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A STRUCTURAL ECONOMETRIC MODEL OF THE WORLD MARKETS FOR RAPESEED, SOYBEANS AND THEIR PRODUCTS

by
G.R. Griffith and K.D. Meilke

**School of Agricultural Economics and Extension Education
Ontario Agricultural College
University of Guelph**



ISSN 0229-6217

April 1982

AEEE/82/5

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PREFACE

The purpose of this study is to describe the formulation, estimation and validation of an econometric model of the world market for rapeseed, soybeans and their products. This model identifies the economic factors which influence production, consumption, stocks and prices in the rapeseed and soybean and product markets in Canada, Japan, the European Community, the United States and Brazil, as well as trade between these regions.

The initial work on this model was undertaken by Dr. Griffith, and reported in his doctoral thesis, completed in 1979. Subsequently, the data was revised and updated, additional commodity detail added, and the model respecified and reestimated. This work was largely completed during November 1980 while the senior author was a visiting professor in the School. Copies of the model, in TROLL (NBER, 1972) simulation format are available on request.

This study was funded by Agriculture Canada, the Ontario Ministry of Agriculture and Food and the School of Agricultural Economics and Extension Education. Dr. Griffith's study leave at the University of Guelph was financed by the Australian Pig Industry Research Committee and the New South Wales Department of Agriculture.

We acknowledge with thanks the helpful comments on an earlier draft of this report by G. Lentz and M. MacGregor.

Special thanks are due to Gary Williams who provided most of the Brazil data and J. Jackson Gardner who provided some of the Japanese data.

We would also like to express our appreciation to Mrs. Debbie Harkies and Mrs. Helen Martin for their careful typing of the many drafts of this paper.

Despite the assistance of the above people, the authors are responsible for any errors in the analysis.

G. R. Griffith
K. D. Meilke
April 1982

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CHAPTER 1

INTRODUCTION

1.1 Background

The international oilseed market is of substantial and growing importance in global agricultural production and trade. The average annual increase in the volume of trade in fats and oils, and cakes and meals, over the past two decades is estimated to be almost four percent and 12 percent respectively (FAO, 1979c).^{1/}

These increases in the consumption, output and trade of fats and oils, and meals seem certain to continue in the future. Most of the growth in the demand for edible oil is likely to occur in developing countries where rapid population growth and relatively high income elasticities serve to expand consumption. Growth in the demand for protein meal depends on the increasing use of vegetable protein for human consumption; high income elasticities for meat products, which increases the derived demand for feed ingredients; expansion in the use of high protein formula feeds in intensive feeding operations; and an increasing willingness on the part of centrally planned economies to import oilseeds.

Several other factors related to agricultural policy also point towards increased world production and consumption of oilseeds. First, the Common Agricultural Policy in the European Community (EC), which holds feed grain prices above world market levels, continues to favor the use of high protein oilmeals relative to domestically produced feed grains. Second, oilseeds are an important foreign exchange earner for a number of developed and developing countries; and third, the sharp oilseed price increases in the early 1970's, and the short soybean embargo by the United States, caused a number of countries to attempt to expand their domestic oilseed production and to diversify their sources of supply. For all of these reasons the world oilseed sector can look forward to a role of increasing importance in international commerce and in the deliberations of policy makers.

Within the world oilseed market Canada has an important stake in the structure and operation of the rapeseed and soybean markets.

^{1/} In this brief introduction it is possible to present only the flavor of Canada's role in the world oilseed and products market. The reader who needs more descriptive material is referred to a recent survey of five oilseed and products markets by Griffith and Meilke (1980b). In addition, more detailed information on specific oilseed markets is provided in Houck, Ryan and Subotnik (1972) for the United States; Parris and Ritson (1977) for the EC; Perkins (1976), Rigaux (1976) and Meilke, Young and Miller (1980) for Canada; Williams (1977) and Thompson (1978) for Brazil; and Moe and Mohtadi (1971) for the less developed countries.

Rapeseed is by far the most important oilseed crop grown in Canada and ranks second only to wheat in terms of farm cash receipts of all crops grown (Table 1.1). Rapeseed exports are also very important to Canada as a source of foreign exchange. Further, Canada dominates world trade in rapeseed and rapeseed products, and rapeseed's position in world oilseed trade is significant and expanding. Canada is now the leading rapeseed producer, and its ability to export a significant proportion of its output enables it to play a major role in rapeseed and rapeseed product trade (Griffith and Meilke, 1980b). Rapeseed forms a significant component of international trade in oilseeds and oilseed products - nine percent of trade in edible vegetable and palm oils (up from six percent in the early 1960's), and an estimated five percent of oilcake and meal trade (FAO, 1979c).

Many commentators on the Canadian rapeseed industry argue however that there exist a number of constraints retarding the achievement of a much larger potential than is currently being exploited (Perkins, 1976; Agriculture Canada, 1977; Furtan et al. 1978, 1979). These constraints have led to under-utilization of domestic crushing capacity, the loss of value added revenue to the economy, larger foreign exchange expenditures on oil and meal imports and smaller foreign exchange earnings. It is vital that the effects of these constraints be subjected to economic analysis and the results transmitted to appropriate policy-making authorities. Recent studies singled out three factors for analysis that may limit the expansion of the Canadian rapeseed production, crushing and manufacturing complex (Griffith, 1979; Griffith and Meilke, 1981b). These were a reduction in tariff levels for rapeseed oil in the major import markets; an alteration in nontariff border measures facing rapeseed products in the major import markets; and an alteration in support price policies affecting rapeseed and soybean production in the major markets.

Table 1.1 Total Farm Cash Receipts and Percent of Cash Receipts from All Crops, Canada, 1979

Crop	Farm Cash Receipts (Mil. dol.)	Percent of Total
Wheat	2366.7	40.4
Barley	544.7	9.3
Oats	35.6	0.6
Corn	227.5	3.9
Potatoes	158.7	2.7
Fruits	180.2	3.1
Vegetables	310.1	5.3
Tobacco	289.7	4.9
Rapeseed	780.8	13.3
Flaxseed	137.7	2.3
Soybeans	128.8	2.2
Other Crops	693.6	12.0
All Crops	5861.3	100.0

Source: Ontario Ministry of Agriculture and Food. Agricultural Statistics for Ontario, 1979.

Canadian soybean production, while insignificant in terms of world soybean production (0.07 percent in 1979), is significant in Canada (Table 1.1) and of substantial and growing importance in Ontario (Table 1.2) which produces all of Canada's soybeans. Canada is a net importer of soybeans and any expansion of soybean production replaces imports and saves foreign exchange.^{2/}

Since the mid 1960's Canada has been a net exporter of oilseeds and oilseed products in all but one year (Table 1.3). Net exports of oilseeds and products averaged \$115 million between 1970 and 1974, increased to \$527.7 million in 1979 and averaged \$310.5 million during 1977-79. These figures however mask the fact that Canada is a net importer of oilseed products, mainly soybean meal and a net exporter of oilseeds, namely rapeseed and flaxseed. Net imports of oilseed products were relatively stable, in value terms, between 1974 and 1979 ranging between \$124.7 million and \$158.7 million. Net exports of oilseeds have however expanded from an average of \$187.2 million in 1970-1974 to \$456.6 million in 1977-1979, reaching \$686.4 million in 1979. The value of net exports of Canadian oilseeds and products has been quite variable but the trend is clearly upward, equalling \$527.7 million in 1979.

1.2 Purpose of Research

Given the importance of the world oilseed and products market, and Canada's role in the market, it would seem likely that a number of quantitative world trade models of the oilseed sector would exist. That this is

Table 1.2 Total Farm Cash Receipts and Percent of Receipts
From All Crops, Ontario, 1970-74 and 1978-79

Crop	1970-1974		1977-1979		Percentage Increase Between 1970-74 and 1977-79
	mil.dol.	percent	mil.dol.	percent	
Tobacco	148.6	25.4	232.7	21.4	56.6
Vegetables	96.6	16.5	174.6	16.0	80.9
Fruits	50.0	8.5	74.2	6.8	48.4
Corn	84.8	14.5	186.9	17.2	120.4
Wheat	31.3	5.3	64.7	5.9	106.7
Soybeans	43.3	7.4	120.4	11.1	178.1
Other Crops	131.0	22.4	235.3	21.6	79.6
All Crops	585.6	100.0	1088.8	100.0	85.9

Source: Ontario Ministry of Agriculture and Food. Agricultural Statistics for Ontario, 1979.

^{2/} Flaxseed is also an important oilseed in Canada but since its oil is used for industrial purposes it faces different demand conditions than the edible oils from rapeseed and soybeans. For this reason it is not considered in the model developed later.

Table 1.3. Canada's Trade in Oilseeds and Oilseed Products, Selected Years

Calendar Year	Imports			Exports			Net Exports		
	Oilseeds	Oilseed Products	Total	Oilseeds	Oilseed Products	Total	Oilseeds	Oilseed Products	Total
million dollars									
1951	16.4	42.3	58.7	11.0	7.6	18.6	-5.4	-34.7	-40.1
1956	24.4	38.9	63.3	50.4	29.5	79.9	26.0	-9.4	16.6
1961	30.3	48.9	79.2	70.7	18.5	89.2	40.4	-30.4	10.0
1966	65.4	63.9	129.3	118.0	28.0	146.0	52.6	-35.9	16.7
1967	61.8	60.1	121.9	101.9	26.0	127.9	40.1	-34.1	6.0
1968	44.0	63.1	107.1	83.6	23.9	107.5	39.6	-39.2	0.4
1969	59.2	69.1	128.3	94.3	21.0	115.3	35.1	-48.1	-13.0
1970	67.5	78.7	146.2	146.6	30.4	177.0	79.1	-48.3	30.8
1971	67.0	72.1	139.1	226.6	33.7	260.3	159.6	-38.4	121.2
1972	55.4	80.9	136.3	212.8	30.3	243.1	157.4	-50.6	106.8
1973	78.7	118.2	196.9	369.4	43.9	413.3	290.7	-74.3	216.4
1974	131.3	194.6	325.9	380.5	44.9	425.4	249.2	-149.7	99.5
1975	131.7	181.2	312.9	336.3	34.1	370.4	204.6	-147.1	57.5
1976	131.0	190.5	321.5	283.3	48.5	331.8	152.3	-142.0	10.3
1977	147.1	226.6	373.7	440.7	101.9	542.6	293.6	-124.7	168.9
1978	154.0	264.2	418.2	543.7	109.5	653.2	389.7	-154.7	235.0
1979	176.3	299.4	475.7	862.7	140.7	1003.4	686.4	-158.7	527.7

Source: Agriculture Canada. Selected Agricultural Statistics for Canada and the Provinces
1981.

not the case is clear from Williams' (1981a) survey in which the only linked country models (including multiple oilseeds and one or more of their products) are the U.S. Department of Agriculture's GOL model (Rojko, et al. 1978a, 1978b), a model by Moe and Mohtadi (1971) and an early version of the model developed in this paper by Griffith (1979).^{3/}

The GOL model includes 28 regions and 14 commodities. Williams' (1981a) major criticism of the oilseed block in GOL is that soybeans are the only oilseed considered and vegetable oils are not treated, thereby limiting the model's usefulness in analyzing the world oilseed and products market. In addition some of the coefficients in the GOL model are based on "best guesses" rather than estimated relationships.

Moe and Mohtadi's objective was to estimate the long-term prospects for world trade in oilseeds and products. The major shortcoming of their model is that the supply side of the model is based on trend analysis and consequently there is no link between market supplies and market prices (Williams, 1981a). In addition all oilseeds are aggregated implying perfect substitution among the various oilseeds.

In commenting on Griffith's study, Williams' (1981a) major concern is that the model includes only two oilseeds. He states,

"It makes little sense to arbitrarily select only one of the minor oilseeds to interact in a simultaneous world model with a major oilseed like soybeans".^{4/}

Consequently, it appears that not withstanding the importance of oilseeds in the world economy there has been only limited research completed on how the various oilseeds act and interact in the market to determine demands, supplies, trade and prices. The purpose of this study is to provide at least some of this information for soybeans, rapeseed and their products.

1.3 Objectives

The major objective of this research is to formulate, estimate and validate an econometric model of the world market for six commodities; namely, soybeans, soybean meal, soybean oil, rapeseed, rapeseed meal and rapeseed oil. The structural equations embedded within the model provide important new or additional information on the parameters, determinants, and interaction of supply and demand in the world soybean, rapeseed and products market.

^{3/} Williams (1981b) has recently developed a comprehensive model of the world's oilseed and products market including multiple oilseeds and multiple regions. The authors however have not yet had a chance to see this study.

^{4/} Williams (1981a) apparently disregards the fact that the objective of Griffith's (1979) study was to analyze the impact of various policy changes in the Canadian rapeseed industry.

The secondary objectives are: (1) to use the model to test some new ideas on how to make government policy endogenous in structural econometric models (Griffith and Meilke, 1980a; Meilke and Griffith, 1981a); and, (2) to test the applicability of a market share approach to the estimation of the demand for soybean and rapeseed oil (Meilke and Griffith, 1981b).

The model should be useful in: (1) providing medium term forecasts of supply, demand, trade and price for rapeseed, soybeans and their products in five regions of the world; (2) providing estimates of the impact of exogenous shocks, i.e., impact and cumulative multipliers for various exogenous variables within the model; and, (3) providing a tool with which to analyze the impact of potential policy changes.

1.4 Scope of the Study

A decision was made to limit the scope of the study by focusing attention on only soybeans, rapeseed and their products in five countries, Canada, United States, Brazil, EC, and Japan, and an aggregate rest of the world (ROW) region.

The decision to limit the model to two oilseeds was made primarily on pragmatic grounds. First, soybeans and rapeseed are the most important oilseeds grown in Canada. Second, soybeans and its products are so important in the world marketplace that its price and the price of its products should be an excellent proxy for the competition faced by rapeseed and its products.^{5/} Third, this initial model provides a basic structure, to which additional commodities can be added if the initial work proves successful and useful. Finally, while agreeing with Williams (1981a) that including only two oilseeds is a limitation of the study we do not feel it is a major limitation and was necessary given limited research funds and human capital.

The study includes only five single country regions but given the pattern of oilseed production and trade, this seems a reasonable compromise between the additional detail obtainable by further disaggregation and the additional cost of doing so. Brazil and the United States are the world's major producers and exporters of soybeans and products, while Japan and the EC are major importers of rapeseed, soybeans and their products. In addition, Canada and the EC are major producers and consumers of rapeseed and its products. The influence of all other regions is captured, in the model, by estimating net trade relationships for each product from an aggregate rest of world region.

1.5 Outline of the Study

Chapter 2 contains the general specification of the econometric model, including those areas where methodological advances have been made.

^{5/} The spectral analysis of Griffith and Meilke (1979) provides quantitative support for this statement.

Estimates of the behavioral equations are presented in Chapter 3, followed by static and dynamic validations of the complete model and a prediction interval test in Chapter 4. Chapter 5 contains an analysis of selected impact and cumulative multipliers generated by the model, while the conclusions, implications and suggestions for further work reside in Chapter 6. A reference list and an appendix on data definitions complete the paper.

CHAPTER 2

SPECIFICATION OF THE STRUCTURAL MODEL

2.1 General Considerations in Specifying Econometric Commodity Models

As defined by Labys (1978), a commodity model is a quantitative representation of a commodity market or industry, composed of behavioral relationships which reflect demand and supply aspects of price determination as well as other related economic, political and social phenomena.

Depending on the purpose of the model, the underlying quantitative framework, and the economic behavior that is being modeled, there are a number of different types of commodity models that may be applied. Labys (1973, 1978) provides a listing and discussion of these various types. The most common form in agricultural commodity modeling, and the one employed in this study, is the market econometric model. This type of model uses econometric methods to statistically estimate a system of demand and supply relationships leading to the determination of an equilibrium price.

Commodity market econometric models exhibit a fairly standard form which has evolved from the underlying economic and statistical theory. However even given this uniformity, models of commodity markets differ greatly in many respects (Adams, 1978). These differences may reflect the structure of the market being modeled, the detail required to accomplish the objectives for which the model is designed and the availability of resources for model construction and application. The models also obviously differ in their ability to depict the operation of the market and to introduce and evaluate policy alternatives. In fact, as Adams (1978, p. 6) points out, "The job of model construction for policy analysis involves important trade-offs in order to produce at reasonable cost a model that will serve as a flexible tool for ... policy studies." Thus, in addition to economic and statistical theory, there are a number of practical considerations in econometric commodity modeling which may modify the underlying theoretical constructs. Aspects of these factors faced by commodity modelers are dealt with by Labys (1973) and Adams and Behrman (1978).

2.2 Model Specification

The market and institutional characteristics peculiar to each region's oilseed sector (Griffith and Meilke, 1980b); general considerations important in specifying econometric market models; suggestions relating specifically to the use of econometric models for the evaluation of policy alternatives (Griffith and Meilke, 1980a); and the aims of the study are all combined and consolidated to assist in the specification of a structural econometric model.

The standard econometric representation of a market for oilseeds and their products has evolved to a large degree from the work on the U.S.

soybean complex that Houck and his associates have been engaged in since the early 1960's (Houck and Mann, 1968 ; Houck, Ryan and Subotnik, 1972). Using the concepts that: (1) oil and meal are joint products; (2) there are multiple-market outlets for oilseeds, oil and meal; (3) oilseeds and products are part of a complex sector in which competition is important; (4) prices and demands are determined simultaneously within each crop year; and, (5) oilseed supply interacts with demand recursively, a basic block framework has been developed. This framework contains a recursive supply block and simultaneous seed, oil and meal demand blocks.

In the present model, this standard partitioning into blocks is used, but with the following important extensions and modifications. First, since one objective of this study is to evaluate the effects of various policy alternatives on the world market for rapeseed and its products, the model explicitly includes structural equations explaining behavior in the important rapeseed producing and consuming regions (Canada, Japan and EC). Thompson (1978) stresses the need for detailed, policy-inclusive structural models of major producing and consuming regions, rather than simply excess demand and supply schedules, in determining trade volumes and values. The evidence presented by Binkley and McKinzie (1979) supports this view. Including these other regions leads to a greater understanding of the relative roles each region plays in world price determination and a more accurate estimation of trade behavior.

Second, the model explicitly includes as endogenous variables activity in the U.S. and Brazilian soybean sectors, as well as imports and use of soybeans and products in the major import markets. Craddock (1973) and Agriculture Canada (1977) support the need to quantify U.S. soybean behavior so that Canadian rapeseed models can be more accurately estimated and therefore be of greater value to policymakers in explaining behavior in the rapeseed market and in estimating future movements in supplies, demands, prices and trade volumes. Further, in the presence of significant degrees of substitutability between the various fats and oils, and oilcakes and meals, (FAO, 1971a; Labys, 1977; Griffith, 1978) and especially when these substitution relationships have become much stronger in recent years, Griffith and Meilke (1979) and Rigaux (1976), among others, have indicated the importance of incorporating these price interdependencies into quantitative analyses of oilseed product markets. Therefore incorporating the soybean sector into the model recognizes the dominance of soybeans in the world oilseed complex and the highly interrelated substitution patterns in the demand for rapeseed products, and allows these relationships to be incorporated in the model as part of a simultaneously determined system.

Third, the model uses market share analysis to determine the level of demand for the endogenous vegetable oils in the relevant regions.^{6/} Houck and Ryan (1978) have suggested that improvements in the specification of demand functions for highly substitutable products are possible using market shares.

Fourth, the model explicitly includes policy response functions

^{6/} For a more detailed description of the specification of these oil demand functions, see Meilke and Griffith (1981b).

which determine, in many regions, the links between domestic and world prices.^{7/} Thus seed, oil and meal blocks for each oilseed in each region contain an explicit price-based policy response function linking the domestic seed, oil and meal prices to a "world price". Where support prices are used at the farm level, policy response equations are also estimated which link these support prices to the market price within that region. Downs (1957), Brock and Magee (1975), Lindbeck (1976), Lucas (1976), Heidhues (1979), Zwart and Meilke (1979), Anderson (1980), Sarris and Freebairn (1981) plus a number of authors writing in the general area of the "theory of regulation" (Peltzman, 1976; Rausser, *et al.*, 1980), have provided the conceptual basis for the inclusion of endogenous government behavior in the analysis of economic systems. Empirical studies by Brainard (1971), Rausser and Freebairn (1974), Lattimore, Schuh and Thompson (1975), Weaver (1978, 1979), Abbott (1979a, 1979b), Gulliver *et al.* (1979), Rausser and Stonehouse (1978), Lattimore and Schuh (1979) and Meilke and Griffith (1981b) have shown that government policy making behaviour can be made endogenous and effectively used to improve the specification of agricultural commodity models. Directly modeling these policy links allows more precise estimation, and hence a better understanding of actual market behavior and more accurate prediction and evaluation of policy alternatives.

Finally, the "world price" is determined by global market clearing conditions for rapeseed and soybeans and their oil and meal derivatives. These conditions are based on trade volumes since these variables are common to all regions and they simultaneously cause and react to price differentials between regions. Net imports or exports of seed, oil or meal in any region are then determined by market clearing conditions within each region.

Each single country submodel can be conceived as consisting of four blocks; a supply block, an oilseed block, an oil block and a meal block. In the supply block, regional behavioral equations are estimated for both area and production, with production specified as a function of area. Price support functions, where relevant, are also estimated behaviorally. In the oilseed block, crush and stock demand functions are estimated behaviorally, and net trade is determined from a domestic market clearing condition. Rapeseed and soybean wholesale prices are estimated as functions of world price, while farm prices are specified to be dependent on the relevant wholesale price. Within the oil block the demand for all edible vegetable oil is estimated initially, and then market share equations are estimated for the individual oils of interest, with demand for the individual oils equal to the product of the total oil demand and the market share. Stock demand is specified behaviorally, and the domestic wholesale price is estimated as a function of the world price. Oil production is determined by multiplying crush times oil yield, and net trade is calculated from a domestic market clearing condition. For the meal block, stock demand, domestic wholesale price, and the level of domestic demand are specified as behavioral equations. Meal production is

^{7/} A comprehensive treatment of the theoretical and empirical aspects of the policy response functions specified in this model are given in Griffith and Meilke (1980a) and Meilke and Griffith (1981a).

equal to meal yield times crush and net trade is calculated from a domestic market clearing condition. A summary of this block structure is given in Figure 2.1.

The individual region models are linked together in two ways. First, the net trade volumes determined within each region are aggregated into a world net trade identity for each of the six products. These equilibrium conditions determine the world price for each of the six products. Second, these world prices simultaneously feed back into the individual regions through the price linkage mechanisms. The adjustment process of the structural model towards a set of equilibrium values is now clear.^{8/} For example, suppose there is an exogenous decline in Canadian rapeseed production, *ceteris paribus*, this results in a decline in Canadian rapeseed exports, an "under supply" situation in the world market for rapeseed, and a consequent increase in the world equilibrium price. This higher price feeds back into the domestic rapeseed markets, reducing crush and stock demand thus making more available for export or decreasing import requirements. The decline in crush however means that rapeseed oil and rapeseed meal production are reduced in all regions, causing relative "under supply" in these world markets and an increase in the world equilibrium rapeseed oil and rapeseed meal prices. These prices also feed back into the domestic markets, reducing domestic rapeseed oil and rapeseed meal demands but also stimulating crush since the margin will widen. These simultaneous adjustments result in a new set of equilibrium prices and quantities for the world and Canadian rapeseed and product markets. Also, because of the extent of substitutability between the rapeseed and soybean sectors, the soybean market also adjusts because of changes in the rapeseed market. Finally, the equilibrium wholesale rapeseed and soybean prices influence farm prices and future support prices, and thus area planted and output in future years.

There are three other aspects of the specification of the structural econometric model which should be mentioned. First, it is obvious from Figure 2.1 that not all equations in the specification are relevant to all regions. The producing and consuming regions for rapeseed and products are Canada, Japan and the EC. All of the regions consume soybeans but the EC does not produce soybeans. Thus, the U.S. and Brazil have no rapeseed model, and the EC has no soybean supply block, but does have soybean, soybean oil and soybean meal blocks because imported soybeans are crushed for domestic use. Second, the information contained in Griffith and Meilke (1980b), and the available data, are used to determine which individual equations are relevant in particular regions. Thus, Canada has no rapeseed support price equation, and market determined farm prices are relevant only for Canada and the U.S. Only the U.S., Japan and Canada have endogenous stock demand functions. Domestic wholesale prices for rapeseed and soybeans are published for Canada, the U.S. and Brazil, respectively, while import prices are used as proxies for wholesale prices in other regions. All relevant regions have domestic wholesale rapeseed oil, soybean oil, rapeseed meal and soybean meal prices except the EC where

^{8/} These adjustments are of course simultaneous, but are discussed sequentially for ease of exposition.

Figure 2.1 A General Oilseed Market Model Specification

Specified Equations	Applicable Regions	
	Rapeseed	Soybeans
SUPPLY BLOCK		
$\text{Area}_i = f(\text{lagged farm price}_i, \text{support price}_i, Z_i)$	3, 5, 7	3, 4, 5, 6
$\text{Production}_i = f(\text{area}_i, Z_i)$	3, 5, 7	3, 4, 5, 6
$\text{Support Price}_i = f(\text{lagged farm price}_i, Z_i)$	5, 7	4, 5, 6
SEED/BEAN BLOCK		
$\text{Seed Stocks}_i \equiv f(\text{seed price}_i, \text{seed production}_i, Z_i)$	3, 5	3, 4, 5
$\text{Seed Crush}_i = f(\text{seed price}_i, \text{output value}_i, Z_i)$	3, 5, 7	3, 4, 5, 6, 7
$\text{Output Value}_i \equiv \text{oil price}_i * \text{oil yield}_i + \text{meal price}_i * \text{meal yield}_i$	3, 5, 7	3, 4, 5, 6, 7
$\text{Seed Price}_i = f(\text{world price})$	3, 5, 7	3, 4, 5, 7
$\text{Farm Price}_i = f(\text{seed price}_i)$	3, 5	4, 5, 6
$\text{Net Trade}_i \equiv \text{production}_i + \text{stocks}(-1)_i - \text{crush}_i - \text{stocks}_i$	3, 5, 7, 9	3, 4, 5, 6, 7, 9
OIL BLOCK		
$\text{Oil Production}_i \equiv \text{crush}_i * \text{oil yield}_i$	3, 5, 7	3, 4, 5, 6, 7
$\text{Total Oil Demand}_i^{a/} = f(\text{oil price}_i, Z_i)$		
$\text{Market Share}_i = f(\text{oil price}_i, \text{competing oil price}_i, Z_i)$	3, 5, 7	3, 4, 5, 6, 7
$\text{Oil Demand}_i \equiv \text{total demand}_i * \text{share}_i$	3, 5, 7	3, 4, 5, 6, 7
$\text{Oil Price}_i = f(\text{world price})$	3, 5, 7, 9	3, 4, 5, 6, 7, 9
$\text{Oil Stocks}_i = f(\text{oil price}_i, \text{oil production}_i, Z_i)$	3	4
$\text{Net Trade}_i \equiv \text{production}_i + \text{stocks}(-1)_i - \text{demand}_i - \text{stocks}_i$	3, 5, 7, 9	3, 4, 5, 6, 7, 9
MEAL BLOCK		
$\text{Meal Production}_i \equiv \text{crush}_i * \text{meal yield}_i$	3, 5, 7	3, 4, 5, 6, 7
$\text{Meal Demand}_i = f(\text{meal price}_i, \text{competing meal price}_i, Z_i)$	3, 5, 7	3, 4, 5, 6, 7
$\text{Meal Price}_i = f(\text{world price})$	3, 5, 7	3, 4, 5, 6, 7
$\text{Meal Stocks}_i = f(\text{meal price}_i, \text{meal production}_i, Z_i)$	3	3, 4
$\text{Net Trade}_i \equiv \text{production}_i - \text{demand}_i + \text{stocks}(-1)_i - \text{stocks}_i$	3, 5, 7, 9	3, 4, 5, 6, 7, 9

i = region

3 = Canada

6 = Brazil

Z = exogenous variables

4 = USA

7 = European Community (9)

5 = Japan

9 = Rest of World

a/ Only one total demand function is estimated for each region.

import unit values, adjusted for tariffs, are used. The Canadian soybean oil and soybean meal price links depend on U.S. prices rather than world prices because of the nature of the North American market. Finally, in the ROW region, excess demand or excess supply functions are estimated directly rather than as residuals of domestic market clearing conditions. Third, it is apparent that the specification used is essentially a synthesis of a number of the modifications and extensions to econometric commodity models in general, and oilseed sector models in particular, that have been suggested in recent years. These extensions, as outlined above, include a detailed multi-region, multi-product specification; policy response functions that explain the links between support and market-determined producer prices, and the links between domestic wholesale prices and world equilibrium prices; and, market share functions to better account for substitutability in vegetable oil demands.

To summarize, the structural econometric model contains 141 behavioral equations, market-clearing conditions and technical identities, representing six commodity markets (rapeseed oil, rapeseed meal, soybeans, soybean oil and soybean meal) in six regions (Canada, Japan, European Community, U.S., Brazil and an aggregate Rest of World). The model is therefore fairly comprehensive in its coverage of products and regions and flexible in the way in which policy variables are incorporated. As such, the specification provides the capability for medium term forecasting and for evaluating a large number of different types of domestic and trade policy alternatives.

CHAPTER 3

ESTIMATION OF THE STRUCTURAL MODEL

3.1 Data

Annual data are used in this study for three major reasons. First, the prime concern of the study lies in providing a quantitative framework for medium term forecasting and policy analysis. With this objective, the use of annual data is a least-cost means of achieving the desired results. Second, the supply block of the specified structural model is of necessity in annual terms. Finally, as discussed in Appendix 1, there are considerable problems with the data available to estimate the structural model. These problems would be greatly magnified if data of greater periodicity than annual were chosen for the analysis.

The sample period for most of the model is 1963/64 to 1977/78. This reflects the beginning of a large number of data series relating to the Canadian rapeseed sector and the difficulty of obtaining more up-to-date world or national data for area, production, trade, prices and exogenous variables such as GNP and balance of payments. This sample period covers instances of both relative stability and extreme instability in the world oilseed sector. The final estimation period is 1976/77 for all equations, except one, to allow for a prediction interval test on the 1977/78 data.

The data used in this study were obtained from a combination of individual country or regional sources and international sources. These sources are explicitly identified in the data definitions presented in Appendix 1. The two major data problems that arose in the course of the study were the large number of non-existent, inconsistent or incomplete data series, and the comparability between calendar year and crop year statistics. These problems also are discussed in detail in Appendix 1.

3.2 Estimation Technique

The structural econometric model, as noted above, is essentially a simultaneous model, and it is well known that the application of the ordinary least squares estimation technique (OLS) to an equation embedded in a simultaneous system of equations results in biased and inconsistent estimates of the relevant parameter values (Johnston, 1972; Kmenta, 1971). Methods of estimating simultaneous systems which attempt to reduce these problems are either single equation methods such as two-stage least squares (2SLS), or complete system methods such as three-stage least squares (3SLS). Both the single equation and full information methods result in biased though consistent estimates of the structural parameters, *i.e.*, the bias diminishes as the sample size increases. The system methods may, under certain circumstances, be asymptotically more efficient than the single equation methods. Thus, econometric theory would suggest that simultaneous equation models, such as the model specified above, should be estimated by

techniques which lead to consistent estimates of the relevant parameter values.

