship their palm oil in limited amounts.

Imports are less concentrated. The highest import share is held by the European Union, which has about 17 percent of total world import, followed by China, India, Pakistan, Japan, and the United States and several countries in Asia and Africa. In the 1970s, the United States, Japan and other European countries imported almost 70 percent of the total palm oil traded. Since the 1980s, only the European Union remains as the biggest importer. The United States and Japan imports have remained steady at about three percent. New importing countries such as China, India and Pakistan have become major importers of palm oil. Other new importing countries are Egypt, Kenya, South Africa, Bangladesh, Myanmar, Iran, Iraq, Jordan and Mexico (Table 1). The following section describes the vegetable oil situation and government policy in several major trading countries.

2. 2. 1. Producing and Exporting Countries

Indonesia. Palm oil sector is the most corporate-dominated agricultural industry in Indonesia. It is dominated by state-owned plantations. In the 1970s, state-plantations owned 65 percent of the total area and private plantations owned 35 percent. Production shares also about the same proportion. In 1979, the government introduced palm oil extensification program through the development of the nucleus-estate-smallholder (NES) program. In this program, a smallholder who is responsible for about 2-3 hectares of land, acts as fringe producer of the state plantations (Saragih, 1994). Smallholders are either local residents or people mostly from Java as part of government resettlement program (Sumartini, 1990).

In the 1980s, the success of this NES program was extended throughout Indonesia. Private investors were also invited to cost-share this program. The government provides an interest rate subsidy for private investors to build their estates and processing facilities. Development of plantations, infrastructures and settlement areas for smallholders are mostly funded by the government. Smallholders pay for part of their plantations after palm oil produces revenues (Department of Agriculture, 1985). This policy has contributed to increasing production from about 200 thousand tons in 1970 to more than 5 million tons in 1997. This increased production has satisfied the increasing consumption of vegetable oil and has contributed to non-oil exports. In 1997, almost 60 percent of palm oil produced was exported. The rest of the supply contributes about 70 percent of domestic vegetable oils use (Oil World Annual, 1998). Palm oil export is the second biggest provider of export revenue from the plantation sector, after natural rubber.

The composition of producers also changed after the government promoted private sector involvement in palm oil production. The NES program has increased the production share of private plantations from 30 percent in 1979 to 43 percent in 1997. Production by smallholders which is part of both state and private plantations also has increased from less than 1.0 percent to 24 percent over the same period. The state plantation production share declined from 68 percent to 33 percent (Department of Forestry and Plantations, 1998).

Palm oil marketing and trade are regulated. A ceiling price and quantity allocation is applied to ensure an adequate supply for the cooking oil industry. An export tariff is applied to make sure the cooking oil industry has enough supply to keep cooking oil prices low. A flat export tariff was introduced in 1974 and additional surcharges were frequently imposed when the domestic supply was low. In 1994, a differential tariff was introduced to increase the value added exports of palm oil. A higher tariff was imposed on less processed palm oil.

All palm oil produced by state plantations is marketed through a Joint Marketing Board set up by state plantations in the 1960s. Foreign-owned plantations are required to allocate part of their production to the domestic market and to the Joint Marketing Board. Domestically-owned plantations are not subject to domestic allocations and are not required to sell their product through the Joint Marketing Board. Most private plantations, however, own cooking oil plants. This integrated government policy has succeeded in stabilizing the domestic price for cooking oil (Larson, 1996).

Malaysia. Government involvement in the palm oil sector in Malaysia is as heavy as in Indonesia, but there are several differences. First, private plantations in Malaysia are relatively more active than Indonesia's private plantations. It was the private sector which initiated and set up a pool system, which is the origin of the Palm Oil Regulating and Licensing Authority (PORLA). The pool set a common selling price and allowed members to use ports owned by major palm oil companies (Kajisa et.al., 1997).

Second, the Malaysian government promotes the development of smallholder plantations independently from private plantations. There are three categories of plantations: a. large plantations; b. organized smallholders; and c. independent smallholders. Four smallholder organizations in Malaysia today are Federal Land Development Authority (FELDA), Federal Consolidation and Rehabilitation Authority (FELCRA), Rubber Industry Smallholder Development Authority (RISDA) and the State Economic Development Corporation (SEDC). Plantations of less than 42.5 hectares are considered independent smallholder lands (PORLA, 1998). In 1993, large plantations owned 47 percent of total palm oil areas, and organized smallholders and independent smallholders had 44.5 percent and 8.5 percent respectively (Samsudin and Abdillah, 1994).

Third, the government does not set producers' prices. In 1980, Malaysia established the Kuala Lumpur Commodity Exchange (KLCE) to facilitate palm oil trade.

Indirect government intervention is conducted through direct government participation in the market (Samsudin and Abdillah, 1994).

Fourth, government involvement in the palm oil trade in Malaysia is also more consolidated. The government, in cooperation with the private sector, provides an integrated institutional support in the area of R&D, production technology (seedling), information, a marketing network and financing to increase palm oil exports. In addition to privately-owned marketing and R&D institutions, there are 9 government sponsored institutions providing these supports (PORIM, 1998). Export taxes were established to encourage a higher added-value of palm oil exports. The export tax is higher for unprocessed (crude) palm oil and lower for processed palm oil products. Fully refined palm oil is exempted from the export tax. Financial incentives are given to invest in processing facilities and R&D. The government helps the private sector in promoting quality to satisfy the importing country's health standards. With these integrated supports, Malaysia attempts to export 80 percent of its produced palm oil to the world market. Recently, the government also established export credit arrangements to enable a large volume of palm oil to be contracted on a government-to-government trade basis. Recently, agreements were made between Malaysia and India, Pakistan, Egypt, Iran, Myanmar and the former Soviet Union (Othman, 1998). Technical cooperations on palm oil are also given to other countries in Nigeria, China, Vietnam, Thailand, Pakistan, India, Brazil, and Colombia. This technical cooperation is in the form of training, expertise/consultancy, feasibility studies and financial aid (Malaysia Palm Oil Promotion Council, 1998).

Nigeria. During the 1960s, Nigeria was the biggest palm oil producer in the world, long before Malaysia and Indonesia. Production was conduced by state-owned plantations, organized and individual (wild growers) smallholders. Individual smallholders covered an area of 2.4 million hectares, while the other two groups owned only about 0.2 million hectares. Most of the production and export of palm oil came from individual smallholders. The government controlled quality and marketing of palm oil from these smallholders by establishing state-owned pioneer mills and issuing marketing licenses (Lynam, 1972).

After the war in 1966, the palm oil sector was disrupted and neglected. Government rehabilitation started in the 1970s and nucleus-estate plantation development was introduced to increase palm oil production. To support this rehabilitation program, the government set minimum prices for annual seeds (groundnut, sesame seed and soybeans) and tree products (coconut and palm oil). Subsidized credit was also given to enhance production, especially for smallholders. Tax incentives, such as tax relief and free tariff on imported machineries, was offered to encourage private investment in palm oil. Majority rule of domestic ownership was changed to attract foreign investment in this sector. The government established the Nigerian Palm Producer Board which consists of large-scale plantations and a processing plant. The Nigerian Institute for Oil Palm Research was also established to improve production (FAO, 1984).

Exportation of palm oil and groundnut was prohibited to secure domestic consumption. Later, export was allowed, but it was organized by the Nigerian Palm

Producer Board. Imports on oilseeds, oils and oilmeal are not centralized through this board, but licenses are required. Those various policies have been sufficiently successful to supply enough vegetable oils for domestic consumption (Kajisa et. al., 1997).

2. 2. 2. Importing Countries

European Union. The European Union is the biggest producer and exporter of rapeseed and sunflower oils in the world. In 1997, the European Union's production of these two oils were 27 percent and 26 percent of world production. It's export share for rapeseed oil is 38 percent, while for sunflower oil it is 14 percent. Other domestic sources of vegetable oils are olive and soybean oils. These domestically-produced oils supply about 70 percent of domestic vegetable oil consumption. Another 30 percent of vegetable oil is imported. All domestically-produced and imported vegetable oils contribute about 50 percent of total fats and oils consumption. The rest of domestic use is supplied by butter (as fats), lard, tallow and grease (30 percent) and fish and castor oil (Oil World Annual, 1998).

The European Union provides a support policy on oilseeds to protect domestic producers from world price fluctuations. Target and basic intervention prices are set for rapeseed, sunflower, soybean, and linseed producers. An intervention price is fixed for a given standard quality of oilseeds to guarantee that producers can sell their products close to the target price. Payment of the intervention price is given through crushers to make sure that crushers obtain oilseeds at the world price.

Imports of oilseeds are duty free whereas vegetable oils are subject to tariff. The tariff rate for food uses is higher than the tariff for industrial uses. Tariffs on crude and refined fats and oils range from 4 -15 percent. The higher the processing level, the higher the import tariff. Several nontariff measures are applied too. To protect unfair competition from foreign producers and growers, a compensatory levy could be imposed if imports are in such quantities and under conditions that might seriously injure the community interest. Import also has to obey divergent national packaging and labeling regulations for processed vegetable oils (FAO, 1984).

With those production policies on oilseeds, growth in vegetable oils imports are kept low. In 1970, the amount of vegetable oil imported was 3.9 million tons or about 48 percent of the total domestic use. In 1997 it increased to 4.5 million tons which was only 27 percent of total domestic use. Palm oil's contribution, however, has increased. In 1970, palm oil contributed about 6 percent of the total domestic use. In 1997, it grew to 12 percent of total domestic use. Palm oil's share of imported oil is even bigger. In 1970, 12 percent of imported oil was palm oil. In 1997, this palm oil share had increased to 45.6 percent (Table 3).

The United States. The United States government heavily supports its oilseeds productions. Production of oilseeds such as soybean, sunflower, and rapeseed are subsidized by the government. The United States is the world's biggest soybean producer. Fifty percent of soybean is produced in the United States. Half of the soybean produced is exported and another half is crushed for soybean meal and oil, making this country the largest producer of those products. In 1997, 37 percent of the world's soybean oil was produced in the United States (USDA, 1997).

Table 3. Palm oil Import as Percentage of Total Fats and Oil Import and Use (1000 tons)

Year	Country					
	EU	US	Japan	China	India	Pakistan
1970						
Total Use	8,237	6,880	1,379	2,005	3,069	na
Total Import	3,964	465	340	24	196	na
Palm oil	486	64	40	-	-	na
%	*12.3*	*13.8*	*11.8*	-	-	-
1980						
Total Use	10,791	8,214	1,904	3,883	4,687	na
Total Import	5,550	693	418	383	1,411	na
Palm oil	792	117	148	57	534	249
%	*14.3*	*16.9*	*35.4*	*14.9*	*37.8*	-
1990						
Total Use	13,703	10,501	2,591	8,810	6,353	1,969
Total Import	3,435	1,140	567	2,405	735	1,150
Palm oil	1,318	130	276	1,133	668	683
%	*38.4*	*11.4*	*48.7*	*47.1*	*90.9*	*59.4*
1997						
Total Use	16,333	12,844	2,698	14,710	9,307	2,405
Total Import	4,467	1,714	713	4,868	2,025	1,450
Palm oil	2,038	135	369	1,860	1,465	1,120
%	*45.6*	*7.9*	*51.7*	*38.2*	*72.3*	*77.2*

Source: Oil World Annual 1984, 1993, and 1998. The Oilworld, Hamburg

In 1997, the United States produced 7.4 million tons of soybean oil. Eighty-eight percent of this soybean oil is consumed domestically. Most fats and oils in the United States are used for salad or cooking oils (45 percent), baking and frying fats and margarine (40 percent) and other edible use (USDA, 1998). The United States is the second biggest exporter of soybean oil after Argentina.

On the export side, the United State subsidizes the export of oilseeds and vegetable oils. Under the current Farm Bill, vegetable oils continue to receive subsidies. Various export policy mechanisms are applied: the Export Enhancement Program (EEP), Export Credit Guarantee Program (GSM-102), Intermediate Export Credit Program (GSM-103) and also Foreign Market Development Program (FMDP). EEP is an export subsidy to make the United States commodity more competitive in the world market. Export credit provides credits for the importing country to buy the United States agricultural products. FMDP is a cost-share assistance to non-profit agricultural and trade organizations for market development activities to develop, maintain and expand long-term exports.

The United States does not impose any tariff on palm oil imports (USITC, 1983). The high availability of other vegetable oils, however, may limit the need to import palm oil from the world market. The United States intensive policy on oil crops has enabled the country to maintain palm oil imports at about 100-150 thousand tons per year. This palm oil import is about 8 percent of all imported vegetable oils (Table 3).

Japan. Domestic production of oilseeds is mainly limited to soybeans. Japan produces 145 thousand tons of soybeans and import 5 million tons, to meet its domestic need. In spite of this, the country is supporting domestic oilseed cultivation to retain farmers in rural areas. The standard prices for soybeans and rapeseed are fixed by the government to compensate the high production costs. Japan has a large and efficient crushing industry. They import oilseeds and crush them domestically (Oda, 1994). Therefore, import of vegetable oils can be kept low.

To protect their vegetable oil industry, the import of oilseed is free of tariff, but not for vegetable oils. In 1997, the import tariff on soybean oil was 20-28 Yen per kilogram, or about 14 percent of the current price (Oda, 1994). The import tariff on palm oil in 1995 was about 6-7 percent (Japan Agro Trade, 1995). For the last ten years, imports of palm oil also remained at about 300 thousand tons per year. This relatively low palm oil import however, contributes about 50 percent of the total import of vegetable oil to Japan (Table 3).

India. India is the biggest groundnut producer in the world. In the last five years, India produced on average about 5 million tons of groundnut per year. With this groundnut production, India can produce about 1.5-1.9 million tons of groundnut oil, which makes them the biggest groundnut oil producer in the world. Another source of domestic vegetable oils is rapeseed oil. India is the third biggest rapeseed and rapeseed oil producer after the European Union and China. These vegetable oil productions, however, are almost entirely consumed domestically. Domestically-produced vegetable oils in India supplies about 80 percent of the domestic use of fats and oils in 1997. Imported vegetable oil supply the rest of domestic requirement, and 72 percent of it was met by imported palm oil (Table 3).

India's edible oil imports have steadily increased over the last two decades. In 1970, imports of edible oil were only 200 thousand tons or about 0.6 percent of total domestic use. In 1980 imports jumped to 1.4 million tons or around 30 percent of total domestic use. Almost 40 percent of this imported vegetable oil is palm oil. Severe strain on foreign exchange reserves forced the government to establish an integrated policy on vegetable oils. To increase domestic production, the government provides price supports for groundnut, soybean, rapeseed, and sunflower seed. A State Trading Corporation (STC) was established to control vegetable oils imports. Import of all vegetable oils is done by the STC. The imported oil then is distributed at a price below the domestic price of other vegetable oils. Imported oils were sold at lower price to slow-down the increasing domestic price. This resale price, however, is still above the world price. STC also maintains a buffer stock of imported oil to stabilize the domestic price. In the 1970s, imported vegetable oils were free of tariff. In 1979/80, import licenses were given to the private sector. The government set an import tariff at 12.5 percent for private importers and 5 percent for STC. STC frequently also set quantity restrictions. Tariff rates are also changed frequently (FAO, 1984).

In 1986, the Technology Mission on Oilseed (TMO) was established to integrate government institutions, producers and industries in increasing oilseed production and reduce vegetable oil imports. TMO developed an integrated policy to provide price incentives, technology improvement and efficient supply of inputs and extension services. These efforts succeeded in lowering vegetable imports (Shenoi, 1994). Despite those efforts, vegetable oils imports continue to increase. In 1996, an equal import tariff for private importers and STC was set at 20 percent (USDA, 1997).

Pakistan. The most important sources of vegetable oils in Pakistan are cottonseed, rapeseed and mustard seed. Cottonseed contributes 82 percent of domestic source of oilseeds, while the rest is mostly supplied by rapeseed and sunflower seed. Cottonseed is a byproduct of fiber crops, therefore its supply response is more influenced by the cotton fiber market (Mahmood, 1996). In 1997, 2.4 million tons of cottonseed produced, yielded only 362 thousand tons of cottonseed oil. Rapeseed which only produced at 407 thousand provided 139 thousand tons of rapeseed oil. In total, domestically-produced vegetable oils only supply about 50 percent of domestic use fats and oils. This domestically-produced fats and oils supply only 42 percent of the domestic need, making Pakistan imports most of its vegetable oils for domestic consumption. About 75 percent of Pakistan's expenditure on food import, is on vegetable oil (Sharif, 1994).

In 1970, 28 percent of the vegetable oils consumed was imported. In 1990, import increased to 66 percent of the total vegetable oil consumption. This import mainly consists of palm and soybean oils. In 1997, palm oil was the biggest source of oils and supplied almost 50 percent of domestic use on vegetable oil. This palm oil import was 77 percent of the total vegetable oils imported (Oil World Annual, 1998).

Various policies are applied to increase domestic production. The government implements support prices to increase the diversity of vegetable oil sources. Support prices are provided for cottonseed, sunflower, soybean and safflower. The Ghee

Corporation of Pakistan (GCP) has a role in domestic sunflower marketing, but the private sector is free to buy from farmers too. Most non-conventional oilseeds such as sunflower and safflower are sold to GCP. Cottonseed is sold to crushing units which then sell their oil to processing industries. Sunflower oil is refined and marketed as cooking oil by GCP and other private processors. Rapeseed is sold to an expeller and its oil is sold to wholesalers and retailers directly. Imported oils are used as input for ghee and cooking oil industries. GCP also distributes seeds (Sharif, 1994).

Domestic production of vegetable oils remain stagnant, while consumption increases steadily due to growth in population and per capita income. As a result, in the last five years, import of palm oil totalled more than one million tons per year (Table 3).

China. The major sources of vegetable oils in China are rapeseed, groundnut, soybean, and cottonseed oil. These four oils contribute 90 percent of the total domestic vegetable oil supply, or 63 percent of the domestic fat and oil supplies in 1997. The total domestic fat and oil production provides 74 percent of all domestic use (Oil World Annual, 1998).

In the last two years, oilseed production has been declining. In 1996, China became a net importer of oilseed for the first time. The most common oilseed imported was soybean (USDA, 1997). This declining was the result of agricultural reform in China. After the economic reform in 1978, the agricultural sector underwent a major transition from communal farming to household farming. The production quota for commodities was reduced and the support price was increased. Higher support price cannot restore the previous production level, because the market price in the production area is higher than the target price (Carter et.al, 1996). In 1997, import of soybean oil was twice that import in 1994. Imports of palm oil, which is the second biggest imported vegetable oil, also increase continuously.

All oilseed and vegetable oil imports except olive oil and coconut oil are controlled by the government. Importers have to get approval from the government. Besides the China Cereal Oil and Foodstuff Company, there are limited number of licensed trading agents and processing companies. Foreign-owned and joint ventures can have licenses to import soybeans directly, provided that they are all processed at their plant. The soybean import tariff is set at 3 percent, soybean meal at 5 percent and soybean oils at 13 percent. An import quota is set for soybean oil imports but not for the soybean and its meal (USDA, 1998).

Concentrations of palm oil production and various government policies in both exporting and importing countries as described above are potential factors in creating market power. How those factors may produce selling and buying power is discussed in the following section.

2. 3. Potential Sources of Market Power

Market power is the ability to influence market outcome. More specifically, it is defined as the ability to control quantity and therefore influence prices (Lerner, 1934). One indicator of market power is the size of the importer or exporter relative to market size. Size alone however is not sufficient evidence of market power. A monopoly (monopsony) must have the control necessary to alter supply (demand) by its own action, so that competitors cannot offset it.

Exercise of market power by sellers or buyers could influence market structure. There are two types of market structure intrinsic and derived market structures. An intrinsic market structure is caused by a variable that is completely determined by the nature of the product or available technology for production or marketing. A derived market structure is a market structure derived from or as a reflection of government policy or business strategy (Schmalensee, 1982).

The ability of a seller to control supply could be in the form of a storage mechanism, possession of superior information, participation in many markets, or control over channels in the marketing system. Quantity control also exists when a country can influence the market through domestic policies (under a large country assumption) such as: export tariff, import tariff or planned economic system. Multinationals could also have market power due to their size, access to many markets or their superior information over a domestic firm or even the host country. In terms of size, a multinational is relatively much bigger than local companies. Therefore, relatively it has more potential market power than a local company. Superior information and access to more than one market (countries) can also make multinationals capable of taking advantage of price differences across countries. They operate in several markets or countries through their subsidiaries, which local companies do not have. In many cases, multinationals are also associated with vertical integrations (McCalla and Josling, 1981). In the case of palm oil, processing firms or users of palm oil in importing countries are interested in having trading agents or even palm oil plantations in producing countries to obtain a cheaper and more continuous supply of inputs. Existence of such multinationals then could reduce the potential selling power that exporting countries or companies in exporting countries can have if they are all locally-owned.

Kolstad and Burris (1989) suggest that:

> *"government policy could serve to coordinate consumers or producers so that they may jointly exercise power in the international market. Thus, the international market would be expected to operate as any oligopsony/oligopoly with countries as the participant" (p.28).*

Using the above definitions, market power maybe exercised in the world market of palm oil. The intrinsic structure variable is the nature of palm oil. Palm oil grows only in tropical countries. Therefore, exporters of palm oil are concentrated in tropical countries such as Malaysia and Indonesia. In addition, there are derived variables that also support the existence of market power. Government policy in each trading country potentially contributes to generating market power that may influence market structure. The use of an export tariff in both Malaysia and Indonesia may contribute to the capability of the country to control their supply to the world market. The policy may not be intended to control quantity to generate market power, but the impact on the market can be the same.

Concentrations of palm oil users on the buyers' side also exist. In the European Union, for example, fat and oil processing industries (crushing and refineries) consist of 140 production units. Eighty percent of the capacity however, belongs to five multinational companies, namely ADM, Cargill, Unilever, Cereol and Vandemortele

(Cogels, 1999). In the United States, the number of companies on vegetable oils decreases steadily. Industrial census in 1992 found that four largest companies (CR-4) have 35 percent and 37 percent of the total value of shipments in edible fats and oils and animal and marine fats industries. In vegetable oil mills, soybean oil mills, and cottonseed mills the CR-4 are at 89 percent, 71 percent and 62 percent respectively (U.S. Bureau of the Census, 1992).

These small number of companies may have the potential to control their import of palm oil from the world market. Government supports on palm oil substitutes increase the availability of other vegetable oils. Increasing health concerns in the developed countries can reduce the demand for palm oil. All those factors can increase the use of palm oil substitutes and further reduce the need to use palm oil. The use of state-trading and import licensing in importing countries can also generate buying power.

The above factors can be classified into two levels of potential factors for market power: firm and country levels. At the firm level, the creation of organized smallholders in the exporting countries reduces the number of palm oil producers into a fewer units of palm oil producers. In importing countries, the increased concentration of companies as palm oil users may also generate their buying power. With this potential firms' market power, various government policies add further effects that unite and strengthen those few firms with potential market power to have a concerted market power at the country level, as suggested by Kolstad and Burris (1989). So, from both firm and national levels, and from both exporting and importing countries, there is potential market power that might be exercised in the world market.

The above potential market power, however, needs to be examined in the actual situation. To examine whether this potential market power is exercised in the market, and whether the market power imposition significantly changes the market outcome, several models to investigate whether the world palm oil market is in imperfect competition are formulated and tested using empirical data.

The next chapter elaborates theory and empirical models that can be used to conduct this study. Based on these theory and empirical studies, estimated models are formulated so that hypotheses can be tested.

CHAPTER 3

Theory and Literature Review

This chapter reviews the theoretical background and previous studies on imperfectly competitive markets. This chapter is divided into two parts. The first part explores the theory on oligopoly/oligopsony and various models used for empirical studies. The second part reviews the econometric theory and models used in the empirical studies. These two parts are the bases for the model formulation and econometric estimations done on the world market for palm oil.

3. 1. The Oligopoly-Oligopsony Theory

An oligopoly market exists when there are an unlimited number of buyers with few sellers in the market. Each seller then has a market share that makes them capable of affecting market prices. In an oligopoly market, sellers face a downward-sloping demand function. The more they sell to the market, the lower the market price. Taking this into consideration, the seller then tries to control the quantity of sale to maximize its own profit. When one seller limits its sale, this seller may not get its expected price because other sellers may react to this seller's action to get a higher profit. Therefore each seller is not free to act without taking into account competitors' actions.

There are two models of the oligopoly/oligopsony market: the Cournot model and the conjectural variations model. In the Cournot model, sellers know that their actions can affect market price, but they ignore reaction of other sellers. Each seller then maximizes his own profit by equating his marginal revenue to the market price. Under conjectural variations model, sellers know that their action can affect market price and other sellers' output. In this model there is an interdependence among sellers and it is the key to market solutions. Stackelberg model is a conjectural variations model with the assumptions that only the leader who recognized other sellers reactions.

3. 1. 1. Cournot Model

In the Cournot model each seller recognizes that its own output decisions affects market price, but that any seller's output decision does not affect those of other firms. That is to say, each firm recognizes that $\partial P/\partial qi \neq 0$, but assumes that $\partial qj/\partial qi = 0$ for all $j \neq i$. Using this assumption, the first-order conditions for maximum profit in the Cournot model are:

$$\frac{\partial \pi_i}{\partial q_i} = P + q_i \frac{\partial P}{\partial q_i} - MC_i(q_i) = 0 \qquad \text{for all } i = 1, \ldots\ldots n.$$

This first order condition shows that the seller assumes that changes in q_t affects its total revenue only through their direct effect on the market price of its own sale. When there are n sellers, then there n of the above equations. These n equations and the market demand will result in an equilibrium solution for market price and quantity sold from each seller.

3. 1. 2. Stackelberg Model

The Stackelberg model assumes that the market consists of a single price leader and a group of followers. In the Stackelberg model, there is one seller that has a significant market share. This seller also has a lower marginal cost to supply the product due to its size, so that it can dominate the market. Other sellers do not have enough market share to react to this dominant seller. This dominant seller acts as a leader in the market, and the rest of the sellers follow the market price set by the leader. The leader controls its quantity supplied to get the selling price that maximizes its profit, and followers supply the responding quantity.

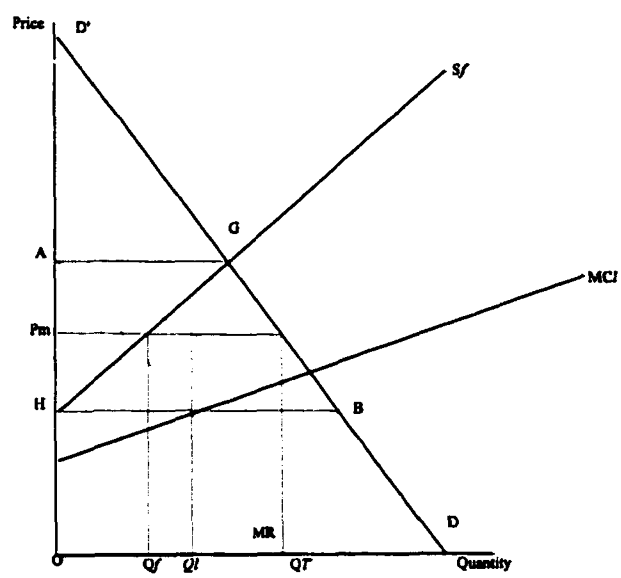


Figure 2. Stackelberg Model (Duopoly)

In Figure 2, both follower and leader face a total demand function *DD'*. The follower's supply function is represented by *Sf.* With this supply function, at the price above *A*, the whole market is served by the follower. When the market price is below *H*, however, the follower will not be able to supply, and so the whole market supply comes from the leader. When market price is between *HA*, both will supply to the market.

The market equilibrium is solved by finding the excess demand faced by the leader (*ABD*), where this leader is capable of limiting its supply to maximize profit. To maximize profit, the leader controls its supply at the level that equates its marginal cost (*MCl)* and marginal revenue (*MR*). The prevailing market price set by the leader is *Pm,* which becomes the market price. At his price the leader supplies at *OQl* and the followers supply at *OQf.* The total quantity traded in the market is *OQT =OQf + OQl.*

3. 1. 3. Conjectural Variations Model

In this model each seller acts to control its own selling and at the same time react to other sellers action to maximize its profit. The Cournot and Stackelberg models are the conjectural variations model under certain assumptions. The Cournot model assume that a seller's output level does not affect other sellers' output levels. There is no conjecture in Cournot model. Stackelberg model recognizes both the sellers' influence on market prices and other sellers (conjectures), but the conjectures is limited to the leader. Thus, the leader reacts to other sellers output but the followers take the market price set by the leader.

