THE IMPACT OF TRADE BARRIERS ON THE CANADIAN CANOLA CRUSHING INDUSTRY

by

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ABSTRACT

Trade restrictions in the international marketplace have inhibited the movement of products and distorted the location of processing activities. Following the Tokyo round of GATT negotiations, Japan withdrew its tariff on oilseeds but retained its tariff on vegetable oils. Consequently, Japanese oilseed imports increased while vegetable oil imports were effectively restricted.

Japan is a regular and almost the sole importer of Canadian canola. In most years about 95 percent of Japan`s canola imports originate in Canada and normally 90 percent of Canada's canola exports are destined for Japan. The Canadian industry crushes about 0.9 million tonnes of canola each year, compared with 1.2 million tonnes exported to Japanese crushers. The competition facing Canadian crushers, is therefore greatly influenced by Japan's import tariffs which encourage canola crushing activity there.

The main objective of this study was to empirically estimate the impact of changes to the Japanese import tariffs on vegetable oils. A single-period spatial-equilibrium trade model of the market for canola, soybeans and their products was developed. It focussed on trade amongst Canada, the United States, the European Community and Japan. Quarterly data for the period 1974 to 1984 were used to estimate demand funtions employing the ordinary least squares approach. The demand functions were incorporated into the trade model and estimates were produced using quadratic programming.

A benchmark solution was established and four alternate tariff scenarios were run. These were compared with the benchmark to evaluate their impact on prices, crushing activities and trade. The results indicate that Japanese import tariffs on vegetable oils cause economic hardship for Canadian canola crushers. As well, they support the argument that the tariffs provide more protection for canola crushing in Japan than for soybean crushing. It was estimated that the removal of Japanese tariffs on canola and soybean oils would lead to a 3.7 percent increase in annual revenue received by Canadian canola crushers. This corresponds to approximately $1.8 million per year. However, if the Japanese are unwilling to eliminate tariffs completely but would negotiate a reduction in the Japanese tariff on canola oil relative to the soybean oil tariff based on equal relative rates of protection; then Canadian canola crushers were estimated to receive a $1.6 million increase in annual revenues.

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INTRODUCTION

The agriculture sector is an important component in the Canadian economy. Over the past decade the canola[1] industry has increased it's importance within agriculture. The value of canola exports exceeded $648 million in 1984 compared with only $200 million in 1977. Canola crushing is also important to the Canadian economy. One study[2] concluded that in 1983/84, the canola crushing industry in western Canada contributed about $650 million to the Canadian economy.

Canada's export market for canola and its products, oil and meal is diversified. Japan is the single most important market for Canadian canola. Oil is exported to various countries, while the European Community is the largest importer of canola meal (Table 1.1).

After the Tokyo round of GATT[3] negotiations in the 1970's, Japan withdrew its import tariff on oilseeds but retained a tariff on vegetable oils. Consequently, Japanese oilseed imports have increased but the existing import tariff on vegetable oil has effectively restricted Japanese vegetable oil imports.

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[1] The name "canola" represents rapeseed varieties with less than 3mg/g glucosinolate in the meal and less than 5% erucic acid in the oil.

[2] Canola Crushers of Western Canada, Western Canadian Agri-Food Processing Potential Opportunities for Canola Crushing, Winnipeg, Manitoba, 1984.

[3] General Agreement on Tariffs and Trade.

TABLE 1.1

CANADIAN EXPORTS: 1982

Commodity	Destination US	EC	Japan	Rest of World
	....................000 Tonnes			....
Rapeseed	0.0	79.7	1170.1	75.8
Rapeoil	4.1	0.0	11.8	128.9
Rapemeal	23.1	97.3	0.0	5.3
Soybeans	6.8	19.8	47.4	58.3
Soyoil	0.0	0.0	0.0	30.4
Soymeal	0.0	11.3	0.0	0.0

Source: Statistics Canada, "Exports by Commodities", Catalogue No. 65-004.

1.1 PROBLEM STATEMENT

Although the relative importance of the canola industry continues to increase in the Canadian economy, the future of canola crushing in Western Canada is uncertain. Variable and at times negative crush margins have resulted in temporary plant shutdowns across Western Canada. Canadian crushers must compete with crushers in other countries, whose governments through trade barriers encourage canola imports versus oil and meal imports. In particular, Japanese import tariffs on vegetable oils provide protection for its' domestic crushing industry.

Japan is a regular and almost the sole importer of Canadian canola. In most years about 95 percent of Japan`s canola imports originate in Canada and normally about 90 percent of Canada's canola exports are destined for Japan. The Canadian industry crushes about 0.9 million tonnes of canola each year, compared with 1.2 million tonnes exported to Japanese crushers. The competition facing Canadian crushers, is therefore greatly influenced by Japan's import tariffs which encourage canola crushing activity there.

Japanese tariffs on oil discourage canola oil imports and raise the price of canola oil in Japan. acts like a double-edged sword. By raising the Japanese canola oil price, crushers are able to pay higher prices for imported canola. This raises input costs for Canadian crushers as they must compete with the Japanese for available canola supplies. On the revenue side, the tendency of the Japanese import tariff to limit canola oil imports, puts downward pressure on the price of canola oil in Canada.

The situation facing canola crushers is compounded by the nature of the Japanese tariff structure. Nominal tariffs on rapeseed oil and soybean oil are equal.[4] However, one tonne of canola yields more oil than one tonne of soybeans.[5] Thus, the import tariffs provide more protection for crushing canola than soybeans (Carter and Mooney, 1985).

The Japanese import tariff on edible oils is a major factor in the economic uncertainty facing Western Canadian canola crushers. A viable canola crushing industry is important to the Canadian economy as it provides both a market for Canadian canola and competitively priced products for export and domestic consumption.

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[4] Japanese import tariffs on vegetable oils are 17,000 and 23,500 yen/tonne on crude and refined oils, respectively.

[5] Canola yields approximately 40% oil and 57% meal, whereas soybeans yield approximately 17.5% oil and 79% meal.

1.2 OBJECTIVES

Canola, soybeans and their products are substitutes in the international oilseed market. These goods will be incorporated into an economic model of the oilseed industry. Canada, the United States, the European Community and Japan are major importers and exporters in this market. In order to assess the price and trade relationships in the international oilseed complex, the trade flows between these regions will also be incorporated into the model.

Japanese vegetable oil import tariffs distort the free movement of vegetable oils as well as oilseeds and their joint products. Hence, import tariffs are determinants in the location of crushing activities. The influence of the Japanese tariff structure is the major focus of the study.

The objectives of the study are to:

1) review protectionism in the international market and recent developments in the measurement of protection;

2) develop a trade model of the market for rapeseed, soybeans and their products, focusing on trade amongst Canada, the United States (US), the European Community (EC) and Japan;

3) incorporate distortions resulting from trade barriers in each of these regions;

4) assess the impact of tariff changes on prices, quantities traded and crushing levels and location.

1.3 OUTLINE OF STUDY

Chapter II includes a brief description of the market for rapeseed and its products. A summary of theoretical work in the area of joint and intermediate products follows. Market power and its impact on world price formation will then be discussed. Finally, previous empirical studies are presented and evaluated. Various forms of protectionism are discussed in Chapter III. Two methods for measuring protection are presented and applied to the Japanese tariffs on rapeseed and soybeans.

The conceptual framework of the study is developed in Chapter IV. An illustration of a simple one good, two region model is used as the basis for the mathematical development of a multi-region trade model. In Chapter V the general mathematical model developed in the previous chapter is tailored to the four-region, six-commodity oilseed market. Demand, supply and cost estimates required for the oilseed model are given. The quadratic programming matrix used to solve prices, quantities and trade flows is then presented.

The model's solution provides a base for evaluating changes to the Japanese tariff structure. Four alternative tariff scenarios are considered in Chapter VI. Their impacts on crushing, trade and prices in the four regions are discussed. Conclusions and suggetions for further research are presentd in Chapter VII.

Chapter II

LITERATURE REVIEW

2.1 INTRODUCTION

The theoretical framework and analytical technique used in modelling the oilseed market are presented in the following sections: theory of joint and intermediate products as it applies to trade; world price formation; and empirical methods employed in modelling the oilseed complex. The latter includes linear and quadratic programming techniques, as well as econometric methods of estimation.

2.2 THEORY OF JOINT AND INTERMEDIATE PRODUCTS

Rapeseed[6] is an intermediate good. It's an input into the production of the products, meal and oil. In 1964, Bhagwati surveyed international trade theory and recognized the absence of joint and intermediate products from the research. The importance of these products in international trade stimulated the subsequent development of literature in this area.

The final product model of international trade led to the extension of trade theory to include joint and intermediate products. A literature review indicates that intermediate products have received the most

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[6] "Rapeseed" will be used for the remainder of this study as it refers to canola and other varieties of rapeseed.

attention. The Stopler-Samuleson and Rybczynski theorems supported the inclusion of intermediate products in the final product model of international trade. Woodland (1977) contends that the final product model's inclusion of intermediate products breaks down when applied to joint products. Woodland's pursuit of a general international trade theory of joint products, reveals that the Heckscher-Ohlin, Stopler-Samuelson and Rybczynski theorems in international trade do not hold when applied to joint products.

Although theoretical work on intermediate products has been extensive, little empirical research was undertaken for either intermediate or joint products. Dardis (1967) analyzed the protection in the livestock and feed grain trade in West Germany. Dardis and Dennison (1969) followed up with a study about protection methods for US raw wool. These studies employed the model developed by Dardis for trade in intermediate and final goods. The simple two-good model under the small country assumption did not explicitly link the intermediate and final goods market by a marketing margin. Thus, the model had limited application.

Wiseman and Sedjo (1981) studied the effects of an export embargo on the US logging industry. Once again, the scope of the study was limited by the simplicity of their model. Their model considered extreme cases of foreign demand for lumber and logs without a link between the two.

Other studies of joint and intermediate products in international trade were based on concepts of protected value-added and effective protection. Application of the effective rate of protection concept was undertaken by Balassa (1965), Basevi (1966), Melvin and Wilkinson (1968) and Corden (1971).

Carter and Mooney (1985) show that the effective rate of protection is a function of the world price of inputs. Therefore, as the world price increases, the effective rate of protection increases. When absolute tariffs are imposed upon two commodities, the effective rates of protection cannot be compared between the two commodities. Therefore, they propose a relative rate of protection to compare the value-added in the production of each commodity considered. This method is detailed in chapter III.

2.3 PRICE FORMATION

Rapeseed trade between Canada and Japan may be analogous to the world wheat trade. Recent developments in the world wheat market suggest that market power has been shifted from wheat exporters to wheat importers. According to McCalla (1966), the Canadian Wheat Board exerted monopoly power with Canada leading the US in price formation where Canada and the US acted as duopolists in the world wheat market. Alouze, Watson and Sturgess (1978), conceived of the market as a triopoly comprised of Canada, US and Australia. Finally, Carter and Schmitz (1979) described it as a buyer's market with the EC and Japan imposing optimal tariffs in order to extract monopsony rents.

The development of the wheat market may have followed a natural progression. Canada, acting as a large exporter increased its production, as did the US, Australia, France and Argentina. The result was a world grain surplus. Consequently, exporters became price takers as market power shifted to the large importers. Schmitz, McCalla, Mitchell and Carter (1981) analyzed the formation of an export cartel to counteract the monopsonistic power currently facing exporting nations.

Rapeseed trade between Canada and Japan consists of a major buyer and a major seller. In 1982, approximately 90% of Canada's rapeseed exports went to Japan. For the Japanese this represented roughly 95% of their total rapeseed imports. This suggests that both countries have the potential to exert market power on the other, which could include optimal Japanese import tariffs and optimal Canadian export taxes. In his study, Swallow (1983) concluded that Japan's tariff on rapeseed oil may have been superior to optimal tariffs in that, value-added is gained because domestic processing is encouraged as a result of the tariff. On the other hand, he suggests Canada would experience substantial gains by introducing optimal export taxes on rapeseed, rapeseed meal and rapeseed oil. This result is unlikely given the existence of strong substitutes for rapeseed and its products; primarily soybeans and soybean products which were treated exogenously in his model.

Carter and Mooney (1985) studied the influence of Japan's oil import tariffs upon canola and soybean crushing activity there. Applying the relative rate to measure protection afforded each crushing activity, they concluded that over the 1977 to 1983 period, canola crushing received a higher level of protection relative to soybean crushing in Japan. Thus, Japanese crushers can bid up the world price of rapeseed during periods of short supply, while still maintaining positive crush margins. Carter and Mooney estimated that a $38.56 US reduction in Japan's canola oil import tariff would equalize the relative rates of protection for both canola and soybean crushing activities.

2.4 EMPIRICAL METHODS OF ESTIMATION

Over the past decade, the Canadian rapeseed market has been analyzed in several studies.[7] The oilseed complex, however, has been qualitatively described in only a few studies. Houck, Ryan and Subotnik (1972) studied the US soybean industry while Parris and Ritson (1977) described the oilseed market within the European Community. A complete description of the oilseed complex was presented by Griffith and Meilke (1980). Their study provides an insight into the Japanese oilseed market. The authors suggest that shipping raw materials to a crushing plant located near the market is more economical than shipping the final product from a plant located near the source of raw materials. According to Griffith and Meilke, rapeseed crushing should be located near oil markets and soybean crushing near meal markets, due to the relatively higher oil yield from rapeseed crushing versus soybean crushing. They state that Canadian and US transportation policies and tariff policies in Japan and the EC have influenced the current location of crushing activities.

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[7] Studies undertaken by Agriculture Canada (1977), Canadian International Grains Institute (1977), Craddock (1973), Furtan, Nagy and Storey (1978 and 1979), Griffith (1979), Griffith and Meilke (1980, 1982a and 1982b), Kulshreshtha et al (1979), Kwon and Um (1980), Lowe and Petrie (1979), Martin and Storey (1975), Meilke and Giffith (1982), Meilke, Young and Miller (1980), Nagy and Furtan (1977), Natural Products Marketing Council (1981), Perkins (1976), Rapeseed Association of Canada (1973), Rigaux (1976), Spriggs (1981), Swallow (1983), Uhm (1975) and Umemoto (1973).

A few empirical studies of the rapeseed trade between Canada and Japan have estimated the impact of changing Japanese tariffs. Furtan, Nagy and Storey (1978) used a quadratic programming (QP) model to estimate the net welfare effects of changes to the Japanese tariff on rapeseed oil and changes to Canadian transportation policies. The approach employed by Swallow (1983) was similar to that used in the study by Furtan et al. Swallow attempted to incorporate a rapeseed supply function in his model and analyzed the introduction of export taxes on rapeseed exports. An econometric analysis was undertaken by Griffith (1979) and later extended by Griffith and Meilke (1982b). These studies include the impact of eliminating the Japanese import tariff on both rapeseed oil and soybean oil.

In their 1974 study, Furtan et al. concluded that including rapeseed oil and meal under the Crow rate, together with the removal of the Japanese import tariff on rapeseed oil would increase Canadian rapeseed processing and raise foreign exchange earnings by $31.4 million. Removing the tariff on rapeseed oil alone would result in a 13.0 percent increase in Canadian rapeseed crushing activity. On the other hand, Swallow did not predict any changes if only the rapeseed oil tariff was removed. In his model, Canada's rapeseed oil exports to Japan would not increase because the shadow price of exporting rapeseed oil was less than the transportation cost. The EC was treated as a net importer in each study, so its ability to influence the rapeseed oil market was not included. The soybean sector was also treated exogenously in each study. Although the price of soybean oil was included in the rapeseed oil demand equations, its value was fixed and the coefficient compressed into the intercept before the parametric changes to the model were made. Thus, in their analyses, changes to the Japanese tariff do not take into account the effects of soybean and soybean product substitutes. The exogenous treatment of the soybean market implicitly assumes Japanese tariff reductions would apply to rapeseed oil alone and this is unlikely.

Griffith and Meilke (1982) undertook a study that included Canadian trade of rapeseed and rapeseed products with Japan, the EC and other countries. In their findings, rapeseed crush in Japan fell by 7.5 percent when the Japanese tariff on rapeseed oil was removed. In Canada, rapeseed crush increased by only 0.2 percent and soybean crushing activity remained unchanged in both countries. Removing the tariff on soybean oil alone, resulted in a 0.8 percent decline in Japanese soybean crush but rapeseed crush would increase by 1.4 percent. In Canada, rapeseed crush would fall by 0.1 percent and soybean crush would again remain unchanged.

The above scenarios are unrealistic since it is unlikely that Japan would remove the tariff on either rapeseed or soybean oil alone. It is more reasonable to expect simultaneous tariff reductions on similar products. Soybeans and soybean products were included as substitutes for rapeseed and its products when Griffith and Meilke analyzed the impact that removing Japanese tariffs on edible oils would have on the rapeseed market. In their study, the removal of rapeseed and soybean oil tariffs had a positive effect on the Canadian rapeseed crushing industry. Although rapeseed crush increased by only 0.2 percent, rapeseed oil exports from Canada increased by 3.5 percent. In Japan, rapeseed crush decreased by 6.0 percent while rapeseed oil trade increased by 1930.7 percent and the value of that trade by 633.3 percent. Japanese tariff cuts were estimated to have a large impact on Japanese rapeseed oil imports. However, only 5 percent of these increased imports were accounted for by Canadian exports. The remaining oil imports were estimated to originate in the EC. It was predicted the EC would increase its oil production through increased domestic supply and increased imports of Canadian rapeseed. The lack of a limit on crush capacity in the EC resulted in that region's tremendous supply response in the Griffith and Meilke model.

The quadratic programming approach was chosen for this study because of its ability to handle policy variables in a straightforward manner. Parametric changes to the QP matrix can be made to reflect alternative scenarios. As well, the results can be interpreted clearly.

The relevant mathematical programming literature serves as a guideline in developing the QP model. The most highly regarded work in this field was completed by Takayama and Judge (1971). Their models were applied to spatially separated markets with variations of temporal and allocative relationships. Their study incorporates monopolies, monopsonies and market distortions, such as tariffs. A simplified version of the QP model developed by Takayama and Judge is found in a study by Martin (1981).

Weinschenck, Henrichsmeyer and Albinger (1969), studied locational theory and developed models for practical application to the agricultural processing industry. Further applications of programming models are found in Judge and Takayama (1973), where spatial and temporal markets are examined.

2.5 SUMMARY

The Canadian rapeseed market has been discussed in several studies, but few have focused on the oilseed complex within which this market must compete. Griffith and Meilke (1980) have suggested that rapeseed crushing should be located near oil markets and soybean crushing near meal markets due to the relative amounts of oil and meal each produces. They argued that transportation and tariff policies tend to distort the location of crushing activity.

Increasing attention has been given to the theory of trade in intermediate and joint products, though little empirical work has been done. Carter and Mooney (1985) measured the protection Japanese vegetable oil import tariffs provide crushers in that country. They concluded that rapeseed processing received more protection than soybean processing and found that Japanese crushers were able to bid up the world price of rapeseed while still maintaining positive crush margins. Carter and Mooney estimated that $38.56 US reduction in the tariff on rapeseed oil would remove the bias which exists under the current tariff structure.

Furtan, Nagy and Storey (1974), Griffith and Meilke (1982b) and Swallow (1983) included trade in their studies of the markets for rapeseed and its joint products, oil and meal. Griffith and Meilke included soybeans and soybean products in their model of the oilseed market. In each of these studies the Japanese import tariff on rapeseed oil was removed. Swallow reported no changes to his model's solution while Furtan, Nagy and Storey predicted the tariff removal would result in a 13.0 percent increase in Canadian rapeseed crushing activity. Griffith and Meilke were able to include the removal of the soybean oil tariff in their study. They predicted a 6.0 percent decline in Japan's rapeseed crushing activity while rapeseed crush in Canada increased by only 0.2 percent. Although Japan's rapeseed oil imports increased substantially, very little of it orginated in Canada. Rather, the EC was estimated to supply Japan's increased rapeseed oil imports. The lack of a restriction on EC crush capacity in their model accounts for the tremendous supply response estimates.

A single period spatial price equilibrium trade model was developed in the current study and solved using quadratic programming (QP). Trade in both canola and soybeans and their products was included in the model. The model was designed to evaluate the economic impact of changes to the Japanese vegetable oil import tariff structure. The EC was treated as both an importer and exporter of canola, soybeans and their products. As well, regional crush capacities were incorporated into the model. The inclusion of these variables make this modelling approach more comprehensive than those which preceeded it.

Chapter III

PROTECTIONISM IN THE INTERNATIONAL MARKET

3.1 INTRODUCTION

Throughout history, intervention in one form or another has played an important role in industrial location and resource allocation. Theoretical models have been developed to explain the movement of goods across borders. Tariffs, subsidies and quotas have distorted the free movement of factors and products. Potential gains from trade are based upon comparative advantage and trade barriers are regarded as distortions that reduce those gains. Trade barriers were imposed in order to either exploit market power or to protect domestic industries. Where significant market power does not exist, substantial gains from trade could be realized through the reduction of trade barriers.

As exporting countries face greater competition in the world market, tariff structures become increasingly more important. Exporting countries compete for gains when trade restrictions are reduced. However, the desire for self-sufficiency and the political strength of domestic producer groups make trade liberalization important to both importing and exporting countries.

This chapter reviews developments in international trade theory with specific emphasis on protectionism. The basis for trade restrictions will be discussed first. Section 3 deals with the evolution of protection theory, from the early forms of licencing to the more recent import tariffs and export taxes. The concept of the effective rate of protection is discussed in Section 4. The relative rate is introduced in the next section where both methods of measuring protection will be applied to the Japanese vegetable oil tariffs.

3.2 BASIS FOR TRADE RESTRICTIONS

Trade restrictions have provoked a continued debate regarding their welfare effects. Arguments about using trade barriers to correct domestic distortions provided the basis for Johnson's (1971) analysis. He examined the following cases for protectionist policies:

1. distortions in the factor and commodity markets;
2. infant industry argument;
3. non-economic argument.

Johnson discussed these issues and advanced some arguments in favor of trade restrictions based on domestic distortions such as, natural monopolies and social externalities. However, he concluded that in cases where a country may be made better off through trade restrictions, an economically superior domestic policy could be implemented instead. This indicated that trade restrictions were not "first-best" solutions.

Perhaps the most commonly cited reason for trade restrictions is to protect infant industries. The argument for protection is based on the premise that incurring consumption costs (in the form of higher import costs for a limited time period) for future benefits, may be considered an investment in the infant industry. In such a case, free trade would not allocate investment resources efficiently. This suggests that the capital market operates inefficiently in allocating investment resources or the infant industry is unprofitable from a private standpoint but not from a public standpoint. According to Johnson (1971), production subsidies are preferable to trade restrictions in increasing domestic production.

The argument for self-sufficiency or reduced reliance upon imports, is a non-economic argument. Import tariffs are more capable of restricting trade than are production subsidies. Thus, the argument favouring import restrictions in the form of import tariffs is often based on non-economic grounds.

Based on Johnson's presentation one would conclude that the Japanese tariff on rapeseed oil is not economical. Japanese consumers and the Japanese economy in general, would be made better off with the removal of the tariff. However, Japan's government policies may be directed at limiting imports through import tariffs. In this case Japan's rationale for imposing tariffs is based on the non-economic argument for self-sufficiency in the production of vegetable oil and meal.

3.3 EVOLUTION OF TRADE RESTRICTIONS

Licencing imports was an early form of trade restriction. It was used to control import levels. However, arbitrary assignment of import licences gave a few importers the capabiliy of attaining monopoly profits, even though exporters were aware of the demand for the scarce good. Limiting imports through import licencing may have lead to a reallocation of resources within the importing country in favour of domestic development, but the existence of monopoly and monopsony profits often provoked tension between the business community, consumers and the government. Corden (1963), advocated a change from import licencing to imposing "uniform" import tariffs. Although governments could redistribute monopoly profits received from a "uniform" import tariff, it could also increase import restrictions on inputs. Corden felt this would inevitably lead to an import saving because industries using imported materials would seek import substitutes. For a country with abundant resources, such as Australia, this may have had desirable developmental effects but it also resulted in higher consumer costs. In a country highly dependent on imported materials, such a policy would be extremely uneconomical.

Carter, Gallini and Schmitz (1980) and Swallow (1983) recently studied the introduction of export taxes in response to distortions in the international commodity market. Carter et al. concentrated on the effects of a grain cartel composed of major wheat exporters restricting the wheat trade. Their conclusion suggested that export taxes would provide substancial gains to cartel members. Swallow studied the effect of Canada imposing an export tax on rapeseed. This was initiated by the interdependence of Canadian/Japanese rapeseed trade and the possible exploitation by Japan of that relationship. Swallow found that Canada could realize significant gains from imposing an export tax on rapeseed.

3.4 MEASUREMENT OF PROTECTION

The debate over protection, free trade and production subsidies included the issue of measuring protection. The nominal tariff on final products is often used although this form of measurement may be inappropriate.

> "In the presence of trade in intermediate products, however, nominal rates will not appropriately indicate the extent of protection since decisions will be affected by the protection of their processing acitivity rather than the product itself."[8]

Previous to the effective rate, nominal rates of protection were used to measure protection afforded a product. As inputs faced tariffs, the concept of adjusted nominal rate was used to measure the net rate of protection provided a domestically, produced good. Once the adjusted nominal rate was introduced, consideration of the activity employed in producing the protected product was a natural progression. Another measure, the effective rate of protection, was first applied by Barber (1955). Undoubtedly, full employment and protection for domestic industries was a major impetus for studying value-added in production. The relevance of effective rates was referred to much earlier though, in a presentation by Schuller (1905). Since most theoretical work dealt with "first-best" policies concerning protection and free trade, it is understandable that effective protection was not considered in detail until the late 1950's through the 1960's. Since Barber's application of the effective rate of protection, several contributions to the literature have followed.[9]

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[8] Balassa, B., "Effective Protection: A Summary Appraisal", in Grubel and Johnson (Eds.) Effective Tariff Protection (Geneva, 1971) p.247

[9] See Appendix B; Effective Rate of Tariff Protection, Grubel and Johnson (Eds.), (Geneva 1971), for a complete list of publications on the topic.

Perhaps the most significant contributions have been made by Balassa(1965), Basevi (1966), Corden (1966), Johnson (1965), Soligo and Stern (1965) and Melvin and Wilkinson (1968). Corden (1971), noted that the main advances in this field were made by Canadians, Australians and Swedes, possibly due to the sensitivity of the effective rate of protection in a "small" country.

The effective rate of protection provides an index of the level of protection afforded an activity when import tariffs are applied. Four definitions of effective protection have been developed. These measure the proportional total value-added in gross output; in the primary factor price; in value-added per unit of output; and to the industry. The third definition is used in the following presentation.

A comparison of nominal and effective rates of protection is illustrated below. Nominal rates measure the product's prices before and after tariff, whereas the effective rate measures the protection afforded value added in production. A simple numerical example will help distinguish the difference between each rate. Consider a country producing cloth which may be sold at a world price of $300. The value of inputs is divided between labour and all other inputs. Assume all other inputs are valued at the world price of $200, leaving $100 for the input labour. A 20% nominal import tariff applied to cloth increases the price of cloth within the country to the world price plus 20% or $360. Assuming the world price of all other inputs remains the same, the tariff allows the country to allocate $160 towards the input, labour. Thus, the nominal rate of protection afforded the product cloth is 20%. However, the effective rate of protection afforded the activity of producing cloth is 60%.

