RURAL ECONOMY

Export Markets for Canada's Foodgrains and Feedgrains

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Project Report 92-06

Farming for the Future Project 88-0355

PROJECT REPORT

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February 1992

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Abstract

The subject of this study is the economic characteristics of Canada's export markets for foodgrains and feedgrains. The focus is on economic analysis of barley export markets. Over time Canada has become the largest barley exporter, replacing France as the leading source of barley. On the import side, developing countries have become the fastest growing market segment for barley imports, replacing developed countries as the leading market outlet. Canada's export profile data reveal that developing and Eastern European countries became expansionary markets in the 1980s while developed countries have imported a decreasing share of Canada's barley exports.

Constant market share analyses of the world barley and coarse grain markets reveal that those exporters with the highest export concentration in the rapidly expanding markets in richer developing countries registered positive export growth impacts due to this concentration. While corn is still the dominant feedgrain traded on world markets, barley became, by 1985, the fastest growing feedgrain export, resulting in positive export growth for those exporters, like Canada, for which barley is a prominent feedgrain. Despite appreciable reliance on less rapidly growing import markets for barley, Canada has been relatively competitive in world barley markets, at least up to the mid 1980s. In wheat, Canada's exports have tended to be more concentrated on less rapidly growing market segments and on less rapidly growing classes of wheat. Canada's competitive position in world wheat markets has varied over time and, toward the end of the 1980s, was worsened by the United States export enhancement program subsidies.

The major determinants of cereal import demand in seventy-four developed countries (LDCs) were analyzed through the use of an econometric cross-sectional model. Key explanators of import demand in these increasingly important markets included the level of income and degree of urbanization, financial capacity proxies, and domestic grain supply variables. A contribution to the study of cereal markets involved the analysis of the impact of income distribution on less developed countries' cereal import demand in 1986 and 1987 for a more restricted sample of twenty-three nations. These developing countries exhibit a greater than proportional increase in cereal imports due to an increase in the income share of the poorest 40 percent of their populations. The inclusion of regional slope and intercept dummies in the cereal import demand model was an innovation that provided improved results. High levels of government debt appear to have inhibited cereal importation in nations in South America, but not in Asia and Africa. In all three continental regions, particularly in Africa, there is a positive relationship between food aid and cereal imports. The model predicts cereal imports for nations in Asia and South America more satisfactorily than for those in Africa. The results support the view that improvements in income distribution in developing nations would considerably stimulate cereal imports.

In models where cereal imports were disaggregated into feedgrains and foodgrains, the estimated income elasticity of import demand for feedgrains is higher than that for foodgrains. In other words, feedgrain import demand is more sensitive to either upward or downward changes in income than is foodgrain import demand. This is one factor which helps to explain why feedgrain exports grew more rapidly in the 1970s and collapsed to a greater degree than wheat exports in the 1980s. World import demand for wheat appears to be relatively more "recession proof" than is the case for world barley imports. However, world barley markets show potential for greater future growth subject to improvements in the income levels of importing regions.

Detailed time series studies of barley import demand in four Canadian export markets--the (former) USSR, Japan, Colombia and China--were undertaken. The results revealed that Russia's characteristic pattern of import fluctuations is caused mainly by domestic barley and livestock production fluctuations. The price of barley imports also affects USSR barley import decisions, implying financial constraints are an important aspect of the Soviet market.

In the Japanese market, barley import demand underwent a structural shift around 1972 when usage of barley changed from a foodgrain to feedgrain. Canadian barley changed from an inferior foodgrain to a normal feedgrain, as reflected in the income elasticity of demand. The Canadian dollar-Japanese yen exchange rate is an important determinant of Japan's barley import demand.

Colombia's import demand for barley has been influenced by barley import price and foreign exchange reserves. As a developing country, Columbia faces financial constraints that influence import decisions. For China, another developing country, barley imports are affected by the price of barley imports and by the price of wheat imports which is, for China, a substitute for barley imports. Domestic barley and hog production also influence this nation's barley imports.

Overall, our empirical analysis supports the contention that the fortunes of the developed and the developing nations are closely intertwined in the world food economy. The pace at which poor nations can develop, both through increasing income levels and improving income distribution, significantly influences their cereal imports and, concomitantly, cereal exports from rich nations such as Canada. A successful conclusion to the negotiations within the General Agreement on Tariffs and Trade and efforts to improve the economic situation of developing countries will benefit the Canadian grain producing and exporting sector.

1. Introduction

The export market is a vital component of the economic environment facing prairie grain producers, given that over one-third of barley production and approximately three-quarters of wheat production is sold in export markets. However, world markets for both feedgrains and foodgrains grew more slowly in the 1980s than in the preceding two decades. This research project is directed to identifying and estimating the influence of the major economic forces affecting Canada's foodgrain (wheat) and feedgrain (barley) export markets. It builds upon two previous Farming for the Future studies of world wheat markets and market shares. To complement this previous work, a major focus of the current project is the analysis of Canada's role in the world barley market and of the import demand for Canadian barley in the USSR, Japan, Columbia, and China.