In conjectural variations, every seller is assumed to have power to take action and react to other sellers' actions. Under this model, we want to examine how firm *i*'s decisions might affect those of seller j. For each seller i, we are concerned with the assumed value of the derivative of $\partial qj/\partial qi$ for all sellers j other than seller i itself. Because the value of its derivative will be varied, models based on various assumptions about the value are termed conjectural variations models (Nicholson, 1995). The first order conditions for maximum profit is slightly different than the Cournot above, and it is:

$$\frac{\partial \pi_i}{\partial q_i} = P + q_i \left[\frac{\partial P}{\partial Q}\frac{\partial Q}{\partial q_i} + \sum \frac{\partial P}{\partial Q}\frac{\partial Q}{\partial q_j} * \frac{\partial q_j}{\partial q_i}\right] - MC_i(q_i) = 0$$

This shows that a seller is not only concerned with how its own output affects market price directly, but also considers how variations in its own output will affect the market price through their effect on other seller's output decisions. The above first order condition is usually simplified into:

$$\frac{\partial \pi_i}{\partial q_i} = P + q_i \frac{\partial P}{\partial Q}[1 + \gamma_i] - MC_i(q_i) = 0$$

$$where\ \gamma_i = \frac{\partial}{\partial q_i}\left(\sum q_k\right) \qquad for\quad k \neq i$$

If all $\gamma_i = 0$, the solution is as in Cournot model. If at least one of $\gamma_i \neq 0$ while others are equal to zero, this means that at least one seller is concerned with other sellers' behavior.

Iwata (1974) measured the conjectural coefficient among glass industries in Japan. He formulated the following equation by taking the second derivative of the profit maximization equation (above) and regressed it to get the measure of conjectural variation parameters.

$$\gamma_i = \alpha \frac{c_i - p}{p} \frac{D}{q_i} - 1$$

where: α is the price elasticity of demand, c_i is marginal cost of the *ith* firm, p is the market price, D is the total demand, and q_i is quantity from the *ith* firm.

Gollop and Roberts (1979) improved Iwata's formulation to separate the conjecture of each firm with other firms. Iwata lumped all conjectural variations of *ith* firm as γ_i. Gollop and Roberts developed a model that is capable of identifying the pattern of conjectural variations across firms in an oligopoly industry.

An oligopsony market is the opposite situation of the oligopoly market. In an oligopsony market, few buyers face an infinite number of sellers. The quantity buyers acquire will affect market price. The bigger the quantity of purchase, the higher the market price. A buyer in oligopsony markets then faces an upward-sloping supply function. Therefore, the buyer tries to limit its purchase to obtain the price that will maximize its profit. When a buyer limits its purchase however, other buyers may react to increase their purchases so the market price will not be at the level the first buyer expected. There is no specific model developed for oligopsony, so the oligopsony model is adapted from the oligopoly model and solutions.

3. 1. 4. Bilateral Monopoly Theory

The above market situations observe imperfect competition on one side of the market while assuming the other side is perfectly competitive. When a single buyer meets a single seller in the market, the market is under a bilateral monopoly situation.

A monopolist does not have an output supply function relating price and quantity. He selects a point on his buyers' demand function that maximizes his profit. Similarly, a monopsonist does not have an input demand function. He selects a point on his sellers' supply function that maximizes his profit. There are several possible market solutions for the bilateral monopoly model, as shown in Figure 3.

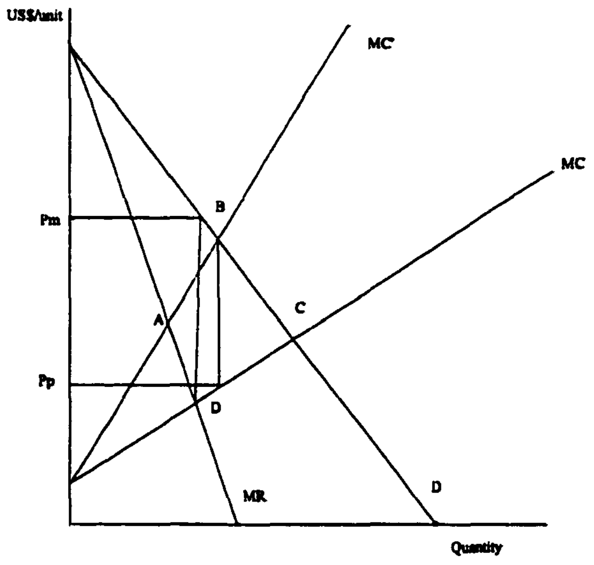


Figure 3. Bilateral Monopoly Model

The first solution is the equilibrium point at A. This solution exists when monopolist and monopsonist cooperate to maximize joint profit (Bowley, 1928).

Cournot, however, argues that because of the different pricing from seller's profit maximization and buyer's profit maximization, the solution is undetermined. The monopolist offers price at *Pm* and the monopsonist asks price at *Pp*, and the market mechanism may break down resulting in no trades taking place at all.

The bilateral oligopoly model is an extension of bilateral monopoly; it represents the oligopoly-oligopsony relationship (Fellner, 1949). This relationship exists in agriculture as well as in the manufacturing sector. A high concentration in industries buying their materials from agriculture implies oligopsony power in the purchase of raw material as well as oligopoly power in the sale of finished goods. One example is when a leading tobacco firms or meat packers as a group are capable of influencing prices of the materials they buy.

3. 1. 5. Empirical Studies

Empirical studies dealing with oligopoly, oligopsony and bilateral monopoly are numerous. Most researchers realize that the world is full of imperfect competition due to supply concentrations, demand concentrations and/or government regulations. Two study approaches are recognized in the study of market imperfections: the new empirical industrial organization and game theoretic approaches.

3. 1. 5. 1. New Empirical Industrial Organization (NEIO) Approach

A testable model for non-competitive behavior was developed by Appelbaum (1979) to distinguish between price-taking behavior (competitive market) and non-price-taking behavior (non-competitive market). This model estimates the demand faced by the industry and the industry marginal cost of production to calculate the monopoly mark-up and demand elasticity and then calculates the market power parameter. Appelbaum used input cost data to estimate industry marginal cost. Most of the time data and information on input costs are not available to researchers. To solve this problem, Lau (1982) estimated the marginal cost using the industry output data observed from the market. His model required a non-linear demand function to enable the model to identify the market power parameter (λ). Bresnahan (1982) improved Lau's model by adding a multiplicative variable in the linear demand function, so that when the demand curve shifts, the model can distinguish between a perfect competitive solution and a monopoly solution.

Buschena and Perloff (1991) applied Lau's and Bresnahan's approaches on the Stackelberg model to study the Philippines' coconut oil exports. They argued that the Philippines acts as an export leader in the coconut oil market while the rest of the exporting countries (Malaysia, Indonesia, Sri Lanka, Papua New Guinea and Ivory Coast) act as followers. Their system of equations consists of world export demand, competitive fringe exports, the Philippines' exports and the Philippines' marginal cost of producing and exporting coconut oil. This system is simultaneously estimated to obtain the magnitude of the market power parameter.

Love and Murniningtyas (1992) applied this industrial organization approach to determine whether the Japanese Food Agency (JFA) exerts its market power in importing wheat from the world market and reselling wheat in the domestic market. They developed import demand and domestic selling functions for JFA to test whether this JFA has monopsony buying power in the world market, and at the same time has monopoly power in reselling wheat in the domestic market. They found that JFA acts as a monopsonist in importing wheat, but did not behave as a monopolist in the domestic market.

Lopez and You (1993) used the same approach to study Haitian coffee exports, which are concentrated among few exporters and involved a high export tax. They found the oligopsony market and government export has reduced production and exports. The deadweight loss created by the export tax is higher than that created by oligopsony in the absence of an export tax.

Azzam (1996) provided an empirical framework for the bilateral oligopoly model. When one conducts a test on the selling power of a downstream industry and buying power of the upstream industry and concludes that both exist, then the question is which market power is stronger. He introduced a model to test the dominance of the oligopoly power exerted by packers and oligopsony power exercised by the retail-grocery stores. The study did not reject the hypothesis that both sellers and retail-grocery stores equally have market power, so neither one of them completely dominates the market.

3. 1. 5. 2. Game Theoretic Approach

The application of game theory to study oligopoly behavior was made by Karp and McCalla (1983). They argued that previous studies had concentrated only on the seller's side. Researchers then cannot study the interaction between buyers and sellers and the possibility of change in market power balanced between buyers and sellers. Using game theory, the researchers were able to analyze various scenarios, for example, by having more trading countries (as well as fewer); to examine how change in exogenous variables such as weather, taxes, and subsidies can affect market power and behavior (reaction) of the participating countries; and to know whether the results from static analysis hold in the dynamic model. They then applied this model to the world corn market.

They analyzed four games, with the United State as the seller and the European Union and Japan as the buyers. In the first game, the three countries all exercise market power. In the second only the United States and the European Union play the game (bilateral monopoly). In the third, the European Union sets import tariffs and acts as a monopsonist, while the United States and Japan act competitively. In the last game, only the United States plays the game and acts as a monopolist. Two of the important findings are: 1. The static game may approximate the long run stationary equilibrium, and the dynamic game models short and medium term effects; and 2. The game approach is a complement rather than a substitute for other models.

Karp and Perloff (1989) used the same model to study the world rice market. He argued that the central agency trading for rice exports from Thailand, China and Pakistan makes these countries are capable of acting as oligopolists in the world market. Koontz, Garcia and Hudson (1993) used game theory to examine the oligopsony power of meat-packers in feed-cattle markets.

3. 1. 5. 3. Recent Studies

The two approaches are still used in various empirical studies. For example, Deodhar and Sheldon (1997) used the industrial organization approach to test market power in the world soymeal export market. They found that Argentina, Brazil and the

United States did not exert market power in their soymeal exports. Arnade, Pick and Gopinath (1998) used this industrial organization approach to test oligopoly power exerted by processing industries in both domestic and export markets. They argued that the United States poultry, rice milling, meat and cigarette processors have selling power in both domestic and export markets. Their study found that the coefficient of selling power in meat processing and rice milling is higher than in the other two industries, and that oligopoly power in the domestic market is stronger than in the export market.

Corts (1999) critized the use of the NEIO approach. He argued that comparing equilibrium variations resulting from the estimated supply function with its price-cost margin can create confusion between an increase in marginal cost and an increase in the price-cost margin. Corts then also said that this problem can be corrected by using one of three methods: a. assuming a constant marginal cost to disentangle between increasing cost and increasing price-cost margin in Iwata's (1974); b. by including shifters of demand elasticity (Bresnahan 1982 and Lau 1982); and c. by permitting supply shocks or multiple pricing regimes (Potter, 1983). Having those three approaches to eliminate the first problem, does not eliminate the second problem. Corts argued that if the underlying behavior is not the result of a conjectural variations equilibrium, the estimated conduct parameter underestimates the degree of market power. If demand shocks are completely transitory, the NEIO may fail to detect any market power even if average price-cost margins are near the monopoly level.

Genesove and Mullin (1998), however, pointed out that one may test the estimates obtained from the NEIO approach if one has an alternate measure of conduct cost with which the NEIO can be compared. Their study was exactly trying to compare both approaches on the United States sugarcane refining industry. They measured the conduct parameter using the NEIO approach and direct measure of industry's cost function on the Unites States sugarcane industry. They found that the estimated conduct parameter from the NEIO model was close to one from the direct cost function approach, insensitive to demand function specification, and it underestimated the conduct parameter, but the deviation was minimal. The advantage of using the NEIO is that it provides a better estimate on the value of the conduct parameter.

The game theory approach also continues to be used in studying imperfect competitive markets. Karp and Perloff (1996) applied game theory to study the oligopoly power in the rice and coffee world markets. The institutional arrangement of the coffee exporters through the International Coffee Association suggests that exporters exercise their selling power. Similar issues arise in the world rice market. Government trading agencies which control rice exports from Thailand, China and Pakistan enable them to act as leaders in an oligopoly market with the United States as the competitive fringe exporter. Koontz and Garcia (1997) extended their game theoretical approach from their previous study to examine the oligopsony behavior of meat packers in cross-geographic feed-cattle markets (multiple markets). Erickson (1997) used game theory to examine dynamic conjectural variations of cereal competitors when advertising is used as a marketing strategy. He then used the model to examine reactions of rivals and impacts on firm sales and profits.

3. 2. Econometric Theory

3. 2. 1. Panel Data Models

Panel data refers to data sets that combined time series and cross sections. Time series data is a set of data collected over long period of time on a single unit. Cross section data contains a set of observations on thousands of individuals, families or countries, each observed at one point in time. When these two types of data are combined, it provides a rich source of information about the economy. Combined data possess several major advantages over time series or cross-sectional data sets.

First, they provides a large number of data points, increasing the degrees of freedom and reducing the collinearity among explanatory variables. Improvement of efficiency of the econometric estimates is the advantage. Second, longitudinal data allows researchers to analyze a number of important economic questions that cannot be addressed using time series or cross-sectional data alone. Cross sectional data allow researchers to observe the difference between various numbers of distinct groups in the society. Time series data allow researchers to see the dynamics of change over time. Therefore, the combination of these two type of data sets will allow researchers to observe the difference of groups in the society over time. The third advantage is technical. Panel data allow us to construct and test more complicated behavioral models than purely cross-sectional or time series data. The use of panel data also provides a means of resolving or reducing the problem of omitted or unobserved variables that are correlated with explanatory variables. By utilizing information on both the inter-temporal dynamics and the individuality of the entities being investigated, one is better able to control in a more natural way for effects of missing or unobserved variables (Hsiao, 1986). There are two basic frameworks used to generalize this model: the fixed effects model and the random effects model.

The Fixed Effects Model. This approach takes the value of an intercept to be a group specific constant term in the regression model. The differences across units or groups can be captured in the shift of the function due to different values on the constant term (intercept). The usual approach to this effect then is the use of a dummy variable or fixed effect model or least square dummy variable (LSDV) model. A typical equation to represent this model is:

$$y_{it} = \alpha_i + \beta' x_{it} + \mu_{it}$$

i = 1, ..., N the number of cross sectional units,

t = 1, ..., T the number of time series.

β' is a usual (1 x K) vector of constants on K exogenous variables. α_t is a (1x1) scalar constant representing the effect of *ith* individual cross section, which is assumed to be constant over time. This is a parameter on the dummy variable placed on the intercept to capture individual unit differences. The error term, μ_{it}, represents the omitted variables related to both individual units and time periods.

The fixed effects model is a reasonable approach when we can be confident that the differences between units can be viewed as parametric shifts of the regression function. This model might be viewed as applying only to the cross sectional units in the study, not to additional ones outside the sample. For example, an intercountry comparison may well include the full set of countries from which it is reasonable to assume that the model is constant. In other settings, it may be more appropriate to view individual specific constant terms as randomly distributed across sectional units. This would be appropriate if we believed that sampled cross-sectional units were drawn from a large population.

Random Effects Model. The random effects approach specifies that differences between groups are not only reflected in the intercept but also in the slope of explanatory variables. In a standard regression analysis, it is assumed that a large number of factors that affect the value of the dependent variable have not been explicitly included as independent variables, and this is summarized in the random disturbances. In a panel, numerous individual units are observed over time. Therefore some of the omitted variables represent factors peculiar to individual units, some represent factors that are similar across individual units but vary over time, and some represent both the individual units and time periods for which observations are obtained. Thus, the random disturbances, v_{it}, are assumed to consist of three components: an intercept that constant over time (α_i); a slope that is constant across individual but varies overtime (w_t); and a residual that varies both across individual and over time (μ_{it}). Thus, distinct representation of a random error model is presented as the following.

$$y_{it} = \alpha + \sum_{j=1}^{k} \beta_j x_{jit} + v_{it}$$

$$\textit{where } v_{it} = \alpha_i + w_t + \mu_{it}$$

Ordinary least squares is not appropriate in the presence of the three components in the residuals, because the residuals across individuals are correlated with each other due to the existence of w_t, and residuals across time are correlated to each other due to the existence of a_i. The suggested approach suitable for estimating the parameters for a random effects model is the error component model (ECM). The ECM is a generalized least squares method using the variance-covariance matrix of the residuals (V^{-1}) as a weight to obtain a best linear unbiased estimate of the parameters.

$$\delta_{GLS} = \frac{[\sum_{i=1}^{N} X_i \, V^{-1} \, y_i]}{[\sum_{i=1}^{N} X_i \, V^{-1} \, X_i]}$$

Hsiao (1986) stated, when w_t is assumed = 0 for all t, V^{-1} can be defined as:

$$V^{-1} = \frac{1}{\sigma_\mu^2} [I_T - \frac{\sigma_\alpha^2}{\sigma_\mu^2 + T\sigma_\alpha^2} ee']$$

where:

$$\sigma_\mu^2 = \frac{\sum_{i=1}^{N} \sum_{t=1}^{T} [(y_{it} - y_i) - \beta_{cv} (x_{it} - x_i)]^2}{N(T - 1) - K}$$

$$\sigma_\alpha^2 = \frac{\sum_{i=1}^{N} (y_i - \mu \beta x_i)^2}{N - (K + 1)}$$

From the above component of variances, when the number of individual units (N) is less than the number of parameters to be estimated (K), σ^2_α cannot be estimated, and so the ECM cannot be applied.

3. 2. 2. Simultaneous Panel Data

A simultaneous equation with panel data is similar to a regular simultaneous equations on time series data. The difference is that in time series data, for each time series we have one individual item of data. In the panel data, in each time series there are *N* individual units of data. Therefore, a panel consists of *N* individual units along *T* time series will create *NT* cross-time series of data. Using this framework, a pure time series is a panel data with one individual unit, and cross section data is a panel data with a single time series.

The structure of panel data influences the data arrangement in simultaneous equations. In regular time series, the data is arranged with *T* rows and *K* columns, where $k=1,....K$ is the number of independent variables. With *G* structural equations then a simultaneous panel data can be represented as:

$$\underset{GNT \times 1}{y} = \underset{GNT \times [\Sigma(K_G+1)]}{W} \; \underset{[\Sigma(K_G+1)] \times 1}{\theta} + \underset{GNT \times 1}{v}$$

where: $\underset{1 \times GNT}{y = (y'_1, ...y'_G)'}$; $\underset{1 \times GNT}{v = (v'_1, ... v'_G)'}$;

$$W = \underset{GNT \times [\Sigma(K_G+1)]}{\begin{matrix} W_1 & 0 & 0 \\ 0 & W_2 & 0 \\ 0 & 0 & W_G \end{matrix}} \qquad \text{and } \underset{1 \times [\Sigma(K_G+1)]}{\theta' = (\theta_1, \ldots, \theta_G)}$$

As in the single equation, the regular two and three-stage least square (2SLS and 3SLS) application on panel data also need to be adjusted by the variance-covariance matrix of the residuals.

Extended application of the ECM for simultaneous equations is elaborated by Baltagi (1981). In his paper he showed that error component two-stage least square (EC2SLS) is a weighted average of between groups, between periods and within groups of 2SLS estimators. He also demonstrated that error component three-state least square (EC3SLS) is also a weighted average between groups, between periods and within groups of 3SLS estimators. EC3SLS will reduce to EC2SLS when the variance and covariance matrix of error components is a block diagonal and every equation is just identified. If the variance covariance matrix of error component is a block diagonal but every equation is not exactly identified, EC3SLS does not reduce to EC2SLS, because EC2SLS does not take into account restrictions across structural equations in the system. Therefore, application of EC3SLS will always have a better performance than the EC2SLS.

The above method assumes that error components are independent of the right hand side variable. Therefore, the instruments used for the estimations above are the same for the whole system. Cornwell, Schmidt and Wyhowski (1992) developed a method for use when variables are correlated with statistical noise and individual effects. They define a doubly exogenous variable if it is uncorrelated with statistical noise and individual effects in the model. It is termed a singly exogenous variable if it is uncorrelated with the noise but correlated with individual effect. Then based on these correlations, the method suggests whether to use the same or different instruments across equations.

Kinal and Lahiri (1993) thought that application of Cornwell's procedures is complicated especially if the data is very limited. They then simplify the EC3SLS procedure through data arrangement to transform the data. Transformed data then are used to calculate variance-covariance of the error component, which then is used to apply the ECM. The important advantage of their transformation is that it guarantees uncorrelation between instruments and the errors in each equations. They later applied this procedure to estimate export and import equations for 31 developing countries.

Vickner and Davies (1999) applied the Kinal and Lahiri method to estimate market power and pricing conduct in the United States spaghetti industry. Supply and demand functions for five types of spaghetti sauce are estimated using AIDS model. Their study combined the application of NEIO based on a panel of scanner sales data on 10 local markets. The model then is simultaneously estimated using the ECM.

The above is an ideal example of panel data estimations. In some cases, the ECM model may not be applicable when data is limited. While Pesaran and Smith (1995) suggest abandoning the pooled approach in the case of individual heterogeneity, Baltagi and Griffin (1997) compared the empirical performance of both estimators. They estimated the demand for gasoline in 13 OECD countries over 30 year periods, and then compared the results. Their results justify the use of pooled estimators, because the heterogenous models for individual countries tend to produce less plausible estimates which are inferior to the overall forecast performance. They argue that pooled estimators outperform the heterogeneous estimators because there is an efficiency gain from pooling that can offset biases due to inter country heterogeneity. They conclude, however, that this result is limited to the cases they studied and may not apply on general cases.

3. 3. Transportation Cost

The spatial competition model provides reference for transportation cost. Two assumptions are necessary to treat spatial effects (Waterson, 1984). First is that transport is supplied at non-trivial cost t per unit of distance (x). Thus delivered price, Pd, is related to mill price, Pm, as follows :

$$Pd = Pm + xt.$$

Secondly, there are scale economies or increasing returns in the supply of the product, at least initially. The simplest relation is:

$$C = F + cq$$

where C is total cost, F is fixed cost and c is variable cost of transportation. If there is no assumption of increasing returns, firms would produce at the point where consumers are located. Given C as above, however, the number of firm will be limited by the necessity to remain profitable. Customers buy from the firm with the lowest delivered price. This implies that consumers are concerned about delivered price that contains the transportation cost in it, and firms are concerned about the net price of the transportation cost.

Having considered the above theories and various approaches, this study formulates models to examine the trade behavior of both exporting and importing countries. The first formulated model is based on the Stackelberg model by assuming that Malaysia and the European Union are leading countries in the world palm oil market. In the triopoly model, Malaysia is assumed as the leading exporter facing rest-of-world importing countries as price takers. In the triopsony model the European Union is assumed as the leading importing country facing rest-of-world exporting countries as price takers. These two results then are put together to test their degree of dominance using a framework developed by Azzam (1996). The empirical triopoly model developed by Buschena and Perloff (1991) and applied by Chengula (1997) is used in the model formulations. The triopsony model is an adaptation of those models.

The bilateral oligopoly model consists of an oligopoly model and an oligopsony model. In the oligopoly it is assumed that every exporting country has some market power and faces importing countries as price takers. Therefore, every country's pricing behavior is similar to the leading trading country in the Stackelberg model. In the oligopsony model every importing country is assumed to have some market power facing passive exporting countries. The buying price equation for each importing country is similar to the buying price equation of the leader in the triopsony model. Resulting equilibrium price equations from these 6 trading countries then are put together to measure their degree of dominance.

Despite the weaknesses of the NEIO model, this study used it to formulate the hypothesis models because it's the only model capable of measuring the magnitude of market power (Hyde and Perloff, 1995). It would be complete if this study can compare results of both NEIO and other approaches as Genesove and Mullin (1998) did. The available data, however, does not permit the study to do such an exercise. This study also does not pursue the game theory approach to the situation. As Karp and McCalla (1983) pointed out that game theory is a complement of other approaches, therefore, the choice of method will not reduce the usefulness of findings from this study.

In the world market of vegetable oils, this study is the first attempt to recognize and explicitly measure the market power of trading countries. This study also improves on Azzam's dominance test by measuring elasticities and slopes based on an oligopoly market situation, instead of just using estimated values from other studies which may come from different specifications.

Based on the above arguments, a classical pooling of panel data of trading countries is used in the estimations. A dummy variable to measure effects of individual characteristics is used. Another approach to recognizing individual characteristics by distinguishing slopes of some important independent variables in an equations is also applied. These two attempts are expected to compensate for the inapplicability of the ECM in this study. Detailed discussions and procedures on model formulations and the econometric estimations are presented in the next chapters.

CHAPTER 4

The World Palm Oil Market Models

This chapter describes model formulations for the world palm oil market. It is divided into two parts. The first part explains the grouping of trading countries, which are done due to data availability and to simplify the system of equations. The second part explains the model formulations.

Two types of market imperfection models used to test market power: 1. Stackelberg (leader-follower) model; and 2. bilateral oligopoly model. The Stackelberg model consists of a triopoly and a triopsony models (Chart 1). The triopoly model is used to test whether Malaysia as the biggest exporter acts as leading exporter in the world market. The triopsony model is used to test whether European Union as the biggest importer acts as a leader. Price equations resulted from these two models then are used to test the degree of dominance to determine whether Malaysia or European who has a stronger power in the world market.

The bilateral oligopoly model consists of an oligopoly model and an oligopsony model (Chart 2). In the oligopoly model exporting countries are assumed to have some market power, while importing countries are price takers. In the oligopsony model importing countries are assumed to have some buying power, while exporting countries are price takers.

Triopoly

A. Trading countries:
Leader: Malaysia (l)
Followers: Indonesia, rowex (j)
Importers: EU, rowed, rowing (i) are price takers (passive buyers).

B. System of equation

1. *World demand function:*
Members: EU, rowed, rowing
$q^d_{it} = f(Pw, Z_1)$

2. *Fringe Supply function*
Members: Indonesia and rowex
$q^s_{jt} = f(Pw, Z_2)$

3. *Equilibrium price function when Malay. as a Leading Exporter*
[redacted]

4. *Trade balance*

Sum q^d_i = sum $q^s_j + q^s_l$ = Q total trade

Triopsony

C. Trading countries:
Leader: EU (l)
Followers: Rowed and rowing (i)
Importers: Malay, Indo, rowex (j) are price takers (passive sellers).

D. System of equation

1. *World Supply function*
Members: Malay, Indo, rowex
$q^s_{jt} = f(Pw, Z_4)$

2. *Fringe Demand function*
Rowed and rowing
$q^d_{it} = f(Pw, Z_5)$

3. *Equilibrium price function when EU as a Leading importer*
[redacted]

4. *Trade balance*

Sum q^s_j = sum $q^d_i + q^d_l$ = Q total trade

Dominance test:

$$Pw = a_1 * P^m w + (1 - a_1) * P^{eu} w$$

Z_n where n = 1,....6, are independent variables in each equation.
F^m and F^{eu} are market power parameter for Malaysia and EU, respectively.

Chart 1. Empirical Framework for the Stackelberg Model

Oligopoly

E. Trading countries:

Passive buyers: EU, rowed, rowing (i)
Sellers with market power: Malaysia, Indonesia and rowex

F. System of equation

1. World demand:

Members: EU, rowed, rowing

$q^d_{it} = f(Pw, Z_7)$

2. Selling price equation for Malaysia

[redacted]

3. Selling price equation for Indonesia

[redacted]

4. Selling price equation for rowex

[redacted]

Trade balance

Sum $q^d_i = q^s_m + q^s_I + q^s_{wex} = Q$ total trade

Oligopsony

G. Trading countries:

Passive sellers: Malay., Indonesia, rowex (j)
Buyers with market power: EU, rowed and rowing.

H. System of equation

1. World Supply

Members: Malay, Indo, rowex

$q^s_{jt} = f(Pw, Z_9)$

2. Buying price equation from EU

[redacted]

3. Buying price equation from rowed

[redacted]

4. Buying price equation from rowing

[redacted]

Trade balance

Sum $q^s_j = q^d_{eu} + q^d_{wed} + q^d_{wing} = Q$ total trade

Dominance test:

$$Pw = a_1 * P^m w + a_2 * P^I w + a_3 * P^{wex} w + a_4 * P^{eu} w + a_5 * P^{wed} w + a_6 * P^{wing} w$$

$$a_1 + a_2 + a_3 + a_4 + a_5 + a_6 = 1$$

Z_n where n = 7,....10 are independent variables in each equation.

F^x where x = m, I, wex, eu, wed, wing, are market power parameter for Malaysia, Indonesia, *rowex*, European Union, *rowed*, and *rowing* respectively.

Chart 2. Empirical Framework for the Bilateral Oligopoly Model

Each of those four models consist of a system of equations and each of them is estimated as a simultaneous equation. The basic difference between Stackelberg and bilateral oligopoly model is, in the former only leading trading countries have the selling or the buying price equations. In the bilateral oligopoly model all exporting countries have the selling price equations and in the oligopsony model all importing countries have the buying price equations. These price equations, three selling equations from the oligopoly model and three buying price equations from the oligopsony model, are then used to test which trading country is the most dominant in the world market.

Detail description on the grouping of trading countries and on the model formulations are described in the following section.

4. 1. Trading Countries

Trading countries are put into six groups. Exporters are Malaysia, Indonesia and the rest-of-world exporting countries *(rowex)*. Importers are European Union, rest-of-world developed countries (*rowed)* and rest-of-world developing countries (*rowing*). Formation of these groups is necessary because the available statistics only record trade data from large trading countries. The rest of the countries either have non-continuous trade activities or have small trade volumes, and they are grouped as "others". Another reason is to simplify the system without losing trading countries' characteristics. Therefore, trading countries other than Malaysia, Indonesia and European Union are classified as rest-of-world. While on export side, rest-of-world has about 20 percent of trade share, on import side rest-of- world has 80 percent trade share. Putting rest-of-world on cxport side as one group is appropriate, but not on import side, because rest-of-world importer have larger trade share than European Union, even if every country has smaller trade share. In addition, observation on the data suggest two separate groups within the rest-of-world importers. Before the 1980s, developed countries such as United States and Japan had large market shares. After this period, developing countries such as India, China and Pakistan import palm oil more than those developed countries. These rest-of-world importers then are grouped as rest-of-world developed countries (*rowed*) and rest-of-world developing countries (*rowing*). Therefore, by putting them into different groups different country characteristics is better represented in the model.