In general terms we may consider the product's unit prices before and after the tariff as P and P*, respectively. V and V* represent the pre- and post-tariff value-added per unit value of output, respectively. The nominal and effective rates of protection may be written:

$$(P^* - P)/P = t \tag{3.4.1}$$

$$(V^* - V)/V = e \tag{3.4.2}$$

The effective rates of protection expressed in terms of nominal rates will be presented. First the relationships between the inputs and output before and after the tariff (t).

$$V + a = 1 \tag{3.4.3}$$

$$V^* + a = 1 + t \tag{3.4.4}$$

Where a represents the value of all other inputs per unit value of output. These relationships sum the proportion of value-added plus the portion of all other inputs to equal one unit of output before and after tariffs, respectively.

Rearranging equations (3.4.3) and (3.4.4) we have:

$$V = 1 - a \tag{3.4.5}$$

$$V^* = 1 + t - a \tag{3.4.6}$$

Substituting 3.4.5 and 3.4.6 into 3.4.2 gives the effective rate in terms of the nominal rate.

$$[(1 + t - a) - (1 - a)]/(1 - a) = e$$

or

$$t/(1 - a) = e \tag{3.4.7}$$

Returning to our example, we may express this relationship numerically.

$$0.20/(1 - 200/300) = 0.60$$

Equation (3.4.7) illustrates the effective rate as an increasing function of the nominal rate, given the proportion of the value-added. Thus, at a particular level of value-added, a reduction in the nominal rate will result in an even larger reduction in the level of protection afforded value-added. Reducing the nominal tariff by 5%, from 20% to 15%, results in a reduction in the effective rate from 60% to 45%.

The effect of a tariff on imported inputs is similar to a tax on these inputs (Grubel and Johnson). That is, the cost of imported inputs is raised, lowering the effective rate of protection afforded the activity of production. Introducing the tariff on the imported input alters equation (3.4.6) to:

$$V^* = 1 + t - a(1 + t^*) \qquad (3.4.8)$$

Where (t^*) equals the tariff on the imported input. Our new formula measuring effective rates of protection is now:

$$(t - at^*)/(1 - a) = e \qquad (3.4.9)$$

If yarn, assumed the only other input into cloth production, faced a 5% nominal tariff, its price would now be $210. Retaining the 20% tariff on cloth, its price of $360 leaves $150 remaining for the input labour, or a 50% effective rate of protection.

$$[(0.20 - (200/300)0.05]/(1 - 200/300) = 0.50$$

Taken to the extreme, a negative effective rate could exist if the nominal tariff on the input was significantly larger than the nominal tariff on the product. For example, a 10% nominal tariff on cloth coupled with a 20% tariff on yarn results in a -10% effective rate of protection on cloth production. Although negative effective rates of protection are unlikely, they can exist in countries with complicated tariff structures (Guisinger, 1969). Negative effective rates may also be found in cases where the infant industry argument is supported. Given that the value of imports exceeds the value of output, the output may be purchased for a lesser price on the world market. Yet, its production is encouraged because the acquisition of production expertise or economies of scale result in lower anticipated input costs.

3.5 APPLICATION TO THE OILSEED MARKET

The previous example measured the effective rate of protection afforded the production of one output, cloth. Whereas, the oilseed industry observes the production of joint outputs, meal and oil. The previous example must be modified to accomodate for this distinction. The value-added before and after a tariff on output 1 becomes:

$$V = (aPo1 + bPo2) - Pi1 \qquad (3.5.1)$$

and

$$V' = (a(1+t)Po1 + bPo2) - Pi1 \qquad (3.5.2)$$

where:

Po1,Po2 = price of output 1 and 2, respectively;

Pi1 = price of input 1;

a,b = units of output 1 and output 2, respectively, produced from one unit of input 1.

Substituting into equation (3.4.2) we express the effective rate as:

$$e = \{[(a(1+t)Po1+bPo2)-Pi1]-[(aPo1+bPo2)-Pi1]\}/[(aPo1+bPo2)-Pi1]$$

and reduced to form:

$$e = atPo1/[(aPo1 + bPo2) - Pi1] \qquad (3.4.3)$$

If the tariff was on product 2, the effective rate would be written as:

$$e = btPo2/[(aPo1 + bPo2) - Pi1] \quad (3.5.4)$$

The relative rate, which measures the relative value-added following the introduction of a tariff on two competing products,was presented by Carter and Mooney (1985).

Rapeseed, soybeans and their products compete directly in the international oilseed complex where the Japanese currently impose an import tariff on edible oil products. The relative rate can be used to measure the protection afforded the processing of oil products. The relationship is expressed as:

$$Rr = V'r/V's \quad (3.5.5)$$

where:

Rr = relative rate of protection afforded the activity of processing rapeseed.

V'r,V's = value-added in the activity of processing rapeseed and soybeans, respectively following the introduction of a tariff on oil.

Both the effective rate of protection on rapeseed processing and the rate of protection relative to soybean processing can be determined. Using equations (3.4.1) and (3.4.2), the respective value-added for rapeseed and soybean processing can be computed before and after the tariff on oil.

$$Vr = (aPro + bPrm) - Prs \quad (3.5.6)$$

$$Vs = (fPso + gPsm) - Psb \quad (3.5.7)$$

$$V'r = (a(1+t)Pro + bPrm) - Prs \quad (3.5.7)$$

$$V's = (f(1+t)Pso + gPsm) - Psb \quad (3.5.8)$$

where:

t = tariff on the import of oil

a,b = units of rapeseed oil and meal, respectively produced from one unit of rapeseed

f,g = units of soybean oil and meal, respectively produced from one unit of soybeans

Vr,V'r = value-added from the activity of processing rapeseed before and after the tariff on oil, respectively

Vs,V's = value-added from the activity of processing soybeans before and after the tariff on oil, respectively

Prs,Prm,Pro = price of rapeseed, rapeseed meal and oil, respectively

Psb,Psm,Pso = price of soybeans, soybean meal and oil, respectively

In order to determine the value-added for rapeseed and soybean processing in Japan, prices of rapeseed, soybeans and their products are required. Expressed in $U.S., these are:[10]

Pro = $902.33, Prm = $206.44, Prs = $296.90, Psb = $288.87[11]

Pso = $883.58, Psm = $345.90[12]

The oil:meal ratio for rapeseed and soybeans is 39.5:57.0 and 17.4:79.0, respectively.[13] So:

a = 0.395, b = 0.57, f = 0.174, and g = 0.79

---

[10] These prices are the average of monthly prices from Aug. 1977 to July 1983 converted to $U.S. using the average of monthly exchange rates for the same period, (228.541). From Monthly Trade Statistics, Ministry of Finance, Tokyo.

[11] Wholesale prices. Japan Economic Journal, Tokyo. Various Issues.

[12] Monthly Trade Statistics, Ministry of Finance, Tokyo.

[13] Five year average oil and meal yields (1977/1983), Canola Council of Canada, Winnipeg.

Because the tariff imposed on rapeseed oil and soybean oil is an absolute tariff, it has a different value in percentage terms. Using the previous exchange rate, the Japanese absolute tariff is \$74.38. The average Japanese price of rapeseed oil is \$902.33 which implies a world price of \$827.95 relating to an 8.98% tariff. The average Japanese price of soybean oil is \$883.58 associated with a world price of \$809.20 relating to a 9.19% tariff. Comparing these tariff levels suggests the nominal rate of protection is higher on soybean oil than rapeseed oil.

The rate of protection on the processing activity is calculated below. The pre- and post-tariff values-added for rapeseed processing are:

$$Vr = (0.395(827.95) + 0.57(206.44)) - 296.90 = 147.81 \quad (3.5.9)$$

$$V'r = (1.0898(0.395)(827.95) + 0.57(206.44)) - 296.90 = 177.19 \quad (3.5.10)$$

the effective rate is therefore,

$$er = (177.18 - 147.81)/147.81 = 0.20 \quad (3.5.11)$$

The pre- and post-tariff values-added in soybean processing are:

$$Vs = (0.174(809.20) + 0.79(345.90)) - 288.87 = 125.19 \quad (3.5.12)$$

$$V's = (1.0919(0.174(809.20) + 0.79(345.90)) - 288.87 = 138.13 \quad (3.5.13)$$

the effective rate for soybean processing is:

$$es = (138.13 - 125.19)/125.19 = 0.10 \quad (3.5.14)$$

The effective rate of protection is higher on rapeseed processing than on soybean processing. The relative rate, using equations (3.5.4), (3.5.10) and (3.5.13) is:

$$Rr = 177.19/138.13 = 1.28 \quad (3.5.15)$$

A ratio greater than 1.0 indicates the value-added in processing rapeseed is larger than in soybean processing. Thus, rapeseed processing is encouraged vis-a-vis soybean processing.

3.6 SUMMARY

A brief background to international trade theory was given with an emphasis on protectionism. It included a discussion of arguments in favour of trade barriers. The self-sufficiency argument, supports trade barriers since they are most effective in attaining self-sufficiency. Methods of restricting trade evolved from import licencing to "uniform" tariffs, ad valorem and absolute tariffs. More recently, introducing export taxes has been studied.

Through continued GATT talks, reduced trade barriers in manufacturing industries are being negotiated. However, there is a significant level of trade intervention in the agricultural sector. This could be due to the self-sufficiency argument as well as effective lobbying by producer groups. Studies regarding export taxes address existing distorions in agricultural trade and a method of offsetting these distortions.

The measurment of tariff protection was presented in the third section. The effective rate and the nominal rate were introduced and compared. The effective rate measures the rate of protection afforded an activity while the nominal rate measures that afforded the product. A simple numerical example illustrated the appropriate use of each and the effect of a tariff on an imported input.

In section 4, the nominal and effective rates were used to measure protection provided by Japanese import tariffs. The relative rate was introduced to compare the levels of protection afforded the production of rapeseed oil and soybean oil. Soybean oil faces a higher nominal rate of protection in percentage terms but the effective and relative rates indicate that rapeseed crushing receives more protection than soybean crushing in Japan.

In the next chapter, a simple two-region trade model will be used to illustrate the benefits of unrestricted trade. A mathematical form of this model will be presented and later expanded to include trade of many goods amongst several regions.

Chapter IV

MODEL OF THE OILSEED COMPLEX

4.1 INTRODUCTION

The world oilseed market is a complex, interactive system, allowing for trade flows of many competing products destined for various locations. Oilseeds are either processed at the source of supply or exported and subsequently processed in the importing region. Following processing, the products are consumed in the processing region or traded. Production, processing and consumption may take place in several locations with trade linking these activities. An accurate graphical representation of the oilseed market would be extremely complex. A simple two-region, one-good model will help conceptualize the framework for trade flows between excess producing and consuming regions.

The effect on consumer and producer welfares of introducing trade, will be illustrated. Once trade exists, the consequences of an importing region implementing a tariff is presented and a mathematical form is specified to quantify distortions resulting from this imposition. The final section generalizes the mathematical form to allow trade of m commodities between n the effects of tariffs and changes to the tariff structure of regions.[14]

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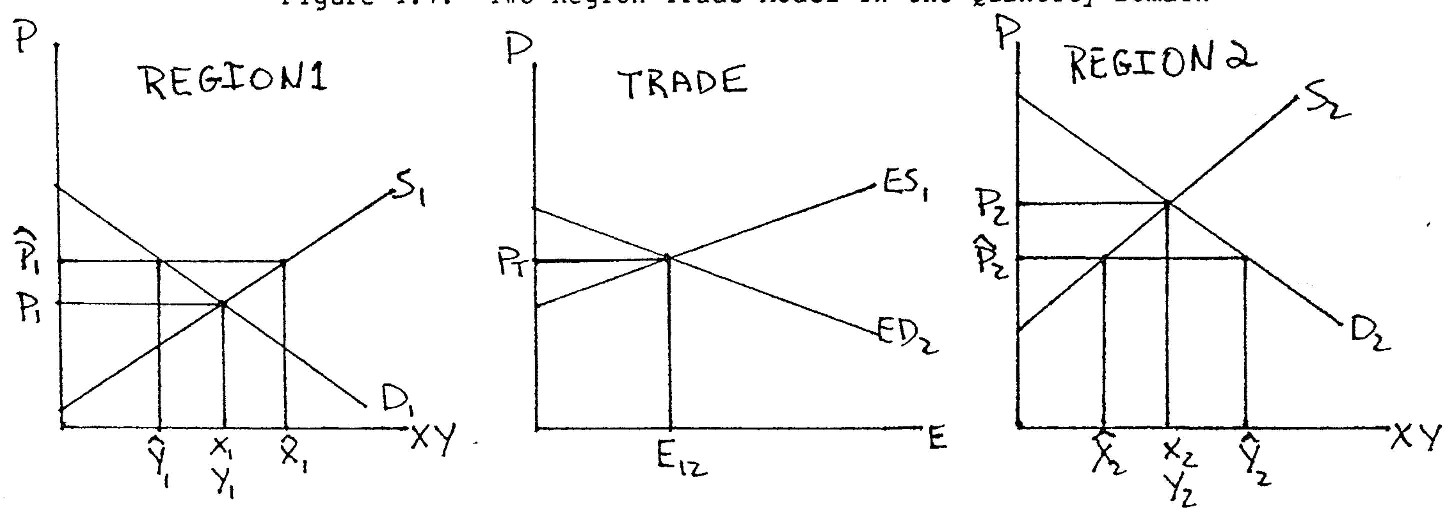
[14] This chapter follows the work of Takayama and Judge (1971) and parallels Martin's (1981) presentation.

4.2 GRAPHICAL MODEL

A two-region one commodity trade model is found in Figure 4.1. The model is presented in the quantity domain. Initial prices (P_1,P_2), are found at the intersection of demand and supply in Region 1 and Region 2, respectively. Excess demand (ED_2) in Region 2, is the difference between demand and supply, below the domestic price (P_2). Excess supply (ES_1) is the difference between supply and demand above the domestic equilibrium price (P_1) in Region 1. The intersection of excess supply (ES_1) and excess demand (ED_2) establishes the volume traded (E_{12}) and the free trade price (P_T). The volume traded (E_{12}) equals the difference between consumption and production in each region (ie. $\hat{Y}_2 - \hat{X}_2 = \hat{X}_1 - \hat{Y}_1$). Similarily, the free trade price (P_T) is equal to each regions' price once trading has been introduced ($\hat{P}_1 = \hat{P}_2$).[15]

Figure 4.1: Two-Region Trade Model in the Quantity Domain



[15] Assuming the currency exchange rate is at parity and zero transport cost.

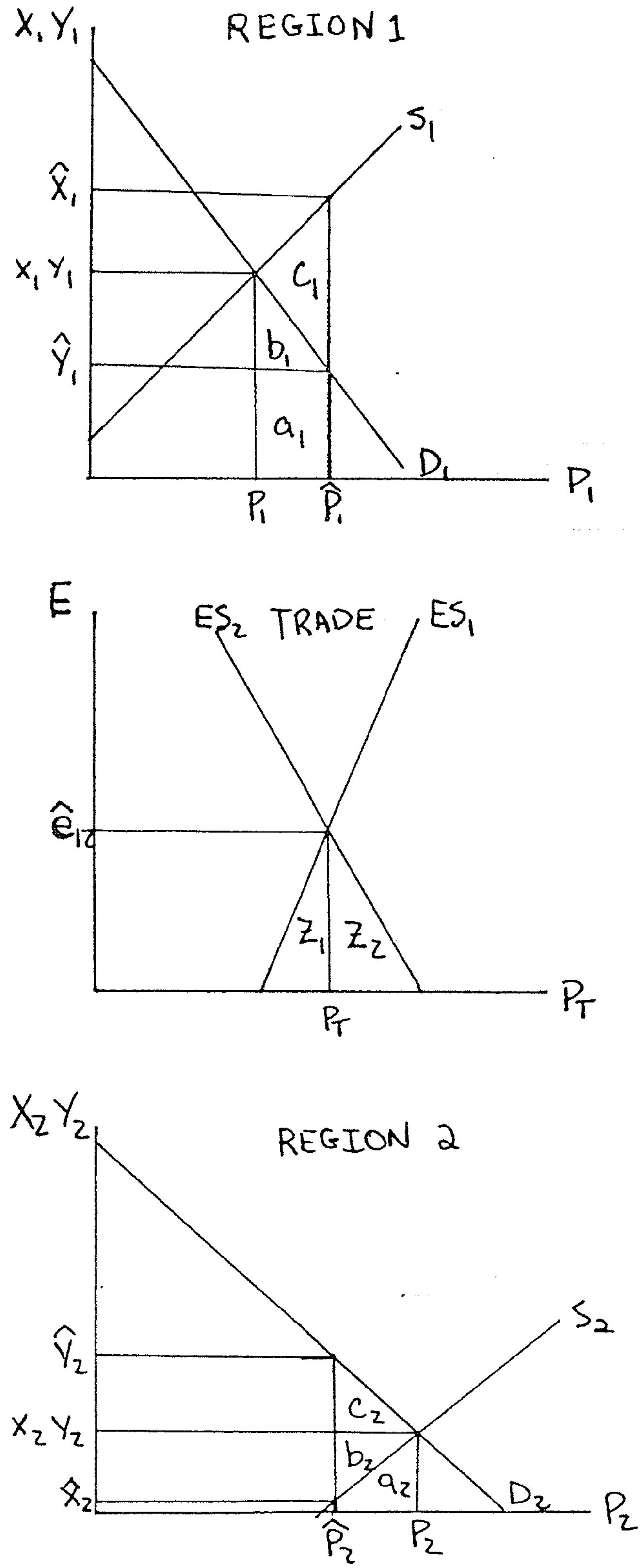
In this study, supply and demand functions are expressed in the price domain ie. $Q_D = f(P_1, P_2)$. This relationship is expressed diagramatically in Figure 4.2.

Once again, the interaction of excess supply and demand curves determines the equilibrium prices and trade level in the two-region market. Their intersection at the price (P_T), provides the level of trade $(\hat{e}_{12})$. The welfare gain to society resulting from trade at price level (P_T) is the sum of changes in producer and consumer surplus in each region. In Region 1 the change in producer surplus, as price increases from P_1 to $\hat{P}_1$ is $(a_1 + b_1 + c_1)$. However, the change in consumer surplus from a price increase is $-(a_1 + b_1)$. The sum is $(a_1 + b_1 + c_1) - (a_1 + b_1) = (c_1)$, which by construction equals (Z_1).

In Region 2, the change in producer surplus as price decreases from P_2 to $\hat{P}_2$ is $-(a_2)$. The benefit to consumers as price falls is expressed as $(a_2 + b_2 + c_2)$. The change in welfare in Region 2 is their sum, $-(a_2) + (a_2 + b_2 + c_2) = (b_2 + c_2) = (Z_2)$.

The sum of the welfare gains in each region are $(Z_1 + Z_2)$, yielding the net welfare effect of the introduction of trade into a two-region society.

Figure 4.2: Two-Region Trade Model in Price Domain



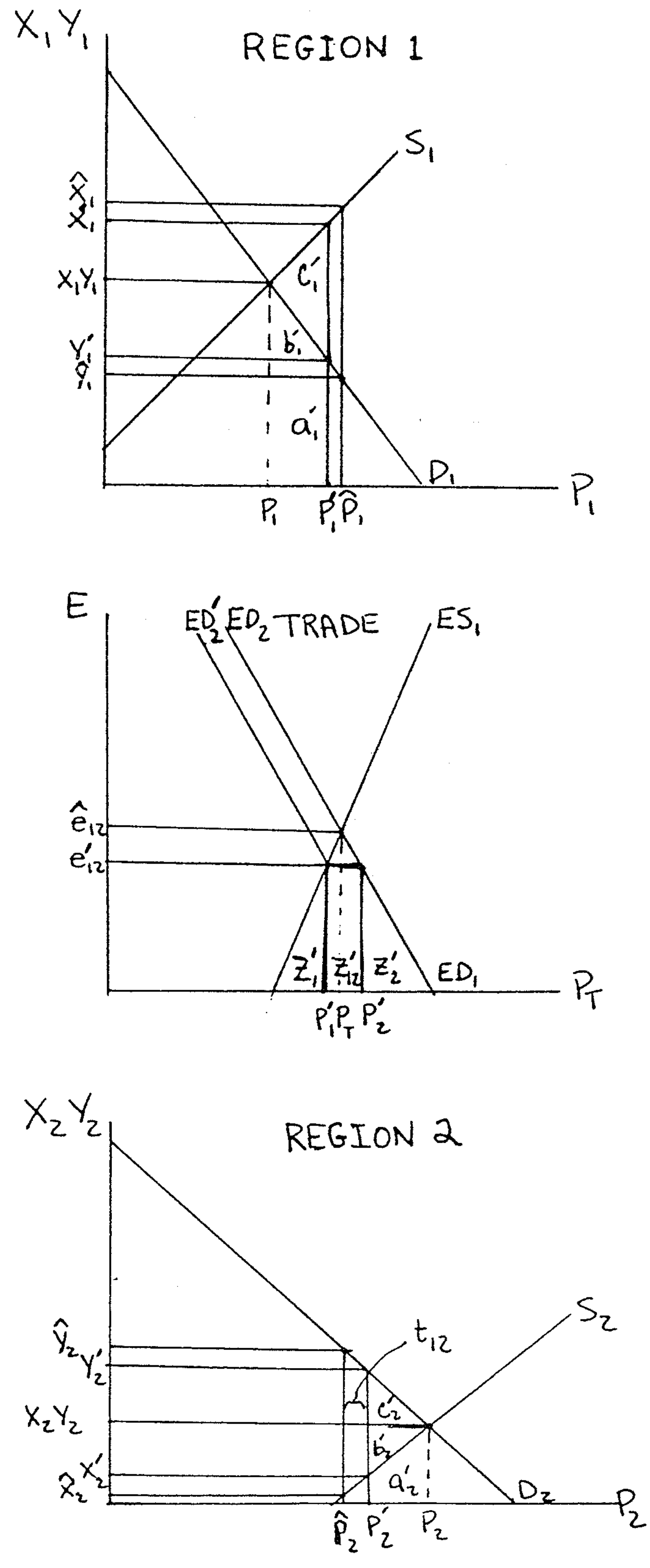
In Figure 4.3, the introduction of an absolute tariff into Region 2 increases that region's price to (P_2'). The demand for imports decreases to $(Y_2' - X_2')$. Since Japan is a large importer of Canadian rapeseed, a large importing country is assumed in this example. The decline in exports from Region 1 results in a price reduction to (P_1') in that region. Production (X_1') and consumption (Y_1') in Region 1 are undertaken at the price level (P_1'). The differences between production and consumption in each region equals the level of trade (e_{12}'). The difference between each regions' prices $(P_2'-P_1')$ is greater than the tariff level (t_{12}).

Society could potentially gain $(Z_1' + Z_2' + Z_{12}')$ from trade. However, the actual gain from trade is the sum of the changes in producer and consumer surplus in each region. The net welfare gain in Region 1 is the area (c_1') which equals (Z_1'), the net gain in Region 2 is $(c_2' + b_2')$ equalling (Z_2') and the loss due to tariffs is the area (Z_{12}').

4.3 MATHEMATICAL FORM OF MODEL

The graphical form of the model shows an equilibrium level of trade (e_{12}') under a tariff (t_{12}) imposed by the importing region. The direct cost of the tariff was absorbed by the importing region which also collected the revenues from the tariff. However, the indirect cost attributed to reduced trade is borne by the exporting region. This assumes a large importing country. In reality, the burden of trade loss would be shared by both regions. The relative size of each region's share would depend upon its market strength.

Figure 4.3: Two-Region Trade Model with Tariff in the Importing Region



Returning to the free-trade case in Figure 4.1, the optimal trade level is reached where the areas $Z_1 + Z_2$ are maximized. The area designated by Z_1 is determined by summing the changes in producer and consumer surplus in Region 1. Similarly, the area designated by Z_2 may be found by summing the changes in consumer and producer surplus in Region 2. Equilibrium is achieved when the total of the sums of changes in producer and consumer surplus in each region is maximized.

Once the tariff (t_{12}) is imposed we are concerned with the area $(Z_1' + Z_2')$. This is found by maximizing $(Z_1' + Z_2' + Z_{12}') - (Z_{12}') = (Z_1' + Z_2')$.

To determine consumer and producer surplus in each region, it is necessary to estimate each region's supply and demand functions. Supply and demand relationships in the price domain are assumed to be linear functions of the following form:

$$Y_1 = f(a_1 + b_1 P_1) \quad (4.3.1)$$

$$Y_2 = f(a_2 + b_2 P_2) \quad (4.3.2)$$

$$X_1 = f(c_1 - d_1 P^1) \quad (4.3.3)$$

$$X_2 = f(c_2 - d_2 P^2) \quad (4.3.4)$$

where:

Y_i, X_i = consumption and production respectively;

a_i, c_i = intercepts of the demand and supply functions respectively; $a_i > 0$, $c_i < 0$

b_i, d_i = slope coefficients for the demand and supply functions respectively; $b_i < 0$, $d_i > 0$

P_i, P^i = demand and supply prices respectively;

$i = 1,2$

In matrix form the demand functions may be written as:

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} b_1 & 0 \\ 0 & b_2 \end{bmatrix} \begin{bmatrix} P_1 \\ P_2 \end{bmatrix}$$

The supply functions may be written as:

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} d_1 & 0 \\ 0 & d_2 \end{bmatrix} \begin{bmatrix} P^1 \\ P^2 \end{bmatrix}$$

Given the supply and demand functions for each region, each function can be intergrated over the range between pre- and post-trade equilibrium to find the area $(Z_1 + Z_2)$. The quasi-welfare function for the two region model is:

$$w(P_1, P^1, P_2, P^2) = \int_{\hat{P}_1}^{P_1} (a_1 - b_1 P_1)\partial P - \int_{\hat{P}^1}^{P^1} (c_1 + d_1 P^1)\partial P^1 + \int_{\hat{P}_2}^{P_2} (a_2 - b_2 P_2)\partial P_2 - \int_{\hat{P}^2}^{P^2} (c_2 + d_2 P^2)\partial P^2 \quad (4.3.5)$$

Evaluating the supply and demand functions throughout their quantity ranges, provides the following indirect-welfare function.

$$IW(P_1, P^1, P_2, P^2) = K_1 + a_1 P_1 - 1/2b_1(P_1) - c_1 P^1 - 1/2d_1(P^1) + K_2 + a_2 P_2 - 1/2b_2(P_2) - c_2 P^2 - 1/2d_2(P^2) \quad (4.3.6)$$

$$= K_1 + a_1 P_1 - 1/2b_1 P_1 P_1 - c_1 P^1 - 1/2d_1 P^1 P^1 + K_2 + a_2 P_2 - 1/2b_2 P_2 P_2 - c_2 P^2 - 1/2d_2 P^2 P^2 \quad (4.3.7)$$

In this case K_1 and K_2 are the constants of integration. After dropping these constants, equation (4.3.7) becomes the objective function for the quadratic programming model.

Since equation (4.3.7) is integrated throughout the range of prices, it is not equal to equation (4.3.5). Therefore, it is necessary to include a constraint in order to ensure an equilibrium solution. Figure 4.3 illustrates that equilibrium occurs where the tariff cost equals the difference between regional prices. Equilibrium could occur where prices differ by less than the tariff costs, resulting in no trade. So, a price equilibrium condition will be used as a constraint. The price equilibrium condition is as follows:

$$P_2 - P^1 - t_{12} < 0 \qquad \text{or} \qquad t_{12} + P_2 + P^1 > 0 \qquad (4.3.8)$$

The quadratic programming problem can be stated as the maximization of (4.3.7) subject to (4.3.8) and $P_1, P^1, P_2, P^2 => 0$.