1.1 Nature and Scope of the Problem

Export markets for grain have been, and continue to be, critically important to prairie producers. In 1989-90, over 70 percent of Canadian wheat production and nearly 40 percent of barley production were exported to foreign markets. Canada, too, is a major player in the international trade of grains, accounting for slightly under 20 percent of world trade in wheat and approximately 25 percent of the world trade in barley in the latter half of the 1980s.

Between 1960 and 1970, world consumption of grain grew at an average annual rate of 3.2 percent, compared to the 2 percent annual rate of growth in the world population during this period. During the 1970s, world markets for feedgrains accelerated and grew at a faster rate than did markets for foodgrains. In the 1980s, however, the reverse was true as markets for grains grew at a slower pace and world foodgrain exports grew more rapidly than did feedgrain exports.

Slower economic growth in major segments of the grain import market (particularly in the middle-income and low-income developing countries) is one possible cause of the relatively depressed nature of world grain markets through the 1980s. Shortage of foreign exchange by some importing nations, stemming from their high levels of debt and repayment liabilities, is another possible cause. The rate of increase in world grain consumption levels recovered somewhat in the latter 1980s (although recent events in the former USSR have led to forecasts of a decline in world consumption in 1992). World market prices for grains became particularly depressed reflecting the export subsidy war between the European Economic Community (EC) and the United States, as well as the continued increases in grain production throughout the world.

This study focuses on the identification and analysis of the major economic factors influencing Canada's export markets for feedgrains and foodgrains. The emphasis is on export markets for feedgrains--in particular, on export markets for Canada's premier feedgrain, barley.

1.2 Research Objectives

The objectives of this study are:

1. To test the hypothesis that recession in the world economy during the 1980s had an appreciable negative impact on imports of foodgrains and feedgrains by major segments of world markets for these grains.

2. To test the hypothesis that changes in income levels in recent years in major importing regions have had a proportionately greater impact on imports of feedgrains than foodgrains by major segments of world markets for these grains.

3. To assess the relative impact of specific economic factors (including gross national product, inflation levels, measures of foreign exchange availability and, if possible, measures of urbanization and income distribution) on imports of foodgrains and feedgrains in selected major segments of world markets for these grains.

4. To gain an understanding of the competitive position of Western Canadian barley exports in recent years through an analysis of changes in market shares for barley relative to other feedgrains traded in world markets.

5. To extrapolate the evidence from 1, 2, 3 and 4 above to an assessment of the relative market prospects for Western Canadian barley and wheat over the balance of the 1980s.

1.3 Orientation and Format of the Study

The study emphasized economic characteristics of Canada's barley export market. Barley exports are an important outlet for Canada's domestic barley production. Between 1980 and 1987, Canada never exported less than one third of its barley crop and annual values for such exports have been as high as 600 million dollars. Obviously, barley exports represent a major commodity transaction for Canada on world markets. Another reason for studying the export market for barley is the apparent, substantial import potential for such feed grains found in the higher-income developing countries. As incomes in these countries continue rising, so too will the demand for meat products and the resulting demand for feed grain imports, at least in the short to medium run. It is important for Canada to identify and understand the factors influencing import demand in these developing country markets to take advantage of export opportunities.

Initially, in Chapter 2, descriptive statistics based on detailed USDA breakdowns to 1985 and more aggregate statistics to 1990 are presented to obtain a better understanding of Canada's position in the overall international barley and feedgrain market. A major focus of this analysis is to assess the nature and extent of the changes that have occurred in the structure of world feed grain trade. These statistics include market share data of the major feed grain and barley exporters. These exporter data were used to identify the relative importance of the exporters in the world feed grain and barley markets. As well, market share data of the major importing regions were developed. These data revealed which import market segments have been relatively expansionary and which have been contractionary. Other tables present exporter profile data which consist of an individual exporter's relative market share in each of the five major importing regions. These profile data are a means of identifying which of the market segments a particular exporter has chosen to concentrate exports in and are presented for the barley market only.

Another objective of this report is to assess the competitive position of Canadian barley exports relative to world feed grain exports during the early to mid-1980s. This objective is accomplished through constant market share analyses of the world barley and coarse grain markets. These CMS analyses measure how the changing structural aspects of the world coarse grain markets, as revealed by the descriptive statistics, have affected the market share performance of the various exporters. The CMS analyses, which are presented in Chapter 3 of this report, provide information on the relative competitive and structural performances of the major feed grain exporters marketing efforts. A similar analysis is performed for wheat.