In practice, the choice between OLS and consistent methods of estimating simultaneous models is not as clear. Nearly all the properties of the various estimators are asymptotic properties, and little is known about their small-sample properties that are more relevant in practical applications. Johnston (1972) and Kmenta (1971) provide detailed reviews of Monte Carlo studies which have attempted to evaluate the various estimators in small-sample situations. Overall, the differences in the performance of the various estimators are not great, and the rankings of the different estimators depend on the exact set of exogenous data used, the true values of the structural coefficients, the correlation between the structural disturbances, and the sizes of the structural disturbances. OLS is uniformly weakest in the absence of specification error, but improves relatively and absolutely once specification errors are introduced. Further, OLS generally does relatively better when the sample size is small. In an agricultural context, Binkley and McKinzie (1979) provide similar evidence.

If a consistent estimator is to be used, 2SLS seems to be the most robust under various specification error regimes. However, use of 2SLS involves estimating K parameters in the reduced form, where K is the total number of predetermined variables in the model. In medium sized or large models, especially those using scarce annual data, K often exceeds the sample size, so the first stage of 2SLS breaks down because of degrees of freedom problems. Various modifications to overcome this problem involve the use of instrumental variables. Usually the predetermined variables included in an equation are taken as instruments for themselves, but there is no commonly agreed upon method for choosing the other instruments.

Principal component estimators have been advanced by, for example, Kloeck and Mennes (1960) and McCarthy (1971) as appropriate for estimating parameters in large systems. In this method the instruments are formed for all of the endogenous variables on the basis of the same set of principal components. The principal component estimator is, however, consistent if and only if the restrictions imposed are true.

Structural ordering is a method proposed by Fisher (1965) and Mitchell (1971). The basic argument is that a hierarchy in the explanatory variables for each equation be determined using a priori information. The instrumental variables form of this estimator may be consistent but not generally efficient.

Another method is that of iterated instrumental variables (IIV) (Lyttkens, 1974). Here the instruments are chosen from derived or restricted reduced form estimates. The initial restricted reduced form estimates could, for example, be based on OLS estimates from the structural model. With consistent initial estimators, the final estimators will be full information maximum likelihood, and may also be used for non-linear systems. Brundy and Jorgenson (1974) have shown empirically that IIV estimators appear superior for large models where data limitations make the application of more common systems of estimation methods impossible.

In all cases, however, little guidance is given as to how or how many instruments should be chosen. A minimum condition to attain consistent reduced form estimates is that all RHS exogenous variables in a given structural equation, must be included in the reduced form representation. Thus, to maintain consistency, instruments need to be selected separately for each equation.

Structural equations containing lagged endogenous variables will be inconsistently estimated unless all lagged as well as current endogenous variables are replaced by their reduced form representation. This obviously increases the computational burden of estimating the reduced form and of selecting instruments. Further, if there is autocorrelation anywhere in the model in the presence of lagged dependent variables, the reduced form estimates will not be independent of the disturbances. Thus, lagged endogenous variables used in the reduced form or as instruments, must lead to biased and inconsistent estimates of the reduced form.

In this study, all behavioral equations are estimated by OLS. It is recognized that in theory the application of OLS techniques to simultaneous equation models will result in biased and inconsistent estimates of the relevant parameter values. However, the reality of the situation is also recognized - the sample size is small and there is a high likelihood of at least some misspecification. Under these conditions, OLS performs relatively better than in the well-specified case and perhaps as well as the consistent estimators. In addition, there are many more exogenous variables than observations.

The specification of the structural model discussed above also includes a large number of lagged endogenous variables and is nonlinear in both the parameter and variables space. This, together with the obvious presence of autocorrelation, makes the reduced form more cumbersome to estimate and probably requires an IIV estimator to provide consistent parameter estimates.^{9/} Finally, Johnson (1977) points out that since the major gains to be made in sectoral modeling are in specification, it is appropriate to employ scarce resources in model specification and data assembly rather than in more sophisticated estimation techniques. Thus, OLS is in some sense a preferred technique in the early stages of a modeling project. When anticipated returns to specification diminish, then improved estimation methods may be applied. For all these reasons it was decided to accept the possibly larger bias of the OLS estimator and forego the very serious problems associated with employing a simultaneous equation technique. The supply block being recursive, would be estimated by OLS irrespective of the technique chosen to estimate the demand blocks.

3.3 Estimation Results

This section presents the results of estimating the behavioral equations in the structural econometric model and also provides more detailed

^{9/} Since a few of the equations in the model are estimated over a 1968/69 to 1976/77 sample period, using a simultaneous estimator would mean ignoring nearly one-half of the available data in most of the remaining equations.

justification of the explanatory variables included in each equation.

The discussion is organized around the outline of the structural model presented in Figure 2.1, *i.e.* the estimated equations are presented and discussed by type of equation, and where appropriate, by product, rather than by region. Tables of results are presented for each group of behavioral endogenous variables, using five major groupings: a supply block, an oilseed demand block, a vegetable oil demand block, a meal demand block and a regional price link block.

For each group of equations the explanatory variables in general form are listed horizontally and the regions are listed vertically. Exceptions to, or points worth noting about these general forms are discussed in the text. For each equation, the specific explanatory variables are presented^{10/} together with their estimated coefficients, *t* values, and elasticities calculated at the sample means. Also included are the coefficient of determination adjusted for degrees of freedom (\bar{R}^2); the Durbin-Watson statistic for autocorrelation (DW); and where appropriate, Durbin's (H) statistic for autocorrelation in the presence of a lagged dependent variable (Durbin, 1970) and the standard error of the dependent variable estimates (SEE). For perspective the mean of the dependent variable (Mean) and the number of observations in the sample (*n*) are also given.

3.3.1 The Supply Block

The regional supply of oilseeds is determined by the interaction of area and yield. Meilke and deGorter (1978) distinguish three alternative means of estimating total production: (1) estimate production directly; (2) estimate area and yield functions separately, with production equal to their product; or (3) estimate area and production functions separately, with area as an input into the total production function. Based on the results obtained by Heien (no date) and Meilke and deGorter (1978), the third alternative is used in this study. Rapeseed area and production equations are estimated for Canada, Japan and the EC, and soybean area and production equations are estimated for the U.S., Japan and Brazil.

The major innovation in the supply block is the specification of a regional endogenous guaranteed or support price variable, linked in most cases to the market determined farm price within the corresponding region. More detail on specifying these guaranteed price functions is given in Griffith and Meilke (1980a), and Meilke and Griffith (1981a). Directly modeling these policy variables should allow more precise estimation, explanation and prediction. Support price equations are estimated for Japan and the EC (rapeseed), and the U.S., Japan and Brazil (soybean).

3.3.1.1 Area Planted of Rapeseed and Soybeans

The area planted of rapeseed and soybeans in different regions is generally specified to be a function of the guaranteed price, the lagged farm price and the lagged farm price of competitive enterprises, all deflated

^{10/} The mnemonics and definitions of the data are discussed in Appendix 1. As a general guide, the first letter represents the type of variable (P=wholesale price, D=demand, etc.), the second two letters represent the product (SO=soybean, RM=rapeseed meal, etc.) and the number at the end represents the region (as defined in Figure 2.1).

by a lagged fertilizer or input price index; other government policy variables, and a lagged dependent variable. The lagged farm prices are the major market incentives, the guaranteed prices and other policy variables capture the government support effects, and the lagged area reflects the partial adjustment effect due to constraints preventing the attainment of desired acreage levels (Nerlove, 1958; Griliches, 1967; Askari and Cummings, 1977). This general specification follows previous studies by Uhm (1975), Houck *et al.* (1972), Evans and Kenyon (1974), Lowe and Petrie (no date) and Colmen (1979). The results of estimating the area functions for rapeseed are presented in Table 3.1

In Canada there is no guaranteed price for rapeseed, and the lagged area variable is excluded because of the extreme variability in area planted from year to year. The inclusion of the lagged LIFT dummy variable captures the delayed, but positive, impacts on rapeseed area of wheat area restrictions imposed under the LIFT program in 1970.^{11/} Two marketability variables, rapeseed exports (EXRA3(-1)) and wheat inventories (IWH3(-1)) reflect positive non-price market inducements for rapeseed (Uhm, 1975), and additionally both variables provide an indication of Canadian Wheat Board activities as reflected in wheat stocks and rapeseed trade.^{12/} Efforts to include more than one competitive price failed because of the high collinearity between all prices. The barley price was chosen because it seems more appropriate given that wheat is the preferred crop and competition tends to be between the secondary crops such as barley and rapeseed. However, for different objectives, such as investigating the links between the Canadian rapeseed and wheat sectors, the wheat farm price or guaranteed price could be substituted for the barley price or a weighted average of the two prices used with little change in the other parameters of the equation. Also, the prices of other oilseed crops were insignificant when used as competitive enterprises, a result opposite to that obtained by Paddock (1971).

In other studies of Canadian rapeseed area response, Uhm (1975) found short-run and long-run rapeseed farm price elasticities of 1.18 and 2.53 respectively for the Prairie region, and short-run and long-run cross-elasticities with respect to the farm price of wheat of -1.14 and -2.45. Uhm's estimated wheat stock elasticities of 0.40 and 0.86 are similar to those of the present study (0.50), while the reverse holds for lagged rapeseed exports; 0.08 and 0.18 as against 0.40. Paddock (1971) using a much earlier sample period found relatively high elasticities of 2.35, -1.92 and -1.35 for lagged farm prices of rapeseed, flaxseed and current wheat exports respectively. Rojko, *et al.* (1978b) estimated a direct price elasticity for total Canadian oilseed area of 1.00. More recently, Kwon and Uhm (1980) using 1963/77 data estimated short-run rapeseed and wheat price elasticities of 2.22 and -2.55, respectively. Our direct and cross price elasticity estimates of 2.0 and -1.3 are consistent with the earlier estimates in the sense that the response of Canadian area planted is clearly price elastic.

^{11/} This switch to oilseed crops was more incidental than intentional, since the LIFT program was primarily aimed at reducing wheat production through allocating higher acreages to forage crops.

^{12/} The Wheat Board has no direct control of rapeseed marketing but does control the allocation of rail transportation services.

Table 3.1: Area of Rapeseed^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics			
		Product Price	Competing Price	Other Variables		Constant	R ²	DW	SEE
Canada	ARA3 (981)	FPRA3(-1) PFERT3(-1)	FPBA3(-1) PFERT3(-1)	LIFT(-1)	EXRA3(-1)	IWH3(-1)			
		1694.3 (6.9) [2.0]	-2760.7 (-4.7) [-1.3]	454.2 (2.4)	0.805 (5.6) [0.4]	0.036 (3.7) [0.5]	.93	1.40	153.5
									14
Japan	ARA5 (19)	GPRA5(-1) PFERT5(-1)	FPBA5(-1) PFERT5(-1)	Ln(TIME)					
		.026 (1.7) [1.1]	-.092 (-5.1) [-2.8]	-95.9 (-8.7)		306.8	.97	2.57	2.7
									10
EC	ARA7 (356)	GPRA7(-1) FPPI7(-1)	FPWH7(-1) FPPI7(-1)	Ln(TIME)					
		32.2 (3.3) [0.9]	-85.9 (-2.2) [-1.2]	250.6 (9.7)		-114.4	.96	1.44	27.6
									15

a/ t values are given in parenthesis and elasticities in brackets below the estimated coefficients.

In Japan, the time trend variable is characterized as a policy variable in that it represents the government-sponsored diversion of upland rapeseed area to foodgrains such as wheat and barley, and to fruits and vegetables. Around the strong negative trend, however, rapeseed area has been quite responsive to changes in the price of rapeseed and barley with estimated elasticities of 1.1 and -2.8, respectively.

In the EC rapeseed area has trended upward over time with estimated direct and cross price elasticities close to unity.

Table 3.2 contains estimates of the area planted to soybeans in Canada, Brazil and Japan. In Canada corn is the main crop competing with soybeans and the estimated short-run supply response is very inelastic at 0.2 and -0.3 with respect to soybean and corn prices, respectively. The long-run elasticities are more than five times larger than the short-run estimates. The short-run estimates are similar to those obtained by Meilke *et al.* (1980) but the long-run estimates are about twice as large.

In Brazil no individual crop could be identified as competing with soybeans so the price of soybeans is deflated by an index of the price of all other agricultural commodities. Brazilian soybean acreage responds positively to both the lagged market price of soybeans and the government guaranteed price (Fox, 1979), although the response to both is very inelastic. The estimated direct price elasticity of 0.07 is far more inelastic than Rojko *et al.*'s (1978b) estimate for total oilseed area of 1.6. Over the short estimation period (1967-1976) Brazilian soybean area has been expanding by over 1.0 mil. ha per year as indicated by the trend variable.

Japanese soybean area, similar to rapeseed, has been declining over time; but the estimated direct and cross price elasticities are much smaller than for rapeseed at 0.3 and -0.7 respectively. The direct price elasticity is similar to Rojko *et al.*'s (1978b) estimate for total oilseeds of 0.28.

The estimated behavioral equation for United States soybeans is contained in Table 3.3. The estimation procedure introduced by Gallagher (1978) is employed and for the details of this method the reader is referred to Gallagher's original contribution. The basic idea is, however, that government support prices influence area decisions more if the market price is close to the support price. As market prices rise above the support price farmers place less importance on the support price and more on market prices. Following Gallagher (1978) the area planted to soybeans is assumed to depend on the supply inducing price of soybeans, which is a function of the soybean loan rate and the lagged market price of soybeans, and the supply inducing price of corn which is the chief competitor for land. The supply inducing price of corn depends on the weighted support price for corn and the lagged market price for corn.^{13/} Using this procedure the direct price elasticity with

^{13/} The concept of a weighted support price is discussed in Houck and Ryan (1972) and the data used in this study is given in Gallagher (1978).

Table 3.2: Area of Soybeans: Canada, Brazil and Japan^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics			
		Own Price	Competing Price	Other Variables	Lagged Dependent Variable	Constant	R ²	DW (H)	SEE RHO n
Canada	ASO3 (367)	PSO3(-1) PFERT3(-1) 64.5 (3.3) [0.2]	PCO2(-1) PFERT3(-1) -188.7 (-3.2) [-0.3]		ASO3(-1) 0.816 (4.93)	119.4	.89	1.43 (1.06)	18.8 na 10
Brazil	ASO6 (3533)	FPSO6(-1) FPPI6(-1) 7.13 (5.6) [0.07]		TIME 1078.0 (3.3)	GPSO6(-1) FPPI6(-1) 9.65 (3.6) [0.06]	-16221.2	.99	2.09	140.5 0.80 10
Japan	ASO5 (100.5)	GPSO5 PFERT5(-1) 0.032 (2.0) [0.3]	FPBA5(-1) PFERT5(-1) -0.131 (-3.8) [-0.7]	Ln(TIME) -109.2 (-6.8)		436.1	.92	1.54	5.2 na 10

a/ t values are given in parenthesis and elasticities at mean values below the estimated coefficients.

na = not applicable

respect to the lagged soybean market price, at mean values, is 0.50, which is somewhat lower than Houck *et al.*'s (1972) estimated short-run elasticity of 0.84.

The response with respect to the soybean support price is estimated to be 0.07 at mean values. However, if the same elasticities are calculated, at mean values excluding 1975 when there was no price support program for soybeans, the elasticity with respect to lagged market price falls to 0.40 and the elasticity with respect to the support price increases to 0.12.

Wherever possible an attempt was made to incorporate both market and support prices for competitive enterprises into the area response functions (Meilke, 1976). However in most cases this approach had to be modified because of the high collinearity between prices in general and the fact that in most regions the only relevant prices were support prices. The exception was the U.S. where both market and support prices for soybeans and corn could be incorporated into the soybean area equation. Also, efforts to include simple risk variables failed in all regions. This was probably to be expected, following Just (1974, 1975), in the regions where guaranteed prices have a dominant effect, but its lack of significance was somewhat surprising for Canadian rapeseed, and U.S. and Brazil soybeans.

All regressions shown in Tables 3.1, 3.2 and 3.3 track the sample periods very well and display sound statistical properties. The SEE's represent between 2.4 and 15.6 percent of the value of the mean of the dependent variables. The estimated coefficients have the correct signs, are in general statistically significant, and are of acceptable magnitudes with the estimated elasticities indicating a low degree of short-run price responsiveness for soybeans and elasticities of unity or greater for rapeseed.

3.3.1.2 Production of Rapeseed and Soybeans

The production of rapeseed and soybeans in different regions is specified to be a function of the area planted, a trend to capture technological changes in yields and in some cases dummy variables to account for unusually poor weather conditions.^{14/} The results of estimating the oilseed production functions are presented in Table 3.4.

For the five regions, the area variable is obviously the prime determinant of output. Time trends are important in 3 of the 4 soybean equations and one of the rapeseed equations. All of the regressions track the sample period well and display in general sound statistical properties. R^2 are greater than 0.92 in 6 of the 7 equations with Canadian soybean production having the lowest R^2 at 0.78. Two of the production functions are corrected for first order autocorrelation, namely, Brazilian and Canadian soybean production. The SEE's represent between 3.7 and 13.8 percent of the value of the

^{14/} An attempt was made to include the ratio of output price to input price in the production function to capture the impact of increased input use in profitable years but contrary to the findings of Houck and Gallagher's (1976) work on U.S. corn yields, the price variables were either of the wrong sign or had small t ratios associated with their coefficients. This may be due to the fact that soybeans respond far less to increased fertilizer use than corn.

Table 3.3: Area of U.S. Soybeans^{a/}

$$ASO4 = 7226.2 + 686.8 \text{ TIME} + 83.7 (\text{LRSO4} + 0.211((\text{DS}+1) \ln(\text{DS}+1) - \text{DS}))) / \text{PFERT4}(-1) \\ (17.6) \quad (11.3)$$

$$-167.5 (\text{WSPCO4} + 0.178 ((\text{DC}+1) \ln(\text{DC}+1) - \text{DC}))) / \text{PFERT4}(-1) \\ (-6.6) \quad (3.9)$$

where, DS = FPSO4(-1) - LRSO4 and DC = FPCO4(-1) - WSPCO4 .

$$\bar{R}^2 = .98 \quad DW = 3.29 \quad SEE = 419.5 \quad n = 14 \quad \text{LHSMAN} = 17533.4$$

Elasticities (at mean values) with respect to:

$$\text{lagged soybean market price}^{\text{b/}} = 0.50 ; \text{excluding 1975} = .40$$

$$\text{soybean loan rate}^{\text{b/}} = 0.07 ; \text{excluding 1975} = .12$$

$$\text{lagged corn market price} = -0.30$$

$$\text{corn weighted support price} = -0.15$$

$$\text{lagged fertilizer price} = -0.06$$

^{a/} For a discussion of the model specification and the calculation of elasticities see Gallagher (1978).

^{b/} In 1975 the soybean loan rate was zero thereby biasing the market price elasticity upward and the support price elasticity downward when calculated at mean values.

Table 3.4: Production of Rapeseed and Soybeans^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics			
		Area	Trend	Other Variables	Constant	\bar{R}^2	DW	SEE	RHO n
Canada	QRA3 (956)	ARA3 ⁻ 1.00 (35.9) [1.0]			-25.2	.99	1.42	59.4	na 14
Japan	QRA5 (49)	ARA5 0.83 (6.2) [0.6]	TIME -3.67 (-2.9)		67.1	.98	1.97	6.8	na 13
EC	QRA7 (778)	ARA7 2.16 (14.3) [1.1]			-53.6	.94	2.50	69.8	na 14
U.S.	QSO4 (30254)	ASO4 2.24 (22.8) [1.3]		D74 -5898.5 (-4.8)	-8689.7	.97	2.07	1120.	na 14
Canada	QSO3 (292)	ASO3 1.09 (5.5) [1.4]	TIME -2.92 (-0.8)		-60.6	.78	2.45	30.9	- .74 10
Brazil	QSO6 (5908)	ASO6 1.59 (6.4) [1.1]	Ln(TIME) 43148.8 (2.0)	D77 -3416.6 (-9.1)	-142472	.99	2.07	284.1	.90 11
Japan	QSO5 (60)	ASO5 0.86 (8.0) [1.4]	TIME 2.45 (3.7)		-61.9	.92	2.77	3.0	na 10

^{a/} t values are given in parenthesis and elasticities in brackets below the estimated coefficients.

na = not applicable

means of the dependent variables. The estimated coefficients have acceptable signs, in most cases have large t values, and are of acceptable magnitudes with area elasticities generally between unity and 1.4. Only for Japanese rapeseed is the area elasticity significantly below 1.0.

3.3.1.3 Guaranteed Farm Prices for Rapeseed and Soybeans

Both Brazil and the United States provide minimum price guarantees for their soybean producers, although the minimum price in both countries is usually set below the world market price. The floor price is maintained in Brazil using intervention purchases (Fox, 1979), and in the United States through non-recourse loans. Japan has minimum guaranteed prices for both soybeans and rapeseed as does the EC for rapeseed. In both of these countries the floor price is generally set above the world market price and for this reason the guaranteed price is assumed to be the relevant supply inducing price.

Having established the importance of guaranteed prices in determining the supply of soybeans and rapeseed (in section 3.3.1.1) the problem remains of how to endogenize these variables in a world trade model. Since the establishment of minimum producer price is a government decision the various theories of government intervention reviewed by Rausser, Lichtenberg and Lattimore (RLL, 1980) are relevant. RLL argue that for the case of government intervention in agriculture "the bureaucratic choice process is crucial; that is, our concern is with the selection of alternative levels of given policy instruments (policy implementation) rather than the discrete choice of available instruments from the universe of all policy instruments (policy setting)." For the soybean/rapeseed economy RLL's supposition is clearly true, *i.e.*, we are interested in the levels at which minimum prices are set rather than why they were the chosen instrument.

In order to estimate behavioral equations for the minimum price variables a very simple reduced form specification is used. While agreeing with RLL that the "conceptual base for much of this work leaves much to be desired" the more complicated structural models suggested by RLL will require massive doses of human capital to be successfully applied in multiregion trade models. Consequently there appears to be some justification in testing ^{15/} to see if small reduced form representations can give satisfactory results.

Given limited degrees of freedom, three variables may be sufficient to capture the major factors influencing the level at which guaranteed prices are set; namely, the lagged price of the product, lagged input prices and a lagged dependent variable. The first two variables influence net returns to production. As the market price of soybeans increases, the level of protection provided to producers by price guarantees, in the United States and Brazil, declines. This should result in increased pressure from producers to increase price supports to provide at least the former level of risk protection. In Japan and the EC, market price increases reduce the subsidy being granted to producers and again political pressure will likely result in price support increases. The second variable included is a

^{15/} Anderson (1980) has discussed some of the factors which influence the decision to support an industry.

measure of input costs. It seems likely that as costs go up so will nominal price supports so as to maintain the level of protection in real prices. Finally, a lagged dependent variable is included to allow for a partial adjustment process. This can be justified on the grounds that the treasury cost to any individual government of increasing support prices to an inappropriately high level, and the political costs of lowering price guarantees, can be substantial and therefore there is likely to be a strong tendency to be cautious in adjusting minimum prices.

The empirical estimates of the minimum price equations are contained in Table 3.5. In general the explanatory power of all of the equations is high with \bar{R}^2 's greater than 0.94. Feedback from market prices to the support price is found in all cases except for the guaranteed rapeseed price in the EC. The strength of the feedback is strongest for Japanese rapeseed and soybeans and weakest for United States soybeans.^{16/} A measure of input costs is included in all the equations, with the exception of Brazil, where an index of farm product prices is used because no suitable data on input costs could be found. Costs are important in determining minimum prices for United States soybeans, EC rapeseed and Japanese soybeans, but has a small t ratio in the Japanese rapeseed equation. A lagged dependent variable is an important explanatory variable in the U.S., Brazil and the EC but not in Japan, where it entered the equations with a very small t value and hence was dropped from the final specification. Other variables included in the support price equations are: D75 a zero-one dummy variable for the one year in the sample period when the U.S. did not have a loan rate for soybeans; DCAP a dummy variable to account for the formation of the CAP, and, foreign exchange reserves in Brazil which have a negative although weak influence on the soybean support rate (see section 3.3.5).

3.3.2 The Seed/Bean Demand Block

As outlined previously, the basic characteristics of this block are that crush demand and, where appropriate, stock demand, are estimated behaviorally and net trade is determined from a domestic market clearing condition.

Crush demands are estimated for rapeseed in Canada, Japan and the EC and for soybeans in all five regions. A rapeseed stock demand is estimated for Canada and Japan; and, soybean stock demand for the U.S., Canada and Japan. Net trade equations for rapeseed and soybeans are estimated for the ROW region but these are not discussed until section 3.3.6.

3.3.2.1 Rapeseed and Soybean Crush Demand

The crush demand for rapeseed and soybeans is a derived demand for the joint products, oil and meal, from a single variable input, rapeseed or soybeans, and a fixed input, crushing capacity. Thus, crush demand is specified to be a function of the price of soybeans or rapeseed relative to the combined value of the output of oil and meal, and crushing capacity.

The results of estimating the rapeseed and soybean crush demand functions are presented in Tables 3.6 and 3.7 respectively. For both commodities, in the EC, in order to obtain the expected negative relationship between the price variable and crush it was necessary to renormalize

^{16/} The market price is lagged two time periods in the United States because the loan rate is normally established 3 to 9 months prior to the start of crop year t. At that time prices in t-1 are not known with certainty.

Table 3.5: Guaranteed Prices for Rapeseed and Soybeans^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		Market Price	Cost Index	Other Variables	Lagged Dependent Variable	Constant	\bar{R}^2	DW (H) SEE n
Japan	GPRA5 (88619)	FPRAS(-1) 1.32 (6.2) [1.1]	FPERT5(-1) 197.2 (1.1) [0.3]			-33933	.98	1.76 6110 14
EC	GPRA7 (1001)		FPPI7(-1) 2.69 (3.0) [0.3]	CAPDUM 98.1 (2.9)	GPRA7(-1) 0.635 (4.3)	43.9	.96	1.77 43.1 14 (0.51)
U.S.	LRSO4 (79.2)	FPSO4(-2) 0.084 (1.7) [0.1]	PFERT4(-2) 34.0 (2.0) [0.4]	D75 -94.4 (-12.3)	LRSO4(-1) 0.347 (2.3)	13.5	.94	1.99 5.0 17 (-.26)
Brazil	GPSO6 (622.4)	FPSO6(-2) 0.509 (6.3) [0.5]	$\frac{1}{2}$ (FPPI6(-1)+FPPI6(-2)) 52.2 (1.9) [0.3]	FER6(-2) INVAL6(-1) -1.04 (-1.6) [-0.05]	GPSO6(-1) 0.455 (2.7)	-70.7	.99	2.35 28.6 10 (0.67)
Japan	GPSO5 (108015)	FPSO5(-1) 0.819 (7.1) [0.7]	PFERT5(-1) 808.0 (6.6) [0.8]			-58099.3	.98	1.90 847.0 13

^{a/} t values are given in parenthesis and elasticities at mean values in brackets under the estimated coefficients.

Table 3.6: Crush Demand for Rapeseed^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		Price seed/ Product Value	Capacity Variable	Other Variables	Constant	\bar{R}^2	DW	SEE
Canada	CRR3 (219)	PRA3/VALURA3	CRCAP3		65.8	.92	2.21	41.4
		-100.4 (-0.9) [-0.4]	0.77 (10.2) [1.1]					14
Japan	CRR5 (481)	PRA5/VALURA5	CRCAP5	DUMLIB	PSO5/VALUSO5	.94	1.64	47.5
		-376.1 (-1.6) [-0.6]	0.054 (4.2) [1.6]	-267.9 (-7.3)	287.5 (1.1) [0.4]			14
EC ^{b/}	PRA9/VALURA7 (0.944)	CRR7		D72		.26	2.05	0.055
		-0.00010 (-2.38) [-0.1]		0.115 (1.8)	1.04			14

a/ t values are given in parenthesis and elasticities at mean values below the estimated coefficients.

b/ This equation is renormalized on rapeseed price, with the coefficient on the rapeseed oil and rapeseed meal prices constrained to equal their crushing yields. In this case the number in square brackets is a flexibility.

Table 3.7: Crush Demand for Soybeans^{a/}

Region	Dependent Variable (Mean)	Independent Variables					Statistics		
		Bean Price/ Product Value	Capacity Variable	Other Variables		Constant	\bar{R}^2	DW	SEE RHO n
U.S.	CRS04 (18102)	PSO4/VALUS04 -22249.7 (-4.1) [-1.1]	CRCAP4 0.575 (11.8) [0.8]			25082.0	.92	2.29	1010.0 na 14
Canada	CRS03 (630)	PSO3/VALUS03 -791.6 (-5.6) [-0.9]		TIME 30.3 (9.8)	BSO3 -0.841 (-1.5) [-.004]	BSM3 0.976 (3.4) [0.1]	BSL3 0.333 (3.7) [0.04]	3.01	9.6 na 10
Brazil	CRS06 (2524)	FPS06/VALUS06 -914.8 (-1.6) [-0.2]	CRCAP6 0.585 (6.7) [0.7]			138.3	.99	2.28	300.2 1.0 14
Japan	CRS05 (2390)	PSO5/VALUS05 -647.3 (-1.1) [-0.2]	CRCAP5 0.237 (6.8) [1.4]	DUMLIB -268.5 (-2.6)		-406.2	.92	1.95	138.7 na 14
EC ^{b/}	PSO9/VALUS07 (0.930)	CRS07 -0.000009 (-1.90) [-0.06]		D72 -0.147 (-3.5)		0.992	.56	2.49	0.039 na 14

^{a/} t values are given in parenthesis and elasticities at mean values below the estimated coefficients.

^{b/} This equation is renormalized on soybean price, with the coefficient on the soyoil and soymeal prices constrained to equal their crushing yields. In this case the number in square brackets is a flexibility.

the equations on the price variable. The problem in obtaining the expected relationship was probably caused by the fact that no reliable time series data could be obtained on EC crushing capacity. The two EC crush functions, in their renormalized form, turn out to be extremely elastic with respect to changes in the price variable. While this seems possible in the case of rapeseed, where crushing has varied greatly between years, it seems less likely for soybeans where there has not been as much variation.^{17/} In addition to the crush variable a dummy variable (D72) has been included in both of the EC functions to account for the U.S. soybean embargo.

The Japanese rapeseed equation includes a dummy variable (DUMLIB) to account for the liberalization of rapeseed product imports after 1970/71. In addition, the Japanese rapeseed equation is the only crush equation where a cross price effect was found. The Canadian soybean crush equation includes three variables representing the basis between futures market prices for soybeans (BS03), soybean oil (BSL3) and soybean meal (BSM3) in the next crop year, and cash market prices during the current crop year. These three variables are important explanatory variables in this equation and their exclusion leads to an insignificant current price coefficient. The results are consistent with the estimates of Meilke, *et al.* (1980) for a quarterly Canadian soybean crush equation. It is interesting that this influence remains important in an annual model, and only in Canada.

All of the crush regressions, except for the two EC equations, track the sample period well and display good statistical properties. Some 90 percent or more of the variation in these dependent variables is explained by the independent variable sets. The standard errors of the two rapeseed functions range between 9.9 and 18.9 percent of the value of the dependent variable means, while for soybean crush the corresponding values are much lower and range from 1.5 to 11.9 percent. The two EC functions are considerably worse in terms of R^2 , but the coefficients are correctly signed, significant, and the SEE's are small in relation to the dependent variables mean.