Exporting countries. On the export side, Malaysia has the biggest export share, followed by Indonesia and *rowex*. Among these exporting countries, only Malaysia and Indonesia maintain intensive policies on the palm oil sector. Empirical data shows that Malaysia and Indonesia have relatively high ending stocks compared to other countries that may enable both countries to control their export behavior. In addition, the policy implemented in both countries could contribute to their control ability. In Malaysia, a high tax on crude palm oil to encourage domestic industries could be used as "intended means" to maintain control power. Indonesia could use domestic market to"dump" their palm oil surplus to control the export market. Based on these assumed behavior Malaysia and Indonesia can potentially impose selling power.

Importing countries. Import is less concentrated than export. European Union as the largest importer has 20 percent of import share. Before the 1980s, the United States, Canada and Japan (*rowed*) shared about 60 percent of palm oil import. After the

1980s, however, their position was taken over by China, India and Pakistan (*rowing*). Among these three groups, only European Union that maintains some level of palm oil stock. Imports of vegetable oil are taxed, but there is no information what is the level their import tariff. European Union has a price support policy on soybean, rapeseed and olive oil. The United States intensively supports soybean and other oilseed productions, such as flaxseed, sunflower and peanut. These two countries also have agreement on their rapeseed, sunflower and soybean policies (the Blair Agreement). Japan highly protects their soybean producers from world market fluctuations. The rest-of-world developing (*rowing*) countries maintain production and trade policies on palm oil and other vegetable oil substitutes to meet their increasing vegetable oil demand. China intensively maintains production policy on rapeseed and India has an integrated policy on vegetable oils. Policies on these palm oil substitutes increase the availability of vegetable oils and could affect their palm oil import. Therefore, it is assumed that their policy on vegetable oils enable importing countries to limit imports on palm oil and act as if they exercise buying power on the world market.

4. 2. Model Formulations

4. 2. 1. Stackelberg Models

Two models are developed, triopoly and triopsony models. The triopoly model is used to test whether Malaysia imposes market power and acts as a leader in exporting palm oil with Indonesia and *rowex* as followers. The triopsony system is used to test whether European Union exerts market power and acts a leader in importing palm oil with *rowed* and *rowing* as followers.

4. 2. 1. 1. Triopoly Model

In the world market, Malaysia as leading exporter and Indonesia and *rowex* as competitive fringes face the world demand from importers (Q^D). Importers' demand depends on world price: $Q^D = f(Pwpo)$. Quantity supplied by competitive fringe is $q^{fs} = f(Pwpo)$. The residual demand is met by supply from the leading exporters. Therefore, demand for leading exporter is $q^{ls} = Q^D - \sum q^{fs}$. As a leader, Malaysia maximizes profit (π_M) from buying palm oil from the domestic market and selling it to the world market. Given that $Pwpo(q^{ls})$ is their selling price in the world market, and C_M is their total cost of buying from the domestic market minus transportation cost (t), their profit function is:

$$\pi_M = Pwpo(q^{ls}) * q^{ls} - C_M(q^{ls}) - t * q^{ls}$$

The first term $[Pwpo(.) * q^{ls}]$, is the total revenue from palm oil export, where $Pwpo(q^{ls})$ is the inverse of residual demand function faced by Malaysia. Transportation cost is specified separately from the cost function to recognize that importing countries are concerned about price in their port of destination (*cif*) and exporting countries are concerned about price on port of source (*fob*). Another reason is to make the difference between marginal cost and price received by exporter is netted from transportation cost. So, any discrepancy between price received and marginal cost is the margin that is caused by the existence of market power.

The first order condition for maximum profit for Malaysia is:

$$\frac{\partial \pi_M}{\partial q^{ls}} = Pwpo + [\frac{\partial Pwpo(q^{ls})}{\partial q^{ls}}] * q^{l} - MC_M - t \equiv 0$$

Or,

$$Pwpo + [\frac{\partial Pwpo(q^{ls})}{\partial q^{ls}}] * q^{l} = MC_M + t \equiv 0$$

This first order condition states that Malaysia's marginal revenue from palm oil export is equal to its marginal cost of exporting palm oil. It is assumed that Malaysia's export influences the world market, so that the market price (selling price) is higher than its marginal cost of export. Malaysia can collect a leader's markup $[(\partial Pwpo/\partial q^{ls})*q^{ls}]$ because Malaysia faces a downward sloping demand function ($\partial Pwpo/\partial q^{ls} < 0$). The world market price as a result of Malaysia selling power then is:

$$Pwpo - t = MC_M - \lambda_M * [\frac{\partial Pwpo(q^{ls})}{\partial q^{ls}}] * q^{ls} \qquad [4.1]$$

Parameter λ_M is added to measure the significance of the leadership markup collected by Malaysia. A statistical test is conducted to check whether this markup creates an equilibrium price that is different than a perfect competitive price.

To estimate the market power parameter the residual demand function faced by Malaysia and the marginal cost of palm oil export function need to be specified. The residual demand faced by Malaysia is the world demand function subtracted by the supply function from fringe exporting countries. Therefore, world demand, fringe supply, and Malaysia's marginal cost functions need to be need to be specified.

World demand function. The world demand for palm oil (q_i^D) from three importers (i) is estimated as a function of price of palm oil in the world market *(Pwpo)*, prices of soybean oil (*Pwso*) and animal oil (*Panim*) as substitutes, and income in the importing countries (Y_i).

$$q^D_{it} = a_0 + a_1 * Pwpo_t + a_2 * Pwso_t + a_3 * Panim_t + a_4 * (Pwpo_t * T) + a_5 * Y_{it} \qquad [4.2]$$

Parameter on own price is expected to have a positive sign. As a palm oil substitute, parameters on soybean and animal oils prices are expected to be positive. As a normal good, parameter on income is expected to positive too. A multiplicative variable *(Pwpo*T)* suggested by Bresnahan (1982) is used to identify the market power parameter. Time trend *(T)* is used to represent changes in taste and health awareness that influence consumption of vegetable oils.

Supply function from the followers. Export supply from the competitive fringe (q^{fs}_{jt}) is estimated as a function of prices of palm oil (*Pwpo*), coconut oil (*Pwco*) as the substitutes, exchange rate (X_{jt}), interest rate (R_{jt}), stock (ST_{jt}) and income (Y_{jt}) in exporting countries. Subscript j indicates exporting countries.

Parameter on own price is expected to have a positive sign. Parameters on coconut oil is expected to be negative. When price of coconut oil increase, its export is expected to increase. Domestic market in exporting country will have less coconut oil.

This decrease availability of coconut oil will be fulfilled by palm oil. As a result, export supply of palm oil will decline. Exchange rate and interest rate are included in the excess supply function because these two variables are important factors for exporters. An increase in exchange rate (higher dollar value) will make: *i.* world market to be relatively more attractive than domestic market; and *ii.* export cost increases too. Impact on world will have a positive effect on export supply, while export cost will have the negative effect on export supply. The net effect depends on the strength of these two effects. Parameter on interest rate is expected to have a negative sign, because the higher the cost of export born by exporters, and the lower their capability to export palm oil.

$$q_{jt}^{fs} = b_o + b_1 * Pwpo_t + b_2 * Pwco_t + b_3 * X_{jt} + b_4 * R_{jt} + b_5 * Y_{jt} + b_6 * ST_{jt} \quad [4.\ 3]$$

Residual demand for the leader. Export demand faced by Malaysia as the leading exporting country is the residual demand $q^{ls} = \sum q_i^D - \sum q_j^{fs}$. By subtracting equation [4. 3] from [4. 2], we have the export demand faced by Malaysia as the leader.

$$q_t^{ls} = (a_0 - b_0) + (a_1 - b_1 + a_4 * T) * Pwpo_t + a_2 * Pwso_t + a_3 * Panim_t + a_5 * Y_{it}$$
$$- b_2 Pwco_t - b_3 * X_{jt} - b_4 * R_{jt} - b_5 * Y_{jt} - b_6 * ST_{jt}$$

The slope of the residual demand faced by Malaysia is:

$$\frac{\partial q^{ls}}{\partial Pwpo} = a_1 - b_1 + a_4 * T \qquad \text{or,}$$

$$\frac{\partial Pwpo}{\partial q^{ls}} = \frac{1}{a_1 - b_1 + a_4 * T} \qquad [4.\ 4]$$

Equation [4. 4] measures the changes in the world price caused by marginal changes in palm oil export from Malaysia.

Export cost function for the leader. Malaysia's marginal export cost is estimated as a function of export quantity (q^{ls}), purchasing price in the domestic market ($Ppod_M$), exchange rate (X_M), wages (W_M), and ending stocks' of palm oil (ST_M). The higher purchasing price of palm oil, the more expensive exports cost are. The higher the exchange rate and wage rate, the higher cost of export. Stock will also increase the cost borne by exporting country. The marginal cost function then is:

$$MC_{Mt} = c_0 + c_1 * q_t^{ls} + c_2 * Ppod_{Mt} + c_3 * X_{Mt} + c_4 * W_{Mt} + c_5 * ST_{Mt} \qquad [4.\ 5]$$

In order to obtain maximum profit, the selling price from Malaysia is found by inserting equations [4. 5] and [4. 4] into [4. 1]. The world market price when Malaysia acts as an export leader then is:

$$Pwpo_t = c_0 + c_{ls} * q_t^{ls} + c_2 * Ppod_{Mt} + c_3 * X_{Mt} + c_4 * W_{Mt} + c_5 * ST_{Mt} - \lambda_M \left[\frac{q_t^{ls}}{a_1 - b_1 + a_4 * T}\right] \qquad [4.\ 6]$$

Parameter λ_M represents the market power possessed by Malaysia as the leader. If $\lambda_M = 0$, then equation [4. 6] gives the first order condition for a competitive market, and it means that Malaysia does not have market power in the world market. A value of $\lambda_M > 0$ means that Malaysia acts as an export leader in the world palm oil market.

To find the estimates for λ_M, the measure of market power and other parameters, equations [4. 2], [4. 3], the identity of $\sum q_i^D = q^{ls} + \sum q_j^{fs}$ and [4. 6] are simultaneously estimated. A complete system of equation for the triopoly model is presented in Appendix 1.1.

4. 2. 1. 2. Triopsony Model

To formulate the triopsony model, the same procedures and specifications in the triopoly model are applied. In this model, it is assumed that Malaysia, Indonesia and *rowex* are price takers. Importers (i) are assumed to have buying power, with the European Union as the leader. *Rowed* and *rowing* are assumed to be followers.

As the leader in triopsony, European Union maximizes net import revenue (π_{EU}) by adjusting its purchases (q^{ld}) from exporting countries. Assuming that the domestic market in European Union is perfectly competitive, the price of palm oil in the European Union, $Pwpo^{EU}$, is the price received by traders from selling palm oil in the domestic market. Given that $Pwpo^{EU} * q^{ld}$ as the total revenue from selling palm oil in the domestic market and $(Pwpo^{W}(q^{ld}) * q^{ld} + t\, q^{ld})$ is the total cost of import, the net revenue function then is:

$$\pi_{EU} = Pwpo^{EU} * q^{ld} - Pwpo^{W}(q^{ld}) * q^{ld} - t * q^{ld}$$

The first order condition for the European Union profit maximization is:

$$\frac{\partial \pi_{EU}}{\partial q^{ld}} = Pwpo^{EU} - Pwpo^{W} - [\frac{\partial Pwpo^{W}(q^{l})}{\partial q^{ld}}] * q^{ld} - t \equiv 0$$

Therefore:

$$Pwpo^{EU} = Pwpo^{W} + \lambda_{EU} * [\frac{\partial Pwpo^{W}(q^{ld})}{\partial q^{ld}}] * q^{ld} + t \equiv 0$$

This first order condition for maximum profit requires that the European Union's marginal revenue from selling imported palm oil in the domestic market ($Pwpo^{EU}$) is equal to its marginal cost of importing it from the world market, $Pwpo^{W}$, plus transportation cost (t) and the leader's markup ($\partial Pwpo^{W} / \partial q^{ld}$)$*q^{ld}$.

The parameter λ_{EU} is added to enable a statistical test on the magnitude of this monopsony markup. If this parameter is statistically insignificant ($\lambda_{EU} = 0$), the European Union marginal revenue ($Pwpo^{EU}$) will be equal to its marginal cost or its buying price from the world market ($Pwpo^{W} + t$). If this parameter is statistically significant ($\lambda_{EU} > 0$), the buying price in the world market is lower than the marginal revenue from selling imported palm oil in the domestic market (equation 4. 7).

$$Pwpo^{W} + t = Pwpo^{EU} - \lambda_{EU} * [\frac{\partial Pwpo^{W}(q^{ld})}{\partial q^{ld}}] * q^{ld} \qquad [4.\ 7]$$

To estimate the market power (markup) parameter, we need to specify the inverse demand of palm oil in the European Union's domestic market and the residual supply function faced by European Union as leading importer. The residual demand is obtained from the world export supply function and import demand equation from followers.

World supply function. The world export supply of palm oil (q_j^S) is estimated as a function of world palm oil price *($Pwpo^w$)*, price of coconut oil ($Pwco^w$) as its substitute, stocks (ST_j) and income (Y_j). The excess supply function from exporting country is:

$$q_{jt}^{S} = d_o + d_1 * Pwpo_t^w + d_2 * Pwco_t^w + d_3 * (Pwpo_t^w * T) + d_4 * ST_{jt} + d_5 * Y_{jt} \qquad [4.8]$$

An increase in world price will increase palm oil supply from exporting countries. As palm oil substitute, the parameter on coconut oil price is expected to be negative. An increase in coconut oil price in the world market will increase its export. As a result, availability of coconut oil in the domestic market will decline. Domestic demand on palm oil is expected to increase, which will decrease export supply of palm oil in the world market. An increase in stock will cause an increase in the capability to export If palm oil is normal good, the parameter on income is expected to be negative. As income in exporting country increases, domestic demand on palm oil will increase and reduce its supply to the world market. The multiplicative variable is used to identify the difference between perfect competitive and triopsony solution when the excess supply function shifts.

Demand from the competitive fringe. Demand from the competitive fringe is estimated as a function of palm oil price ($Pwpo^w$), price of soybean oil as the substitute ($Pwso^w$), importing countries' income (Y_i) and stock level of palm oil *(ST_i)* and time trend *(T)* to represent change in taste and health awareness.

$$q_{it}^{fd} = e_0 + e_1 * Pwpo_t^w + e_2 * Pwso_t^w + e_3 * Y_{it} + e_4 * ST_{it} + e_5 * T \qquad [4.\ 9]$$

Parameter on own price is expected to be negative. As a palm oil substitute, parameter on soybean oil price should be positive. If palm oil is a normal good in importing countries, the parameter on income will be positive. An increase of palm oil stocks in importing country will reduce their need to import. So, the parameter on stocks is expected to be negative. Palm oil is known to have high content of saturated fat. As time elapses, health concern is expected to increase and palm oil consumption is expected to decrease.

Residual supply faced by the leader. The palm oil supply function faced by European Union as leading importer is a residual supply, $q^{ld} = \sum q_j^S - \sum q_i^{fd}$ or [4.8] - [4. 9].

$$q^{ld} = (d_0 - e_0) + (d_1 - e_1 + d_3 * T) * Pwpo_t^w + d_2 * Pwco_t^w + d_4 * ST_{jt} + d_5 * Y_{jt}$$
$$- e_2 * Pwso_t^w - e_3 * Y_{it} - e_4 * ST_{it} - e_5 * T$$

The slope of this residual supply faced by the leading importer is:

$$\frac{\partial q^{ld}}{\partial Pwpo^w} = d_1 - e_1 + d_3 * T \qquad \text{or,}$$

$$\frac{\partial Pwpo^w}{\partial q^{ld}} = \frac{1}{d_1 - e_1 + d_3 * T} \qquad [4.\ 10]$$

Equation [4. 10] measures the change in the world price of palm oil when there is a marginal changes in palm oil import from European Union.

Domestic selling price. Selling price in the domestic market is obtained from the inverse demand of palm oil in the domestic market. The European Union does not produce palm oil, so the import demand of palm oil is the total demand from the domestic market. Import demand of palm oil from European Union is estimated as a function of palm oil price in the European Union market *($Pwpo^{EU}$)*, price of soybean and animal oils *($Pwso_{(-1)}$ and Panim)* as palm oil substitutes, stocks (ST_{EU}) and income level (Y_{EU}). Lagged of soybean oil price *($Pwso_{(-1)}$)* is used to represent trade agreement/contract on soybean oil trade.

$$q^{Id}_t = f_0 + f_1 * Pwpo_t^{EU} + f_2 * Pwso_{(-1)}^{EU} + f_3 * Panim_t^{EU} + f_4 * ST_{EU,t} + f_5 * Y_{EU,t}$$

Rearranging the import demand of the European Union, we get the inverse demand function:

$$Pwpo_t^{EU} = [\frac{1}{f_1}] * [q_t^{Id} - f_0 - f_2 * Pwso_{(-1)}^{EU} - f_3 * Panim_t^{EU} - f_4 * ST_{EU,t} - f_5 * Y_{EU,t}]$$

To simplify, we can express the inverse demand equation as the following:

$$Pwpo_t^{EU} = g_0 + g_1 * q_t^{Id} + g_2 * Pwso_{(-1)}^{EU} + g_3 * Panim_t^{EU} \qquad [4.\ 11]$$
$$+ g_4 * ST_{EU,t} + g_5 * Y_{EU,t}$$

The first order condition for maximum profit in equation [4. 7] requires that the European Union's buying price is equal to its selling price minus the leader's markup. Substituting equations [4. 11] and [4. 10] into [4. 7], we have the complete form of market price equation when European Union acting as import leader. The resulting equation becomes the equation for the (buying) price asked by European Union when European Union is the import leader in the world market.

$$Pwpo_t^w = g_0 + g_1 * q_t^{Id} + g_2 Pwso_{(-1)}^{EU} + g_3 * Panim_t^{EU} + g_4 * ST_{EU,t} + g_5 * Y_{EU,t} - \lambda_{EU} * \left[\frac{q_t^{Id}}{d_1 - e_1 + d_3 * T}\right] \qquad [4.\ 12]$$

The value of $\lambda_{EU} = 0$, means that European Union does not have buying power in the world palm oil market. A value of $\lambda_{EU} = 1$ shows that European Union behave as a perfect monopsonist in palm oil import. A value of $0 < \lambda_{EU} < 1$ indicates that European Union imposes buying power less than a perfect monopsonist.

To obtain the estimate of the market power parameter, λ_{EU}, and other parameters in the structural equations, the system of equations that consist of [4. 8], [4. 9], the identity, $q^{Id} = \sum q_t^S - \sum q_t^{fd}$, and [4. 12] are estimated simultaneously. A complete system of equation for this triopsony model is summarized in Appendix 1.2.

4. 2. 1. 3. The Degree of Dominance

To test whether the actual world price is closer to the estimated selling price or to the estimated buying price, a dominance test used by Azzam (1996) is established,

$$Pwpo_t^w = \alpha * [4.6] + (1 - \alpha) * [4.12] \qquad [4.\ 13]$$

where [4. 6] is equilibrium price equation when Malaysia has selling power and [4. 12] is the equilibrium price equation when the European Union has buying power. A value of $\alpha = 0.5$ means that neither one is dominant. A value of α closer to one means that the market equilibrium is closer to the triopoly solution. The opposite result exist if the value of α closer to zero.

4. 2. 2. Bilateral Oligopoly Model

The bilateral oligopoly is adopted from the bilateral monopoly concept. In this bilateral oligopoly model, it is assumed that exporting countries have selling power in the world market. Traders in the exporting countries buy palm oil from the domestic market and sell it to the world market. It is assumed that they do not have buying power in the domestic market. Traders in the importing countries buy palm oil from the world market and sell it to domestic market. It is also assumed that traders do not have selling power in the domestic importing countries' market. These estimated behavior from both sides fits into a bilateral oligopoly situation.

To observe these assumed behaviors, two sub-systems of oligopoly models are developed: *i.* Oligopoly model to test whether exporters have selling power. In this model importing countries are passive buyers. *ii.* Oligopsony model to test whether importing countries have buying power. Under oligopsony model, exporters are assumed as passive sellers. As in Stackelberg model the two models then are put together to measure the degree of dominance in the world market. Transportation cost is treated as in the Stackelberg model. The difference between this bilateral oligopoly and the Stackelberg model is, in the Stackelberg model only Malaysia and European Union are the exporting countries that have influences in the world market. So, only these two countries have their price equations. In the oligopoly model all exporting countries have some market power. Therefore, Malaysia, Indonesia and *rowex* have their own selling price equations. Likewise, in the oligopsony model European Union, *rowed* and *rowing* have their own selling price equations.

4. 2. 2. 1. Oligopoly Model

This model conducts statistical tests whether in each exporting country's (j) have selling power in the world market. The intended result is to find selling price equations from each exporting country. In the market, the total quantity of palm oil traded (Q^s) in the world market comes from three exporting countries (j), so $Q^s = \sum q^s_j$. These available quantities are bought by three importing countries (i), so $Q^D = \sum q^d_i$. The market is assumed always clear, so that $Q^s = \sum q^s_j = Q^D = \sum q^d_i = Q$ the total world trade.

Profit maximization for exporting countries. Traders in exporting countries are assumed to have an objective to maximize profit (π_j) from exporting palm oil. *Pwpo* is their selling price in the world market. *Ppo* is their buying price from the domestic market. Q^S is the total quantity of palm oil exported to the world market. It is assumed that the difference of prices between two borders (ports) is just transportation cost (t), and the exporters' profit is equal to total sales at the port of destinations minus buying cost and transportation cost to the port of destination.

$$\pi_{jt} = Pwpo_t(Q) * q_{jt} - Ppo_{jt} * q_{jt} - t_{jt} * q_{jt}$$

Profit from exporting palm oil is maximized when marginal revenue is equal to marginal cost of trade.

$$\frac{\partial \pi_{jt}}{\partial q_{jt}} = Pwpo_t + [\frac{\partial Pwpo_t}{\partial Q}] * [\frac{\partial Q}{\partial q_{jt}}] * q_{jt} - Ppo_{jt} - t_{jt} \equiv 0$$

Marginal revenue for each exporting country is the selling price in the world market minus transportation cost plus the markup collected because they have some selling power. Their marginal cost is the buying price in the domestic country. Taking into account other exporting countries' reactions, the above first order condition becomes:

$$\frac{\partial \pi_{jt}}{\partial q_{jt}} = Pwpo_t + \frac{\partial Pwpo_t}{\partial Q} * (1 + \gamma_{jt}) * q_{jt} - Ppo_{jt} - t_{jt} \equiv 0$$

$$where\ \gamma_j = \frac{\partial}{\partial q_j}(\sum q_k) \quad for\ j, k \in exporting\ countries \quad k \neq j$$

Rearranging the above equation, we have a selling price in the port of destination minus transportation cost equal to the buying price in the domestic market minus the oligopoly markup.

$$Pwpo_t - t_{jt} = Ppo_{jt} - \delta_j^s \frac{\partial Pwpo_t}{\partial Q} * (1 + \gamma_{jt}) * q_{jt} \qquad [4.\ 14]$$

Parameter δ^s_j is added to test the significance of exporters' selling power in the world market. $Pwpo_t$ is the price in the world market and obtained from the world demand function. Ppo_{jt} is the buying price in the exporter's domestic market, and it is obtained from the inverse of export supply function from exporters' domestic markets. To estimate this market power parameter, the world demand and export supply functions from each exporting country needs to be specified.

Previously, the study intended to estimate conjectural variations endogenously in the system. The use of panel data however, complicated the model formulations. Therefore, to simplify the system, the conjectural variation coefficient is estimated outside the system

Estimation of the conjectural variation coefficients. Iwata (1974) measured the conjectural variation coefficient (γ) using the following equation:

$$\gamma_j = \alpha \frac{cj - p}{p} \frac{D}{q_j} - 1$$

where α is the price elasticity of demand, c_j is marginal cost of the *jth* firm and p is market price which is obtained from market demand function, D is total market demand and q_j is supply from the *jth* firm. Marginal cost (c_j) in this model is buying price in the exporting country's domestic market. Selling price (p) is price in the world market. Total demand (D) is the total quantity imported which is equal to the total supply of the three exporting countries. Elasticity of demand is estimated from the system demand of the three importing countries. A series of conjectural coefficients for each exporting country then are treated as variables in the oligopoly system.

World demand function. World demand of palm oil is a function of price of palm oil (*Pwpo*) and price of soybeans (*Pwso*) and animal oils (*Panim*) as palm oil substitutes, income (Y_i) and stock in the importing countries (ST_i).

$$q_{it}^{D} = h_0 + h_1 * Pwpo_t + h_2 * Pwso_t + h_3 * Panim_t + h_4 * (Pwpo_t * T) + h_5 * Y_{it} + h_6 * ST_{it} \qquad [4.\ 15a]$$

The slope of the demand function is:

$$\frac{\partial q^{D}}{\partial Pwpo} = h_1 + h_4 * T \quad \text{or,}$$

$$\frac{\partial Pwpo}{\partial q^{D}} = \frac{1}{h_1 + h_4 * T} \qquad [4.\ 15b]$$

Buying price from the domestic exporting countries' market. The buying price is obtained from the inverse export supply function in the exporting country's domestic market. Export supply (q_j) is estimated as a function of domestic price of palm oil (*Ppo*), price of coconut oil as a substitute (*Pwco*), level of income (Y_j), interest rate (R_j), stocks (ST_j) and wage (W_j).

$$q_{jt}^{S} = k_0 + k_1 * Ppo_{jt} + k_2 * Pwco_{jt} + k_3 * Y_{jt} + k_4 * R_{jt} + k_5 * ST_{jt} + k_6 * W_{jt}$$

The inverse export supply function then is:

$$Ppo_{jt} = \frac{1}{k_1} * (q_{jt}^{S} - k_0 - k_2 * Pwco_{jt} - k_3 * Y_{jt} - k_4 * R_{jt} - k_5 * ST_{jt} - k_6 * W_{jt})$$

To simplify, this inverse export supply can be expressed as:

$$Ppo_{jt} = l_0 + l_1\, q_{jt}^{S} + l_2 * Pwco_{jt} + l_3 * Y_{jt} + l_4 * R_{jt} + l_5 * ST_{jt} + l_6 * W_{jt} \qquad [4.\ 16]$$

The profit maximum selling price for each exporting country is formed by substituting equation [4. 16] and [4. 15b] into equation [4. 14]. The complete form of selling price equation then is:

$$Pwpo_t - t_{jt} = l_0 + l_1 * q_{jt} + l_2 * Pwco_{jt} + l_3 * Y_{jt} + l_4 * R_{jt} + l_5 * ST_{jt} + l_6 * W_{jt} - \delta_j * \frac{(1 + \gamma_{jt}) * q_{jt}}{h_1 + h_4 * T} \qquad [4.\ 17]$$

If exporting country has selling power, we expect that parameter l_l to be negative and δ_j to be positive. A negative value of l_l indicates that the more exporter sells in the world market, the lower world price of palm oil. Since the slope of the inverse demand in [4.15b] is negative, a positive value of δ_j means that exporters' selling price in the world market is higher than their buying price from their domestic market. To find the values of those parameters, the oligopoly system that consist of the world demand equation [4. 15a], three selling price equations as in [4. 17], and trade identity is estimated simultaneously. A summary of equations in this oligopoly model is presented in Appendix 1.3.

4. 2. 2. 2. Oligopsony Model

Importing countries do not directly regulate palm oil marketing in the domestic market. So, in this model it is assumed that the domestic markets in importing countries are perfectly competitive. To obtain the function for price asked by the importing countries, the same procedure in finding selling price from oligopolist is used. We start a with profit function for traders in importing countries.

Profit maximization for importing countries. Profit is defined as total revenue from selling imported palm oil in the domestic market ($Pwpo^i.q_i$) minus the cost of buying from the world market ($Pwpo^W(.) \cdot q_i$) and minus transportation costs (t^*q_i).

$$\pi_i = Pwpo_t^i * q_i - Pwpo^w(Q) * q_i - t_i * q_i$$

Exporting countries obtain maximum profit when marginal revenue from selling imported palm oil in the domestic market is equal to marginal cost of import. Marginal revenue of selling imported palm oil is equal to the selling price per unit of palm oil in the domestic market ($Pwpo^i$). Marginal cost of imported palm oil is equal to buying price ($Pwpo^W$) plus transportation cost per unit of weight (t). If traders from the importing countries have buying power, as assumed, the marginal cost of buying will be lower than the perfectly competitive buying price because they can collect a oligopsony markup in the amount of $[\partial Pwpo^W/\partial q_i]^*q_i$ as stated in the following condition for a maximum profit.

$$\frac{\partial \pi}{\partial q_i} = Pwpo_t^i - Pwpo_t^w - [\frac{\partial Pwpo^w}{\partial Q}][\frac{\partial Q}{q_i}] * q_i - t_i \equiv 0$$

Using Iwata's conjectural variations coefficient formula, we have:

$$\frac{\partial \pi}{\partial q_i} = Pwpo_t^i - Pwpo_t^w - \frac{\partial Pwpo^w}{\partial Q}[1 + \theta_i] * q_i - t_i \equiv 0$$

where θ_i is the conjectural variation of each importing country. The buying price equation when importers act as oligopolist is:

$$Pwpo_t^w + t_i = Pwpo_t^i - \lambda_i \frac{\partial Pwpo^w}{\partial Q}[1 + \theta_i] * q_i \qquad [4.18]$$

To measure the significance of this oligopsony markup, a market power parameter (λ_i) is introduced in the above equation. Since the slope of inverse export supply function is positive ($\partial Pwpo^W/\partial q_t > 0$), then when $\lambda_t > 0$, the buying price in the world market is lower than the selling price in the domestic importing country's market. A value of $\lambda_t = 0$ indicates a perfectly competitive market solution, so that the buying price in the world market = selling price in the domestic market. The parameter θ_t represents the impact of other sellers' exports when one exporter changes its export (conjectural variation). To simplify the estimation, this parameter is estimated outside the oligopsony system.