In Chapter 4, the relative impacts of specific economic factors on imports of foodgrains and feedgrains in developing nations are estimated and analyzed. To accomplish this task, a cross-sectional, multivariate regression analysis of the import demand for cereals in developing countries is undertaken. The results of this analysis provide a better understanding of the factors influencing cereal import demand in developing countries, the fastest growing import market segment. In this analysis, developing countries are aggregated and treated as a single market segment by using cross-sectional data from seventy-four developing countries covering three continents, Asia, Africa and South America. The purpose of this analysis is to identify general import demand determinants common to a wide range of developing countries and to determine any structural differences that influence cereal import demand across countries.

In this cross-sectional analysis, the demand for total cereal imports rather than barley or coarse grain imports is analyzed because of data limitations with respect to the number of developing countries which import barley and coarse grains for use as livestock feed. Too few developing countries import barley to allow for simple analysis of a barley import demand function across LDCs. Although more countries import coarse grains than just barley, the import demand for coarse grains in LDCs is not analyzed in detail because of the disparity of coarse grain use between countries, which ranges from direct human consumption to animal feed. Instead, following the total cereal import demand analysis, a brief section on cereal imports disaggregated into fine and coarse grains is presented as a means of gaining some insight as to the validity of aggregating cereals in import demand analysis. Another section of the chapter explores the effects of income distribution on cereal import demand in LDCs.

The fourth and final major objective of this report is to provide a more detailed analysis of barley import demand functions in selected Canadian markets in order to identify possible future barley import patterns under alternative scenarios of income growth, debt level and policy interventions. To accomplish this objective, namely a more detailed understanding of Canada's international barley markets, the analyses in the remainder of the report focus on identifying the determinants of barley import demand in four selected importing countries. Two of the countries, the USSR and Japan, are chosen for analysis since they are Canada's two largest markets for which there is a sufficient time series of import data for analysis. The third country, Colombia, is chosen as an example of a middle income developing country. Colombia is one of the few developing countries with a long enough time series of barley imports from Canada to allow regression analysis. For these three countries, the time series analyses consist of determining the import demand functions for total barley and for Canadian barley. The fourth and final country chosen for analysis is China. The potential of China becoming a major market for Canadian barley justifies including this country in the time series analyses. For China, an import demand function is specified only for total barley imports, because China does not have a long enough time series of barley imports from Canada for analysis.

For all four time series analyses, the general structure of the import demand model is based loosely on the work of Borsody (1987), with modifications introduced for each country to account for the unique economic conditions that exist within that country. The analyses are presented in Chapters 5 to 8 for the USSR, Japan, Colombia and China respectively. The purpose of these time series analyses is to gain a fairly detailed understanding of the factors which influence an individual country's import decisions with respect to barley and with respect to Canadian barley.

The final chapter of this report presents a summary of the conclusions from the various chapters and analyses. The elasticities from the four time series analyses are compared and discussed. The final purpose of this summary chapter is to discuss the implications of the various conclusions for Canada's future feedgrain and foodgrain trade.

2. The Composition of World Feed Grain Trade

2.1 Introduction

In this chapter descriptive statistics on the world feed grain market are presented. The first section covers the aggregate feed grain market. The focus then turns to the barley market and the third section covers the remaining component coarse grains, namely corn, rye, oats and a collective category of 'other' feed grains (which includes sorghum, millet, buckwheat and canary seed). This initial overview served as a basis for the market share analysis summarized in Chapter 3. It focused on the twenty-four year period from 1962 until 1985; more recent trends are also summarized. The major data source was the USDA report by Mackie, Hiemstra and Sayre (1987).

The tables presented in this chapter include export data of the major grain exporting countries. These indicate the relative importance and involvement of the exporters in particular coarse grain markets. Other tables present grain trade data from the import market perspective. These reveal the relative importance of importing regions as markets for feed grains. In addition there are tables containing exporter profiles which describe how single exporter's total exports have been allocated among the importing regions. These are useful in identifying growing or contracting markets for a particular exporter's feed grain exports, and are in the form of market share data.

The major exporters in the feed grain market are Canada, the U.S.A., Argentina, France, and Australia. The category 'others' contains the remaining exporters. In the barley market, Argentina is not a major exporter and so is contained in the 'others' category. The importers have been divided into five regions based on socio-economic and geographic criteria: developed (or high income) countries which includes North America, Western Europe, Oceania, and Japan; Eastern European countries; China; richer less developed countries (LDCs) which includes Central America, South America, West Asia, East Asia, Southeast Asia, North Africa, Southern Africa (including South Africa), the Caribbean, and Pacific Islands; the poorest LDCs which includes South Asia, East Africa, and West Africa. A precise list of countries is in Mackie, Hiemstra and Sayre (1987).

2.2 The World Feed Grain Market

<u>Share of Individual Grains</u>

Table 2.1 reveals that exports of three grains, corn, barley and others, have all increased steadily in volume over three sub-periods. Exports of rye increased in the 1970s but declined slightly in the early 1980s and exports of oats declined steadily in all three periods. Corn is by far the dominant coarse grain traded by volume accounting for more than three times the average volume of the next most traded grain, barley.