To make this problem operational, the Lagrangian of the objective function must be formed.

$$L(P_1, P^1, P_2, P^2, T_{12}) = a_1 P_1 - b_1 P_1 P_1 - c_1 P^1 - d_1 P^1 P^1 + a_2 P_2 - b_2 P_2 P_2$$
$$-c_2 P^2 - d_2 P^2 P^2 - e'_{12}(t_{12} - P_2 + P^1).$$

The Kuhn-Tucker necessary conditions for each variable are:[16]

a) $\frac{\partial \bar{L}}{\partial P_1} = a_1 - b_1 \bar{P}_1 < 0$ and $\left(\frac{\partial \bar{L}}{\partial P_1}\right)\bar{P}_1 = 0$

b) $\frac{\partial \bar{L}}{\partial P^1} = -c_1 - d_1 \bar{P}^1 - e'_{12} < 0$ and $\left(\frac{\partial \bar{L}}{\partial P^1}\right)\bar{P}^1 = 0$

c) $\frac{\partial \bar{L}}{\partial P_2} = a_2 - b_2 \bar{P}_2 + e'_{12} < 0$ and $\left(\frac{\partial \bar{L}}{\partial P_2}\right)\bar{P}_2 = 0$

d) $\frac{\partial \bar{L}}{\partial P^2} = -c_2 - d_2\bar{P}^2 < 0$ and $\left(\frac{\partial \bar{L}}{\partial P^2}\right)\bar{P}^2 = 0$

e) $\frac{\partial \bar{L}}{\partial e'_{12}} = -t_{12} + P_2 - P^1 < 0$ and $\left(\frac{\partial \bar{L}}{T_{12}}\right)\bar{e}'_{12} = 0.$

The Lagrangian (e'_{12}) represents the trade flow from Region 1 to Region 2 associated with the price constraint (t_{12}). Conditions a) and c) represent optimum consumption with no excess demand since $c_1 - d_1\bar{P}_1 = \bar{Y}_1$ and $c_2 - d_2\bar{P}_2 = \bar{Y}_2$. Conditions b) and d) represent optimum production. However, the possibility of excess supply exists since the following can hold: $a_1 + b_1\bar{P}^1 = \bar{X}_1$ and $a_2 + b_2\bar{P}^2 = \bar{X}_2$. Condition e) represents the spatial price equilibrium condition. The two-region model satisfies trade, spatial price and

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[16] A bar (—) over a variable indicates its optimum value.

optimum production and consumption conditions. The model is expressed as:

$$\text{Max } IW(P_1, P_2, P^1, P^2, e_{12}) = a_1 P_1 - 1/2 b_1 P_1 P_1 + a_2 P_2 - 1/2 b_2 P_2 P_2$$
$$- c_1 P^1 - 1/2 d_1 P^1 P^1 - c_2 P^2 - 1/2 d_2 P^2 P^2 \qquad (4.3.9)$$

Subject to:

$$t_{12} - P_2 + P^2 => 0 \qquad (4.3.10)$$

and $$P_1, P_2, P^1, P^2, e_{12} => 0 \qquad (4.3.11)$$

4.4 GENERALIZED MATHEMATICAL FORM

The previous model considered trade in only one commodity between two regions. Since this study is concerned with the trade of many commodities amongst several regions, the model is extended into a generalized mathematical form. Once again, consider supply and demand functions in the price domain.

$$y_i^k = a_i^k - \Sigma b_i^{kh} P_i^k \qquad \text{for } i,j = (1,2,...,n) \text{ regions}$$
$$k,h = (1,2,...,n) \text{ commodities.} \qquad (4.4.1)$$

$$x_i^k = c_i^k + \Sigma d_i^{kh} P_i^k \qquad \text{for all } i \text{ and } k. \qquad (4.4.2)$$

where:

y_i^k, x_i^k are the quantities demanded and supplied, respectively of commodity k in region i.

P_i^k, P^{ik} are demand and supply prices, respectively for commodity k in region i.

a_i^k, c_i^k are intercepts of demand and supply functions, respectively for commodity k in region i; a >0, c <=>0.

b_i^{kh}, d_i^{kh} are the slope coefficients relating the quantity demanded or supplied, of commodity k to the demand or supply price, respectively of commodity k in region i; b , d >0 for h=k;

b_i^{kh}, d_i^{kh} <=>0 for $h \neq k$

In region i, the demand functions for all m commodities are writen as:

$$y_i = \begin{bmatrix} y_i^1 \\ y_i^2 \\ \vdots \\ y_i^m \end{bmatrix} = \begin{bmatrix} a_i^1 \\ a_i^2 \\ \vdots \\ a_i^m \end{bmatrix} + \begin{bmatrix} d_i^{11} & d_i^{12} & \cdots & d_i^{1m} \\ d_i^{21} & d_i^{22} & \cdots & d_i^{2m} \\ \vdots & \vdots & \ddots & \vdots \\ d_i^{m1} & d_i^{m2} & \cdots & d_i^{mm} \end{bmatrix} \begin{bmatrix} P_i^1 \\ P_i^2 \\ \vdots \\ P_i^m \end{bmatrix}$$

The supply functions are written as:

$$X_i = \begin{bmatrix} X_i^1 \\ X_i^2 \\ \vdots \\ X_i^m \end{bmatrix} = \begin{bmatrix} C_i^1 \\ C_i^2 \\ \vdots \\ C_i^m \end{bmatrix} + \begin{bmatrix} d_i^{11} & d_i^{12} & \cdots & d_i^{1m} \\ d_i^{21} & d_i^{22} & \cdots & d_i^{2m} \\ \vdots & \vdots & \ddots & \vdots \\ d_i^{m1} & d_i^{m2} & \cdots & d_i^{mm} \end{bmatrix} \begin{bmatrix} p^{i1} \\ p^{i2} \\ \vdots \\ p^{im} \end{bmatrix}$$

The set of demand and supply functions for m commodities and n regions summed up are:

$$Y = A - B\ P_y \tag{4.4.3}$$

$$X = C - D\ P_x \tag{4.4.4}$$

Y, X, A, C, P_y, P_x have dimensions (nm x 1). The matrices B and D have dimensions (nm x nm) containing non-zero, off-diagonal elements.

The vector of interregional tariff costs and trade flows associated with price constraints is defined as follows:

$$T'E_x = \Sigma\Sigma t_{ij}^k\ e_{ij}^k \tag{4.4.5}$$

where:

t_{ij}^k is the tariff cost associated with transferring commodity k between the producing region i and the consuming region j.

e_{ij}^k is the trade flow between i and j.

As in the two commodity case, a constraint must be introduced to ensure equilibrium. The price difference between the producing and consuming regions is equal to, or less than, the tariff costs. Thus, the price equilibrium condition may be written as follows:

$$t_{ij}^k - P_j^k + P^{ik} => 0 \tag{4.4.6}$$

where:

P_j^k is the demand price of k in region j.

P^{ik} is the supply price of k in region i.

The generalized form of the price equilibrium condition is:

$$T - Gy'Py - Gx'Px => 0 \tag{4.4.6}$$

where:

T is an $(mn^2 x\ 1)$ vector of transfer costs.

Gy is an $(mn\ x\ mn^2)$ matrix of the form:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & \cdots & 0 & 1 & 0 & 0 & \cdots & 0 & 1 & 0 & \cdots & 0 \\ 0 & 1 & & & & & 1 & & & & & 1 & \ddots & & 0 \\ \vdots & & \ddots & & & & & \ddots & & & & & \ddots & & \vdots \\ \vdots & & & \ddots & & & & & \ddots & & & & & \ddots & 0 \\ 0 & \cdots & & & 0 & 1 & 0 & \cdots & & & 0 & 1 & 0 & \cdots & 0 & 1 \end{bmatrix}$$

Gx is an $(mn\ x\ mn^2)$ matrix of the form:

$$\begin{bmatrix} -1 & -1 & \cdots & -1 & 0 & 0 & \cdots & & & & & 0 \\ 0 & 0 & \cdots & 0 & -1 & -1 & \cdots & -1 & 0 & & & 0 \\ \vdots & & & & & & & & 0 & \ddots & & \vdots \\ \vdots & & & & & & & & & 0 & \ddots & \vdots \\ \vdots & & & & & & & & & & \ddots & 0 \\ 0 & 0 & \cdots & & & & & 0 & -1 & -1 & \cdots & -1 \end{bmatrix}$$

Our quadratic programming model is of the form:

$$\text{Max } NR(Py,Px,Ex) = (A - BPy)Py - (C - DPx)Px - T'Ex \tag{4.4.7}$$

Subject to:

$$T - GyPy - GxPx => 0 \tag{4.4.8}$$

The Lagrangian is specified to show that the model's solution meets trade, optimum production and consumption conditions as well as price equilibrium condition.

$$L(Py,Px,Ex)=APy-1/2PyBPy-CPx-1/2PxDPx+Ex(T-GyPy-GxPx)$$

E is a (nm x 1) vector of Lagrangian multipliers which may be interpreted as interregional trade flows associated with the price constraints.

$E_x=(e_{11}, e_{12}, \ldots, e_{1n}, e_{21}, \ldots, e_{2n}, \ldots, e_{i1}, e_{i2}, \ldots e_{n1}, \ldots, e_{nn})$.

The (generalized) necessary Kuhn-Tucker conditions are:

A) $\frac{\partial \bar{L}}{\partial P_y} = A - B\bar{P}y - Gy\bar{E}x <= 0$ and $0\left(\frac{\partial \bar{L}}{\partial P_y}\right)'\bar{P}y = 0$

where Py are the optimal regional demand prices and $\left(\frac{\partial \bar{L}}{\partial P_y}\right)'\bar{P}y = 0$ is the complimentary slackness condition.

1. If $\bar{P}y > 0$, $\frac{\partial \bar{L}}{\partial P_y} = 0$. Thus $GyEx = A - B\bar{P}y$ since $A - B\bar{P}y = \bar{Y}$, $G_y\bar{E}x = \bar{Y}$; ie. when optimum demand prices are positive there is no excess demand or excess supply.

2. If $\bar{P}y = 0$, $\frac{\partial \bar{L}}{\partial P_y} <= 0$. Thus, $Gy\bar{E}x => A - B\bar{P}y$; ie. when optimum demand prices equal zero there is no possibility of excess demand, however the possibility of excess supply exists.

B) $\frac{\partial \bar{L}}{\partial P_x} = -(C + D\bar{P}x) - Gx\bar{E}x <= 0$ and $\left(\frac{\partial \bar{L}}{\partial P_x}\right)'Px = 0$

where Px are the optimal regional supply prices and $\left(\frac{\partial \bar{L}}{\partial P_x}\right)'\bar{P}x = 0$ as the complimentary slackness condition.

1. If $\bar{P}x > 0$, $\frac{\partial \bar{L}}{\partial P_x} = 0$, thus $Gx\bar{E}x = -(C + D\bar{P}x)$, since $C + D\bar{P}x = \bar{X}$, $Gx\bar{E}x = -\bar{X}$; ie. when optimum supply prices are positive there is no excess supply.

2. If $\bar{P}x = 0$, $\frac{\partial \bar{L}}{\partial P_x} <= 0$, thus $Gx\bar{E}x <= -(C + D\bar{P}x)$; ie. when supply prices are zero there still exists the possibility of excess supply.

C) $\frac{\partial \bar{L}}{\partial E_x} = T - G'y\bar{P}y + G'x\bar{P}x => 0$ and $\left(\frac{\partial \bar{L}}{\partial E_x}\right)'Ex = 0$, where $\bar{E}x$ are the optimal trade flows and $\left(\frac{\partial \bar{L}}{\partial E_x}\right)'\bar{E}x = 0$ as the complimentary slackness condition.

1. If $\bar{E}x > 0$, $\frac{\partial \bar{L}}{\partial E_x} = 0$, thus $G'y\bar{P}y - G'x\bar{P}x = T$; ie. if there are positive trade flows, then the demand prices minus the supply prices equal the tariff costs between trading regions. This is the price condition.

2. If $\bar{E}x = 0$, $\frac{\partial \bar{L}}{\partial Ex} > 0$, thus $T - G'x\bar{P}x > G'y\bar{P}y$; ie. if the tariff cost plus the supply price is greater than the demand price, then no trade flows will exist.

These then are the trade, price and optimum production and comsumption conditions.

The net revenue quadratic programming model is specified as:

$$\text{Max } NR(Py,Px,Ex) = (A - BPy)'Py - (C - DPx)'Px - T'Ex \tag{4.4.9}$$

Subject to:

$$A - BPy - GyEx <= 0 \tag{4.4.10}$$

$$C + DPx + GxPx <= 0 \tag{4.4.11}$$

$$T - GyPy - GxPx => 0 \tag{4.4.12}$$

and $Py,\ Px,\ Ex => 0$

Matrices B and D are likely to be asymmetric. Symmetry is required to solve a quadratic programming problem (MacAulay, 1976). In this model, symmetry is satisfied by replacing each element of the matrix by the average of the off diagonal pairs. That is, the value for d and d is given by (d + d)/2. This procedure distorts the estimated demand and supply structure. Since the linear constraint set (4.4.10) and (4.4.11) does not require symmetry it preserves the "true" demand and supply structure (Martin, 1981).

The QP model may be expressed as:

Maximize Net Revenue = Quantity of oil sold x Price of oil
+ Quantity of meal sold x Price of meal
- Change in meal stocks x Price of meal stocks
+ Change in seed stocks x Price of seed stocks
- Available seed supply x Price of seed
- Cost of crushing seed x Quantity of seed crushed
- Cost of transferring oil x Quantity of oil transferred
- Cost of transferring meal x Quantity of meal transferred
- Cost of transferring seed x Quantity of seed transferred

or mathematically as:

Maximize

$$\text{Max } NR(P_i^k,\ P_i^h,\ P_i^\ell,\ P_i^n,\ P_i^g, Q_i^g,\ X_{ji}^k, X_{ji}^\ell,\ X_{ji}^g) =$$

$$(a_i^k - b_i^{kk} P_i^k + b_i^{kh} P_i^h) P_i^k + (a_i^\ell - b_i^{\ell\ell} P_i^\ell + b_i^{\ell n} P_i^n) P_i^\ell - (c_i^\ell - d_i^\ell P_i^\ell) P_i^\ell$$

$$+ (e_i^g - f_i^g P_i^g) P_i^g - S_i^g P_i^g - C_i^g Q_i^g - T_{ji}^k X_{ji}^k - T_{ji}^\ell X_{ji}^\ell - T_{ji}^g X_{ji}^g$$

Subject to:

$P_j^k - P_i^k <= T_{ij}^k \quad , P_j^\ell - P_i^\ell <= T_{ij}^\ell \quad , P_j^g - P_i^g <= T_{ij}^g$
Price of good in region j is less than the price of good in region i plus cost of shipping good from region i to region j.

$r_i^k P_i^k + r_i^\ell P_i^\ell - P_i^g <= C_i^g + T_i^g$
Marginal revenue of crushing one unit of oilseed g in region i is less than the cost of crushing one unit of oilseed g in region i plus cost of transferring oilseed from region j to region i.

$a_i^k - b_i^{kk} P_i^k + b_i^{kh} P_i^h <= X_{ji}^k$
Shipment of oil from itself and other regions to region i must fulfill demand for oil in that region.

$(a_i^\ell - b_i^{\ell\ell} P_i^\ell + b_i^{\ell n} P_i^{\ell n}) + (c_i^\ell - d_i^\ell P_i^\ell) <= X_{ji}^\ell$
Shipment of meal from itself and other regions must satisfy demand for meal plus demand for meal stocks in region i.

$Q_i^g + (e_i^g - f_i^g P_i^g) <= X_{ji}^g$
Quantity of input g crushed in region i plus demand for input stocks is less than quantity of inputs transferred to region i from itself and other regions.

$S_i^g => X_{ij}^g + (e_i^g - f_i^g P_i^g)$
Supply of input g in region i minus demand for oilseed stocks is less than quantity transferred from region i to itself and other regions.

$r_i^k Q_i^g => X_{ij}^k$
Quantity of oil shipped from region i to itself and to other regions cannot exceed final product equivalent from quantity crushed in region i.

2. If Ex = 0, > 0, thus T - GxPx > GyPy; ie. if the tariff cost plus the supply price is greater than the demand price, then no trade flows will exist.

These then are the trade, price and optimum production and comsumption conditions.

The net revenue quadratic programming model is specified as:

$$\text{Max } NR(Py,Px,Ex) = (A - BPy)Py - (C - DPx)Px - T'Ex \tag{4.4.9}$$

Subject to:

$$A - BPy - GyEx <= 0 \tag{4.4.10}$$

$$C + DPx + GxPx <= 0 \tag{4.4.11}$$

$$T - GyPy - GxPx => 0 \tag{4.4.12}$$

and Py, Px, Ex => 0

Matrices B and D are likely to be asymmetric. Symmetry is required to solve a quadratic programming problem (MacAulay, 1976). In this model, symmetry is satisfied by replacing each element of the matrix by the average of the off diagonal pairs. That is, the value for d and d is given by (d + d)/2. This procedure distorts the estimated demand and supply structure. Since the linear constraint set (4.4.10) and (4.4.11) does not require symmetry it preserves the "true" demand and supply structure (Martin, 1981).

4.5 SUMMARY

In section one the graphical form of the trade model was presented in both price and quantity domains. The effects of tariffs in the price domain indicated a reduction in trade as well as lower prices in the producing region and higher prices in the consuming region. The graphs serve to illustrate the benefits of trade and the subsequent impacts on consumer and producer surplus once a tariff is introduced in the importing region.

The mathematical form of the two-region model was presented in section 2. In section 3, the two-region model was extended to a more general form that satisfied optimum trade, price, consumption and production conditions. A general net revenue quadratic programming model for trade of m goods in n regions was specified.

The general mathematical form provides the basis for modelling a specific problem. A five-region, six-good trade model will be specified in the following chapter.

Chapter V

EMPIRICAL SPECIFICATION OF THE OILSEED MODEL

5.1 INTRODUCTION

This study focuses on the production, consumption and trade of six commodities between five regions. The commodities are: rapeseeed, rapeseed meal, rapeseed oil, soybeans, soybean meal and soybean oil. The five regions in the study are: Canada, United States, European Community, Japan, and the rest of the world (ROW).

The relationship between consumption and production is initiated by the demand for the final products in each region. Vegetable oil is demanded for human consumption and meal is used in livestock feed.[17] These demands may be seperated into the demand for oil and meal imports and the demand for domestically produced oil and meal. The latter forms the derived demand for seed. The demand for imported products and for seed are satisfied through domestic production, domestic crushing and trade. Demand for seed and meal stocks also exist.

In most regions, soybeans and their products are substitutes for rapeseed and its products in most regions. Thus, in the demand equations, cross-price coefficients have been included in regions where significant substitution takes place.

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[17] Due to the nature of Japanese soils, rapeseed meal is used there as a fertilizer as well as for feed.

5.1.1 Mathematical Model

The QP model maintains the perfect competition assumption with prices clearing the market. In the objective function, prices and quantities are maximized. Tariffs are treated like transportation costs separating prices in each region. As rapeseed and soybean supplies are fixed, the model represents a single time period.

The QP model may be expressed as:

Maximize Net Revenue = Quantity of oil sold x Price of oil
+ Quantity of meal sold x Price of meal
- Change in meal stocks x Price of meal stocks
+ Change in seed stocks x Price of seed stocks
- Available seed supply x Price of seed
- Cost of crushing seed x Quantity of seed crushed
- Cost of transferring oil x Quantity of oil transferred
- Cost of transferring meal x Quantity of meal transferred
- Cost of transferring seed x Quantity of seed transferred

or mathematically as:

Maximize

$$\text{Max } NR(P, P, P, P, P, Q, X, X, X) =$$

$$(a - b P + b P)P + (a - b P + b P)P - (c - d P)P$$

$$+ (e - f P)P - S P - C Q - T X - T X - T X$$

Subject to:

$P - P <= T, P - P <= T, P - P <= T$
Price of good in region j is less than the price of good in region i plus cost of shipping good from region i to region j.

$r P + r P - P <= C + T$
Marginal revenue of crushing one unit of oilseed g in region i is less than the cost of crushing one unit of oilseed g in region i plus cost of transferring oilseed from region j to region i.

$a - b P + b P <= X$
Shipment of oil from itself and other regions to region i must fulfill demand for oil in that region.

$(a - b P + b P) + (c - d P) <= X$
Shipment of meal from itself and other regions must satisfy demand for meal plus demand for meal stocks in region i.

$Q + (e - f P) <= X$
Quantity of input g crushed in region i plus demand for input stocks is less than quantity of inputs transferred to region i from itself and other regions.

$S => X + (e - f P)$
Supply of input g in region i minus demand for oilseed stocks is less than quantity transferred from region i to itself and other regions.

$r Q => X$
Quantity of oil shipped from region i to itself and to other regions cannot exceed final product equivalent from quantity crushed in region i.

$r_i^{\ell} Q_i^{g} => X_{ij}^{\ell} + (c_i^{\ell} - d_i^{\ell} P_i^{\ell})$
Meal shipments from region i to itself and other regions plus demand for meal stocks cannot exceed final product equivalents from quantity crushed in region i.

$Q_i^{g} <= K_i^{g}$
Quantity of input crushed in region i cannot exceed crush capacity.

$P_i^{k}, P_i^{h}, P_i^{\ell}, P_i^{n}, P_i^{g}, Q_i^{g}, X_{ji}^{k}, X_{ji}^{\ell}, X_{ji}^{g}, => 0$

Where:

a_i^{k}, a_i^{ℓ} = intercepts of demand for oil and meal, respectively in region i ; $a_i^{k}, a_i^{\ell} \geqslant 0$

$b_i^{kk}, b_i^{\ell\ell}$ = direct price coefficients relating the quantity of oil and meal demanded to demand prices of oil and meal, respectively in region i; $b_i^{kk}, b_i^{\ell\ell}$ <= 0

$b_i^{kh}, b_i^{\ell n}$ = cross price coefficients relating quantity of oil and meal demanded to substitute oil and meal demand prices, respectively in region i; $b_i^{kh}, b_i^{\ell n}$ <=> 0

P_i^{k}, P_i^{ℓ} = demand prices of oil and meal, respectively in region i

P_i^{h}, P_i^{n} = substitute oil and meal demand prices, respectively in region i

c_i^{ℓ}, e_i^{g} = intercepts of the demand for meal and seed stocks, respectively in region i; c_i^{ℓ}, e_i^{g} => 0

d_i^{ℓ}, f_i^{g} = direct price coefficients relating quantity of meal and seed stocks demanded to demand and supply prices of meal and seed, respectively in region i; d_i^{ℓ}, f_i^{g} <= 0

P_i^{g} = supply price of oilseed in region i

S_i^{g} = available supply of rapeseed or soybeans in region i

C_i^{g} = cost of crushing rapeseed or soybeans in region i

Q_i^{g} = quantity of rapeseed or soybeans crushed in region i

$T_{ji}^{k}, T_{ji}^{\ell}, T_{ji}^{g}$ = cost of transferring oil, meal and oilseeds, respectively from region j to region i

$X_{ji}^{k}, X_{ji}^{\ell}, X_{ji}^{g}$ = quantities of oil, meal and oilseeds, respectively transferred from region j to region i

r_i^{k}, r_i^{ℓ} = oil and meal yields, respectively from crushing one unit of oilseed in region i

K_i^{g} = crushing capacity in region i

i,j = 1,2,3,4 regions

$k,h,l,n,g = 1,2$ goods

The net revenue function has several components. These include the demand for the joint products oil and meal; demand for stocks; the supply of the inputs seed and beans; prices for inputs and products; crushing, transportation and tariff costs; quantities crushed; and quantitities of inputs and products consumed in each region and traded between regions.

The demand coefficients corresponding to each product in each region have been estimated using ordinary least squares (OLS)_. In this single period short run model the supply of each input is fixed. Crushing, transportation and tariff costs are given for each region. The input and product prices and the quantities crushed, consumed and traded will be generated in the solution to the trade model.

5.2 DEMAND FOR PRODUCTS

The general form of each oil and meal demand function is expressed as:

$$\text{Demand} = f(P_P, P_S, X_1, X_2) \qquad (5.1.1)$$

where:

P_P = price of product

P_S = price of substitute

X_1, X_2 = other variables

The quadratic programming model requires demand to be expressed as a function of prices only. Therefore, 1982 observations corresponding to the X variables are substituted into the equation and multiplied by their coefficients. These values are then added to the value of the intercept, leaving the collapsed demand equation for 1982 as a function of direct and cross prices. This equation is written as:

$$\text{Demand} = A_i^k - B_i^{kk}P_i^k + B_i^{kh}P_i^h \qquad (5.2.2)$$

For consistency, all prices must be expressed in a common currency. Prices can either be converted to a common currency before the regional demand equations are estimated or estimated in their domestic currencies and then converted to a common currency. This is done by multiplying the price coefficient by appropriate exchange rates. The latter method was suggested by Elliot (1972) and employed by Furtan, Nagy and Storey (1978). In this study, Canadian exchange rates will be used to convert regional demand price coefficients in terms of Canadian dollars.

5.3 DEMAND FOR OIL

World trade of vegetable oil has increased steadily from 1977 to 1983 (Table 5.1). During this period export quantities have increased 64%, while export value has increased by 40%. Rapeseed oil and soybean oil compete with several other oils for shares in this increasing market. These oils include: palm, sunflower, groundnut, palm kernal, coconut and olive oils. Some of these oils are important factors in the estimation of regional rapeseed and soybean oil demand equations. Increasing populations and incomes are also important variables in the estimation of regional demands (Williams,1981). An oil demand function is presented in equation 5.3.1.

$$Do = f(Po,Pso,I,P) \qquad (5.3.1)$$

where:

Do = Demand for oil

Po = Price of the oil

Pso = Price of a substitute oil

I = Income

P = Population

TABLE 5.1

WORLD TRADE OF MAJOR VEGETABLE OILS 1977-83

Export Quantities

Year	Palm	Soy bean	Olive	Ground nut	Palm Kernal	Sun flower	Rapeseed Mustard	Coconut
	....	..000 Tonnes..						....
1977	2176.3	2104.3	253.4	578.8	243.6	692.2	668.6	1095.7
1978	2114.9	2607.4	260.8	436.1	265.6	798.3	520.2	1329.3
1979	2838.9	2953.2	302.4	501.1	365.8	821.4	624.3	1142.5
1980	3589.5	3196.0	265.1	482.1	383.0	1118.0	687.5	1216.0
1981	3213.6	3487.8	268.8	320.4	382.7	1101.8	847.9	1356.5
1982	3731.5	3402.1	248.1	447.1	466.1.	1251.2	799.7	1265.3
1983	3938.4	3677.1	404.4	524.3	511.6	1594.1	814.1	1328.6

Source: FAO Trade Yearbook, 1985.

Export Value

Year	Soy bean	Ground nut	Olive Olive	Sun flower	Rapeseed Mustard	Palm Kernal	Palm	Coconut
	....	..$US 1,000,000 ..						....
1977	1232.2	468.1	317.1	453.9	396.6	130.4	1133.4	608.7
1978	1608.9	389.4	349.2	525.0	317.7	162.9	1191.5	829.7
1979	1994.1	483.2	489.8	656.5	404.1	312.2	1751.4	1072.5
1980	1997.0	367.3	502.0	727.2	432.7	253.0	2022.4	792.4
1981	1888.6	317.1	469.6	723.2	454.9	209.0	1696.0	727.8
1982	1642.8	289.0	423.1	710.0	386.9	211.5	1647.8	583.2
1983	1813.0	292.6	605.3	809.7	410.0	293.8	1743.0	681.2

Source: FAO Trade Yearbook, 1985.