Estimation of the conjectural variation coefficient. A modification of Iwata's conjectural variation equation is used to obtain the buyer conjectural variations coefficients (θ_i), given as the following.

$$\theta_i = \beta \frac{r_i - c}{c} \frac{S}{q_i} - 1$$

where β is the price elasticity of supply, c is the marginal cost of import from the world market and r_i is marginal revenue (selling price) in the importing country's domestic market. S is the total supply in the market and q_i is import quantity of the *ith* country. Marginal cost (c) in this model is the buying price from the world market and r_i is the selling price in the importing country's domestic market. Total supply (S) is the total quantity traded which is also the total of three importing countries' demand. Elasticity of supply is estimated from the supply system of the three exporting countries. The series of conjectural coefficients for each importing country then are used as variables in the estimation of oligopsony model.

Excess supply function. Excess supply from exporting countries is estimated as a function of world price ($Pwpo^w$), price of a palm oil substitute ($Pwco^w$), interest rate in the exporting country (R_j), income (Y_j), level of palm oil stocks in the exporting country (ST_j) and wage rate (W_j).

$$q_{jt}^S = n_0 + n_1 * Pwpo_t^w + n_2 * Pwco_t^w + n_3 * (Pwpo_t^w * T) + n_4 * R_{jt} + n_5 * Y_{jt} + n_6 * ST_{jt} + n_7 * W_{jt} \qquad [4.19]$$

The slope of the world supply function is:

$$\frac{\partial q_{jt}^S}{\partial Pwpot^w} = n_1 + n_3 * T \qquad \text{or,}$$

$$\frac{\partial Pwpo_t^w}{\partial q_{jt}^S} = \frac{1}{n_1 + n_3 * T} \qquad [4.19a]$$

Domestic demand in importing countries. Selling price is obtained from the inverse demand function and it is estimated as a function of quantity (q_i^D), price of soybean ($Pwso^w$), sunflower ($Pwsfl^w$) and animal oils ($Panim^w$) as palm oil substitutes in the importing country's market, income (Y_i) and level of stocks in the importing country (ST_i).

$$
\begin{aligned}
Pwpo_t^t &= r_0 + r_1 * q_{it}^D + r_2 * Pwso_t^w + r_3 * Pwsfl_t^w \\
&\quad + r_4 * Panim_t^w + r_5 * Y_{it} + r_6 * ST_{it}
\end{aligned}
\qquad [4.20]
$$

The buying price equation when importers have buying power is formed by substituting equations [4. 20] and [4. 19b] into equation [4. 18].

$$
\begin{aligned}
Pwpo_t^w + t_{it} &= r_0 + r_1 * q_{it}^D + r_2 * Pwso_t^w + r_3 * Pwsfl_t^w \\
&+ r_4 * Panim_t^w + r_5 * Y_{it} + r_6 * ST_{it} - \lambda_i \\
&\quad + r_4 * Panim_t^w + r_5 * Y_{it} + r_6 * ST_{it} - \lambda_i \frac{[\ 1 + \theta_{it}] * q_{it}^D}{(n_1 + n_3 * T)}
\end{aligned}
\qquad [4.21]
$$

Therefore, there are three buying price equations for three importing country groups. To estimate the market power parameter and other the estimated parameters, a system consists of equations [4. 19], three equations as in [4. 21] and a trade identity is estimated simultaneously. A complete system of equation for this oligopsony model is summarized in Appendix 1. 4.

4. 2. 2. 3. The Degree of Dominance

In order to test whether the actual world price is closer to the estimated selling price or to the estimated buying price, a dominance test established by Azzam (1996) is used. Three estimated price equilibrium equations from the oligopoly model and three estimated price equilibrium from the oligopsony model are put into the following equation.

$$Pwpo_t^w = \sum \alpha_j * [4.17] + \sum \beta_i * [4.21]$$
$$\text{where} \quad \sum \alpha_j = 1 - \sum \beta_i \qquad [4.\ 22]$$

Equation [4. 22] is estimated as a single equation by restricting the value of the parameters obtained from the oligopoly and the oligopsony system to get the estimates for αj and βi, the measures of the degree of dominance.

In summary, the four (4) systems of estimated models are: *i.* triopoly; *ii.* triopsony; *iii.* oligopoly; and *iv.* oligopsony. Each system is estimated simultaneously. Estimated equilibrium price equations from the triopoly and the triopsony results then are used test which model is more dominant in the world market. That is to say, whether world price variations is closer to a duopoly or duopsony solution. Likewise, a degree of dominance test is also conducted between the oligopoly and the oligopsony solutions. The next chapter describes the econometric method and empirical data used in the estimations.

CHAPTER 5

The Econometric Estimation

This chapter consists of three parts. The first part elaborates steps and procedures to estimate the formulated models. The second part describes the data used and its sources. The third part explains the method used to analyze welfare impacts of the estimated models.

5. 1. The Econometric Estimation

There are four systems to be estimated simultaneously. Each consists of 6 (six) trading groups. Each system uses a combination of cross section and time series (panel) data. By pooling these trading countries together, the estimated system gains degrees of freedom but still retains individual trading countries' information. Therefore, the system gains efficiency in its estimation.

The main mathematical problem when dealing with panel data is the potentially biased estimation when using the random effects model. Previous applications seemed to indicate that the unbalanced nature of panel data was not a problem. Another potential problem was the statistical justification to have separate slopes for the leading country. To examine the first issue, the Chamberlain approach (Chamberlain, 1982) was investigated in some detail, but it was problematic because it requires a dataset with a large number of individual units.

Another method used to estimate this type of system is the Error Component Three-Stage-Least-Squares (EC3SLS). This EC3SLS allows the estimations to distinguish between information which differs across trading countries (individual effects) and across time (time effects). This method, however, requires that the number of individual cross-sections is greater than the number of estimated parameters. The limited number of trading countries in this analysis does not permit the model to be estimated using EC3SLS. Therefore, classical pooling is applied. The estimation, however, still gains in efficiency as compared to mean-group estimation, or regular time series, because the individual country's information is retained in the model (Baltagi and Griffin, 1997). This meant that the simultaneous equations model became a fixed effects model with simultaneity. The unbalanced number of units was not a problem to implement within the panel data structure. When the number of units across equations are not the same, simultaneity cannot be imposed easily in the model, so it is more of a challenge put them into a simultaneous equations framework. This study then combined simultaneity in a system of equations built with unbalanced panels. The ability to create separate slopes for the leader had been established by Cornwell, Schmidt and Sickles (1990), so this did not end up being as large an issue as anticipated. In their paper, they argue that one can have parameters that vary across units as long as the number of parameters is less than the number of time periods. So, for the Stackelberg model used in this thesis, there was in effect a supply equation with a different parameter for the leader.

In the triopoly model, the world demand function consists of pooled data from three trading countries, the European Union, *rowed* and *rowing*. Supply from the competitive fringe is a classical pooling of Indonesia and *rowex*. The selling price function from the leader is just an individual time series data on Malaysia. In the triopsony model, the world supply function consists of pooled data from Indonesia, *rowex* and Malaysia. The competitive fringe is a pooling of *rowed* and *rowing*. The European Union as leading importer is estimated as an individual time series. The data arrangement follows the work of Kinal and Lahiri (1997), which was recently applied by Chengula (1997).

In the oligopoly model, the world demand function is pooled data from all three importing countries. A different intercept to represent individual characteristics is introduced by using a dummy variable for the European Union. Dummy variables for two other importing countries are omitted because they are statistically insignificant and the model performed better without them. To estimate a selling price equation from different exporting countries, three exporting countries' data are pooled together. To obtain a different selling price from each exporting country, the model distinguishes the slope of the key variable, i.e. quantity exported, for each exporting country. Therefore, a different data arrangement is applied on the export quantity from each exporting country.

In the oligopsony model, three exporting countries' data are pooled together. In this model, a dummy variable to distinguish different country's characteristics is not used because it does not improve the model's performance. The buying price equation is estimated in the same way as the selling price equation in the oligopoly model.

Considering the limited numbers of cross-section members, regular Non-Linear Three-Stage-Least-Square (NL3SLS) is used on all four systems. The NL3SLS procedure in SAS 7.0 is used to obtained estimates of the parameters and is given in Appendix 2. A complete data configuration for all four models is presented in Appendix 3. The data used in the estimations and its source are described in the following part.

5. 2. Data and Its Sources

The estimations are based on annual data from 1976-1997. This period was chosen due to the availability of data that covers a wide variety of variables for all six groups of trading countries. A summary of analysis of variance of the data used in this estimation is given in Table 4.

Trade quantities are in thousand tons per year of palm oil exported from and imported to six trading groups. The units for stocks are in thousands of tons annual ending stocks in each trading country. World prices are based on palm oil and other substitute prices in the port of destination (*cif*), Rotterdam for the European Union and the Pacific Coast for the United States. The price of animal oil (*Panim*) is an average of fish oil, tallow and grease prices. All prices are in U.S. dollar per ton. All quantities traded, stocks and world price data are from the Oil World, Hamburg.

To calculate the export price in the port of origin (*fob*), this price then is netted from transportation costs. Transportation cost data is from the World Wheat (Grain) Council, London. This transportation cost is in U.S. dollar per ton of cost to transport wheat from and to various major port of destinations. It is the best transportation cost

Table 4. Analysis of Variance on Key Variables, 1976-1997

Variables	Maximum	Minimum	Mean	Standard deviation	Coef. of Variations
Prices (USD/ton)					
Palm oil	729.0	257.0	479.3	125.1	26.1
Soybean oil	724.0	334.0	518.0	100.8	19.5
Coconut oil	1,155.0	297.0	597.9	197.0	32.9
Animal oil	582.3	301.8	433.2	72.8	16.8
Sunflower oil	767.0	360.0	569.7	111.2	19.5
Rapeseed oil	687.0	305.0	497.9	105.4	21.2
Trade quantity (1000 ton)					
Total (world)	12,354.0	2,111.0	6,379.1	3,199.6	50.2
Suppply from:					
Indonesia	2,982.0	206.0	1,000.4	751.9	75.2
Rowex	1,835.0	431.0	1,134.3	454.5	40.1
Malaysia	7,747.0	1,135.0	4,244.4	2,073.6	48.9
Demand from:					
European Union	1,994.0	683.0	1,177.3	459.5	39.0
Rowed	2,958.0	731.0	1,765.9	730.5	41.4
Rowing	7,964.0	196.0	3,435.8	2,136.5	62.2
Stocks (1000 ton)					
Indonesia	930.0	18.0	292.7	256.0	87.5
Rowex	145.0	20.0	67.6	32.9	48.7
Malaysia	1,179.0	143.0	617.0	288.8	46.8
European Union	126.0	48.0	86.9	22.8	26.3
Rowed	364.0	127.0	240.2	65.1	27.1
Rowing	1,261.0	97.0	579.1	309.3	53.4

Table 4. continued

Variables	Maximum	Minimum	Mean	Standard deviation	Coef. of Variations
Income/cap (USD/cap)					
Indonesia	1,155.4	260.3	609.0	248.9	40.9
Rowex	1,027.1	332.1	591.3	222.0	37.5
Malaysia	12,707.3	2,283.3	6,092.9	2,994.8	49.2
European Union	23,084.7	5,394.8	13,236.1	5,917.2	44.7
Rowed	31,185.5	6,904.9	18,509.5	8,069.6	43.6
Rowing	8,632.5	713.4	392.4	144.5	36.8
Wages (USD/hr)					
Indonesia	0.46	0.09	0.26	0.11	42.3
Rowex	1.28	0.01	0.47	0.38	81.5
Malaysia	3.50	1.02	1.83	0.74	40.2
Exchange rates (local curr/USD)					
Indonesia	4,034.4	415.0	1,482.9	869.6	58.6
Rowex	209.3	42.7	106.8	49.1	46.0
Malaysia	2.8	2.2	2.5	0.2	7.1
Interest rates (%)					
Indonesia	24.0	9.0	15.9	6.1	38.2
Rowex	22.7	9.4	15.5	4.5	29.2
Malaysia	11.4	5.5	8.5	1.6	19.2
Transporation Cost (USD/ton)					
EU-Malaysia/Indonesia	35.3	13.2	23.8	5.5	22.9
EU-Rowex	30.0	11.3	19.8	4.5	22.4

data available, and therefore it is used as a proxy for vegetable oil transport cost. Transportation cost from the European Union and the United States to Malaysia, Indonesia and *rowex* are not directly available. Therefore, transport costs from Malaysia and Indonesia to the European Union are transportation costs from the European Union (Rotterdam port) to Australia. The transportation cost from the United States to Malaysia and Indonesia is the transport cost from the United States to the Philippines plus the transport cost from the Philippines to Australia. The transportation cost from the European Union to *rowex* is the transport cost from Rotterdam port to a Moroccan port.

Domestic price data for Malaysia and Indonesia is available in domestic currencies. Exchange rate data from the International Monetary and Fund (IMF) is used to convert these prices into U.S. dollars. Malaysia's price data is taken from PORLA Statistics, Malaysia. Domestic price data for Indonesia is from Indonesia's Central Bureau of Statistics.

Income is the gross domestic product (GDP) from each participating country. Income data for the European Union is calculated from the GDP of each member multiplied by its exchange rate to convert into U.S. dollars so they can be summed. Summation is weighted by the share of each country's GDP in the total. Income for *rowex* is a weighted sum of GDP from Nigeria, Ghana, Cameroon, Papua New Guinea and Ivory Coast, the major exporting countries after Malaysia and Indonesia. Income of *rowed* is a weighted average of the United States' and Japan's. Income of *rowing* is a weighted average of GDP from India, China, and Pakistan.

To eliminate country size bias, per capita income data is used. Per capita income is calculated by dividing GDP by the country's population. The interest rate is the annual lending rate from the IMF. Wage is hourly wage data from the Statistical Yearbook of the United Nations. They are available in domestic currencies. Conversion into U. S. dollars is done to obtain an average wage for a group of trading countries. All income, exchange rate and population data are from the International Monetary Statistics of the International Monetary Fund (IMF).

Elasticity of demand (supply) used to calculate the conjectural variations variables is estimated separately using pooled data from importing (exporting) countries. Marginal cost data in exporting countries are palm oil prices in the domestic market. The market price is the price of palm oil in the world market. In calculating the conjectural variations for importing countries, the marginal cost of importing palm oil is the price of palm oil in the world market. Marginal revenue which is the domestic price in the importing country is the world price plus the assumed tariff. The level of tariff was assumed because data on actual tariff levels are not available. For the European Union, the tariff is assumed at 5 percent, and tariff for *rowed* is assumed at 1 percent. For *rowing*, the domestic price is the price for vegetable ghee in Pakistan obtained from Asian Productivity Organization (1994). This price is used because the domestic price of vegetable ghee is used as a base for the resale price of imported vegetable oil.

Considering that panel data involves countries of different sizes, a procedure to reduce this variation is done by normalizing all data by the individual standard deviations. The normalized data then is used in the estimation.

5. 3. Welfare Analysis

The welfare impact of different market structures is reflected in the changes in importing and exporting countries' surplus due to changes in market prices under different market structures. Different market structure solutions are obtained by restricting the value of the market power parameters. Setting the value of a market power parameter to zero allows the model to simulate a perfect competitive market solution. A typical graph used to show welfare changes under different market structures is presented in Figure 3.

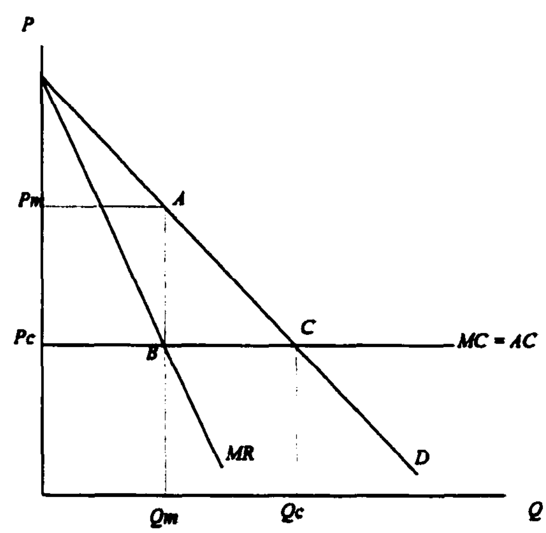


Figure 3. Welfare impact of a Monopolist

In the above figure, a monopolist supplies at *Qm* when marginal revenue is equal to its marginal cost. With this quantity, its monopolist's price is at *Pm*. Under a perfect competitive market, price would be lower at Pc and quantity at Qc. Therefore a monopoly market creates deadweight loss (DWL) the size of ABC.

The estimated market power parameters and oligopolistic nature of the problem will produce different situations than the one shown in the figure, but the mechanism remains the same. Put in mathematical terms, the deadweight loss is measured as:

$$DWL = \frac{1}{2} * (Q_c - Q_m) * (P_m - P_c)$$
$$= \frac{1}{2} \Delta Q * \Delta P$$

Peterson and Connor (1995) adjust the above formula for the imperfectly competitive model. This adjusted formula has the advantage that the model is derived from an explicit oligopoly model. Two related estimates for DWL are relevant for this study: a price leadership model and an oligopoly model.

a. Stackelberg (price leadership) model

$$DWL = \frac{CR^2}{(2n - 1)^2 \; 2|\varepsilon|} \qquad [5.1]$$

where CR is concentration ratio, n is the number of dominant firms and $|\varepsilon|$ is elasticity of market demand. Concentration ratio is given by Tirole (1988) as:

$$CR \equiv \sum_{i=1}^{n} \alpha_i, \quad where \quad \alpha_i = \frac{q_i}{Q}$$

q_i *is firm supply,* Q *= total market supply.*

b. Oligopoly Pricing

$$DWL = \frac{H^2}{2\,|\varepsilon|} \qquad [5.2]$$

Another modification of the Lerner index suggested by Krouse (1990) for a leadership model is:

$$L_d = \frac{S_d}{\eta + S_f\,\eta_f} \qquad [5.3]$$

where $S_d = q_d/Q$, share of dominant group, S_f is the share of fringe group and $S_f = 1\text{-}S_d$; η is market demand elasticity and η_f is supply elasticity of fringe group. Using this modified Lerner index, one can calculate the Herfindahl index and use the modified Herfindahl index to calculate DWL of leadership model using equation [5.2]. The result then can be compared with measures of DWL from equation [5.1].

CHAPTER 6

Empirical Results

Four models are estimated and reported in this chapter. They are two Stackelberg models: triopoly and triopsony models, and a bilateral oligopoly model consisting of oligopoly and oligopsony models. Each model consists of a system of equations and is estimated simultaneously. Two degree of dominance tests are conducted. The first is between triopoly and triopsony solutions, and the second is between the oligopoly and oligopsony solutions.

On these four systems simulations are conducted to examine welfare impacts due to market power exertion. Results from the Stackelberg models are presented first, as they reflect the finding of the main hypothesis that both leading exporting and leading importing countries exert some market power. Results from the bilateral oligopoly model is presented at the end of the chapter to explore the further possibility that other trading countries potentially impose some market power as well. Now, we turn to the findings from the Stackelberg models.

6. 1. Triopoly Model

Malaysia has selling power in the world market. A large export share from Malaysia combined with its domestic policy induced the formulation of a duopoly model. This duopoly model is to test whether under those two factors Malaysia is capable of exerting selling power in the world market. Estimations based on empirical data shows that most estimates on parameters have the expected signs. Values of the estimated parameters do not reflect the marginal effect of independent variables on dependent variables due to the normalization of the data. The marginal effect is calculated by multiplying the value of parameter with the ratio of the standard deviations of dependent variables and the independent variables (S_y/S_x). Table 5 presents the value of the estimated parameters, marginal effects and calculated elasticities at the mean.

World demand function. The estimated world demand function based on data from European Union, *rowed* and *rowing* shows that 62 percent of the movement in world demand for palm oil is explained by its own price, soybean oil and animal oil prices and income in the importing countries. These four variables are statistically significant.

The parameter on own price gives a negative sign as expected. A dollar per ton increase in palm oil prices will reduce palm oil demand by 43.4 thousand tons. This is equivalent to the value of price elasticity of demand -3.3. Parameters on soybean oil and animal oil prices are positive, meaning that both are palm oil substitutes in importing countries. As prices of soybean and animal oils increase, demand for these oils decreases. Consumers then substitute their consumption of these oils to palm oil. The magnitude shows that a one dollar increase in soybean oil prices will increase the demand for palm oil by 23.3 thousand tons. A one dollar increase in animal oil price will increase palm oil demand by 24.3 thousand tons.

Table 5. Estimates of Parameters when Malaysia as Leading Exporter

Variables	Expected signs	Values	t-value	Marginal Effect[1]	Elasticity
World Demand (1000 ton)					
constant		0.0127	0.14	-	-
Pwpo (USD/ton)	-	-4.8780	5.39	-43.39	-3.26
Substitute prices:					
- Soybean oil (USD/ton)	+	2.0362	4.56	23.28	1.89
- Animal oil (USD/ton)	+	1.9041	4.85	24.26	1.97
Pwpo*trend		0.6821	5.47	-	-
Income (USD/cap)	+	-2.2246	4.03	-0.56	-0.94
R^2		0.6246			
Supply of fringe exporters (1000 tons)					
constant		-0.016	0.49	-	-
Pwpo (USD/ton)	+	0.039	0.43	0.18	0.04
Pwco (USD/ton)	-	-0.136	1.33	-0.37	-0.10
Exchange rate (curr/USD)	+/-	0.916	9.16	1.23	0.46
Interest rate (%)	-	-0.058	0.69	-6.80	-0.05
Income (USD/cap)	-	0.227	4.01	1.63	0.15
Stock (1000 tons)	+	0.017	0.32	0.06	0.01
R^2		0.925			
World (selling) Price (USD/ton)					
					Flexibility
constant		0.0009	0.07	-	-
Leader's supply (1000 tons)	-	-1.426	4.69	-0.09	-0.80
Domestic price (USD/ton)	+	0.831	15.24	1.06	0.90
Exchange rate (curr/USD)	+	0.106	5.91	74.7	0.41
Wage (USD/hr)	+	0.316	1.48	5.60	0.22
Stock (1000 tons)	+	0.050	0.96	0.02	0.03
Market power	+	*1.420*	*1.24*	*0.02*	*0.21*
R^2		0.991			

[1] **Due to normalization, marginal effect is obtained by multiplying each slope by its standard deviation used in the normalization process.**

Income has a negative sign, meaning that as income increases, palm oil demand will decrease. A one dollar increase in per capita income in importing countries will reduce the demand for palm oil by 560 tons. This negative sign indicates that palm oil is an inferior good. This is unexpected. Palm oil was expected to be a normal good. It could be the case that, as income increases, health concerns also increase. Palm oil contains saturated fat which is considered bad for people's health. When income increases, people switch from saturated fat vegetable oil (palm oil) to non-saturated fat vegetable oils such as soybean oil, rapeseed oil, and sunflower oils, which are also more expensive than palm oil. As a result, the demand for palm oil decreases.

This phenomenon, however, is expected in developed countries. Three groups of countries are used to estimate this world demand function. They are the European Union, developed country importers (the United States and Japan) and developing country importers (India, China and Pakistan). It might be that the negative effect of income on palm oil demand from the developed countries is stronger than the positive income effect from the developing countries. So, when they are pooled together, the influence of the developed countries overshadows the developing country's income effect.

Supply function for fringe exporters. The estimated model explained 92 percent of the variation on the quantity supplied from Indonesia and *rowex*. The exchange rate and income are two variables that significantly explained the variations. A one percent increase in the U.S. dollar exchange rate will increase the palm oil supply from fringe exporting countries by 0.46 percent.

Per capita income among the fringe exporters has a positive relationship to exports from these countries. A one U.S. dollar increase in per capita income in Indonesia and *rowex* will increase supply of palm oil from these countries by 1.63 thousand tons per year. This can happen if, as income increases, the domestic demand for palm oil decreases, so palm oil is more available for export. This means palm oil is an inferior good in Indonesia and *rowex*.

If this is true, it is an interesting phenomenon, especially for Indonesia. On the one hand, Indonesia's government regulates palm oil exports because it is considered an important commodity in domestic consumption. On the other hand, the parameter on income shows that an increase in income will reduce palm oil consumption so that the export supply will increase. This result is in line with Larson's (1996) suggestion that protection of the palm oil sector to stabilize the domestic market results in a minor gain to consumers. He found that palm oil contributed only 1.4 percent consumer price index measures. Even the bottom twenty percent level of income of people in the rural area only spend 4 percent of their total expenditure on cooking oil. So, this study result might support the argument that palm oil was an important commodity but its importance is declining as income is rising.

The parameter on coconut oil price is negative but insignificant. This negative sign indicates that coconut oil is a palm oil substitute in fringe exporting countries. The parameter on stock and interest rates are also insignificant. The signs, however, are as expected. As stock increases, the capability of an exporting country to export palm oil increases. A negative sign on interest rate indicates that as interest rate increases, export will decrease because the cost to export palm oil increases too.

The parameter on own price has a positive sign but is not significant. Palm oil price does not significantly explain supply behavior from these two countries. The insignificant influence of own price on supply may be because Indonesia's export of palm oil is a residual of domestic demand. As mentioned before, domestic policy on palm oil is highly regulated and focused on stabilization of cooking oil prices in the domestic market. With this policy, export variations from Indonesia are somehow isolated from world price fluctuations. As a result, the world price has a less significant effect on export variations from Indonesia.

On the *rowex* side, the insignificant influence of world price on exports might be due to close trading relations between the European Union and palm oil exporting countries in Africa. Information on European Union import policy revealed that the European Union has concessionary trading arrangements with 62 African, Caribbean and Pacific (ACP) countries. Export of oils and fats from these countries is free of tariff. In 1979 imports from these countries reached about 12 percent of the total value of imports of all vegetable oils. Another trading arrangement with ACP is a compensatory financial scheme (STABEX) to stabilize export earnings on seed, oil and meal from groundnut, coconut, palm, sesame and cottonseed (FAO, 1984). This factor may contribute to reducing the response of palm oil exports from *rowex* to the world price variations.

Malaysia's selling price equation. A selling price equation is formed to test whether world price is influenced by exports from Malaysia, the assumed leading exporter, and whether this world price contains some markup from selling power exertion. The estimation shows that 99 percent of palm oil price movement in the world market is explained by the predicted model. The result estimates that the quantity of palm oil exports from Malaysia has a significant contribution in explaining world price movement. A one percent increase in palm oil exports from Malaysia will reduce world prices by 0.8 percent. The domestic price also has a positive and significant relationship with the world price, which reflects a strong connection between domestic pricing policy in Malaysia and the world market. A one dollar increase in domestic prices will increase world prices by USD 1.06 per ton. The strong influence of these two variables on world price suggests that Malaysia's policy is more responsive to world price fluctuations compared to fringe exporting countries.

The exchange rate has a positive relationship with world price, meaning that as exchange rates increase, the world price will increase too. There are two possible effects: one effect is on world prices and the second effect is on export costs. As exchange rates increase, the world price becomes relatively higher than the domestic price which will induce more palm oil export from Malaysia and cause a decrease in world price. At the same time, however, export costs also increase because they are also in foreign currency. Examples of export costs are transportation costs, insurance costs, contract costs, costs to meet the importing country's quality and packaging requirements. An increase in those export costs will increase the selling price of palm oil from Malaysia. The net effect will depend on which effect is stronger. In this result the exchange rate has a positive effect on price, which means that an increase of exchange rate effect on cost is larger than the effect on price. Wages have a positive influence on world prices but are insignificant.

The estimates of the market power parameter shows that Malaysia imposes market power at 1.42. The converted market power value however is 0.27[1], which indicates that the market power is lower than a perfect monopoly which has a value of market power at unity.

6. 2. Triopsony Model

European Union has buying power. Persistence of market share and domestic policy on palm oil substitutes in the importing countries encourages formulation of the triopsony model. Results from this model support the hypothesis that the European Union has buying power in their palm oil imports. Table 6 presents estimates of parameters, the calculated marginal effect of independent variables on dependent variables in each equation, and the elasticities.

The world supply function. Three exporting countries are pooled together to estimate the world supply function of palm oil. In this model, exporting countries are assumed to be price takers in the world market. The estimated model explains 87 percent of the variation in the quantity supply of palm oil in the world market.

