The Effects of Global Trade Reform on the World Vegetable Oil Markets

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Abstract

The purpose of this paper is to analyze the impacts of global trade reform on the world vegetable oil market. For this purpose, this study developed a world spatial equilibrium model for vegetable oil that incorporates palm oil and soybean oil. The model contained major palm and soybean oil importing and exporting countries and regions. The results show that free and fair agreement trade leads to an increase in vegetable oil trade. Malaysian producers and China consumers are the biggest beneficiaries. Trade liberalization improves the overall world welfare as world producer and consumer surpluses increase. This implies the importance of moving towards free and fair agreement trade in the global vegetable oil market.

1- Introduction

Vegetable oils are some of the most heavily traded agricultural commodities in the world. Major vegetable oil produced in the world includes soybean oil, palm oil, rapeseed oil and coconut oil. The trade patterns in the vegetable oil industry are primarily dominated by the global import and export of palm and soybean oil. Countries such as Malaysia, Indonesia and Nigeria have been playing major roles in the production of palm oil. Prior to 1964, Nigeria was the largest producer with 44.3% world share, Indonesia was second with 13.0%, and Malaysia was third with 12.5% (FAS Online, 2009). In the early sixties, particularly in the period of prolonged depression in the price of rubber, the government of Malaysia saw the need for diversification and chose oil palm as the promising crop. As a start, it introduced incentive schemes for oil palm plantations. Within six years, Malaysia overtook

Indonesia and Nigeria in terms of palm oil production. In 1970 Malaysia became the largest producer of this particular vegetable oil. For instance, Malaysia accounted for 55% of world's palm oil production in 1980; in 2006 Malaysia produced 41% and Indonesia 45% of the world production. On the contrary, the production of the same oil in Nigeria declined steadily, and for the last 10 years, it has been a net importer of palm oil. The production of palm oil at 37.02 million ton is the highest among the world's vegetable oil and fat production in 2009 followed by soybean oil at 36.25 million ton. Soybean oil is the second fastest growing vegetable oil, after palm oil. The production of soybean oil has only been concentrated in few countries. The four largest producers of soybean are the USA, Argentina, China and, Brazil with 25.6%, 17.7%, 17.5% and 16.2% of the total production of soybean oil, respectively. Argentina exports 56% of the total world's export of soybean oil. In the international trade, soybean generally accounts for at least 22% of the total vegetable oil export (FAS Online, 2009). The three leading world exporters of soybean oil are Argentina, Brazil and United States.

2- Literature review

In the following, we reviewed some relevant literature on palm and soybean oil export supply and import demand studies. These studies are useful in understanding the structure of vegetable oil trade industry. In addition, literatures on spatial equilibrium model are also reviewed. There studies are useful in understanding the technique and applicability of this model to trade analysis.

Palm and Soybean oil export supply and import demand Studies

Empirical estimations of the import demand and export supply elasticities were predicated based on specifications from standard trade models. A number of different model specifications have appeared in the literature, and some of these were reported by Sarris (1983) and Thompson (1993). Many standard trade equations, linking the volume of imports or exports to relative prices and to the levels of economic activities, and have been estimated over the last two decades with good empirical success finding. The success of the standard trade model does not, however, rule out the existence of academic disagreements. To some extent, such arguments have focused more on the magnitude and the importance of specific parameters and variables than on the underlying empirical approach. The import demand and export supply functions have traditionally included a relative price variable and real income, to account for the unusual periods such as devaluation or policy changes. The relative price measure is often the ratio of the import price to the domestic price index of the commodity adjusted to exchange rate, which gives a measure of the real exchange rate. The estimation method used for the import demand and export supply, in the international trade in general and in agricultural trade in particular, remains an issue for discussions. Most economists are comfortable with the assumption that the elasticity of supply is infinitely elastic, and therefore prices are exogenous, i.e. the small country assumption. This assumption allows for the utilization of a single equation in deciding import demand elasticities. Although the majority of the empirical trade literature reports single estimating equations, the procedure has been criticized by a number of economists who insist on using simultaneous equations for this purpose. For example, Riedel (1988) refuted the low demand elasticity estimates as dominant in the economic literature, on the basis that they suffered from a simultaneity bias. He further argued that researchers usually incorrectly assumed that the elasticity of the export supply was infinity, making the price exogenous and leading them to estimate the demand equation independently of the supply. Nguyen (1989) was rather unconvinced by this analysis; he offered a detailed critique of Riedel's work and discussed several points in his critique and concluded that they were wrong, misleading or irrelevant.