5.3.1 Demand for Oil in Canada

Rapeseed oil and soybean oil are the two major oils produced and consumed in Canada. In 1977/78, rapeseed oil consumption surpassed that of soybean oil as rapeseed oil increased its share of the "margarine" oil and "salad" oil markets (Table 5.2). Other oils have smaller shares in these markets. Since their influence in determining rapeseed oil and soybean oil demand equations is insignificant, they are not included in their estimation.

TABLE 5.2

VEGETABLE OIL PRODUCTION AND CONSUMPTION IN CANADA: 1974-84

	Production		Consumption	
Year	Rapeseed	Soybean	Rapeseed	Soybean
	.000 Tonnes			
1974	112.872	122.415	96.706	145.968
1975	125.017	113.105	105.690	133.270
1976	157.138	117.327	103.407	148.888
1977	205.475	116.915	144.431	145.321
1978	269.841	125.403	194.594	152.245
1979	313.689	137.514	168.346	147.822
1980	385.327	168.465	203.259	173.688
1981	439.681	148.878	262.040	145.550
1982	362.210	175.796	219.597	146.336
1983	411.249	177.237	315.419	174.509
1984	463.064	159.088	251.491	156.849

Source: Unpublished calendar year data from Grain Marketing Unit, Statistics Canada.

A large gap in the collection of rapeseed oil and soybean oil prices by Statistics Canada, from 1974 to 1981, required interpolation of data from other sources.[18] Rapeseed oil prices were taken from a study by Dawson, Dau and Associates (1983) and quarterly soybean oil import values were added to published Statistics Canada data. The estimated rapeseed oil and soybean oil demand equations are presented in (5.2.2) and (5.2.3).

$$DRO1 = -4.583 - \underset{(-1.983)}{0.048\ PRO1} + \underset{(2.166)}{0.023\ PSO1} + \underset{(1.38)}{0.028\ CPCDY} \qquad R2 = 0.791 \tag{5.2.2}$$

$$DSO1 = -8.327 - \underset{(-1.083)}{0.028\ PSO1} + \underset{(1.58)}{0.016\ PRO1} + \underset{(4.31)}{0.018\ CPCDY} \qquad R2 = 0.53 \tag{5.2.3}$$

where:

DRO1 = Domestic disappearance of rapeseed oil in Canada (quarterly, 1000 MT)

DSO1 = Domestic disappearance of soybean oil in Canada (quarterly 1000 MT)

PRO1 = Price of rapeseed oil in Canada (quarterly, C$/MT)

PSO1 = Price of soybean oil in Canada (quarterly, C$/MT)

CPCDY = Canadian per capita disposable income (C$2599.00, quarterly avg., 1982)

After substituting the 1982 observations and multiplying by four,[19] the Canadian rapeseed oil and soybean oil collapsed demand equations for 1982 are:

$$DRO1 = 272.756 - 0.192PRO1 + 0.092PSO1 \tag{5.2.4}$$

$$DSO1 = 174.612 - 0.112\ PSO1 + 0.064\ PRO1 \tag{5.2.5}$$

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[18] Confidentiality regulations did not allow Statistics Canada to collect or publish rapeseed oil and soybean oil prices during this period since there were too few processors in the industry.

[19] Since the data is quarterly, it must be multiplied by four to produce equations representing demand for the year.

5.3.2 Demand for Oil in the United States

Soybean oil dominates the US vegetable oil market which also includes cottonseed, peanut, linseed, sunflower, coconut, corn, palm kernel and other oils. Cottonseed oil, peanut oil, corn oil and palm oils are significant in the estimation of the domestic demand for soybean oil in the US. The demand for animal fats is also an important component of the soybean oil demand equation estimated in the study by Qasmi (1986). Qasmi's soybean oil demand equation is used in this study and presented below.

$$\begin{array}{llll} DPSO2 = 16.635 - 5.114\ USPWS4O & - 1.018\ USDPBLA & + 0.521\ DPSO2L & \\ R2 = 0.888 \qquad (-2.273) & (-2.852) & (2.994) & (5.2.6) \end{array}$$

where:

DPSO2 = DSO2 / USPOP

DSO2 = Domestic disappearance of soybean oil in the US (1000 MT)

USPOP = US population (232.00 million, 1982)

USPWS4O = PSO2 / USPV4VO

PSO2 = Price of soybean oil in the US (US$/MT)

USPV4VO = Average US price of peanut oil, cottonseed oil, corn oil and palm oil weighted by their respective market shares (US$532.87/MT, 1982)

USDPBLA = USDDBLA / USPOP

USDDBLA = US domestic disappearance of butter and lard (879.077 thousand MT, 1982)

DPSO2L = DSO2L / USPOPL

DSO2L = Domestic disappearance of soybean oil in the US, lagged one period (4337.84 thousand MT, 1982)

USPOPL = US population, lagged one period (229.78 million, 1982)

Substituting in 1982 observations for the following exogenous variables, USPOPL, DSO21, USDDBLA, USPV4VO and USPOP and multiplying the price coefficients by the 1982 average US/Canadian exchange rate (0.8105), yields the collapsed US soybean oil demand equation for 1982.

The price of rapeseed oil is insignificant in the estimation of US soybean oil demand. Therefore, the corresponding cross-price coefficient is zero.

$$DSO2 = 5228.035 - 1.822\ PSO2 + 0.0\ PRO2 \qquad (5.2.7)$$

In 1984, rapeseed oil received GRAS (Generally Regarded As Safe) Status in the US, rendering it acceptable for human consumption. Consequently, little consumption and price data is available for this good. Rapeseed oil demand in the US has therefore been treated exogenously in the 1982 QP model.

$$DRO2 = 6.9 - 0.0\ PRO2 + 0.0\ PSO2 \qquad (5.2.8)$$

5.3.3 Demand for Oil in the European Community

The vegetable oil market in the EC is to be difficult to model. This is partly due to data limitations as well as the impact of market intervention policies in the EC.

In the EC, rapeseed oil and soybean oil demand is influenced by other vegetable oils. The sunflower oil price is a significant variable in the the rapeseed oil demand equation while, the price of palm oil is important in estimating soybean oil demand. Collinearity problems require the use of price ratios in the estimation of these demand equations. The demand arguments were treated in the same manner as in previous estimates where terms are collapsed into the intercept.

The demand schedules for rapeseed oil and soybean oil in the EC are presented in equations (5.2.9) and (5.2.10).

$$DRO3 = -6.342 - 0.127\ PRO3 + 3.592\ PSO3/PSFO3 + 0.796\ POP3 \qquad (5.2.9)$$
$$R2 = 0.64 \qquad (-2.455) \qquad (1.03) \qquad (2.863)$$

$$DSO3 = -541.31 - 0.034\ PSO3 + 0.242\ PRO3/PPO3 + 0.109\ GDP3 \qquad (5.2.10)$$
$$R2 = 0.78 \qquad (-2.30) \qquad (3.15) \qquad (4.371)$$

where:

DRO3 = Domestic disappearance of rapeseed oil in the EC (1000 MT)

DSO3 = Domestic disappearance of soybean oil in the EC (1000 MT)

PRO3 = Price of rapeseed oil in the EC (ECU/MT)

PRO3 = Price of soybean oil in the EC (ECU/MT)

PSFO3 = Price of sunflower oil in the EC (461.08 ECU/MT,1982)

PPO3 = Price of palm oil in the EC (400.75 ECU/MT,1982)

POP3 = Population in the EC (271.755 million, 1982)

GDP3 = Gross domestic product in the EC (8916 billion ECU, 1982)

Substituting 1982 observations and converting to Canadian dollars with an exchange rate of 0.828, the demand estimates for rapeseed oil and soybean oil are:

$$DRO3 = 839.90 - 0.421\ PRO3 + 0.026\ PSO3 \qquad (5.2.11)$$

$$DSO3 = 1722.136 - 0.113\ PSO3 + 0.002\ PRO3 \qquad (5.2.12)$$

5.3.4 Demand for Oil in Japan

The vegetable oil market in Japan is dominated by rapeseed oil and soybean oil. Together they accounted for 72% of the domestic disappearance of the seven major oils in Japan in 1982. The disappearance of soybean oil, rapeseed oil and palm oil has increased steadily over the past ten years. The demand for cottonseed oil, peanut oil, palm kernel oil and coconut oil has remained relatively static over the same period (JOPA,1982). The level of income in Japan has also risen steadily, resulting in increased consumption of both rapeseed and soybean oils.

Japanese consumers have a taste preference for rapeseed oil. It is an important ingredient in "salad" oil and "cooking" oil, particularly for tempura. Soybean oil is used primarily in the manufacture of margarine, shortening and similar products. The estimated rapeseed oil and soybean oil demand equations are presented below.

$$DRO4 = 10.515 - \underset{(-2.18)}{0.003325PRO4} + \underset{(2.107)}{0.00117PSO4} + \underset{(8.38)}{0.00057INC4} \qquad (5.2.13)$$
$R2 = 0.83$

$$DSO4 = 131.52 - \underset{(-1.313)}{0.000331PSO4} + \underset{(2.816)}{0.01751PRO4/PPO4} + \underset{(3.451)}{0.00027INC4} \qquad (5.2.14)$$
$R2 = 0.59$

where:

DRO4 = Domestic disappearance of rapeseed oil in Japan (1000 MT)

DSO4 = Domestic disappearance of soybean oil in Japan (1000 MT)

PRO4 = Price of rapeseed oil in Japan (Yen/MT)

PSO4 = Price of soybean oil in Japan (Yen/MT)

PPO4 = Average import price of palm oil in Japan (US$ 118.92/MT,1982)

INC4 = National income in Japan (226607 billion yen, quarterly avg, 1982)

Observations for 1982 are substituted into the equations which are multiplied by the exchange rate of 202 Yen/$Cdn, to give the collapsed rapeseed oil and soybean oil demand equations.

$$DRO4 = 564.805 - 0.263\ PRO4 + 0.242\ PSO4 \qquad (5.2.15)$$

$$DSO4 = 770.067 - 0.267\ PSO4 + 0.119\ PRO4 \qquad (5.2.16)$$

5.4 DEMAND FOR MEALS

Soybean meal dominates the world meal market (Table 5.3). Soybean meal's characteristics make it an ideal component in feed rations.[20] However, recent developments in the quality and marketing of rapeseed meal has lead to increased demand for this product as livestock feed. The demand for meal is characterized by the general function:

$$Dm = f\ (\ Pm,\ Psm,\ L\ ) \qquad (5.3.1)$$

where:

Dm = Demand for meal

Pm = Price of meal

Psm = Price of substitute

L = Livestock numbers

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[20] Discussions with livestock feed manufacturers.

TABLE 5.3

WORLD TRADE OF OILSEED CAKE AND MEAL: 1977-83

	Export Quantity							
	Soy bean	Ground nut	Cotton seed	Lin seed	Sun flower	Rape seed	Copra	Palm kernal
	.........................000 Tonnes							
1977	11848.4	1568.8	834.6	670.7	507.1	560.1	870.4	347.9
1978	14962.2	903.2	894.6	768.5	728.3	605.9	991.8	319.1
1979	14953.4	1386.6	976.2	700.8	777.1	683.1	1015.6	486.0
1980	17818.0	1023.5	892.0	731.5	910.8	644.2	1059.1	540.0
1981	20091.5	658.9	786.3	653.0	897.4	705.8	1028.4	498.8
1982	20118.0	696.3	754.9	579.0	933.5	728.2	1049.4	631.6
1983	22658.7	739.6	835.4	673.0	1430.0	977.6	1007.0	734.1

	Export Value							
Year	Soy bean	Ground nut	Cotton seed	Lin seed	Sun flower	Rape seed	Copra	Palm Kernal
	......................US$ 1,000,000							
1977	2665.4	293.6	140.4	199.5	77.1	84.0	108.8	41.7
1978	3017.8	149.3	128.3	120.6	92.4	84.1	119.8	33.6
1979	3472.5	249.7	140.8	140.5	108.1	103.3	152.4	65.7
1980	4215.6	178.6	145.5	146.8	134.1	111.1	149.2	74.5
1981	5050.1	120.6	125.9	130.9	143.5	123.7	129.9	61.7
1982	4411.9	109.8	110.6	101.9	130.6	116.8	123.9	74.5
1983	5121.1	103.6	115.9	110.3	193.0	149.5	117.2	83.5

Source: FAO Trade Yearbook, 1984.

5.4.1 Demand for Meal in Canada

Rapeseed meal and soybean meal account for a major portion of Canada's domestic use of protein meals. Linseed meal, sunflower meal and fishmeal make up only 3-5% of the domestic market (Griffith,1978). Canada imports large quantities of soybean meal to satisfy its domestic meal demand, however, rapeseed meal is steadily increasing in its share of the domestic market (Table 5.4). Reductions in glucosinolate levels and aggressive marketing have contributed to this increase. In the study by Griffith and Mielke (1982), livestock population and price were important factors in the estimated demand for rapeseed meal in Canada. Their demand equation is used in the 1982 QP model (5.3.2). Livestock prices were no longer significant in the soybean meal demand equation, thus a new equation was estimated (5.3.3).

$$DRM1 = -215.2 - \underset{(-1.8)}{1.46PRM1} + \underset{(2.2)}{1.0PSM1} + \underset{(1.4)}{1.22PLSC1} + \underset{(3.9)}{0.25LPROD1W} \qquad R2 = 0.94 \tag{5.3.2}$$

$$DSM1 = -55.779 - \underset{(-2.1)}{0.505PSM1} + \underset{(1.6)}{0.359PRM1} + \underset{(3.3)}{0.0377CLVSK} \qquad R2 = 0.74 \tag{5.3.3}$$

where:

DRM1 = Domestic disappearance of rapeseed meal in Canada (1000 MT)

DSM1 = Domestic disappearance of soybean meal in Canada (1000 MT)

PSM1 = Wholesale price of rapeseed meal in Canada ($C/MT)

PSM1 = Wholesale price of soybean meal in Canada ($C/MT)

PLSC1 = Average slaughter steer and hog prices (C$80.06/cwt,1982)

LPROD1W = Weighted average of pork and western beef production in Canada (2031.326 million lbs., 1982)

CLVSK = Weighted average of pork and beef production in Canada (0.6*hogs + 0.4*cattle, 10964.75 '000 hd, quarterly avg.,1982)

Collapsed Canadian rapeseed meal and soybean meal demand equations for 1982 are:

$$DRM1 = 394.39 - 1.46\ PRM1 + 1.0\ PSM1 \tag{5.3.4}$$

$$DSM1 = 1440.368 - 2.02PSM1 + 1.436\ PRM1 \tag{5.3.5}$$

TABLE 5.4

OILSEED CAKE AND MEAL PRODUCTION AND CONSUMPTION IN CANADA: 1974-84

Year	Production: Rapeseed	Production: Soybean	Consumption: Rapeseed	Consumption: Soybean
	...000 Tonnes...			
1974	112.872	122.415	96.706	145.968
1975	125.017	113.105	105.690	133.270
1976	157.138	117.327	103.407	148.888
1977	205.475	116.915	144.431	145.321
1978	269.841	125.403	194.594	152.245
1979	313.689	137.514	168.346	147.822
1980	385.327	168.465	203.259	173.688
1981	439.681	148.878	262.040	145.550
1982	362.210	175.796	219.597	146.336
1983	411.249	177.237	315.419	174.509
1984	463.064	159.088	251.491	156.849

Source: Statisitics Canada, Catalogue No. 22-201.
Statistics Canada.

5.4.2 Demand for Meal in the United States

Soybean meal is by far the largest component of the US protein meal market. Approximatly 80% of soybean meal produced is consumed domestically. Farmers, feedlots and custom mixers acquire about 10% of soybean meal production directly from crushers. Feed manufacturing plants utilize the remaining 70% (Williams,1981). The other protein meals used in commercial feeds include peanut meal, cottonseed meal, linseed meal, sunflower meal and fish meal. As with rapeseed oil, rapeseed meal is insignificant in the US demand for soybean meal so its cross-price coefficient is zero. The demand for rapeseed meal is also treated exogenously in the 1982 QP model.

The US demand for soybean meal estimated in the study by Qasmi, is presented in equation (5.3.6).

$$DSM2 = -6512.83 - 6269.54 PSM2/P2M2 + 194.7 USHPAU + 433.51 Time \quad (5.3.6)$$
$$R2 = 0.937 \qquad (-2.96) \qquad (4.497) \qquad (11.052)$$

where:

DSM2 = Domestic disappearance of soybean meal in the US (1000 MT)

PSM2 = Average wholesale price of soybean meal in the US (US$/MT)

P2M2 = Average wholesale price of peanut meal and cottonseed meal weighted by their respective market shares ($US 174.13/MT,1982)

USHPAU = US high protein consuming animals (111.715 million, 1982)

TIME = Trend (1965 = 1.0,1966 = 2.0...1982 = 18.0)

The collapsed US soybean meal demand equation for 1982 in terms of Canadian dollars is:

$$DSM2 = 23041.037 - 29.182\ PSM2 + 0.0\ PRM2 \quad (5.3.7)$$

The exogenous US rapeseed meal demand equation is:

$$DRM2 = 26.1 - 0.0\ PRM2 + 0.0\ PSM2 \quad (5.3.8)$$

5.4.3 Demand for Meal in the European Community

The demand for soybean meal and rapeseed meal have recently experienced rapid growth in the EC. The demand for fish meal and linseed meal has remained static and the demand of palm kernel meal, cottonseed meal and peanut meal have actually decreased. Meals are used primarily for livestock feed rations, with soybean meal dominating the market. EC policy has distorted the price relationship between cereals and oilcakes, leading to increased use of oilcakes in concentrated feed. Cereals fed on the farm are being replaced by purchased compound feed as farms are increasing in size, specialization and efficiency (Williams, 1981). The rapeseed meal and soybean meal demand equations are estimated as:

$$DRM3 = -1441.909 - \underset{(-2.716)}{4.684}\ PRM3 + \underset{(1.86)}{3.73}\ PSM3 + \underset{(3.01)}{0.059}\ IHG3 \qquad R2 = 0.71 \tag{5.3.9}$$

$$DSM3 = -3500.41 - \underset{(-2.18)}{4.166}\ (PSM3 + PCO3) + \underset{(4.422)}{12.093}\ PRM3 \qquad R2 = 0.65 \tag{5.3.10}$$

where:

DRM3 = Domestic disappearance of rapeseed meal in the EC (1000 MT)

DSM3 = Domestic disappearance of soybean meal in the EC (1000 MT)

PRM3 = Price of rapeseed meal in the EC (ECU/MT)

PSM3 = Price of soybean meal in the EC (ECU/MT)

PCO3 = Import price of corn in the EC (164.49 ECU/MT)

IHG3 = EC hog numbers (31756 thousand,1982)

The collapsed demand equations for the EC(1982) in terms of Canadian dollars are presented in equations (5.3.11) and (5.3.12).

$$DRM3 = 1726.78 - 15.513\ PRM3 + 12.35\ PSM3 \tag{5.3.11}$$

$$DSM3 = 11260.578 - 13.798\ PSM3 + 40.05\ PRM3 \tag{5.3.12}$$

5.4.4 Demand for Meal in Japan

The Japanese livestock industry has been growing at a considerable pace. This growth is reflected in the demand for rapeseed meal and soybean meal. Since the demand for meal is a derived demand, this demand is specified as a function of its own price, the price of a substitute and livestock numbers. The Japanese demand equations for each meal are given in (5.3.13) and (5.3.14).

$$DRM4 = -3.512 - 0.0007\ PRM4 + 0.0005\ PSM4 + 0.1535\ LPROD4 \quad (5.3.13)$$
$$R2 = 0.79 \quad (-1.852) \quad (0.948) \quad (5.208)$$

$$DSM4 = 420.734 - 0.0037\ PSM4 + 0.0029\ PRM4 + 0.0011\ HGS4 \quad (5.3.14)$$
$$R2 = 0.605 \quad (-2.434) \quad (1.473) \quad (5.66)$$

where:

DRM4 = Domestic disappearance of rapeseed meal in Japan (1000 MT)

DSM4 = Domestic disappearance of soybean meal in Japan (1000 MT)

PRM4 = Wholesale price of rapeseed meal in Japan (Yen/MT)

PSM4 = Wholesale price of soybean meal in Japan (Yen/MT)

HGS4 = Japanese hog numbers (316,578, 1983)

LPROD4 = Weighted average of livestock production (1316 thousand MT, 1982)

The collapsed demand equations for 1982, in terms of Canadian dollars at an exchange rate of 202 are:

$$DRM4 = 793.976 - 0.580\ PRM4 + 0.404\ PSM4 \quad (5.3.15)$$

$$DSM4 = 3075.88 - 2.99\ PSM4 + 2.343\ PRM4 \quad (5.3.16)$$

5.5 DEMAND FOR STOCKS

The demand for stocks is comprised of speculative and transaction demands (Griffith and Meilke, 1982). Speculative demand is a function: of both current and expected future prices. Transactionary demand is measured by incoming stocks plus current production. The stock demand equation is expressed as follows:

$$Dstk = f\ (\ Pc,\ Pe,\ Sc\ ) \quad (5.4.1)$$

where:

Dstk = Demand for stock

Pc = Current price for commodity

Pe = Expected price of commodity

Sc = Available supply of commodity; composed of production plus incoming stocks.

5.5.1 Demand for Stocks in Canada and the US

In Canada, the demand for rapeseed and rapeseed meal stocks are given in equations (5.4.2) and (5.4.3). In the US, the demand for soybean and soybean meal stocks are given in equations (5.4.4) and (5.4.5).

$$DRSS1 = 223.8 - \underset{(-1.89)}{1.32PRSS1} + \underset{(1.58)}{0.213(RSPDN1 + DRSS)} + \underset{(1.55)}{0.075DSBS2} \quad (5.4.2)$$
$R2 = 0.64$

$$DRMS1 = 2.6 - \underset{(-1.82)}{0.053PRSM1} + \underset{(2.13)}{0.031(RMPDM1 + DRM1)} + \underset{(1.01)}{0.04FPSM2} \quad (5.4.3)$$
$R2 = 0.56$

$$DSBS2 = 2104.3 - \underset{(-3.28)}{19.8\ PSBS2} + \underset{(5.54)}{0.135\ (SBPDN2 + DSB2)} \quad (5.4.4)$$
$R2 = 0.82$

$$DSMS2 = 112.3 - \underset{(-2.33)}{1.96PSMS2} + \underset{(1.34)}{0.00004(SMPDN2 * PSO2)} + \underset{(1.4)}{0.98FPSM2} \quad (5.4.5)$$
$R2 = 0.71$

where:

DRSS1 = Demand for rapeseed stocks in Canada (1000 MT)

DRMS1 = Demand for rapeseed meal stocks in Canada (1000 MT)

DSBS1 = Demand for soybean stocks in Canada (1000 MT)

DSMS1 = Demand for soybean meal stocks in Canada (1000 MT)

PRSS1 = Price of rapeseed stocks in Canada ($C/MT)

RSPDM1 = Rapeseed production in Canada (1,849 thousand MT,1981/82)

DRSS1 = Incoming rapeseed stocks in Canada (1327.9)thousand MT, 1981/82)

DSBS2 = Demand for soybean stocks in the US (7,2253thousand MT, 1981/82)

PRMS1 = Price of rapeseed meal stocks in Canada ($C/MT)

RMPDM1 = Rapeseed meal production in Canada (522.6 thousand MT,1982)

DRMS1 = Incoming rapeseed meal stocks (13.8 thousand MT,1982)

FPSM2 = Future's price of soybean meal in the US (US $216.46,1982)

PSBS2 = Price of soybean stocks in US ($US/MT)

SBPDN2 = Soybean production in US (54,434 thousand MT, 1981/82)

DSBS2 = Incoming soybean stocks in the US (8663 thousand MT,1981/82)

PSMS2 = Price of soybean meal stocks in the US ($US/MT)

SMPDN2 = Soybean meal production in the US (22682.7 thousand MT,1982)

PSO2 = Price of soybean in the US (US $405.17,1982)

Substituting the 1982 observations, the stock demand equations may be rewritten in terms of Canadian dollars as:

$$DRSS1 = 1226.1 - 1.32\ PRSS1 \tag{5.4.6}$$

$$DRMS1 = 27.9 - 0.073\ PRMS1 \tag{5.4.7}$$

$$DSBS2 = 10622.4 - 11.41\ PSBS2 \tag{5.4.8}$$

$$DSMS2 = 692.0 - 1.59\ PSMS2 \tag{5.4.9}$$

5.6 OILSEED SUPPLY

In the short run, oilseed supply is assumed fixed. In regions where stocks are insignificant, available domestic supply is composed only of annual production. Stock levels are assumed to remain constant from one year to the next. However, where significant stock levels and data exist, oilseed supply is measured as production plus changes in stock. That is,

Supply = Stocks + Production - Stocks

In the QP model, available supply is comprised of production plus incoming stocks. The stock demand equations will be used in the model to generate carry-out stock levels which are subtracted from supply to provide available supply. Oilseed supplies for 1982 are given in Table 5.5.

TABLE 5.5

RAPESEED AND SOYBEAN SUPPLY: 1974-84

RAPESEED

Year	Canada Prod'n	Canada Stock	Canada Supply	EC Supply	Japan Supply
	....	.000 Tonnes	....		
74/75	1164	310.7	1474.7	1208	7
75/76	1749	413.6	2162.6	925	7
76/77	837	1082.3	1919.8	1026	7
77/78	1973	39.4	2012.4	951	5
78/79	3497	65.2	3562.3	1236	5
79/80	3411	309.0	3720.1	1210	5
80/81	2483	1476.9	3960.3	1995	4
81/82	1849	1327.9	3176.4	2016	4
82/83	2225	629.4	2917.3	2678	4
83/84	2609	486.4	3095.7	2362	3

SOYBEANS

Year	Canada Supply	US Prod'n	US Stock	US Supply	EC Supply	Japan Supply
	....	.000 Tonnes	....			
74/75	280	33,102	4651	37,753	40	133
75/76	367	42,138	5122	47,260	15	126
76/77	250	35,070	6665	41,735	6	110
77/78	527	48,098	2801	50,899	11	112
78/79	516	50,860	4382	55,242	22	190
79/80	671	61,722	4738	66,460	35	192
80/81	713	48,773	9765	58,538	30	174
81/82	607	54,434	8663	63,097	26	212
82/83	857	60,677	7225	67,922	35	226
83/84	721	43,420	10432	53,852	114	217

Source:
1. Statistics Canada Cat.# 22-201
2. Economic Research Service, USDA
3. Production Yearbook, F.A.O.

5.6.1 Canadian Supply of Oilseeds

Canada's major oilseed crop is rapeseed. Introduced in the 1940's, Canada's "Cinderella" crop has increased in area from 1950 hectares to 2950 thousand hectares in 1983. Successful rapeseed breeding has taken rapeseed oil from an industrial oil to an oil preferred for human consumption. The name "Canola" signifies double-zero[21] varieties of rapeseed. Canada is currently the only exporter of canola although China, Australia and the EC are placing major emphasis on the production of "canola" rapeseed which would compete directly in the established Canadian export market. Lack of suitable climatic regions is the limiting factor in increasing soybean production in Canada.

5.6.2 US Supply of Oilseeds

Since a large proportion of US soybean production is consumed domestically, the major emphasis of its marketing strategy has focussed on domestic demand. The US did not produce commercial quantities of rapeseed in 1982.