Stock is the most significant influence on the supply function of palm oil. Own price is significant at the 94 percent level of confidence, which is more significant than

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1 Calculation of this converted market power is in Appendix 4.

Table 6. Estimates of Parameters when European Union as Leading Importer

Variables	Expected signs	Values	t-value	Marginal Effect[1]	Elasticity
		World Supply(1000 tons)			
constant		0.031	0.54	-	-
Pwpo (USD/ton)	+	0.241	1.84	2.00	0.15
Pwco (USD/ton)	-	-0.292	1.87	-1.49	-0.14
Pwpo*trend		0.176	7.68	-	-
Stock (1000 ton)	+	0.382	7.00	6.65	0.34
Income (USD/cap)	-	0.039	0.46	0.05	0.02
R^2		0.869			
		Demand of fringe importers (1000 tons)			
constant		-0.010	0.49	-	-
Pwpo (USD/ton)	-	-0.290	2.46	-3.26	-0.30
Pwso (USD/ton)	+	0.107	1.28	1.50	0.15
Income (USD/cap)	+	0.904	4.93	0.34	0.62
Stock (1000 ton)	-	0.250	4.88	4.70	0.37
Trend	+/-	-0.288	1.09	-66.20	-0.14
R^2		0.971			
		World (buying) Price (USD/ton)			
					Flexibility
constant		-0.0004	0.02	-	-
Leader's demand (1000 ton)	+	1.952	2.76	0.53	1.31
Pwso(-1) (USD/ton)	+	0.257	1.56	0.30	0.33
Panim (USD/ton)	+	0.898	8.84	0.37	1.34
Stock (1000 ton)	-	-0.320	4.10	-7.38	-0.32
Income (USD/cap)	+	-0.970	1.61	-0.02	-0.58
Market power	+	*1.443*	*2.16*	*0.46*	*1.12*
R^2		0.982			

[1] Due to normalization, marginal effect is obtained by multiplying each slope by its standard deviation used in the normalization process.

the estimation of the fringe supply function in the triopoly model. The additional pooling of data from Malaysia may explain this improvement because Malaysia's exports are relatively more connected to the world price movement than the other two exporting countries. The marginal effect however is small. A dollar per ton increase in the world price will induce an additional 2.0 thousand tons of palm oil export from these three exporting countries. This is shown also by an inelastic supply function of palm oil from exporting countries, which is only 0.15.

The parameter on coconut oil is negative, indicating that coconut is a substitute for palm oil. This is consistent with the estimation result on supply function from the competitive fringe in the triopoly model (Table 5), that coconut oil is a substitute for palm oil in the exporting countries' domestic market. Income does not significantly influence palm oil exports from any of these three exporting countries. Income significantly influences the supply from fringe exporters in the triopoly result. The sign, which is positive, is consistent with the triopoly result that palm oil is an inferior good in exporting countries.

Demand function from fringe importers. The estimated model explains 97 percent of variation in palm oil demand from *rowed* and *rowing*. Variables that contribute to this model performance are own price, income and stocks. Own price has a negative sign as expected. A one percent increase in palm oil prices will decrease world demand by -0.30 percent. With this elasticity, a one U.S. dollar increase in palm oil price will decrease world demand by 3.26 thousand tons. This is very different from the estimate of world demand in the triopoly model (Table 5), which shows price elasticity of demand of -3.3. This is maybe due to the absence of the European Union in this system.

Two interesting results in this model are different from the finding of the world demand function in the triopoly model, which may also be associated with the separation of the European Union from the estimation of this fringe demand function.

First, soybean oil is a less significant substitute for palm oil in fringe importing countries. This result may suggest that soybean oil is a strong substitute in the European Union but not in the fringe importing countries, especially *rowing*. The increasing import share from *rowing* (India, China, and Pakistan) may overshadow the impact from *rowed* (the United States and Japan). Another factor is that high availability of soybean oil in the United States reduces the possible substitution from a very minimal share of palm oil in the total of vegetable oil supply in the domestic market. Almost all soybean oil consumed in the United States is domestically produced. The highly protected soybean oil market in Japan may dampen the commercial substitutability of palm oil as well. Japan prefers to import oilseeds and crush them domestically to meet the domestic demand for vegetable oils. Imports of soybean and palm oils are also restricted by import tariffs. These two factors possibly reduce the substitutability between soybean oil and palm oil in *rowed*.

Second, the parameter on income in these two countries has a positive sign, meaning that, as income increases, demand for palm oil from *rowed* and *rowing* increases too. This is because palm oil is still an important commodity for consumers in importing countries such as India, Pakistan and China (*rowing*). Significant import increases in the

1990s were caused by increased income and population in these three countries. It seems that the possible negative impact of income from *rowed* (United States and Japan) is overshadowed by the influence of increasing income in *rowing*. This is consistent with the discussion on the result of the triopoly model. In the estimation of the world demand function in the triopoly model, income in importing countries has a negative sign indicating that palm oil is an inferior good. In the estimation of the fringe demand function in this triopsony model, where the European Union is separated from the estimation, the parameter on income has a positive sign. This means that palm oil may be an inferior good in the European Union market but not in the fringe importing countries' markets.

Stocks significantly explain the variation in demand from these fringe importers. A positive relation indicates that, as stocks increase, the need to import palm oil increases too. So, the need to have stocks increases the demand for palm oil. In Pakistan and India stocks are needed to satisfy domestic consumption especially when the world price increases and the countries do not have enough foreign exchange to import palm oil. It was expected that as stocks increase, the need to import will decrease; i.e., that importing countries use stocks to control their imports. The result however shows the opposite. This means that these fringe importers do not use stocks as a tool for strategic behavior. This result supports the assumption that these fringe importing countries are price takers, and that they do not have capability or intention to impose import controls on palm oil. It is a large importing country that can use stocks as a tool to control import. This should be expected in the European Union import behavior, but not on these fringe importers. The time trend parameter has an insignificant influence on demand of palm oil from fringe importing countries.

European Union buying price equation. The estimated model explains 98 percent of the world palm oil price variation. An increase in European demand significantly causes world price to increase. Price flexibility shows a value of 1.3, meaning that a one-percent increase in palm oil demand from the European Union will increase world prices by 1.3 percent. The parameter on soybean oil and animal oil prices are positive, indicating that both oils are palm oil substitutes in the European Union market. This is consistent with the world demand estimation in the triopoly model.

In relation to stocks and income influences on fringe importers' demand, as expected, the European Union might use stocks to control their imports. The parameter on stocks has a negative sign and is very significant at 99 percent level of confidence. This means that as stocks increase, the world price will decrease. When stocks in the European Union increase, the need to import palm oil will decline. As a significant importer, reduction of European Union imports will cause world price to decline. This result supports the argument that as a large importing country, the European Union may use their stocks to control imports of palm oil from the world market.

Another finding is that income also has a negative sign. When income in the European Union increases, the world price decreases. A decrease in the world price is associated with a decrease of palm oil imports to the European Union. As income increases, demand for palm oil from the European Union decreases. So, palm oil is an inferior good in the European Union market. It is the influence of the European Union that supports the negative estimate of income parameter in world demand estimation on the triopoly model (Table 5). We also see that when the European Union is separated from the fringe importers in the estimation of fringe demand function above, income parameters become positive in the remaining countries.

As a result of the significant influence of the European Union's demand on the world market, then this country can control their imports as shown by the positive sign on quantity import parameter. This is supported by the significance of the market power parameter. The value of the market power parameter is 1.44. The converted value of this market power is 0.88, which is lower than a pure monopsony power.

6. 3. Welfare Effect

The predicted values on equilibrium price and quantity traded are obtained by substituting the mean values of independent variables for each related equation. Two advantages from this study are obtained. First, the use of panel data allows the possibility to trace back trade compositions from each trading country used as cross-section members. Second, the use of a nested model enables the study to observe different market structures. Empirical estimates of price obtained from the leader price equation presents the predicted market equilibrium price under the hypothesized market structure. By setting the value of the market power parameter $\lambda=0$, the estimated model can predict a simulated perfect competitive market structure, which results in an equilibrium price at $P^w = MC$ for the triopoly or $P^w=MR$ for the triopsony model. This simulated perfect competitive market solution then can be used to calculate the DWL resulting from the market power imposition from major trading countries. The DWL for the Stackelberg model is calculated using both equation [5. 1] and [5. 2] using the adjusted Lerner index introduced by Krouse (1990). Empirical trade results and measures of DWL are discussed in the following sections.

The triopoly result shows the value of selling power imposed by Malaysia at 0.27. Using [5. 1], with an elasticity of demand -3.3, and CR from Malaysia at 0.644, the resulted DWL is 0.0636 or 6.36 percent of the total trade. With the estimated world price under a triopoly scenario, 467.68 U.S. dollars per ton of palm oil and total quantity traded of a 6.587 million tons, the total value of trade is 3.08 billion U.S. dollars. Therefore, DWL 6.36 percent is worth about 196 million U.S. dollars. Using Krouse's (1990) adjusted Lerner index [5.3] and [5.2] results in DWL at 0.06309 which is very close to the previous calculation. Selling power by Malaysia has caused the world price to be 98.5 U.S. dollars per ton higher than it would be under a perfect competitive market.

In the triopsony model, the European Union imposes market power at the magnitude of 0.88 which is close to a perfect monopsonist. If the European Union did not impose this buying power, the market price would be at U.S. $ 781.08 per ton. By imposing this buying power, the European Union can import palm oil at U.S. $ 441.59 per ton and collect a monopsony mark-up of U.S.$ 339.49 per ton.

Calculation of DWL uses the Krouse's adjusted Lerner index for leadership model [5.3] and oligopoly pricing [5.2]. With the elasticity of demand for fringe at -0.3, the calculated DWL is 0.0145 or 1.5 percent. With the estimated world price at 441.59 U.S.

dollar per ton and the total trade quantity at 6,975.5 thousand tons, the total value of world trade is 3.08 billion U.S. dollars. The calculated DWL at 1.5 percent is equivalent to the value of 46.2 million U.S. dollars.

Table 7. Estimated trade from Triopoly-triopsony Models

	Triopoly result	Triopsony result
World Price (USD/ton)	467.68	441.59
World Trade (1000 tons)	6,587.00	6,975.50
Export from (1000 tons):		
Malaysia	4,243.00	4,411.00
Indonesia	1,458.00	1,597.50
Rowex	886.00	967.00
Import of (1000 tons):		
European Union	941.00	1,212.00
Rowed	1,281.00	1,308.50
Rowing	4,365.00	4,455.00
No market power		
World price (USD/ton)	369.18	781.08
DWL (million USD)	195.93	46.2
	(6.36%)	(1.5 %)

6. 4. The Degree of Dominance

In this equation, the selling price equation from Malaysia and the buying price equation from the European Union are put into equation [4.13]. Those two estimated equations are used as explanatory variables to explain the movement of world palm oil prices. A parameter (α) is attached to each equation to measure the degree of dominance in influencing the empirical price data fluctuation. In this estimation, the value of market power parameter from equations [4. 6] and [4. 12] are not restricted to the value of market power parameters estimated in the triopoly and triopsony models. This equation then is estimated using NL2SLS. The result of the market power dominance is in equation [6. 1] below.

$$Pwpo_t^{w} = \underset{(2.81)}{0.29} * Pwpo_t^{EU} + \underset{(6.84)}{0.71} * Pwpo_t^{M} \quad \ldots\ldots t\text{-value} \qquad [6.\ 1]$$

$$For \quad \lambda_{EU} = 1.15 \qquad \lambda_M = .956$$

Statistic test on the degree of dominance confirms that European Union also has some buying power. The coefficient on market dominance for Malaysia is α=0.71 and for European Union is α=0.29, this means Malaysia is more dominant in the world market of palm oil. Malaysia, which has twice the market share of the European Union, is capable of exerting selling power. The importing country, however, also reacts to this market power. Through its policy on other vegetable oils, the European Union is capable of having buying power as well. This result was not as hypothesized in the beginning. The large share of exports from Malaysia is assumed to relate to a capability to impose selling power. Reaction from the importing country also matters. The result shows that Malaysia imposes market power at the level of only 0.28, while European Union is at 0.88.

The low value of the market power parameter which can be imposed by Malaysia is due to high elasticity on the world demand market (-3.3). With a more elastic demand, a greater quantity is needed to obtain an additional dollar of selling price. With a less elastic demand, less quantity control is needed to obtain this additional dollar of price. Previous studies observed a less elastic demand of palm oil. Suryana (1989) and Sumartini (1990) observed the palm oil market using 1979-1983 and 1968-1989 data. Suryana's estimates on price elasticity of palm oil demand from European Union, the United States and Japan were -1.46, -0.53 and -0.89 respectively. Sumartini's estimate of price elasticity demand from European Union was -0.94. This study estimates a price elasticity for world demand at -3.3. Based on these numbers, we can say that palm oil demand has become more elastic, so that it is more difficult for Malaysia to impose its market power in the world market.

Another difficulty in imposing market power also arises from the increasing elasticity of substitution among vegetable oils. Sumartini's estimate on cross-price elasticity between palm oil and other vegetable oils (weighted average) was 0.6. This study estimates that soybean price elasticity on world demand of palm oil (triopoly) is 1.89. This shows that the soybean is becoming a stronger substitute for palm oil. Cross price elasticity from lard and fish oil (Sumartini, 1990) were 0.09 and 0.20. This study's estimate of animal oil price elasticity on the world demand of palm oil is 1.97 (Table 5). This supports the evidence that substitution across fat and oil sources are increasing and this may contribute to the increase of the elasticity of demand on palm oil too.

Other factors that may reduce Malaysia's selling power are the increasing concentration of vegetable oil industries in developed countries and the possible existence of foreign ownership in the palm oil industry (multinational firm) in the exporting countries. This discussion will be taken up in Chapter 7.

6. 5. Possible Imposition of Market Power from Other Trading Countries

Results from triopoly and triopsony models lead to a question on the possibility of market power from other major trading countries. Indonesia's palm oil sector with its domestic policy could result in a restrictive export that resembles an imposition of selling power. Emergence of new importing countries such as China, India and Pakistan with their huge market share and restrictive import policies may suggest other buying powers exist on the import side.

To observe those possibilities, a triopoly model with Indonesia as a leader was estimated. A bilateral oligopoly model which explores the possibility that each trading country has some market power was also utilized. The findings are presented in the following sections.

6. 5. 1. Indonesia as Leading Exporter

This estimation was conducted to investigate the possibility that domestic policy causes export of palm oil from Indonesia to resemble the market power imposition. The same specification from the triopoly model is used in this estimation. The estimated parameters on important variables such as own price on the world demand and fringe supply functions have the correct signs (Appendix 5. 1). The parameter on the quantity supplied by Indonesia has a negative sign, indicating that when exports from Indonesia increase, the world price will decrease. This is expected since in this case Indonesia is assumed to be a large country trader. The value of market power, however, is low (-0.012) and insignificant (t-value = 0.94). This means Indonesia does not have enough selling power in the world market. Based on this result, the possibility that Indonesia may lead other exporting countries is ruled out.

6. 5. 2. Bilateral Oligopoly Model

This model is used to explore the possibility that all trading countries have some market power. Under the oligopoly model, importers are assumed to be price takers as in the triopoly model, while all exporters are assumed to have some market power. So, every exporter has its own selling price equation. Under the oligopsony model, exporters are assumed to be price takers, while importers have some market power. Therefore, every importer has its own buying price equation. Results on estimations from each model are discussed in the following sections.

Oligopoly Model. In general, the estimated parameter on own prices have the expected signs (Appendix 5. 2). Own price on the world demand function has a positive sign and is significant. Other variables that influence the world demand function are income and stock. Estimated selling price equation from the three exporting countries also have the correct signs. A negative value on the parameter of quantity of palm oil exported from these countries indicates that as palm oil exports increase, the world price will decline. Estimates of market power parameters, however, are very low and insignificant. Indonesia, Malaysia and *rowex* have market power at the level of 0.024, 0.16, and 0.009 respectively. Their t-values are also very low. Based on this result, we can say that we cannot accept the possibility of market power imposition from all three exporting countries.

Oligopsony Model. In this oligopsony system, the estimated parameters on own price on the world supply function give a positive sign as expected (Appendix 5. 3). Parameters on quantity import on the buying price equation from three importing countries also have positive values as expected, but are insignificant. The estimates of the market power parameter are slightly more significant than the estimates of exporting countries' market power in the oligopoly model. The market power of the European Union, however, is low (0.20) and insignificant (t-value = 0.44). This is inconsistent with the result from the triopsony model. A stronger market power is shown on market power from *rowed* and *rowing*. The estimates of market power for *rowed* is 0.11 (with t-value of 1.89) and *rowing* is -0.16 (with t-value of 1.84). The more significant values of these market power on importing countries sides may indicate that importing countries have a prospect to impose market power. Empirical data shows that in 1997, China alone had an import share as large as the European Union. Even though uniting the United States and Japan as *rowed*, and China, India, and Pakistan as *rowing* and assuming that they jointly impose some market power may not be reasonable empirically, the result of this exercise maybe an indication that these *rowing* individually may become important importing countries in the world market. This is shown in the exercise on the degree of dominance test (equation 6. 2).

$$Pwpo_t^{w} = \underset{(9.26)}{1E\text{-}8} * Pwpo_t^{Indo} + \underset{(2.18)}{1E\text{-}8} * Pwpo_t^{rowex} + \underset{(2.76)}{0.134} * Pwpo_t^{M} \qquad [6.2]$$

$$+ \underset{(3.6)}{1E\text{-}8} * Pwpo_t^{EU} + \underset{(6.12)}{1E\text{-}8} * Pwpo_t^{rowed} + \underset{(17.79)}{.865} * Pwpo_t^{rowing} \ \ldots\ldots\ldots\ldots\ t\text{-}value$$

This equation shows that when every trading country has market power, importing countries are more dominant in the world market. The exporting countries in total have a value of the degree of dominance in total at $\alpha = 0.13$, while importing countries have a total value of $\alpha = 0.87$, meaning that the oligopsony result is more dominant than the oligopoly result. On the export side, Malaysia is more dominant than Indonesia and *rowex*. On the import side *rowing* is much more dominant than the European Union and *rowed..*

This is an interesting indication. Eighty seven percent of the world price is influenced by the buying price from *rowing*. The strong characteristics of *rowing* in the result of the triopsony model may support this indication. In these three *rowing* countries, China, India, and Pakistan, where palm oil is a normal good, their income and population growth are still increasing. These countries certainly will be an alternative market for palm oil.

CHAPTER 7

Empirical Implications and Future Research

This study formulated a complete model to investigate the exertion of market power and test for the degree of dominance between importers and exporters in the world palm oil market. Previous studies either were just a set of market power tests, usually looking at one side of the market, or they only conducted degree of dominance tests. The application of panel data with unbalanced individual units across equations is another empirical contribution, as previous panel data studies all had balanced panels in which the same countries, or units, were found in all structural equations in the model (Kinal and Lahiri, 1993). The sections that follow summarize the empirical finding, possible policy implications and challenges that still remain in the estimations methodology.

7 .1. Summary of the Empirical Results

Estimated Stackelberg models suggest that Malaysia and the European Union are two big trading countries who are capable of imposing market power in the market for palm oil. The big market share from Malaysia, however, does not guarantee that they can strongly impose their selling power. The European Union, with import shares of about 20 percent, is also capable of imposing buying power in the world market.

Empirical results suggest that, during the period of observation, Malaysia was the principal exporting country capable of imposing selling power on the world palm oil market, and the European Union was the main imporer able to counter such market power. Malaysia had an estimated market power parameter with a value of 0.27, where a perfectly competitive market has a value if zero and a monopoly takes on a value of one. This market power imposition has caused a dead-weight-loss (DWL) of about 6 percent of the total value of the world palm oil trade. The European Union has a stronger buying power at a level of 0.88. With this high market power, the European Union's buying power created a DWL of about 1.5 percent of the world palm oil world trade. Higher oligopsony power from the European Union results in a less DWL on the world market because the European Union's trade share is much lower than Malaysia's trade share. The results of the market dominance test suggest that Malaysia's selling power, due to its large market share coupled with its domestic policy, more heavily influences the world price.

Malaysia and the European Union were thought to be the most likely participants in the market with potential market power. The possibility that Indonesia might be a price maker in the world market was tested for but was rejected. Further investigation on the possibility that other countries may impose such market power was tested using dominance tests and oligopoly models that allowed more participants to exert some market power. While these results were not overly strong, China, Pakistan and India were seen to be countries with possible buying power in the world market. These three countries may have market power due to their trade share, increasing income and protective policy (i.e. import licenses and state trading). In the future, potential market power from these three countries, combined with continued buying power from the developed countries, may increase a total buying power of importing countries in the world palm oil market.

At the country level, government policies on palm oil imports and supporting policies on other vegetable oil production could create buying power in mporting countries. At the firm level, industries that use palm oil and vegetable oils in the developed countries are increasingly concentrated. With the increasing health concerns in the developed countries, the consumption of palm oil has shifted from direct consumption as cooking oil and salad oils to indirect consumption, as an industrial input. The concentration of these industries has led to the ability to acquire inputs with lower prices. As mentioned before, industries using imported vegetable oils in the European Union are concentrated in five firms.

In Japan, the free tariff on oilseeds is intended to promote domestic refineries. The vegetable oil crushing industry is one of the most concentrated industries in Japan (along with other industries such as brewing and distilling, sugar refining, dairy marketing, grain milling). Big companies that dominate the oil crushing industry are Mitsui (Hohnen Oil), Yoshihara (Sumitomo) and Fuji Oil (Daicichi Kangyo/C. Itoh). In 1980, one firm had 39.4 percent of market share of edible oils, two firms had 64.4 percent and five firms had 91.6 percent of market share (Rothacher, 1989).

In the United States, industries that use imported vegetable oil are also increasingly concentrated. In 1972, the number of companies in vegetable oil industries

Table 8. Vegetable Oils Industry in the United States, Selected Years, 1972-1992

Industry	Year of Census				
	1972	1977	1982	1987	1992
2074. Cottonseed oil mills					
Companies	74	62	47	31	22
Shipments (million USD)	410.7	763.1	933.3	470.7	737.8
Shipment by x-largest (%):					
- 4					62
- 8					81
2075. Soybean oil mills					
Companies	54	65	52	47	42
Shipments (million USD)	2652.1	6116.5	8603.6	9074.1	10,650.6
Shipment by x-largest (%):					
- 4					71
- 8					91
2076. Vegetable oil mills					
Companies	28	37	26	20	18
Shipments (million USD)	263.4	401.3	556.9	431.5	666.2
Shipment by x-largest (%):					
- 4					89
- 8					97
2077. Animal and Marine fats and oils					
Companies	402	384	270	194	159
Shipments (million USD)	977.1	2,102.2	1,752.5	1,753.1	1,858.2
Shipment by x-largest (%):					
- 4					37
- 8					52
- 20					74
- 50					91
2079. Edible Fats and Oils					
Companies	64	67	69	66	72
Shipments (million USD)	2,274.5	4,272.2	4,902.6	4,151.1	4,830.4
Shipment by x-largest (%):					
- 4					35
- 8					56
- 20					82
- 50					99
Total					
Companies	622	615	464	358	313
Shipments (million USD)	6,577.8	13,655.3	16,748.9	15,880.5	18,743.2

Source:

1. 1987, 1992 Census of Manufcaturing, U.S. Dept. of Commerce 1990, 1995.
2. 1992 Concentration Ratios in Manufacturing (www.census.gov:80/mcd/mancen/mc92cr.sum)

was 622; this was down to 313 in 1992 (Table 8). Within the last 20 years, the number of companies on average decreased by 2.5 percent per year, while the value of shipments increased on average by 9 percent per year. The number of companies in each category of industry varies, but the percentage of shipments in each industry is concentrated among the four largest companies. In cottonseed oil mills, 62 percent of shipments are in the hands of the four largest companies. In soybean oil it is 71 percent, while the four largest companies in vegetable oil mills hold 89 percent of total shipments. In animal and fish oil and edible fats, concentrations are lower, but more than half of the shipments are in the hands of the eight largest companies in the industries.

In addition, in line with McCalla's suggestions, the existence of multinational corporations in an exporting country may not guarantee that potential market power due to export share and government policy can be exercised. Looking deeper into the structure of Malaysia's industry, the existence of foreign ownership has a long history. A close relationship between Malaysia and the British may suggest that palm oil development is led by foreign owners. There is no study that supports the argument that private palm oil plantations that started a pooling system were multinational corporations, but the close ties between Malaysia and the British may suggest that those companies are either multinationals or domestic companies that developed because of the existence of multinationals during the British occupation. A recent study also supports the argument that there are many influences of the multinational corporations in this palm oil sector.

Jomo, et.al. (1997) did a study on industrial policy and manufacturing firms in Malaysia, which included palm oil processing industries. They observed that in the late

1980s foreign investment entered Malaysia, attracted by its industrialization policy. Most foreign firms investing in the palm oil refining industry were from India, Singapore and Hongkong. The Indian firms played the leading and key role in the Malaysian palm oil refining industries. The main reason has been the considerable imports of processed palm oil product to India from Malaysia from the late seventies until the late eighties. Another factor is the foreign exchange control in India, which encouraged Indian capital overseas to continue investing their profit abroad rather than be repatriated home. Japan also invested significantly in refining and fractioning palm oil for export when Malaysia's policy incentives encouraged rapid growth. Despite the generous incentives, western companies showed no interest in investments in palm oil refining and fractioning for export in the 70s and 80s. Unilever was the only western multinational company that had interests in processing crude palm oil in Malaysia in the seventies. These multinationals invest in Malaysia to acquire lower palm oil price. Therefore, with their existence, exporters from Malaysia could have difficulties in collecting markup as leading exporting country in the world palm oil market.

In Indonesia, the presence of multinationals or foreign ownership in the palm oil sector was also triggered by strong incentives in the palm oil sector during the 1980s. In 1992, 65 percent of all plantations were owned by the private sector. In 1994, private ownership increased to 72 percent. From all of these private plantations, 7.4 percent of private owners are foreign. Therefore, foreign ownership constituted about 5.3 percent of plantations in 1994. Thirty two (32) percent of the foreign ownership is in palm oil plantations. Joint ventures also contribute 1.9 percent of all plantations' ownership

(Central Bureau of Statistics, 1992 and 1994). The country of origin of these foreign investors is unknown. The palm oil policy that focuses on the domestic market, however, may result in different influences of this foreign ownership on palm oil in Indonesia as compared with those in Malaysia.

While import regulations coupled with increasing industrial concentration in the importing countries increases their buying power in the world market, the existence of multinationals in the exporting countries could further reduce the country's capability to impose selling power. A possible indication that market power from the exporting country is starting to decline is Malaysia's inreasing effort to ship palm oil. In the last five years, Malaysia had been conducting a government to government (G-G) trade in palm oil. The G-G trade is applied as a trading mechanism to adjust to the stagnant market opportunity in developed countries, and as a way to deal with state-controlled trading in developing countries.

7. 2. Policy Implications

Considering the above interactions, domestic policy formulation cannot ignore the dynamics of both industrial structure and government policies in importing countries. Limited government budgets to finance such policies in the exporting countries may not be able to counter the concerted buying power caused by both government policy and the private sectors in the importing countries. A further increase of buying power in the palm oil market in the future is expected from the increasing demand from *rowing*. Despite the negative sign on the estimate of market power from *rowing*, the degree of dominance test tentatively indicates they have a strong influence on world price movement. Based on population and income growth, they may become big potential buyers in the future. Import regulations (import licenses and state trading) in these countries also may create buying power.

The finding on the potential market power from these three importing countries is valuable information for policymaking. Exporting countries should anticipate the rising market power from these emerging importers as well as continued buying power from the European Union. Therefore, policies that are formulated without regard to such dynamics certainly need to be reviewed. On one hand, export restrictions on palm oil are needed to provide low-price of cooking oil. On the other hand, as price takers, the export tax burden for Indonesia can not be shared with importing countries. It is the domestic economy which bears the cost. Further reviews to investigate the beneficiaries of the government policy on the palm oil sector need to be conducted. Who really gets the policy benefits ? Is it the palm oil industries (plantations and refiners) or the consumers? Larson (1996) indicates that the benefit of price stabilization to the consumer is small because expenditure on cooking oil is minimum. If it is for revenue collections, is it an efficient way? With limited government budget especially after the financial crisis, this is certainly a strong reason to review the policy and try to explore other possible policy actions that are more effective for the intended objective.

For Malaysia, an attempt to develop the oleo-chemical industry and exports (Othman, 1998) to increase added value to palm oil exports also needs to be studied further. The dynamics of government policy and the industry in importing countries need to be taken into account. The developed countries apply higher import tariffs on fatty acids originating from palm oil and other vegetable oils than the import tariff on palm oil itself. Data from the United States International Trade Commission (USITC, 1984 and 2000) shows that the United States imposed a fixed tariff at 1.5-3 percent plus 5-20 percent ad-valorem import tariffs on oleic and stearic acids originating from animal and vegetable oils. The European Union maintains a tariff rate at 4-12 percent. Canada imposes an import tariff at 8-14.4 percent and Japan 5-9.5 percent. These import tariffs will limit Malaysia's export of palm oil products. Further review also needs to be done on how Malaysia's industry will compete with the oleo-chemical industries in the developed countries.