The dominance of corn in the world feed grain market is revealed in the market share data. Between 1962 and 1985, corn accounted for an average of 65% of all feed grain traded. Barley was next with 16%, followed by 'others' with 13%, oats with 2.4% and rye with a share of less than 2% of the world feed grain market. Though the volume of corn increased in the early 1980s, the market share of corn declined slightly. The average market share of barley increased between the 1970s and 1980s, indicating that barley exports were expanding at a faster rate than corn imports in the 1982-85 sub-period. The market share of other coarse grains remained fairly stable over the three sub-periods. Rye and oats, both minor grains in the export market, experienced declining market shares.

Table 2.1: World Coarse Grain Exports by Component Grain, Average Quantity (1000 MT) and Market Share (Percent), 1962-1985 and Sub-Periods

Coarse Grain:	Barley	Corn	Rye	Oats	Others
1962 - 1972:					
Avg. Quantity	8084.8	26,399.0	855.4	1456.1	5609.0
Standard Dev.	2513.4	5268.5	528.5	313.0	1616.4
Avg. Market Share	18.8	62.3	2.2	3.5	13.2
1973 - 1981:					
Avg. Quantity	14,043.0	62,623.0	976.2	1387.3	11,453.0
Standard Dev.	2095.0	13,043.0	459.1	205.6	1676.2
Avg. Market Share	15.6	68.9	1.1	1.6	12.8
1982 - 1985:					
Avg. Quantity	20,236.0	67,140.0	930.0	1246.4	13,260.0
Standard Dev.	2434.5	1424.3	205.7	264.3	1170.8
Avg. Market Share	19.7	65.3	0.9	1.2	12.9
1962 - 1985:					
Avg. Quantity	12,344.0	46,773.0	913.2	1395.4	9075.8
Standard Dev.	5067.8	20,988.0	451.1	268.5	3646.5
Minimum	5456.6	19,629.0	446.1	947.2	3653.2
Maximum	23,005.0	80,284.0	2160.0	2177.3	14,699.0
Avg. Market Share	17.8	65.3	1.6	2.4	13.0
% Annual C.G.R.[1]					
a) Quantity	6.0	6.8	-	-	6.1
b)Market Share	-	0.7	-5.6	-6.4	-

[1]Compound growth rate = [Antilog(b) - 1], where b is from [log(variable) = a + b(Time)];
- means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 1.717).

Exporters' Market Shares

The average volumes and market shares of major exporters' feed grain exports are shown in Table 2.2. All of the exporters increased their volume of feed grains exported over the three sub-periods but exporters did not experience a similar increase in market share. Within the sub-periods, Canada increased its market share from 4% in the 1960s to 5.2% in the early 1980s. Australia also experienced a steady but small increase in market share in each period. The U.S.A. increased its market share from 45% in the 1960s to 59% in the 1970s but then experienced a decline to 54% of world feed grain exports in the early 1980s. Both France and Argentina experienced small decreases in market share over the sub-periods.

Table 2.2: World Coarse Grain Exports of the Major Exporters, Average Quantity (1000 MT) and Market Share (Percent), 1962-1985 and Sub-Periods

Exporting Regions:	Argentina	Australia	Canada	France	U.S.A.	Others
1962 - 1972:						
Avg. Quantity	4921.1	1151.9	1861.6	4190.1	18,805.0	11,475.0
Standard Dev.	1574.6	933.6	1546.1	2263.0	3755.0	1431.8
Avg. Market Share	11.6	2.5	4.0	9.4	44.7	27.7
1973 - 1981:						
Avg. Quantity	8889.4	2711.5	4056.3	6824.1	54,128.0	13,874.0
Standard Dev.	3054.1	841.2	1075.2	1735.4	12,654.0	1807.8
Avg. Market Share	9.8	3.0	4.5	7.7	59.3	15.7
1982 - 1985:						
Avg. Quantity	10,651.0	4552.4	5311.5	8529.2	55,299.0	18,470.0
Standard Dev.	872.9	2729.6	1968.5	1011.6	3272.4	2178.3
Avg. Market Share	10.4	4.4	5.2	8.3	53.8	18.0
1962 - 1985:						
Avg. Quantity	7364.1	2303.5	3259.6	5901.0	38,133.0	13,540.0
Standard Dev.	3172.5	1782.1	1965.3	2518.4	19,831.0	2,992.8
Minimum	3047.7	354.8	725.0	945.9	14,830.0	9,377.5
Maximum	14,926.0	7075.5	7123.8	9503.6	72,029.0	21,710.0
Avg. Market Share	10.7	3.0	4.4	8.6	51.7	21.6
% Annual C.G.R.[1]						
a) Quantity	5.5	9.8	9.3	6.9	7.7	2.5
b) Market Share	2.2	3.2	2.1	-	1.2	-3.7

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 1.717).