5.6.3 EC Supply of Oilseeds

The EC imports 90 % of its annual oilseeds use. Soybeans constitute the major oilseed import. Since rapeseed and soybean stock data were unavailable, estimated supplies consist of production only. Ninety percent of domestic production is comprised of rapeseed and olive production. Other oilseeds produced in the EC are flaxseed and sunflower

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[21] low erucic acid, low glucosinolate

seed. Soybeans make up a very small proportion of total oilseed production in the EC.

5.6.4 Japanese Supply of Oilseeds

Japan's emphasis on self-sufficiency resulted in government policies which encouraged oilseed production. However, once import quotas and tariffs were removed from rapeseed and soybeans, domestic production became less attractive. The higher value-added processing industry was able to import less expensive rapeseed and soybeans while being protected from oil imports. Consequently, Japan's oilseed production is low. Stocks are relatively small and assumed to be constant.

5.7 CRUSHING, TRANSPORTATION AND TARIFF COSTS

Crushing, transportation and tariff costs are fixed for the period considered. These costs contribute to the allocation of crushing activity, the level of trade and the determination of relative prices. Various policy scenarios can be evaluated by making parametric changes to the QP model through changes in the cost variables. Previous studies have included transportation and tariff costs as policy variables.[22] The inclusion of crushing costs in this study would allow the evaluation of possible changes to regional cost structures such as variable, capital and labour costs. However, the central purpose of this study is to estimate the consequences of changes in tariff costs.

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[22] Furtan, Nagy and Storey (1978), Swallow (1982), Qasmi (1985)

5.7.1 Crushing Costs

Crushing costs in each region are difficult to estimate due to insufficient data. Therefore, cost estimates are based upon consultation with industry members and existing Canadian crushing cost estimates.

Canadian crushing costs for 1982 have been estimated by the Oilseed Products Review Group (1983). Both fixed and variable costs are included. Japanese crushing costs are estimated to be similar to those in Canada for 1982.[23]

Efficient US plants have been established much longer than those in Canada and Japan. Therefore, soybean crushing costs in the US are lower than the rest of the regions.[24]

The structure of the EC market makes a reliable estimate of crushing costs in the EC difficult. Subsidy policies from production to export sales allow oilseed crushers to effectively compete with foreign processors, even though, a large percentage of the oilseeds processed in the EC are imported. EC crushing costs are estimated to be slightly below Canadian crushing costs.[25] Regional crushing costs are presented in Table 5.6.

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[23] Discussions with Japanese officials at the Canola Council of Canada General Meeting, 1985.

[24] Correspondence with the US Soybean Association.

[25] Discussion with H.R.Krigham, Agriculture Canada.

TABLE 5.6

CRUSHING COSTS: 1982

Commodity	Canada	US	EC	Japan
	..................CDN $/Tonne......................			
Rapeseed	50.71	-	48.00	50.60
Soybeans	48.16	46.00	48.00	50.80

Source: Oilseed Products Minimum Compensatory Rate Review Group Final Report.

1. Total costs for a plant crushing 600 tonnes per day.
2. Older, established eastern Canadian soybean crushing plants are expected to have lower deprication and capital costs.
3. Soybean crushing requires a prepress process which is unnecessary in rapeseed processing.

5.7.2 Transportation Costs

Transportation costs have been estimated from known shipments between Canada, Japan, EC and US.

Canadian and US transportation costs to Japan and the EC consist of land and ocean freight rates. Costs between Canada and the US include of rail and trucking rates. Most prices in Japan and the EC are at port so transportation rates are made up of ocean freight rates only. Transportation costs are given in Table 5.7.

TABLE 5.7

OILSEED TRANSPORTATION COSTS FOR CANADA, US, EC AND JAPAN: 1982

Origin & Commodity	Destination & Route			
	Canada	US	EC	Japan
	....................$/tonne....................			
Canada				
Rapeseed	0.0	-	44.00	49.50
Rapeseed oil	0.0	30.00	-	71.20
Rapeseed meal	0.0	22.00	52.00	57.00
Soybeans	0.0	-	43.00	51.00
Soybean meal	0.0	-	51.00	-
US				
Soybeans	10.52	0.0	41.00	45.00
Soybean oil	30.00	0.0	72.05	67.42
Soybean meal	20.00	0.0	49.00	53.51
EC				
Rapeseed	-	-	0.0	53.00
Rapeseed oil	-	72.05	0.0	72.96

Sources:
1. Statistics Canada Catalogue #22-201.
2. Maritime Research Inc., Paslin N.J.
   -avg. transportation costs include through Atlantic, Gulf and Pacific ports.
3. X-Can Grain Ltd., Winnipeg, Manitoba.
4. Kerr Steamships (Mike Oosterhuis)
5. CVOP Hamilton (Mr. Glenney) (Toledo-Hamilton).
6. Cargill Grain Ltd., Winnipeg, Manitoba.

5.7.3 Tariff Costs

In each region of the oilseed model, import tariffs are imposed on vegetable oil but not on meal or seed. Canada, the US and the EC levy ad valorem tariffs while Japan has a fixed tariff on vegetable oil imports.

Each type of tariff is specified differently in the QP model. Japanese tariffs are treated like transportation costs and are subtracted directly in the objective function. Ad valorem tariffs are deducted in the QP matrix as suggested by Takayama and Judge (1971) and applied by Furtan, Nagy and Storey (1978). Tariff costs for 1982 are presented in Table 5.8.

TABLE 5.8

VEGETABLE OIL TARIFFS: 1982

	Country			
Commodity	Canada	US	EC	Japan
Rapeseed oil	10.0%	8.5%	10.0%	C$84.16/MT
Soybean oil	8.5%	22.5%	10.0%	C$84.16/MT

Sources:
McGoldrick's Canadian Customs and Excise Tariffs,
1982 (Ed.) Arthur L. Brunette Ltd., Montreal, McMillin Inc.

Tariff Schedules for the U.S., Annotated, (1982), USITC Pub. 1610, Washington, U.S. International Trade Commission, 1982.

Grain Marketing Bureau, Department of External Affairs, Ottawa.

5.8 QUADRATIC PROGRAMMING MATRIX

The single-period spatial equilibrium quadratic programming model specified in this study allows trade flows of all goods between each region. Regional demand functions, seed supplies, crushing, transportation and tariff costs interact in the QP model to determine equilibrium prices, optimal crush levels and trade flows. MINOS 5.0 (Modular In-core Nonlinear Optimization System) (Murtagh and Saunders 1983) was used to solve the linearly constrained optimization problem in this study. The trade model is specified in a format consistent with the requirements of MINOS 5.0. Prices and quantities are ordered in the columns of the matrix. The linear constraint set is expressed in the rows. The linear objective function contains the intercepts of the demand equations, predetermined supplies and costs associated with crushing, transportation and tariffs.

The quadratic programming matrix is presented in Appendix A. The objective function is found in Table A1. It includes the values of the intercepts in each demand equation, available oilseed supplies in each region, crushing costs and the costs associated with transferring goods between each region.

Equilibrium price conditions are found in the first 41 rows of Table A2. The relationship between prices of goods in each region and costs must satisfy these conditions. That is, the difference between the price of a good in one region and it's price in another region must be equal to or less than the tranfer cost between these regions. For example, the cost of transferring rapeseed oil between Canada and Japan is \$155.36/Tonne, including the transportation cost of \$71.20 plus the Japanese import tariff of \$84.16. The difference between the price of rapeseed oil in Canada (PRO1) and the price of rapeseed oil in Japan (PRO4) cannot exceed \$155.36. Otherwise, arbitrage would occur and more rapeseed oil would be shipped to Japan, narrowing the price spread back to \$155.36. Thus row 2 contains the equation:

$$PRO1 - PRO4 > 155.36 \quad \text{or} \quad PRO4 - PRO1 < 155.36 \qquad (R002)$$

The relationship between revenues, input costs and crushing costs must also satisfy equilibrium price conditions. If the revenue from the outputs, oil and meal, minus the cost of the input (plus the cost of transporting the input, if imported) is greater than the crushing cost, one of several events can occur. Increased oil or meal imports would lower the domestic price of either good, reducing revenues until revenues minus input costs equal crushing costs. Alternatively, crushing activity could increase causing the price of inputs to rise while increased supplies of oil and meal would translate into lower product prices and reduce the spead between revenues and input costs. Three equations are necessary to ensure equilibrium price conditions are satisfied for rapeseed crushing activity in Japan.

$$0.406\ PRO4 + 0.581\ PRM4 - PRS1 < 100.10 \qquad (R029)$$

$$0.406\ PRO4 + 0.581\ PRM4 - PRS4 < 50.60 \qquad (R039)$$

$$0.406\ PRO4 + 0.581\ PRM4 - PRS3 < 103.60 \qquad (R041)$$

In row 29 the Japanese price of rapeseed oil times its crush coefficient plus the Japanese price of rapeseed meal times its crush coefficient minus the price of rapeseed in Canada cannot exceed the cost of crushing rapeseed in Japan ($50.60) plus the cost of transporting rapeseed from Canada to Japan ($49.50). In row 39 Japanese crushing revenues minus the price of rapeseed in Japan cannot exceed the cost of crushing rapeseed in that region. Row 41 is similar to row 29 except rapeseed imported from the E.C. would be substituted for Canadian rapeseed imports.

Optimum consumption conditions (R042-R068) ensure that regional demands for oil and meal are satisfied. The movement of a product from a region to itself and from other regions exceeds the demand for the product in that region. For instance, the demand for rapeseed oil in Japan (DRO4) is satisfied by the transfer of rapeseed oil from Japan to itself (RO44) plus the transfer of rapeseed oil from Canada (RO14), the E.C. (RO34) and the ROW (RO54) to Japan.

$$RO14 + RO34 + RO44 + RO54 > DRO4$$

Substituting the estimated rapeseed oil demand equation for Japan:

$$DRO4 = 564.805 - 0.263\ PRO4 + 0.242\ PSO4 \qquad (5.2.15)$$

and rearranging gives the consumption condition for Japanese rapeseed oil demand.

$$0.263\ PRO4 - 0.242\ PSO4 + RO14 + RO34 + RO44 + RO54 > 564.805 \qquad (R045)$$

The demand for the inputs, rapeseed and soybeans, is a derived demand composed of the demand for stocks and for crushing. Since stocks in the E.C. and Japan are assumed constant, input demands consist of crushing demand alone. In Canada, the demand for rapeseed stocks (DRSS1) plus the crushing demand (QRS1) is satisfied by the transfer of rapeseed from Canada to itself (RS11).

$$RS11 > QRS1 + DRSS1$$

Substituting in the Canadian demand for rapeseed stocks:

$$DRSS1 = 1226.1 - 1.32\ PRSS1 \qquad (5.4.6)$$

and rearranging gives the relationship presented in the oilseed model.

$$1.23\ PRSS1 - QRS1 + RS11 > 1226.1 \qquad (R061)$$

In Table A3, the optimum production conditions ensure that the quantity of a good consumed in a region plus the quantity of the good transferred from that region does not exceed the available supply of the good in that particular region. For example, the available supply of rapeseed in Canada (SRS1) must be greater than the quantity of rapeseed consumed in Canada (RS11) plus the quantity of rapeseed required for stocks in Canada (RS1S) plus the quantity of rapeseed transferred from Canada to other regions (RS13), (RS14), (RS15).

$$SRS1 > RS11 + RS1S + RS13 + RS14 + RS15$$

Using the 1982 available Canadian supply and rearranging provides the relationship found in the model.

$$- RS11 - RS1S - RS13 - RS14 - RS15 > -3176.4 \qquad (R069)$$

The supply of a product such as rapeseed meal is derived from the quantity of rapeseed crushed. The quantity of meal consumed in a region plus the quantity required for stocks plus the quantity transferred to other regions cannot exceed the quantity of seed crushed times the meal yield plus incoming stocks. In Canada, this relationship is expressed as:

$$0.582\ QRS1 + RM1S > RM11 + RM1S + RM12 + RM13 + RM14 + RM15$$

In 1982, incoming rapeseed meal stocks were 13.817 thousand tonnes. Substituting this value and rearranging the equation, the meal supply equation for Canada is given in (R083).

$$0.582\ QRS1 - RM11 - RM1S - RM12 - RM13 - RM14 - RM15 > -13.8 \qquad (R083)$$

Crush capacity levels are specified in rows 90 to 96, followed by trade with ROW which was set at 1982 levels.

The quadratic portion of the matrix is presented at the bottom of Table A3. Values on either side of the diagonal are equated to avoid problems resulting from assymetry (Martin 1981). The true values of the cross-price coefficients are retained in the linear constraint (price equilibrium, consumption and production) conditions.

5.9 SUMMARY

The general mathematical form of the net revenue model was specified for the oilseed market. The objective function was given along with the linear constraints which required the model to satisfy spatial price equilibrium and optimal consumption and production conditions.

The components of the oilseed model were specified in the next section where estimates of the demand for products and stock functions were presented. Regional supply levels along with crushing, transportation and tariff costs which existed in 1982, were also identified.

Finally, the quadratic programming matrix was presented in three separate tables. These tables contain the objective function to be maximized; spatial price equilibrium conditions; optimal consumption and production conditions; crush capacities; trade with the rest of the world and the quadratic portion of the QP matrix.

In the next chapter, the 1982 base simulation will be discussed and four alternative scenarios will be introduced. The results of these scenarios will be compared with the base run to evaluate their impacts upon the Canadian crushing industry.

Chapter VI

EMPIRICAL RESULTS

6.1 INTRODUCTION

To establish a base for the various policy scenarios, the QP matrix was solved under 1982 conditions. That is, crushing, transportation and tariff costs and exogenous variables in the demand equations were given the values which existed that year. Although no strict statistical methods exist to validate the solution to the QP matrix, prices and quantities crushed and traded should closely reflect actual 1982 prices and quantities. Any divergence from actual values would result from inaccurate cost data, inconsistent demand equations or market clearing conditions not characteristic of a competitive equilibrium. The latter is limited to the price coefficients since all other variables are set to actual 1982 values.

The solution to the QP matrix provides the base for this study. Making parametric changes to the QP matrix facilitates the evaluatiion of solutions representing four alternative tariff scenarios:

1. removal of the Japanese import tariff on rapeseed oil;
2. removal of the Japanese import tariff on soybean oil;
3. reduction of the Japanese import tariff on rapeseed oil;
4. removal of the Japanese import tariffs on both rapeseed and soybean oils.

The new solutions to the QP matrix will be compared with the base solution (Appendix C). Changes in regional crushing revenues will be presented when evaluating the impacts of the four scenarios (Appendix D).

6.2 SOLUTIONS TO THE QUADRATIC PROGRAMMING MATRIX

6.2.1 Base Results

The base solution along with actual values for 1982 are found in Table C1. These are presented with the difference and percent difference between the two. Although no rigorous statistical tests exist for measuring the model's predictive ability, the base results appear to reflect 1982 values quite well. The predicted price and quantity relationships between the four regions are as expected with few exceptions. Oil prices are slightly higher than those observed in 1982, whereas meal and seed prices are lower. Quantities crushed in each region are very similar to actual values. As well, trade flows are generally reflective of 1982 observations although there are cases where trade flows had actually occurred but are not generated in the model's solution. For instance, the solution reported zero rapeseed oil trade between Canada and Japan (RO14) although Canada had exported 11.8 thousand tonnes of rapeseed oil to Japan in 1982. In the solution to the model and under existing tariffs, it was estimated to be more profitable for the Japanese to import rapeseed from Canada and crush it for oil there than to import the oil from Canada.

In 1982, Japan did not import any rapeseed meal from Canada and the base solution did not produce any rapeseed meal trade between these regions (RM14). Canadian exports of rapeseed (RS14) were generated at a level close to actual 1982 exports. Since the E.C. is a net importer of rapeseed, Japan does not import rapeseed from that region in the base solution (RS34). As well, soybeans can not be exported from Canada while they are imported from the U.S. (SB21). Trade flows to and from the rest of the world region were treated exogenously, fixed at 1982 levels.

6.2.2 Scenario I: Removal of the Japanese Tariff on Rapeseed Oil

In this first scenario the Japanese rapeseed oil tariff has been removed, leaving a tariff on soybean oil. The results of Scenario I are given in Table C2. As expected, the price of rapeseed oil decreases significantly in Japan and increases in all other regions. Soybean oil prices are reduced slightly in each region as Japanese consumers substitute rapeseed oil for soybean oil. Increased demand for rapeseed oil results in higher prices paid for rapeseed. Similarly, lower soybean oil prices result in increased soybean oil consumption in the U.S. and Canada causing an increase in the quantity demanded for soybeans in both regions.

As the quantity of rapeseed crushed in Japan decreases, the available supply of rapeseed meal is reduced. Lower meal supplies in Japan are reflected in higher meal prices. The model finds a solution in a competitive equilibrium, thus higher Japanese meal prices and higher seed costs push meal prices up in other regions.

Canadian rapeseed crushing activity rose an estimated 8.9 percent (measured by volume of crushing) in response to increased Japanese demand for rapeseed oil imports from Canada. As well, the substitution of soybean oil for rapeseed oil in Canada resulted in a slight increase in Canadian soybean crush (QSB1). On the other hand, the quantities of rapeseed and soybeans crushed in Japan (QRS4,QSB4) fell by 5.0 and 0.3 percent, respectively. Crushings in other regions were only marginally affected by the removal of the Japanese rapeseed oil tariff.

Trade flows coincide with changes in prices and crushing activity. The lower cost of importing rapeseed oil into Japan results in increased movement of rapeseed oil from Canada to Japan (RO14) and reduced consumption of Japanese produced rapeseed oil (RO44). In this scenario, Canada does not export rapeseed meal to Japan as soybean meal is substituted for rapeseed meal in that region. Although Japan reduces its soybean crush, soybean meal consumption is increased through increased soybean meal imports from the U.S. (SM24).

Rapeseed and soybean trade flows satisfy regional crushing activities. Japanese rapeseed and soybean imports are reduced, coinciding with lower Japanese consumption of both oilseeds and increased domestic usage of rapeseed in Canada (RS11) and soybeans in the U.S. (SB22). Since the rest of the world region was treated exogenously, ROW trade remains unchanged.

6.2.3 Scenario II: Removal of the Japanese Tariff on Soybean Oil

Removal of the Japanese tariff on soybean oil while retaining the tariff on rapeseed oil has a slightly different impact on prices than does the removal of the rapeseed oil tariff. Price changes were generally larger in Scenario II. Meal prices were reduced in each region except Japan and seed prices were lower in all regions. This result was surprising as the opposite was expected to occur. That is, Japan's share of the soybean market is much less than its share of the rapeseed market. Thus, reduced demand for rapeseed in Japan was expected to have a relatively larger impact on its price. However, removal of the rapeseed oil tariff in Scenario I led to a net increase in total rapeseed oil consumption which related to an increase in the total demand for rapeseed and increased rapeseed prices in all regions. On the other hand, the removal of the Japanese soybean oil tariff resulted in a net decrease in total soybean oil consumption. This is due to Japan's relatively small share fo world soybean oil demand. Consequently, reduced soybean demand resulted in a fall in the price of soybeans in each region.

Canada's rapeseed crushing activity increased slightly as soybean imports from the U.S. were reduced. Soybean movement from the U.S. to the E.C. and Japan was also lower. This coincides with a rise in U.S. soybean crush to satisfy increased Japanese soybean oil demand. Rapeseed meal was unable to compete with soybean meal in the Japanese market, U.S. exports of soybean meal increased substantially to compensate for reduced soybean crush in Japan.

The Japanese demand for rapeseed falls as consumers there substitute soybean oil for rapeseed oil. Consequently, Canadian exports of rapeseed to Japan decreased by 21.6 percent. The EC capitalizes on lower priced rapeseed, increasing rapeseed imports by 6.6 percent. Canadian rapeseed use increased only slightly while stocks increased by 1.0 percent.

6.2.4 Scenario III: Reduction of the Japanese Import Tariff on Rapeseed Oil

Carter and Mooney (1985) concluded that Japanese vegetable oil import tariffs provide more protection for rapeseed crushing than for soybean crushing in that country. To eliminate the distortive influence of the tariffs upon Japan's crushing industry, they suggested this would require reducing the rapeseed oil tariff relative to the tariff on soybean oil. An estimated $38.56 US/tonne reduction in the rapeseed oil tariff, leaving the soybean oil tariff unchanged, would remove the bias. In Canadian dollar terms, a $45.18 reduction in the Japanese tariff on rapeseed oil was used in Scenario III.

The results of Scenrio III are presented in Table C3. As expected, price and quantity relationships are similar to those found in Scenario I. The Japanese price of rapeseed oil falls by $9.88/tonne while its price in Canada goes up $2.35/tonne. Increased demand for rapeseed products leads to a $1.56 increase in the price of rapeseed in each region.

Rapeseed crushing is estimated to fall 4.1 percent in Japan while Canada's rapeseed crush is predicted to rise by 6.6 percent. This coincides with an increase in rapeseed oil trade between Canada and Japan while rapeseed exports to Japan are predicted to decrease.

6.2.5 Scenario IV: Removal of the Japanese Tariffs on Rapeseed Oil and Soybean Oil

In their study, Carter and Mooney initially considered the elimination of the tariff on both rapeseed and soybean oils. This recommendation has been considered in Scenario IV. In this scenario, a fall in the Canadian price of rapeseed oil was obtained. This outcome had not been expected. However, the result of eliminating the tariff on both rapeseed and soybean oils is cummulative in Japan. This leads to larger reductions in the price of each oil there. Consequently, lower Japanese rapeseed oil prices have the ability to push down the price of rapeseed oil in Canada. The price of rapeseed oil in the E.C. rises slightly while soybean oil prices in the U.S., Canada and the E.C. increase by 1.3 percent in each region.

In Japan, rapeseed oil and soybean oil prices fall by 9.1 and 6.8 percent, respectively. This would suggest, the lrelative evel of protection afforded rapeseed oil production vis-a-vis soybean oil production is higher, under 1982 conditions, given the tariffs which existed in the base solution. Following the removal of the Japanese tariffs, the Japanese price of rapeseed oil falls by 2.3 percent more than the soybean oil price does, while rapeseed and soybean prices fall by 1.5 percent. These price movements indicate that rapeseed processing was relatively more attractive in Japan than soybean processing under 1982 base conditions.

The above conclusion is supported by changes in Japanese crushings. With the elimination of the tariffs on rapeseed oil and soybean oil, Japanese rapeseed crushing falls by 4.6 percent while soybean crushing drops only 0.6 percent. Had the tariffs provided equal protection for each crushing activity, equal reductions would be expected.

TABLE 6.1

OILSEED CRUSHINGS

	CANADA	U.S.	E.C.	JAPAN
RAPESEED CRUSHING	-----------------	1000 T.	-----------------	
Base 1982	892.4	______	2168.8	1330.5
Rapeseed Oil				
Tariff Removal	971.7	______	2160.2	1264.5
Change	79.3	______	-8.6	-66.0
% Change	8.9%	______	-0.4%	-5.0%
Soybean Oil				
Tariff Removal	899.1	______	2175.4	1308.9
Change	6.7	______	6.6	-21.6
% Change	0.8%	______	0.3%	-1.6%
Rapeseed Oil				
Tariff Reduction	951.0	______	2166.2	1276.6
Change	58.6	______	-2.6	-53.9
% Change	6.6%	______	-0.1%	-4.1%
Rapeseed/Soybean Oil				
Tariff Removal	952.1	______	2163.8	1269.2
Change	59.7	______	-5.0	-61.3
% Change	6.7%	______	-0.2%	-4.6%
SOYBEAN CRUSHING				
Base 1982	983.0	27658.3	14169.4	3591.4
Rapeseed Oil				
Tariff Removal	985.5	27688.6	14171.6	3577.9
Change	2.5	30.3	2.2	-12.2
% Change	0.3%	0.1%	0.0%	-0.3%
Soybean Oil				
Tariff Removal	972.9	27840.0	14162.6	3393.0
Change	-10.1	181.7	-6.8	-197.1
% Change	-1.0%	0.7%	0.0%	-5.5%
Rapeseed Oil				
Tariff Reduction	984.6	27669.5	14170.2	3585.0
Change	1.6	11.2	0.8	-6.4
% Change	0.2%	0.0%	0.0%	-0.2%
Rapeseed/Soybean Oil				
Tariff Removal	969.0	27671.5	14163.5	3568.6
Change	-14.0	13.2	-5.9	-21.5
% Change	-1.4%	0.0%	-0.0%	-0.6%

In Canada, reduced soybean crushing is compensated for by a 6.7 percent increase in rapeseed crushing. This rise in crushing activity provides the rapeseed oil required for increased domestic consumption and exports. A summary of the impacts of the four scenarios upon regional oilseed crushings is presented in Table 6.1.

6.2.6 Comparison with Other Studies

Scenario I is similar to Simulation III in the study by Furtan, Nagy and Storey (1979) and Case I in the study by Swallow (1982), in that they considered the removal of the rapeseed oil tariff in isolation. However, the soybean sector was treated exogenously in both of these earlier studies. Swallow did not report any changes to prices and quantities since Canada's rapeseed oil exports to Japan were not predicted to increase because the shadow price of exporting rapeseed oil was less than the transportation cost. In their 1974 study, Furtan, Nagy and Storey estimated the removal of the tariff would result in a 13.0 percent increase in Canadian crushing activity (Table 6.2).

Griffith and Meilke estimated Japanese crushings would decrease by 7.5 percent with the removal of the rapeseed oil tariff alone. They estimated Canadian rapeseed crush would increase by only 0.2 percent. When only the soybean oil tariff was removed, soybean crush fell by 0.8 percent in Japan, but rapeseed crush increased by 1.4 percent. In Canada, rapeseed crush fell by 0.1 percent, while soybean crush remained unchanged in each scenario. Once both rapeseed oil and soybean oil tariffs were removed, Griffith and Meilke found little change in Canada's rapeseed crush while Japan decreased its crushing activity by 6.0 percent.

In the current study, rapeseed crushing activity was predicted to increase by 8.9 percent in Canada and fall by 5.0 percent in Japan if only the rapeseed oil tariff was removed. Removing the soybean oil tariff alone would lead to an estimated 1.6 percent decrease in Japanese rapeseed crushing and soybean crushing would fall by 5.5 percent. While the results of the first scenario are similar to those of previous studies, the second scenario predicts a larger impact on Japanese crushing activity than did the study by Griffith and Meilke (Table 6.3). It was estimated the removal of the tariffs on both oils would result in a 6.7 percent increase in Canadian rapeseed crush while Japan's rapeseed crushing activity would fall by 4.6 percent. The increase in Canadian rapeseed crushing activity is inconsistent with Griffith and Meilke's findings where the E.C. was predicted to satisfy Japan's increased demand for rapeseed oil imports.