The most general feature of the rapeseed crush functions is the low t values associated with the market price variables and the low price elasticities (except EC) in comparison to the crush capacity elasticities. Consequently, the capacity variables explain almost all of the variation in rapeseed crush demand in Canada and Japan. The response of soybean crush to price variation is very inelastic in Brazil and Japan with an estimated elasticity of -0.2, in both countries, but far more elastic in the United States and Canada with estimated elasticities of -1.1 and -0.9 respectively.

The price elasticity for U.S. soybean crush is several times larger than Vandenborre's (1970) estimate of -0.36. Williams (1977) estimated a crushing margin elasticity of 0.01 for the U.S. and found no significant margin response in Brazil.

3.3.2.2 Rapeseed and Soybean Stock Demand

The level of commercial rapeseed and soybean stocks is specified to consist of transactions and speculative components. Available supply,

^{17/} The coefficients on the crush variables are likely to be biased towards zero since the omitted variable, crushing capacity, would be positively correlated with the included variable actual crush (Kmenta, 1971).

including opening stocks, is expected to capture transactions demand in exporting regions while the level of crush is used in importing regions. The speculative component is generally dependent on the relationship between current and expected prices. While the relationship between current cash prices and futures market prices, in the next crop year, is the most obvious measure of speculative demand the futures market price was a significant variable only in the Japanese soybean equation. Consequently, proxy measures of speculative demand are used in several of the other regions and they are discussed in detail below.

In the Canadian rapeseed stock equation, the level of U.S. soybean stocks in commercial positions (ISO4C) is used as a proxy for expected price in that it represents supply pressure in the world oilseed market and hence, future demand for Canadian rapeseed. No variable representing speculative demand is used in the Japanese rapeseed stock equation but both current price and rapeseed crush have t values greater than 2.2

In the U.S. soybean stock function, forecast planted area for the next crop year was tried as a proxy variable for price expectations, but it was found to be insignificant, opposite to the results obtained by Meyers (1978). Stocks owned by the U.S. Commodity Credit Corporation (ISOCCC) are expected to depress speculative demand (Gardner, 1979; Peck, 1977), and following Meyers (1978), a dummy variable (ISO4DUM) is included to capture the upward structural shift in stock holding behavior after 1973/74 that is unexplained by any of the other independent variables. In Canada only the current market price (PS03) entered the equation with the expected sign and a significant coefficient. For Japan both the current price (PS05) and the futures price in the next crop year (EP1S04) have the expected signs and large t values.

Estimation of the stockholding functions is hampered, more than most of the equations in the model, by a lack of degrees of freedom. In Canada only 10 observations are available for the soybean function and in Japan only 9 observations are available. Although the explanatory power of the various equations varies widely with R^2 's between 0.40 and 0.89, the estimated elasticities with respect to the current market price are surprisingly consistent with 4 of the 5 between -0.9 and -1.1 and the Canadian rapeseed price elasticity only slightly more elastic at -1.5.

The estimated elasticities are considerably higher, in absolute value, than those found in previous studies. Furtan *et al.* (1978) found a price elasticity for Canadian rapeseed stock demand of only -0.10 and Houck *et al.* (1972) and Meyers (1978) estimated price elasticities for U.S. soybean stock demand of -0.06 and -0.76 respectively.

3.3.3 The Vegetable Oil Demand Block

In this block the demand for total edible vegetable oil is estimated, first. A market share equation is then formulated for rapeseed oil and soybean oil, with a technical identity determining the level of demand for rapeseed and soybean oil. Stock demand, where appropriate, is specified behaviorally, with net trade determined by a domestic market clearing condition, and a technical identity multiplying crush times oil yield providing oil production.

Table 3.8: Commercial Stock Demand for Rapeseed and Soybeans^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		Market Price	Transactions Variable	Other Variables	Constant	R ²	DW	SEE
Canada	IRA3 (307)	PRA3 -2.84 (-3.2) [-1.5]	QRA3+IRA3(-1) 0.275 (4.0) [1.1]	ISO4C 0.129 (3.3) [0.9]	147.6	.83	2.58	151.3
								14
Japan	IRA5 (41.8)	PRA5 -0.168 (-2.2) [-0.9]	CRAA5 0.151 (3.1) [2.1]		-11.5	.63	2.66	13.3
								9
U.S.	ISO4C (2208.7)	PSO4 -17.0 (-2.9) [-1.1]	QSO4+ISO4C(-1) 0.138 (3.3) [2.0]	ISOCCE -0.306 (-3.8) [-0.2]	ISO4DUM 2971.6 (3.9)	.89	2.28	663.6
								14
Canada	ISO3 (46.8)	PSO3 -0.259 (-2.6) [-0.9]			91.1	.40	1.56	20.0
								10
Japan	ISO5 (280.9)	PSO5 -1.23 (-2.8) [-0.9]	CRSO5 0.139 (1.1) [1.3]	EPISO4 1.68 (2.65) [1.0]	-140.2	.69	2.90	39.5
								9

^{a/} t statistics are in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

Total edible vegetable oil demand functions are estimated for Canada, Japan, EC, and the U.S.; rapeseed oil market shares are estimated for Canada, Japan and the EC; and, soybean oil market shares are estimated for all regions except Brazil. For Brazil, a soybean oil demand function is estimated directly. Rapeseed oil stock demand is estimated for Canada, and soybean oil stock demand for the U.S. and Canada. ROW net trade functions are estimated for both rapeseed oil and soybean oil, and are reported in section 3.3.6.

3.3.3.1 Total Edible Vegetable Oil Demand

The total edible vegetable oil demand in four regions (U.S., Canada, Japan, EC) is specified to be dependent on real income and a representative real vegetable oil price. In the U.S. function, this representative price is the price of soybean oil; in the functions for Canada, Japan and the EC, it is a weighted average of rapeseed oil and soybean oil prices. In the Brazil soybean oil demand function, the price used is the soybean oil price divided by the price of lard. A substitute variable (DBL4), domestic disappearance of butter and lard, is also included in the U.S. equation, as is a dummy variable (D73) for the aftermath of the embargo.

All attempts to estimate the Japan equation resulted in a positive but insignificant sign on the representative price variable, so rather than omit price response completely, the equation was re-estimated with the direct price elasticity constrained to be -0.10 at mean values. This assumed value compares favorably with the other estimates reported in Table 3.11. The Brazil equation was estimated as a conventional soybean oil demand function because of problems in obtaining an acceptable Brazil soybean oil market share function, while the U.S. equation was renormalized on price to aid in simulation.

The results of estimating these equations are presented in Table 3.9. All regressions track the sample period well and all have acceptable statistical properties. Some 78 to 99 percent of the variation in the dependent variable is explained by the independent variables. The Japanese and EC equations are corrected for auto correlation and the standard errors of the estimates range between 3.2 and 15.5 percent of the value of the dependent variable means.

The estimated coefficients all have the correct signs, and relatively high t values. The estimated income elasticities range between 0.6 and 1.8 while the estimated price elasticities are quite inelastic lying in the range -0.10 to -0.70. In general, these estimates are similar to those found in the other studies listed in Table 3.11.

3.3.3.2 Market Share Equations for Rapeseed Oil and Soybean Oil

The market shares of rapeseed oil and soybean oil are specified to be functions of relative prices, policy variables, a time trend and a lagged dependent variable.^{18/} The relative prices are the major market determinants

^{18/} The use of market share equations has been criticized because of the restrictions they imply for the underlying demand relations (Richardson, 1973). However, the work of Sirhan and Johnson (1971), Houck and Ryan (1978) and Richardson (1973) shows that in spite of some theoretical drawbacks the functions often perform very well.

Table 3.9: Total Vegetable Oil Demand, and Brazil Soybean Oil Demand^{a/}

Region	Dependent Variable (Mean)	Independent Variables					Statistics			
		Income	Rep. Price	Substitute Variable	Lagged Dependent Variable	Other Variable	Constant	R ²	DW (H)	SEE RHO n
U.S. ^{c/}	PSL4/CPI4	DY4/CPI4	DAL4	DBL4	PSL4(-1) CPI4(-1)	D73				
	(263)	0.0013 (0.9) [0.7]	-0.255 (-4.4) [-3.9]	-0.299 (-3.5) [-2.9]	0.219 (1.7)	213.0 (6.3)	1777.7	.88	2.37 (0.79)	31.4 na 14
Canada	DAL3	DY3/CPI3	(0.5*PRL3+0.5*PSL3) CPI3							
	(264)	2.10 (25.3) [1.2]	-13.1 (-5.2) [-0.2]				-7.55	.98	2.46	8.35 na 14
Japan ^{b/}	DAL5	DY5/CPI5	(0.3*PRL5+0.7*PSL5) CPI5							
	(1232)	1.56 (10.0) [0.8]	-0.050 - [-0.1]				324.5	.95	1.53	73.9 0.31 14
EC	DAL7	DY7/CPI7	(0.24*PRL7+0.76*PSL7)*EXR74 CPI7							
	(3388)	3.27 (9.1) [0.6]	-0.979 (-2.5) [-0.15]				1800.0	0.77	2.13	185.1 -0.43 14
Brazil	DSL6	DY6/CPI6	PSL6/RPLA6							
	(365)	151.2 (14.3) [1.8]	-337.2 (-2.3) [-0.7]				-60.0	.97	2.32	56.5 na 14

a/ t statistics are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

b/ The price elasticity is constrained to -0.10, thus no t statistic is reported.

c/ This equation is renormalized on the soybean oil price and the numbers in square brackets are flexibilities.
na = not applicable

of market shares; the trend captures shifts in tastes not embedded in prices; the policy variables represent non-market determinants, and the lagged dependent variable incorporates the partial adjustment hypothesis.

Table 3.10 contains the estimated market share equations for soybean oil and rapeseed oil in each of the four markets. All of the equations are linear in logarithms and hence the elasticity estimates can be read directly from the coefficient values.

The estimated market share elasticities for soybean oil are quite inelastic for both the United States (-0.131) and Japan (-0.153) but somewhat more elastic in Canada (-0.338) and close to unity (-0.942) in the EC. Time trends are important in explaining the soybean oil market share in three of the four regions. In the EC the soybean oil market share has been increasing while in Canada it has been declining. There is no evidence of a trend in Japan's market share until after the United States soybean embargo, at which time the soybean oil share began to decline. In addition to the time trend variables there is a once and for all jump in the soybean oil share in the EC caused by a major increase in soybean crushing capacity in 1969/70. A dummy variable is included in the Canadian equation to account for an outlying observation in 1973/74. A lagged dependent variable is important only in the United States and it enters the equation with a coefficient close to one which implies the long-run market share elasticity is some 30 times larger than the short-run elasticity (Nerlove, 1958).

Market share equations for rapeseed oil are estimated for only three regions because in the United States only small quantities of rapeseed oil are utilized, and most of this is for inedible purposes.

The estimated rapeseed oil market share elasticities range from very elastic in the EC (-3.47) to rather inelastic in Japan (-.28). Canada's rapeseed oil market share elasticity of -0.61 is slightly higher than its estimated soybean oil market share elasticity.

Time trend and lagged market share variables are included in the Canadian function and indicate that the rapeseed oil market share is increasing and that the long-run price elasticity is nearly three times larger than the short-run estimate. The production of rapeseed (QRA7) is included in the EC market share equation to reflect the fact that the Common Agricultural Policy requires that this production be crushed domestically to qualify for the deficiency payment program (Griffith and Meilke, 1980b). Between 1963/64 and 1970/71 the Japanese rapeseed oil market share averaged 12.1 percent, but following the liberalization of rapeseed oil trade in 1971/72 the market share jumped to 21.6 percent in 1973/74 and ranged between 19.1 and 18.6 percent from 1974/75 to 1977/78. A dummy variable (DUMLIBX) is included in the Japanese rapeseed oil market share equation to capture this influence and it indicates the market share increased substantially because the trade liberalization.

Of the seven market share equations five have price coefficients with estimated t values greater than two in absolute value. The two price coefficients with smaller t values are found in the Japanese soybean oil and rapeseed oil equations. The explanatory power of the market share equations, as represented by R^2 , varies widely from a low of 0.47 percent

Table 3.10: Market Share Equations for Rapeseed Oil and Soybean Oil^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics			
		Price Ratio	Other Variables	Trend	Lagged Dependent Variable	Constant	\bar{R}^2	DW (H)	SEE RHO n
Canada	Ln(MKSRL3) (-1.47)	Ln(PRL3/PSL3) -0.612 (-2.6)		Ln(TIME) 0.871 (2.8)	Ln(MKSRL3(-1)) 0.353 (1.6)	-3.12	.89	1.29 (1.95)	0.144 na 14
Japan	Ln(MKSRL5) (-1.92)	Ln(PRL5/PSL5) -0.289 (-1.1)	DUMLIBX 0.506 (8.0)			-2.24	.80	1.07	0.118 -0.28 14
EC	Ln(MKSRL7) (-2.51)	Ln(PRL7/PSL7) -3.47 (-2.2)	Ln(QRA7) 0.556 (2.5)			-6.41	.58	1.85	0.305 na 14
U.S.	Ln(MKSSL4) (-0.404)	Ln(PSL4/POL4) -0.131 (-3.2)			Ln(MKSSL4(-1)) 0.970 (16.3)	-0.022	.92	2.15 (0.28)	0.021 -0.37 14
Canada	Ln(MKSSL3) (-0.907)	Ln(PSL3/PRL3) -0.337 (-2.1)	D73 0.283 (2.3)	Ln(TIME) -0.408 (-4.7)		0.102	.47	2.26	0.107 -0.23 14
Japan	Ln(MKSSL5) (-1.10)	Ln(PRL5/PRL5) -0.152 (-1.6)		Ln(TIME)*DUMEMB -0.054 (-6.0)		-0.98	.68	1.84	0.040 -0.26 14
EC	Ln(MKSSL7) (-1.38)	Ln(PSL7/PRL7) -0.942 (-2.1)	D6976 -0.287 (3.0)	Ln(TIME) 0.329 (2.4)		-2.29	.89	2.09	0.088 na 14

^{a/} t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

na = not applicable

for soybean oil in Canada to a high of 0.92 for soybean oil in the United States. Four of the seven market share equations require a correction for first order autocorrelation and a sixth, the market share for Canadian rapeseed oil, appears to need a correction based on Durbin's H statistic (Durbin, 1970). Nevertheless correcting this equation for autocorrelation produced a very small and insignificant RHO value so the equation was left uncorrected.

Telser (1962) and Sirhan and Johnson (1971) have shown that the direct and cross price elasticities of demand for a good can be obtained from knowledge of the elasticity of total demand and the market share elasticity. This is illustrated for soybean oil in equations (1) and (2),

$$(1) \quad \frac{dDSL_i}{dPSL_i} \frac{PSL_i}{DSL_i} = \frac{dMKSSL_i}{dPSL_i} \frac{PSL_i}{MKSSL_i} + \frac{dDAL_i}{dPSL_i} \frac{PSL_i}{DAL_i},$$

$$(2) \quad \frac{dDSL_j}{dPRL_j} \frac{PRL_j}{DSL_j} = \frac{dMCSSL_j}{dPRL_j} \frac{PRL_j}{MKSSL_j} + \frac{dDAL_j}{dPRL_j} \frac{PRL_j}{DAL_j},$$

where, $i = 3, 4, 5, 7$, $j = 3, 5, 7$ and equation (1) gives an estimate of the soybean oil direct price elasticity and equation (2) an estimate of the soybean oil cross price elasticity. The comparable equations for rapeseed oil are obvious.

Table 3.11 contains the calculated direct and cross price elasticities for soybean and rapeseed oil. As is clear from the table the direct price elasticity of soybean oil tends to be less elastic than that for rapeseed oil. In general the United States and Japan are the most price inelastic markets with Canada slightly more elastic and the EC being by far the most price responsive market.

In another market share analysis of the vegetable oil sector, Houck and Ryan (1978) found price ratio elasticities for export shares of -0.35 and -0.49 for soybean oil and rapeseed oil respectively. Price elasticities from conventionally specified rapeseed oil and soybean oil demand functions are listed in Table 3.11.

3.3.3.3 Rapeseed Oil and Soybean Oil Stock Demand

Stock demand for rapeseed oil and soybean oil, as for oilseed stock demand, is specified using variables representing transactions demand and speculative demand, with the results presented in Table 3.12.

For the Canadian rapeseed oil equation the futures market price of soybean oil (EP1SL3), converted to Canadian dollars, is used to represent speculative demand since there is no futures market for rapeseed oil and because they are close substitutes (Griffith and Meilke, 1979). Both the current market price (PRL3) and the futures price have the correct signs but the t value for the market price is small. Stocks are responsive to the level of production plus carry-in with an estimated elasticity of 0.7.

The demand for soybean oil stocks in the U.S. is related to current and futures market prices with estimated elasticities of 0.7 and -0.7 respectively, although the t values on both variables are less than 1.6 in absolute value.

Table 3.11.: Comparison of Income and Direct Price Elasticities for Vegetable Oil Demand

Region	Study	Income Elasticity All Oils	Price Elasticity All Oils	Price Elasticity Rapeseed Oil	Price Elasticity Soybean Oil
Canada	Moe et al. (1971)	0.64	-0.42		
	Furtan et al. (1978)			-3.78	
	Vandenborre (1970)				-1.19
	Al-Zand et al. (1977) Present Study	0.12 to 0.80 1.20	-0.70 -0.17	-0.70	-0.42
Japan	Moe et al. (1971)	0.55	-0.05		
	Furtan et al. (1978)			-1.17	
	Labys (1977)				-1.71
	Present Study	0.80	-0.10	-0.31	-0.23
EC	Moe et al. (1971)	0.47	-0.00		
	Furtan et al. (1978)			-4.08	
	Vandenborre (1970)				-1.19
	Labys (1977)				-1.66
U.S.	FAO (1971b)	0.15 to 0.30			
	Present Study	0.60	-0.15	-3.51	-1.06
	Moe et al. (1971)	1.00	-0.01 to -0.16		
	Vandenborre (1970)				-0.43
Brazil	Labys (1977)				-1.28
	Houck et al. (1972)				-0.28
	Houck et al. (1968)				-0.51
	Present Study	1.42	-0.26		-0.26
	Moe et al. (1971)	2.20	-1.15		
	Williams (1977)				-0.15
	Present Study	1.85 ^{a/}	-0.68 ^{a/}		-0.68

^{a/} Soybean oil only.

Table 3.12: Stock Demand for Rapeseed Oil and Soybean Oil^{a/}

Region	Dependent Variable (Mean)	Independent Variables					Statistics		
		Market Price	Transactions Variable	Other Variables	Constant	\bar{R}^2	DW	SEE	n
Canada	IRL3 (3.6)	PRL3 -.0017 (-0.9) [0.13]	QRL3+IRL3(-1) 0.029 (4.3) [0.7]	EPISL3 0.0070 (1.8) [0.6]	D69 -1.90 (-2.2)	.93	3.17	0.8	14
					0.438				
U.S.	ISL4 (288)	PSL4 -0.526 (-1.6) [-0.7]	QSL4 (0.108) (2.6) [1.2]	EPISL4 0.633 (1.4) [0.7]	-77.5	.60	1.95	66.2	14
Canada	ISL3 (4.4)	PSL3 -0.0041 (-1.7) [-0.3]	DSL3 0.049 (2.6) [1.2]	D72 -1.29 (-1.2)	0.81	.27	1.50	1.0	14

^{a/} t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

The Canadian soybean oil equation is estimated poorly with an \bar{R}^2 of only 0.27, although both the current price and the transactions demand variable (DSL3) have the expected signs.

3.3.4 The Meal Demand Block

In this block consumption and stock demand functions are specified behaviorally, net trade is determined by a domestic market clearing condition, and a technical identity determines meal production from crush.

Rapeseed meal demand functions are estimated for Canada, Japan and the EC, soybean meal demand functions for all regions, a soybean meal stock function for the U.S. and Canada and a rapeseed meal stock function only for Canada. ROW net trade functions are estimated for both rapeseed meal and soybean meal in section 3.3.6.

3.3.4.1 Rapeseed Meal and Soybean Meal Demands

The domestic demands for rapeseed meal and soybean meal in the appropriate regions are derived demands from the livestock sector, and thus may be treated as input demand functions. The demands for rapeseed meal and soybean meal are theoretically dependent on the price of livestock, the price of the meal of interest, the prices of competing variable inputs (other protein meals and feed grains), and the quantity of fixed input (livestock numbers or production).

Corn prices were initially included in all soybean meal demand functions and in the Canadian and EC rapeseed meal demand functions, but the separate effects of the individual prices could not be distinguished either because of multicollinearity or an insignificant relationship.^{19/} Since it was considered more important in this study to maintain the linkages within the protein meal market, rather than between the meal and feedgrain markets, the feedgrain prices were regrettably omitted. For the Japan soybean meal demand function, the information contained in a report by the Boston Consulting Group (1977) on the structure and operation of the Japanese compound feed sector led to the inclusion of soybean meal and feedgrains as complements rather than substitutes. This is accomplished by defining a weighted average complete feed variable in which soybean meal has a weight of 0.15 and feedgrains have a weight of 0.85. A similar approach was attempted for the substitute rapeseed meal price variable, but could not be used because of the very high collinearity between the two resultant, feedgrain-dominated, variables. Another exception to the general specification outlined above is the absence of any livestock variables in the Brazil soybean meal demand function. In Brazil, soybean meal is used mainly in poultry feed, but poultry data is reportedly very unreliable. Following Williams (1977), a real income variable is included to indicate the high income elasticity of demand for meat and hence the derived demand for inputs into the meat (mainly broiler) production process. Further, all equations were specified initially with the livestock price included in an input-output ratio; however, the Canadian rapeseed meal and U.S. soybean meal functions were found to be estimated more reliably with livestock prices included linearly. Including livestock prices in the Brazil soybean meal functions, and in the EC and Japanese functions for both meals resulted in consistently incorrect signs for the

^{19/} The lack of significance of feedgrain price variables in soybean meal demand functions has been mentioned in several soybean meal demand studies.

livestock and protein price variables so livestock prices are omitted from the final specification. Finally, as with the U.S. soybean oil demand equation, the U.S. soybean meal demand equation is estimated renormalized on price, while the Brazilian prices are deflated by the wholesale price index. A dummy variable (D73) is included in the EC demand function to account for a year in which EC rapeseed meal production declined sharply and its use was reduced. The rapeseed meal demand functions track the sample extremely well and display sound statistical properties (Table 3.13). Over 93 percent of the variation in the dependent variables is explained by the independent variable sets, there are no autocorrelation problems, except for Japan, and the standard errors range between 8.1 and 13.5 percent of the dependent variable mean values. In all three equations the estimated coefficients have the correct signs, although some t values are only slightly greater than 1.0 in absolute value. The calculated elasticities indicate that the direct and cross price elasticities are low for Japan and EC but high for Canada; the livestock price elasticity is 0.4 in Canada; and, the livestock number elasticities are large in all regions.

As shown in Table 3.14, all the soybean meal demand functions track the sample period well and display sound statistical properties. Over 94 percent of the variation in the dependent variable is explained by the independent variable sets, autocorrelation corrections are required for the EC and Japan equations and the standard errors range between 4.5 and 9.4 percent of the dependent variable mean value, with the exception of Brazil where the standard error is a large 19.4 percent. All estimated coefficients have the correct signs and acceptable t values, except for the U.S. livestock price (LPRICE4) which has a t of 1.2. The calculated elasticities indicate that the direct and cross price elasticities are generally larger than those in the rapeseed meal demand equations. The livestock price and production elasticities are inelastic in the U.S. and Japan, and large for EC hog numbers whose value at over 3 is similar to that found in the EC rapeseed meal demand function. The Canadian livestock production elasticity of 2.0 is also similar to that found in the EC function. Real income although only a proxy variable for livestock activity, is found to have a very significant positive effect on Brazil soybean meal demand.

Estimates by other authors of total rapeseed meal and soybean meal price elasticities of demand are listed in Table 3.15. The estimates calculated from the meal demand equations in the present study accord well with previous estimates, with the exception of relatively lower values for the EC functions.

3.3.4.2 Rapeseed Meal and Soybean Meal Stock Demand

The meal stock demand functions are specified using the same principles as for the oilseed and oil stock demand equations (Table 3.16).

The spot market price and the futures market price are used to represent speculative demand in both the U.S. soybean meal and Canadian rapeseed meal equations. Although all of the price variables have the correct signs the t values are between 1.1 and 1.8 in absolute value.

In the U.S. soybean meal equation a procedure employed by Meilke and Young (1979) is used to represent transactions demand. This involves specifying a variable parameter on meal production to capture the effect, during 1974 and 1975, of

Table 3.13: Demand for Rapeseed Meal^{a/}

Region	Dependent Variable (Mean)	Independent Variables					Statistics			
		Price	Competitive Price	Livestock Price	Livestock Activity	Other Variables	Constant	\bar{R}^2	DW	SEE RHO n
Canada	DRM3 (110)	PRM3 -1.46 (-1.8) [-1.3]	PSM3 1.00 (2.2) [1.6]	PLIVE3 1.22 (1.4) [0.4]	LPROD3 0.250 (3.9) [2.3]		-215.2	.94	2.29	14.9 na 14
Japan	DRM5 (299)	PRM5 -0.002 (-1.3) [-0.2]	PSM5 0.002 (2.1) [0.35]		LPROD5 0.421 (6.5) [0.9]		-28.3	.96	1.58	24.3 0.43 13
EC	DRM7 (658)	PRM9 -1.67 (-2.1) [-0.2]	PSM9 1.82 (2.8) [0.4]		IHG7 0.032 (7.9) [3.0]	D73 -280.4 (-3.7)	-1381.1	.93	1.87	68.9 na 14

^{a/} t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

na = not applicable

Table 3.14: Demand for Soybean Meal^{a/}

Region	Dependent Variable (Mean)	Independent Variables					Statistics					
		Price	Competitive Price	Live-stock Price	Live-stock Activity	Other Variables	Constant	\bar{R}^2	DW	SEE	RHO	n
U.S. ^{b/}	PSM4 (122)	DSM4 -0.013 (-3.2) [-1.2]	POM4 0.852 (7.9) [1.1]	LPRICE4 21.3 (1.2) [0.3]	LPROD4 76.1 (2.3) [0.9]		-5.3	.96	2.63	11.5	na	14
Canada	DSM3 (578.5)	PSM3/PLIVE3 -85.8 (-2.8) [-0.8]	PRM3/PLIVE3 102.8 (1.9) [0.5]		LPROD3X 0.863 (10.6) [2.0]		-473.4	.89	2.11	44.3	na	14
Brazil	DSM6 (396)	PSM6/WPI6 -30.3 (-1.9) [-1.0]	PCTM6/WPI6 31.0 (2.2) [0.7]			DY6/WPI6 158.9 (12.8) [1.8]	-228.1	.94	1.53	76.9	na	14
Japan	DSM5 (2047)	(0.15*PSM5 + 0.85*IMPC05) -0.017 (-3.0) [-0.3]	PRM5 0.013 (3.6) [0.2]		LPROD5 1.77 (5.0) [0.6]		965.5	.95	1.46	92.4	-0.66	13
EC	DSM7 (7201)	PSM9 -10.4 (-2.0) [-0.2]	PRM9 32.8 (5.6) [0.4]		IHG7 0.267 (9.8) [2.3]		-11118.6	.96	1.98	557.1	0.29	14

a/ t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

b/ This equation is renormalized on the soybean meal price so the numbers in square brackets are flexibilities.

Table 3.15: Comparison of Direct Price Elasticities for Meal Demand

Region	Study	All Oilmeal	Rapemeal	Soymeal
Canada	Rojko, et al. (1978b)			
	Furtan et al. (1978) Present Study	-0.98	-0.63 -1.33	-0.80
Japan	Rojko et al. (1978b)			
	Furtan et al. (1978) Present Study	-0.30	-0.58 -0.20	-0.30
EC	Rojko et al. (1978b) EC6 EC3	-0.25 -0.37		
	Furtan et al. (1978) Vandenborre (1970) Present Study		-1.86 -0.20	-1.21 -0.20
U.S.	Rojko et al. (1978b)			
	Vandenborre (1970)	-0.53		-0.44
	Houck et al. (1972)			-0.18
	Others ^{1/} Present Study			-0.40 -0.85
Brazil	Rojko et al. (1978b) ^{2/}			
	Williams (1977) Present Study	-0.40		-3.74 -1.0

1/ Rojko et al. (1978b) suggest this value as a consensus of previous estimates.

2/ South America in total.

Table 3.16: Stock Demand for Rapeseed Meal and Soybean Meal^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		Market Price	Transactions Variable	Other Variables	Constant	\bar{R}^2	DW	SEE
Canada	IRM3 (3.4)	PRM3	QRM3+IRM3(-1)	EPISM3				
		-0.061 (-1.1) [-1.8]	0.028 (1.8) [1.1]	0.039 (0.9) [1.4]	1.1	.47	1.92	2.3
								14
U.S.	ISM4 (188)	PSM4	QSM4	QSM4*PSL4	EPISM4			
		-1.81 (-2.1) [-1.2]	-0.0058 (-0.8)	.000033 (6.1)	1.71 (1.7) [1.1]	.86	1.88	39.2
								14
Canada	ISM3 (11.3)		DSM3					
			0.028 (2.1) [1.4]		-4.9	.21	1.86	6.5
								14

a/ t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

crushers processing to take advantage of high soybean oil prices. Note that the meal production variable (QSM4) alone may have a negative sign as long as the combined effect of it and the interaction term (QSM4*PSL4) is positive. For the Canadian soybean meal equation no price effects were found and it is expressed solely as a function of soybean meal demand.

The U.S. soybean meal stock demand equation fits the sample period reasonably well but the other two equations exhibit low explanatory power. The estimated direct price elasticity for U.S. soybean meal of -1.2 is somewhat more elastic than Vandenborre's (1970) estimate of -0.70.

3.3.5 Regional-World Price Link Equations

The world oilseed market is a relatively free market, particularly so for Canada, the EC and the U.S., where the only barriers to trade are modest tariffs on vegetable oils. In this situation the relationship between prices in an exporting region and an importing region, measured in a common currency, should be the same after accounting for transportation costs and tariffs. Consequently, seed, oil and meal prices in the U.S. and Canada are expressed as functions of the world price (assumed to be European Community import prices) and transportation costs.

The situation for Brazil and to a lesser extent Japan cannot be handled in the above fashion because of the extensive use of non-tariff barriers to trade in these regions (Griffith and Meilke, 1980b; Jabara, 1981). In fact world trade analysts are becoming increasingly aware that non-tariff measures are replacing tariffs as the most important impediment to increased trade (Hillman, 1978; Jabara, 1981; Ray, 1981; Olechowshi and Sampson, 1980).

Brazil in particular uses a complex system of export taxes in an attempt to protect domestic price ceilings on soybean meal and soybean oil, and to influence the composition of exports, *i.e.*, whether soybeans or soybean meal is exported. While in theory it is possible to incorporate the Brazilian taxes explicitly in an econometric model; the rapidity of changes and the difficulty of obtaining this information creates problems for the modeler, more so because they are clearly endogenous variables. Other non-tariff measures are impossible to explicitly include in a model because of their non-quantifiable nature. For this reason a different method of accounting for non-tariff measures is adopted. The approach is conceptually similar to Lattimore and Schuh's (1979) and implicit in the work of Zwart and Meilke (1979). The basic idea is that most non-tariff measures drive a wedge between domestic and world market prices, and the analysts problem is to try and identify variables which account for all or part of the difference between domestic and world price caused by the non-tariff measures.