Overall, the United States was by far the dominant exporter in the world market with an average share of over 50% of all exports in the study period. Argentina and France each accounted for about one tenth of exports. Canada exported the fourth largest volume of feed grains with an average share of 4.4%, and Australia followed with 3% of the market. Other exporters collectively had an average share of 22% of world feed grain exports.

Importers' Market Shares

The import quantity data in Table 2.3 reveal that of the five importing regions, only the richer and poorest LDCs consistently increased imports by volume in all of the sub-periods. China only imported appreciable amounts of feed grains in the 1960s. Eastern European imports increased sharply in the 1970s, then stabilized somewhat. Developed countries' imports expanded in the 1970s but contracted somewhat in the early 1980s. The market share data reveal that developed countries, though still importing the largest share of coarse grains, have experienced a declining average market share. In the 1960s, developed countries imported almost 80% of all feed grain exports and by the early 1980s this share had declined dramatically to 45%. This decline in the developed country market is due to the fact that their livestock sectors are either operating near market capacity (i.e., not expanding appreciably) or domestic feed grain production in those countries has grown to fulfill feed grain requirements.

The declining import share of the developed countries contrasts to that of richer LDCs whose share of world feed grain imports has steadily increased. The share of exports going to richer LDCs more than tripled from 9.5% in the 1960s to 34.5% in the 1980s. This increase seems mainly due to rising per capita incomes causing an increase in the demand for meat in these countries, which has created and fueled expanding livestock sectors.

The poorest LDCs did not import a significant amount of feed grains (less than 2% of all feed grain imports) partly due to such factors as per capita incomes being too low to support a livestock sector; food aid and domestic grain production being used instead of imports as major food sources; and since foreign exchange restrictions may have limited the ability of these countries to import much grain.

China ceased importing significant amounts of coarse grains after the 1960s. This import decline was probably due to domestic policy, the low level of meat production, import competition with higher priority wheat imports, and growth in the domestic feed grain sector.

Exporters' Profiles

Table 2.4 contains exporter profile data which consists of the percent share of an exporter's total feed grain exports allocated to each of the five importing regions. These serve to reveal in which market(s) an exporter has chosen to concentrate. In general, the share of feed grain exports to developed countries has decreased while the share to richer LDCs has increased.

Table 2.3: World Coarse Grain Imports of the Importing Regions, Average Quantity (1000 MT) and Market Share (Percent), 1962-1985 and Sub-Periods

Importing Regions:	Developed	East Europe	China	Richer LDCs	Poorest LDCs
1962 - 1972:					
Avg. Quantity	33,532.0	3919.0	125.9	4116.6	710.3
Standard Dev.	5080.6	3211.6	280.6	1719.1	710.8
Avg. Market Share	79.8	8.7	0.4	9.5	1.7
1973 - 1981:					
Avg. Quantity	50,407.0	20,439.0	N/A[2]	18,555.0	1081.9
Standard Dev.	2406.0	8614.0		7889.1	414.2
Avg. Market Share	57.1	21.8		19.8	1.3
1982 - 1985:					
Avg. Quantity	46,230.0	19,962.0	N/A	35,421.0	1199.0
Standard Dev.	3162.9	4535.4		4504.9	304.2
Avg. Market Share	45.0	19.4		34.5	1.2
1962 - 1985:					
Avg. Quantity	41,977.0	12,788.0	57.7	14,748.0	931.1
Standard Dev.	8922.0	10,122.0	195.8	12,635.0	579.7
Minimum	25,509.0	2076.5	0.0	2588.9	257.5
Maximum	53,248.0	34,229.0	733.5	40,183.0	2292.0
Avg. Market Share	65.5	15.4	0.2	17.5	1.4
% Annual C.G.R.[1]					
a) Quantity	2.7	13.3	-	14.4	6.3
b) Market Share	-3.3	5.8	-	7.6	-

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 1.717).
[2]Not available: Mackie *et al* do not report China separately for years of low imports. China, for these years, is contained in the poorest LDCs category.

More specifically, these data revealed that although Canadian export markets were concentrated in developed countries in the 1960s, there was a move to more evenly distributed markets in the 1980s. By the early 1980s, Eastern European, richer developing and developed countries each accounted for about one third of Canada's feed grain exports. Argentina's largest export market in the early 1980s was Eastern Europe, a region that imported, on average 42% of Argentina's exports. Both richer developing countries and Eastern Europe have been important, growing markets for Argentina. Australia's major export markets have also shifted from developed countries to richer LDC countries. Eastern Europe has been a relatively small market for Australia's feed grain exports. Of all the exporters, France has maintained the highest market concentration in developed countries, most likely due to trade with other EC countries. France's export shares to developed and Eastern European countries declined slightly and its share to richer developing countries increased slightly but not to as large a degree as the rest of the feed grain exporters. The U.S.A.'s export profile reveals that although developed countries have imported a declining share of U.S.A. exports, these countries are still an important outlet for U.S.A. feed grains. Richer developing