7. 3. Future Research

This study should be interpreted carefully because of the persistence of heteroscedasticity. This problem is expected from such diverse cross-country observations. Normalization which is a standard procedure in panel data to reduce this heteroscedascity problem, did not overcome this problem. Application of fixed effects and varying slopes also did not help to remedy the problem. Application of NL3SLS in all systems should improve the results because it takes into account a variance-covariance matrix across equations. All of those three approaches should reduce the heteroscedasticity effect. Therefore, the remaining problem may be because this study cannot apply an error components model, as discussed before. With the presence of heteroscedasticity, the estimates are still unbiased and consistent, but their variances are not minimum.

Despite those careful interpretations, the indications that Indonesia is a price taker, that both Malaysia and the European Union have market power, and that buying power from importing countries may increase in the future remain as valid observations. The world price variation in the last twenty years has also shown a decreasing trend (Figure 1), which may also indicate the decline of market power on sellers side. As a complete framework of analysis on palm oil market, this analysis provides additional information on the dynamics of the world market of palm oil and also vegetable oils in general. Future research should be done by estimating conjectural variations in the model, adding more data on individual countries, using different functional forms to improve results, and by investigating using different approaches for comparison.

REFERENCES

Alwi, Ali. *An Economic Analysis of Trade Liberalization in the International Market for Palm and Related Oils.* Ph.D. Dissertation. Colorado State University, 1997.

Appelbaum, Elie. "Testing Price Taking Behavior." *Journal of Econometrics.* 9(1979):283-294.

Arnade, Carlos, Daniel Pick and M. Gopinath. "Testing Oligopoly Power in Domestic and Export Markets." *Applied Econometrics.* 30(1998):753-760

Azzam, Azzedine M. "Estimating the Degree of Dominance in a Bilateral Oligopoly." *Applied Economics Letters,* 3(1996):209-211.

Baltagi, Badi H. "Simultaneous Equations with Error Components." *Journal of Econometrics.* 17(1981):189-200.

Baltagi, Badi H. *Econometric Analysis of Panel Data.* John Wiley and Sons, New York, 1995.

Baltagi, Badi, and James Griffin. "Pooled Estimators vs. Their Heterogenous Counterparts in the Context of Dynamic Demand for Gasoline." *Journal of Econometrics.* 77(1997):303-327.

Bek-Nielse, Tan Sri Dato'. *"The Growth of Malaysian Palm Oil Industry in Relation to the Global Utilization of Edible Oil".* Paper presented in the 32nd Canola Council of Canada. Mexico City 14-17 March, 1999.

Bevan, David. L., Paul Collier and J.W. Gunning. *Nigeria and Indonesia: The Political Economy of Poverty, Equity and Growth.* The World Bank, 1999.

Bhuyan, Sanjib, and R. A. Lopez. "Oligopoly Power and Allocative Efficiency in U.S. Food and Tobacco Industries." *Journal of Agricultural Economics.* 49(1998):434-442.

Boyer, Kenneth D. "Can Market Power Really be Estimated?." *Review of Industrial Organization.* 11(1996):115-124., Kluwer Academic Publisher, the Netherlands.

Bowley, A.L. "Bilateral Monopoly." *Economic Journal.* XXXVIII (1928).

Bresnahan, Timothy F. "The Oligopoly Solution Concept is Identified." *Economics Letters* 10(1982):87-92.

Buschena, David E., and Jeffrey M. Perloff. "The Creation of Dominant Firm Market Power in the Coconut Oil Export Market." *American Journal of Agricultural. Economics* (1991):1000-1008.

Carter, Collin, Funing Zhong and Zang Cai. *China's Ongoing Agricultural Reform.* The 1990 Institute, San Francisco, 1996.

Chamberlain, Gary. "Multivariate Regression Models for Panel Data." *Journal of Econometrics* 18(1982) :5-46.

Chamberlain, Gary. "Panel Data." In *Handbook of Econometrics.* Edited by Griliches and Michael D. Intrilligator. North-Holland, Amsterdam, 1984.

Chengula, Ladisy, K. *Estimation of Oligopolistic Behavior in the Cashew Kernel Export Market: A Simultaneous Equations and Panel Data Analysis.* Ph. D. Dissertation. Colorado State University, 1997.

Cogels, Pascal. *"Oilseed Utilization in Europe".* Paper presented in the 32nd Canola Council of Canada. Mexico City 14-17 March, 1999.

Cornwell, C., Peter Schmidt and Robin Sickles. "Production Frontiers with Cross-sectional and Time-series Variation in Efficiency Levels." *Journal of Econometrics.* 46(1990):185-200.

Cornwell, C., Peter Schmidt and D. Wyhowski. "Simultaneous Equation and Panel Data." *Journal of Econometrics.* 51(1992):151-181.

Corts, Kenneth S. "Conduct Parameters and the Measurement of Market Power." *Journal of Econometrics,* 88(1999):227-250.

Deodhar, S. Y., and Ian M. Sheldon. "Market Power in the World Market for Soymeal Exports." *Journal of Agricultural. and Resource Economics.* 22(1997):78-86

Ender, Gary. *Malaysia's Production of Palm Oil with Projections to Year 2000.* International Economics Division, ERS, USDA, 1985.

Erickson, Gary M. "Dynamic Conjectural Variations in A Lanchaster Oligopoly." *Management Science.* 43(1997):1603-1608.

FAO. *Report on Intergovernmental Group on Oilseeds, Oils and Fats to the Committee on Commodity Problems.* Rome, 1980.

FAO. *The Commodity Trade Implications of the EEC Enlargement.* FAO Economic and Social Development Paper No. 26. Rome, 1983.

FAO. *Oilseed and Oils: National Policies of Selected Countries* FAO Economic and Social Development Paper No. 38. Rome, 1984.

FAO. *Production Yearbook.* various years.

Fellner, William. *Competition Among the Few: Oligopoly and Similar Market Structures.* Alfred A. Knopf, New York, 1949.

Friedman, James. *Oligopoly Theory.* Cambridge University Press, 1983.

Genesove, David, and W. P. Mullin. "Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890-1914." *Rand Journal of Economics,* 29(1998):355-377.

Gollop, Frank M., and Mark J. Roberts. "Firm Interdependence in Oligopolistic Markets." *Journal of Econometrics.* 10(1979):313-331

Greene, William H. *Econometric Analysis.* Prentice-Hall Inc., New Jersey, 1997.

Griffith, G. R., and Karl D. Meilke. "Relationships among North American Fats and Oils Prices." *American Journal of Agricultural Economics.* 61(1979):335-341.

Grossman, Gene M. (ed). *Imperfect Competition and International Trade.* The MIT Press, Cambridge, Massachusetts, 1992.

Hicks, J.R. "Annual Survey of Economic Theory: The Theory of Bilateral Monopoly." *Econometrica.* 3(1936):1-20.

Hsiao, Cheng. *Analysis of Panel Data.* Cambridge University Press, Cambridge, 1986.

Hussain, Ashiq, and T.D. Wallace. "The Use of Error Component Models in Combining Cross Section with Time Series Data." *Econometrica.* 37(1969):55-72.

Hyde, Charles E., and Jeffrey M. Perloff. "Can Market Power be Estimated?" *Review of Industrial Organization* 10(1995):465-485.

International Monetary Fund. *International Financial Statistics. various years.*

Iwata, Gyoichi. "Measurement of Conjectural Variations in Oligopoly." *Econometrica*: 42(1974):947-966.

Jomo, K.S., et.al. *Industrial Policy and Emergence of Internationally Competitive Manufacturing Firms in Malaysia.* Foundation for Advanced Studies on International Development (FASID), 1997. (www. fasid. or. jp/ public/ occasional.html)

Kajisa, Kei, M. Maredia and Duncan Boughton. *Transformation versus Stagnation in the Oil Palm Industry: A Comparison Between Malaysia and Nigeria.* Staff Paper No. 97-5. Department of Economics, Michigan State University, 1997.

Karp, Larry S., and Alex McCalla. "Dynamic Games and International Trade: An Application to the World Corn Market." *American Journal of Agricultural Economics.* 65(1983):641-50.

Karp, Larry S., and Jeffrey M. Perloff. "Dynamic Models of Oligopoly in Rice and Coffee Export Markets." In *Agricultural Markets: Mechanisms, Failures and Regulations.* Edited by D. Martimort. North Holland, 1996.

Keaton, Clyde R. *The Palm Oil Industry in West Malaysia.* Foreign Agricultural Services FAS M-276, USDA, 1977.

Kinal, T., and K. Lahiri. "On the Estimation of Simultaneous-Equations Error-Components Models with an Application to a Model of Developing Country Foreign Trade." *Journal of Applied Econometrics.* 8(1993):81-92.

Kolstad, C. D., and A. E. Burris. "Imperfectly Competitive Equilibria in International Commodity Markets." *American Journal of Agricultural Economics.* 68(1986): 27-36.

Koontz, Stephen R., and Phillip Garcia. "Meatpacker Conduct in Fed Cattle-Pricing: An Investigation of Oligopsony Power." *American Journal of Agricultural Economics.* 75(1993):537-548.

Koontz, Stephen R., and Phillip Garcia. "Meat-Packer Conduct in Fed Cattle-Pricing Multiple-Market Oligopsony Power." *Journal of Agricultural and Resource Economics.* 22(1997):87-103

Krouse, Clement G. *Theory of Industrial Economics.* Basil Blackwell, Cambridge, Massachusetts, 1990.

Krouse, Clement G. "Measuring Monopoly Power, Revisited." *Review of Industrial Organization.* 13(1998):687-696.

Lardy, Nicholas R. *Agriculture in China's Modern Economic Development.* Cambridge University Press. 1983.

Larson, Donald F. *Indonesia's Palm Oil Subsector.* Policy Research Working Paper #1654. The World Bank, 1996.

Lau, Lawrence. "On Identifying the Degree of Competitiveness from Industry Price and Output Data." *Economics Letters* 10(1982):93-99.

Lopez, R. A., and Zhikang You. "The Impact of Oligopsony and Taxation on the Haitian Coffee Economy." *World Development.* 21(1993):465-473.

Love, H. Alan, and Endah Murniningtyas. "Measuring the Degree of Market Power Exerted by Government Trade Agencies." *American Journal of Agricultural Economics.* 74(1992):546-555.

Lynam, John. *West African Production and Export Prospect for Palm Oil and Palm Kernel Oil to 1980.* FAS, USDA, 1972.

McCalla, Alex F., and T. E. Josling (ed). *Imperfect Markets in Agricultural Trade.* Allanheld, Osmun and Co. New Jersey, 1981

Mahmood, Amir. "Pakistan's Edible Oil Crisis and the Comparative Advantage of Edible Oil Production Under Alternative Oilseed Processing Technology." *The Indian Economic Journal.* 43(1996):64-73.

Marks, Stephen V., Donald F. Larson and J. Pameroy. "Economic Effect of Taxes on Exports of Palm Oil Products." *Bulletin of Indonesian Economic Studies.* 3(1998):37-58. Australia National University.

Matyas, Lazlo and P. Sevestre (eds). *The Econometrics of Panel Data: Handbook of the Theory with Application.* Kluwer Academic Pub. Dordrecht, Netherland, 1996.

Murniningtyas, Endah. *Does Japan Exert Market Power in the World Wheat Market?.* Masters Thesis. Oregon State University, 1989.

Nicholson, Walter. *Microeconomic Theory: Basic Principles and Extensions.* The Dryden Press, Texas. 1995.

Oda, Shigeaki. "Japan." In *Oilseed Production and Marketing in Asia and the Pacific Region.* Asian Productivity Organization, Tokyo. 1994

Othman, Jamal, et.al. "World Palm Oil Market under Freer Trade: Implication for Malaysia." *ASEAN Economic Bulletin.* 15(1998):168-183, Singapore.

OECD. *Agricultural Policies, Markets and Trade in OECD Countries: Monitoring and Evaluation 1995.* Paris, 1995.

OECD. *Agricultural Policies in OECD Countries: Monitoring and Evaluation.* Paris, 1999.

Owen, A. D., K. Chowdhury and J.R.R. Garrido. "Price Interrelationships in the Vegetable and Tropical Oils Market." *Applied Economics.* 29(1997):119-124.

Owen, A. D., K. Chowdhury and J.R.R. Garrido. "A Market Share Model for Vegetable and Tropical Oils Market." *Applied Economics Letters.* 3(1996):95-99.

Pesaran, M. Hashem. "Estimating long-run Relationships from Dynamic Heterogeneous Panels." *Journal of Econometrics.* 68(1995):79-113.

Peterson, E.B., and John M. Connor. "A Comparison of Oligopoly Welfare Loss Estimates for U.S. Food Manufacturing." *American Journal of Agricultural Economics.* 77(1995):300-308.

Rothatcher, Albecht. *Japan's Agro-Food Sector.* St. Martin's Press, New York, 1989.

Samsudin, Md. Jani, and Syed Abdillah. "Malaysia." In *Oilseed Production and Marketing in Asia and the Pacific Region.* Asian Productivity Organization, Tokyo. 1994

Saragih, Bungaran. "Indonesia." In *Oilseed Production and Marketing in Asia and the Pacific Region.* Asian Productivity Organization, Tokyo. 1994

Schmalensee, Richard, and R. Willig. *Handbook of Industrial Organization.* North-Holland, 1989.

Searle, Peter. *The Riddle of Malaysian Capitalism: Rent-seekers or Capitalists?.* Asian Studies Association of Australia, University of Hawai'i Press, 1999.

Senteri, Zulkifli bin. *An Econometric Analysis of the United States Palm Oil Market.* Ph.D. Dissertation. Ohio State University, 1985.

Sharif, Muhammad. "Pakistan." In *Oilseed Production and Marketing in Asia and the Pacific Region.* Asian Productivity Organization, Tokyo. 1994

Shenoi, P.V. "Integrated Policy for Oilseeds Development in Asian Countries - A Case Study of India." In *Oilseed Production and Marketing in Asia and the Pacific Region.* Asian Productivity Organization, Tokyo. 1994

Skinner, Snider W. *The Agricultural Economy of Nigeria.* ERS-Foreign 329, USDA., 1972.

Spriggs, John. *An Econometric Analysis of Canadian Grains and Oilseeds.* Technical Bulletin No. 1662. ERS, USDA., 1982.

Sumartini, Maria. *Factors Affecting Palm Oil Trade Between Indonesia and the European Community.* Masters Thesis. Mississipi State University, 1990.

Suryana, Ahmad. *Trade Prospect of Indonesian Palm Oil Industry in the International Markets for Fat and Oils.* Ph.D. Dissertation. North Carolina State University, 1986.

Tirole, Jean. T*he Theory of Industrial Organization.* MIT Press, Cambridge, 1988.

The Oil World. *Oil World Annual.* ISTA Mielke, Hamburg. 1984, 1993 and 1998.

United States Bureau of The Census. *Census of Manufactures.* Washington D.C, 1987 and 1992.

United States Bureau of the Census. *Concentration Ratios in Manufacturing.* 1992. (www.census.gov:80/mcd/mancen)

USDA. *Oil Crops: Situation and Outlook Yearbook.* Economic Research Services, various years.

USDA. *Oilseeds and Products: World Markets and Trade.* Foreign Agriculture Services Online. March, 1997.

USDA. *Statistics of Agriculture.* Washington D.C., 1998.

USDA. *Summary of Program Activities, December 1999.* Foreign Agricultural Services Online. (www.fas.usda.gov/excredits/quarterly/1999/dec-sum.html)

Vickner, Steven S., and Stephen P. Davies. "Estimating Market Power and Pricing Conduct in a Product-Differentiated Oligopoly: The Case of the Domestic Spaghetti Sauce Industry." *Journal of Agricultural and Applied Economics.* 31(1999):1-13.

Wallace, T. D., and Ashiq Hussain. "The Use of Error Component Models in Combining Cross Section with Time Series Data." *Econometrica.* 37(1969):55-72.

Waterson, Michael. *Economic Theory of the Industry.* Cambridge University Press, Massachusetts, 1984.

APPENDICES

APPENDIX 1

The World Palm Oil Market Models

1. 1. Triopoly Model

World demand function.

$$q^{D}_{it} = a_0 - a_1 * Pwpo_t + a_2 * Pwso_t + a_3 * Panim_t$$
$$+ a_4 * (Pwpo_t * T) + a_5 * Y_{it}$$

Export supply function from the followers

$$q_{jt}^{fs} = b_o + b_1 * Pwpo_t + b_2 * Pwco + b_3 * X_{jt} + b_4 * R_{jt} + b_5 * Y_{jt} + b_6 * ST_{jt}$$

The world market price when Malaysia act as export leader

$$Pwpo_t = c_0 + c_1 * q_t^{ls} + c_2 * Ppod_{Mt} + c_3 * X_{Mt} + c_4 * W_{Mt}$$
$$+ c_5 * ST_{Mt} - \lambda_M [\frac{q_t^{ls}}{a_1 - b_1 + a_4 * T}]$$

Trade Balance

$$\sum_{i=1}^{3} q_{it}^{D} = \sum_{j=1}^{2} q_{jt}^{fs} + q_t^{ls} = Q \text{ total world trade}$$

1. 2. The Triopsony Model

World Supply function

$$q_{jt}^{S} = d_o + d_1 * Pwpo_t^{w} + d_2 * Pwco_t^{w} + d_3 * (Pwpo_t^{w} * T) + d_4 * X_{jt} + d_5 * Y_{jt}$$

Excess demand from the competitive fringe.

$$q_{it}^{fd} = e_0 + e_1 * Pwpo_t^{w} + e_2 * Pwso_t^{w} + e_3 * Y_{it} + e_4 * ST_{it} + e_5 * T$$

World equilibrium price when EU has buying power

$$Pwpo_t^{w} = g_0 + g_1 * q_t^{ld} + g_2 Pwso_{(-1)}^{EU} + g_3 * Panim_t^{EU} + g_4 * ST_{EU,t} + g_5 * Y_{EU,t} - \lambda_{EU} * \left[\frac{q_t^{ld}}{d_1 - e_1 + d_3 * T}\right]$$

Trade Balance

$$\sum_{i=1}^{2} q_{it}^{fd} + q_t^{ld} = \sum_{j=1}^{3} q_j^{S} = Q \textit{ total world trade}$$

1. 3. Oligopoly Model

The world demand of palm oil

$$q_{it}^{D} = h_0 + h_1 * Pwpo_t + h_2 * Pwso_t + h_3 * Panim_t + h_4 * (Pwpo_t * T) + h_5 * Y_{it} + h_6 * ST_{it}$$

Selling price equations from Indonesia

$$Pwpo_t - t_{Indo,t} = k_0 + k_1 * q_{Indo,t}^{s} + k_2 * Pwco_t + k_4 * Y_{Indo,t} + k_5 * R_{Indo,t}$$

$$+ k_6 * ST_{Indo,t} + k_7 * W_{Indo,t} - \delta_{Indo} \frac{(1 + \gamma_{Indo}) * q_{Indo,t}^{s}}{h_1 + h_4 * T}$$

Selling price equation from *rowex*

$$Pwpo_t - t_{rowex,t} = l_0 + l_1 * q_{rowex,t}^{s} + l_2 * Pwco_t + l_4 * Y_{rowex,t} + l_5 * R_{rowex,t}$$

$$+ l_6 * ST_{rowex,t} + l_7 * W_{kt} - \delta_{rowex} \frac{(1 + \gamma_{rowex}) * q_{rowex,t}^{s}}{h_1 + h_4 * T}$$

Selling price equation from Malaysia

$$Pwpo_t - t_{M,t} = m_0 + m_1 * q_{M,t}^{s} + m_2 * Pwco_t + m_4 * Y_{M,t} + m_5 * R_{M,t} + m_6 * ST_{M,t}$$

$$+ m_7 * W_{M,t} - \delta_M \frac{(1 + \gamma_M) * q_{M,t}^{s}}{h_1 + h_4 * T}$$

Trade Balance

$$q_{Indo,t}^{S} + q_{rowex,t}^{S} + q_{M,t}^{S} = q_{EU,t}^{D} + q_{rowed,t}^{D} + q_{rowing,t}^{D} = Q \textit{ total world trade}$$

1. 4. Oligopsony Model

Excess supply function

$$q_{jt}^{S} = n_0 + n_1 * Pwpo_t^{w} + n_2 * Pwco_t^{w} + n_3 * (Pwpo_t^{w} * T) + n_4 * R_{jt}$$
$$+ n_5 * Y_{jt} + n_6 * ST_{jt} + n_7 * W_{jt}$$

Buying price equations from European Union

$$Pwpo_t^{w} + t_{eu,t} = r_0 + r_1 * q_{eu,t}^{D} + r_2 * Pwso_t^{w} + r_3 * Pwsfl_t^{w} + r_4 * Panim_t^{w}$$
$$+ r_5 * Y_{eu,t} + r_6 * ST_{eu,t} - \lambda_{eu,t} \frac{[1 + \theta_{eu}] * q_{eu,t}^{D}}{(n_1 + n_3 * T)}$$

Buying price equations from *rowed*

$$Pwpo_t^{w} + t_{rowed,t} = s_0 + s_1 * q_{rowed,t}^{D} + s_2 * Pwso_t^{w} + s_3 * Pwsfl_t^{w} + s_4 * Panim_t^{w}$$
$$+ s_5 * Y_{rowed,t} + s_6 * ST_{rowed,t} - \lambda_{rowed} \frac{[1 + \theta_{rowed}] * q_{rowed,t}^{D}}{(n_1 + n_3 * T)}$$

Buying price equations from *rowing*

$$Pwpo_t^{w} + t_{rowing,t} = p_0 + p_1 * q_{rowing,t}^{D} + p_2 * Pwso_t^{w} + p_3 * Pwsfl_t^{w} + p_4 * Panim_t^{w}$$
$$+ p_5 * Y_{rowing,t} + p_6 * ST_{rowing,t} - \lambda_{rowing} \frac{[1 + \theta_{rowing}] * q_{rowing,t}^{D}}{(n_1 + n_3 * T)}$$

Trade Balance

$$q_{Indo,t}^{S} + q_{rowex,t}^{S} + q_{M,t}^{S} = q_{EU,t}^{D} + q_{rowed,t}^{D} + q_{rowing,t}^{D} = Q \text{ total world trade}$$

APPENDIX 2

SAS Program and Results

2. 1. Triopoly: Malaysia as a Leading Exporting Country

2. 1. 1. Program

```
****stak3s.sas: triopoly;
**FIND ESTIMATES FOR PARAMETERS USING NL3SLS;
**DATA A: IS A POOL DATA OF THREE IMPORTING COUNTRIES, TO
ESTIMATE EQUATION I;
**DATA B: IS A POOL DATA OF TWO FRINGE EXPORTERS TO ESTIMATE
FRINGE'S SUPPLY
**EQUATION;
**DATA C: IS A TIME SERIES DATA OF LEADING SUPPLIER TO ESTIMATE
PRICE FOR PROFIT MAX. EQUATION
**FOR LEADING COUNTRY BECAUSE LEADING ACT AS MONOPOLY;
data a;
infile 'a:dat41at.sas';
input year dworld pwpo1 pwso1 pwco1 pwsfl1 pwr1 yim stim teum trend pveg1 panim1;
pwpot=pwpo1*trend;
data b;
infile 'a:dat41b.sas';
input year sfringe yfr stfr pwpo2 pwco2 pwsfl2 pwr2 pous2 cous2  xfr rfr pveg2 panim2;
data c;
infile 'a:dat41c.sas';
input year slead stm wm ppm ppom cpim pwpo3 pwso3 sous3 rrate xrate ym trend3
pveg3 panim3;
data market;
merge a b c;
run;
proc model data=market n3sls;
parms a0-a5 b0-b6 c0-c5 f1;
dworld      = a0+a1*pwpo1 + a2*pwso1+a3*pwpot+a4*yim +a5*panim1;
sfringe     = b0+b1*pwpo2 + b2*cous2+b3*yfr + b4*xfr + b5*stfr+b6*rfr;
pwpo3       =c0+ c1*slead+ c2*ppom+c3*stm + c4*xrate + c5*wm
            - (f1*slead/(a1-b1+a3*trend3));
```

```
endogenous dworld sfringe pwpo3;
instruments inst1-inst20;
inst1=pwso1*yim;inst2=pwpot;inst3=yim*pwsfl1;inst4=stim;inst5=pwr1;
inst6=pwco2*pwco2;inst7=yfr;inst8=stfr;inst9=xfr;inst10=pwsfl2*xfr;inst11=rfr*panim2
;inst12=ppom;inst13=xrate;inst14=stm;inst15=wm;inst16=ppm;inst17=xrate*rrate;
inst18=stm*wm;inst19=ppom*rrate;inst20=rrate*wm;
fit dworld sfringe pwpo3/ out=raw1 dw white breusch yim;
run;
```

2. 1. 2. Result

```
The SAS System 22:49 Monday, January 24, 2000  90
The MODEL Procedure
Model Summary
Model Variables        3
Endogenous             3
Parameters            20
Equations              3
Number of Statements  23
Model Variables  dworld sfringe pwpo3
Parameters  a0 a1 a2 a3 a4 a5 b0 b1 b2 b3 b4 b5 b6 c0 c1 c2 c3 c4 c5 f1
Equations  dworld sfringe pwpo3
NOTE: The parameter a1 is shared by 2 of the equations to be estimated.
NOTE: The parameter a3 is shared by 2 of the equations to be estimated.
NOTE: The parameter b1 is shared by 2 of the equations to be estimated.
The 3 Equations to Estimate
dworld =  F(a0(1), a1(pwpo1), a2(pwso1), a3(pwpot), a4(yim), a5(panim1))
sfringe =  F(b0(1), b1(pwpo2), b2(cous2), b3(yfr), b4(xfr), b5(stfr), b6(rfr))
pwpo3 =  F(a1, a3, b1, c0(1), c1(slead), c2(ppom), c3(stm), c4(xrate), c5(wm), f1)
Instruments  1 inst1 inst2 inst3 inst4 inst5 inst6 inst7 inst8 inst9 inst10 inst11 inst12
inst13 inst14 inst15 inst16 inst17 inst18 inst19 inst20
NOTE: At 3SLS Iteration 1 CONVERGE=0.001 Criteria Met.
The MODEL Procedure
Model  3SLS Estimation Summary
Data Set Options
DATA       =  MARKET
OUT  =  RAW1
Minimization Summary
Parameters Estimated       20
Method                     Gauss
Iterations                 1
```

Final Convergence Criteria

R	0.000018
PPC(f1)	0.000073
RPC(a0)	0.008857
Object	3.298E-6
Trace(S)	0.679768
Objective Value	0.280235

Observations Processed

Read	132
Solved	132

The MODEL Procedure Nonlinear 3SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq	Durbin Watson
dworld	5	127	71.4681	0.5627	0.7502	0.6246	0.6128	1.6628
sfringe	6.5	125.5	12.3315	0.0983	0.3135	0.9249	0.9217	0.6825
pwpo3	8.5	123.5	2.3179	0.0188	0.1370	0.9913	0.9908	1.3248

Nonlinear 3SLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
a0	0.012743	0.0923	0.14	0.8904
a1	-4.87801	0.9055	-5.39	<.0001
a2	2.036116	0.4462	4.56	<.0001
a3	0.682074	0.1247	5.47	<.0001
a4	-2.22462	0.5518	-4.03	<.0001
a5	1.904113	0.3923	4.85	<.0001
b0	-0.01621	0.0334	-0.49	0.6280
b1	0.038947	0.0896	0.43	0.6647
b2	-0.13582	0.1020	-1.33	0.1853
b3	0.227291	0.0566	4.01	0.0001
b4	0.916139	0.1000	9.16	<.0001
b5	0.016547	0.0520	0.32	0.7510
b6	-0.05783	0.0841	-0.69	0.4927
c0	0.00085	0.0131	0.07	0.9482
c1	-1.42571	0.3037	-4.69	<.0001
c2	0.831383	0.0545	15.24	<.0001
c3	0.049813	0.0519	0.96	0.3390
c4	0.105858	0.0179	5.91	<.0001
c5	0.315515	0.2137	1.48	0.1424
f1	1.419623	1.1435	1.24	0.2168

Number of Observations		Statistics for System	
Used	132	Objective	0.2802
Missing	0	Objective*N	36.9910

2. 2. Triopsony: European Union as a Leading Importing Country

2. 2. 1 Program

```
****stakeulg.sas: duopsony;
data a;
infile 'a:datsuplg.sas';
input year supply yex stex stexlg pwpo1 pwco1 pwco1lg pwsfl1 pwr1 pwpo1lg cous1
xrate rrate panim1 trend1 pwpot;
**proc print;
**run;
data b;
infile 'a:defrilg.sas';
input year demand1 pwpo2 pwso2 pwso2lg pwco2 pwsfl2 pwr2 yim2  stim2 stim2lg
pveg2 panim2 trend2;
**run;
data c;
infile 'a:deleadlg.sas';
input year demand2 pwpo3 pwpo3lg pwso3 pwso3lg pwco3 pwsfl3 pwr3 yim3 stim3
stim3lg pveg3 panim3 trend3 pwpo7;
**proc print;
**run;
data d;
infile 'a:dumlag.sas';
input year d1 d2 d3 d4 d5;
*run;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a6 b0-b6 c0-c6 f1;
supply = a0+ a1*pwpo1 + a2*pwco1 + a3*pwpot + a4*yex + a5*stex;
demand1= b0+b1*pwpo2 + b2*pwso2 + b3*yim2 + b4*stim2 + b5*trend2;
pwpo3= c0+ c1*demand2 + c2*pwso3lg + c3*stim3 + c4*yim3 + c5*panim3
- (f1*demand2/(a1 - b1+a3*trend3));
endogenous supply demand1 pwpo3;
instruments inst1-inst19;
inst1=pwco1*yex;inst2=pwpot;inst3=yex*pwsfl1;inst4=stex;inst5=pwr1;inst6=pwco2*p
wco2;inst7=yim2;inst8=stim2;inst9=pwsfl2;inst10=pwsfl2*yim2;inst11=panim2*panim2
;inst12=pwso3;inst13=yim3;inst14=stim3;inst15=pwr3;inst16=pwco3;inst17=stim3*stim
3;inst18=stim3*yim3;inst19=yex*stex;fit supply demand1 pwpo3/ out=raw1 dw;
run;
```