Lindbeck (1976) has argued that intervention in the market place can often be proxied for using what he terms four "idealistic variables, each one characterized by falling marginal utility, or rising marginal disutility: real disposable income of households, unemployment, inflation, and the current account of the balance of payments (or the stock of reserves) - and most likely also the rate of change of these variables". Since the commodities of interest are important tradeables, for both Japan and Brazil, the search for variables to explain the difference between domestic and world prices was limited to the balance of payments deflated by an index of import values (BOP/IMVAL), foreign

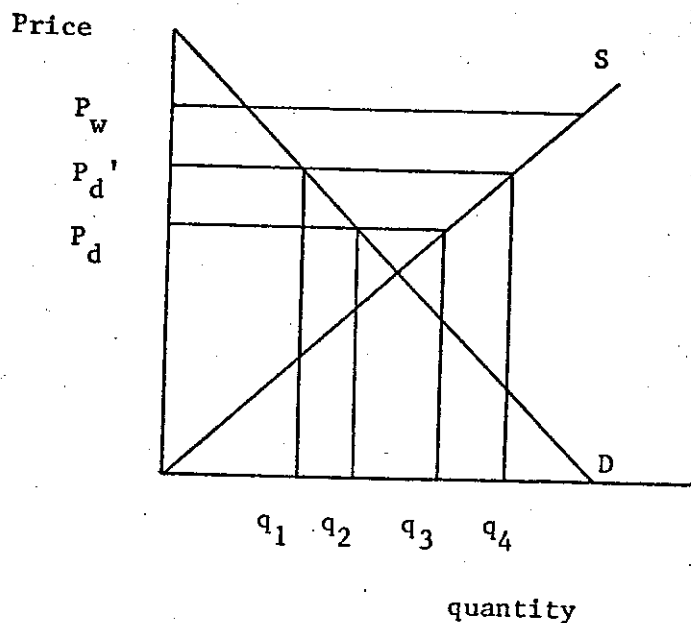
exchange reserves deflated by an index of import unit values (FER/IMVAL) and for Brazil the rate of change in prices (ΔP). In addition, it was postulated that the policy response functions may involve a partial adjustment process. Hence the estimated policy inclusive price link functions are of the following form.

$$PX_t = a_0 + a_1(PW_t + T) - a_2 TR_t - a_3 FER_{t-1}/IMVAL_{t-1} - a_4 BOP_{t-1}/IMVAL_{t-1} - a_5 \Delta P + a_6 PX_{t-1},$$

where PX is price in an exporting region, PW is the world price, T a fixed tariff and TR transportation costs.

The expected signs for the balance of payments and/or foreign exchange reserve variables are negative. This can be seen from Figure 3.1 where P_w is the world market price and P_d' represents the domestic price when foreign exchange reserves or balance of payments are small, resulting in exports of $q_1 q_4$. If the balance of trade is less constraining the country can lower the domestic price to P_d , to meet domestic price objectives, and export the smaller quantity $q_2 q_3$. Consequently, higher trade balances are likely to result in lower domestic prices. A similar line of reasoning can be developed for an importing country and again the expected relationship between trade balances and domestic prices is negative.

Figure 3.1: Influence of Domestic Price Distortions



The significance of the macroeconomic policy variables will be discussed in sections 3.3.5.1 through 3.3.5.4 where the empirical estimates of the price link equations are presented. However, before proceeding, another important issue related to the estimation of policy inclusive price transmission equations must be addressed. This is the question of whether the parameter values in these functions can be expected to be stable under different policy regimes.^{20/} Lucas (1976), Supel (1980) and others have argued that the parameter values in private consumption and investment functions change as the economic policies, e.g. tax rates, which affect these decisions change. In agriculture support for the argument that private decision rule parameters vary under different policy regimes is found in the work of Morzuch, Weaver and Helmberger (1980) and Gallagher (1978).

If we find that intervention in some commodity markets can be partially explained using macroeconomic variables as indicators of different policy making conditions, and if we view the domestic price as being determined as a result of policy makers maximizing a welfare function subject to a set of constraints, then the same arguments Lucas makes with regard to private decision rules seem equally applicable to public decision rules. These public decision rules are represented, in a reduced form sense, in our model by the domestic-world price link equations. Under these conditions Griffith and Meilke (1980a) have argued that the slope coefficient relating domestic to world prices may vary systematically with the economic environment. To test for this systematic parameter variation interaction terms between the world price and the policy indicator variables were entered in each price link equation for Brazil and Japan. In all cases the interaction terms were either insignificant or implied unrealistic parameter values. Thus for the commodities under consideration it appears that intercept shifters are sufficient to capture the influence of policy intervention.

3.3.5.1 Rapeseed and Soybean Wholesale Prices

The results of estimating the wholesale price links for soybeans and rapeseed, with the exception of Brazil (where the farm price is used since there is no reported wholesale price) are given in Table 3.17. All of the domestic prices are linked to the EC import price (CIF) except for Canadian soybeans which are linked to the U.S. soybean price because of their geographical proximity and similar crop years. The EC import price (CIF) is also assumed to be representative of EC domestic prices. The sign of the freight rate variable will be negative for an exporting region and positive for an importing region.

Macro policy indicator variables enter only the Japanese rapeseed equation where the balance of payments variable has the expected negative sign and a t value of -1.7. A lagged dependent variable is also important in this equation.

All of the price link equations have high \bar{R}^2 's and track the sample period well, with price transmission elasticities around 1.0. The Durbin-Watson statistic for the Brazil soybean equation indicates negative first

^{20/} For a more complete discussion of this issue the reader is referred to Griffith and Meilke (1980a).

Table 3.17: Wholesale Prices for Rapeseed and Soybeans^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		World Price	Other Variables	Freight Rate	Lagged Dependent Variable	Constant	R ²	DW (H)
Canada	PRA3 (165)	PRA9 ^{b/} 1.04 (20.9) [1.2]		FR37 ^{c/} -1.96 (-1.8) (-0.1)		-5.0	.98	2.51 12.0 14
	PRA5 (181)	PRA9 ^{b/} 0.841 (9.6) [0.9]	BOP5(-1)*EXRSDR4(-1) IMVAL5(-1) -0.154 (-1.7) [-0.05]		PRA5(-1) 0.349 (4.3)	-32.4	.96	2.89 18.2 14 (1.74)
U.S.	PS04 (148)	PS09 0.994 (12.6) [1.1]	D72 27.9 (1.8)	FR37 -2.36 (-1.1) [-0.1]		-6.16	.95	3.24 14.4 14
	PS03 (155)	PS04 1.02 (36.9) [1.0]	TIME -0.412 (-1.0)			4.4	.99	1.77 3.5 14
Japan	PS05 (172)	PS09 ^{b/} 1.09 (11.5) [1.1]		FR45-FR37 ^{c/} 0.0084 (1.7) [0.1]		-41.0	.95	2.78 16.6 14
	FPS06/EXR64 (123)	PS09 0.669 (12.0) [0.9]				12.2	.91	3.1 13.2 14

a/ t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

b/ The world price variables are corrected for exchange rates, tariffs and crop year where appropriate.

c/ The freight rate variable is corrected for exchange rates and crop year where appropriate.

order autocorrelation in the residuals. Including the macro policy variables in this equation failed to correct the autocorrelation and they consistently entered the equation with positive signs. In addition, when the equation was corrected for first order autocorrelation it has a very adverse impact on the dynamic simulation of the model so it was left uncorrected.

3.3.5.2 Rapeseed and Soybean Farm Prices

The farm prices of Canadian rapeseed and U.S. soybeans are specified to be directly related to the wholesale price within the same region. The margin between the two prices, accounted for by handling, storage, domestic transport and other transaction costs, are proxied using a time trend. A dummy variable (D74) is included in the U.S. soybean equation to account for an outlying observation caused by the fact that farm prices are calculated using weighted averages and wholesale prices using simple averages.

In Japan the farm price of soybeans and rapeseed are set by the government. In general these prices follow the world market price but they are also adjusted to account for changes in domestic handling costs. To account for this the wholesale price index is included in both of these equations. The farm price of soybeans appears to have been far more responsive to both world market prices and domestic price level changes than has the rapeseed farm price. A lagged dependent variable is also incorporated in the Japanese farm price equation to account for the stated desire for stability in the Japanese agricultural sector (Griffith and Meilke, 1980b).

There is no market determined farm price for rapeseed in the EC because of the provisions of the CAP, while in Brazil the market determined farm price is regarded as the major domestic price variable for soybeans and was discussed in the previous section. In Canada soybean farm prices are determined by formula, from the cost of imported U.S. soybeans, and consequently farm prices add little information to that already contained in the wholesale price (Jaeger, 1977).

3.3.5.3 Rapeseed Oil and Soybean Oil Wholesale Prices

The domestic wholesale prices for rapeseed oil and soybean oil in the appropriate regions are specified to be dependent on the world price, freight rates, and in Japan and Brazil, macroeconomic policy indicators. EC import prices (CIF) are taken to be the world prices for rapeseed oil and soybean oil. In the absence of consistent data, EC domestic prices are defined as the import price times the tariff. The world price is converted to domestic currency by the appropriate exchange rate and corrected for tariff and crop year effects where necessary.

The results of estimating these rapeseed oil and soybean oil price link equations are presented in Tables 3.19 and 3.20 respectively.

Both rapeseed oil regressions track the sample period well and in general display sound statistical properties. Over 94 percent of the variation in the dependent variables is explained by the independent variable sets, there are no autocorrelation problems, and the standard errors represent only 1.9 to 15.5 percent of the dependent variable mean values. All soybean oil regressions perform well in tracking ability and in statistical properties.

Table 3.18: Farm Prices for Rapeseed and Soybeans^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		Wholesale Price	Lagged Dependent Variable	Other Variables	Constant	\bar{R}^2	DW (H)	SEE
Canada	FPRA3 (151)	PRA3		TIME				
		1.03 (25.2) [1.1]		-0.830 (-1.1)	-9.37	.99	1.80	7.3
Japan	FPRA5 (83033)	PRA5*EXR54	FPRA5(-1)	WPI5(-1)				
		0.244 (2.4) [0.2]	0.712 (4.1)	527.7 (1.50) [0.4]	-21935	.98	1.46 (1.30)	4250
U.S.	FPSO4 (136)	PSO4		D74				
		0.825 (13.1) [0.9]		40.6 (2.6)	11.5	.95	2.25	13.8
Japan	FPSO5 (96770)	PSO5*EXR54		WPI5(-1)				
		1.56 (3.60) [0.9]		985.6 (2.3) [0.7]	-56754	.92	1.85	12500

^{a/} t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

Table 3.19: Wholesale Prices for Rapeseed Oil^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		World ^{b/} Price	Other Variables	Freight Rate	Lagged Dependent Variable	Constant	\bar{R}^2	DW (H) SEE n
Canada	PRL3 (376)	PRL9 1.64 (14.1) [1.5]		FR37 -15.7 (-3.1) [-0.5]		-5.05	.94	1.92 58.5 14
Japan	PRL5 (120709)	PRL9+TARRL5 1.24 (65.0) [1.2]	FER5(-1)/INVAL5(-1)	D70 -32175.3 (-13.5)	PRL5(-1) 0.076 (5.2)	-23133	.99	2.14 2270 14 (0.26)
EC	PRL7 (371)	PRL9*TARRL7 1.00						Identity

^{a/} t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

^{b/} The world price and freight rate variables are corrected for exchange rate and crop year where appropriate.

Table 3.20: Wholesale Prices for Soybean Oil^{a/}

Region	Dependent Variable (Mean)	Independent Variables			Statistics		
		World _{b/} Price	Other Variables	Lagged Dependent Variable	Constant	R ²	DW (H) SEE n
U.S.	PSL4 (338)	PSL9 0.927 (29.4) [1.0]			2.99	.98	2.35 21.3 14
Canada	PSL3 (377)	PSL4*TARSL3 1.00 (17.3) [1.0]			-14.9	0.96	2.05 37.5 14
Brazil	PSL6/EXR64 (580)	PSL9 0.802 (4.2) [0.5]	FER6(-1)/IMVA6(-1) -2.00 (-2.00) [-0.1]	PSL6(-1)/EXR64(-1) 0.378 (2.6)	144.8	.89	2.02 46.4 14 (0.04)
Japan	PSL5 (185636)	PSL9+TARSL5 0.855 (7.9) [0.6]	BOP5(-1)/IMVAL5(-1) -39.9 (-0.5) [-0.01]	PSL5(-1) 0.449 (4.8)	271.1	.95	1.71 14500 14 (0.72)
EC	PSL7 (398)	PSL9*TARSL7 1.00					Identity

a/ t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

b/ The world price is corrected for exchange rates where appropriate.

Over 89 percent of the variation in the dependent variables is explained by the independent variable sets and there is no evidence of autocorrelation. The standard errors range from 6.3 to 9.9 percent of the dependent variable mean values.

The estimated coefficients have the correct signs and acceptable levels of significance except for the low t value on balance of payments in the Japanese rapeseed oil function. The elasticities on the world price variables range from 0.5 for Brazil soybean oil to 1.5 for Canadian rapeseed oil. Three of the six elasticities are close to unity. Freight rates are significant only in the Canadian rapeseed oil equation. The policy variables tend to exhibit very low elasticities, ranging from -0.01 to -0.10 in the short-run. Lagged dependent variables are highly significant in three equations and the adjustment coefficient indicates long-run elasticities ranging from 8 to 60 percent greater than the respective short-run values.

3.3.5.4 Rapeseed Meal and Soybean Meal Wholesale Prices

The domestic wholesale prices for rapeseed meal and soybean meal in the appropriate regions are specified to be dependent on the world price, freight rates, and macroeconomic policy indicators (in Japan and Brazil). EC import prices (CIF) represent both the world prices and the EC domestic prices for rapeseed meal and soybean meal since intervention in meal trade is minimal in this region.^{21/} The world price is converted to domestic currency by the appropriate exchange rate, and corrected for crop year effects in the Canadian equations.

The results of estimating these rapeseed meal and soybean meal price link functions are presented in Tables 3.21 and 3.22 respectively.

The two rapeseed meal price links track the sample period reasonably well and display sound statistical properties. Over 85 percent of the variation in the dependent variables is explained by the independent variable sets, there is no significant autocorrelation, and the standard errors represent about 10 percent of the dependent variable mean values. The estimated coefficients all have the correct signs and acceptable t values. World price elasticities are all inelastic and indicate roughly a 70 to 80 percent response of domestic prices to world price changes. Neither balance of trade nor foreign exchange reserves were found to significantly explain Japan rapeseed meal price, however a dummy variable for rapeseed product liberalization shows a significant effect on prices since 1970/71, as does an embargo dummy in 1972. Finally, freight rates were found to be insignificant, while a lagged dependent variable was significant in the Japan equation.

The soybean meal price linkages track the sample period very well and display sound statistical properties. Over 93 percent of the variation in the dependent variables is explained by the independent variables, there are no autocorrelation problems, except in Brazil, and the standard errors represent between 3.7 and 7.8 percent of the dependent variable mean values. The estimated coefficients all have the correct signs and acceptable t values. World price elasticities range from slightly inelastic (0.70) to

^{21/} Canadian prices are again linked to their U.S. counterparts.

Table 3.21: Wholesale Prices for Rapemeal^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics		
		World Price ^{b/}	Other Variables	Lagged Dependent Variable	Constant	R ²	DW (H)	SEE n
Canada	PRM3 (100)	PRM9	D72		20.6	.93	2.00	9.6
		0.787 (11.6) [0.7]	68.4 (6.8)					
Japan	PRM5 (37729)	PRM9	D72	PRM5(-1)	-8933.7	.85	1.62 (0.90)	3790.0
		0.934 (6.2) [0.8]	17389.6 (3.3)	0.337 (2.0)				
			DUMLIB					
			4502.7 (1.4)					

a/ t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

b/ The world price is corrected for exchange rate, tariffs and crop year where appropriate.

Table 3.22: Wholesale Prices for Soymeal^{a/}

Region	Dependent Variable (Mean)	Independent Variables				Statistics			
		World _{b/} Price	Other Variables	Freight Rate	Constant	\bar{R}^2	DW	SEE	RHO
U.S.	PSM4 (122)	PSM9	D72	FR37	-0.878	.99	2.33	4.55	na
		0.930	23.3	-1.28					
		30.8	(3.9)	(-2.1)					
Canada	PSM3 (179)	PSM4	TIME		20.0	.97	2.02	10.9	na
		1.07	2.03						
		(13.0)	(1.9)						
Brazil	PSM6/EXR64 (122)	PSM9	<u>BOP6(-1)*EXRSDR4(-1)</u>						
		1.02	IMVAL6(-1)	FR67	56.8	.93	2.45	9.5	-0.92
		(10.8)	-0.352	-5.93					
Japan	PSM5 (62050)	PSM9	(-2.6)	(-6.9)					
		1.69	[-0.02]		-16418.6	.98	2.54	2460.0	na
		(26.5)							
		[1.3]							

a/ t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

b/ The world price variables are corrected for exchange rates and tariffs where appropriate.

na = not applicable

slightly elastic (1.3). The balance of payments variable was found to be highly significant in the Brazil equation and to have an elasticity of -0.02. Freight rates are significant and correctly signed only for the U.S. and Brazil soybean meal functions.

3.3.6 ROW Net Trade Equations

These six equations have many characteristics in common so it was decided to describe their specification and estimation as a group.

Initially the ROW region was specified in a manner similar to the other regions, *i.e.*, demand and production equations estimated separately for all six products with net trade volumes as their respective differences. However two practical problems caused this specification to be abandoned. First, efforts to estimate demand equations for rapeseed oil and rapeseed meal led to consistently incorrect signs on the price coefficients. Second, although the ROW region is a relatively large producer of all six products, net trade volumes are relatively small and they often switch from being net exporters to net importers and back again. Thus even small errors in the estimated production and demand equations lead to large errors in calculated excess supply or demand and in turn world prices. It was therefore decided to estimate net trade equations for the ROW directly.

These six net trade equations are specified to be dependent on world price ratios (with negative signs for excess demand and positive signs for excess supply), domestic production, a time trend and a lagged dependent variable.^{22/} Because of aggregation problems specific policy variables are excluded from these equations, so in the notation of Zwart and Meilke (1979) these functions may be regarded as policy inclusive, derived excess demand and supply curves. They are similar in many respects to the equations estimated by Abbott (1979a, 1979b) for wheat and feedgrains.

The results of estimating these equations are presented in Table 3.23. In only one equation, net imports of soybean oil (NISL9), was it possible to obtain correctly signed price terms as well as retain variables such as production and time which contributed to high explanatory power. Rather than assume the ROW completely exogenous or accept incorrect signs, the price ratios in the remaining equations were constrained to be correctly signed and to have given elasticities. The elasticities are set at 1.4 for rapeseed and soybeans (as estimated in preliminary regressions for soybean demand in the ROW region); -0.5 for rapeseed oil (approximately the same as estimated for soybean oil); and +0.5 and -0.5 for rapeseed meal and soybean meal respectively (reflecting roughly the meal demand elasticities in other regions of the model).

The excess demand equations are generally good in terms of \bar{R}^2 , but the excess supply equations have considerably less explanatory power. There is no evidence of first order autocorrelation, but Durbin's (H) statistic cannot be calculated for several of the equations because the denominator of the statistic is negative (Durbin, 1970). Most estimated coefficients

^{22/}

For rapeseed, soybeans, rapeseed oil and soybean oil these ratios incorporate competitive products, so the equations are conventional excess supply or demand functions. In the meal equations the ratios incorporate a wholesale price index rather than a competitive price, since only in this form were the coefficients on other variables correctly signed.

Table 3.23: Rest of World Net Trade Equations^{a/}

Region	Dependent Variable (Mean)	Independent Variables					Statistics				
		World Price	Other Variables	Production	Trend	Lagged Dependent Variable	Constant	R ²	DW (H)	SEE	n
ROW	NXRA9 ^{b/} (37.2)	PRA9/PSO9 47.0 (constrained) [1.4]	D73 -368.3 (-3.3)	QRA9 0.149 (1.9) [17.7]	TIME -16.1 (-1.1)		-441.4	.46	1.37	105.0	14
ROW	NISO9 ^{b/} (2494)	PSO9/PRA9 -3795.0 (constrained) [-1.4]			TIME 377.5 (9.2)		1270.4	.88	3.04	621.7	14
ROW	NIRL9 ^{b/} (103)	PRL9/PSL9 -54.6 (constrained) [-0.5]		QRL9 -0.158 (-3.0) [-2.1]	TIME 19.70 (3.20)	NIRL9(-1) 0.684 (2.1)	75.2	.81	1.31 (c/)	47.1	14
ROW	NISL9 (790)	PSL9/PRL9 319.2 (-0.6) [-0.4]		QSL9 -0.193 (-2.7) [-0.3]	TIME 62.87 (3.3)	NISL9(-1) 0.532 (1.9)	240.2	.87	1.89 (c/)	112.1	14
ROW	NXRM9 ^{b/} (73.3)	PRM9/WPI4 48.8 (constrained) [0.5]		QRM9 0.032 (1.6) [1.03]		NXRM9(-1) 0.449 (1.6)	-69.0	.34	2.03 (c/)	33.9	14
ROW	NISM9 ^{b/} (2117)	PSM9/WPI4 -942.3 (constrained) [-0.5]			TIME 260.9 (2.4)	NISM9(-1) 0.453 (1.5)	-900.6	.84	1.60 (c/)	680.2	14

^{a/} t values are given in parenthesis and elasticities at mean values in brackets below the estimated coefficients.

^{b/} No t statistics are reported for the price term in this equation because the coefficient is constrained.

^{c/} Durbin's H statistic cannot be calculated for this equation.

have significant t values.

The potential errors in the analysis caused by these constrained estimates are likely to be small. Even though production and consumption of oilseeds and products in the ROW region are significant proportions of world production and consumption, the net trade volumes are relatively small. Thus, as long as the parameter estimates have the correct signs, there is likely to be little effect (of an error in the magnitude of the price elasticities) on world price determination, and hence on other prices and quantities in the model. Further, because of the diverse nature of the ROW region, it is impossible to obtain data on the relevant direct supply and demand shifters, and recourse has to be made to very poor proxy variables (time trends). Consequently, given these specification problems, it is probably better to force in a reasonable and theoretically correct sign than to ignore price response entirely.

CHAPTER 4

VALIDATION OF THE STRUCTURAL MODEL

4.1 General Considerations in Validating Econometric Models

Validation of a model is generally regarded as distinct from verification of a model. Indeed, verification - establishing whether the model is a true statement of reality - is, as Sowe (1973) points out, "...essentially a fruitless objective since after all no conclusive evidence can ever be adduced about the precise way in which complex economic forces interact". Validation, on the other hand, is simply the determination of whether the model fulfils well the demands made upon it: is it a valid representation of reality in the sense that it can adequately predict both within and beyond the sample period? A number of statistical tests are available to determine this validity.

To some extent, of course, validation of models within the sample period is carried out during the estimation phase. Tests of significance on estimated coefficients, R^2 , SEE, and DW statistics all provide evidence on the explanatory power and hence validity, of individual structural equations. However, and especially in the case of non-linear models, it is not until all the separate equations of the model are integrated and the entire model solved that its quality over the estimation period is apparent. For example, Holt (1965) observes "... it is quite possible for the individual equations to fit reasonably well, but when all the equations are solved jointly, errors may accumulate and a bad fit may be obtained".

Hence it is critical to assess the validity of the complete model over the estimation period even though individual component equations may be quite acceptable. Note that comparison of actual and model solution values beyond the estimation period can be done only if the test is carried out after the ex ante forecast period has become the actual past. A model validated, however comprehensively, from historical data can never ensure the sustained quality of forecasts into the distant future. This is primarily because of errors in projecting the exogenous variables, the possibility of significant structural change, and the errors generated by the forecasting methodology employed. This problem leads to Sowe's (1973) observations that "it is clear that the process of validation must be regarded as at best a close approximation to the unattainable ideal of verification." Nonetheless, it is reasonable to believe that a model which has shown itself to be valid in the historical context, and hence has presumably captured the leading attributes of the underlying structure, will yield more reliable forecasts in the short term than a model which has not been so validated".

4.2 Validation Procedures

When validating a dynamic, non-linear econometric model, the type of simulation used should be, in theory, a dynamic, stochastic, historical,

control simulation.^{23/} First, dynamic simulation of a dynamic model offers a more exacting test of the model's stability and hence its capacity to follow the sequence of recorded events. Further, since the dynamic solution path usually tends to progressively diverge from the true path because of error accumulation, it is possible from graphical examination of the two time paths for each endogenous variable to draw conclusions about the quality of different parts of the model specification. Selective re-estimation may then be considered in an attempt to improve the model's ex post predictive capacity.

Second, as there is no assurance that the behavioral disturbances in all equations will equal zero, a deterministic simulation is unlikely to describe reality very well, but since there is no assurance that the shocks assigned in any one stochastic simulation run will coincide in magnitude and sign with the true disturbances, there is similarly no basis for presuming that a single stochastic run will better describe reality than a single deterministic run. Replicated stochastic runs do, however, produce a distribution of outcomes for each period which provides valuable data for the evaluation of the model's dynamic performance. Further, Howrey and Kelejian (1969) demonstrate that in a non-linear model, deterministic simulations yield results that are inconsistent with the analytic-reduced form equation set, i.e. solutions may diverge systematically from the historical values. The mean path of a set of stochastic simulations will not be subject to this problem. Several empirical studies (Fitzgerald, 1973; Higgins and Fitzgerald, 1973; Nagar, 1969) have, however, found that the bias and inconsistency in deterministic simulation is small. Therefore unless there is particular interest in the distribution or confidence interval around the mean stochastic simulation, the practical gains of stochastic simulation are questionable, especially in light of the computational cost differences involved.

Third, since in validation interest lies in explaining actual reality, the focus of the simulation should be on using actual data and actual parameter estimates over the actual past. Thus, a control rather than an experimental solution and an historical rather than a forecast solution is called for.

Using the rationale developed above, the complete structural econometric model of the world market for rapeseed, soybeans and their products is validated using historical, dynamic, deterministic simulation procedures. In the face of limited resources, the high cost and questionable efficiency gains of stochastic simulation, ruled against its use. The simulations are performed using the TROLL system (National Bureau of Economic Research, 1972).

4.3 Historical Validation

The model estimated in Chapter 3 is validated over the period 1968/69 through 1976/77. This is the longest historical period available given that

^{23/} By historical we do not mean to imply that validation should be limited to only the estimation period but for any ex post forecasts that the actual data be available.

several of the endogenous variable series did not begin until 1968/69. A static as well as a dynamic validation is performed to provide a base against which to assess the impact of the dynamic properties of the model. Ex ante forecasts for 1977/78 are also reported in the next section.

Tables 4.1 to 4.4 present summary statistics for the validation of the supply, rapeseed/soybean, oil and meal blocks respectively. The descriptive statistics provided for both historical validations are mean percent error (MPE) and root mean square percent error (RMSPE), and for the 1977/78 forecasts, the percent error (PE). The RMSPE's from single equation simulations of the behavioral equations, and the means of the endogenous variables over 1968-1976 are also provided for comparative purposes.^{24/}

Before assessing the validation characteristics of the individual variables, the nature of the study should again be mentioned. The structural model developed in this study is of the world market for rapeseed, soybeans and their products. It is much larger than previous models of this sector, and the interdependencies and feedback effects are much more complicated. Thus, the potential sources of errors are more numerous, and the probability of these errors being amplified is greater. The model is highly non-linear and dynamic, and many variables are endogenous which other studies have typically assumed exogenous, e.g. the support price variables, and the prices of competing products. The support price variables in particular are often step functions, so although they are estimated with low RMSPE over the whole sample, in any one period they may exhibit relatively high errors. These errors feed through the acreage and production variables to crush, and thus to the whole spectrum of seed, oil and meal variables.^{25/} The presence of lagged dependent variables in the support price equations tends to extend these errors into future time periods as well. Finally, it has been shown (Howrey and Kelejian, 1969) that the joint presence of autocorrelation and a lagged dependent variable in any (not necessarily the same) equation in a simultaneous model results in dynamic validation errors which are autocorrelated and heteroskedastic. Therefore, it is possible that this model will not validate dynamically as well as the previous, simpler econometric models of the oilseed sector, and in some respects, the static validation outlined below is similar to dynamic validation of more conventionally specified models. It is believed, however, that the richness in structural detail, the comprehensive nature of the model, and the considerable advances made in commodity modeling methodology all contribute to a much improved specification over previous efforts and, therefore, to a more realistic view of behavior in the world markets for rapeseed, soybeans and their products.

^{24/} The RMSPE's in the single equation simulations will correspond exactly to the estimated behavioral equations if the equation does not include a lagged dependent variable. This is the case because in single equation simulations all RHS variables are set to their actual values, except lagged endogenous variables, which are set to the value generated in the previous period. In an equation with a lagged dependent variable it is possible for error build up to occur over time.

^{25/} For a detailed analysis of the impacts of the support price equations on the performance of the model the reader is referred to Meilke and Griffith (1981a).

4.3.1 The Supply Block

The static validation results indicate that the supply block approximates reality well. Of the 19 endogenous variables in the supply block only one Japanese rapeseed production (QRA5) has a RMSPE greater than 20 percent and this variable has some very small values which increase the likelihood of high percentage errors. It is also evident that QRA5 is substantially biased in the simulation and this is likely the cause of the large RMSPE. For the dynamic validation, the RMSPE are worse than in the static validation for most of the area and production variables, and are similar for the price support variables, with the exception of Brazil. Still, only three variables have RMSPE's greater than 20 percent. Thus, in the dynamic simulation, Japanese and Canadian rapeseed area and production variables perform relatively poorly, but the performance of the support price variables and the other area and production variables seems reasonable.

4.3.2 The Seed/Bean Block

With several exceptions, the rapeseed/soybean block validates well. In the static validation, all crush equations have RMSPE's less than 20 percent, although the two European Community variables have RMSPE near 17. This reflects the low explanatory power in these structural equations. In the dynamic validation, both of these variables and Brazilian crush perform worse, while there is little change in the other variables.

Considering that the rapeseed/soybean trade variables are generally calculated as residuals from market clearing identities, these equations perform surprisingly well. In the static validation, one half of the RMSPE's exceed 20 percent, but NXRA9 contains both positive and negative values and the other large errors can be traced to errors in supply (NXS06), crush (NXRA7) or stocks (EXRA3). In the dynamic simulation, the two European Community trade equations perform relatively poorly, while the remainder simulate about the same as the static specification although there is some deterioration in the U.S. export variable. Considerable positive bias is evident in the simulated values of NXRA7 and NXS06.

All of the stock demand variables validate poorly, especially dynamically, with four of five RMSPE's greater than 20 percent, although these results are similar to the structural equations on which they are based.

Prices in the rapeseed/soybean block generally validate well given that they must adjust to equate world excess supply and excess demand. In the static validation all price variables RMSPE's are less than 20 percent and four of 10 are under 10 percent. In the dynamic validation, the RMSPE's all increase by roughly 50 percent but only two (PS04 and PS03) have RMSPE's greater than 20 percent. The dynamics of the model, therefore, have an adverse effect on the RMSPE's in the model primarily because larger supply side errors are being fed through.