TABLE 6.2

COMPARISON WITH PREVIOUS STUDIES

PRICES ($/t)	Rapeoil Tariff Removal Current Chge	Study %Chge	G.M. Chge	Study %Chge	F.N.S. Chge	Study %Chge
Oil Prices						
PRO1	1.32	.2	6.2	1.3	38.52	5.5
PRO3	7.76	1.3			42.33	5.0
PRO4	-24.56	-3.5	-21.1	-14.5	-18.50	-2.2
PSO1	-3.02	-.4	.7	.2		
Meal Prices						
PRM1	5.06	3.3	-.6	-.6	-18.96	-17.0
PRM3	2.84	1.4			-18.96	-11.4
PRM4	23.15	11.9			21.03	14.7
PSM1	3.16	1.6	-.2	-.1		
Seed Prices						
PRS1	3.48	1.2	.1	.1	4.97	1.8
PRS3	4.66	1.5			4.97	1.5
PRS4	3.48	1.0			4.97	1.5
PSB1	1.99	.9	.0	.0		
QUANTITIES (000 t)						
Crushings						
QRS1	79.3	8.9	.7	.2	40.20	13.0
QRS3	-8.6	-.4				
QRS4	-66.0	-5.0			-36.70	-5.5
QSB1	2.5	.3	.0	.0		
Oil Trade						
RO11	-.5	-.2	-1.6	-1.7	-9.10	-8.9
RO13	0	0			-.43	-53.1
RO14	32.5		1.9	10.5	26.03	2,502.9
RO33	-3.3	-.5				
RO44	-26.8	-5.0			-14.34	-5.5
SO11	.5	.3	.5	.4		
Meal Trade						
RM11	46.5	9.6	.6	.4	17.41	11.5
RM1S	-.3	-2.0				
RM13	.0		-.2	-1.3	5.49	43.4
RM33	-5.0	-.4				
RM44	-38.3	-5.0			-21.33	-5.5
Seed Trade						
RS11	79.3	8.9	3.2	.3	40.20	13.0
RS1S	-4.6	-.6			-2.65	-.3
RS13	-8.6	-9.7			-.78	-1.9
RS14	-66.0	-5.1	2.8	.3	-36.70	-8.0
SB11	.0	.0	-.1	.0		

TABLE 6.3

COMPARISON WITH PREVIOUS STUDIES

PRICES ($/t)	Soyoil Tariff Removal				Rapeoil/Soyoil Tariff Removal			
	Current Study		G.M. Study		Current Study		G.M. Study	
	Chge	%Chge	Chge	%Chge	Chge	%Chge	Chge	%Chge
Oil Prices								
PRO1	-9.27	-1.5	-2.1	-.4	-21.64	-3.4	3.9	.8
PRO3	-5.41	-.9			5.18	.9		
PRO4	-35.12	-5.0	-.5	-.3	-47.41	-6.8	-21.6	-14.9
PSO1	10.09	1.5	.1	.0	9.00	1.3	.8	.2
Meal Prices								
PRM1	-4.40	-2.8	.3	.3	6.31	4.1	-.3	-.3
PRM3	-7.03	-3.4			-7.21	-3.5		
PRM4	13.69	7.0			24.40	12.5		
PSM1	-5.73	-2.8	.1	.0	-5.06	-2.5	-.2	-.1
Seed Prices								
PRS1	-6.30	-2.1	-.1	-.1	-5.07	-1.7	.1	.1
PRS3	-6.18	-2.0			-2.17	-.7		
PRS4	-6.30	-1.8			-5.07	-1.5		
PSB1	-2.83	-1.2	.0	.0	-2.48	-1.1	.0	.0
QUANTITIES (000 t)								
Crushings								
QRS1	6.7	.8	-.2	-.1	59.7	6.7	.6	.2
QRS3	6.6	.3			-5.0	-.2		
QRS4	-21.6	-1.6			-61.3	-4.6		
QSB1	-10.1	-1.0	.1	.0	-14.0	-1.4	.1	.0
Oil Trade								
RO11	2.7	1.3	.5	.5	5.0	2.3	-1.1	-1.1
RO13	0	0			0	0		
RO14	.0		-.6	-3.3	19.1		1.3	7.2
RO33	2.6	.4			-1.9	-.3		
RO44	-8.8	-1.6			-24.9	-4.6		
SO11	-1.7	-1.2			-2.4	-1.7		
Meal Trade								
RM11	-31.0	-6.4	-.3	-.2	-17.2	-3.5	.2	.1
RM1S	.4	2.4			-.4	-2.5		
RM13	34.6		.2	1.3	52.3		.1	.6
RM33	3.8	.3			-2.9	-.2		
RM44	-12.5	-1.6			-35.6	-4.6		
Seed Trade								
RS11	6.7	.8	-1.9	-.2	59.7	6.7	.9	.0
RS1S	8.3	1.0			6.7	.8		
RS13	6.6	7.4			-5.0	-5.6		
RS14	-21.6	-1.7	-1.9	-.2	-61.3	-4.8	.5	.1
SB11	.0	.0	.1	.0	.0	.0	.0	.0

6.2.7 Impacts of Alternative Tariff Scenarios on Crushing Revenues

In the base solution, Canada's revenue (gross crush margin) from crushing rapeseed was $47.4 million compared with $67.3 million in Japan. Regional crush revenues indicate each region's ability to meet crush costs while maximizing prices, crushings and trade flows. Revenues from crushing soybeans in the U.S., the E.C. and Japan were larger than rapeseed crushing revenues due to the volume of soybeans crushed in each of these regions. Regional crush revenue calculations are found in Appendix D. A summary of the effects of the four tariff scenarios upon regional crush revenues is presented in Table 6.4.

Once rapeseed oil tariffs are removed, it is expected that Canadian rapeseed oil exports to Japan would provide increased revenues for Canadian rapeseed crushers. Although rapeseed oil is substituted for soybean oil in Japan, lower prices and reduced crushings lead to a 5.0 percent drop in rapeseed crushing revenue there. Canada's annual gross crush margins from rapeseed processing increased by an estimated 6.3 percent. Revenues changed by less than 1.0 percent in other regions.

In contrast, revenues from soybean crushing following the removal of the Japanese soybean oil tariff varied most significantly in Japan while revenues in Canada and the U.S. increased by less than 1.0 percent.

Reducing the Japanese import tariff on rapeseed oil by $45.18 is expected to result in a slight decrease in Canadian rapeseed oil consumption. However, this would be more than compensated for by increased rapeseed oil exports to Japan. Revenues from rapeseed crushing were es-

TABLE 6.4

GROSS CRUSH MARGIN SUMMARY

	CANADA	U.S.	E.C.	JAPAN
RAPESEED CRUSHING		$C 1,000		
Base 1982	$47,387	______	$104,088	$67,336
Rapeseed Oil				
Tariff Removal	$50,353	______	$103,689	$63,986
Change	$2,966	______	$-399	$-3,350
% Change	6.26%	______	-.38%	-4.98%
Soybean Oil				
Tariff Removal	$47,588	______	$104,421	$66,228
Change	$201	______	$333	$-1,108
% Change	.42%	______	.32%	-1.65%
Rapeseed Oil				
Tariff Reduction	$49,009	______	$103,971	$64,600
Change	$1,622	______	$-117	$-2,735
% Change	3.42%	______	-.11%	-4.06%
Rapeseed/Soybean Oil				
Tariff Removal	$49,147	______	$103,882	$64,191
Change	$1,760	______	$-206	$-3,145
% Change	3.71%	______	-.20%	-4.67%
SOYBEAN CRUSHING				
Base 1982	$47,349	$1,317,598	$680,163	$182,377
Rapeseed Oil				
Tariff Removal	$47,490	$1,318,916	$680,264	$181,750
Change	$141	$1,318	$101	$-627
% Change	.30%	.10%	.01%	-.34%
Soybean Oil				
Tariff Removal	$46,885	$1,325,399	$679,907	$172,417
Change	$-464	$7,801	$-256	$-9,960
% Change	-.98%	.59%	-.04%	-5.46%
Rapeseed Oil				
Tariff Reduction	$47,450	$1,318,157	$680,277	$182,139
Change	$101	$559	$114	$-238
% Change	.21%	.04%	.02%	-.13%
Rapeseed/Soybean Oil				
Tariff Removal	$46,669	$1,317,804	$679,857	$181,253
Change	$-680	$206	$-306	$-1,124
% Change	-1.44%	.02%	-.04%	-.62%

timated to increase by 3.4 percent or $1.6 million in Canada. Japan's rapeseed crushing revenues were predicted to fall by 4.1 percent or $2.7 million. In this case, the loss exceeds the gain. This is consistent with theory as the removal of trade barriers can benefit consumers more than producers. In this study the gain to consumers was larger than the loss to producers, leaving a net gain to society.

The removal of Japanese tariffs on both rapeseed oil and soybean oil had the largest impact on Canadian and Japanese revenues. Although soybean revenues fell by only 0.6 percent in Japan, revenues from crushing rapeseed fell by an estimated 4.7 percent. This coincides with a 3.7 percent increase in rapeseed revenues in Canada. Canadian soybean crushing revenues are expected to fall by 1.4 percent due to increased costs of imported soybeans. The US increases its own level of soybean crush to satisfy increased demand for soybean oil exports to Japan. The Japanese tariff reductions have a minimal impact on the EC since they are unable to compete with either Canada or the US for rapeseed oil and soybean oil exports.

6.3 SUMMARY

Prices and quantities in the base solution were representative of values which existed in 1982. The results of the four scenarios were as expected, with few exceptions. In each case, rapeseed crushing increased in Canada and decreased in Japan. The Japanese price of rapeseed oil fell in each scenario whereas Canada's rapeseed oil price rose in Scenario I and fell in Scenario III and Scenario IV. Although a fall in the Canadian price of rapeseed oil had not been expected, significant reductions in the Japanese price of rapeseed oil and soybean oil offset any movement toward an increase in Canada's rapeseed oil price in the last two scenarios. Lower rapeseed oil prices however, did not reduce rapeseed crushing revenues in Canada.

Lowering the Japanese tariff on rapeseed oil would lead to increased exports of Canadian produced rapeseed oil. Canadian rapeseed crushers would receive a 3.4 percent increase in revenues while rapeseed crushing revenue in Japan would fall by 4.1 percent. Soybean crushing revenues would change very little, 0.2 and -0.1 percent in Canada and Japan, respectively. Once the Japanese tariffs on both rapeseed and soybean oils are removed, Canadian rapeseed crushers would realize a 3.7 percent increase in revenues but soybean crushers in Canada would face a 1.4 percent decrease. Japan's revenues are predicted to fall by 4.7 and 0.6 percent for rapeseed and soybean crushing, respectively.

Finally, reducing the rapeseed oil tariff or eliminating both tariffs, removes the distortive level of protection afforded rapeseed crushing over soybean crushing in Japan. Following adjustments to the import tariffs in each scenario, reductions in the quantity of rapeseed crushed in Japan which exceed reductions in soybean crushing there, suggest rapeseed crushing was encouraged vis-a-vis soybean crushing under the tariff structure which existed in the base.

Chapter VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY

The future of the Canadian rapeseed crushing industry is uncertain. Variable and at times negative crush margins have resulted in plant shutdowns across Western Canada. Competition from other regions for limited Canadian rapeseed supplies threatens the existence of a viable Canadian rapeseed industry. Extreme competition distorted by tariffs in importing countries provides their domestic crushers a relative advantage in purchasing Canadian rapeseed.

Japan imports 90 % of its rapeseed from Canada. In 1982, Japanese imports surpassed Canada's own domestic use of rapeseed. Japanese crushers are able to competitively purchase Canadian rapeseed because of the protection given by vegetable oil import tariffs. Japanese import tariffs encourage domestic crushing activity by raising the domestic price of oil, while limiting oil imports. Japan's rapeseed oil import tariff allows Japanese crushers to bid up rapeseed prices and depress rapeseed oil prices in Canada.

The general objective of this study was to analyze the impact that removing Japanese vegetable oil tariffs would have on the Canadian rapeseed crushing industry. Specifically, the objectives were:

1. to review protectionism in the international market;
2. to develop a model of the market for rapeseed, soybeans and

their products, focussing on trade among Canada, the E.C., Japan and the U.S.;

3. to incorporate into the model, distortions resulting from trade barriers in each of these regions;
4. to assess the impact that tariff changes have on prices, quantities traded and the location of crushing activity.

Protectionism in the international market was reviewed in Chapter III, where the measurement of protection and its impact on international markets was evaluated in the context of the rapeseed market. A general model of the oilseed market was developed in chapters III and IV and later specified to represent the rapeseed market and major influences in that market. Distortions resulting from trade barriers in each region, were incorporated into the model.

The international trade model of the market for rapeseed, soybeans and their products was specified in Chapter V. Trade barriers in Canada, the United States, the European Community and Japan were incorporated into the model. Reductions in Japanese import tariffs were studied under four different scenarios and their impacts on regional crushing revenues were presented in Chapter VI.

7.2 CONCLUSIONS AND RECOMMENDATIONS

It is estimated that the largest gain for Canadian crushers would result from the removal of the Japanese import tariff on rapeseed oil alone. However, removal of the tariffs on both rapeseed and soybean oils is more realistic. If this was negotiated, Canadian rapeseed crushers would still be made better off. According to this analysis, the removal of tariffs on rapeseed oil and soybean oil would lead to increased Japanese imports of vegetable oils and a 3.7 percent increase in annual revenue received by Canadian rapeseed crushers. This corresponds to approximately $1.8 million per year. Although the impact on Canadian canola growers had not been emphasized in this study, it is estimated that although crushings decrease, higher world prices for rapeseed would result in highrer revenues for Canadian farmers.

In Japan, a 4.7 percent drop in revenues from rapeseed crushing compared with a decrease of only 0.6 percent from soybean crushing suggests rapeseed crushing is encouraged vis-a-vis soybean crushing as long as existing tariffs are in place. Elimination of the tariffs would remove the distortive level of protection afforded rapeseed crushing over soybean crushing in Japan.

However, if the Japanese are unwilling to eliminate the tariffs completely, but choose to retain some level of protection, negotiations for reduced rapeseed oil tariffs relative to soybean oil tariffs are proposed. Lowering the Japanese import tariff on rapeseed oil to $36.58 while retaining the existing tariff on soybean oil, would equalize the relative rates of protection on rapeseed and soybean crushing in Japan. This would lead to an estimated $1.6 million increase in Canadian rapeseed crushing revenues annually.

Reducing the Japanese tariff on rapeseed oil is essential in enabling Canada's rapeseed crushing industry to be competitive in the world market. A viable crushing industry in Canada will provide both a market for domestic rapeseed as well as competitively priced products for export and domestic consumption.

7.3 LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

A short run model was developed in this study. To reflect the long run, rapeseed and soybean supply functions should be estimated and incorporated into the model. However, reliable supply functions were difficult to obtain for these products in each producing region. Possibly more important for future research would be the inclusion of more oilseed substitutes and other producing regions. Palm oil and rice bran are increasing their importance as substitutes for rapeseed products in Japan while Brazil's influence in the soybean market is substantial.

LITERATURE CITED

Agriculture Canada, Oilseeds in Canada - An Oilseed System Reference, Food Systems Branch, Ottawa, 1977.

Alaouze, G.M., A.S. Watson and N.H. Sturgess, "Oligopoly Pricing in the World Wheat Market", American Journal of Agricultural Economics, Vol. 60, No. 2 (May 1978): 173-185.

Balassa, B., "Tariff Protection in Industrial Countries: An Evaluation", Journal of Political Economy, 73, Dec. 1965, 573-94.

Balassa, B., et al., The Structure of Protection in Developing Countries (Johns Hopkins University Press, Baltimore, 1971).

Balassa, B., "Effective Protection in Developing Countries", in Grubel and Johnson (Eds.) Effective Tariff Protection (Geneva, 1971).

Barber, C.L., "Canadian Tariff Policy", Canadian Journal of Economics and Political Science, 21, Nov. 1955, 513-30.

Basevi, G., "The United States Tariff Structure: Estimates of Effective Rates of Protection of United States Industries and Industrial Labour", Review of Economics and Statistics, (1966) 48: 147-60.

Bhagwati, J., "The Pure Theory of International Trade: A Survey", Economic Journal, LXXIV (March 1964): 1-84.

Canadian International Grains Institute, Grains and Oilseeds: Handling, Marketing and Processing, (Second Edition), Winnipeg, Manitoba, August, 1977.

Canola Crushers of Western Canada, Western Canadian Agri-Food Processing Potential Opportunities for Canola Crushing, Winnipeg, Manitoba, 1984.

Carter, C., N. Gallini and A. Schmitz, "Producer-Consumer Trade-Offs in Export Cartels", American Journal of Agricultural Economics, Vol. 62, No. 5 (November 1980).

Carter, C.A., and W.D. Mooney, "Japanese Tariff Protection of Rapeseed and Soybean Oil", unpublished paper, Dept. of Ag. Economics, University of Manitoba, 1985.

Carter, C. and A. Schmitz, "Import Tariffs and Price Formation in the World Wheat Market", American Journal of Agricultural Economics, Vol. 61, No. 3 (August 1979): 517-522.

Corden, W.M., "The Tariff", in A. Hunter, ed., The Economics of Australian Industry (Melbourne University Press, Melbourne, 1963).

Corden, W.M., "Protection", Economic Record, 42, March 1966, 129-48.

Corden, W.M., "The Structure of a Tariff System and the Effective Protective Rate", Journal of Political Economy, 74, June 1966, 221-37.

Corden, W.M., "The Effective Protective Rate, the Uniform Tariff Equivalent and the Average Tariff", Economic Record, 42, June 1966, 200-16.

Corden, W.M., The Theory of Protection, Toronto: Oxford University Press, 1971.

Craddock, W., A Preliminary Demand Analysis and Price Prediction of Canadian Rapeseed and its Joint Products, Rapeseed Meal and Oil, unpublished paper, University of Manitoba, 1973.

Dardis, R., "Intermediate Goods and the Gain from Trade", Review of Economics and Statistics, Vol. 49 (November 1967): 502-509.

Dardis, R. and J. Dennison, "The Welfare Cost of Alternative Methods of Protecting Raw Wool in the United States", American Journal of Agricultural Economics, Vol. 51, No. 2 (May 1969): 303:319.

Dawson, Dau and Associates Ltd. and Lynn Malmberg, A Study of the Marketing of Canola and Canola Products, Calgary, Alberta, April 1985.

Food and Agriculture Organization of the United Nations (A), FAO Production Yearbook, Rome, various issues.

Food and Agriculture Organization of the United Nations (B), FAO Trade Yearbook, Rome, various issues.

Furtan, W.H., J.G. Nagy and G.G. Storey, The Canadian Rapeseed Industry: The Economic Implications of Changes in Transporation and Tariff Costs, Department of Agricultural Economics, University of Saskatchewan, BL: 78-1, February, 1978.

Furtan, W.H., J.G. Nagy and G.G. Storey, "The Impact on the Canadian Rapeseed Industry From Changes in Transport and Tariff Rates", American Journal of Agricultural Economics, Vol. 61, No. 2 (May 1979): 238-248.

Griffith, G.R., "An Econometric Simulation of Alternative Domestic and Trade Policies in the World Markets for Rapeseed, Soybeans and Their Products", unpublished Ph.D. Thesis, University of Guelph, 1979.

Griffith, G.R. and K.D. Meilke, A Description of the Market Structure and Agricultural Policies in Five Regional Oilseed and Oilseed Product Markets, School of Agricultural Economics and Extension Education, University of Guelph, AEEE/80/13, November, 1980.

Griffith, G.R. and K.D. Meilke (A), A Structural Econometric Model of the World Markets for Rapeseed, Soybeans and Their Products, School and Agricultural Economics and Extension Education, University of Guelph, AEEE/82/5, April, 1982.

Griffith, G.R. and K.D. Meilke (B), Tariffs and the Canadian Rapeseed Industry, School of Agricultural Economics and Extension Education, University of Guelph, Discussion Paper No. 82/1, September, 1982.

Grubel H. and H.G. Johnson (Eds.) Effective Rate of Tariff Protection, (Geneva, 1971).

Guisinger, S. E., "Negative Value Added and the Theory of Effective Protection", Quarterly Journal of Economics, 83, Aug. 1969, 415-33.

Houck, J.P., M.E. Ryan and A. Subotnik, Soybeans and Their Products - Markets, Models and Policy, Minneapolis: University of Minnesota Press, 1972.

Japan Economic Journal Tokyo, various issues.

Japan Oilseed Processors Association (JOPA), Statistics for 19__ of Oilseeds, Oils, and Oilcakes, Tokyo, various issues.

Johnson, H.G., "The Theory of Tariff Structure, with Special Reference to World Trade and Development", in Johnson, H. G. and Kenen, P. B., Trade and Development (Librairie Droz, Geneva, 1965).

Johnson, H.G., "Effective Protection and General Equilibrium Theory", in Johnson H.G., Aspects of the Theory of Tariffs (Allen and Unwin, London, 1971).

Judge, G.G. and T. Takayama, Studies in Economic Planning Space and Time, Amsterdam: North Holland Publishing Company, 1973.

Kulshreshtha, B.N., A.K. Banerjee, W.H. Furtan and G.G. Storey, Quarterly Rapeseed, Rapeseed Oil and Rapeseed Meal Forecasting Model, Agriculture Canada Working Paper No. 5 for FARM Project, Ottawa, 1979.

Kwon, O.Y. and I.H. Uhm, "Provincial Rapeseed Acreage Models and Some Policy Implications", Canadian Journal of Agricultural Economics, Vol. 28, No. 3 (1980): 37-50.

Lowe, J.C. and T.M. Petrie, Grains and Oilseeds Supply Block of Food and Agriculture Regional Model, Agriculture Canada Working Paper No. 3 for FARM Project, Ottawa, 1979.

McCalla, A.F., "A Duopoly Model of World Wheat Pricing", Journal of Farm Economics, Vol 48 (August 1966): 711-727.

Martin, L., "Quadratic Single and Multi-Commodity Models of Spatial Equilibrium: A Simplified Exposition", Canadian Journal of Agricultural Economics, Vol. 29, No. 1 (1981): 21-48.

Martin, L. and G.G. Storey, "Temporal Price Relationships in the Vancouver Rapeseed Futures Market and Their Implications to Farm Prices", Canadian Journal of Agricultural Economics, Vol. 23, No. 3 (November 1975): 1-12.

Martin, L. and A.C. Zwart, "A Spatial and Temporal Model of the North American Pork Sector for the Evaluation of Policy Alternatives", American Journal of Agricultural Economics, Vol. 57, No. 1 (February 1975): 55-66.

Meilke, K.D. and G.R. Griffith, "Incorporating Policy Variables in an Econometric Model of the World Soybean/Rapeseed and Products Market", unpublished paper, School of Agricultural Economics and Extension Education, University of Guelph, 1982.

Meilke, K.D., L. Young and D. Miller, A Quarterly Forecasting Model of the Canadian Soybean Sector, (Policy, Planning and Economics Branch, Agriculture Canada: Working Paper No. 9, 1980).

Melvin, J. and B.W. Wilkinson, Effective Protection in the Canadian Economy, (Economic Council of Canada, Ottawa, 1968).

Ministry of Agriculture, Forestry and Fisheries, Edible Oil Situation in Japan, Tokyo, various issues.

Ministry of Finance, Monthly Trade Statistics, Tokyo, various issues.

Nagy, J.G. and W.H. Furtan, The Socio-Economic Costs and Returns From Rapeseed Breeding in Canada, Department of Agricultural Economics, University of Saskatchewan, Technical Bulletin, BL: 77-1, May 1977.

Natural Products Marketing Council, Performance of the Rapeseed Marketing System, Saskatchewan Agriculture, Regina, 1981.

Oilseed Products Minimum Compensatory Rate Review Group Final Report, Ottawa, August, 1983.

Oilworld, Hamburg, various issues.

Parris, K. and C. Ritson, EEC Oilseed Products Sector and the Common Agricultural Policy, (Wye College: Centre for European Agricultural Studies, Occasional Paper No. 4, 1977).

Perkins, P., An Economic Review of Western Canada's Rapeseed Processing Industry, Alberta Agriculture, Edmonton, 1976.

Pieri, R.G., K.O. Meilke and T.G. MacAulay, "North American-Japanese Pork Trade: An Application of Quadratic Programming", Canadian Journal of Agricultural Economics, Vol. 25, No. 2 (1977): 61-79.

Qasmi, B., "Analysis of the 1980 U.S. Trade Embargo on Exports of Soybeans and Soybean Products to the Soviet Union: A Spatial Price Equilibrium Approach", unpublished Ph.D. Thesis, Iowa State University, 1986.

Rapeseed Association of Canada, Processing of Sixth Annual Meeting of the Rapeseed Association of Canada, Vancouver, British Columbia, 1973.

Rigaux, L.R., A Preliminary Paper on the Canadian Edible Oils Industry, University of Manitoba, Winnipeg, 1976.

Schmitz, A., A.F. McCalla, D.O. Mitchell and C. Carter, Grain Export Cartels, Cambridge: Ballinger Publishing Co., 1981.

Schuller, R., Schutzzoll und Freihandel (Vienna and Leipzig, 1905), pp.149-50.

Soligo, R. and J. Stern, "Tariff Protection, Import Substitution and Investment Efficiency", Pakistan Development Review, Vol. 5 (1965) pp. 249-270.

Spriggs, J., An Econometric Analysis of Canadian Grains and Oilseeds, U.S.D.A., Economic Research Service, Technical Bulletin, No. 1662, December, 1981.

Statistics Canada, National Income and Expenditure Accounts, Catalogue No. 13-001, Ottawa, various issues.

Statistics Canada, Oilseeds Review, Catalogue No. 22-006, Ottawa, various issues.

Statistics Canada, Cereals and Oilseeds Review, Catalogue No. 22-007, Ottawa, various issues.

Statistics Canada, Grain Trade of Canada, Catalogue No. 22-207, Ottawa, various issues.

Statistics Canada, Livestock Report, Catalogue No. 23-008, Ottawa, various issues.

Statistics Canada, Consumer Prices and Price Indexes, Catalogue No. 62-010, Ottawa, various issues.

Statistics Canada, Exports by Commodities, Catalogue No. 65-004, Ottawa, various issues.

Statistics Canada, Imports by Commodities, Catalogue No. 65-007, Ottawa, various issues.

Swallow, B., "Policy Analysis of Canadian/Japanese Trade of Rapeseed and Rapeseed Products", unpublished M.Sc. Thesis, Univeristy of Saskatchewan, June 1983.

Takayama, T. and G.G. Judge, Spatial and Temporal Price and Allocation Models, Amsterdam: North Holland Publishing Company, 1971.

Uhm, I.H., A Supply Response Model of Canadian Rapeseed and Soybeans, Agriculture Canada: Economics Branch Publication No. 75/15, 1975.

Umemoto, H.E., "The Service of the Winnipeg Commodity Exchange to Foreign Customers", paper presented at the Annual Meeting of the Rapeseed Association of Canada, Winnipeg, 1973.

United States Department of Agriculture, Foreign Agriculture Service, Washington, various issues.

Weinschenk, G., W. Henrichsmeyer and F. Albinger, "The Theory of Spatially Equilibrium and Optimal Location in Agriculture: A Survey", Review of Marketing and Agricultural Economics, Vol. 37, No. 1 (March 1969): 3-73.

Williams, G., "The U.S. and World Oilseeds and Derivatives Markets: Economic Stucture and Policy Interventions", unpublished Ph.D. Thesis, Purdue University, 1981.

Winnipeg Commodity Exchange, Annual Report, Winnipeg.

Wiseman, A.C. and R.A. Sedjo, "Effects of an Export Embargo on Related Goods: Logs and Lumber", American Journal of Agricultural Economics, Vol. 63, No. 3 (August 1981): 423-429.

Woodland, A.D., "Joint Outputs, Intermediate Inputs and International Trade Theory", International Economic Review, Vol. 18, No. 3 (October 1977): 517-534.