2. 2. 2. Result

The SAS System 00:51 Saturday, February 12, 2000 13
The MODEL Procedure
Model Summary
Model Variables 3
Endogenous 3
Parameters 22
Equations 3
Number of Statements 22
Model Variables supply demand1 pwpo3
Parameters a0 a1 a2 a3 a4 a5 a6 b0 b1 b2 b3 b4 b5 b6 c0 c1 c2 c3 c4 c5 c6 f1
Equations supply demand1 pwpo3
NOTE: The parameter a1 is shared by 2 of the equations to be estimated.
NOTE: The parameter a3 is shared by 2 of the equations to be estimated.
NOTE: The parameter b1 is shared by 2 of the equations to be estimated.
The 3 Equations to Estimate
supply = F(a0(1), a1(pwpo1), a2(pwco1), a3(pwpot), a4(yex), a5(stex))
demand1 = F(b0(1), b1(pwpo2), b2(pwso2), b3(yim2), b4(stim2), b5(trend2))
pwpo3 = F(a1, a3, b1, c0(1), c1(demand2), c2(pwso3lg), c3(stim3), c4(yim3), c5(panim3), f1)
Instruments 1 inst1 inst2 inst3 inst4 inst5 inst6 inst7 inst8 inst9 inst10 inst11 inst12 inst13 inst14 inst15 inst16 inst17 inst18 inst19
NOTE: At 3SLS Iteration 2 CONVERGE=0.001 Criteria Met.
The SAS System 00:51 Saturday, February 12, 2000 14
The MODEL Procedure 3SLS Estimation Summary
Data Set Options
DATA= MARKET
OUT= RAW1
Minimization Summary
Parameters Estimated 19
Method Gauss
Iterations 2
Final Convergence Criteria
R 0.000222
PPC(b2) 0.000582
RPC(b2) 0.004165
Object 0.000028
Trace(S) 0.289551
Objective Value 0.2947
Observations Processed
Read 126
Solved 126

The MODEL Procedure Nonlinear 3SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq	Durbin Watson
supply	5	121	26.3507	0.2178	0.4667	0.8691	0.8647	0.9741
demand1	5.5	120.5	3.9593	0.0329	0.1813	0.9713	0.9702	1.3407
pwpo3	8.5	117.5	4.5729	0.0389	0.1973	0.9823	0.9812	1.7412

Nonlinear 3SLS Parameter Estimates

Parameter	Estimate	Approx Std Err	Approx t Value	Pr > |t|
a0	0.031137	0.0580	0.54	0.5924
a1	0.241246	0.1311	1.84	0.0682
a2	-0.29245	0.1561	-1.87	0.0634
a3	0.176018	0.0229	7.68	<.0001
a4	0.039194	0.0861	0.46	0.6496
a5	0.381559	0.0545	7.00	<.0001
b0	-0.00968	0.0196	-0.49	0.6227
b1	-0.28995	0.1180	-2.46	0.0154
b2	0.107392	0.0838	1.28	0.2023
b3	0.903519	0.1832	4.93	<.0001
b4	0.250465	0.0513	4.88	<.0001
b5	-0.28826	0.2643	-1.09	0.2776
c0	-0.00037	0.0193	-0.02	0.9847
c1	1.952377	0.7066	2.76	0.0066
c2	0.257461	0.1646	1.56	0.1204
c3	-0.31995	0.0780	-4.10	<.0001
c4	-0.96974	0.6033	-1.61	0.1107
c5	0.897955	0.1016	8.84	<.0001
f1	1.443344	0.6670	2.16	0.0325

Number of Observations		Statistics for System	
Used	126	Objective	0.2947
Missing	0	Objective*N	37.1321

2. 3. Triopoly: Indonesia as a Leading Exporting Country

2. 3. 1. Program

```
****stak3si.sas: triopoly;
**FIND ESTIMATES FOR PARAMETERS USING NL3SLS;
**DATA A: IS A POOL DATA OF THREE IMPORTING COUNTRIES, TO
ESTIMATE EQUATION I;
**DATA B: IS A POOL DATA OF TWO FRINGE EXPORTERS TO ESTIMATE
FRINGE'S SUPPLY
**EQUATION;
**DATA C: IS A TIME SERIES DATA OF LEADING SUPPLIER TO ESTIMATE
PRICE FOR PROFIT MAX. EQUATION
**FOR LEADING COUNTRY BECAUSE LEADING ACT AS MONOPOLY;
data a;
infile 'a:dat41at.sas';
input year dworld pwpo1 pwso1 pwco1 pwsfl1 pwr1 yim stim teum trend pveg1 panim1;
pwpot=pwpo1*trend;
data b;
infile 'a:dat41bm.sas';
input year sfringe yfr stfr pwpo2 pwco2 pwsfl2 pwr2 pous2 cous2  xfr rfr pveg2 panim2;
data c;
infile 'a:dat41ci.sas';
input year slead stindo windo ppindo ppoindo cpim pwpo3 pwso3 sous3 rrate xrate ym
trend3 pveg3 panim3;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a6 b0-b6 c0-c5 f1;
dworld       = a0+ a1*pwpo1 + a2*pwso1+a3*pwpot + a4*stim + a5*yim +
a6*panim1;
sfringe      = b0+b1*pwpo2 + b2*stfr + b3*xfr+b4*yfr+b5*rfr+b6*pwco2;
pwpo3        =c0+ c1*slead+ c2*ppoindo + c3*stindo + c4*rrate + c5*windo
             - (f1*slead/(a1-b1+a3*trend3));
endogenous dworld sfringe pwpo3;
instruments inst1-inst20;
inst1=pwso1*yim;inst2=pwpot;inst3=yim*pwsfl1;inst4=stim;inst5=pwr1;
inst6=pwco2*pwco2;inst7=yfr;inst8=stfr;inst9=xfr;inst10=pwsfl2*xfr;inst11=rfr*panim2
;inst12=ppoindo;inst13=xrate;inst14=stindo;inst15=windo;inst16=ppindo;inst17=xrate*rr
ate;inst18=stindo*windo;inst19=ppoindo*rrate;inst20=rrate*windo;
fit dworld sfringe pwpo3/ out=raw1;run;
```

2. 3. 2. Result

The MODEL Procedure
Model Summary

Model Variables	3
Endogenous	3
Parameters	23
Equations	3
Number of Statements	23

Model Variables dworld sfringe pwpo3
Parameters a0 a1 a2 a3 a4 a5 a6 a7 b0 b1 b2 b3 b4 b5 b6 c0 c1 c2 c3 c4 c5 c6 f1
Equations dworld sfringe pwpo3
NOTE: The parameter a1 is shared by 2 of the equations to be estimated.
NOTE: The parameter a3 is shared by 2 of the equations to be estimated.
NOTE: The parameter b1 is shared by 2 of the equations to be estimated.
The 3 Equations to Estimate
dworld = F(a0(1), a1(pwpo1), a2(pwso1), a3(pwpot), a4(stim), a5(yim), a6(panim1))
sfringe = F(b0(1), b1(pwpo2), b2(stfr), b3(xfr), b4(yfr), b5(rfr), b6(pwco2))
pwpo3 = F(a1, a3, b1, c0(1), c1(slead), c2(ppoindo), c3(stindo), c4(rrate), c5(windo), f1)
Instruments 1 inst1 inst2 inst3 inst4 inst5 inst6 inst7 inst8 inst9 inst10 inst11 inst12 inst13 inst14 inst15 inst16 inst17 inst18 inst19 inst20
NOTE: At 3SLS Iteration 1 CONVERGE=0.001 Criteria Met.
The MODEL Procedure
3SLS Estimation Summary
Data Set Options
DATA= MARKET
OUT= RAW1
Minimization Summary

Parameters Estimated	21
Method	Gauss
Iterations	1

Final Convergence Criteria

R	0.000072
PPC(f1)	0.000247
RPC(a1)	0.314801
Object	0.000033
Trace(S)	0.496423
Objective Value	0.377456

Observations Processed

Read	132
Solved	132

The MODEL Procedure Nonlinear 3SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
dworld	6	126	15.5337	0.1233	0.3511	0.9184	0.9152
sfringe	6.5	125.5	11.8908	0.0947	0.3078	0.9276	0.9245
pwpo3	8.5	123.5	34.3814	0.2784	0.5276	0.8711	0.8633

Nonlinear 3SLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
a0	-0.01699	0.0432	-0.39	0.6948
a1	-0.01149	0.1329	-0.09	0.9312
a2	-0.1535	0.1134	-1.35	0.1782
a3	0.035061	0.0295	1.19	0.2364
a4	0.403326	0.0370	10.90	<.0001
a5	0.349069	0.1194	2.92	0.0041
a6	0.078093	0.1086	0.72	0.4735
b0	-0.01555	0.0328	-0.47	0.6362
b1	0.021822	0.1144	0.19	0.8491
b2	0.037843	0.0529	0.71	0.4760
b3	0.876269	0.0941	9.32	<.0001
b4	0.232869	0.0555	4.19	<.0001
b5	-0.05565	0.0831	-0.67	0.5042
b6	-0.10382	0.1218	-0.85	0.3957
c0	0.018013	0.0503	0.36	0.7207
c1	-0.57482	0.2015	-2.85	0.0051
c2	1.542291	0.1712	9.01	<.0001
c3	-0.27054	0.2019	-1.34	0.1826
c4	0.280901	0.1970	1.43	0.1565
c5	-0.9081	0.3001	-3.03	0.0030
f1	-0.01212	0.0129	-0.94	0.3497

Number of Observations		Statistics for System	
Used	132	Objective	0.3775
Missing	0	Objective*N	49.8242

2. 4. Oligopoly: All Exporting Countries have Market Power

2. 4. 1 Program

1. poligo1.sas

```
data a;
infile 'a:datdem.sas';
input year d01 d02 d03 demand pwpo1 pwso pwco1 pwsfl pwr1 yim stim pveg1 panim1
trend1 pwpot deu dewed dewing;
pwpot=pwpo1*trend1;
data b;
infile 'a:datsup.sas';
input year supply ycap stock ppdi ppdw ppdm wage ppi pwpo2 pwco2 pwpo3 pwr2
pwpo4 cous xrate rrate
pveg2 panim2 trend2 srowex sm sindo;
pwpo5=pwpo2;
pwpo6=pwpo2;
data c;
infile 'a:conjs.sas';
input year conj1 conj2 conj3;
run;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a9 b0-b6 c0-c6 d0-d6 f1 f2 f3;
demand =    a0+a1*d01+a2*d02+a3*d03 + a4*pwpo1 + a5*pwso
            + a6*pwpot + a7*yim + a8*panim1+a9*stim;
pwpo2 =     b0 +b1*sindo+b2*ycap +b3*stock+b4*wage+b5*rrate +b6*cous
            - (f1*sindo)*(1+conj1)/(a4+a6*trend2);
pwpo5 =     c0+ c1*srowex+c2*ycap+c3*stock+c4*wage+c5*rrate+c6*cous
            - (f2*srowex)*(1+conj2)/(a4+a6*trend2);
pwpo6 =     d0+d1*sm+d2*ycap+d3*stock+d4*wage+d5*rrate +d6*cous
            - (f3*sm)*(1+conj3)/(a4+a6*trend2);
endogenous demand pwpo2 pwpo5 pwpo6;
instruments d01 d02 d03 trend1 pwso yim stim pwr1 pwsfl ycap stock
wage rrate pwco2 conj1 conj2 conj3;
restrict a0=0;
*fit demand pwpo2 pwpo5 pwpo6/ out=raw1;
```

2: poligo1.sas

```
data a;
infile 'a:datdem.sas';
```

```
input year d01 d02 d03 demand pwpo1 pwso pwco1 pwsfl pwr1 yim stim pveg1 panim1
trend1 pwpot deu dewed dewing;
pwpot=pwpo1*trend1;
data b;
infile 'a:datsup.sas';
input year supply ycap stock ppdi ppdw ppdm wage ppi pwpo2 pwco2 pwpo3 pwr2
pwpo4 cous xrate rrate
pveg2 panim2 trend2 srowex sm sindo;
pwpo5=pwpo2;
pwpo6=pwpo2;
data c;
infile 'a:conjs3.sas';
input year conj1 conj2 conj3;
run;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a9 b0-b6 c0-c6 d0-d6 f1 f2 f3;

demand =   a0+a1*d01+a2*d02+a3*d03 + a4*pwpo1 + a5*pwso
           + a6*pwpot + a7*yim + a8*panim1+a9*stim;
pwpo2 =    b0 +b1*sindo+b2*ycap +b3*stock+b4*wage+b5*rrate +b6*cous
           - (f1*sindo)*(1+conj1)/(a4+a6*trend2);
pwpo5 =    c0+ c1*srowex+c2*ycap+c3*stock+c4*wage+c5*rrate+c6*cous
           - (f2*srowex)*(1+conj2)/(a4+a6*trend2);
pwpo6 =    d0+d1*sm+d2*ycap+d3*stock+d4*wage+d5*rrate +d6*cous
           - (f3*sm)*(1+conj3)/(a4+a6*trend2);
endogenous demand pwpo2 pwpo5 pwpo6;
instruments d01 d02 d03 trend1 pwso yim stim pwr1 pwsfl ycap stock
wage rrate pwco2 conj1 conj2 conj3;
*restrict a0=0;
*fit demand pwpo2 pwpo5 pwpo6/ out=raw1;
run;
*3. poligo.sas;
data a;
infile 'a:datdem.sas';
input year d01 d02 d03 demand pwpo1 pwso pwco1 pwsfl pwr1 yim stim pveg1 panim1
trend1 pwpot deu dewed dewing;
pwpot=pwpo1*trend1;
data b;
infile 'a:datsup.sas';
```

```
input year supply ycap stock ppdi ppdw ppdm wage ppi pwpo2 pwco2 pwpo3 pwr2
pwpo4 cous xrate rrate
pveg2 panim2 trend2 srowex sm sindo;
pwpo5=pwpo2;
pwpo6=pwpo2;
data c;
infile 'a:conjs4.sas';
input year conj1 conj2 conj3;
run;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a9 b0-b6 c0-c6 d0-d6 f1 f2 f3;
demand =    a0+a1*d01+ a4*pwpo1 + a5*pwso + a6*pwpot + a7*yim + a8*panim1
            +a9*stim;
pwpo2 =     b0 +b1*sindo+b2*ycap +b3*stock+b4*wage+b5*rrate +b6*cous
            - (f1*sindo)*(1+conj1)/(a4+a6*trend2);
pwpo5 =     c0+ c1*srowex+c2*ycap+c3*stock+c4*wage+c5*rrate+c6*cous
            - (f2*srowex)*(1+conj2)/(a4+a6*trend2);
pwpo6 =     d0+d1*sm+d2*ycap+d3*stock+d4*wage+d5*rrate +d6*cous
            - (f3*sm)*(1+conj3)/(a4+a6*trend2);
endogenous demand pwpo2 pwpo5 pwpo6;
instruments d01 d02 d03 trend1 pwso yim stim pwr1 pwsfl ycap stock
wage rrate pwco2 conj1 conj2 conj3;
restrict a0=0;
*restrict f1=0, f2=0, f3=0;
fit demand pwpo2 pwpo5 pwpo6/ out=raw1 dw white breusch yim;
run;
```

2. 4. 2. Result

```
The SAS System 22:49 Monday, January 24, 2000  56
The MODEL Procedure
Model Summary
Model Variables        4
Endogenous             4
Parameters            34
Equations              4
Number of Statements   6
The SAS System  22:49 Monday, January 24, 2000  57
The MODEL Procedure
```

Model Summary
Model Variables 4
Endogenous 4
Parameters 34
Equations 4
Number of Statements 4
The SAS System 22:49 Monday, January 24, 2000 58
The MODEL Procedure
Model Summary
Model Variables 4
Endogenous 4
Parameters 34
Equations 4
Number of Statements 6
NOTE: The parameter a4 is shared by all 4 of the equations to be estimated.
NOTE: The parameter a6 is shared by all 4 of the equations to be estimated.
The 4 Equations to Estimate

demand =	F(a0(1), a1(d01), a4(pwpo1), a5(pwso), a6(pwpot), a7(yim), a8(panim1), a9(stim))
pwpo2 =	F(a4, a6, b0(1), b1(sindo), b2(ycap), b3(stock), b4(wage), b5(rrate), b6(cous), f1)
pwpo5 =	F(a4, a6, c0(1), c1(srowex), c2(ycap), c3(stock), c4(wage), c5(rrate), c6(cous), f2)
pwpo6 =	F(a4, a6, d0(1), d1(sm), d2(ycap), d3(stock), d4(wage), d5(rrate), d6(cous), f3)

Instruments 1 d01 d02 d03 trend1 pwso yim stim pwr1 pwsfl ycap stock wage rrate pwco2 conj1 conj2 conj3
NOTE: At 3SLS Iteration 4 CONVERGE=0.001 Criteria Met.
The MODEL Procedure 3SLS Estimation Summary
Data Set Options
DATA= MARKET
OUT= RAW1
Minimization Summary
Parameters Estimated 31
Method Gauss
Iterations 4
Subiterations 1
Average Subiterations 0.25
Final Convergence Criteria
R 0.000669
PPC(b3) 0.007769
RPC(c4) 0.03829
Object 0.000057

Trace(S) 3.030338
Objective Value 0.039421
Observations Processed
Read 132
Solved 132
The MODEL Procedure Nonlinear 3SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq	DW
demand	5.5	126.5	7.4679	0.0590	0.2430	0.9645	0.9633	0.9491
pwpo2	8.5	123.5	92.1807	0.7464	0.8639	0.8176	0.8065	2.2786
pwpo5	8.5	123.5	116.1	0.9400	0.9695	0.7703	0.7563	2.2010
pwpo6	8.5	123.5	158.6	1.2845	1.1333	0.6861	0.6670	2.3177

Nonlinear 3SLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|	Label
a0	0	0	.	.	
a1	0.725463	0.0746	9.72	<.0001	
a4	-0.0127	0.00406	-3.12	0.0022	
a5	-0.09008	0.0786	-1.15	0.2542	
a6	0.071285	0.0220	3.24	0.0015	
a7	0.565813	0.0750	7.54	<.0001	
a8	0.006608	0.0762	0.09	0.9310	
a9	0.141055	0.0276	5.10	<.0001	
b0	0.014289	0.0896	0.16	0.8735	
b1	-0.63747	0.3689	-1.73	0.0865	
b2	0.446602	0.1730	2.58	0.0110	
b3	-0.0062	0.1211	-0.05	0.9593	
b4	0.056458	0.1503	0.38	0.7078	
b5	0.10045	0.0788	1.27	0.2048	
b6	1.027709	0.1201	8.55	<.0001	
c0	0.0154	0.1002	0.15	0.8781	
c1	-0.36018	0.2883	-1.25	0.2139	
c2	0.313576	0.2082	1.51	0.1346	
c3	0.076451	0.1294	0.59	0.5557	
c4	0.016079	0.1524	0.11	0.9162	
c5	0.056498	0.1019	0.55	0.5804	
c6	1.183424	0.1224	9.67	<.0001	
d0	0.016331	0.1034	0.16	0.8747	
d1	-0.28536	0.5022	-0.57	0.5709	
d2	0.424488	0.1908	2.23	0.0279	
d3	-0.14636	0.1951	-0.75	0.4546	
d4	-0.03776	0.2397	-0.16	0.8751	

d5	0.097956	0.1386	0.71	0.4810
d6	1.149834	0.2163	5.32	<.0001
f1	0.016326	0.0153	1.07	0.2868
f2	0.009091	0.00824	1.10	0.2721
f3	0.024045	0.0258	0.93	0.3536

Number of Observations		Statistics for System	
Used	132	Objective	0.0394
Missing	0	Objective*N	5.2035

2. 5. Oligopsony: All three importing countries have market power

2. 5. 1. Program

```
**A. FIND ESTIMATE OF PARAMETERS USING NL3SLS;
**DATA ARE POOLED: CLASSICAL POOLING ON FIRST EQUATION, AND
POOLING WITH;
**DIFFERENT SLOPES ON TRADE QUANTITY ON THE REST OF THE
STRUCTURAL EQUATION;
****1. poligop.sas: exporters' selling price in the world market;
data a;
infile 'a:datdemp.sas';
input year demand pwpo1 pwpo2 pwpo3 pwso pwco1 pwsfl1 pwr1 yim stim pveg1
panim1 trend1 pwpot deu dewed dewing;
data b;
infile 'a:datsupp.sas';
input year d01 d02 d03 supply ycap stock ppdi ppdw ppdm wage ppi pwpo4 pwco pwsfl
pwr pous cous
xrate rrate pveg2 panim2 trend2 srowex sm sindo;
data c;
infile 'a:condem.sas';
input year coneu coned coning;
run;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a7 b0-b7 c0-c7 d0-d7 f1 f2 f3;
supply =     a0 + (a1 + a2*trend2)*pwpo4 + a3*pwco + a4*ycap + a5*stock +
             a6*rrate + a7*wage;
pwpo1 =      b0 + b1*deu+b2*yim +b3*stim+b4*pwso+b5*pwsfl1+b6*panim1
             - ((f1*deu)*(1+coneu)/(a1+a2*trend1));
pwpo2 =      c0+ c1*dewed+c2*yim+c3*stim+c4*pwso+c5*pwsfl1+c6*panim1
             - (f2*dewed)*(1+coned)/(a1+a2*trend1);
```

```
pwpo3 =     d0+d1*dewing+d2*yim+d3*stim+d4*pwso+d5*pwsfl1+d6*panim1
            - (f3*dewing)*(1+coning)/(a1+a2*trend1);
endogenous supply pwpo1 pwpo2 pwpo3 deu dewed dewing;
instruments trend2 pwco stock rrate wage ycap xrate
yim stim pwso panim1 pwsfl1 pwr1 coneu coned coning;
*fit supply pwpo1 pwpo2 pwpo3/ out=raw1;
*run;
****2. poligop.sas: exporters' selling price in the world market;
data a;
infile 'a:datdemp.sas';
input year demand pwpo1 pwpo2 pwpo3 pwso pwco1 pwsfl1 pwr1 yim stim pveg1
panim1 trend1 pwpot deu dewed dewing;
data b;
infile 'a:datsupp.sas';
input year d01 d02 d03 supply ycap stock ppdi ppdw ppdm wage ppi pwpo4 pwco pwsfl
pwr pous cous
xrate rrate pveg2 panim2 trend2 srowex sm sindo;
data c;
infile 'a:condem1.sas';
input year coneu coned coning;
run;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a7 b0-b7 c0-c7 d0-d7 f1 f2 f3;
supply =    a0 + (a1 + a2*trend2)*pwpo4 + a3*pwco + a4*ycap + a5*stock + a6*rrate
            + a7*wage;
pwpo1 =     b0 + b1*deu+b2*yim +b3*stim+b4*pwso+b5*pwsfl1+b6*panim1
            - ((f1*deu)*(1+coneu)/(a1+a2*trend1));
pwpo2 =     c0+ c1*dewed+c2*yim+c3*stim+c4*pwso+c5*pwsfl1+c6*panim1
            - (f2*dewed)*(1+coned)/(a1+a2*trend1);
pwpo3 =     d0+d1*dewing+d2*yim+d3*stim+d4*pwso+d5*pwsfl1+d6*panim1
            - (f3*dewing)*(1+coning)/(a1+a2*trend1);
endogenous supply pwpo1 pwpo2 pwpo3 deu dewed dewing;
instruments trend2 pwco stock rrate wage ycap xrate
yim stim pwso panim1 pwsfl1 pwr1 coneu coned coning;
*fit supply pwpo1 pwpo2 pwpo3/ out=raw1;
*run;
```

```
****3. poligop.sas: exporters' selling price in the world market;
data a;
infile 'a:datdemp.sas';
input year demand pwpo1 pwpo2 pwpo3 pwso pwco1 pwsfl1 pwr1 yim stim pveg1
panim1 trend1 pwpot deu dewed dewing;
data b;
infile 'a:datsupp.sas';
input year d01 d02 d03 supply ycap stock ppdi ppdw ppdm wage ppi pwpo4 pwco pwsfl
pwr pous cous
xrate rrate pveg2 panim2 trend2 srowex sm sindo;
data c;
infile 'a:condem2.sas';
input year coneu coned coning;
run;
data market;
merge a b c;
run;
***running n3sls;
proc model data=market n3sls;
parms a0-a7 b0-b7 c0-c7 d0-d7 f1 f2 f3;
supply =     a0 + (a1 + a2*trend2)*pwpo4 + a3*pwco + a4*ycap+a5*stock+a6*rrate
             +a7*wage;
pwpo1 =      b0 + b1*deu+b2*yim +b3*stim+b4*pwso+b5*pwsfl1+b6*panim1
             - ((f1*deu)*(1+coneu)/(a1+a2*trend1));
pwpo2 =      c0+ c1*dewed+c2*yim+c3*stim+c4*pwso+c5*pwsfl1+c6*panim1
             - (f2*dewed)*(1+coned)/(a1+a2*trend1);
pwpo3 =      d0+d1*dewing+d2*yim+d3*stim+d4*pwso+d5*pwsfl1+d6*panim1
             - (f3*dewing)*(1+coning)/(a1+a2*trend1);
endogenous supply pwpo1 pwpo2 pwpo3 deu dewed dewing;
instruments trend2 pwco stock rrate wage ycap xrate
yim stim pwso panim1 pwsfl1 pwr1 coneu coned coning;
fit supply pwpo1 pwpo2 pwpo3/ out=raw1 dw white breusch ycap;
run;
```

*2. 5. 2. **Result***

```
The SAS System  22:49 Monday, January 24, 2000  77
The MODEL Procedure
Model Summary
Model Variables      7
Endogenous           7
Parameters           35
Equations            4
```

Number of Statements 4
NOTE: The parameter a1 is shared by all 4 of the equations to be estimated.
NOTE: The parameter a2 is shared by all 4 of the equations to be estimated.
The 4 Equations to Estimate
supply = F(a0(1), a1(pwpo4), a2, a3(pwco), a4(ycap), a5(stock), a6(rrate), a7(wage))
pwpo1 = F(a1, a2, b0(1), b1(deu), b2(yim), b3(stim), b4(pwso), b5(pwsfl1), b6(panim1), f1)
pwpo2 = F(a1, a2, c0(1), c1(dewed), c2(yim), c3(stim), c4(pwso), c5(pwsfl1), c6(panim1), f2)
pwpo3 = F(a1, a2, d0(1), d1(dewing), d2(yim), d3(stim), d4(pwso), d5(pwsfl1), d6(panim1), f3)
Instruments 1 trend2 pwco stock rrate wage ycap xrate yim stim pwso panim1 pwsfl1 pwr1 coneu coned coning
NOTE: At 3SLS Iteration 3 CONVERGE=0.001 Criteria Met.
The MODEL Procedure 3SLS Estimation Summary
Data Set Options
DATA = MARKET
OUT = RAW1
Minimization Summary
Parameters Estimated 32

Method	Gauss
Iterations	3

Final Convergence Criteria

R	0.000274
PPC(a0)	0.007698
RPC(a0)	0.193601
Object	0.000464
Trace(S)	0.536245
Objective Value	0.345687

Observations Processed

Read	132
Solved	132

The MODEL Procedure

Nonlinear 3SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq	Durbin Watson
supply	6.5	125.5	30.3249	0.2416	0.4916	0.8518	0.8453	1.4080
pwpo1	8.5	123.5	12.4262	0.1006	0.3172	0.9796	0.9783	0.9884
pwpo2	8.5	123.5	13.3171	0.1078	0.3284	0.9781	0.9768	1.0628
pwpo3	8.5	123.5	10.6414	0.0862	0.2935	0.9825	0.9814	1.0646