4.3.3 The Oil Block

The four total oil demand equations validate extremely well. In

Table 4.1: Validation of the Supply Block

Variable Type	Endogenous Variable	Mean of Endogenous Variable	Single Equation RMSPE	1968 - 1976				1977/78 Forecast
				Static Validation		Dynamic Validation		
				MPE	RMSPE	MPE	RMSPE	
Area Planted	ARA3	1263.4	12.2	-1.3	12.2	4.3	19.2	12.4
	ARA5	15.0	22.9	-1.8	16.8	-25.9	41.8	33.3
	ARA7	467.7	4.6	-0.3	4.7	0.0	5.5	10.2
	AS03	375.2	5.3	0.0	4.3	-0.6	6.6	-17.0
	AS04	19426.5	1.8	0.1	1.9	0.8	8.5	0.9
	AS05	95.9	4.1	-0.1	3.5	-1.5	5.8	-1.5
	AS06	3845.4	5.2	2.7	7.0	4.0	11.7	5.9
Oilseed Production	QRA3	1249.5	7.2	-2.6	15.4	2.7	20.0	-18.5
	QRA5	24.1	34.9	5.2	20.7	-10.5	31.9	20.0
	QRA7	951.3	8.4	1.6	10.5	1.7	11.9	7.9
	QS03	300.3	12.3	1.9	11.1	2.1	16.2	-37.1
	QS04	34509.2	2.8	-0.6	3.2	0.4	10.5	-5.8
	QS05	57.5	4.9	0.0	4.6	-2.0	7.6	-17.7
	QS06	6014.7	9.3	2.7	10.9	2.8	13.2	6.9
Support Price	GPRA5	105148	6.0	1.0	6.0	-5.1	9.8	1.2
	GPRA7	1127.5	4.2	0.1	4.2	0.1	4.2	-0.4
	LRS04	75.53	3.4	-0.2	3.6	-0.3	3.6	4.5
	GPS05	127609	8.6	-2.0	8.6	-6.1	10.9	6.8
	GPS06	670.3	6.6	2.3	5.9	3.0	11.8	19.5

Table 4.2: Validation of the Seed/Bean Block

Variable Type	Dependent Variable	Mean of Endogenous Variable	Single Equation RMSPE	1968 - 1976				1977/78 Forecast	
				Static Validation		Dynamic Validation			
				MPE	RMSPE	MPE	RMSPE		
Crush Demand	CRRA3	295.8	14.9	0.4	15.0	0.6	15.1	7.1	
	CRRA5	591.5	7.5	0.6	10.9	1.1	12.4	-14.5	
	CRRA7	1208.5	51.0	2.7	16.0	4.8	20.9	5.6	
	CRS03	640.1	1.1	-0.8	5.8	-0.6	7.6	-0.4	
	CRS04	20330.0	5.3	-1.0	6.2	-0.8	7.5	-4.9	
	CRS05	2701.2	4.2	-1.0	4.8	-0.9	4.7	-9.3	
	CRS06	3709.2	11.0	-0.4	7.8	-2.7	11.1	5.9	
Trade	CRS07	7103.0	49.4	4.2	18.2	8.0	26.1	-30.1	
	EXRA3	807.4	-	6.3	34.2	10.4	40.0	-29.0	
	NXRA5	-569.8	-	0.5	11.9	0.9	13.6	-13.9	
	NXRA7	-257.1	-	27.3	93.3	42.5	129	-13.8	
	NXRA9	19.5	97.1	-6.9	90.9	-9.0	91.2	241	
	EXS04	12485.8	-	0.8	7.0	1.6	13.7	-10.9	
	NXS03	-350.8	-	-0.8	21.9	1.4	28.6	91.4	
	NXS05	-3312.4	-	-0.9	4.4	-1.0	5.2	-13.8	
	NXS06	1772.6	-	28.4	83.4	25.5	61.3	-29.0	
	NXS07	-7103.0	-	4.2	18.2	8.0	26.1	-30.1	
	NIS09	3492.2	23.0	-0.1	18.4	0.1	18.7	40.4	
	Stock Demand	IRA3	424.7	63.6	8.2	68.0	7.4	68.3	-35.3
		IRA5	41.8	28.9	4.8	29.6	9.0	37.7	44.8
ISO3		47.4	36.8	7.0	44.0	10.4	61.2	-67.5	
ISO4		4511.7	21.4	0.0	17.8	4.8	36.2	12.3	
ISO5		280.9	12.8	-1.4	13.3	-2.0	14.4	-50.4	

... continued

Table 4.2 continued

Variable Type	Dependent Variable	Mean of Endogenous Variable	Single Equation RMSPE	1968 - 1976				1977/78 Forecast	
				Static Validation		Dynamic Validation			
				MPE	RMSPE	MPE	RMSPE	MPE	PE
World Price	PRA9	221.8	-	1.3	10.0	0.8	15.3		40.1
	PS09	193.1	-	1.3	12.4	1.4	17.5		7.2
Wholesale Price	PRA3	191.7	7.1	1.8	5.9	0.5	7.2		27.2
	PRA5	215.2	6.8	-0.8	10.4	-2.8	14.7		34.2
	PS03	178.2	1.7	2.1	11.4	3.2	21.0		15.6
	PS04	173.9	7.9	2.4	11.0	3.4	20.6		18.5
	PS05	200.3	7.3	-0.3	9.3	0.1	17.9		8.7
Farm Price	FPRA3	175.4	4.1	2.7	5.1	1.3	7.5		NA
	FPRA5	97559.2	6.7	-1.5	5.6	-5.3	9.0		-19.8
	FP04	159.5	8.9	2.3	11.0	2.7	15.3		6.9
	FP05	116818.0	11.4	-4.2	11.6	-4.9	12.9		-20.7
	FP06	1141.2	7.9	0.7	15.2	1.5	21.7		3.6

NA = not available due to data limitations.

both validations, the RMSPE of all the variables are less than 10 percent (Table 4.3). The market share equations validate equally well, especially dynamically with all RMSPE except one under 20 percent.

The oil demand variables are in most cases dependent on total oil demand and market shares, so they validate somewhere between these two variables. Static and dynamic validations are quite similar except for DRL7, which mirrors the poor dynamic performance of MKSRL7. The DSL6 variable simulates poorly both statically and dynamically. All three oil stock demand functions validate poorly, with RMSPE's between 20 and 35 percent, respectively, while the oil production variables are derived from the crush variables, so their validation characteristics merely reflect those of the crush equations.

With most being residuals from market clearing conditions, the oil net trade equations are not expected to have very good validation properties. This should be reinforced by the fact that many of the oil net trade variables have many very small values which increases the likelihood of high percentage errors. All net trade variables except two have RMSPE's greater than 100 percent. Most of these variables also exhibit substantial bias in the simulated values.

In the static validation, the oil block prices perform well with only two variables having RMSPE's greater than 20 percent. Both rapeseed oil and soybean oil prices are adversely affected by the dynamics of the model, with almost all variables having RMSPE's between 20 and 30 percent in the dynamic simulation.

4.3.4 The Meal Block

The meal demand equations validate well. In the static validation, all variables have RMSPE's less than 18 percent (Table 4.4). There is however some deterioration in performance in the dynamic validation, with RMSPE's rising.

As with the oil production variables, meal production is linked directly to crush, so the validation characteristics of the meal production variables mirror those of the respective crush equations. Again the stock variables validate poorly but this is expected given the behavioral equations on which they are based.

As in the oil block, the meal net trade equations are not expected to validate well because they are residuals from domestic market clearing identities, and many have very small values which increases the chance of a high RMSPE. In the static validation, all except one RMSPE exceeds 20 percent, and there is evidence of considerable bias in the simulated values. All the trade equations are essentially unchanged in dynamic validation.

The rapeseed meal price variables validate less well than the soybean meal prices with RMSPE's roughly twice as large as for soybean meal. In the dynamic validation, most prices have greater errors (although only three are greater than 20 percent).

Table 4.3 Validation of the Oil Block

Variable Type	Dependent Variable	Mean of Endogenous Variable	Single Equation RMSPE	1968 - 1976				1977/78 Forecast			
				Static Validation		Dynamic Validation		Static Validation		Dynamic Validation	
				MPE	RMSPE	MPE	RMSPE	MPE	RMSPE	MPE	RMSPE
Total Oil Demand	DAL3 DAL4 DAL5 DAL7	302.0 4339.5 1429.9 3599.0	2.6 2.0 6.2 5.8	0.0 -0.9 -0.4 -0.4	2.4 2.7 5.5 3.4	0.2 -0.8 -0.5 -0.2	3.4 4.5 6.0 5.9				
Market Shares	MKSRL3 MKSRL5 MKSRL7 MKSSL3 MKSSL4 MKSSL5 MKSSL7	0.30 0.17 0.10 0.38 0.70 0.32 0.30	10.7 7.3 29.7 10.6 2.5 3.3 9.1	4.4 2.0 0.2 -1.0 -0.5 0.8 0.5	16.8 8.6 16.7 9.0 2.3 4.4 4.8	5.7 2.4 0.5 -1.4 -1.6 0.3 1.1	14.5 7.4 26.9 5.5 2.5 4.7 6.9				
Individual Demand	DRL3 DRL5 DRL7 DSL3 DSL4 DSL5 DSL6 DSL7	90.7 243.1 360.5 115.3 3053.9 459.9 522.1 1078.6	- - - - - - 20.9 -	4.3 1.4 -0.5 -1.0 -1.4 0.2 1.7 -0.2	16.2 8.5 14.7 9.3 4.4 4.3 13.7 6.0	5.7 1.8 -0.8 -1.2 -2.4 -0.3 2.2 1.1	13.9 8.2 22.7 6.3 6.2 4.4 15.4 11.1				
Stock Demand	IRL3 ISL3 ISL4	4.7 4.3 323.0	23.8 17.5 20.9	6.3 6.2 4.5	35.4 20.7 21.3	6.4 7.1 6.1	35.4 23.1 30.2				
Oil Production	QRL3 QRL5 QRL7 QSL3 QSL4 QSL5 QSL6 QSL7	117.0 242.5 482.4 108.4 3662.6 459.2 686.2 1257.2	- - - - - - - -	0.4 0.6 2.7 -0.8 -1.0 -1.0 -0.4 4.2	15.0 10.9 16.0 5.8 6.2 4.8 7.8 18.2	0.6 1.1 4.8 -0.6 -0.8 -0.9 -2.7 8.0	15.1 12.4 20.9 7.6 7.5 4.7 11.1 26.1				

... continued

Table 4.3 continued

Variable Type	Dependent Variable	Mean of Endogenous Variable	Single Equation RMSPE	1968 - 1976				1977/78 Forecast
				Static Validation		Dynamic Validation		
				MPE	RMSPE	MPE	RMSPE	
Trade	EXRL3	25.4	-	63.0	228	39.4	233	83.4
	NXRL5	-0.6	-	-18.4	574	35.9	567	148
	NXRL7	121.9	-	-242	739	-205	746	33.8
	NIRL9	146.8	397	132	394	160	402	42.5
	NXSL3	-7.0	-	-39.6	174	-57.8	166	-83.5
	EXSL4	597.1	-	5.5	43.8	9.4	34.4	24.1
	NXSL5	-0.7	-	-509	899	-504	944	-2761
	NXSL6	164.1	-	18.5	294	-132	654	32.7
	NXSL7	178.6	-	232	615	225	558	-196
	NISL9	932.2	13.8	3.4	8.3	7.8	12.7	-17.0
World Price	PRL9	406.8	-	3.7	17.7	4.6	24.4	37.8
	PSL9	436.2	-	2.9	17.4	3.4	24.9	20.8
Wholesale Price	PRL3	461.6	16.7	-1.6	14.2	-2.4	15.9	41.6
	PRL5	138895.0	1.1	3.4	22.3	3.8	29.8	NA
	PRL7	445.1	-	3.7	17.7	4.6	24.4	37.8
	PSL3	439.8	10.7	3.7	21.2	3.2	22.4	25.3
	PSL4	402.9	5.3	4.4	17.5	5.0	25.9	23.2
	PSL5	207166.0	10.5	2.5	12.6	3.2	15.0	NA
	PSL6	4828.9	4.8	2.5	10.3	3.0	11.5	4.5
	PSL7	479.8	-	2.9	17.4	3.4	24.9	20.8

NA = not available due to data limitations.

Table 4.4: Validation of the Meal Block

Variable Type	Dependent Variable	Mean of Endogenous Variable	Single Equation RMSPE	1968 - 1976				1977/78 Forecast
				Static Validation		Dynamic Validation		
				MPE	RMSPE	MPE	RMSPE	
Meal Demand	DRM3	146.2	6.4	-2.2	13.3	2.4	21.8	0.7
	DRM5	351.9	6.9	1.5	5.7	2.7	7.9	-7.1
	DRM7	800.5	6.2	1.9	9.8	2.3	11.6	6.5
	DSM3	654.4	6.1	-1.4	5.6	-2.2	9.7	-7.8
	DSM4	12019.2	7.4	0.0	9.4	1.4	17.9	-8.6
	DSM5	2278.0	3.9	-0.4	5.6	-2.4	5.0	2.0
	DSM6	531.2	15.2	4.3	17.7	3.9	22.9	-11.9
	DSM7	8767.3	6.9	-2.0	6.6	-2.8	10.7	-20.2
Stock Demand	IRM3	4.2	399	218	519	269	666	-0.8
	ISM3	14.1	65.4	14.6	63.7	14.0	66.1	106
	ISM4	228.1	18.8	5.5	24.0	6.5	27.7	83.8
Meal Production	QRM3	170.7	-	0.4	15.0	0.6	15.1	7.1
	QRM5	343.1	-	0.6	10.9	1.1	12.4	-14.5
	QRM7	700.9	-	2.7	16.0	4.8	20.9	5.6
	QSM3	502.9	-	-0.8	5.8	-0.6	7.6	-0.4
	QSM4	16083.8	-	-1.0	6.2	-0.8	7.5	-4.9
	QSM5	2160.9	-	-1.0	4.8	-0.9	4.7	-9.3
	QSM6	2781.9	-	-0.4	7.8	-2.7	11.1	5.9
	QSM7	5682.4	-	4.2	18.2	8.0	26.1	-30.1

... continued

Table 4.4 continued

Variable Type	Dependent Variable	Mean of Endogenous Variable	Single Equation RMSPE	1968 - 1976				1977/78 Forecast
				Static Validation		Dynamic Validation		
				MPE	RMSPE	MPE	RMSPE	
Trade	EXRM3	23.9	-	9.4	144	14.3	223	15.4
	NXRM5	-8.9	-	-19.7	713	63.1	919	140
	NXRM7	-99.6	-	7.6	63.0	5.4	71.0	9.0
	NXRM9	84.6	140	37.1	141	41.2	150	31.6
	NXSM3	-154.0	-	-3.5	33.7	-4.1	38.2	-18.1
	EXSM4	4056.2	-	-2.5	32.1	-5.0	36.5	1.7
	NXSM5	-117.1	-	-77.1	256	-19.1	176	87.2
	NXSM6	2250.7	-	-0.7	14.8	-3.1	18.7	9.9
	NXSM7	-3084.9	-	-12.1	37.4	-22.9	54.4	-4.2
	N SM9	2950.9	46.1	15.0	37.3	20.8	40.7	12.5
World Price	PRM9	111.9	-	-1.4	29.6	-2.8	37.0	17.6
	PSM9	162.0	-	0.8	11.2	0.8	16.3	3.3
Wholesale Price	PRM3	112.7	8.3	1.0	12.7	-2.3	18.3	2.6
	PRM5	40588.9	4.1	-1.2	24.3	-5.1	26.3	NA
	PSM3	205.7	5.4	1.3	9.3	1.4	14.4	5.4
	PSM4	143.9	3.4	1.9	11.6	2.2	18.0	5.4
	PSM5	69088.8	3.9	1.5	14.5	1.4	19.9	NA
	PSM6	1107.8	14.6	0.2	18.2	0.0	23.8	5.6

NA = not available due to data limitations.

4.4 Predictions for 1977/78

Ex ante predictions for 1977/78 are reported in Tables 4.1 to 4.4 for the supply, rapeseed/soybean, oil and meal blocks respectively.

4.4.1 The Supply Block

The poor simulation performance of the Japanese rapeseed supply block continues into the ex post forecast period, but while the over-estimate is large in percentage terms the quantities involved are small, so little impact should be noticed in prices. The EC rapeseed and U.S. soybean variables are well predicted, and although the Canadian rapeseed area is over-estimated by 12.4 percent the corresponding production variable is under-estimated by 18.5 percent. Brazil soybean production is well predicted but this is largely due to the inclusion of a dummy variable in the structural equation to account for the very poor weather in this year.^{26/} Apart from the Brazil support price the model does a good job of predicting support prices in this period, being off target by less than 10 percent. Overall, three of the 19 endogenous variables in the supply block have prediction errors greater than 20 percent.

4.4.2 The Rapeseed/Soybean Block

With the exception of CRRA5 and CRS07, all crush equations have forecast errors of less than 10 percent. The net trade variables are however predicted about as successfully as indicated in the static validation. Rapeseed export volumes from Canada and ROW are under-estimated by 29 and 241 percent respectively, and while there is some offsetting increase in imports into the EC (following the upward bias in the simulated values of this variable), the net result is an over-estimate of the world price by 40.1 percent. In the soybean sector, U.S. and Japanese volumes are well predicted, but EC imports, and exports from Brazil are substantially under-estimated. The net result is an over-estimate of 7.2 percent in the world price.

The errors in predicting these world prices are transmitted via the price linkage functions to the domestic wholesale and farm prices, and these domestic price errors explain errors in stocks and to a lesser extent the crush variables. Overall 15 of the 33 endogenous variables in this block, for which predictions were made, have prediction errors of greater than 20 percent.

4.4.3 The Oil Block

World rapeseed oil and soybean oil prices are over-predicted by 37.8 and 20.8 percent respectively. These over-estimates are fed via the price link equations into the regional models where total vegetable oil demand is under-estimated, by less than 10 percent, in all regions except the EC. Similarly the demands for all individual oils are under-estimated, except

^{26/} Brazil soybean production is the only equation in which a value for 1977 was used in estimating a structural equation.

EC soybean oil, but with the exception of DRL3 all errors are less than 20 percent. The net trade segment of the oil block has some substantial prediction errors, with eight of ten being over 25 percent.

In the oil block in total, 19 of 48 endogenous variables have forecast errors greater than 20 percent.

4.4.4 The Meal Block

The model does a relatively good job of predicting 1977/78 meal block endogenous variables, with only seven out of 35 having prediction errors greater than 20 percent. The prediction of world rapeseed meal and soybean meal prices reflect errors in predicting world soybean and rapeseed crush, and these are transmitted to the regional markets via the price linkages. However with demands being more accurately predicted (one error over 20 percent) and meal production mirroring crush (one error over 20 percent), the net trade variables tend to be predicted a little better than the oil trade variables. Most of the prediction errors reflect consistent biases in the simulation model.

CHAPTER 5

MULTIPLIER ANALYSIS

5.1 Calculation Procedure

The calculation of multipliers for a linear econometric model is a straightforward exercise in matrix manipulation (Labys, 1973). The soybean/rapeseed model is however nonlinear in both parameter and variable space. Consequently, in order to calculate multipliers, the model either has to be linearized, or the multipliers obtained using simulation techniques (Sowey, 1973; Heien, Matthews and Womack, 1973; Meilke and Young, 1979). Both methods have their limitations but given the large number of nonlinear variables, it was decided to generate multipliers, for selected exogenous variables, using simulation techniques. Before turning to a discussion of how the multipliers are calculated it should be noted that for nonlinear models the multipliers are not unique, and depend on the size of the change in the exogenous variable and the starting values used for the endogenous variables (Pindyck and Rubinfeld, 1981, p. 393). ^{27/}

If impact multipliers are calculated for a linear model, using matrix manipulation, the multipliers show the change in each endogenous variable (in period t), given a unit change in a single exogenous variable (in period t). Depending on the units of measurement, for the exogenous variable, a unit change can be either a very large or very small percentage change from the exogenous variable's normal level. For this reason the impact multipliers reported in the next section do not correspond to a unit change in the exogenous variable. Instead, the perturbation chosen for each of the exogenous variables is equal to one percent of its value in 1968/69. The impact multipliers are calculated by simulating the model, using historical values of the exogenous variables, to obtain equilibrium (the base simulation) values for the endogenous variables in 1968/69. These values are reported in the first column of Tables 4.1 and 4.2 for selected endogenous variables. The value of the exogenous variable, of interest, is then increased by one percent of its 1968 value and the model resimulated. The difference between the value of the endogenous variables in the perturbed simulation and the base simulation provide the impact multipliers. The impact multiplier is also expressed in percentage terms by dividing the unit change in the endogenous variable by its equilibrium value in the base simulation. Percentage changes in the endogenous and exogenous variables can be combined to calculate impact or total elasticities (Pindyck and Rubinfeld, 1981; Tomek and Robinson, 1981). In fact, since the percentage change in the exogenous variable is always one percent the percentage change reported for each endogenous variable is also the impact elasticity.

^{27/}

Some limited testing has been done to check the sensitivity of the multipliers with respect to the size of the exogenous shock. For shocks between 1 and 10 percent, of the value of the exogenous variables, the multipliers appear to be nearly linear.

5.2 Impact Multipliers for Demand Variables

The impact multipliers, for selected exogenous variables, which directly influence the demand for soybeans, rapeseed, and their products are reported in Tables 5.1 to 5.7, for a representative group of endogenous variables. It should be kept in mind that these multipliers represent the response of the endogenous variables, in period t , to a shock in an exogenous variable, in period t . Consequently, there is no production response, since production only responds to price changes on a delayed basis, *i.e.*, total supply in period t is fixed.

5.2.1 Impact Multipliers for Income Variables

The first set of multipliers (Table 5.1) show the impact of a one percent change in real income for each of the countries in the model. The impact of income changes on crush are similar across all five regions, and in general small with most of the total elasticities less than 0.10 percent. An increase in real income, in any one country, increases the demand for vegetable oil in that country and has mixed impacts on vegetable oil consumption in the other countries. For example, a one percent increase in Canadian real income (DY3) increases Canadian soybean oil consumption 1,020 mt (1.17%) and rapeseed oil consumption 710 mt (1.07%); a one percent rise in U.S. real income (DY4) increases U.S. soybean oil consumption 1,630 mt (0.07%); a one percent increase in Japanese real income (DY5) increases Japanese soybean oil and rapeseed oil consumption 3,230 mt (0.83%) and 990 mt (0.73%), respectively; a Brazilian real income (DY6) expansion of one percent results in 4,640 mt (2.89%) more soybean oil consumption, while in the EC a one percent real income (DY7R) rise results in 3,740 mt (0.59%) more soybean oil consumption and 750 mt (0.24%) more rapeseed oil consumption.^{28/} Impacts of real income changes on the soybean meal and rapeseed meal sectors are uniformly small for Canadian, U.S. and Japanese income changes. Income changes in Brazil have a large positive impact on Brazilian soybean meal consumption, 5,540 mt (4.27%), because income enters directly in the Brazilian soybean meal demand function. A one percent increase in EC income increases its consumption of rapeseed meal slightly, 280 mt. (0.05%), but decreases its use of soybean meal by 6,640 mt (-0.13). One of the major impacts of growing real incomes is increased exports of vegetable oil from the exporting countries. One percent real income increases in Canada, U.S., Japan, Brazil and the EC results in -17.92 percent, 2.42 percent, 3.78 percent, 2.30 percent and 5.41 percent changes in Canadian rapeseed oil exports, respectively; and, 0.19 percent, -0.30 percent, 0.45 percent, 0.49 percent and 0.57 percent changes in U.S. soybean oil exports, respectively. Real income growth also increases the price of soybean and rapeseed oil, with rapeseed oil prices generally more responsive to income changes than soybean oil prices. The largest impact on vegetable oil prices occurs with income increases in the EC, where a one percent rise in income pulls up the Canadian rapeseed oil price by \$1.15/mt (0.71%) and the U.S. soybean oil price by \$0.98/mt (0.43%). Real income changes in the U.S., Japan and

^{28/}

The abbreviation mt is used to represent metric tonnes.

Table 5.1: Impact Multipliers for Changes in Real Income in Canada, United States, Japan and the European Community

Value in Base Simulation ^a	Exogenous Variables					
	DY3		DY4		DY5	
	Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Change in Exogenous Variable	122.14	1.00	1545.0	1.00	313.82	1.00
<u>Endogenous Variables</u>						
Crush:						
Canada rapeseed	157.20	0.06	0.04	0.06	0.11	0.07
Japan rapeseed	352.80	0.10	0.03	0.07	0.23	0.06
EC rapeseed	1026.41	0.20	0.02	0.03	0.38	0.04
Canada soybeans	548.63	-0.10	-0.02	-0.04	-0.22	-0.04
U.S. soybeans	16653.10	-1.78	-0.01	-0.02	-3.87	-0.02
Japan soybeans	2152.40	-0.14	-0.01	-0.01	-0.30	-0.01
Brazil soybeans	736.67	-0.07	-0.01	-0.02	-0.16	-0.02
EC soybeans	3400.92	0.47	0.01	0.11	2.01	0.06
Oil Demand:						
Canada rapeseoil	66.42	0.71	1.07	-0.08	-0.10	-0.15
Japan rapeseoil	134.93	-0.06	-0.04	-0.06	0.99	0.73
EC rapeseoil	311.62	-0.49	-0.16	0.12	-0.57	-0.18
Canada soyoil	87.40	1.02	1.17	-0.03	*	*
U.S. soyoil	2415.26	-1.24	-0.05	0.07	-2.88	-0.12
Japan soyoil	390.51	0.03	0.01	*	3.23	0.83
Brazil soyoil	161.18	-0.16	-0.10	-0.24	-0.36	-0.23
EC soyoil	633.58	0.09	0.01	-0.10	-0.10	-0.01
Meal Demand:						
Canada rapemeal	100.40	0.04	0.04	0.06	0.08	0.08
Japan rapemeal	224.70	0.03	0.01	0.04	0.06	0.03
EC rapemeal	589.60	0.10	0.02	0.17	0.20	0.03

Table 5.1 continued

	Value in Base Simulation ^a	Exogenous Variables			
		DY6		DY7R	
Change in Exogenous Variable		Unit Δ	% Δ	Unit Δ	% Δ
		1.05	1.00	5.66	1.00
<u>Endogenous Variables</u>					
Crush:					
Canada rapeseed	157.20	0.09	0.06	0.15	0.10
Japan rapeseed	352.80	0.22	0.06	0.31	0.09
EC rapeseed	1026.41	0.43	0.04	0.54	0.05
Canada soybeans	548.63	-0.27	-0.05	-0.29	-0.05
U.S. soybeans	16653.10	-4.00	-0.02	-5.18	-0.03
Japan soybeans	2152.40	-0.32	-0.01	-0.40	-0.02
Brazil soybeans	736.67	-0.19	-0.02	-0.22	-0.03
EC soybeans	3400.92	5.66	0.17	2.09	0.06
Oil Demand:					
Canada rapeseed	66.42	-0.05	-0.07	-0.14	-0.22
Japan rapeseed	134.93	-0.08	-0.06	-0.16	-0.12
EC rapeseed	311.62	0.41	0.13	0.75	0.24
Canada soybean	87.40	-0.03	-0.03	0.01	0.01
U.S. soybean	2415.26	-3.10	-0.13	-3.72	-0.15
Japan soybean	390.51	-0.01	*	0.06	0.01
Brazil soybean	161.18	4.64	2.89	-0.47	-0.29
EC soybean	633.58	-0.65	-0.10	3.74	0.59
Meal Demand:					
Canada rapemeal	100.40	0.09	0.09	0.11	0.10
Japan rapemeal	224.70	0.08	0.04	0.08	0.04
EC rapemeal	589.60	0.20	0.03	0.28	0.05

Table 5.1 continued

	Value in Base Simulation ^{a/}	Exogenous Variables			
		DY6		DY7R	
		Unit Δ	% Δ	Unit Δ	% Δ
Canada soymeal	476.03	-0.22	-0.05	-0.23	-0.05
U.S. soymeal	10075.60	-0.55	-0.1	3.40	0.03
Japan soymeal	1723.47	-0.50	-0.03	-0.84	-0.05
Brazil soymeal	129.66	5.54	4.27	0.19	0.15
EC soymeal	4983.27	-3.83	-0.08	-6.64	-0.13
Net Exports:					
Canada rapeseed	481.94	0.64	0.13	0.78	0.16
Canada rapeseed	-3.84	0.09	2.30	0.21	5.41
Canada rapemeal	-8.44	-0.04	-0.50	-0.03	-0.33
Canada soybeans	-315.38	0.32	0.10	0.34	0.11
Canada soyoil	4.89	-0.01	-0.22	-0.06	-1.20
Canada soymeal	-42.60	0.01	0.02	*	*
U.S. soybeans	7235.48	6.79	0.09	7.89	0.11
U.S. soyoil	593.85	2.90	0.49	3.41	0.57
U.S. soymeal	3298.59	-3.00	-0.09	-8.06	-0.24
Brazil soybeans	78.44	0.19	0.24	0.21	0.28
Brazil soyoil	-24.89	-4.68	-18.82	0.43	1.73
Brazil soymeal	422.84	-5.68	-1.34	-0.35	-0.08
Prices:					
Canada rapeseed	92.85	0.13	0.14	0.21	0.22
World rapeseed	109.58	0.20	0.18	0.32	0.29
U.S. soybeans	104.56	0.16	0.16	0.16	0.15
Canada rapeseed	163.12	0.70	0.43	1.15	0.71
World rapeseed	216.16	1.23	0.57	1.12	0.52
U.S. soyoil	225.97	0.82	0.36	0.98	0.43
Canada rapemeal	65.18	-0.06	-0.09	-0.11	-0.16
World rapemeal	44.27	-0.11	-0.26	-0.22	-0.49
U.S. soymeal	87.81	0.01	0.01	-0.04	-0.05

^{a/} All quantities are measured in 1,000 mt. All Canadian prices are in Canadian dollars and all others in U.S. dollars.

* Less than 0.005.

Brazil have smaller impacts on rapeseed and soybean oil prices.

Table 5.2 summarizes the impacts of changing world income on the value of Canada's rapeseed/soybean and products trade. Increases in Canada's real income generate a lower value for rapeseed oil and soybean oil net exports. These losses, in the value of trade, are only partially offset by a small increase in the value of rapeseed trade. Overall, a one percent increase in Canada's real income results in a \$329,980 (-13.11%) decline in the value of rapeseed, soybean and products trade.

Of the countries considered, income increases in the EC have the most positive impact on Canada's trade. For a one percent increase in EC real income Canada exports \$224,750 more rapeseed and products, reduces soybean and product imports by \$3,120, giving a net gain of \$227,870 (9.1%) in the value of total trade.

5.2.2 Impact Multipliers for Crushing Capacity

Changes in crushing capacity have little impact on endogenous variables, except for the obvious ones; crush in the country whose capacity has increased and trade flows (Table 5.3). A one percent increase in Canadian rapeseed crushing capacity (CRCAP3) increases rapeseed crush in Canada by 1,800 mt (1.15%), while decreasing Canadian rapeseed exports by 1,730 mt (0.36%), and increasing rapeseed oil and meal exports 710 mt (18.5%) and 990 mt (11.75%), respectively. A one percent rise in U.S. crushing capacity (CRCAP4) increases U.S. soybean crush by 103,120 mt (0.62%) and decreases U.S. soybean exports by 101,700 mt (1.41%). At the same time U.S. exports of soybean oil and meal go up by 2.89 percent and 2.33 percent, respectively. A one percent increase in Japanese crushing capacity (CRCAP5) increases Japanese rapeseed crush by 7,520 mt (2.13%) and soybean crush by 33,440 mt (1.55%). These increases are largely offset by declines in rapeseed 7,730 mt (-0.75%) and soybean crush, 29,550 mt (-0.87%), in the EC.