Appendix A

OILSEED MODEL

TABLE A.1

OBJECTIVE FUNCTION

TABLE A.2

EQUILIBRIUM PRICE AND OPTIMUM CONSUMPTION CONDITIONS

TABLE A.3

OPTIMUM PRODUCTION CONDITIONS, CRUSH CAPACITY, ROW TRADE AND QP PORTION OF MATRIX

A1

PSM3	PSM4	PRS1	PRSS1	PRS3	PRS4	PSB1	PSB2	PSBS2	PSB3	PSB4
11260.58	3075.88	-3176.4	1226.1	-2016.0	-4.0	-576.65	-59042.2	10622.4	-24.7	-212.0

Crushings

QRS1	QRS3	QRS4	QSB1	QSB2	QSB3	QSB4
-50.71	-48.0	-50.6	-48.16	-46.00	-48.00	-50.80

Trade Flows

RO11	RO12	RO14	RO32	RO33	RO34	RO44	SO11	SO21	SO22	SO23	SO24	SO33	SO44	RM11	RM1S	RM12	RM13	RM14	RM33
-0.0	-30.0	-155.36	-72.05	-0.0	-157.12	-0.0	-0.0	-30.00	-0.0	-72.05	-151.58	-0.0	-0.0	-0.0	-0.0	-22.00	-52.00	-57.00	-0.0

RM44	SM11	SM13	SM21	SM22	SM2S	SM23	SM24	SM33	SM44	RS11	RS1S	RS13	RS14	RS33	RS34	RS44	SB11	SB13	SB14
-0.0	-0.0	-51.00	-20.00	-0.0	-0.0	-49.00	-53.51	-0.0	-0.0	-0.0	-0.0	-44.00	-49.50	-0.0	-53.00	-0.0	-0.0	-43.00	-51.00

SB21	SB22	SB2S	SB23	SB24	SB33	SB44	RO15	RO35	SO15	SO25	SO35	RM15	SM25	RS15	SB15	SB25	RO54	SO54	RM53	RM54
-10.52	-0.0	-0.0	-41.00	-45.00	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

TABLE A.2: EQUILIBRIUM PRICE AND OPTIMUM CONSUMPTION CONDITIONS

	PRO1	PRO2	PRO3	PRO4	PSO1	PSO2	PSO3	PSO4	PRM1	PRMS1	PRM2	PRM3	PRM4	PSM1	PSM2	PSMS2	PSM3	PSM4	PRS1	PRSS1	PF
R001	1.0	-0.922																			
R002	1.0			-1.0																	
R003		0.922	1.0																		
R004			1.0	-1.0																	
R005					-0.922	1.0															
R006						1.0	-0.909														
R007						1.0		-1.0													
R008									1.0	-1.0											
R009									1.0		-1.0										
R010									1.0			-1.0									
R011									1.0				-1.0								
R012														1.0			-1.0				
R013														-1.0	1.0						
R014															1.0	-1.0					
R015															1.0		-1.0				
R016															1.0			-1.0			
R017																			1.0	-1.0	
R018																			1.0		[illegible]
R019																			1.0		
R020																					
R021																					
R022																					
R023																					
R024																					
R025																					
R026																					
R027	0.404								0.582										-1.0		
R028			0.338									0.58							-1.0		
R029				0.406									0.581						-1.0		
R030					0.171									0.734							
R031							0.173										0.304				
R032								0.175										0.279			
R033					0.171									0.734							
R034						0.178									0.297						
R035							0.173										0.304				
R036								0.175										0.279			
R037			0.338									0.58									[illegible]
R038							0.173										0.304				
R039				0.406									0.581								
R040								0.175										0.279			
R041				0.406									0.581								[illegible]
R042	0.192				-0.092																
R043		0.0				-0.0															
R044			0.421				-0.026														
R045				0.263				-0.242													
R046	-0.064				0.112																
R047		-0.0				1.322															
R048			-0.002				0.113														
R049				-0.119				0.257													
R050									1.46					-1.0							
R051										0.073											
R052											0.0				-0.0						
R053												15.513					-12.35				
R054													0.580					-0.404			
R055									-1.436					2.02							
R056											-0.0				29.182						
R057																3.59					
R058												-40.05					13.798				
R059													-2.343					2.99			
R060																				1.32	
R061																					
R062																					
R063																					
R064																					
R065																					
R066																					
R067																					
R068																					

S1	PSB1	PSB2	PSB32	PSB3	PSB4	QRS1	QRS3	QRS4	QSB1	QSB2	QSB3	QSB4	RO 11	RO 12	RO 14	RO 32	RO 33	RO 34	RO 44	SO 11	SO 21	SO 22	SO 23	SO 24	SO 33	SO 44	RN 11	RN 15	RN 12	RN 13	RN 14	RN 33	RN 44	SN 11	SN 13	SN 21	SN 22
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SM 25	SM 23	SM 24	SM 33	SM 44	RS 11	RS 15	RS 13	RS 14	RS 33	RS 34	RS 44	SE 11	SE 13	SE 14	SE 21	SE 22	SE 25	SE 23	SE 24	SE 33	SE 44	RO 15	RO 35	SO 15	SO 25	SO 35	RH 15	SM 25	RS 15	SE 15	SE 25	RO 54	SO 54	RH 53	RH 54	SM 53	SM 54	RS 53	RS 54	SE 54		RHS
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																																									=	6.9
																																									>	839.90
																																									>	524.305
																																									>	174.612
																																									>	5223.035
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																																									>	27.9
																																									=	26.1
																																									>	1726.78
																																									>	793.976
																																									>	1440.308
1																																									>	23041.07
	1		1																																						>	692.0
		1		1																																					>	11250.58
					1																																			>	3075.88
																1																									=	1226.1
					1																																				=	10622.4
							1		1																																>	0
								1		1	1																											1			>	0
											1			1																								1		>	0
															1																									>	0
													1					1		1																					>	0
														1						1		1																			>	0
																														1										1	>	0

TABLE A.3: OPTIMUM PRODUCTION CONDITIONS, CRUSH CAPACITY, ROW TRADE AND OF POTION OF MATRIX

	PR01	PR02	PR03	PR04	PS01	PS02	PS03	PS04	PRM1	PRMS1	PRM2	PRM3	PRM4	PSM1	PSM2	PSM52	PSM3	PSM4	PRS1	PRS51	PF
R069																					
R070																					
R071																					
R072																					
R073																					
R074																					
R075																					
R076																					
R077																					
R078																					
R079																					
R080																					
R081																					
R082																					
R083																					
R084																					
R085																					
R086																					
R087																					
R088																					
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R099																					
R100																					
R101																					
R102																					
R103																					
R104																					
R105																					
R106																					
R107																					
R108																					
R109																					
R110																					
R111																					
R112																					
R113																					
R114																					
R115																					
	-0.192				0.073																
		-0.0				0.0															
			-0.421				0.014														
				-0.263				0.181													
	0.078				-0.112																
		0.0				-1.822															
			0.014				-0.113														
				0.181				-0.267													
									-1.46					1.218							
										-0.073											
											-0.0				0.0						
												-15.515					26.2				
													-0.58					1.3735			
									1.218					-2.02							
											0.0				-29.182						
																-1.59					
												26.2					-13.798				
													1.3735					-2.99			

PRS4	PSB1	PSB2	PSB32	PSB3	PSB4	QRS1	QRS3	QRS4	QSB1	QSB2	QSB3	QSB4	RO 11	RO 12	RO 14	RO 32	RO 33	RO 34	RO 44	SO 11	SO 21	SO 22	SO 23	SO 24	SO 33	SO 44	RM 11	RM 15	RM 12	RM 13	RM 14	RM 33	RM 44	SM 11	SM 13	SM 21
						0.404							-1	-1	-1																					
							0.388									-1	-1	-1																		
								0.406											-1																	
									0.171											-1																
										0.178											-1	-1	-1	-1												
											0.173														-1											
												0.175														-1										
						0.582																					-1	-1	-1	-1	-1					
							0.56																									-1				
								0.581																									-1			
									0.794																									-1	-1	
										0.797																										-1
											0.804																									
												0.779																								
						-1																														
							-1																													
								-1																												
									-1																											
										-1																										
											-1																									
												-1																								

SH 2[illegible]	SH 24	SH 33	SH 44	RS 11	RS 12	RS 13	RS 14	RS 33	RS 34	RS 44	SE 11	SE 13	SE 14	SE 21	SE 22	SE 25	SE 23	SE 24	SE 33	SE 44	RC 15	RC 35	SC 15	SC 25	SC 35	RM 15	SM 25	RS 15	SE 15	SE 25	RC 54	SC 54	RM 53	RM 54	SM 53	SM 54	RS 53	RS 54	SE 54		RHS
				-1	-1	-1	-1																					-1												>	-3176.4
								-1	-1																															>	-2016
										-1																														>	-4
											-1	-1	-1																-1											>	-576.65
														-1	-1	-1	-1	-1												-1										>	-59042.2
																			-1																					>	-24.7
																				-1																				>	-212
																					-1																			>	0
																						-1																		>	0
																																								>	0
																							-1																	>	0
																								-1																>	0
																									-1															>	0
																																								>	0
																										-1														>	-13.8
																																								>	0
																																								>	0
																																								>	0
1	-1																										1													>	-253.4
		-1																																						>	0
			-1																																					>	0
																																								>	-1556.6
																																								>	-2217.4
																																								>	-1512.4
																																								>	-1199.4
																																								>	-26420.0
																																								>	-14253.1
																																								>	-4913.3
																					1																			=	133.915
																						1																		=	232.064
																							1																	=	30.362
																								1																=	932.2
																									1															=	603.455
																										1														=	5.271
																											1													=	1921.1
																												1												=	75.757
																													1											=	58.312
																														1										=	5509.601
																															1									=	2.362
																																1								=	2.962
																																	1							=	104.227
																																		1						=	22.328
																																			1					=	3265.944
																																				1				=	31.641
																																					1			=	63.907
																																						1		=	43.013
																																							1	=	223.125

Appendix B

DATA SOURCES

DRM1 Demand for rapeseed meal in Canada, '000 tonnes. Unpublished quarterly data from the Grain Marketing Unit, Statistics Canada.

DRM2 Demand for rapeseed meal in the United States, '000 tonnes. Oilworld (various issues).

DRM3 Demand for rapeseed meal in the EC, '000 tonnes. Oilworld (various issues).

DRM4 Demand for rapeseed meal in Japan '000 tonnes. Oilworld (various issues).

DRO1 Demand for rapeseed oil in Canada, '000 tonnes. Unpublished quarterly data from the Grain Marketing Unit, Statistics Canada.

DRO2 Demand for rapeseed oil in the United States, '000 tonnes. Oilworld (various issues).

DRO3 Demand for rapeseed oil in the EC, '000 tonnes. Oilworld (various issues).

DRO4 Demand for rapeseed oil in Japan, '000 tonnes. Oilworld (various issues).

DSM1 Demand for soybean meal in Canada, '000 tonnes. Calculated as beginning inventory + imports - exports + production - ending inventory. Unpublished quarterly data from the Grain Marketing Unit, Statistics Canada.

DSM2 Demand for soybean meal in the United States, '000 tonnes. Foreign Agriculture Service (FAS), United States Department of Agriculture (USDA).

DSM3 Demand for soybean meal in the EC, '000 tonnes. Oilworld (various issues).

DSM4 Demand for soybean meal in Japan, '000 tonnes. Oilworld (various issues).

DSO1 Demand for soybean oil in Canada, '000 tonnes. Calculated as DSM1. Unpublished quarterly data from the Grain Marketing Unit, Statistics Canada.

DSO2 Demand for soybean oil in the United States, '000 tonnes. FAS,USDA.

DSO3 Demand for soybean oil in the EC, '000 tonnes. Oilworld (various issues).

DSO4 Demand for soybean oil in Japan, '000 tonnes. Oilworld (various issues).

DY1/C Canadian real per capita disposable income. Calculated as personal disposable income/cpi/population. Statistics Canada Catalogue #13-001 and #62-010.

FP4 Feed production in Japan, Oilworld (various issues).

HOGINV1 Canadian hog inventory, '000s of hogs. Statistics Canada, Catalogue #23-008.

HOGNUM3 Hog numbers in the EC, '000s of hogs. FAO.

PL1	Price of livestock in Canada, $/tonne. Calculated as a simple average of slaughter steer and hog prices, Toronto. Agriculture Canada.
PPO4	Price of palm oil in Japan, Yen/tonne. Calculated as imported value/quantity imported. Ministry of Finance, Tokyo.
PRM1	Price of rapeseed meal in Canada, $C/tonne. Alberta crushers' prices from Dawson, Dau and Associates report data spliced to Statistics Canada, Catalogue #22-006/7 from first quarter 1977 to third quarter 1981.
PRM2	Price of rapeseed meal in the United States, $US/tonne. Import value/quantity imported. Statistics Canada Catalogue #65-004.
PRM3	Price of rapeseed meal in the EC, 34% FOB ex-mill, Hamburg. Converted to ECU/tonne using average annual exchange rates. FAS,USDA.
PRM4	Price of rapeseed meal in Japan, Yen/tonne. Wholesale price. JOPA,MAFF
PRO1	Price of rapeseed oil in Canada, $C/tonne. Alberta crushers' price from Dawson, Dau and Associates report data spliced to Statistics Canada Catalogue #22-006/7, from fitst quarter 1977 to third quarter 1981.
PRO2	Price of rapeseed oil in the United States, $US/tonne. Refined, denatured, tanks, New York, FAS,USDA.

PRO3 Price of rapeseed oil in the EC, FOB ex-mill, Rotterdam. Converted to ECU/tonne. FAS,USDA. (various issues).

PRO4 Price of rapeseed oil in Japan, Yen/tonne. Wholesale price. JOPA,MAFF

PRS1 Price of rapeseed in Canada, $C/tonne. Cash price, Winnipeg Commodity Exchange, Annual Report.

PRS2 Price of rapeseed in the United States, $US/tonne. Valueof imports/quantity imported. Statistics Canada Catalogue #65-004.

PRS3 Price of rapeseed in the EC, Canadian 40%, CIF Rotterdam, Converted to ECU/tonne. FAS,USDA.

PRS4 Price of rapeseed in Japan, Yen/tonne. CIF Japan, JOPA,MAFF

PSB1 Price of soybeans in Canada. $C/tonne, producer's price, Catham. Statistics Canada Catalogue #22-006/7.

PSB2 Price of soybeans in the US. $US/tonne, #1 yellow. FAS,USDA.

PSB3 Price of soybeans in the EC. CIF Rotterdam. Converted to ECU/tonne. FAS,USDA.

PSB4 Price of soybeans in Japan. Yen/tonne, CIF Japan. JOPA,MAFF.

PSM1 Price of soybean meal in Canada. $C/tonne, Montreal. Livestock Feed Board data spliced to Statistics Canada Catalogue #22-006/7 from the first period 1977 to the third period 1980.

PSM2 Price of soybean meal in the US. $US/tonne, 44% solvent, bulk, Decatur. USDA.

PSM3 Price of soybean meal in the EC. CIF Rotterdam. Converted to ECU/tonne. FAS,USDA.

PSM4 Price of soybean meal in Japan. Yen/tonne, wholesale price. JOPA,MAFF.

PSO1 Price of soybean oil in Canada. $C/tonne, Import value/quantity imported spliced to Statistics Canada Catalogue #22-006/7 from the first quarter 1977 to the third quarter 1980.

PSO2 Price of soybean oil in the US. $US/tonne, FAS, USDA.

PSO3 Price of soybean oil in the EC. FOB Rotterdam, Converted to ECU/tonne using average annual exchange rates. FAS, USDA.

PSO4 Price of soybean oil in Japan. Yen/tonne, wholesale price, JOPA, MAFF.

Appendix C

QUADRATIC PROGRAMMING RESULTS

TABLE C.1

QUADRATIC PROGRAMMING RESULTS I

(Where 1 is Canada, 2 is U.S., 3 is E.C., 4 is Japan)

VARIABLES

PRICES
($/t.)

	Actual	Benchmark Solution		
		Base	Diff	%Diff
Rapeseed Oil				
PRO1	$515.83	$633.42	$117.59	22.8
PRO2	$800.87	$719.54	$-81.33	-10.2
PRO3	$515.01	$591.37	$76.36	14.8
PRO4	$720.65	$696.65	$-24.00	-3.3
Soybean Oil				
PSO1	$584.15	$691.23	$107.08	18.3
PSO2	$499.90	$678.96	$179.06	35.8
PSO3	$551.82	$712.04	$160.22	29.0
PSO4	$687.92	$830.50	$142.58	20.7
Rapeseed Meal				
PRM1	$176.64	$155.52	$-21.12	-12.0
PRMS1	$176.64	$155.52	$-21.12	-12.0
PRM2	$194.70	$177.52	$-17.18	-8.8
PRM3	$220.33	$207.52	$-12.81	-5.8
PRM4	$249.26	$194.43	$-54.83	-22.0
Soybean Meal				
PSM1	$259.04	$202.15	$-56.89	-22.0
PSM2	$243.95	$182.15	$-61.80	-25.3
PSMS2	$243.95	$182.15	$-61.80	-25.3
PSM3	$267.85	$231.15	$-36.70	-13.7
PSM4	$374.86	$218.85	$-156.01	-41.6
Rapeseed				
PRS1	$313.74	$295.70	$-18.04	-5.7
PRSS1	$313.74	$295.70	$-18.04	-5.7
PRS3	$353.49	$301.81	$-51.68	-14.6
PRS4	$359.74	$345.20	$-14.54	-4.0
Soybeans				
PSB1	$251.44	$230.55	$-20.89	-8.3
PSB2	$265.37	$220.03	$-45.34	-17.1
PSBS2	$265.37	$220.03	$-45.34	-17.1
PSB3	$301.47	$261.03	$-40.44	-13.4
PSB4	$323.09	$265.03	$-58.06	-18.0

QUANTITIES (Table C1 cont'd.)
(000 t)

	Actual	Benchmark Solution		
		Base	Diff	%Diff
Rapeseed Crushing				
QRS1	892.0	892.4	.4	.0
QRS3	2,291.0	2,168.8	-122.2	-5.3
QRS4	1,189.0	1,330.5	141.5	11.9
Soybean Crushing				
QSB1	1,026.8	983.0	-43.8	-4.3
QSB2	28,462.0	27,658.3	-803.7	-2.8
QSB3	11,695.0	14,169.4	2,474.4	21.2
QSB4	3,591.4	3,590.1	-1.3	.0
Rapeoil Trade				
RO11	219.6	214.7	-4.9	-2.2
RO12	4.1	6.9	2.8	68.3
RO14	11.8	.0	-11.8	-100.0
RO32	2.8	.0	-2.8	-100.0
RO33	639.0	609.4	-29.6	-4.6
RO34	4.1	.0	-4.1	-100.0
RO44	490.8	540.2	49.4	10.1
Soyoil Trade				
SO11	140.7	137.7	-3.0	-2.1
SO21	3.8	.0	-3.8	-100.0
SO22	4,337.8	3,991.0	-346.8	-8.0
SO23	.0	.0	.0	.0
SO24	26.3	.0	-26.3	-100.0
SO33	1,597.0	1,642.9	45.9	2.9
SO44	639.8	628.3	-11.5	-1.8

QUANTITIES (Table C1 cont'd.)

(000 t)

	Actual	Benchmark Solution Base	Diff	%Diff
Rapemeal Trade				
RM11	395.5	485.3	89.8	22.7
RM1S	15.1	16.5	1.4	9.3
RM12	26.1	26.1	.0	.0
RM13	97.3	.0	-97.3	-100.0
RM14	.0	.0	.0	.0
RM33	1,323.4	1,257.9	-65.5	-4.9
RM44	698.8	773.0	74.2	10.6
Soymeal Trade				
SM11	809.6	780.5	-29.1	-3.6
SM13	11.3	.0	-11.3	-100.0
SM21	359.3	474.9	115.6	32.2
SM22	16,409.9	17,725.7	1,315.8	8.0
SM2S	301.5	402.4	100.9	33.5
SM23	4,091.8	1,724.3	-2,367.5	-57.9
SM24	47.2	48.7	1.5	3.2
SM33	9,009.3	11,392.2	2,382.9	26.4
SM44	2,886.6	2,796.7	-89.9	-3.1
Rapeseed Trade				
RS11	892.0	892.4	.4	.0
RS1S	486.4	835.8	349.4	71.8
RS13	79.7	88.9	9.2	11.5
RS14	1,170.1	1,283.5	113.4	9.7
RS33	2,147.4	2,016.0	-131.4	-6.1
RS34	14.6	.0	-14.6	-100.0
RS44	4.0	4.0	.0	.0
Soybean Trade				
SB11	565.1	518.3	-46.8	-8.3
SB13	19.8	.0	-19.8	-100.0
SB14	47.4	.0	-47.4	-100.0
SB21	461.7	464.7	3.0	.6
SB22	28,462.0	27,658.3	-803.7	-2.8
SB2S	7,244.9	8,111.9	867.0	12.0
SB23	14,487.1	14,144.7	-342.4	-2.4
SB24	4,071.3	3,152.9	-918.4	-22.6
SB33	24.7	24.7	.0	.0
SB44	212.0	212.0	.0	.0

TABLE C.2

QUADRATIC PROGRAMMING RESULTS II

(Where 1 is Canada, 2 is U.S., 3 is E.C., 4 is Japan)

VARIABLES

PRICES
($/t.)

	Base	Scenario I Rapeoil Tariff Removal	Diff	%Diff	Scenario II Soyoil Tariff Removal	Diff	%Diff
Rapeseed Oil							
PRO1	$633.42	$634.74	$1.32	.2	$624.15	$-9.27	-1.5
PRO2	$719.54	$720.98	$1.44	.2	$709.49	$-10.05	-1.4
PRO3	$591.37	$599.13	$7.76	1.3	$585.96	$-5.41	-.9
PRO4	$696.65	$672.09	$-24.56	-3.5	$661.53	$-35.12	-5.0
Soybean Oil							
PSO1	$691.23	$688.21	$-3.02	-.4	$701.32	$10.09	1.5
PSO2	$678.96	$676.00	$-2.96	-.4	$688.74	$9.78	1.4
PSO3	$712.04	$708.87	$-3.17	-.4	$722.34	$10.30	1.4
PSO4	$830.50	$827.54	$-2.96	-.4	$756.12	$-74.38	-9.0
Rapeseed Meal							
PRM1	$155.52	$160.58	$5.06	3.3	$151.12	$-4.40	-2.8
PRMS1	$155.52	$160.58	$5.06	3.3	$151.12	$-4.40	-2.8
PRM2	$177.52	$182.58	$5.06	2.9	$173.12	$-4.40	-2.5
PRM3	$207.52	$210.36	$2.84	1.4	$200.49	$-7.03	-3.4
PRM4	$194.43	$217.58	$23.15	11.9	$208.12	$13.69	7.0
Soybean Meal							
PSM1	$202.15	$205.31	$3.16	1.6	$196.42	$-5.73	-2.8
PSM2	$182.15	$185.31	$3.16	1.7	$176.42	$-5.73	-3.1
PSMS2	$182.15	$185.31	$3.16	1.7	$176.42	$-5.73	-3.1
PSM3	$231.15	$234.31	$3.16	1.4	$225.42	$-5.73	-2.5
PSM4	$218.85	$222.08	$3.23	1.5	$229.93	$11.08	5.1
Rapeseed							
PRS1	$295.70	$299.18	$3.48	1.2	$289.40	$-6.30	-2.1
PRSS1	$295.70	$299.18	$3.48	1.2	$289.40	$-6.30	-2.1
PRS3	$301.81	$306.47	$4.66	1.5	$295.63	$-6.18	-2.0
PRS4	$345.20	$348.68	$3.48	1.0	$338.90	$-6.30	-1.8
Soybeans							
PSB1	$230.55	$232.54	$1.99	.9	$227.72	$-2.83	-1.2
PSB2	$220.03	$222.02	$1.99	.9	$217.20	$-2.83	-1.3
PSBS2	$220.03	$222.02	$1.99	.9	$217.20	$-2.83	-1.3
PSB3	$261.03	$263.02	$1.99	.8	$258.20	$-2.83	-1.1
PSB4	$265.03	$267.02	$1.99	.8	$260.63	$-4.40	-1.7

QUANTITIES (Table C2 cont'd.)
(000 t)

	Base	Scenario I Rapeoil Tariff Removal	Diff	%Diff	Scenario II Soyoil Tariff Removal	Diff	%Diff
Rapeseed Crushing							
QRS1	892.4	971.7	79.3	8.9	899.1	6.7	.8
QRS3	2,168.8	2,160.2	-8.6	-.4	2,175.4	6.6	.3
QRS4	1,330.5	1,264.5	-66.0	-5.0	1,308.9	-21.6	-1.6
Soybean Crushing							
QSB1	983.0	985.5	2.5	.3	972.9	-10.1	-1.0
QSB2	27,658.3	27,688.6	30.3	.1	27,840.0	181.7	.7
QSB3	14,169.4	14,171.6	2.2	.0	14,162.6	-6.8	.0
QSB4	3,590.1	3,577.9	-12.2	-.3	3,393.0	-197.1	-5.5
Rapeoil Trade							
RO11	214.7	214.2	-.5	-.2	217.4	2.7	1.3
RO12	6.9	6.9	.0	.0	6.9	.0	.0
RO14	.0	32.5	32.5		.0	.0	
RO32	.0	.0	.0		.0	.0	
RO33	609.4	606.1	-3.3	-.5	612.0	2.6	.4
RO34	.0	.0	.0		.0	.0	
RO44	540.2	513.4	-26.8	-5.0	531.4	-8.8	-1.6
Soyoil Trade							
SO11	137.7	138.2	.5	.3	136.0	-1.7	-1.2
SO21	.0	.0	.0		.0	.0	
SO22	3,991.0	3,996.4	5.4	.1	3,973.1	-17.9	-.4
SO23	.0	.0	.0		.0	.0	
SO24	.0	.0	.0		50.2	50.2	
SO33	1,642.9	1,643.2	.3	.0	1,641.7	-1.2	.0
SO44	628.3	626.1	-2.2	-.3	593.8	-34.5	-5.5

QUANTITIES (Table C2 cont'd.)
(000 t)

	Base	Scenario I Rapeoil Tariff Removal	Diff	%Diff	Scenario II Soyoil Tariff Removal	Diff	%Diff
Rapemeal Trade							
RM11	485.3	531.8	46.5	9.6	454.3	-31.0	-6.4
RM1S	16.5	16.2	-.3	-2.0	16.9	.4	2.4
RM12	26.1	26.1	.0	.0	26.1	.0	.0
RM13	.0	.0	.0		34.6	34.6	
RM14	.0	.0	.0		.0	.0	
RM33	1,257.9	1,252.9	-5.0	-.4	1,261.7	3.8	.3
RM44	773.0	734.7	-38.3	-5.0	760.5	-12.5	-1.6
Soymeal Trade							
SM11	780.5	782.5	2.0	.3	772.5	-8.0	-1.0
SM13	.0	.0	.0		.0	.0	
SM21	474.9	473.8	-1.1	-.2	488.1	13.2	2.8
SM22	17,725.7	17,633.5	-92.2	-.5	17,892.9	167.2	.9
SM2S	402.4	397.4	-5.0	-1.3	411.5	9.1	2.3
SM23	1,724.3	1,792.6	68.3	4.0	1,527.0	-197.3	-11.4
SM24	48.7	102.9	54.2	111.4	201.2	152.5	313.1
SM33	11,392.2	11,394.0	1.8	.0	11,386.8	-5.4	.0
SM44	2,796.7	2,787.2	-9.5	-.3	2,643.2	-153.5	-5.5
Rapeseed Trade							
RS11	892.4	971.7	79.3	8.9	899.1	6.7	.8
RS1S	835.8	831.2	-4.6	-.6	844.1	8.3	1.0
RS13	88.9	80.3	-8.6	-9.7	95.5	6.6	7.4
RS14	1,283.5	1,217.5	-66.0	-5.1	1,261.9	-21.6	-1.7
RS33	2,016.0	2,016.0	.0	.0	2,016.0	.0	.0
RS34	.0	.0	.0	.0	.0	.0	.0
RS44	4.0	4.0	.0	.0	4.0	.0	.0
Soybean Trade							
SB11	518.3	518.3	.0	.0	518.3	.0	.0
SB13	.0	.0	.0		.0	.0	
SB14	.0	.0	.0		.0	.0	
SB21	464.7	467.2	2.5	.5	454.6	-10.1	-2.2
SB22	27,658.3	27,688.6	30.3	.1	27,840.0	181.7	.7
SB2S	8,111.9	8,089.2	-22.7	-.3	8,144.1	32.2	.4
SB23	14,144.7	14,146.9	2.2	.0	14,137.9	-6.8	.0
SB24	3,153.0	3,140.8	-12.2	-.4	2,955.9	-197.1	-6.3
SB33	24.7	24.7	.0	.0	24.7	.0	.0
SB44	212.0	212.0	.0	.0	212.0	.0	.0

TABLE C.3

QUADRATIC PROGRAMMING RESULTS III

(Where 1 is Canada, 2 is U.S., 3 is E.C., 4 is Japan)

VARIABLES

PRICES
($/t.)