Spatial equilibrium model studies

Spatial equilibrium model (SEM) can be defined as a model which solves the simultaneous equilibrium of plural regional markets, under the assumption of positive transportation cost between regions. Interest in the SEM was initiated by Enke (1951) in his paper on equilibrium among the spatially separated markets and the solution by using an analogue on the transmission of electricity. Samuelson (1952) demonstrated that equilibrium solution could be found by maximizing the total area under the excess demand curve but above the excess supply curve in each region, less the total transportation costs of all shipment. He termed the function as the 'social payoff function'. Some examples of SEM studies in agriculture international trade are Gujardo and Elizondo (2003), where they employed a SEM to study the North American tomato market in a world market perspective; Spreen et al. (2003) focused on the world orange juice market. Gomez and Devadoss (2004) used SEM to analyze the implications of trade liberalization on the world wheat market.

3- The Model

To formulate the SEM, the model need import demand and export supply functions for palm and soybean oil. The import demand and export supply functions are specified as follows:

$$QI^{i}_{p,s} = f(IP^{i}_{p,s}, I^{i}, X^{i}) \qquad (1)$$

$$QX^{j}_{p,s} = f(XP^{j}_{p,s}, T^{j}, X^{j}) \qquad (2)$$

where i and j denote importing and exporting countries respectively. $QI^{i}_{p,s}$ is the quantity of imports demanded of palm oil (p) and soybean oil (s) while $QX^{j}_{p,s}$ is the quantity export supply of palm oil and soybean oil. $IP^{i}_{p,s}$ is the import demand price of palm oil and soybean oil and $XP^{j}_{p,s}$ is the export supply price of palm oil and soybean oil. I^{i} is the personal income while T^{j} is the technology. X^{i} is the exchange rate of importing countries, and X^{j} is the exchange rate of exporting countries. These two functions were estimated by applying ARDL procedure using Microfit.

The spatial equilibrium model

After estimating the export supply and import demand functions, non-price variables have collapsed into the intercepts. Following Takayama and Judge (1971), the objective function of the SEM in this study was constructed in the form of quasi-welfare function determined by the import demands and export supplies. The objective function is maximized subject to the transportation cost, price and quantity constraints. The objective function has the following algebraic form:

$$\max W_{IP_{ps}, XP_{ps}, Q_{ps}} \sum_{i}\sum_{p,s} (\beta^{i}_{p,s} IP^{i}_{p,s} - 0.5 \sum_{p,s} \alpha^{i}_{p,s} IP^{i}_{p,s} IP^{i}_{p,s}) - \sum_{j}\sum_{p,s} (\delta^{j}_{p,s} XP^{j}_{p,s} + 0.5 \sum_{p,s} \lambda^{j}_{p,s} XP^{j}_{p,s} XP^{j}_{p,s}) \qquad (3)$$

where β, α, δ, and λ are parameters obtained from the import demand and export supply functions. Maximization of equation (3) is subjected to equations (4), (5), (6) and (7).

$$IP^{i}_{p,s} - XP^{j}_{p,s} \leq TC^{ji}_{p,s} \quad (4)$$

Equation (4) states that the export supply price of the type of palm oil or soybean oil in the exporting country or region (j) plus the transportation cost from j to i ($TC^{ji}_{p,s}$) is less than or equals to the import demand price of palm oil or soybean oil in the importing country or region (i).

$$QX^{j}_{p,s} = \beta^{j}_{p,s} + \alpha^{j}_{p,s} IP^{j}_{p,s} \quad (5)$$

$$QI^{i}_{p,s} = \delta^{i}_{p,s} + \alpha^{j}_{p,s} XP^{j}_{p,s} \quad (6)$$

Equation (5) and (6) are the material balance equations. Equation (5) indicates that the export quantity of palm oil or soybean oil ($QX^{j}_{p,s}$) equals to the import quantity of palm oil QI^{i}_{p} or soybean oil QI^{i}_{s}. Equation (6) shows that the imported quantity of palm oil or soybean oil ($QI^{i}_{p,s}$) equals to the exported quantity of palm oil QX^{j}_{p} or soybean oil QX^{j}_{s}. Finally, equation (7) is the non-negativity constraints.