Nonlinear 3SLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
a0	-0.00116	0.0605	-0.02	0.9847
a1	0.759078	0.2552	2.97	0.0035
a2	0.304223	0.0365	8.34	<.0001
a3	-1.01845	0.2677	-3.80	0.0002
a4	0.101582	0.1217	0.83	0.4056
a5	0.195253	0.0710	2.75	0.0068
a6	0.19626	0.0550	3.57	0.0005
a7	-0.52919	0.0844	-6.27	<.0001
b0	-0.02564	0.0540	-0.47	0.6360
b1	0.117901	0.3130	0.38	0.7071
b2	-0.2501	0.2775	-0.90	0.3692
b3	-0.05095	0.0724	-0.70	0.4831
b4	0.63464	0.1347	4.71	<.0001
b5	-0.19663	0.1797	-1.09	0.2760
b6	0.415699	0.1078	3.86	0.0002
c0	-0.02495	0.0370	-0.67	0.5010
c1	0.441345	0.3720	1.19	0.2377
c2	-0.48272	0.3386	-1.43	0.1565
c3	-0.11045	0.0724	-1.53	0.1295
c4	0.620228	0.1233	5.03	<.0001
c5	-0.32549	0.2641	-1.23	0.2202
c6	0.589985	0.1982	2.98	.0035
d0	-0.02316	0.0358	-0.65	0.5188
d1	0.112197	0.2406	0.47	0.6417
d2	-0.23398	0.1907	-1.23	0.2221
d3	-0.09359	0.0535	-1.75	0.0826
d4	0.565474	0.0938	6.03	<.0001
d5	-0.11673	0.1119	-1.04	0.2990
d6	0.408928	0.0719	5.69	<.0001
f1	0.020491	0.0461	0.44	0.6575
f2	0.101195	0.0536	1.89	.0613
f3	-0.15886	0.0861	-1.84	0.0676

Number of Observations		Statistics for System	
Used	132	Objective	0.3457
Missing	0	Objective*N	45.6307

2. 6. The Degree of Dominance in Stackelberg Model

2.6.1 Program

```
****1. a:dom.sas:dominance test: stackelberg;
***running n2sls;
data a;
infile 'a:sulead.sas';
input year supply stm wex ppm ppom cpim pwpo1 pwso1 sous1
rrate xrate ym trend1 pveg1 panim1 dls;
*****proc print;
*****run;
data b;
infile 'a:delead.sas';
input year demand pwpo2 pwpo2lg pwso2 pwso2lg pwco2 pwsfl2 pwr2 yim2 stim2
stimlg pveg2 panim2 trend2;
****proc print;
****run;
data market;
merge a b;
pwpo=(pwpo1+pwpo2)/2;
run;
****proc print;
****run;
***running n2sls;
roc model data=market n2sls;
parms d1 d2 f1 f2;
pwpo2= d1*(0.00085 -1.42517*supply +0.831383*ppom+0.049813*stm+0.105855*xrate
       +0.315361*wex -(1.419623*supply)/(-4.87801-0.038947+0.682074*trend1))
       +d2*(-0.00037 + 1.952377*demand + 0.257461*pwso2lg -0.31995*stim2
       -0.96974*yim2+ 0.897955*panim2- (1.443344*demand)/(0.241246 + 0.28995
       +0.17602*trend2));
endogenous pwpo2 demand supply;
*instruments ppom stm xrate wex pwso1 trend1 pwso2 stim2 yim2 trend2;
instruments ppm pwso1 sous1 rrate ym pwco2 pwsfl2 pwr2 stimlg trend2;
restrict d1+d2=1;
restrict d1>0, d2>0;
fit pwpo2/out=raw1;
run;
data raw1;
set raw1;
rename pwpo=er1;
**proc print;
```

```
**var er1;
run;
*2.**running n2sls;
proc model data=market n2sls;
parms d1 d2 f1 f2;
pwpo2= d1*(0.00085 -1.42517*supply +0.831383*ppom+0.049813*stm+0.105855*xrate
+0.315361*wex -(f1*supply)/(-4.87801-0.038947+0.682074*trend1))
+d2*(-0.00037 + 1.952377*demand + 0.257461*pwso2lg -
0.31995*stim2-0.96974*yim2
+ 0.897955*panim2- (f2*demand)/(0.241246 + 0.28995 +0.17602*trend2));
endogenous pwpo2 demand supply;
*instruments pwr2 panim2 yim2 stim2 trend1 wex ppom stm xrate;
instruments ppm pwso1 sous1 rrate ym pwco2 pwsfl2 pwr2 stimlg trend2;
restrict d1+d2=1;
restrict d1>0, d2>0;
restrict f1>0, f2>0;
fit pwpo2/out=raw1;
run;
data raw1;
set raw1;
rename pwpo=er1;
**proc print;
**var er1;
run;
****1. a:dom.sas:dominance test: stackelberg;
***running n2sls;
data a;
infile 'a:sulead.sas';
input year supply stm wex ppm ppom cpim pwpo1 pwso1 sous1
rrate xrate ym trend1 pveg1 panim1 dls;
*****proc print;
*****run;
data b;
infile 'a:delead.sas';
input year demand pwpo2 pwpo2lg pwso2 pwso2lg pwco2 pwsfl2 pwr2 yim2 stim2
stimlg pveg2 panim2 trend2;
****proc print;
****run;
data market;
merge a b;
pwpo=(pwpo1+pwpo2)/2;
run;
***running n2sls;
```

```
proc model data=market n2sls;
parms d1 d2 f1 f2;
pwpo1= d1*(0.00085 -1.42517*supply +
0.831383*ppom+0.049813*stm+0.105855*xrate
+0.315361*wex -(1.419623*supply)/(-4.87801-0.038947+0.682074*trend1))
+d2*(-0.00037 + 1.952377*demand + 0.257461*pwso2lg -
0.31995*stim2-0.96974*yim2
+ 0.897955*panim2- (1.443344*demand)/(0.241246 + 0.28995 +0.17602*trend2));
endogenous pwpo1 demand supply;
*instruments ppom stm xrate wex pwso1 trend1 pwso2 stim2 yim2 trend2;
instruments ppm pwso1 sous1 rrate ym pwco2 pwsfl2 pwr2 stimlg trend2;
restrict d1+d2=1;
restrict d1>0, d2>0;
fit pwpo1/out=raw1;
run;

*2.**running n2sls;
proc model data=market n2sls;
parms d1 d2 f1 f2;
pwpo1= d1*(0.00085 -1.42517*supply +0.831383*ppom+0.049813*stm+0.105855*xrate
        +0.315361*wex -(f1*supply)/(-4.87801-0.038947+0.682074*trend1))
        +d2*(-0.00037 + 1.952377*demand + 0.257461*pwso2lg - 0.31995*stim2
        -0.96974*yim2+ 0.897955*panim2- (f2*demand)/(0.241246 + 0.28995
+0.17602*trend2));
endogenous pwpo1 demand supply;
*instruments pwr2 panim2 yim2 stim2 trend1 wex ppom stm xrate;
instruments ppm pwso1 sous1 rrate ym pwco2 pwsfl2 pwr2 stimlg trend2;
restrict d1+d2=1;
restrict d1>0, d2>0;
restrict f1>0, f2>0;
fit pwpo1/out=raw1;
run;
```

2. 6. 2. Result

```
The SAS System          00:51 Saturday, February 12, 2000  1
The MODEL Procedure
Model Summary
Model Variables      3
Endogenous           3
Parameters           4
Equations            1
Number of Statements 6
```

Model Variables pwpo2 supply demand
Parameters d1 d2 f1 f2
Equations pwpo2
The Equation to Estimate is
pwpo2 = F(d1, d2)
Instruments 1 ppm pwso1 sous1 rrate ym pwco2 pwsfl2 pwr2 stimlg trend2
NOTE: At 2SLS Iteration 1 CONVERGE=0.001 Criteria Met.
The SAS System 00:51 Saturday, February 12, 2000 2
The MODEL Procedure 2SLS Estimation Summary
Data Set Options
DATA= MARKET
OUT= RAW1
Minimization Summary
Parameters Estimated 1
Method Gauss
Iterations 1
Final Convergence Criteria
R 0
PPC 0
RPC(d2) 0.422764
Object 0.250081
Trace(S) 0.05979
Objective Value 0.03023
Observations Processed
Read 21
Solved 21
The SAS System 00:51 Saturday, February 12, 2000 3

The MODEL Procedure Nonlinear 2SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
pwpo2	1	20	1.1360	0.0568	0.2383	0.9451	0.9451

Nonlinear 2SLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|	Label
d1	0.711382	0.1095	6.50	<.0001	
d2	0.288618	0.1095	2.64	0.0158	
Restrict0	-49.4757	71.9096	-0.69	0.5055	d1+d2=1

Number of Observations   Statistics for System
Used   21   Objective   0.0302
Missing   0   Objective*N   0.6348
The SAS System   00:51 Saturday, February 12, 2000 4
The MODEL Procedure
Model Summary
Model Variables   3
Endogenous   3
Parameters   4
Equations   1
Number of Statements   9
Model Variables pwpo2 supply demand
Parameters d1 d2 f1 f2
Equations pwpo2
The Equation to Estimate is
pwpo2 = F(d1, d2, f1, f2)
Instruments 1 ppm pwso1 sous1 rrate ym pwco2 pwsfl2 pwr2 stimlg trend2
NOTE: At 2SLS Iteration 2 CONVERGE=0.001 Criteria Met.
The SAS System   00:51 Saturday, February 12, 2000 5
The MODEL Procedure
2SLS Estimation Summary
Data Set Options
DATA=   MARKET
OUT=   RAW1
Minimization Summary
Parameters Estimated   3
Method   Gauss
Iterations   2
Final Convergence Criteria
R   0
PPC   0
RPC(f2)   0.718263
Object   0.945932
Trace(S)   0.053411
Objective Value   0.022111
Observations Processed
Read   21
Solved   21

The SAS System   00:51 Saturday, February 12, 2000 6
The MODEL Procedure Nonlinear 2SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
pwpo2	3	18	0.9080	0.0504	0.2246	0.9561	0.9513

Nonlinear 2SLS Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|	Label
d1	0.709027	0.1036	6.84	<.0001	
d2	0.290973	0.1036	2.81	0.0116	
f1	0.955875	0.2737	3.49	0.0026	
f2	1.149441	0.1910	6.02	<.0001	
Restrict0	7.918402	21.3315	0.37	0.7217	d1+d2=1

Number of Observations		Statistics for System	
Used	21	Objective	0.0221
Missing	0	Objective*N	0.4643

2. 7. The Degree of Dominance on Bilateral Oligopoly

2. 7. 1. Program

```
**** Use final results from both sides with dummy on oligopoly;
**** Dominance: bil.oligopoly;
data a;
infile 'a:bdem.sas';
input year demand pwpo1 pwpo2 pwpo3 pwso pwco1 pwsfl pwr1 stim yim pveg1
panim1
trend1 pwpot deu dewed dewing;
data b;
infile 'a:bsup.sas';
input year supply ycap stock ppdi ppdw ppdm wage ppi pwpo4 pwco2 pwpo5 pwr2
pwpo6
cous xrate rrate pveg2 panim2 trend2 srowex sm sindo;
data c;
infile 'a:bcons2.sas';
input year conj1 conj2 conj3;
data d;
infile 'a:bcondm2.sas';
input year coneu coned coning;
data market;
```

```
merge a b c d;
pwpo=(pwpo1+pwpo4)/2;
proc model data=market n2sls;
parms a1-a6 f1-f6;
pwpo=a4*((-0.02564+0.117901*deu-0.2501*yim+0.05095*stim+0.63464*pwso
        -0.19663*pwsfl+0.415699*paniml-((.021*deu)*(1+coneu)/(0.759078+0.304223*
        trend1)))) +a5*((-0.02495 + 0.441345*dewed - 0.48272*yim - 0.11045*stim
        +0.620228*pwso-0.32549*pwsfl+0.589985*paniml-((.101*dewed)*(1+coned)/
        (0.759078 + 0.304223*trend1))))+ a6*((-0.02316+0.112197*dewing
        - 0.23398*yim - 0.09359*stim+0.565474*pwso-0.11673*pwsfl +
0.408928*paniml- ((-.159*dewing)*(1+coning)/(0.759078+0.304223*trend1))))
        +a1*((0.014289-0.63747*sindo+0.446603*ycap-0.0062*stock+0.056457*wage
        +0.100451*rrate+1.027709*cous-((0.016326*sindo)*(1+conj1)/(-0.0127+
        0.071286*trend2)))) +a2*((0.0154-0.36018*srowex+0.313575*ycap
        +0.076451*stock +0.01608*wage+0.056498*rrate +1.183425*cous-
        ((.009091*srowex)*(1+conj2)/(-0.0127+0.071286*trend2))))
        +a3*((0.016331-0.28535*sm+0.424487*ycap-0.14636*stock-0.03776*wage
        +0.097955*rrate+1.149837*cous
        -((.024045*sm)*(1+conj3)/(-0.0127+0.071286*trend2))));
endogenous pwpo sindo srowex sm deu dewed dewing;
instruments yim stim pwso pwsfl paniml trend1
ycap stock wage rrate cous trend2;
*conj1 conj2 conj3;
restrict 1=a1+a2+a3+a4+a5+a6;
restrict a1>0, a2>0, a3>0, a4>0, a5>0, a6>0;
fit pwpo/out=raw1;
run;
```

2. 7. 2. Result

```
The SAS System  00:12 Friday, January 28, 2000  36

The MODEL Procedure
Model Summary
Model Variables        7
Endogenous             7
Parameters            12
Equations              1
Number of Statements  10
Model Variables  pwpo deu dewed dewing sindo srowex sm
Parameters  a1 a2 a3 a4 a5 a6 f1 f2 f3 f4 f5 f6
Equations  pwpo
The Equation to Estimate is pwpo =  F(a1, a2, a3, a4, a5, a6)
```

Instruments 1 yim stim pwso pwsfl paniml trendl ycap stock wage rrate cous trend2
NOTE: At 2SLS Iteration 73 CONVERGE=0.001 Criteria Met.
The MODEL Procedure
2SLS Estimation Summary
Data Set Options
DATA= MARKET
OUT= RAW1
Minimization Summary
Parameters Estimated 1
Method Gauss
Iterations 73
Subiterations 279
Average Subiterations 3.821918
Final Convergence Criteria
R 0
PPC 0
RPC(a3) 0.457377
Object 0.164304
Trace(S) 0.162906
Objective Value 0.062563
Observations Processed
Read 66
Solved 66

The MODEL Procedure Nonlinear 2SLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
pwpo	1	65	9.7744	0.1504	0.3878	0.8456	0.8456

Nonlinear 2SLS Parameter Estimates

	Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|	Label
	a1	1E-8	1.08E-18	9.263E9	<.0001	
	a2	1E-8	4.58E-18	2.182E9	<.0001	
	a3	0.134129	0.0487	2.76	0.0076	
	a4	1E-8	2.77E-19	3.61E10	<.0001	
1	a5	1E-8	1.63E-18	6.125E9	<.0001	
	a6	0.865871	0.0487	17.79	<.0001	
Restrict0		-99.5953	79.7949	-1.25	0.2145	1=a1+a2+a3+a4+a5+a6
Restrict1		8.046216	5.9629	1.35	0.1792	a1>0
Restrict5		10.2699	7.4018	1.39	0.1671	a5>0

Restrict4	14.2155	4.9996	2.84	0.0037	a4>0
Restrict2	6.842222	7.0269	0.97	0.3341	a2>0

Number of Observations		Statistics for System	
Used	66	Objective	0.0626
Missing	0	Objective*N	4.1291

APPENDIX 3

Data Arrangement

3. 1. Triopoly Model[1]

Demand	DEU_t	$Pwpo_t$	Z_k	0	0	0	0	0	0
	Drowedt	$Pwpo_t$	Z_k	0	0	0	0	0	0
	$Drowing_t$	$Pwpo_t$	Z_k	0	0	0	0	0	0
Supply from fringe	0	0	0	$Sindo_t$	$Pwpo_t$	Z_l	0	0	0
	0	0	0	$Srowex_t$	$Pwpo_t$	Z_l	0	0	0
Selling price from Malaysia	0	0	0	0	0	0	$Pwpo_t$	SM_t	Z_m
	it x 1	*it x 1*	*it x (k+1)*	*it x 1*	*it x i*	*it x 1*	*it x 1*	*it x 1*	*it x (m+1)*

[1] World demand function is a pooled from EU, *rowed,* and *rowing*. Fringe supply equation is a pooled data from Indonesia and *rowex*. Selling price from Malaysia is a time series data.

3. 2. Triopsony Model[2]

Supply	$Sindo_t$	$Pwpo_t$	Z_n	0	0	0	0	0	0
	$Srowex_t$	$Pwpo_t$	Z_n	0	0	0	0	0	0
	SM_t	$Pwpo_t$	Z_n	0	0	0	0	0	0
Demand from fringe	0	0	0	Drowedt	$Pwpo_t$	Z_o	0	0	0
	0	0	0	$Drowing_t$	$Pwpo_t$	Z_o	0	0	0
Buying price from leading importer	0	0	0	0	0	0	$Pwpo_t$	DEU_t	Z_p
	it x 1	*it x 1*	*it x (n+1)*	*it x 1*	*it x 1*	*it x (o+1)*	*it x 1*	*it x 1*	*it x (p+1)*

[2] World supply function is a pooled data from Malaysia, Indonesia, and *rowex*. Fringe demand equation is a pooled data from *rowed,* and *rowing.* Buying price from EU is a time series data.

Where : $i = 1, \ldots, 6$ is the number of trading countries.
$t = 1, \ldots, 22$ is the number time series (years).
$k = 1, \ldots, K$ is the number of right hand side variables on world demand function.
$l = 1, \ldots, L$ is the number of right hand side variables on fringe supply equation.
$m = 1, \ldots, M$ is the number of right hand side variables on price equation for Malaysia.
$n = 1, \ldots, N$ is the number of right hand side variables on world supply function.
$o = 1, \ldots, O$ is the number of right hand side variables on fringe demand equation.
$p = 1, \ldots, P$ is the number of right hand side variables on price equation for EU.

3. 3. Oligopoly Model[3]

Demand	DEU_t	1	$Pwpo_t$	Z_{qt}	0	0	0	0	0	0	0
	$Drowed_t$	0	$Pwpo_t$	Z_{qt}	0	0	0	0	0	0	0
	$Drowing_t$	0	$Pwpo_t$	Z_{qt}	0	0	0	0	0	0	0
Selling price	0	0	0	0	$Pwpo_t$	$Pwpo_t$	$Pwpo_t$	$Sindo_t$	0	0	Z_{rt}
equations from	0	0	0	0	$Pwpo_t$	$Pwpo_t$	$Pwpo_t$	0	$Srowex_t$	0	Z_{rt}
exporters	0	0	0	0	$Pwpo_t$	$Pwpo_t$	$Pwpo_t$	0	0	SM_t	Z_{rt}
	it x 1	*it x 1*	*it x 1*	*it x (q+1)*	*it x 1*	*it x 1*	*it x 1*	*it x 1*	*it x 1*	*it x 1*	*it x (r+1)*

[3] Demand function is a pooled data with the use of dummy for EU's intercept. Selling price equation also a pooled data by using different slope for quantitity supplied from each exporting country.

3. 4. Oligopsony[4]

Supply	$Sindo_t$	$Pwpo_t$	Z_{st}	0	0	0	0	0	0	0
	$Srowex_t$	$Pwpo_t$	Z_{st}	0	0	0	0	0	0	0
	SM_t	$Pwpo_t$	Z_{st}	0	0	0	0	0	0	0
Buying price	0	0	0	$Pwpo_t$	$Pwpo_t$	$Pwpo_t$	DEU_t	0	0	Z_{ut}
equations for	0	0	0	$Pwpo_t$	$Pwpo_t$	$Pwpo_t$	0	$Drowed_t$	0	Z_{ut}
importers	0	0	0	$Pwpo_t$	$Pwpo_t$	$Pwpo_t$	0	0	$Drowing_t$	Z_{ut}
	it x 1	*it x 1*	*it x (s+1)*	*it x 1*	*it x 1*	*it x 1*	*it x 1*	*it x 1*	*it x 1*	*it x (u+1)*

[4] Supply function is a pooled data from three exporting countries. Buying price equation also a pooled data by using different slope for quantitity supplied from each importing country.

Where : $i = 1, \ldots, 6$ is the number of trading countries.
$t = 1, \ldots, 22$ is the number time series (years).
$q = 1, \ldots, Q$ is the number of right hand side variables on world demand function.
$r = 1, \ldots, R$ is the number of right hand side variables on selling price equations..
$s = 1, \ldots, S$ is the number of right hand side variables on world supply function.
$u = 1, \ldots, U$ is the number of right hand side variables on buying price functions.

APPENDIX 4

Conversion of the Market Power Parameter.

4. 1. Triopoly Model

Selling price equation:

$$Pwpo_t = c_0 + c_1 * q_t^{ls} + c_2 * Ppod_{Mt} + c_3 * X_{Mt} + c_4 * W_{Mt}$$

$$+ c_5 * ST_{Mt} - \lambda_M \left[\frac{q_t^{ls}}{a_1 - b_1 + a_4 * T} \right]$$

Given:

$\lambda^M = 1.419$; $a_1 = -4.878$; $b_1 = 0.039$; $a_4 = 0.6821$; and $c_1 = -1.426$

The value of:

$$\lambda_M \left[\frac{1}{a_1 - b_1 + a_3 * T} \right] = 1.419 \text{ x } [\ 1/\ (-4.878 - .039 + .6821\ (1.771)]$$

$$= 1.419/3.709 = 0.3825$$

This value in proportion to the parameter on the quantity (c_1) in the above price equation

is equal to converted market power = 0.383/1.426 = 0.27.

4. 2. Triopsony model

Buying price equation.

$$Pwpo_t^{w} = g_0 + g_1 * q_t^{ld} + g_2 Pwso_t^{EU} + g_3 * Panim_t^{EU} + g_4 * ST_{EU,t}$$

$$+ g_5 * Y_{EU,t} - \lambda_{EU} * [\frac{q_t^{ld}}{d_1 - e_1 + d_3 * T}]$$

Given:

$\lambda^{EU} = 1.443$; $d_1 = 0.241$; $e_1 = -0.290$; $d_3 = 0.176$; and $g_1 = 1.952$

The value of:

$$\lambda_{EU}[\frac{1}{d_1 - e_1 + d_3 * T}] = 1.443 \times [1/(0.241 +0.29 + .176 (1.771)]$$

$$= 1.443/0.8427 = 1.712$$

This value in proportion to the parameter on the quantity (g_1) in the above price equation is equal to converted market power = 1.712/1.952 = 0.88.

APPENDIX 5

Estimations of Market Power Impositions from Other Trading Countries

Appendix 5. 1. Estimates of Parameters when Indonesia as Leading Exporter

		World Demand (1000 ton)			
				Marginal	Elasticity
Variables		Values	t-value	Effect[1]	
constant		-0.017	0.39	-	-
Pwpo (USD/ton)	-	-0.011	0.09	-0.10	-0.008
Substitute prices:					
- Soybean oil (USD/ton)	+	-0.154	1.35	-1.72	-0.14
- Animal oil (USD/ton)	+	0.078	0.11	0.98	0.08
Pwpo*trend		0.035	10.9	0.01	-
Income (USD/cap)	+	0.349	2.92	0.09	0.15
Stock (1000 ton)	-	0.403	10.90	2.96	0.42
R^2		0.918			
		Supply of fringe exporters (1000 tons)			
constant		-0.016	0.47	-	-
Pwpo (USD/ton)	+	0.022	0.19	0.47	0.04
Pwco (USD/ton)	-	-0.104	0.85	-1.22	-0.13
Income (USD/cap)	-	0.233	4.19	0.39	0.24
Exchange rate (curr/USD)	+/-	0.876	9.32	309.30	3.14
Stock (1000 tons)	+	0.038	0.71	0.23	0.03
Interest rate (%)	-	-0.056	0.67	-49.41	-0.11
R^2		0.928			
		World (selling) Price (USD/ton)			
					Flexibility
constant		0.018	0.36	-	-
Leader's supply (1000 tons)	-	-0.575	2.85	-0.10	-0.21
Domestic price (USD/ton)	+	1.542	9.01	1.18	0.85
Stock (1000 tons)	+	-0.271	1.34	-0.01	-0.008
Interest rate (%)	-	0.281	1.43	3.73	0.13
Wage (USD/hr)	-	-0.908	3.03	-146.75	-0.58
Market power	+	*-0.012*	*0.94*	-0.002	-
R^2	0.871				

[1] Due to normalization, marginal effect is obtained by multiplying each slope by its standard deviation used in the normalization process.

Appendix 5. 2. Estimates of Parameters of the Oligopoly Model

World Demand (1000 tons)					
	Expected			Marginal	Elasticity
Variables	signs	Values	t-value	Effect	
constant		0.00001	0.06	-	-
Dummy on EU	+/-	0.725	9.68	-	-
Pwpo (USD/ton)	+	-0.013	3.11	0.11	-0.008
Pwso (USD/ton)	+	-0.090	1.14	-0.90	-0.073
Panim (USD/ton)	+	0.007	0.09	0.09	0.006
Pwpot		0.071	3.22	-	-
Income (USD/cap)	+	0.566	7.49	0.13	0.221
Stock (1000 tons)	-	0.141	5.07	0.49	0.071
R^2		0.965			
World (selling) price from Indonesia (USD/ton)					Flexibility
constant		0.014	0.16	-	-
Quantity supply (1000 ton)	-	-0.637	1.73	-0.11	-0.232
Pwco (USD/ton)	+	1.028	8.55	0.65	0.819
Income (USD/cap)	+	0.447	2.58	0.22	0.291
Interest rate (%)	+	0.100	1.27	2.90	0.102
Stock (1000 ton)	-	-0.006	0.05	-0.005	-0.003
Wage (USD/hr)	+	0.056	0.38	7.84	0.031
Market power	+	*0.016*	*1.07*	*0.005*	-
R^2		0.818			
World (selling) price from Rowex (USD/ton)					Flexibility
constant		0.015	0.15	-	-
Quantity supply (1000 ton)	-	-0.360	1.25	-0.10	-0.245
Pwco (USD/ton)	+	1.183	9.67	0.75	0.943
Income (USD/cap)	+	0.314	1.51	0.16	0.204
Interest rate (%)	+	0.056	0.55	1.67	0.057
Stock (1000 ton)	-	0.076	0.59	0.24	0.036
Wage (USD/hr)	+	0.016	0.11	8.20	0.009
Market power	+	*0.009*	*1.10*	*0.005*	-
R^2		0.756			
World (selling) price from Malaysia (USD/ton)					Flexibility
constant		0.016	0.16	-	-
Quantity supply (1000 ton)	-	-0.285	0.57	-0.02	-0.159
Pwco (USD/ton)	+	1.150	5.32	0.73	0.917
Income (USD/cap)	+	0.424	2.23	0.02	0.276
Interest rate (%)	+	0.098	0.71	5.36	0.100
Stock (1000 ton)	-	-0.146	0.75	-0.05	-0.070
Wage (USD/hr)	+	-0.038	0.16	5.31	-0.021
Market power	+	*0.024*	*0.93*	*0.001*	-
R^2		0.686			

Appendix 5. 3. Estimates of Parameters of the Oligopsony Model

Variables	Expected signs	Values	t-value	Marginal Effect	Elasticity
		World Supply			
constant		-0.001	0.02	-	-
Pwpo (USD/ton)	+	0.759	2.97	6.63	0.47
Pwco (USD/ton)	-	-1.018	3.80	-5.62	-0.51
Pwpo*trend		0.304	8.34	-	-
Interest rate (%)	-	0.196	3.57	59.47	0.12
Income (USD/cap)	-	0.102	0.83	0.107	0.04
Stock (1000 ton)	+	0.195	2.75	0.39	0.06
Wage (USD/hr)	-	-0.529	6.27	853.6	-0.18
R^2		0.852			
World (buying price) from EU (USD/ton)					Flexibility
constant		-0.026	0.47	-	-
Quantity demand (1000 ton)	+	0.118	0.38	0.032	0.08
Pwso (USD/ton)	+	0.635	4.71	0.77	0.83
Pwsfl (USD/ton)	+	-0.197	1.09	-0.22	-0.25
Panim (USD/ton)	+	0.416	3.86	0.70	0.63
Income (USD/cap)	+	-0.250	0.9	-0.005	-0.16
Stock (1000 ton)	-	-0.051	0.7	-0.23	-0.04
Market power	+	*0.020*	*0.44*	*0.006*	-
R^2		0.978			
World (buying price) from Rowed (USD/ton)					Flexibility
constant		-0.025	0.67	-	-
Quantity demand (1000 ton)	+	0.441	1.19	0.059	0.22
Pwso (USD/ton)	+	0.620	5.03	0.75	0.81
Pwsfl (USD/ton)	+	-0.325	1.23	-0.35	-0.42
Panim (USD/ton)	+	0.590	2.98	0.99	0.90
Income (USD/cap)	+	-0.483	1.43	-0.008	-0.30
Stock (1000 ton)	-	-0.110	1.53	-0.07	-0.09
Market power	+	*0.101*	*1.89*	*0.017*	-
R^2		0.978			
World (buying price) from Rowing (USD/ton)					Flexibility
constant		-0.023	0.65	-	-
Quantity demand (1000 ton)	+	0.112	0.47	0.007	0.05
Pwso (USD/ton)	+	0.565	6.03	0.70	0.74
Pwsfl (USD/ton)	+	-0.117	1.04	-0.13	-0.15
Panim (USD/ton)	+	0.409	5.69	0.70	0.62
Income (USD/cap)	+	-0.234	1.23	-0.18	-0.15
Stock (1000 ton)	-	0.094	1.75	0.15	0.08
Market power	+	*-0.159*	*1.84*	*-0.009*	-
R^2		0.983			