	Base	Scenario III Rapeoil Tariff Reduction	Diff	%Diff	Scenario IV 100 % Tariff Removal	Diff	%Diff
Rapeseed Oil							
PRO1	$633.42	$635.77	$2.35	.4	$611.78	$-21.64	-3.4
PRO2	$719.54	$722.10	$2.56	.4	$696.07	$-23.47	-3.3
PRO3	$591.37	$593.72	$2.35	.4	$596.55	$5.18	.9
PRO4	$696.65	$686.77	$-9.88	-1.4	$649.24	$-47.41	-6.8
Soybean Oil							
PSO1	$691.23	$690.11	$-1.12	-.2	$700.23	$9.00	1.3
PSO2	$678.96	$677.86	$-1.10	-.2	$687.69	$8.73	1.3
PSO3	$712.04	$710.87	$-1.17	-.2	$721.23	$9.19	1.3
PSO4	$830.50	$829.44	$-1.06	-.1	$755.07	$-75.43	-9.1
Rapeseed Meal							
PRM1	$155.52	$156.56	$1.04	.7	$161.83	$6.31	4.1
PRMS1	$155.52	$156.56	$1.04	.7	$161.83	$6.31	4.1
PRM2	$177.52	$178.56	$1.04	.6	$183.83	$6.31	3.6
PRM3	$207.52	$208.56	$1.04	.5	$200.31	$-7.21	-3.5
PRM4	$194.43	$204.02	$9.59	4.9	$218.83	$24.40	12.5
Soybean Meal							
PSM1	$202.15	$203.33	$1.18	.6	$197.09	$-5.06	-2.5
PSM2	$182.15	$183.33	$1.18	.6	$177.09	$-5.06	-2.8
PSMS2	$182.15	$183.33	$1.18	.6	$177.09	$-5.06	-2.8
PSM3	$231.15	$232.33	$1.18	.5	$226.09	$-5.06	-2.2
PSM4	$218.85	$220.05	$1.20	.5	$230.60	$11.75	5.4
Rapeseed							
PRS1	$295.70	$297.26	$1.56	.5	$290.63	$-5.07	-1.7
PRSS1	$295.70	$297.26	$1.56	.5	$290.63	$-5.07	-1.7
PRS3	$301.81	$303.33	$1.52	.5	$299.64	$-2.17	-.7
PRS4	$345.20	$346.76	$1.56	.5	$340.13	$-5.07	-1.5
Soybeans							
PSB1	$230.55	$231.29	$.74	.3	$228.07	$-2.48	-1.1
PSB2	$220.03	$220.77	$.74	.3	$217.55	$-2.48	-1.1
PSBS2	$220.03	$220.77	$.74	.3	$217.55	$-2.48	-1.1
PSB3	$261.03	$261.77	$.74	.3	$258.55	$-2.48	-1.0
PSB4	$265.03	$265.77	$.74	.3	$260.98	$-4.05	-1.5

QUANTITIES (Table C3 cont'd.)
(000 t)

	Base	Scenario III Rapeoil Tariff Reduction	Diff	%Diff	Scenario IV 100 % Tariff Removal	Diff	%Diff
Rapeseed Crushing							
QRS1	892.4	951.0	58.6	6.6	952.1	59.7	6.7
QRS3	2,168.8	2,166.2	-2.6	-.1	2,163.8	-5.0	-.2
QRS4	1,330.5	1,276.6	-53.9	-4.0	1,269.2	-61.3	-4.6
Soybean Crushing							
QSB1	983.0	984.6	1.6	.2	969.0	-14.0	-1.4
QSB2	27,658.3	27,669.5	11.2	.0	27,671.5	13.2	.0
QSB3	14,169.4	14,170.2	.8	.0	14,163.5	-5.9	.0
QSB4	3,590.1	3,585.0	-5.1	-.1	3,568.6	-21.5	-.6
Rapeoil Trade							
RO11	214.7	214.2	-.5	-.2	219.7	5.0	2.3
RO12	6.9	6.9	.0	.0	6.9	.0	.0
RO14	.0	24.2	24.2		19.1	19.1	
RO32	.0	.0	.0		.0	.0	
RO33	609.4	608.4	-1.0	-.2	607.5	-1.9	-.3
RO34	.0	.0	.0		.0	.0	
RO44	540.2	518.3	-21.9	-4.1	515.3	-24.9	-4.6
Soyoil Trade							
SO11	137.7	138.0	.3	.2	135.3	-2.4	-1.7
SO21	.0	.0	.0		.0	.0	
SO22	3,991.0	3,993.0	2.0	.0	3,975.1	-15.9	-.4
SO23	.0	.0	.0		.0	.0	
SO24	.0	.0	.0		18.3	18.3	
SO33	1,642.9	1,643.0	.0	.0	1,641.8	-1.1	.0
SO44	628.3	627.4	-.9	-.1	624.5	-3.8	-.6

QUANTITIES (Table C3 cont'd.)
(000 t)

	Base	Scenario III Rapeoil Tariff Reduction	Diff	%Diff	Scenario IV 100 % Tariff Removal	Diff	%Diff
Rapemeal Trade							
RM11	485.3	519.5	34.2	7.0	468.1	-17.2	-3.5
RM1S	16.5	16.5	.0	-.2	16.1	-.4	-2.5
RM12	26.1	26.1	.0	.0	26.1	.0	.0
RM13	.0	.0	.0		52.3	52.3	
RM14	.0	.0	.0		.0	.0	
RM33	1,257.9	1,256.4	-1.5	-.1	1,255.0	-2.9	-.2
RM44	773.0	741.7	-31.3	-4.0	737.4	-35.6	-4.6
Soymeal Trade							
SM11	780.5	781.8	1.3	.2	769.4	-11.1	-1.4
SM13	.0	.0	.0		.0	.0	
SM21	474.9	472.7	-2.2	-.5	505.2	30.3	6.4
SM22	17,725.7	17,691.1	-34.6	-.2	17,873.2	147.5	.8
SM2S	402.4	400.5	-1.9	-.5	410.4	8.0	2.0
SM23	1,724.3	1,749.0	24.7	1.4	1,510.1	-214.2	-12.4
SM24	48.7	71.6	22.9	47.0	87.6	38.9	79.9
SM33	11,392.2	11,392.9	.7	.0	11,387.5	-4.7	.0
SM44	2,796.7	2,792.7	-4.0	-.1	2,779.9	-16.8	-.6
Rapeseed Trade							
RS11	892.4	951.0	58.6	6.6	952.1	59.7	6.7
RS1S	835.8	833.7	-2.1	-.3	842.5	6.7	.8
RS13	88.9	86.3	-2.6	-2.9	83.9	-5.0	-5.6
RS14	1,283.5	1,229.6	-53.9	-4.2	1,222.2	-61.3	-4.8
RS33	2,016.0	2,016.0	.0	.0	2,016.0	.0	.0
RS34	.0	.0	.0	.0	.0	.0	.0
RS44	4.0	4.0	.0	.0	4.0	.0	.0
Soybean Trade							
SB11	518.3	518.3	.0	.0	518.3	.0	.0
SB13	.0	.0	.0		.0	.0	
SB14	.0	.0	.0		.0	.0	
SB21	464.7	466.3	1.6	.3	450.7	-14.0	-3.0
SB22	27,658.3	27,669.5	11.2	.0	27,671.5	13.2	.0
SB2S	8,111.9	8,103.4	-8.5	-.1	8,140.1	28.2	.3
SB23	14,144.7	14,145.5	.8	.0	14,138.8	-5.9	.0
SB24	3,153.0	3,147.8	-5.2	-.2	3,131.4	-21.6	-.7
SB33	24.7	24.7	.0	.0	24.7	.0	.0
SB44	212.0	212.0	.0	.0	212.0	.0	.0

Appendix D

CRUSHING REVENUES

TABLE D.1

RAPESEED CRUSHING REVENUES (Benchmark)

BASE 1982		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	RO11	214.7	$633.42			$135,995.27
	RO12	6.9	$719.54	$56.37	$30.00	$4,368.88
	RO14	.0	$696.65	$84.16	$71.20	$.00
	RO15	138.9	$633.42			$87,982.04
Meal Revenue	RM11	485.3	$155.52			$75,473.86
	RM1S	16.5	$155.52			$2,566.08
	RM12	26.1	$177.52		$22.00	$4,059.07
	RM13	.0	$207.52		$52.00	$.00
	RM14	.0	$194.43		$57.00	$.00
	RM15	5.3	$155.52			$824.26
Total Revenue						$311,269.45
Seed Cost	QRS1	892.4	$295.70			$263,882.68
CRUSHING REVENUE						$47,386.77
E.C.						
Oil Revenue	RO32	0	$719.54	$56.37	$72.05	$.00
	RO33	609.4	$591.37			$360,380.88
	RO34	0	$696.65	$84.16	$72.96	$.00
	RO35	232.06	$591.37			$137,233.32
Meal Revenue	RM33	1257.9	$207.52			$261,039.41
Total Revenue						$758,653.61
Seed Cost	QRS3	2168.8	$301.81			$654,565.53
CRUSHING REVENUE						$104,088.08
JAPAN						
Oil Revenue	RO44	540.2	$696.65			$376,330.33
Meal Revenue	RM44	773.0	$194.43			$150,294.39
Total Revenue						$526,624.72
Seed Cost	QRS4	1,330.5	$345.20			$459,288.60
CRUSHING REVENUE						$67,336.12

TABLE D.2

RAPESEED CRUSHING REVENUES (Scenario I)

RAPEOIL TARIFF REMOVAL		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	RO11	214.2	$634.74			$135,961.31
	RO12	6.9	$720.98	$56.48	$30.00	$4,378.03
	RO14	32.5	$672.09	$.00	$71.20	$19,528.93
	RO15	138.9	$634.74			$88,165.39
Meal Revenue	RM11	531.8	$160.58			$85,394.84
	RM1S	16.2	$160.58			$2,598.18
	RM12	26.1	$182.58		$22.00	$4,191.14
	RM13	.0	$210.36		$52.00	$.00
	RM14	.0	$217.58		$57.00	$.00
	RM15	5.3	$160.58			$851.07
Total Revenue						$341,068.89
Seed Cost	QRS1	971.7	$299.18			$290,716.20
CRUSHING REVENUE						$50,352.69
E.C.						
Oil Revenue	RO32	0	$720.98	$56.48	$72.05	$.00
	RO33	606.09	$599.13			$363,126.70
	RO34	0	$672.09	$.00	$72.96	$.00
	RO35	232.06	$599.13			$139,034.11
Meal Revenue	RM33	1252.92	$210.36			$263,564.25
Total Revenue						$765,725.06
Seed Cost	QRS3	2160.2	$306.47			$662,036.49
CRUSHING REVENUE						$103,688.57
JAPAN						
Oil Revenue	RO44	513.4	$672.09			$345,037.56
Meal Revenue	RM44	734.7	$217.58			$159,847.32
Total Revenue						$504,884.89
Seed Cost	QRS4	1,264.5	$348.68			$440,898.89
CRUSHING REVENUE						$63,986.00

TABLE D.3

RAPESEED CRUSHING REVENUES (Scenario II)

SOYOIL TARIFF REMOVAL		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	RO11	217.4	$624.15			$135,715.18
	RO12	6.9	$709.49	$55.58	$30.00	$4,304.96
	RO14	.0	$661.53	$84.16	$71.20	$.00
	RO15	138.9	$624.15			$86,694.44
Meal Revenue	RM11	454.3	$151.12			$68,653.82
	RM1S	16.9	$151.12			$2,547.88
	RM12	26.1	$173.12		$22.00	$3,944.23
	RM13	34.6	$200.49		$52.00	$5,137.75
	RM14	.0	$208.12		$57.00	$.00
	RM15	5.3	$151.12			$800.94
Total Revenue						$307,799.20
Seed Cost	QRS1	899.1	$289.40			$260,211.12
CRUSHING REVENUE						$47,588.08
E.C.						
Oil Revenue	RO32	0	$709.49	$55.58	$72.05	$.00
	RO33	612	$585.96			$358,607.52
	RO34	0	$661.53	$84.16	$72.96	$.00
	RO35	232.06	$585.96			$135,977.88
Meal Revenue	RM33	1261.7	$200.49			$252,958.23
Total Revenue						$747,543.63
Seed Cost	QRS3	2175.43	$295.63			$643,122.37
CRUSHING REVENUE						$104,421.26
JAPAN						
Oil Revenue	RO44	531.4	$661.53			$351,543.66
Meal Revenue	RM44	760.5	$208.12			$158,266.94
Total Revenue						$509,810.59
Seed Cost	QRS4	1,308.9	$338.90			$443,582.82
CRUSHING REVENUE						$66,227.77

TABLE D.4

RAPESEED CRUSHING REVENUES (Scenario III)

RAPEOIL TARIFF REDUCTION		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
	RO11	214.2	$635.77			$136,181.93
	RO12	6.9	$722.10	$56.57	$30.00	$4,385.16
	RO14	24.2	$686.77	$36.58	$71.20	$14,011.56
	RO15	138.9	$635.77			$88,308.45
Meal Revenue	RM11	519.5	$156.56			$81,325.09
	RM1S	16.5	$156.56			$2,578.54
	RM12	26.1	$178.56		$22.00	$4,086.22
	RM13	.0	$208.56		$52.00	$.00
	RM14	.0	$204.02		$57.00	$.00
	RM15	5.3	$156.56			$829.77
Total Revenue						$331,706.72
Seed Cost	QRS1	951.0	$297.26			$282,697.23
CRUSHING REVENUE						$49,009.49
E.C.						
Oil Revenue	RO32	0	$722.10	$56.57	$72.05	$.00
	RO33	608.42	$593.72			$361,231.12
	RO34	0	$686.77	$36.58	$72.96	$.00
	RO35	232.06	$593.72			$137,778.66
Meal Revenue	RM33	1256.4	$208.56			$262,034.78
Total Revenue						$761,044.57
Seed Cost	QRS3	2166.2	$303.33			$657,073.45
CRUSHING REVENUE						$103,971.12
JAPAN						
Oil Revenue	RO44	518.3	$686.77			$355,952.89
Meal Revenue	RM44	741.7	$204.02			$151,321.63
Total Revenue						$507,274.53
Seed Cost	QRS4	1,276.6	$346.76			$442,673.82
CRUSHING REVENUE						$64,600.71

TABLE D.5

RAPESEED CRUSHING REVENUES (Scenario IV)

100% TARIFF REMOVAL		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	RO11	219.7	$611.78			$134,420.30
	RO12	6.9	$696.07	$54.53	$30.00	$4,219.62
	RO14	19.1	$649.24	$.00	$71.20	$11,052.12
	RO15	138.9	$611.78			$84,976.24
Meal Revenue	RM11	468.1	$161.83			$75,752.62
	RM1S	16.1	$161.83			$2,602.23
	RM12	26.1	$183.83		$22.00	$4,223.76
	RM13	52.3	$200.31		$52.00	$7,756.61
	RM14	.0	$218.83		$57.00	$.00
	RM15	5.3	$161.83			$857.70
Total Revenue						$325,861.21
Seed Cost	QRS1	952.1	$290.63			$276,714.64
CRUSHING REVENUE						$49,146.58
E.C.						
Oil Revenue	RO32	0	$696.07	$54.53	$72.05	$.00
	RO33	607.51	$596.55			$362,410.09
	RO34	0	$649.24	$.00	$72.96	$.00
	RO35	232.06	$596.55			$138,435.39
Meal Revenue	RM33	1255.04	$200.31			$251,397.06
Total Revenue						$752,242.55
Seed Cost	QRS3	2163.8	$299.64			$648,361.03
CRUSHING REVENUE						$103,881.51
JAPAN						
Oil Revenue	RO44	515.3	$649.24			$334,527.40
Meal Revenue	RM44	737.4	$218.83			$161,356.49
Total Revenue						$495,883.89
Seed Cost	QRS4	1,269.2	$340.13			$431,693.00
CRUSHING REVENUE						$64,190.90

TABLE D.6

SOYBEAN CRUSHING REVENUES (Benchmark)

BASE 1982		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	SO11	137.7	$691.23			$95,182.37
	SO15	30.4	$691.23			$21,013.39
Meal Revenue	SM11	780.5	$202.15			$157,784.14
	SM13	.0	$231.15		$51.00	$.00
Total Revenue						$273,979.90
Seed Cost	QSB1	983.0	$230.55			$226,630.65
CRUSHING REVENUE						$47,349.25
U.S.						
Oil Revenue	SO21	.0	$691.23	$54.15	$30.00	$.00
	SO22	3,991.0	$678.96			$2,709,729.36
	SO23	.0	$712.04	$64.73	$72.05	$.00
	SO24	.0	$830.50	$84.16	$67.38	$.00
	SO25	932.2	$678.96			$632,926.51
Meal Revenue	SM21	474.9	$202.15		$20.00	$86,503.04
	SM22	17,725.7	$182.15			$3,228,736.26
	SM2S	402.4	$182.15			$73,297.16
	SM23	1,724.3	$231.15		$49.00	$314,081.25
	SM24	48.7	$218.85		$53.51	$8,052.06
	SM25	1,921.1	$182.15			$349,928.37
Total Revenue						$7,403,253.99
Seed Cost	QSB2	27,658.3	$220.03			$6,085,655.75
CRUSHING REVENUE						$1,317,598.24
E.C.						
Oil Revenue	SO33	1,642.9	$712.04			$1,169,810.52
	SO35	808.5	$712.04			$575,684.34
Meal Revenue	SM33	11,392.2	$231.15			$2,633,307.03
Total Revenue						$4,378,801.89
Seed Cost	QSB3	14,169.4	$261.03			$3,698,638.48
CRUSHING REVENUE						$680,163.40
JAPAN						
Oil Revenue	SO44	628.3	$830.50			$521,803.15
Meal Revenue	SM44	2,796.7	$218.85			$612,057.80
Total Revenue						$1,133,860.95
Seed Cost	QSB4	3,590.1	$265.03			$951,484.20
CRUSHING REVENUE						$182,376.74

TABLE D.7

SOYBEAN CRUSHING REVENUES (Scenario I)

RAPEOIL TARIFF REMOVAL		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	SO11	138.2	$688.21			$95,083.09
	SO15	30.4	$688.21			$20,921.58
Meal Revenue	SM11	782.5	$205.31			$160,650.97
	SM13	.0	$234.31		$51.00	$.00
Total Revenue						$276,655.65
Seed Cost	QSB1	985.5	$232.54			$229,165.84
CRUSHING REVENUE						$47,489.80
U.S.						
Oil Revenue	SO21	.0	$688.21	$53.92	$30.00	$.00
	SO22	3,996.4	$676.00			$2,701,546.12
	SO23	.0	$708.87	$64.44	$72.05	$.00
	SO24	.0	$827.54	$84.16	$67.38	$.00
	SO25	932.2	$676.00			$630,167.20
Meal Revenue	SM21	473.8	$205.31		$20.00	$87,794.32
	SM22	17,633.5	$185.31			$3,267,663.89
	SM2S	397.4	$185.31			$73,632.93
	SM23	1,792.6	$234.31		$49.00	$332,186.71
	SM24	102.9	$222.08		$53.51	$17,350.91
	SM25	1,921.1	$185.31			$355,999.04
Total Revenue						$7,466,341.11
Seed Cost	QSB2	27,688.6	$222.02			$6,147,425.19
CRUSHING REVENUE						$1,318,915.92
E.C.						
Oil Revenue	SO33	1,643.2	$708.87			$1,164,836.45
	SO35	808.5	$708.87			$573,121.40
Meal Revenue	SM33	11,394.0	$234.31			$2,669,721.11
Total Revenue						$4,407,678.96
Seed Cost	QSB3	14,171.6	$263.02			$3,727,456.75
CRUSHING REVENUE						$680,222.21
JAPAN						
Oil Revenue	SO44	626.1	$827.54			$518,139.34
Meal Revenue	SM44	2,787.2	$222.08			$618,981.38
Total Revenue						$1,137,120.72
Seed Cost	QSB4	3,577.9	$267.02			$955,370.86
CRUSHING REVENUE						$181,749.86

TABLE D.8

SOYBEAN CRUSHING REVENUES (Scenario II)

SOYOIL TARIFF REMOVAL		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	SO11	136.0	$701.32			$95,379.52
	SO15	30.4	$701.32			$21,320.13
Meal Revenue	SM11	772.5	$196.42			$151,734.45
	SM13	.0	$225.42		$51.00	$.00
Total Revenue						$268,434.10
Seed Cost	QSB1	972.9	$227.72			$221,548.79
CRUSHING REVENUE						$46,885.31
U.S.						
Oil Revenue	SO21	.0	$701.32	$54.94	$30.00	$.00
	SO22	3,973.1	$688.74			$2,736,444.81
	SO23	.0	$722.34	$65.67	$72.05	$.00
	SO24	50.2	$756.12	$.00	$67.38	$34,574.75
	SO25	932.2	$688.74			$642,043.43
Meal Revenue	SM21	488.1	$196.42		$20.00	$86,110.60
	SM22	17,892.9	$176.42			$3,156,665.42
	SM2S	411.5	$176.42			$72,598.06
	SM23	1,527.0	$225.42		$49.00	$269,393.34
	SM24	201.2	$229.93		$53.51	$35,495.70
	SM25	1,921.1	$176.42			$338,920.46
Total Revenue						$7,372,246.58
Seed Cost	QSB2	27,840.0	$217.20			$6,046,848.00
CRUSHING REVENUE						$1,325,398.58
E.C.						
Oil Revenue	SO33	1,641.7	$722.34			$1,185,865.58
	SO35	808.5	$722.34			$584,011.89
Meal Revenue	SM33	11,386.8	$225.42			$2,566,812.46
Total Revenue						$4,336,689.92
Seed Cost	QSB3	14,162.6	$258.20			$3,656,783.32
CRUSHING REVENUE						$679,906.60
JAPAN						
Oil Revenue	SO44	593.8	$756.12			$448,984.06
Meal Revenue	SM44	2,643.2	$229.93			$607,750.98
Total Revenue						$1,056,735.03
Seed Cost	QSB4	3,393.0	$260.63			$884,317.59
CRUSHING REVENUE						$172,417.44

TABLE D.9

SOYBEAN CRUSHING REVENUES (Scenario III)

RAPEOIL TARIFF REDUCTION		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	SO11	138.0	$690.11			$95,235.18
	SO15	30.4	$690.11			$20,979.34
Meal Revenue	SM11	781.8	$203.33			$158,963.39
	SM13	.0	$232.33		$51.00	$.00
Total Revenue						$275,177.92
Seed Cost	QSB1	984.6	$231.29			$227,728.13
CRUSHING REVENUE						$47,449.78
U.S.						
Oil Revenue	SO21	.0	$690.11	$54.06	$30.00	$.00
	SO22	3,993.0	$677.86			$2,706,694.98
	SO23	.0	$710.87	$64.62	$72.05	$.00
	SO24	.0	$829.44	$84.16	$67.38	$.00
	SO25	932.2	$677.86			$631,901.09
Meal Revenue	SM21	472.7	$203.33		$20.00	$86,660.09
	SM22	17,691.1	$183.33			$3,243,309.36
	SM2S	400.5	$183.33			$73,423.67
	SM23	1,749.0	$232.33		$49.00	$320,644.17
	SM24	71.6	$220.05		$53.51	$11,924.26
	SM25	1,921.1	$183.33			$352,195.26
Total Revenue						$7,426,752.89
Seed Cost	QSB2	27,669.5	$220.77			$6,108,595.52
CRUSHING REVENUE						$1,318,157.37
E.C.						
Oil Revenue	SO33	1,643.0	$710.87			$1,167,959.41
	SO35	808.5	$710.87			$574,738.40
Meal Revenue	SM33	11,392.9	$232.33			$2,646,912.46
Total Revenue						$4,389,610.26
Seed Cost	QSB3	14,170.2	$261.77			$3,709,333.25
CRUSHING REVENUE						$680,277.01
JAPAN						
Oil Revenue	SO44	627.4	$829.44			$520,390.66
Meal Revenue	SM44	2,792.7	$220.05			$614,533.64
Total Revenue						$1,134,924.29
Seed Cost	QSB4	3,585.0	$265.77			$952,785.45
CRUSHING REVENUE						$182,138.84

TABLE D.10

SOYBEAN CRUSHING REVENUES (Scenario IV)

100% TARIFF REMOVAL		QUANTITY (000 T)	PRICE ($/T)	TARIFF ($/T)	TRANSP. ($/T)	TOTAL ('000$)
CANADA						
Oil Revenue	SO11	135.3	$700.23			$94,741.12
	SO15	30.4	$700.23			$21,286.99
Meal Revenue	SM11	769.4	$197.09			$151,641.05
	SM13	.0	$226.09		$51.00	$.00
Total Revenue						$267,669.16
Seed Cost	QSB1	969.0	$228.07			$220,999.83
CRUSHING REVENUE						$46,669.33
U.S.						
Oil Revenue	SO21	.0	$700.23	$54.86	$30.00	$.00
	SO22	3,975.1	$687.69			$2,733,636.52
	SO23	.0	$721.23	$65.57	$72.05	$.00
	SO24	18.3	$755.07	$.00	$67.38	$12,584.73
	SO25	932.2	$687.69			$641,064.62
Meal Revenue	SM21	505.2	$197.09		$20.00	$89,467.64
	SM22	17,873.2	$177.09			$3,165,164.99
	SM2S	410.4	$177.09			$72,675.97
	SM23	1,510.1	$226.09		$49.00	$267,423.61
	SM24	87.6	$230.60		$53.51	$15,513.08
	SM25	1,921.1	$177.09			$340,207.60
Total Revenue						$7,337,738.75
Seed Cost	QSB2	27,671.5	$217.55			$6,019,934.83
CRUSHING REVENUE						$1,317,803.92
E.C.						
Oil Revenue	SO33	1,641.8	$721.23			$1,184,115.41
	SO35	808.5	$721.23			$583,114.46
Meal Revenue	SM33	11,387.5	$226.09			$2,574,599.88
Total Revenue						$4,341,829.74
Seed Cost	QSB3	14,163.5	$258.55			$3,661,972.93
CRUSHING REVENUE						$679,856.82
JAPAN						
Oil Revenue	SO44	624.5	$755.07			$471,541.22
Meal Revenue	SM44	2,779.9	$230.60			$641,044.94
Total Revenue						$1,112,586.16
Seed Cost	QSB4	3,568.6	$260.98			$931,333.23
CRUSHING REVENUE						$181,252.93