$$IP_{p,s},\ XP_{p,s},\ QI_{p,s},\ QX_{p,s} \geq 0 \quad (7)$$

4- Empirical model estimation

This section discusses the countries/regions included in this study, data and sources, statistical procedure of the export supply and import demand equations, interregional transportation cost, and the import tariffs schedule and scenarios.

To reduce the complexity of the model, countries are indentified either as palm or soybean oil exporting or importing countries. Further, countries with low trade participation in either palm or soybean oil are aggregated into regions. In all, the world was grouped into fifteen countries and regions. Countries included in the model were Malaysia, Indonesia and Region1 for the export of palm oil, while China, India, Pakistan, Japan, Bangladesh, and Region3 were selected as the importing countries/regions of palm oil. As for the export of soybean oil, the countries and regions included in the study were Argentina, Brazil, USA, and Region2. The importing countries and regions of soybean oil included China, India, Pakistan, Bangladesh, and Region4. Table 1 contains the lists of countries in this study.

Table(1): Regions and countries included in the model

Countries/ Regions	Exports	Imports	Port of Entry
1. Malaysia	Palm oil	-	Penang
2. Indonesia	Palm oil	-	Jakarta
3. Region1[1]	Palm oil	-	Bangkok (Thailand)
4. Argentina	Soybean oil	-	La Plata
5. Brazil	Soybean oil	-	Paranagua, Natal
6. USA	Soybean oil	-	New Orleans
7. Region2[2]	Soybean oil	-	Rotterdam (Netherland)
8. China	-	Palm & soybean oil	Dalian
9. India	-	Palm & soybean oil	Mumbai
10. EU25	-	Palm & soybean oil	Rotterdam
11. Pakistan	-	Palm & soybean oil	Anzali
12. Bangladesh	-	Palm & soybean oil	Dhaka
13. Japan	-	Palm oil	Kobe
14. Region3[3]	-	Palm & soybean oil	Port Said (Egypt)
15. Region4[4]	-	Palm & soybean oil	Rotterdam (Netherland)

Source: Bali & Indonesia on the net (2009).

The determination of palm and soybean oil transport costs is an important aspect of the model. This study used transportation cost between two ports computed by multiplying the distance between ports and per unit cost. The per unit transport cost was calculated using the free-on-board (FOB) palm and soybean oil export values, and cost-insurance-freight (CIF) palm and soybean oil import values. The FOB values were subtracted from the CIF values in order to get the transportation cost of the total imports of palm and soybean oil for every year. Next, the total transportation cost was divided by the total quantity of palm and soybean oil imports, as well as the distance between the trading partners to obtain the per unit transportation cost for each year from 1975 to 2007. This per unit transportation cost was averaged for the

[1] Region1 are: Papua New Guinean, Colombia, Thailand, Ecuador, Kenya, Ghana, and Cote d'Ivoire.
[2] Region2 are: EU25, Paraguay, Iran, UAE, Canada, and China.
[3] Region3 are: Russian Federation, Egypt, Turkey, Nigeria, UAE, Myanmar, Saudi Arabia, and Vietnam.
[4] Region4, EU25, Iran, Morocco, Republic of Korea, Peru, South Africa, Ecuador, Venezuela, Mexico, and Canada.

period from 1975 to 2007. Finally, multiplying per unit transportation cost and the distance between a pair of ports yielded the transportation cost between the regions. Table 2 below presents the transportation cost per unit between the different regions selected in the current study. Several countries impose trade barriers to limit palm and soybean oil imports. Information about these trade restrictions is crucial for the trade liberalization analysis. Since the Uruguay round, all forms of quantitative trade restrictions are converted into their equivalent tariff.