In terms of Canada's value of trade (Table 5.4) increases in Canadian rapeseed crushing capacity reduces the value of rapeseed net exports. However, the decline is more than offset by increases in net exports of rapeseed oil and meal. The net impact is an increase of \$27,910 (0.06%) in the value of rapeseed and products trade. The gain in rapeseed and products trade is partially offset by a decline in the value of soybean and products trade of \$2,070, leaving a net gain of \$25,840 (1.03%) in the value of total trade.

5.2.3 Impact Multipliers for Selected Meal Demand Variables

Impact multipliers are reported in Table 5.5 for six variables, LPROD3 and LPROD3X, LPROD4, LPROD5, IHG7, LPRICE4 and IMPC05, which have their most direct influence on the soybean meal and/or rapeseed meal markets. The variable which has the largest impact among these six is EC hog numbers (IHG7). A somewhat surprising result is that a one percent increase in EC hog numbers leads to decreased crush in all regions except the EC where soybean crush is up 79,800 mt (2.35%) and

Table 5.2: Impact of Real Income Changes in Canada, United States, Japan and the European Community on the Value of Canada's Rapeseed, Soybean and Products Trade

Change in Exogenous Variable	Value in Base Simulation (1,000 Can.dol.)	Exogenous Variables					
		DY3		DY4		DY5	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Change in Exogenous Variable		122.14	1.00	1545.0	1.00	313.82	1.00
<u>Endogenous Variables</u>							
Value of net exports:							
Canada rapeseed	44746.90	61.97	0.14	104.57	0.23	125.97	0.28
Canada rapeoil	-626.00	-114.05	-18.22	12.47	2.00	20.50	3.27
Canada rapemeal	-550.15	-0.37	-0.07	-0.05	-0.01	-0.57	-0.10
Canada rapeseed and products	43570.85	-52.45	-0.12	116.98	0.27	145.90	0.33
Canada soybeans	-36203.10	-5.39	-0.01	-12.81	-0.03	-12.29	-0.03
Canada soyoil	1242.72	-273.72	-22.03	4.06	0.33	-4.79	-0.38
Canada soymeal	-6092.93	1.59	0.03	-5.66	-0.09	0.34	0.01
Canada soybeans and products	-41053.4	-277.53	-0.68	-14.41	-0.04	-16.75	0.04
Canada rapeseed, soybeans and products	2517.45	-329.98	-13.11	102.57	4.1	129.16	5.1

Table 5.2 continued

	Value in Base Simulation (1,000 Can.dol.)	Exogenous Variables			
		Unit Δ	% Δ	Unit Δ	% Δ
Change in Exogenous Variable		1.05	1.00	5.66	1.00
<u>Endogenous Variables</u>					
Value of net exports:					
Canada rapeseed	44746.90	122.46	0.27	192.81	0.43
Canada rapeoil	-626.00	11.78	1.88	40.93	6.54
Canada rapemeal	-550.15	-2.29	-0.41	-8.99	-1.64
Canada rapeseed and products	43570.85	131.94	0.30	224.75	-0.51
Canada soybeans	-36203.10	-19.96	0.06	-11.16	-0.03
Canada soyoil	1242.72	2.06	0.17	7.88	0.63
Canada soymeal	-6092.93	1.13	0.02	6.41	0.11
Canada soybeans and products	-41053.4	-16.76	0.04	3.12	0.01
Canada rapeseed, soybeans and products	2517.45	115.18	4.57	227.87	9.05

Table 5.3: Impact Multipliers for Changes in Crushing Capacity in Canada, United States and Japan

Change in Exogenous Variable	Value in Base Simulation ^a	Exogenous Variables			
		CRCAP3	CRCAP4	CRCAP5	
		Unit Δ	% Δ	Unit Δ	% Δ
	2.34	1.00	217.7	1.00	141.7 1.00
<u>Endogenous Variables</u>					
Crush:					
Canada rapeseed	157.20	1.80	1.15	0.02	0.01 -0.06 -0.03
Japan rapeseed	352.80	-0.04	-0.01	0.23	0.07 7.52 2.13
EC rapeseed	1026.41	-1.67	-0.16	-0.14	-0.01 -7.73 -0.75
Canada soybeans	548.63	-0.02	*	-0.59	-0.11 -0.38 -0.07
U.S. soybeans	16653.10	-0.24	*	103.12	0.62 -9.33 -0.06
Japan soybeans	2152.40	-0.01	*	-0.47	-0.02 33.44 1.55
Brazil soybeans	736.67	-0.01	*	-0.38	-0.05 -0.22 -0.03
EC soybeans	3400.92	-0.30	-0.01	-97.02	-2.85 -29.55 -0.87
Oil Demand:					
Canada rapeseed	66.42	*	*	0.01	0.01 -0.01 -0.02
Japan rapeseed	134.93	*	*	-0.02	-0.01 -0.02 -0.01
EC rapeseed	311.62	0.04	0.01	0.07	0.02 0.08 0.02
Canada soyoil	87.40	*	*	-0.01	-0.01 -0.01 -0.01
U.S. soyoil	2415.26	-0.04	*	-0.58	-0.02 -0.75 -0.03
Japan soyoil	390.51	*	*	*	* -0.09 -0.06
Brazil soyoil	161.18	*	*	-0.07	-0.04 -0.09 -0.02
EC soyoil	633.58	-0.03	*	-0.12	-0.02 -0.15 -0.02
Meal Demand:					
Canada rapemeal	100.40	*	*	-0.01	-0.01 * *
Japan rapemeal	224.70	*	*	-0.02	-0.01 0.01 0.01
EC rapemeal	589.60	*	*	0.04	0.01 -0.08 -0.01

Table 5.3 continued

	Value in Base Simulation ^{a/}	Exogenous Variables					
		CRCAP3		CRCAP4		CRCAP5	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Canada soymeal	476.03	-0.01	*	0.06	0.01	-0.06	-0.01
U.S. soymeal	10075.60	-0.61	-0.01	5.50	0.05	-8.04	-0.08
Japan soymeal	1723.47	0.03	*	-0.32	-0.02	0.53	0.03
Brazil soymeal	129.66	-0.03	-0.03	0.31	0.24	-0.46	-0.35
EC soymeal	4983.27	0.25	0.01	-2.60	-0.05	4.30	0.09
Net Exports:							
Canada rapeseed	481.94	-1.73	-0.36	0.15	0.03	0.86	0.18
Canada rapeseed	-3.84	0.71	18.53	0.02	0.51	-0.01	-0.21
Canada rapemeal	-8.44	0.99	11.75	0.02	0.19	-0.02	-0.28
Canada soybeans	-315.38	0.02	0.01	0.61	0.19	0.43	0.13
Canada soyoil	4.89	*	-0.02	-0.09	-1.9	-0.06	-1.16
Canada soymeal	-42.60	*	-0.01	-0.52	-1.2	-0.24	-0.57
U.S. soybeans	7235.48	0.39	0.01	-101.70	-1.41	12.0	0.16
U.S. soyoil	593.85	0.01	*	17.19	2.89	-0.64	-0.11
U.S. soymeal	3298.59	0.43	0.01	76.88	2.33	0.22	0.28
Brazil soybeans	78.44	0.01	0.01	0.38	0.49	0.67	0.02
Brazil soyoil	-24.89	*	0.01	*	0.01	0.05	0.21
Brazil soymeal	422.84	0.03	0.01	-0.60	-0.01	0.29	0.07
Prices:							
Canada rapeseed	92.85	0.02	0.02	*	*	0.16	0.17
World rapeseed	109.58	0.03	0.02	*	*	0.25	0.23
U.S. soybeans	104.56	0.01	0.01	0.08	0.08	0.16	0.15
Canada rapeseed	163.12	*	*	0.13	0.08	0.17	0.10
World rapeseed	216.16	*	*	0.13	0.06	0.17	0.08
U.S. soyoil	225.97	0.01	*	0.15	0.07	0.20	0.09
Canada rapemeal	65.18	0.01	0.01	-0.05	-0.08	0.08	0.12
World rapemeal	44.27	0.01	0.02	-0.10	-0.23	0.16	0.37
U.S. soymeal	87.81	0.01	0.01	-0.07	-0.08	0.10	0.11

^{a/} All quantities are measured in 1,000 mt. All Canadian prices are in Canadian dollars and all others in U.S. dollars.

* Less than 0.005.

Table 5.4: Impact of Crushing Capacity Changes, in Canada, United States and Japan, on the Value of Canada's Rapeseed, Soybean and Products Trade

Change in Exogenous Variable	Value in Base Simulation (1,000 Can.dol.)	Exogenous Variables			
		CRCAP3		CRCAP4	
		Unit Δ	% Δ	Unit Δ	% Δ
		2.34	1.00	217.7	1.00
				141.7	1.00
<u>Endogenous Variables</u>					
Value of net exports:					
Canada rapeseed	44746.90	-152.64	-0.34	13.54	0.03
Canada rapeoil	-626.00	115.97	18.53	2.66	0.42
Canada rapemeal	-550.15	64.57	11.74	1.47	0.27
				157.43	0.35
				-1.99	-0.32
				-2.22	-0.40
Canada rapeseed and products	43570.85	27.91	0.06	17.67	0.04
				153.21	0.35
Canada soybeans	-36203.10	-1.02	*	41.12	0.11
Canada soyoil	1242.72	-0.18	-0.01	-22.69	-1.82
Canada soymeal	-6092.93	-0.86	-0.01	-71.15	-1.17
				-5.30	-0.01
				-13.27	-1.06
				-39.93	-0.65
Canada soybeans and products	-41053.4	-2.07	*	-52.72	-0.13
				-58.50	-0.14
Canada rapeseed, soybeans and products	2517.45	25.84	1.03	-35.05	-1.39
				94.71	3.77

rapeseed crush is up 13,590 mt (1.32%). EC soybean meal demand increases by 382,270 mt (7.67%) and rapeseed meal demand by 12,480 mt (2.12%). In order to satisfy the increased demand for soybean and rapeseed meal, in the EC, consumption of soybean meal drops by 307,030 mt (3.05%) in the U.S. and 15,900 mt (12.32%) in Brazil. U.S. and Brazil soybean meal exports are up by 8.99 percent and 3.65 percent, respectively, as are Canadian rapeseed meal exports (14.69%). U.S. soybean meal prices increase by \$3.87/mt (4.41%) and world rapeseed meal prices rise by \$8.18/mt (18.47%). Soybean and rapeseed oil price fall while rapeseed and soybean prices increase.

In order to calculate the impact of changes in Canadian livestock production, LPROD3 and LPROD3X are both increased by one percent. The variables are increased simultaneously because they are simply different weightings of Canadian beef and pork production. A one percent increase in Canadian livestock production increases the demand for rapeseed meal and soybean meal in Canada by 2,130 mt (2.13%) and 11,580 mt (2.43%), respectively. To meet this demand increase, Canadian exports of rapeseed meal fall by 2,160 mt (25.12%) and soybean meal imports increase by 12,220 mt (28.7%). At the same time U.S. soybean meal exports increase by slightly less than one percent. The rise in Canadian livestock production pulls up the world rapeseed meal price by \$0.91/mt (2.05%) and the U.S. soybean meal price by \$0.41/mt (0.47%).

Increasing U.S. livestock production (LPROD4) by one percent increases U.S. soybean meal demand by 14,930 mt (0.15%) and decreases U.S. soybean meal exports by 13,650 mt (0.41%). U.S. soybean meal prices are increased by \$0.88/mt (1.00%) and world rapeseed meal price by \$0.85/mt (1.92%).

A one percent increase in Japanese livestock production (LPROD5) results in a 2,000 mt (0.89%) increase in Japanese rapeseed meal demand and a 11,580 mt (0.67%) expansion in soybean meal demand. The demand shift raises U.S. soybean meal prices by \$0.26/mt (0.25%) and world rapeseed meal prices by \$0.80 (1.81%).

The impact of U.S. livestock prices (LPRICE4) is generally small. Table 5.5 shows that for a one percent rise in U.S. livestock prices U.S. soybean meal demand increases by 0.03 percent as U.S. soybean meal prices increase by 0.24 percent.

Changes in the price of corn in Japan (IMPC05) have, for the most part, only small impacts. A one percent Japanese corn price rise decreases Japanese rapeseed meal demand by 0.01 percent and soybean meal demand by 0.19 percent.

Table 5.6 shows the impact of changes in selected meal demand variables on the value of Canada's rapeseed, soybean and products trade. Expansion of livestock production in all regions of the world increases export earnings in Canada's rapeseed sector. However, gains in the rapeseed sector are usually partially, and sometimes completely offset by losses in the soybean sector. This is seen most clearly for livestock production increases in Canada, where rapeseed and products trade is up

Table 5.5: Impact Multipliers for Selected Meal Demand Variables

Change in Exogenous Variable	Value in Base Simulation ^a	Exogenous Variables					
		LPROD3		LPROD4		LPROD5	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
		9.24 (13.20)	1.00 (1.00)	0.014	1.00	4.95	1%
<u>Endogenous Variables</u>							
Crush:							
Canada rapeseed	157.20	-0.10	-0.06	-0.16	-0.10	-0.09	-0.06
Japan rapeseed	352.80	-0.16	-0.05	-0.35	-0.10	-0.14	-0.04
EC rapeseed	1026.41	1.76	0.17	1.81	0.18	1.54	0.15
Canada soybeans	548.63	-0.41	-0.07	-0.59	-0.11	-0.35	-0.06
U.S. soybeans	16653.10	-3.44	-0.02	-0.83	-0.01	-3.10	-0.02
Japan soybeans	2152.40	0.06	*	0.42	0.02	0.05	*
Brazil soybeans	736.67	-0.18	-0.02	-0.19	-0.03	-0.15	-0.02
EC soybeans	3400.92	5.26	0.15	24.98	0.73	4.23	0.12
Oil Demand:							
Canada rapeseed	66.42	0.04	0.06	0.09	0.13	0.03	0.05
Japan rapeseed	134.93	0.04	0.03	0.11	0.08	0.03	0.02
EC rapeseed	311.62	0.48	0.16	0.29	0.09	0.43	0.14
Canada soybean	87.40	-0.01	-0.01	0.01	0.01	-0.01	-0.01
U.S. soybean	2415.26	0.52	0.02	3.15	0.13	0.40	0.02
Japan soybean	390.51	-0.02	-0.01	-0.02	-0.01	-0.02	-0.01
Brazil soybean	161.18	0.07	0.04	0.40	0.25	0.05	0.03
EC soybean	633.58	-0.18	-0.03	0.29	0.05	-0.17	-0.03
Meal Demand:							
Canada rapemeal	100.40	2.13	2.13	0.40	0.40	-0.17	-0.17
Japan rapemeal	224.70	-0.09	-0.04	0.49	0.22	2.00	0.89
EC rapemeal	589.60	-0.72	-0.12	0.30	0.05	-0.65	-0.11

Table 5.5 continued

	Value in Base Simulation ^a	Exogenous Variables					
		LPROD3 (LPROD3X)		LPROD4		LPROD5	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Canada soymeal	476.03	11.58	2.43	-1.48	-0.31	0.20	0.04
U.S. soymeal	10075.60	-32.59	-0.32	14.93	0.15	-27.94	-0.28
Japan soymeal	1723.47	3.16	0.18	2.10	0.12	11.58	0.67
Brazil soymeal	129.66	-1.85	-1.42	-3.94	-3.04	-1.58	-1.22
EC soymeal	4983.27	25.28	0.51	18.10	0.36	22.44	0.45
Net Exports:							
Canada rapeseed	481.94	1.47	0.31	1.52	0.32	1.29	0.27
Canada rapeseed	-3.84	-0.08	-2.04	-0.16	-4.05	-0.07	-1.75
Canada rapemeal	-8.44	-2.16	-25.62	-0.47	-5.51	0.15	1.74
Canada soybeans	-315.38	0.50	0.16	0.74	0.23	0.43	0.14
Canada soyoil	4.89	-0.06	-1.17	-0.11	-2.31	-0.05	-1.01
Canada soymeal	-42.60	-12.22	-28.70	1.05	2.48	-0.49	-1.15
U.S. soybeans	7235.48	8.63	0.12	9.79	0.13	7.59	0.10
U.S. soyoil	593.85	-1.14	-0.19	-3.72	-0.62	-0.95	-0.16
U.S. soymeal	3298.59	30.63	0.93	-13.65	-0.41	26.13	0.79
Brazil soybeans	78.44	0.18	0.22	0.19	0.24	0.15	0.20
Brazil soyoil	-24.89	-0.10	-0.39	-0.43	-1.73	-0.08	0.32
Brazil soymeal	422.84	1.71	0.41	3.80	0.90	1.46	0.35
Prices:							
Canada rapeseed	93.85	0.25	0.27	0.07	0.08	0.22	0.24
World rapeseed	109.58	0.38	0.35	0.11	0.10	0.34	0.31
U.S. soybeans	104.56	0.30	0.29	0.53	0.50	0.35	0.40
Canada rapeseed	163.12	-0.23	-0.14	-0.85	-0.52	-0.19	-0.11
World rapeseed	216.16	-0.22	-0.10	-0.83	-0.38	-0.18	-0.08
U.S. soyoil	225.97	-0.14	-0.06	-0.82	-0.37	-0.10	-0.05
Canada rapemeal	65.18	0.45	0.68	0.42	0.64	0.39	0.60
World rapemeal	44.27	0.91	2.05	0.85	1.92	0.80	1.81
U.S. soymeal	87.81	0.41	0.47	0.88	1.00	0.26	0.25

Table 5.5 continued

Value in Base Simulation ^a / Variable	Exogenous Variables			
	IHG7 Unit Δ	% Δ	LPRICE4 Unit Δ	% Δ
Change in Exogenous Variable	586.44	1.00	0.012	1.00
			0.604	1.0
<u>Endogenous Variables</u>				
Crush:				
Canada rapeseed	157.20	-0.72	-0.04	-0.04
Japan rapeseed	352.80	-1.71	-0.08	-0.02
EC rapeseed	1026.41	13.59	0.43	0.04
Canada soybeans	548.63	-3.52	-0.14	-0.02
U.S. soybeans	16653.10	-23.3	-0.21	*
Japan soybeans	2152.40	1.58	0.10	*
Brazil soybeans	736.67	-0.64	-0.04	-0.02
EC soybeans	3400.92	79.80	6.00	0.01
			-0.96	-0.03
Oil Demand:				
Canada rapeseoil	66.42	0.27	0.02	0.03
Japan rapeseoil	134.93	0.51	0.03	0.02
EC rapeseoil	311.62	3.48	0.07	0.02
Canada soyoil	87.40	0.05	*	*
U.S. soyoil	2415.26	10.35	0.76	0.03
Japan soyoil	390.51	-0.32	*	*
Brazil soyoil	161.18	1.31	0.09	0.06
EC soyoil	633.58	-1.64	0.07	0.01
			-0.01	*
Meal Demand:				
Canada rapemeal	100.40	-1.41	0.09	0.09
Japan rapemeal	224.70	-0.59	0.12	0.05
EC rapemeal	589.60	12.48	0.07	0.01
			-0.01	*
			-0.02	-0.02
			-0.02	-0.01
			-0.01	*

Table 5.5 continued

	Value in Base Simulation ^{a/}	Exogenous Variables					
		IHG7		LPRICE4		IMPC05	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Canada soymeal	476.03	1.00	0.21	-0.35	-0.07	0.06	0.01
U.S. soymeal	10075.60	-307.03	-3.05	3.58	0.03	2.66	0.03
Japan soymeal	1723.47	28.08	1.63	0.50	0.03	-3.31	-0.19
Brazil soymeal	129.66	-15.90	-12.32	-0.94	-0.73	0.15	0.12
EC soymeal	4983.27	382.27	7.67	4.34	0.09	-0.69	-0.01
Net Exports:							
Canada rapeseed	481.94	11.39	2.4	0.36	0.07	-0.06	-0.01
Canada rapeseoil	-3.84	-0.55	-1.43	-0.04	-0.97	0.01	0.15
Canada rapemeal	-8.44	1.24	14.69	-0.11	-1.32	0.02	0.21
Canada soybeans	-315.38	4.23	1.34	0.18	0.06	-0.03	-0.01
Canada soyoil	4.89	-0.65	-13.29	-0.03	-0.55	*	0.09
Canada soymeal	-42.60	-3.79	-8.90	0.25	0.59	-0.04	-0.09
U.S. soybeans	7235.48	65.53	0.90	2.36	0.03	-0.37	-0.01
U.S. soyoil	593.85	-15.41	-2.60	-0.89	-0.15	0.14	0.02
U.S. soymeal	3298.59	296.77	8.99	-3.28	-0.10	-2.71	-0.08
Brazil soybeans	78.44	0.64	0.81	0.04	0.06	-0.01	-0.01
Brazil soyoil	-24.89	-1.43	-5.74	-0.10	-0.42	0.02	0.07
Brazil soymeal	422.84	15.42	3.65	0.91	0.21	-0.14	-0.03
Prices:							
Canada rapeseed	92.85	1.83	1.97	0.02	0.02	*	*
World rapeseed	109.58	2.84	2.60	0.03	0.02	*	*
U.S. soybeans	104.56	2.48	2.37	0.13	0.12	-0.02	-0.02
Canada rapeseoil	163.12	-3.60	-2.21	-0.20	-0.12	0.03	0.02
World rapeseoil	216.16	-3.52	-1.63	-0.20	-0.09	0.03	0.01
U.S. soyoil	225.97	-2.54	-1.12	-0.20	-0.09	0.03	0.01
Canada rapemeal	65.18	4.01	6.15	0.10	0.15	-0.01	-0.02
World rapemeal	44.27	8.18	18.47	0.20	0.46	-0.03	-0.07
U.S. soymeal	87.81	3.87	4.41	0.21	0.24	-0.03	-0.04

^{a/} All quantities are measured in 1,000 mt. All Canadian prices are in Canadian dollars and all others in U.S. dollars.
* Less than 0.005.

^{a/} All quantities are measured in 1,000 mt. All Canadian prices are in Canadian dollars and all others in U.S. dollars.

* Less than 0.005.

Table 5.6: Impact of Changes in Selected Meal Demand Variables on the Value of Canada's Trade in Rapeseed, Soybeans and Products

Change in Exogenous Variable	Value in Base Simulation ^a (1,000 Can.dol.)	Exogenous Variables					
		LPROD3 (LPROD3X)	LPROD4	LPROD5	Unit Δ	% Δ	% Δ
		Unit Δ	Unit Δ	Unit Δ	Unit Δ	% Δ	% Δ
Change in Exogenous Variable		9.24 (13.20)	0.014	4.95	1.00	1.00	1.00
<u>Endogenous Variables</u>							
Value of net exports:							
Canada rapeseed	44746.90	256.08	175.78	227.51	0.39	0.51	0.51
Canada rapeseed oil	-626.00	-11.89	-22.04	-10.28	-3.52	-1.64	-1.64
Canada rapemeal	-550.15	-145.63	-34.03	6.33	-6.18	1.15	1.15
Canada rapeseed and products	43570.85	98.55	119.71	223.56	0.27	0.51	0.51
Canada soybeans	-36203.10	-48.25	-96.98	-41.50	-0.27	0.11	0.11
Canada soybean oil	1242.72	-15.31	-33.33	-13.14	-2.68	-1.06	-1.06
Canada soybean meal	-6092.93	-1774.41	109.35	-87.37	1.79	-1.43	-1.43
Canada soybeans and products	-41053.4	-1837.97	-20.96	-142.01	0.05	-0.34	-0.34
Canada rapeseed, soybeans and products	2517.45	-1739.42	98.75	81.55	3.92	3.24	3.24

Table 5.6 continued

	Value in Base Simulation ^a / (1,000 Can.dol.)	Exogenous Variables					
		IHG7		LPRICE4		IMPC05	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Change in Exogenous Variable				0.012	1.00	0.604	1.00
<u>Endogenous Variables</u>							
Value of net exports:							
Canada rapeseed	44746.90	2027.45	4.53	51.16	0.11	-6.78	-0.01
Canada rapeoil	-626.00	-159.15	-25.40	-6.87	-1.10	0.84	0.13
Canada rapeseed	-550.15	245.73	44.66	-5.16	-0.94	1.29	0.23
Canada rapeseed and products	43570.85	2114.02	4.85	39.14	0.09	-4.66	-0.01
Canada soybeans	-36203.10	-343.15	-0.95	-19.69	-0.05	3.76	0.01
Canada soyoil	1242.72	-170.45	-13.72	-10.80	-0.87	1.32	0.11
Canada soymeal	-6092.93	-1044.98	-17.15	0.05	*	-4.10	-0.07
Canada soybeans and products	-41053.4	-1558.58	-3.80	-30.44	-0.07	0.99	*
Canada rapeseed, soybeans and products	2517.45	555.44	22.98	8.69	0.34	-3.66	-0.14

by \$98,550 but the cost of soybean and products imports increase by \$1,837,970.

The most positive impact on Canada's oilseed and products trade comes from livestock production increases in the EC, where a one percent rise in hog numbers increases the value of Canada's rapeseed and products trade by \$2,114,020 (4.85%). However, this gain is partially offset by a loss of \$1,558,580 (3.80%) in the soybean sector, leaving a net increase of \$555,440 (22.98%).

Increases in U.S. and Japanese livestock production generate only small net improvements in the value of Canada's oilseed trade.

5.2.4 Other Demand Side Multipliers

The price of other vegetable oils (POL4) and other protein meals (POM4) in the U.S., as discussed earlier, are treated as exogenous variables. Increasing the price of other vegetable oils by one percent in the U.S. leads to a \$0.55 (0.24%) increase in the U.S. soybean oil price and a \$0.46 (0.21%) increase in the world rapeseed oil price (Table 5.7). Similarly, a one percent rise in the price of other U.S. meals causes a \$0.71 (0.81%) increase in U.S. soybean meal price and a \$0.69 (1.56%) increase in world rapeseed meal price.

The last multiplier presented is for a shock of 100,000 mt in Brazil's soybean stocks (IS06). Increasing Brazil's stock of soybeans increases rapeseed crush and reduces soybean crush in all regions. Prices of all commodities rise in all regions. Canada's net exports of rapeseed increase by 3,170 mt (0.66%) but rapeseed meal net exports are down by 480 mt (5.69%). United States exports of soybeans, oil and meal are all up by 0.63 percent, 0.55 percent and 0.78 percent respectively.

5.3 Impact and Cumulative Multipliers for Supply Side Variables

Table 5.8 presents impact and cumulative multipliers for four representative variables whose direct influence is on the supply of soybeans or rapeseed. The procedure used to calculate the multipliers is to increase the value of the exogenous variable by an amount equal to one percent of its 1968/69 (period t) value and to maintain it at the higher level for five time periods. In all cases, except for the U.S. corn support price (WSPC04), the change in the exogenous variable has no impact on the endogenous variables until the following time period (t+1), because of the time lags built into the crop supply block. In order to give a picture of the dynamics of the model multipliers are presented for three time periods (Labys, 1973).

The first set of multipliers in Table 5.8 are for a one percent change in the U.S. price of fertilizer (PFERT4). The impact of increased fertilizer price in period t is to decrease U.S. soybean production by 50,480 mt and to increase U.S. soybean price by \$0.34/mt, in period t+1. The increased soybean price in t+1 leads to increased soybean production

Table 5.7: Impact Multipliers for Other Demand Variables

Value in Base Simulation ^{a/}	Exogenous Variables				ISO6	
	POL4 Unit Δ	POL4 % Δ	POM4 Unit Δ	POM4 % Δ	Unit Δ	% Δ
Change in Exogenous Variable	2.61	1.00	1.02	1.00	100.0	
<u>Endogenous Variables</u>						
Crush:						
Canada rapeseed	157.20	0.06	0.04	-0.13	-0.08	0.09
Japan rapeseed	352.80	0.15	0.04	-0.28	-0.08	0.45
EC rapeseed	1026.41	0.19	0.02	1.47	0.14	2.57
Canada soybeans	548.63	-0.15	-0.03	-0.48	-0.08	-1.76
U.S. soybeans	16653.10	-2.46	-0.01	-0.68	*	-30.87
Japan soybeans	2152.40	-0.22	-0.01	0.34	0.01	-0.84
Brazil soybeans	736.67	-0.11	-0.01	-0.15	-0.02	-0.85
EC soybeans	3400.92	2.51	0.07	20.36	0.60	-40.25
Oil Demand:						
Canada rapeoil	66.42	-0.04	-0.05	0.07	0.11	0.01
Japan rapeoil	134.93	-0.06	-0.04	0.09	0.07	-0.17
EC rapeoil	311.62	0.24	0.08	0.23	0.07	1.31
Canada soyoil	87.40	-0.02	-0.02	0.01	0.01	-0.16
U.S. soyoil	2415.26	1.07	0.04	2.57	0.11	-7.24
Japan soyoil	390.51	-0.01	*	-0.02	*	-0.02
Brazil soyoil	161.18	-0.26	-0.16	0.32	0.20	-0.92
EC soyoil	633.58	-0.42	-0.06	0.23	0.04	-2.74
Meal Demand:						
Canada rapemeal	100.40	0.04	0.04	0.32	0.32	0.55
Japan rapemeal	224.70	0.03	0.01	0.39	0.18	0.57
EC rapemeal	589.60	0.11	0.02	0.24	0.04	0.82
						0.14

Table 5.7 continued

	Value in Base Simulation ^{a/}	Exogenous Variables					
		POL4		POM4		ISO6	
		Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Canada soymeal	476.03	-0.08	-0.02	-1.20	-0.25	-1.55	-0.32
U.S. soymeal	10075.60	2.51	0.02	12.16	0.12	-50.17	-0.50
Japan soymeal	1723.47	-0.39	-0.02	1.71	0.10	-0.01	*
Brazil soymeal	129.66	0.14	0.11	-3.20	-2.47	-2.60	-2.01
EC soymeal	4983.27	-3.13	-0.06	14.76	0.30	1.25	0.02
Net Exports:							
Canada rapeseed	481.94	0.34	0.07	1.24	0.26	3.17	0.66
Canada rapeseed	-3.84	0.06	1.61	-0.13	-3.31	0.03	0.78
Canada rapemeal	-8.44	-0.01	-0.09	-0.38	-4.49	-0.48	-5.69
Canada soybeans	-315.38	0.17	0.05	0.60	0.19	2.02	0.64
Canada soyoil	4.89	*	-0.04	-0.09	-1.88	-0.12	-2.45
Canada soymeal	-42.60	-0.04	-0.09	0.86	2.02	0.21	0.49
U.S. soybeans	7235.48	3.84	0.05	7.98	0.11	46.01	0.63
U.S. soyoil	593.85	-1.18	-0.20	-3.03	-0.51	3.27	0.55
U.S. soymeal	3298.59	-4.79	-0.14	-11.12	-0.34	25.91	0.78
Brazil soybeans	78.44	0.11	0.14	0.15	0.19	-99.15	-126.40
Brazil soyoil	-24.89	0.24	0.97	-0.35	-1.41	0.76	3.05
Brazil soymeal	422.84	-0.22	-0.05	3.10	0.73	1.96	0.46
Prices:							
Canada rapeseed	92.85	0.08	0.08	0.05	0.06	0.46	0.49
World rapeseed	109.58	0.12	0.11	0.09	0.08	0.72	0.66
U.S. soybeans	104.56	0.08	0.08	0.42	0.41	0.89	0.85
Canada rapeseed	163.12	0.47	0.29	-0.69	-0.42	1.53	0.94
World rapeseed	216.16	0.46	0.21	-0.67	-0.31	1.49	0.68
U.S. soyoil	225.97	0.55	0.24	-0.68	-0.30	1.79	0.79
Canada rapemeal	65.18	-0.05	-0.08	0.34	0.52	0.12	0.18
World rapemeal	44.27	-0.11	-0.24	0.69	1.56	0.25	0.56
U.S. soymeal	87.81	-0.03	-0.04	0.71	0.81	0.63	0.71

a/ All quantities are measured in 1,000 mt. All Canadian prices are in Canadian dollars and all others in U.S. dollars.