Table 2.4: The Export Profile of the Exporters' Coarse Grain Exports to the Importing Regions, 1962-1985 and Sub-Periods, Percent Share (Standard Deviations in Brackets)

Importing Regions:	Developed	East Europe	China	Richer LDCs	Poorest LDCs
Exporters:					
1962 - 1972:					
Argentina	93.2 (4.1)	1.6 (1.5)	0.1 (0.3)	5.0 (3.4)	0.1 (0.2)
Australia	82.7 (6.0)	1.6 (3.9)	2.6 (5.9)	13.0 (4.6)	0.1 (0.1)
Canada	83.6 (11.7)	4.0 (8.0)	5.1 (11.4)	7.3 (4.3)	0.0
France	86.2 (8.1)	9.4 (7.3)	1.6 (4.1)	2.6 (1.2)	0.2 (0.3)
U.S.A.	82.1 (8.6)	5.8 (6.9)	0.0	9.2 (3.1)	2.9 (3.6)
Others	66.9 (6.1)	17.0 (4.7)	0.2 (0.7)	14.7 (4.1)	1.2 (0.4)
1973 - 1981:					
Argentina	53.7 (26.1)	28.7 (31.7)	N/A[2]	15.5 (6.9)	2.1 (2.7)
Australia	62.2 (17.5)	12.4 (11.4)	N/A	25.3 (13.5)	0.1 (0.2)
Canada	53.3 (18.0)	34.2 (15.4)	N/A	12.4 (6.1)	0.1 (0.2)
France	82.1 (8.3)	10.3 (6.4)	N/A	6.6 (5.8)	1.0 (0.6)
U.S.A.	57.3 (8.3)	21.3 (6.7)	N/A	20.2 (6.1)	1.2 (0.6)
Others	47.0 (8.2)	22.5 (2.9)	N/A	28.6 (7.4)	1.8 (0.6)
1982 - 1985:					
Argentina	32.3 (7.2)	42.2 (12.2)	N/A	25.3 (5.2)	0.2 (0.1)
Australia	24.9 (4.0)	7.8 (5.2)	N/A	66.7 (5.9)	0.6 (1.1)
Canada	35.7 (8.5)	33.1 (11.2)	N/A	31.1 (8.7)	0.1 (0.2)
France	78.5 (5.6)	6.6 (5.9)	N/A	13.9 (7.4)	1.0 (0.6)
U.S.A.	45.7 (4.9)	17.4 (7.6)	N/A	35.9 (7.8)	1.1 (0.6)
Others	42.8 (7.1)	16.2 (5.5)	N/A	38.5 (3.9)	2.5 (1.5)
1962 - 1985:					
Argentina	68.2 (29.2)	18.5 (25.4)	0.1 (0.2)	12.4 (9.2)	0.9 (1.9)
Australia	65.4 (23.6)	6.7 (9.0)	1.2 (4.1)	26.6 (21.1)	0.2 (0.4)
Canada	64.3 (23.5)	20.2 (18.9)	2.3 (7.9)	13.2 (10.2)	0.1 (0.1)
France	83.4 (8.0)	9.3 (6.6)	0.8 (2.8)	6.0 (6.0)	0.6 (0.6)
U.S.A.	66.7 (16.9)	13.5 (9.9)	0.0	17.8 (10.9)	1.9 (2.6)
Others	55.4 (12.8)	18.9 (5.0)	0.1 (0.5)	23.9 (10.7)	1.6 (0.9)
% Annual C.G.R.[1]					
Argentina	-6.1	2.6	-	0.6	-
Australia	-5.5	-12.1	-	9.6	-
Canada	-4.5	10.4	-	8.7	-
France	-1.6	-	-	11.1	9.3
U.S.A.	-3.5	11.7	-	8.3	-4.4
Others	-3.0	-	-	6.7	4.3

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 1.717).
[2]Not available: Mackie *et al* do not report China separately for years of low imports. China, for these years, is contained in the poorest LDCs category.

countries have been a growing market segment for U.S. coarse grains, and Eastern European countries, though still relatively important, declined in their share of U.S.A. exports in the early 1980s.

The annual compound growth rate data at the bottom of Table 2.4 reveal that until 1985 all of the major coarse grain exporters experienced declining market share growth in developed countries and increasing market share growth in the richer LDCs. They illustrate the important role that developing countries now play in world feed grain trade.