Table (2): Average ad Valorem Tariff Rates for Importing Countries/Regions, 2007

Regions	Palm Oil(%)	Soybean Oil(%)
China	30	160
India	45	30
EU25	14	4
Pakistan	55	30
Bangladesh	35	35
Japan	7	-
Region3	25	-
Region4	-	17

Sources:

1. the Agricultural Market Access Database (AMAD). (see http://www.amad.org/)
2. FAS Online (see http://www.fas.usda.gov/scriptsw/wtopdf/wtopdf_frm.asp.)

Export supply and import demand data were obtained from the Food and Agriculture Organization of the United Nations (FAO), Trade Year Book. Macroeconomic data was from the FAS online (FAS online website is http://www.fas.usda.gov/psd/complete_tables). The import tariff data were obtained from UNCTAD TRAINS Online Database, United Nations Conference on Trade and Development and The Agricultural Market Access Database, AMAD. The above Table 2 countries/regions impose tariffs (given in the parentheses) on palm and soybean oil imports from all sources: International Monetary Fund (IMF). Linear functional forms were considered for export supply and import demand equations. GAMS software was used for the estimation. The SEM uses the export supply and import demand equations as price dependent form. The estimated export supply and import demand equations were simplified by adding the coefficients and the mean values of other explanatory variables to the intercept and then inverted to express price as a function of quantity. To analyze the impacts of free trade on the world palm and soybean oil markets, the base year trade pattern is compared to a free trade scenario, where tariffs between any pair of countries are eliminated.

5- Results and discussion

The variables of interest in these analyses are palm and soybean oil prices, import demand, export supply of all countries/regions included in the model. The effects are measured as changes in the levels and the percentage change in these variables relative to the baseline. Welfare analyses of the trade policy changes are also conducted and discussed.

Table (3) and Table (4) show global trade impacts of trade liberalization in the palm and soybean oil market. As for the importing countries of palm oil (Table 3), the reduction in the import tariff by 100% would decrease the price by about 4% for China, 9.6% for India, 5% for Pakistan, 13% for Bangladesh, 1.8% for Region3, and decrease the prices for EU25 by 8.6% relative to base year. The quantity imported would rise by 5.93% for China, 5.15% for India, 1.7% for EU25, as well as 3.48%, 4.05%, 0.33% and 5.16% for Pakistan, Bangladesh, Japan, and Region3, respectively. Table 3 shows the due to the increase in the export price for palm oil. The price will increase to restore equilibrium by 4.5% for Malaysian palm oil, 9.7% for Indonesian palm oil and increase by 2% for Region1, and the average increase in the prices of palm oil is 5.4%. The consequences of the change in the export price, then affect, the export supply side, as well as the export quantity of Malaysia, Indonesia, and Region1. As expected, a reduction in import tariff by 100%, will increase the quantity exported by 5.5%, 3.3% and 4% for Malaysia, Indonesia and Region1 respectively.

Table 4 blow, presents the results gathered from the simulation on prices and quantities of soybean oil export and import, as they might be expected if there is reduction in import tariff. The simulation results indicated that the prices of soybean oil for the exporter countries increased when the import tariff was reduced. Similarly, the import quantities were also increased. Argentina was found to experience a marginal increase in the soybean oil price by 5.4%, and an increase in the quantity exported by 3.63%, while the prices for soybean oil in Brazil increased by 2.28% and quantity also increased by 5.65%. For the USA and Region2, the prices were found to increase by 3.3% and 3.4%, and the quantities by 4.8% and 3.1%, respectively.

Table (3): Import Tariff Reduction for Palm Oil

Percent change of simulation over predicted values

Region	Prices (\$/MT)	Quantity (000MT)	Revenue (\$000)
Exporting Region			
Malaysia	4.47	5.47	8.95
Indonesia	9.67	3.31	4.92
Region1	2.08	4.02	5.03
Total			
Importing Region			
China	-4.01	5.93	4.22
India	-9.22	5.15	3.37
EU25	-8.60	1.73	3.56
Pakistan	-5.00	3.48	1.63
Bangladesh	-13.01	4.04	2.54
Japan	-1.79	0.32	0.79
Region3	-1.78	5.15	3.55
Total			

Sources: output analysis using GAMS software.