* Less than 0.005.

of 23,890 mt in t+2. In t+2 the U.S. soybean loan rate is adjusted upwards by \$.32/mt to compensate for the increased fertilizer price. In period t+3 soybean production is up again by 39,371 mt, largely because of the increase in the loan rate. This set of multipliers provides clear evidence of the feedback effect from the economic environment to government policy variables.

An exogenous increase in the U.S. farm price of corn (FPC04), of \$.42/mt in period t, results in reduced soybean production of 85,920 mt and higher U.S. soybean prices, \$.57/mt in t+1. The U.S. corn price increase serves to raise Canadian rapeseed production by 6,210 mt in t+2, and 4,100 mt in t+3. The Canadian rapeseed price is up by \$.20/mt in t+1 and \$.05/mt in t+2, but declines by \$.12 in t+3.^{29/}

A U.S. corn support price (WSPC04) increase of \$.268/mt decreases U.S. soybean production by 53,470 mt in t, raising U.S. soybean prices by \$.36/mt. The impacts on U.S. soybean production and price in t+1 are smaller than those in t, e.g., U.S. soybean production is down by 27,370 mt and price up by \$.11/mt.

The final supply side multiplier presented is for Canadian wheat stocks (IWH3). An increase in Canadian wheat stocks of 231,840 mt causes producers to shift from wheat to rapeseed production, resulting in a 8,380 mt production increase in t+1. This production increase lowers the Canadian rapeseed price by \$.56/mt and the U.S. soybean price by \$.34/mt. In period t+2 Canadian rapeseed production is still up but by only 1,450 mt, while U.S. and Brazilian soybean production fall by 25,940 mt and 5,120 mt, respectively. Canadian rapeseed price is depressed by \$.52/mt in t+2, but U.S. soybean price is up \$.03/mt.

The influence of supply side variables on the value of Canada's rapeseed/soybean and products trade are shown in Table 5.9. In general there are no surprises in the results. The impact of variables which reduce the supply of soybeans in the U.S. is to increase the value of Canada's net exports of rapeseed and products and to increase the cost of Canada's imports of soybeans and products. In all cases the increased value of rapeseed and products trade more than offsets the increased cost of soybean and product imports.

The multiplier for Canadian wheat stocks (IWH3) illustrates the linkage between the Canadian wheat and rapeseed sectors. Increased wheat stocks results in a net gain in rapeseed/soybean and products trade of \$433,180 in year t+1 and \$240,980 in year t+2.

^{29/}

It should be kept in mind that in generating the multipliers for the U.S. corn and fertilizer prices the price of Canadian corn and Canadian fertilizer have been held constant. If the Canadian corn and fertilizer prices are increased along with the U.S. prices the net gain in trade for Canada is smaller.

Table 5.8: Impact and Cumulative Multipliers for Selected Supply Side Exogenous Variables

	Value in Base Simulation ^a	Exogenous Variables				
		PFERT4 Unit Δ	PFERT4 Unit Δ	PFERT4 Unit Δ	FPC04 Unit Δ	FPC04 Unit Δ
Change in Exogenous Variable	t+1	t+2	t+3	t+1	t+2	t+3
<u>Endogenous Variables</u>						
	0.0094	0.0094	0.0094	0.42	0.42	0.42
<u>Crush:</u>						
Canada rapeseed	157.20	0.05	0.03	-0.05	0.09	0.14
Japan rapeseed	352.80	0.22	-0.46	-0.25	0.38	0.11
EC rapeseed	1026.41	1.58	0.68	-1.81	2.70	3.65
Canada soybeans	548.63	-0.69	0.43	0.36	-1.17	-0.55
U.S. soybeans	16653.10	-12.51	6.58	6.74	-21.27	-11.93
Japan soybeans	2152.40	-0.35	0.32	0.35	-0.60	-0.24
Brazil soybeans	736.67	-0.33	0.35	0.19	-0.58	-0.15
EC soybeans	3400.92	-18.30	4.23	19.15	-31.18	-27.12
						-28.78
<u>Oil Demand:</u>						
Canada rapeoil	66.42	0.01	-0.08	0.02	-0.05	-0.06
Japan rapeoil	134.93	-0.01	0.20	0.12	-0.10	0.01
EC rapeoil	311.62	0.73	-0.05	-0.98	1.25	1.66
Canada soyoil	87.40	-0.07	0.10	0.03	-0.12	-0.02
U.S. soyoil	2415.26	-2.96	0.98	2.77	-5.04	-4.64
Japan soyoil	390.51	-0.02	-0.19	0.01	-0.04	0.06
Brazil soyoil	161.18	-0.37	0.07	0.51	-0.64	-0.62
EC soyoil	633.58	-1.33	0.31	0.94	-2.27	-1.60
						-0.84
<u>Meal Demand:</u>						
Canada rapemeal	100.40	0.28	-0.01	-0.19	0.48	0.49
Japan rapemeal	224.70	0.28	-0.04	-0.20	0.47	0.43
						0.62
						0.41

Table 5.8. continued

	Value in Base Simulation ^{a/}	Exogenous Variables					
		PFERT4 Unit Δ			FPCO4 Unit Δ		
		t+1	t+2	t+3	t+1	t+2	t+3
EC rapemeal	589.60	0.50	0.07	-0.73	0.85	1.07	0.78
Canada soymeal	476.03	-0.74	0.13	0.49	-1.27	-1.35	-1.53
U.S. soymeal	10075.60	-17.54	14.86	6.94	-29.84	-7.00	-11.68
Japan soymeal	1723.47	-0.54	-0.81	0.94	-0.93	-2.45	-2.05
Brazil soymeal	129.66	-0.91	0.75	0.33	-1.54	-0.35	-0.56
EC soymeal	4983.27	-3.75	-6.46	11.92	-6.40	-18.56	-11.36
Net Exports:							
Canada rapeseed	481.94	1.92	0.20	-2.08	3.27	3.93	3.52
Canada rapeoil	-3.84	0.01	0.09	-0.04	0.01	0.10	0.10
Canada rapemeal	-8.44	-0.25	0.02	0.17	-0.43	0.43	0.56
Canada soybeans	-315.38	0.78	-0.33	-0.35	1.33	0.89	0.93
Canada soyoil	4.89	-0.04	-0.04	0.03	-0.06	-0.09	-0.05
Canada soymeal	-42.60	0.23	0.18	-0.22	0.38	0.92	1.24
U.S. soybeans	7235.48	-25.29	-0.86	26.82	-43.07	-49.04	-47.21
U.S. soyoil	593.85	1.35	-0.76	-1.90	2.30	2.02	3.01
U.S. soymeal	3298.59	7.64	-9.84	-1.19	13.01	-2.72	5.48
Brazil soybeans	78.44	0.34	4.63	-1.19	0.58	8.64	7.08
Brazil soyoil	-24.89	0.31	-0.01	-0.47	0.53	0.60	0.48
Brazil soymeal	422.84	0.65	-0.48	-0.19	1.11	0.24	0.56
Prices:							
Canada rapeseed	93.85	0.12	-0.09	-0.18	0.20	0.05	-0.12
World rapeseed	109.58	0.18	-0.30	-0.07	0.31	-0.15	-0.09
U.S. soybeans	104.56	0.34	-0.23	0.32	0.57	0.23	0.29
Canada rapeoil	163.12	0.57	0.03	-0.97	0.97	1.13	0.60
World rapeoil	216.16	0.56	-0.38	-0.73	0.95	0.44	0.30

Table 5.8 continued

	Value in Base Simulation ^a	Exogenous Variables					
		t+1	PFERT4 Unit Δ	t+2	t+3	t+1	FPCO4 Unit Δ
		t+2	t+3	t+1	t+2	t+3	
U.S. soyoil	225.97	0.73	-0.41	-1.09	1.24	0.70	0.63
Canada rapemeal	65.18	-0.02	-0.13	0.06	-0.03	-0.27	-0.31
World rapemeal	44.27	-0.04	-0.26	0.33	-0.07	-0.53	-0.29
U.S. soymeal	87.81	0.22	-0.18	-0.08	0.38	0.09	0.15
Guaranteed Prices:							
U.S. soybean loan rate	88.53	0.0	0.32	0.45	0.0	0.0	0.04
Production:							
Canada rapeseed	481.04	0.0	3.65	-1.61	0.0	6.21	4.10
U.S. soybeans	29414.2	-50.48	23.89	39.71	-85.92	-53.76	-55.64
Brazil soybeans	921.11	0.0	4.99	-1.00	0.0	8.50	7.10

Table 5.8 continued

	Value in Base Simulation ^a	Exogenous Variables				
		WSPC04 Unit Δ	t	t+1	t+2	t+3
Change in Exogenous Variable		0.268	0.268	0.268	0.268	231.84 231.84 231.84
<u>Endogenous Variables</u>						
Crush:						
Canada rapeseed	157.20	0.05	0.08	0.07	0.06	0.09 0.06
Japan rapeseed	352.80	0.23	0.01	0.15	0.19	0.30 0.24
EC rapeseed	1026.41	1.67	2.11	2.52	3.15	2.92 1.82
Canada soybeans	548.63	-0.73	-0.26	-0.39	0.57	-0.11 0.09
U.S. soybeans	16653.10	-13.24	-5.94	-7.68	6.53	-3.39 0.35
Japan soybeans	2152.40	-0.37	-0.10	-0.19	0.08	-0.17 -0.02
Brazil soybeans	736.67	-0.36	-0.05	-0.09	0.02	-0.13 0.01
EC soybeans	3400.92	-19.40	-14.67	-25.21	-5.62	-10.71 -1.03
Oil Demand:						
Canada rapeseed	66.42	0.02	-0.04	-0.04	0.07	0.14 0.08
Japan rapeseed	134.93	-0.06	-0.08	-0.04	0.10	0.01 0.04
EC rapeseed	311.62	0.78	0.92	1.10	1.12	1.09 0.65
Canada soyoil	87.40	-0.08	*	-0.03	-0.01	-0.10 *
U.S. soyoil	2415.26	-3.14	-2.48	-3.87	1.29	-0.54 0.34
Japan soyoil	390.51	-0.02	0.01	-0.07	-0.08	-0.01 -0.03
Brazil soyoil	161.18	-0.40	-0.34	-0.45	0.16	-0.04 0.01
EC soyoil	633.58	-1.41	-0.86	-0.82	-0.92	-0.88 -0.23
Meal Demand:						
Canada rapemeal	100.40	0.29	0.27	0.47	0.30	0.71 0.28
Japan rapemeal	224.70	0.30	0.24	0.33	0.20	0.38 0.21

Table 5.8 continued

	Value in Base Simulation ^a	Exogenous Variables				
		t	WSPC04 Unit Δ	t+1	t+2	IWH3 Unit Δ
			t+1	t+2	t+3	
EC rapemeal	589.60	0.53	0.60	0.65	0.97	0.48
Canada soymeal	476.03	-0.79	-0.74	-1.19	-0.47	-1.86
U.S. soymeal	10075.60	-18.57	-2.28	-13.16	29.13	1.58
Japan soymeal	1723.47	-0.58	-1.46	-1.40	-3.67	-2.70
Brazil soymeal	129.66	-0.96	-0.11	-0.63	1.51	0.08
EC soymeal	4983.27	-3.98	-11.06	-8.17	-29.14	-10.00
						-12.27
Net Exports:						
Canada rapeseed	481.94	2.04	2.21	2.75	3.67	3.29
Canada rapeoil	-3.84	0.01	0.07	0.06	-0.05	-0.10
Canada rapemeal	-8.44	-0.27	-0.24	-0.43	-0.30	-0.66
Canada soybeans	-315.38	0.82	0.46	0.75	-0.67	-0.04
Canada soyoil	4.89	-0.04	-0.05	-0.03	0.11	0.09
Canada soymeal	-42.60	0.24	0.53	0.90	0.93	1.81
U.S. soybeans	7235.48	-26.79	-27.44	-37.76	-12.41	-13.30
U.S. soyoil	593.85	1.43	1.04	2.72	-0.41	0.39
U.S. soymeal	3298.59	8.09	-2.59	7.23	-24.44	-3.87
Brazil soybeans	78.44	0.36	5.33	3.93	-0.20	-5.00
Brazil soyoil	-24.89	0.33	0.33	0.43	-0.12	0.02
Brazil soymeal	422.84	0.69	0.08	0.56	-1.36	-0.17
						-0.56
Prices:						
Canada rapeseed	92.85	0.13	0.02	-0.04	-0.56	-0.52
World rapeseed	109.58	0.19	-0.12	0.03	-0.87	-0.18
U.S. soybeans	104.56	0.36	0.11	0.33	-0.34	0.03
Canada rapeoil	163.12	0.60	0.64	0.57	-0.64	-0.41
World rapeoil	216.16	0.59	0.20	0.45	-0.62	0.05
U.S. soyoil	225.97	0.78	0.35	0.76	-0.32	0.20
Canada rapemeal	65.18	-0.02	-0.17	-0.20	-0.49	-0.50
World rapemeal	44.27	-0.04	-0.33	-0.19	-1.01	-0.31
U.S. soymeal	87.81	0.23	0.03	0.17	-0.37	-0.02
						-0.14

Table 5.8 continued

	Value in Base Simulation ^{a/}	Exogenous Variables				
		t	WSPC04 Unit Δ t+1	t+2	t+1	IWH3 Unit Δ t+2
Guaranteed Prices:						
U.S. soybean loan rate	88.53	0.0	0.0	0.02	0.0	0.0
Production:						
Canada rapeseed	481.04	0.0	3.87	2.11	8.38	1.45
U.S. soybeans	29414.2	-53.47	-27.37	-51.77	0.0	-25.94
Brazil soybeans	921.11	0.0	5.28	3.84	0.0	-5.12
						1.65
						0.76
						-1.81
						-0.02

^{a/} All quantities are measured in 1,000 mt. All Canadian prices are in Canadian dollars and
all others in U.S. dollars.

Table 5.9: Impact of Changes in Selected Supply Variables on the Value of Canada's Trade in Rapeseed, Soybeans and Products

	Value in Base Simulation (1,000 Can. dol.)	Exogenous Variables					
		t+1	PFERT4 Unit Δ t+2	t+3	t+1	FPCO4 Unit Δ t+2	t+3
Change in Exogenous Variable		0.0094	0.0094	0.0094	0.42	0.42	0.42
<u>Endogenous Variables</u>							
Value of net exports:							
Canada rapeseed	44746.90	273.58	-33.12	-490.00	460.56	500.5	256.37
Canada rapeoil	-626.00	7.44	21.19	-15.93	12.59	52.60	29.83
Canada rapemeal	-550.15	-21.89	-4.71	10.53	-36.82	-53.28	-29.86
Canada rapeseed and products	43570.85	259.15	-16.69	-495.44	436.32	499.81	256.31
Canada soybeans	-36203.10	-26.00	62.71	53.08	-43.55	-8.61	58.16
Canada soyoil	1242.72	-5.59	-10.18	0.57	-9.37	-14.74	-13.55
Canada soymeal	-6092.93	3.48	62.62	-35.67	6.08	116.67	223.18
Canada soybeans and products	-41053.4	-28.11	115.15	17.94	-46.84	93.30	267.75
Canada rapeseed, soybeans and products	2517.45	231.04	98.47	-477.50	389.48	593.11	524.12

Table 5.8 con.

	Value in Base Simulation (1,000 Can. dol.)	Exogenous Variables				
		t	WSPC04 Unit Δ t+1	t+2	t+1	IWH3 Unit Δ t+2
genous		0.268	0.268	0.268	231.84	231.84
Value of net exports:						
Canada rapeseed	44746.90	289.86	278.75	285.31	248.67	93.87
Canada rapeoil	-626.00	7.90	31.97	20.40	-17.74	-34.18
Canada rapemeal	-550.15	-23.18	-30.62	-24.53	-41.88	-87.21
Canada rapeseed and products	43570.85	274.58	280.12	281.12	189.04	-27.56
Canada soybeans	-36203.10	-27.53	1.96	14.92	41.23	-19.01
Canada soyoil	1242.72	-5.91	-9.43	-4.62	25.69	19.15
Canada soymeal	-6092.93	3.69	72.71	158.78	177.22	268.41
Canada soybeans and products	-41053.4	-29.74	65.23	169.06	244.14	268.54
Canada rapeseed, soybeans and products	2517.45	244.84	345.36	450.19	433.18	240.98
						0.0

CHAPTER 6

SUMMARY

6.1 Summary of Study

Canada has an important stake in the structure and operation of the world markets for rapeseed, soybeans and their products. Rapeseed is by far the most important oilseed crop grown in Canada and in terms of farm value, of all crops grown, ranks second to only wheat. Canadian soybean production and consumption is small, in world terms, but it is an extremely important crop in Ontario where all of Canada's production is located. Rapeseed is a growing and significant source of foreign exchange for Canada; while Canada is a net importer of soybeans and products. Canada's role in world trade of rapeseed and products is significant and expanding, but many within the rapeseed industry argue there are a number of factors which are inhibiting the expansion of Canadian rapeseed production, crushing and manufacturing. For these reasons a quantitative representation of the world soybean/rapeseed and products market is needed to provide information on the structure and interrelationships within the sector. To date there have been few resources devoted to the development of multi-region and multi-commodity models of the oilseed sector.

The major objective of this study was to formulate, estimate and validate an econometric model of the world market for six commodities (soybeans, rapeseed, soybean meal, rapeseed meal, soybean oil, rapeseed oil); in six regions of the world (Canada, U.S., Brazil, EC, Japan, rest of world). The model constructed to meet this objective consists of 141 behavioral, market clearing and technical relations. Most of the behavioral equations were estimated over the time period 1963/64 through 1976/77, using ordinary least squares. The model was validated using a historical, dynamic, deterministic, control simulation, for 1968/69 through 1976/77, and an ex ante simulation for 1977/78.

The model represents an improvement over previous oilseed commodity models in a number of areas. First, the model allows for interaction among rapeseed, soybeans and their products in three of the five regions. Second, government policy variables which are normally considered exogenous in agricultural commodity models are endogenized to allow for feed back from the economic environment to the policy variables. Third, non-tariff barriers to trade, which cause a divergence between domestic market prices and world market prices are partially captured by introducing proxy variables into the domestic world price link equations. Finally, a market share approach to the estimation of soybean and rapeseed oil demand seems to have successfully overcome the multicollinearity problems which have typically plagued traditional demand estimation.

The model provides considerable new and updated information on the structure of the world's oilseed and products market. In addition the model has already proven useful in analyzing policies of importance to Canadian agriculture (Griffith and Meilke, 1981b).

6.2 Research Limitations

As with any study there are a number of limitations of the analysis which the reader should keep in mind. These limitations are discussed below in their order of importance, based on our judgement.

First, is the problem of temporal aggregation of quantity data from Northern and Southern hemisphere countries, and for different crop years. At present there seems to be no solution to this problem. A semi-annual model would largely overcome the aggregation problem but data is unavailable to develop semi-annual supply-utilization tables for more than a few countries.

Second, the absence of, in some cases, key data is a serious problem. This is particularly true for variables such as crushing capacity, whole-sale prices and farm level support prices. Of equal importance, information on the level of government intervention, instruments used, and the exact timing of policy changes are often difficult or impossible to obtain.

Third, one of the primary goals of multi-commodity, multi-region trade models is to capture as many of the general equilibrium impacts of price changes as possible. This goal has been most nearly met in the Canadian subsector where soybeans, rapeseed and their products comprise the majority of the oilseed market. Rapeseed and soybeans comprise smaller, yet significant, portions of the EC and Japanese markets and the model does a good job of capturing the interaction between both commodities. Nevertheless important relationships are omitted by the failure to consider other oilseeds. In the U.S. and Brazil the prices of oilseeds, vegetable oils and protein meals, other than soybeans, are considered exogenous and consequently many of the general equilibrium effects of price changes in these markets are lost. A high priority should be the endogenization of other oilseeds in those regions.

Finally, it is clear from working with the model that the supply of oilseed products tends to be highly inelastic in regions where crush is expressed as a function of crushing capacity and the price of seed relative to the price of oil and meal. This inelasticity in the supply of oil and meal, coupled with small inventories, and generally inelastic demand functions for oil and meal, means that prices must change by a large amount to induce small quantity adjustments. This results in a model where prices are more variable than in the real world and validate much worse than quantities. It is not clear if this reflects deficiencies in the data, model specification, or model estimation, but in any case it is an area deserving more attention.

6.3 Suggestions for Future Research

Several areas in need of more research were suggested in the preceding section, e.g., the need to endogenize more oilseeds, and further study of the price determination process in oilseed markets. In addition several other areas are deserving of additional attention.

First, several of the storage functions include the futures market price in the coming year as an exogenous variable. For forecasts made late in one crop year for the next crop year these futures market prices are known and are truly predetermined. However, for policy analysis these prices cannot be considered exogenous. Therefore a model with endogenous futures market prices would represent a major advance in commodity modeling methods.

Second, crush capacity has been considered an exogenous variable in the various crush equations. Again this creates no great problem for short-run forecasting but in the long-run crushing capacity is clearly an endogenous variable.

Third, policy intervention and government policies have been endogenized in a very simple reduced form fashion. As theoretical work on the theory of government intervention develops it seems likely that the reduced forms used here can be replaced with more sophisticated specifications.

Finally, in the present model structure there is no feedback from the oilseed sector to the non-agricultural sector. However, given the importance of soybean and product trade in Brazil, and to a lesser extent in Japan, it may prove useful to build in feedback mechanisms from oilseed trade to balance of payments, foreign exchange reserves and national income.

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APPENDIX I.

DATA PROBLEMS, DEFINITIONS AND SOURCES

A1.1 Data Problems

The data used in this study was obtained from a combination of individual country and international sources. Wherever possible an attempt was made to rely on sources within individual regions. Thus, most of the U.S. data came from USDA publications, and most of the Canadian data from Statistics Canada publications. These were supplemented by FAO data for oilseed area, production, and trade, as well as many of the prices used in the model. Finally, where the main data sources of a region were published in languages other than English, other sources were used including previous studies in the area. For example, the study by Furtan *et al.* (1978) provided much of the data on the Japanese model, and the study by Williams (1977) and subsequent revisions (Williams, 1980) filled a similar role with respect to the Brazilian model. These sources are explicitly identified in sections A1.3 and A1.4.

The two major data problems arising in the course of the study were the large number of non-existent, inconsistent or incomplete data series, and the comparability between calendar year and crop year statistics.

Non-existent series could not of course be used, and had to be ignored or proxied by time trends, dummy variables or lagged dependent variables. This is especially true for variables in the aggregate ROW region. Incomplete series also posed problems when the gaps meant that the sample period became too short for the acceptable application of tests of significance. In some cases these missing values were relatively easy to fill by, for example, using price indices to generate price levels; or calculating quantity figures from supply-disappearance identities when the other components were either known or could be reliably estimated. Finally, other series which had been identified as unreliable in previous work were excluded or replaced by more reliable but less appropriate variables, *e.g.*, the estimate of poultry numbers in Brazil (replaced by an income variable to represent shifts in the derived demand for soybean meal as a broiler feed).

The bulk of the data are collected and published on a crop year basis, so the model is estimated on a crop year basis. However, the data available in many of the regions is calendar year data. In these cases data for calendar year $t+1$ was defined as crop year t . Thus a problem arises in linking together series which are based on different time periods. The world equilibrium prices (taken to be the Rotterdam CIF import prices) are calendar year averages, while the Canadian and U.S. prices are on crop years. An adjustment for the different crop year is made in the Canadian rapeseed, rapeseed meal and rapeseed oil equations but not in the U.S. soybean and products equations. While this improved the simulation properties of the model as compared to the case when a crop year adjustment was included in the soybean and products equations, it

probably leads to some bias in the estimated coefficients. None the less the price links between regions presented no serious problems. The quantity linkages, however, are more troublesome. Net trade quantities for each product and each region are combined in world net trade identities to determine the world equilibrium prices. These prices plus some of the net trade quantities are on a calendar year basis, but Brazil, U.S. and Canadian net trade quantities are on a crop year basis. For these net trade quantities to be temporally comparable and hence useful for the calculation of a consistent set of world equilibrium prices, several implicit simplifying assumptions have to be made.

First, it is assumed that Canadian and U.S. exports of oil, meal and seed or beans occur predominantly within the period January to September. Second, a special case is presented by Brazil in that their soybean growing and harvesting periods are biannually opposed to Northern Hemisphere suppliers and importers. Thus it is assumed that Brazilian exports of oil, meal and beans occur predominantly within the period May to December. This assumption is acceptable until about 1975/76, but developments in infrastructure make it less so after this point.

It is recognized that for consistency all data in the model should be temporally comparable. Some temporal comparability was achieved through the adjustments in the price linkage functions, but the problem persists in the quantity linkages, and is therefore a limitation of the study and an area for greater effort in the future.

A1.2 Mnemonics

The mnemonic system used to identify endogenous variables in this study is composed of three items. First, one or more letters describes the type of variable. Thus P = wholesale price, Q = supply, D = demand, I = inventory, A = area, CR = crush, EX = exports etc. Variations on these basic types are for example FP = farm price, NI = net imports. Some specialized types have different identifiers such as LR = loan rate, MKS = market share. Second, two letters describe the commodity. The six endogenous commodities are RA = rapeseed, RL = rapeseed oil, RM = rapemeal, SO = soybeans, SL = soybean oil and SM = soybean meal. Third, a number identifies the appropriate region. The six regions are 3 = Canada, 4 = U.S., 5 = Japan, 6 = Brazil, 7 = EC and 9 = Rest of World.

For the exogenous variables the above system is used where possible. Thus for type of variable, YLD = yield, TAR = tariff, BOP = balance of payments, EXR = exchange rate, FR = freight rate, etc. For the commodity description, WH = wheat, FERT = fertilizer, CO = corn, and BA = barley etc. However, there are many variables which do not fit neatly into this categorization. For example, CRCAP = crushing capacity, DY = disposable income, LPROD = livestock production, EPl = futures price, IHG = inventory of hogs, etc. Dummy variables are either like D72 or DUMLIB.

A1.3 Endogenous Variable Descriptions

- ARA3 Canada rapeseed area planted, crop year, '000 ha (Canadian Wheat Board, 1980).
- ARA5 Japan rapeseed area planted, crop year, '000 ha (FAO, 1979a).
- ARA7 EC rapeseed area planted, crop year, '000 ha (FAO, 1979a).
- AS03 Canadian soybean area planted, crop year '000 acres (Statistics Canada, 1979).
- AS04 U.S. soybean area, total area planted, crop year, '000 ha (USDA, 1980a).
- AS05 Japan soybean area planted, crop year, '000 ha (FAO, 1979a).
- AS06 Brazil soybean planted area, crop year, '000 ha (USDA, 1980e).
- CRRA3 Canada rapeseed crush, crop year, '000 mt (Statistics Canada, 1979, 1980c).
- CRRA5 Japan rapeseed crush, calendar year, '000 mt. Calculated as $QRA5 + IRA5(-1) + IMRA5 - IRA5$.
- CRRA7 EC rapeseed crush, calendar year, '000 mt. Calculated as $QRA7 - NXRA7$.
- CRS03 Canada soybean crush, crop year, '000 mt (Canada Grains Council, 1980).
- CRS04 U.S. soybean crush, crop year, '000 mt (USDA, 1980a).
- CRS05 Japan soybean crush, calendar year, '000 mt. Calculated as $QS05 + IS05(-1) - DSS05 - IS05 - NXS05$.
- CRS06 Brazil soybean crush, crop year, '000 mt (Williams, 1980).
- CRS07 EC soybean crush, calendar year, '000 mt. Calculated as $- NXS07$.
- DAL3 Canada total edible oil consumption, crop year, '000 mt. Calculated as domestic disappearance of soybean, rapeseed, corn and sunflower seed oil, plus imports of palm, palm kernel, coconut, peanut, cottonseed and other oils not elsewhere specified (Statistics Canada, 1978, 1979, 1980a, 1980b, 1980c, 1980f).
- DAL4 U.S. total edible oil consumption, crop year, '000 mt. Calculated as domestic disappearance of coconut, corn, cotton, palm kernel, palm, peanut, soybean and sunflower oils (USDA, 1980a, 1980b).
- DAL5 Japan total edible fats and oils domestic disappearance, fiscal year, '000 mt (Prime Minister's Office, 1979).
- DAL7 EC total edible oil domestic disappearance, calendar year, '000 mt. Calculated as the sum of EC domestic disappearance of rapeseed, soybean, peanut, sunflower, sesame, cottonseed, coconut, palm kernel and palm oils, plus other fluid vegetable oils and other lauric oils (European Federation of Oilseed Crushers, 1977).

- DRL3 Canada rapeseed oil domestic disappearance, crop year, '000 mt.
Calculated as $QRL3 + IRL3(-1) - EXRL3 - IRL3$.
- DRL5 Japan rapeseed oil domestic disappearance, calendar year, '000
mt. Calculated as $QRL5 - NXRL5$.
- DRL7 EC rapeseed oil domestic disappearance, calendar year, '000 mt
(European Federation of Oilseed Crushers, 1977).
- DRM3 Canada rapeseed meal domestic disappearance, '000 mt.
Calculated as $QRM3 + IRM3(-1) - EXRM3 - IRM3$.
- DRM5 Japan rapeseed meal domestic disappearance, calendar year, '000
mt. Calculated as $QRM5 - NXRM5$.
- DRM7 EC rapeseed meal domestic disappearance, calendar year, '000
mt. Calculated as $QRM7 - NXRM7$.
- DSL3 Canada soybean oil domestic disappearance, crop year, 000 mt.
Calculated as $QSL3 + ISL3(-1) - ISL3 - NXSL3$.
- DSL4 U.S. soybean oil domestic disappearance, crop year, '000 mt
(USDA, 1980a).
- DSL5 Japan soybean oil domestic disappearance, calendar year, '000
mt. Calculated as $QSL5 - NXSL5$.
- DSL6 Brazil soybean oil domestic disappearance, crop year, '000 mt.
Calculated as $QSL6 - NXSL6$.
- DSL7 EC soybean oil domestic disappearance, calendar year, '000 mt.
Calculated as $QSL7 - NXSL7$.
- DSM3 Canada soybean meal domestic disappearance, crop year, '000 mt.
Calculated as $QSM3 + ISM3(-1) - ISM3 - NXSM3$.
- DSM4 U.S. soybean meal domestic disappearance, crop year, '000 mt
(USDA, 1980a).
- DSM5 Japan soybean meal domestic disappearance, calendar year, '000
mt. Calculated as $QSM5 - NXSM5$.
- DSM6 Brazil soybean meal domestic disappearance, crop year, '000 mt.
Calculated as $QSM6 - NXSM6$.
- DSM7 EC soybean meal domestic disappearance, calendar year, '000 mt.
Calculated as $QSM7 - NXSM7$.
- EXRA3 Canada rapeseed exports, crop year, '000 mt (Statistics Canada,
1979).
- EXRL3 Canada rapeseed oil exports, crop year, '000 mt (Statistics
Canada, 1978, 1980a).