2.3 The World Barley Market

Exporters' Market Shares

Table 2.5 contains barley exporters' average quantity and average market share data. All major exporters have increased their volume of barley exports, i.e. the barley market as a whole has been expanding. This is reflected in the quantity compound growth rates which are all positive. By the early 1980s, Canada had become the largest exporter of barley by volume accounting for 23% of world exports between 1982 and 1985. Australian exports also increased rapidly to account for 16% of world exports by the early 1980s. France dominated the market in the 1960s, falling from an export market share of 31% in the 1960s to an average share of 20% in the early 1980s, a market share growth rate of -4.3% annually.

Table 2.5: World Barley Exports of the Major Exporters, Average Quantity (1000 MT) and Market Share (Percent), 1962-1985 and Sub-Periods

Exporting Regions:	Australia	Canada	France	U.S.A.	Others
1962 - 1972:					
Avg. Quantity	625.1	1529.3	2427.4	1144.0	2359.1
Standard Dev.	531.9	1510.2	837.9	553.2	471.3
Avg. Market Share	6.9	16.1	30.6	15.2	31.2
1973 - 1981:					
Avg. Quantity	1764.6	3310.8	3766.9	1335.0	3865.3
Standard Dev.	634.0	642.2	897.7	326.2	1260.7
Avg. Market Share	12.7	23.6	26.9	9.7	27.2
1982 - 1985:					
Avg. Quantity	3370.9	4469.2	4114.2	1690.4	6588.0
Standard Dev.	2184.8	1591.3	461.0	635.3	1251.5
Avg. Market Share	16.0	22.9	20.4	8.4	32.5
1962 - 1985:					
Avg. Quantity	1510.5	2687.3	3210.9	1306.7	3628.7
Standard Dev.	1374.6	1676.6	1081.6	511.2	1780.3
Minimum	129.2	304.7	945.9	247.0	1751.9
Maximum	5718.5	5752.1	4922.8	2521.0	7984.7
Avg. Market Share	10.6	20.0	27.5	12.0	29.9
% Annual C.G.R.[1]					
a) Quantity	11.8	10.8	4.6	-	5.5
b) Market Share	5.5	4.5	-	-4.3	-

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 1.717).

Importers' Market Shares

Table 2.6 contains the barley quantity and market share data for the major importing regions. All regions, with the exception of developed countries in the 1982-85 sub-period, increased their import volumes of barley. China was a significant participant in the market only in the 1960s and the poorest LDCs were never significant market participants.

The average market share data of the importing regions reveal that the import side of the barley market has undergone significant structural change, going from a market heavily concentrated in developed countries in the 1960s to a market more equally proportioned between developed, richer developing and Eastern European countries in the early 1980s. For the overall period, developed countries had an average market share of 68%, but the sub-period breakdown reveals that the average share of imports in these countries dropped by almost half from 72% in the 1960s to 37% in the 1980s, with a market share compound growth rate of -3.5% annually.

Table 2.6: World Barley Imports of the Importing Regions, Average Quantity (1000 MT) and Market Share (Percent), 1962-1985 and Sub-Periods

Importing Regions:	Developed	East Europe	China	Richer LDCs	Poorest LDCs
1962 - 1972:					
Avg. Quantity	5667.3	1506.8	91.2	817.1	2.6
Standard Dev.	1210.5	1413.9	203.0	391.3	1.1
Avg. Market Share	71.8	16.8	1.3	9.9	0.03
1973 - 1981:					
Avg. Quantity	7551.9	3849.0	N/A[2]	2634.5	7.2
Standard Dev.	633.1	1174.0		1199.7	8.6
Avg. Market Share	54.8	27.0		18.2	0.05
1982 - 1985:					
Avg. Quantity	7332.3	4023.4	N/A	8832.2	47.9
Standard Dev.	831.0	1268.4		2832.1	65.7
Avg. Market Share	37.0	19.9		42.9	0.2
1962 - 1985:					
Avg. Quantity	6651.5	2804.5	41.8	2834.5	11.9
Standard Dev.	1314.4	1746.2	141.6	3135.6	29.4
Minimum	3692.3	441.8	0.0	519.5	1.1
Maximum	8284.7	6022.3	516.4	12,613.0	144.2
Avg. Market Share	67.7	14.6	0.0	16.7	1.0
% Annual C.G.R.[1]					
a) Quantity	2.3	9.2	-	14.1	11.0
b) Market Share	-3.5	3.1	-	7.7	-

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 1.717).
[2]Not available: Mackie *et al* do not report China separately for years of low imports. China, for these years, is contained in the poorest LDCs category.

Over the entire period, Eastern European countries accounted for an average share of 15% of barley imports and richer LDCs averaged 17% of the market; both market segments had positive quantity and market share growth rates. But, while Eastern Europe's import share increased in the 1970s and the decreased in the 1980s, richer LDCs accounted for a steadily increasing share of barley imports over the three sub-periods. These richer developing countries have become the largest market outlet for barley exports in recent trading.