Table 4 further shows the percentage of the price and import quantity changes at reduction of import tariff by 100%. The results indicated that soybean oil had the significant increase in the total import quantities (4.76%) and decrease in the prices (6.19%). The soybean oil exports of China and India were found to increase by 6.28% and 4.15%, while the prices decreased by 5.9% and 7.1%. After the reduction of the import tariff, the quantities imported by Pakistan, Bangladesh and Region4 were also found to increase by 3%, 3.2% and 5.7%, and the prices of soybean oil decreased by 3%, 2.8%, and 4.9%, respectively.

Table (4): Import Tariff Reduction for Soybean Oil

Percent change of Simulation over predicted values			
Region	Prices ($/MT)	Quantity (000MT)	Revenue ($000)
Exporting Region			
Argentina	5.42	3.63	3.25
Brazil	2.28	5.65	2.50
USA	3.30	4.81	3.23
Region2	3.41	3.09	2.81
Total	3.65	4.18	5.63
Importing Region			
China	-5.91	6.28	3.67
India	-7.11	4.15	2.65
Pakistan	-3.11	3.04	4.89
Bangladesh	-2.84	3.23	5.37
Region4	-4.93	5.68	3.40
Total	-6.19	4.76	2.07

Sources: output analysis using GAMS software.

Welfare analysis:

Table 5 presents the change in producer surplus, consumer surplus, and quasi welfare of each country/region resulting from trade liberalization analysis. In the free trade scenario, world's quasi welfare for palm oil increased by US$155.691 million. At the individual country/region level, the quasi welfare effects reflected the participant's weights in the international market. Malaysia, Indonesia and Region1 led the palm oil export by US$ 36.972 Million US$ 21.497 Million and US$ 10.306 Million, respectively in terms of the welfare gains. On the contrary, the country or regional importer gains were found to range between US$ 19.878 Million for China and US$ 5.594 Million for Japan.

Results from the trade liberalization scenarios for soybean oil market are shown in Table 6, under the free trade scenario, the exporters of the traditional soybean oil realized the high welfare gains. Also Argentina led all the exporters with a gain of US$ 22.677 million, Brazil, Region2 and USA followed with gains of about US$

16.117 million, 15.389 million and 14.646 million, respectively. For all the exporters of soybean oil, they gained US$ 68.830 million. The estimated quasi welfare for all importing countries/regions was US$ 147.847 million.

Table (5): Estimated Consumer and Producer Surpluses Gain from the Reduction of all Countries Import Tariff on the Palm Oil Market

Region	Quasi welfare US$(million)	Region	Quasi welfare US$(million)
Malaysia	36.972	China	16.913
Indonesia	21.497	India	11.453
Region1	10.306	EU25	2.895
Total Export	68.776	Pakistan	9.689
		Bangladesh	8.121
		Japan	2.157
		Region3	10.556
		Total Import	61.787
Total			155.691

Sources: output analysis using GAMS software.

Table (6): Estimated Consumer and Producer Surpluses Gain from the Reduction of all Countries Import Tariff on the Soybean Oil Market.

Region	Quasi welfare US$(million)	Region	Quasi welfare US$(million)
Argentina	22.677	China	11.285
Brazil	16.117	India	9.125
USA	14.646	Pakistan	13.958
Region2	15.389	Bangladesh	8.757
Total Export	68.830	Region4	14.157
		Total Import	57.284
Total			147.847

Sources: output analysis using GAMS software.

6- Conclusions

This paper develops a world spatial equilibrium palm and soybean oil model to analyze the impacts of free trade on the world palm and soybean oil market. The increase of palm and soybean oil trade globally is due to demand increases by the importing countries. Outcome of free trade indicated that prices in all importing countries declined while quantities of palm oil and soybean oil import increased, at the same time, export prices and quantities increased for all exporting countries this finding is consistent with the previous findings in the previous literature (see for example Gomez-Plana and Devadoss 2004, Wailes, et al 2002 and example see Devadoss, 2006). After accounting for the tariff reduction, the findings show that the quasi welfare is positive, which clearly improves the overall trade in the palm and soybean oil markets. This implies the importance of moving towards fair trade in the global palm and soybean oil markets.

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