EXRM3	Canada rapeseed meal exports, crop year, '000 mt (Statistics Canada, 1978, 1980c).
EXSL4	U.S. soybean oil exports, crop year, '000 mt (USDA, 1980a).
EXSM4	U.S. soybean meal exports, crop year, '000 mt (USDA, 1980a).
EXS04	U.S. soybean exports, crop year, '000 mt (USDA, 1980a).
FPRA3	Canada rapeseed average farm price, crop year, \$C/mt (Statistics Canada, 1975, 1978). ^{1/}
FPRA5	Japan rapeseed farm price, fiscal year, Y/mt (Prime Minister's Office, 1979).
FPS04	U.S. soybean average price received by farmers, crop year \$US/mt (USDA, 1980a).
FPS05	Japan soybean farm price, fiscal year, Y/mt (Prime Minister's Office, 1979).
FPS06	Brazil soybean farm price, calendar year, Cr/mt (Williams, 1980).
GPRA5	Japan rapeseed guaranteed producer price, includes incentive payments, fiscal year, Y/mt (MOAFF, 1980).
GPRA7	EC (France) rapeseed guaranteed price, calendar year, Fr/mt (FAO, 1979a; Parris and Ritson, 1977; EC, 1978). ^{2/}
GPS05	Japan soybean guaranteed producer price, includes incentive payments, fiscal year, Y/mt (MOAFF, 1980).
GPS06	Brazil soybean guaranteed farm price, calendar year, Cr/mt (Williams, 1980).
IRA3	Canada rapeseed closing stocks, farm plus commercial, crop year, '000 mt (Statistics Canada, 1978, 1980c).
IRA5	Japan rapeseed closing stocks, calendar year, '000 mt (MOAFF, 1980).
IRL3	Canada rapeseed oil closing stocks, held at crushers, crop year, mt (Statistics Canada, 1978, 1980f).
IRM3	Canada rapeseed meal closing stocks, held at crushers, crop year, '000 mt (Statistics Canada, 1978, 1980f).

^{1/} Missing values calculated as Provincial farm prices weighted by production.

^{2/} GPRA7 until 1967/68 is as defined by FAO. After the introduction of the CAP, GPRA7 is the rapeseed target price. Until 1974/75, the conversion from units of account to francs is based on the official parity exchange rate, after 1974/75 is based on the Green Franc exchange rate (Parris and Ritson, 1977, Heidhues et al., 1978; EC, 1978).

- ISL3 Canada soybean oil closing stocks, held at crushers, crop year, '000 mt (Statistics Canada, 1978, 1980f).
- ISL4 U.S. soybean oil closing commercial stocks, crop year, '000 mt (USDA, 1980a).
- ISM3 Canada soybean meal closing stocks, held at crushers, crop year, '000 mt (Statistics Canada, 1978, 1980f).
- ISM4 U.S. soybean meal closing stocks, crop year, '000 mt (USDA, 1980a).
- ISO3 Canada soybean, closing stock, crop year, '000 mt (Canada Grains Council, 1980).
- ISO4C U.S. soybean closing commercial stocks, crop year, '000 mt (USDA, 1980a).
- ISO5 Japan soybean, closing stock, calendar year, '000 mt (MOAFF, 1980).
- LRSO4 U.S. soybean loan rate, crop year, \$US/mt (USDA, 1980a).
- MKSRL3 Canada rapeseed oil share of total edible oil domestic disappearance, crop year, percent. Calculated as DRL3/DAL3.
- MKSRL5 Japan rapeseed oil share of total fats and oils disappearance, calendar year, percent. Calculated as DRL5/DAL5.
- MKSRL7 EC rapeseed oil share of total edible oil domestic disappearance, calendar year, percent. Calculated as DRL7/DAL7.
- MKSSL3 Canada soybean oil share of total edible oil domestic disappearance, crop year, percent. Calculated as DSL3/DAL3.
- MKSSL4 U.S. soybean oil share of total edible fats and oils domestic disappearance, crop year, percent. Calculated as DSL4/DAL4.
- MKSSL5 Japan soybean oil share of total fats and oils disappearance, calendar year, percent. Calculated as DSL5/DAL5.
- MKSSL7 EC soybean oil share of total edible oil domestic disappearance, calendar year, percent. Calculated as DSL7/DAL7.
- NIRL9 Rest of World rapeseed oil net imports, '000 mt. Calculated as EXRL3 + NXRL5 + NXRL7.
- NISL9 Rest of World soybean oil net imports, '000 mt. Calculated as EXSL4 + NXSL5 + NXSL6 + NXSL7 + NXSL3.
- NISM9 Rest of World soybean meal net imports, '000 mt. Calculated as EXSM4 + NXSM5 + NXSM6 + NXSM3 + NXSM7.
- NISO9 Rest of World soybean net imports, '000 mt. Calculated as EXSO4 + NXSO5 + NXSO6 + NXSO7 + NXSO3.

NXRA5 Japan rapeseed net exports, calendar year, '000 mt (MOAFF, 1980).

NXRA7 EC rapeseed net exports, calendar year, '000 mt (USDA, 1980e).

NXRA9 Rest of World rapeseed net exports, '000 mt. Calculated as - EXTRA3 - NXRA5 - NXRA7.

NXRL6 Japan rapeseed oil net exports, calendar year, '000 mt (USDA, 1980e).

NXRL7 EC rapeseed oil net exports, calendar year, '000 mt (USDA, 1980e).

NXRM5 Japan rapeseed meal net exports, calendar year, '000 mt (FAO, 1979b).

NXRM7 EC rapeseed meal net exports, calendar year, '000 mt (FAO, 1979b).

NXRM9 Rest of World rapeseed meal net exports, '000 mt. Calculated as - EXRM3 - NXRM5 - NXRM7.

NXSL3 Canada soybean oil net exports, crop year, '000 mt (Statistics Canada, 1978, 1979, 1980c).

NXSL5 Japan soybean oil net exports, calendar year, '000 mt (FAO, 1979b).

NXSL6 Brazil soybean oil net exports, crop year, '000 mt (Williams, 1980).

NXSL7 EC soybean oil net exports, calendar year, '000 mt (FAO, 1979b).

NXSM3 Canada soybean meal net exports, crop year, '000 mt (Statistics Canada, 1978, 1980c).

NXSM5 Japan soybean meal net exports, crop year, '000 mt (Statistics Canada, 1978, 1980c).

NXSM6 Brazil soybean meal net exports, crop year, '000 mt (Williams 1980).

NXSM7 EC soybean meal net exports, calendar year, '000 mt (FAO, 1979b).

NXS03 Canada soybean net exports, crop year, '000 mt (Canada Grains Council, 1980).

NXS05 Japan soybean net exports, crop year, '000 mt (FAO, 1979b).

NXS06 Brazil soybean net exports, crop year, '000 mt (Williams, 1980).

NXS07 EC soybean net exports, calendar year, '000 mt (FAO, 1979b).

PRA3 Canada rapeseed wholesale price, W.G.E. No. 1 Canadian, basis in store Vancouver, crop year, \$C/mt (Statistics Canada 1978, 1979, 1980c).

- PRA5 Japan rapeseed price, CIF unit import value, calendar year, \$US/mt (FAO, 1979b).
- PRA9 World rapeseed price, Canadian, 40%, CIF European ports, calendar year, \$US/mt (FAO, 1979a).
- PRL3 Canada rapeoil wholesale price, average price paid to crushers by processors, crop year, \$C/mt (Statistics Canada, 1978).^{3/}
- PRL5 Japan wholesale rapeseed oil price, calendar year, Y/mt (Furtan *et al.*, 1978). Missing values calculated from indices in Prime Minister's Office (1978).
- PRL7 EC rapeseed oil wholesale price, calendar year, \$US/mt. Calculated as $PRL9 * TARRL7$.
- PRL9 World rapeseed oil price, Netherlands CIF import unit value, calendar year, \$US/mt (FAO, 1979b).
- PRM3 Canada rapeseed meal wholesale price, 36%, Kamloops, crop year \$C/mt (Statistics Canada 1978, Canadian Livestock Feed Board, 1980).^{4/}
- PRM5 Japan wholesale rapeseed meal price, calendar year, Y/mt (Furtan *et al.*, 1978). Missing values calculated from indices in Prime Minister's Office (1978).
- PRM9 World rapeseed meal price, Netherlands CIF unit import value, calendar year, \$US/mt (FAO, 1979b).
- PSL3 Canada soybean oil wholesale price, average price paid to crushers by processors, crop year, \$C/mt (Statistics Canada, 1978).^{5/}
- PSL4 U.S. soybean oil price, Decatur, crude, crop year, \$US/mt (USDA, 1980a).
- PSL5 Japan wholesale soybean oil price, calendar year, Y/mt (Furtan *et al.*, 1978). Missing values calculated from indices in Prime Minister's Office (1978).

^{3/} Missing values for PRL3 were calculated by regressing PRL3 on $PRL4 * EXR34$ and using the estimated equation to generate the missing values for PRL3. PRL4 is the U.S. wholesale rapeseed oil price, New York, crop year, \$US/mt (USDA, 1980a).

^{4/} Missing values for PRM3 were calculated by regressing PRM3 on $PRM9 * EXR34$, adjusted for crop year, and using the estimated equation to generate the missing values for PRM3.

^{5/} Missing values for PSL3 were calculated by regressing PSL3 on $PSL4 * EXR34$ and using the estimated equation to generate the missing values.

- PSL6 Brazil soybean oil wholesale price, calendar year, Cr/mt (Williams, 1980).
- PSL7 EC soybean oil wholesale price, calendar year, \$US/mt. Calculated as PSL9 * TARSL7.
- PSL9 World soybean oil price, Netherlands CIF unit import value, calendar year, \$US/mt (FAO, 1979b).
- PSM3 Canada soybean meal wholesale price, 49%, Kamloops, crop year, \$C/mt (Statistics Canada, 1978; Canadian Livestock Feed Board, 1980).^{6/}
- PSM4 U.S. soybean meal price, Decatur, 44% protein, crop year, \$US/mt (USDA, 1980a).
- PSM5 Japan wholesale soybean meal price, calendar year, Y/mt (Furtan et al., 1978). Missing values calculated from indices in Prime Minister's Office (1978).
- PSM6 Brazil soybean meal wholesale price, calendar year, Cr/mt (Williams 1980).
- PSM9 World soybean meal price, Netherlands CIF unit import value, calendar year, \$US/mt (FAO, 1979b).
- PSO3 Canada soybean wholesale price, crop year, \$C/mt (Statistics Canada, 1978, 1980c).
- PSO4 U.S. soybean price, Decatur, No. 1 yellow, crop year \$US/mt (USDA, 1980a).
- PSO5 Japan soybean price, CIF import unit value, calendar year, \$US/mt (FAO, 1979b).
- PSO9 World soybean price, U.S. No. 2, CIF U.K. or European ports, calendar year, \$US/mt (FAO, 1979a).
- QRA3 Canada rapeseed production, crop year, '000 mt (Statistics Canada, 1979).
- QRA5 Japan rapeseed production, calendar year, '000 mt (MOAFF, 1980).
- QRA7 EC rapeseed production, calendar year, '000 mt (FAO, 1979a).
- QRL3 Canadian rapeseed oil production, crop year, '000 mt (Statistics Canada, 1978, 1980c).
- QRL5 Japan rapeseed oil production, calendar year, '000 mt. Calculated as CRRA5 * YLDRL5.

^{6/} Missing values for PSM3 were calculated by regressing PSM3 on PSM4 * EXR34 and using the estimated equation to generate the missing values.

- QRL7 EC rapeseed oil production, calendar year, '000 mt. Calculated as $CRRA7 * YLDRL7$.
- QRM3 Canadian rapeseed meal production, crop year, '000 mt (Statistics Canada, 1978, 1980c).
- QRM5 Japan rapeseed meal production, calendar year, '000 mt. Calculated as $CRRA5 * YLDRM5$.
- QRM7 EC rapeseed meal production, calendar year, '000 mt. Calculated as $CRRA7 * YLDRL7$.
- QSL3 Canada soybean oil production, crop year, '000 mt (Statistics Canada, 1978, 1980c).
- QSL4 U.S. soybean oil production, crop year, '000 mt (USDA, 1980a).
- QSL5 Japan soybean oil production, calendar year, '000 mt. Calculated as $CRS05 * YLDSL5$.
- QSL6 Brazil soybean oil production, crop year, '000 mt. Calculated as $CRS06 * YLDSL6$.
- QSL7 EC soybean oil production, calendar year, '000 mt. Calculated as $CRS07 * YLDSL7$.
- QSM3 Canada soybean meal production, crop year, '000 mt (Statistics Canada, 1978, 1980c).
- QSM4 U.S. soybean meal production, crop year, '000 mt (USDA, 1980a).
- QSM5 Japan soybean meal production, calendar year, '000 mt. Calculated as $CRS05 * YLDSM5$.
- QSM6 Brazil soybean meal production, crop year, '000 mt. Calculated as $CRS06 * YLDSM6$.
- QSM7 EC soybean meal production, calendar year, '000 mt. Calculated as $CRS07 * YLDSM7$.
- QS03 Canada soybean production, crop year, '000 mt (Canada Grains Council, 1980).
- QS04 U.S. soybean production, crop year, '000 mt (USDA, 1980a).
- QS05 Japan soybean production, excluding beans produced for food, crop year, '000 mt (MOAFF, 1980).
- QS06 Brazil soybean production, crop year, '000 mt (Williams, 1980; USDA, 1980c).
- VALURA3 Canada value of rapeseed products, \$C/mt. Calculated as $PRM3 * YLDRM3 + PRL3 * YLDRL3$.
- VALURA5 Japan value of rapeseed products, Y/mt. Calculated as $PRM5 * YLDRM5 + PRL5 * YLDRL5$.

- VALURA7 EC value of rapeseed products \$US/mt. Calculated as $PRM9 * YLDRM7 + PRL7 * YLDRL7$.
- VALUS03 Canada value of soybean products, \$C/mt. Calculated as $PSM3 * YLDSM3 + PSL3 * YLDSL3$.
- VALUS04 U.S. value of soybean products, \$US/mt. Calculated as $PSM4 * YLDSM4 + PSL4 * YLDSL4$.
- VALUS05 Japan value of soybean products, Y/mt. Calculated as $PSM5 * YLDSM5 + PSL5 * YLDSL5$.
- VALUS06 Brazil value of soybean products, Cr/mt. Calculated as $PSM6 * YLDSM6 + PSL6 * YLDSL6$.
- VALUS07 EC value of soybean products, \$US/mt. Calculated as $PSM9 * YLDSM7 + PSL7 * YLDSL7$.

A1.4 Exogenous Variable Descriptions

- BOP5 Japan, merchandise trade balance, current account, calendar year, mil. SDR's (IMF, 1980).
- BOP6 Brazil, merchandise trade balance, current account, calendar year, mil. SDR's (IMF, 1980).
- BSL3 Canada soybean oil basis, crop year, \$C/mt. Calculated as $EP1SL4 * EXR34 - PSL3$.
- BSM3 Canada soybean meal basis, crop year, \$C/mt. Calculated as $EP1SM4 * EXR34 - PSM3$.
- BSO3 Canada soybean basis, crop year, \$C/mt. Calculated as $EP1SO4 * EXR34 - PSO3$.
- CAPDUM Dummy variable 1960/61 through 1966/67 = 0 and one thereafter.
- CPI3 Canada consumer price index, crop year, percent 1971=100 (Statistics Canada, 1980d).
- CPI4 U.S. consumer price index, crop year, percent 1967=100 (IMF, 1980).
- CPI5 Japan consumer price index, calendar year, 1975=100 (IMF, 1980).
- CPI6 Brazil consumer price index, calendar year, 1975=100 (IMF, 1980).
- CPI7 EC consumer price index, average of member nations CPI's weighted by private consumption expenditure, calendar year, percent 1975=100 (IMF, 1980).
- CRCAP3 Canada rapeseed crushing capacity, calendar year, '000 mt/year (Perkins, 1976; Scott, 1980).

- CRCAP4 U.S. soybean crushing capacity, crop year, '000 mt/year (USDA, 1980a, 1980b).
- CRCAP5 Japan oilseed crushing capacity, calendar year, '000 mt/year (American Soybean Association, 1980).
- CRCAP6 Brazil soybean crushing capacity, crop year, '000 mt/year (Williams, 1980).
- DBL4 U.S. butter and lard domestic disappearance, crop year, '000 mt (USDA, 1980a, 1980b).
- DSRA3 Canada rapeseed feed, seed and residual uses, crop year, '000 mt. Calculated as $QRA3 + IRA3(-1) - CRRA3 - IRA3 - EXRA3$.
- DSS03 Canada soybean feed, seed and residual uses, crop year, '000 mt. Calculated as $QS03 + IS03(-1) - NXS03 - CRS03 - IS03$.
- DSS04 U.S. soybean feed, seed and residual use, crop year, '000 mt (USDA, 1980a).
- DSS05 Japan soybean food, feed and residual uses, calendar year '000 mt. Calculated as $PERFDS05$ times Japanese imports of soybeans.
- DSS06 Brazil soybean feed, seed and residual uses, crop year, '000 mt. Calculated as $QS06 + IS06(-1) - CRS06 - NXS06 - IS06$.
- DTAR5F Dummy variable, 1960/61 through 1966/67 = 0, and one thereafter.
- DTAR5V Dummy variable, 1960/61 through 1966/67 = 1, and zero thereafter.
- DUMEMB Dummy variable, 1960/61 through 1972/73 = 0, and one thereafter.
- DUMLIB Dummy variable, 1960/61 through 1970/71 = 0, and one thereafter.
- DUMLIBX Dummy variable equal to zero from 1960/61 through 1970/71, 0.5 in 1971/72, and one thereafter.
- DY3 Canada personal disposable income, crop year, mil. \$C (Statistics Canada, 1980f).
- DY4 U.S. disposable income, crop year, mil. \$US (U.S. Dept. of Com., 1980).
- DY5 Japan private consumption expenditure, calendar year, bil. yen (IMF, 1980).
- DY6 Brazil private consumption expenditure, calendar year, mil. Cr. (IMF, 1980).
- DY7R EC real private consumption expenditure, calendar year, bil. \$US (IMF, 1980).
- D69 Dummy variable, 1969/70 = 1, other years = 0.

- D6976 Dummy variable, 1969/70 onwards = 1, other years = 0.
- D70 Dummy variable, 1970/71 = 1, other years = 0.
- D72 Dummy variable, 1972/73 = 1, other years = 0.
- D73 Dummy variable, 1973/74 = 1, other years = 0.
- D74 Dummy variable, 1974/75 = 1, other years = 0.
- D75 Dummy variable, 1975/76 = 1, other years = 0.
- D77 Dummy variable, 1977/78 = 1, other years = 0.
- EP1SL3 Canada soybean oil futures price, \$C/mt. Calculated as EP1SL4 * EXR34.
- EP1SL4 US soybean oil futures price, calculated as the simple average of the May 15, June 15 and July 15 price for the December futures contract, \$US/mt (Chicago Board of Trade, 1979).
- EP1SM3 Canada soybean meal futures price, \$C/mt. Calculated as EP1SM4 * EXR34.
- EP1SM4 US soybean meal futures price, calculated as the simple average of the May 15, June 15 and July 15 price for the December futures contract, \$US/mt (Chicago Board of Trade, 1979).
- EP1SO4 US soybean futures price, calculated as the simple average of the May 15, June 15 and July 15 price for the November futures contract, \$US/mt (Chicago Board of Trade, 1979).
- EXRSDR4 Rate of exchange between US dol. and special drawing rights, calendar year, \$US/SDR (IMF, 1980).
- EXR34 Canada exchange rate, crop year \$C/\$US (IMF, 1980).
- EXR54 Japan exchange rate, calendar year, Yen/\$US (IMF, 1980).
- EXR64 Brazil exchange rate, calendar year, Cruzeiro/\$US (IMF, 1980).
- EXR74 Exchange rate index with respect to the US, calendar year, percent 1967 = 100. Calculated by weighting an index of each individual member country's exchange rate by their personal consumption expenditure (IMF, 1980).
- FER5 Japan foreign exchange reserves, calendar year, mil. \$US (IMF, 1980).
- FER6 Brazil foreign exchange reserves, calendar year, mil. \$US (IMF, 1980).
- FPBA3 Canada barley average farm price, crop year, \$C/mt (Statistics Canada, 1975).

- FPBA5 Japan barley price, naked, government set farm price, fiscal year, Y/mt (Prime Minister's Office, 1979).
- FPC04 U.S. corn average price received by farmers, crop year, \$US/mt (USDA, 1980c).
- FPP16 Brazil farm product price index, calendar year, percent 1965/67 = 100 (Williams, 1980).
- FPP17 France, index of farm production costs, calendar year, percent 1970 = 100 (FAO, 1979a).
- FPWH7 France, farm price of wheat, intervention price, crop year, Fr/mt (IWC, 1978).
- FR37 Freight rate for wheat and/or heavy grains, crop year, St. Lawrence Ports to Rotterdam, \$US/mt (IWC, 1978).^{7/}
- FR45 Freight rate for wheat and/or heavy grains, crop year, Gulf Ports to Tokyo, \$US/mt (IWC, 1978).^{7/}
- FR67 Freight rate for wheat and/or heavy grains, crop year, River Plate to Rotterdam, \$US/mt (IWC, 1978).^{7/}
- IHG7 EC hog numbers, calendar year, '000 head (FAO, 1979b).
- IMPC05 Japan, price of corn, import unit value, calendar year, \$US/mt (FAO, 1979b).
- IMVAL5 Japan, index of import unit values, calendar year, percent 1975 = 100 (UN, 1980).
- IMVAL6 Brazil, index of import unit values, calendar year, percent 1975 = 100 (UN, 1980).
- ISOCCC U.S. soybean closing stocks, CCC owned or under CCC loan and resale, crop year, '000 mt (USDA, 1980a).
- ISO4DUM Dummy variable, 1973/74 onwards = 1, all other years = 0.
- IS06 Brazil soybean closing stocks, crop year, '000 mt (Williams, 1980).
- IWH3 Canada wheat closing stocks, crop year, '000 mt (Canada Wheat Board, 1980).
- LIFT Dummy variable, 1970/71 = 1, all other years = 0.
- LPRICE4 U.S. livestock price index, crop year, percent 1960 = 1.00. Calculated as 9495.66 times the price of slaughter steers in Omaha plus 11101.7 times the price of slaughter hogs at 7 markets divided by 421632 (USDA, 1980d).

^{7/} All freight rates are defined as the annual average of estimated mid-month rates based on current chartering practices for vessels ready to load six weeks ahead; dry cargo vessels; simple average if more than one rate quoted.

- LPROD3 Canada weighted average of livestock production, crop year, mil. lbs. Calculated as 0.4 times total pork production plus 0.6 times total Western Canada beef production (Agriculture Canada, 1980).
- LPROD3X Canada weighted average of livestock production, crop year, mil. lbs. Calculated as 0.4 times total pork production plus 0.6 times total beef production (Agriculture Canada, 1980).
- LPROD4 U.S. livestock production index, crop year, percent 1960 = 1.00. Calculated as 16.79 times total fed beef production plus 24.79 times total pork production + 15.43 times total broiler production divided by 486165 (USDA, 1980d).
- LPROD5 Japan weighted average of livestock production, calendar year, '000 mt. Calculated as 0.5 times pork production plus 0.5 times chicken production (MOAFF, 1979).
- PC02 Canada, wholesale price of corn in Montreal, crop year, \$C/mt (Canadian Livestock Feed Board, 1980).
- PCTM6 Brazil wholesale cottonseed meal price, calendar year, Sao Paulo, Cr/mt (Williams, 1980).
- PERFDS05 Japan estimated use of imported soybeans for food, feed, seed and waste, calendar year, percent; 1960 = 0.1, 1961 = 0.11, 1962 = 0.12, 1963 = 0.13, 1964 = 0.14, 1965 = 0.15, 1966 = 0.16, 1967 = 0.17, 1968 = 0.18, 1969 to present = 0.20.
- PFERT3 Canada, index of fertilizer prices, calendar year, percent 1971 = 100 (FAO, 1980a).
- PFERT4 U.S. index of prices paid by farmers for fertilizer, calendar year, 1967 = 100 (FAO, 1979a).
- PFERT5 Japan fertilizer price index, fiscal year, 1970 = 100 (FAO, 1980a).
- PLIVE3 Canada simple average of slaughter steer and hog prices, Toronto, crop year, C\$/Cwt (Agriculture Canada, 1980).
- POL4 U.S. weighted average of cottonseed, coconut, peanut and palm oils, crop year, \$US/mt (USDA, 1980a). Calculated as $(0.47 * \text{Cottonoil price} + 0.35 * \text{coconut oil price} + 0.07 * \text{peanut oil price} + 0.11 * \text{palm oil price}) * 22.0462$.
- POM4 U.S. weighted average of cottonseed, fish, linseed and peanut meals, crop year, \$US/mt (USDA, 1980a). Calculated as $(0.58 * \text{cotton meal} + 0.31 * \text{fish meal} + 0.06 \text{ linseed meal} + 0.05 * \text{peanut meal}) * 1.1023$.
- QRA9 Rest of World rapeseed production, '000 mt (USDA, 1980e). Calculated as $\text{QRA (world)} - \text{QRA3} - \text{QRA5} - \text{QRA7}$.
- QRL9 Rest of World rapeseed oil production, '000 mt (USDA, 1980e). Calculated as $\text{QRL (world)} - \text{QRL3} - \text{QRL5} - \text{QRL7}$.

- QRM9 Rest of World rapeseed meal production, '000 mt (USDA, 1980e).
Calculated as QRM (world) - QRM3 - QRM5 - QRM7.
- QSL9 Rest of World soybean oil production, '000 mt (USDA, 1980e).
Calculated as QSL (world) - QSL4 - QSL5 - QSL6 - QSL7.
- RPLA6 Brazil retail lard price, calendar year, annual average, Cr/mt
(Williams, 1980).
- TARRA5 Japan rapeseed tariff, calendar year, percent + 1.0 for 1960
through 1967, Y/mt for 1968 through 1972, and zero thereafter.
- TARRL5 Japan rapeseed oil tariff, calendar year, Y/mt. Calculated as a
fixed tariff in Y/mt since 1968. Prior to that date the ad
valorem rate (15% until 1960 and 10% between early 1961 and
1968) was converted to a fixed tariff equivalent (OECD, 1967,
1974; Spurloch, 1964; USDA, 1976b).
- TARRL7 EC rapeseed oil tariff, simple average of member tariffs, calendar
year, percent + 1.0. Prior to 1962, tariff rates were taken from
FAO (1962). From 1962 until 1967, the rates for the EC6
countries were adjusted linearly to reach the ten percent ad
valorem rate of the CAP, at which level they remained until the
present. The Danish tariff remained unchanged until accession,
when the rate was adjusted in regular steps to reach the CAP
ten percent rate in 1977. The U.K. and Ireland tariff was taken
to be the EFTA schedule (since most imports would come from
Sweden, another EFTA member), and this was reduced from five to
zero percent in 1960-68, and then increased to the CAP ten
percent rate in 1973-77 (Parris and Ritson, 1977; USDA, 1976a).
- TARRM5 Japan rapeseed meal tariff, calendar year, percent + 1.0 from
1960 through 1966, Y/mt for 1967 through 1972, and zero there-
after.
- TARSL3 Canada soybean oil tariff, crop year, percent + 1.0.
- TARSL5 Japan soybean oil tariff, calendar year, Y/mt. Calculated in
the same manner as TARRL5, the only difference being that the
soybean oil ad valorem rates were 20 percent prior to the
soybean liberalization of 1961. (OECD, 1967, 1974; Spurloch,
1964; USDA, 1976b).
- TARSL7 EC soybean oil tariff, simple average of member tariffs,
calendar year, percent + 1.0. Calculated in the same manner as
TARRL7, the only differences being that the soybean oil rates
for Denmark and Belgium-Luxembourg were lower than for rapeoil
before the CAP and, therefore, increased up until 1967, and
that higher MFN rates were used for the U.K. and Ireland since
soybean oil imports into these countries would be from non-EFTA
members (mainly the U.S. or EC6). Thus, from 1962 to 1976, the
EC soybean oil tariff is on average greater than one percentage
point higher than the corresponding rapeseed oil tariff. (FAO,
1962; Parris and Ritson, 1977; USDA, 1976a).

TARSM5	Japan soybean meal tariff, calendar year, percent + 1.0 from 1960 through 1966, Y/mt for 1967 through 1972, and zero thereafter.
TARSO5	Japan soybean tariff, calendar year, percent + 1.0 from 1960 through 1967, Y/mt for 1968 through 1972, and zero thereafter.
TIME	Trend variable where 1958/59 = 1, 1959/60 = 2, etc.
WPI4	U.S. wholesale price index, crop year, percent 1967 = 100 (IMF, 1980).
WPI5	Japan wholesale price index, calendar year, percent 1975 = 100 (IMF, 1980).
WPI6	Brazil wholesale price index, calendar year, percent 1975 = 100 (IMF, 1980).
WSPC04	U.S. corn weighted support price, crop year, \$US/mt (Gallagher, 1978).
YLDRL3	Canada rapeseed oil yield, crop year, percent. Calculated as QRL3/CRRA3.
YLDRL5	Japan rapeseed oil yield, crop year, percent. Estimated to equal 0.41.
YLDRL7	EC rapeseed oil yield, crop year, percent. Estimated to equal 0.35 for 1960/61 - 1963/64, 0.36 for 1964/65 - 1965/66, 0.37 for 1966/67, 0.38 for 1967/68, 0.39 for 1968/69 and 0.40 from 1969/70 - present (USDA, 1973).
YLDRM3	Canada rapeseed meal yield, crop year, percent. Calculated as QRM3/CRRA3.
YLDRM5	Japan rapeseed meal yield, calendar year, percent. Estimated to equal 0.58.
YLDRM7	EC rapeseed meal yield, calendar year, percent. Estimated to equal 0.58.
YLDL3	Canada soybean oil yield, crop year, percent. Calculated as QSL3/CRSL3.
YLDL4	U.S. soybean oil yield, crop year, percent. Calculated as QSL4/CRS04.
YLDL5	Japan soybean oil yield, calendar year, percent. Estimated to equal 0.17.
YLDL6	Brazil soybean meal yield, crop year, percent. Estimated to equal 0.185.
YLDL7	EC soybean oil yield, calendar year, percent. Estimated to equal 0.177.

- YLDSM3 Canada soybean meal yield, crop year, percent. Calculated as QSM3/CRS03.
- YLDSM4 U.S. soybean meal yield, crop year, percent. Calculated as QSM4/CRS04.
- YLDSM5 Japan soybean meal, calendar year, percent. Estimated to equal 0.80.
- YLDSM6 Brazil soybean meal yield, crop year, percent. Estimated to equal 0.75.
- YLDSM7 EC soybean meal yield, calendar year, percent. Estimated to equal 0.80.