Exporters' Profiles

Table 2.7 reveals the composition of individual exporter's barley exports to the five importing regions. Canada's export profile has several interesting features. First, China, who only imported significant amounts of barley in the 1962-1972 sub-period, accounted for 7.5% of Canada's total exports in that period. China was once a significant market for Canadian barley and so could be considered a potentially important market in the future, if incomes continue to increase and create a demand for meat products. Canada is the only major barley exporting country with a positive compound growth rate in the Eastern European market. Canada's export share to this region went from 5% in the 1960s to 36% in the early 1980s. Canada is the only exporter for whom Eastern Europe was an expanding market. Richer developing countries were another expanding market segment for Canadian barley, importing an average 32% of recent Canadian exports. Developed countries, on the other hand, were a contracting market segment dropping from a concentrated 79% of exports in the 1960s to an average 33% in the early 1980s. For the overall period developed countries comprised an average 63% of Canada's market, Eastern Europe 20% and richer developing countries 14%.

Australia's export profile reveals a shift of market concentration from developed countries in the 1960s to richer LDCs in recent trading. Exports to Eastern Europe fluctuated in the sub-periods but never accounted for a very large share of Australia's market relative to developed and richer developing countries. France's exports to developed countries also declined but still remain relatively concentrated in that area. Richer LDCs represent a growing market for French barley while exports to Eastern Europe have been highly variable. For the U.S.A., Eastern European and developed countries were contracting market segments until the mid-1980s while richer LDCs were an expanding market segment, accounting for the largest share of U.S.A. barley exports in the earlier 1980s.

Of the four major barley exporters, Australia and the United States had the largest export concentration in the expanding richer LDCs market. In the early 1980s, over 75% of Australia's barley exports went to richer LDCs and almost 70% of the U.S.A.'s exports. In contrast, Canada only sent just over 30% of its barley exports to richer LDCs and France sent just over 25%. The export profile data reveal that both Australia and the United States had a higher concentration of their barley exports in richer LDCs than did Canada. But Canada had the highest barley export concentration in the Eastern European market which, over the study period, was an expanding market, though growing at a slower rate than the richer developing country market.

Table 2.7: The Export Profile of the Exporters' Barley Exports to the Importing Regions, 1962-1985 and Sub-Periods, Percent Shares (Standard Deviations in Brackets)

Importing Regions:	Developed	East Europe	China	Richer LDCs	Poorest LDCs
Exporters:					
1962 - 1972:					
Australia	79.6 (12.3)	2.5 (5.7)	2.2 (7.2)	15.7 (10.9)	0.1 (0.1)
Canada	79.4 (16.4)	4.6 (8.6)	7.5 (16.7)	8.5 (9.2)	0.0
France	80.2 (13.0)	14.1 (12.8)	1.7 (4.2)	3.9 (3.2)	0.03 (0.03)
U.S.A.	58.4 (24.3)	14.3 (20.4)	0.0	27.3 (20.2)	0.1 (0.2)
Others	60.2 (11.6)	30.2 (11.6)	0.1 (0.3)	9.5 (2.4)	0.05 (0.04)
1973 - 1981:					
Australia	52.6 (18.9)	15.8 (14.0)	N/A[2]	31.5 (15.6)	0.1 (0.04)
Canada	56.0 (14.9)	31.9 (13.1)		12.1 (6.2)	0.0
France	71.2 (13.6)	18.0 (11.7)		10.8 (9.2)	0.04 (0.1)
U.S.A.	28.0 (16.3)	18.9 (11.0)		52.9 (9.9)	0.2 (0.5)
Others	48.2 (7.7)	38.7 (4.8)		13.1 (6.4)	0.1 (0.1)
1982 - 1985:					
Australia	14.2 (5.7)	7.9 (5.9)	N/A	77.3 (7.8)	0.7 (1.2)
Canada	32.6 (6.9)	35.6 (8.5)		31.6 (9.6)	0.1 (0.3)
France	59.1 (10.4)	13.4 (12.5)		27.6 (15.0)	0.01 (0.01)
U.S.A.	25.4 (6.3)	5.8 (2.2)		68.8 (4.4)	0.0
Others	42.6 (14.4)	18.9 (12.3)		38.4 (7.1)	0.1 (0.1)
1962 - 1972:					
Australia	58.6 (27.6)	8.4 (11.2)	1.0 (4.8)	31.9 (25.0)	0.2 (0.5)
Canada	62.9 (22.6)	20.0 (17.6)	3.4 (11.6)	13.7 (11.5)	0.02 (0.1)
France	73.3 (14.6)	15.4 (11.9)	0.8 (2.9)	10.4 (11.6)	0.03 (0.05)
U.S.A.	41.5 (24.6)	14.6 (15.6)	0.0	43.8 (22.0)	0.1 (0.3)
Others	52.7 (12.6)	31.2 (11.6)	0.04 (0.2)	15.6 (11.6)	0.1 (0.1)
% Annual C.G.R.[1]					
Australia	-8.0	-10.6	-	13.9	-29.0
Canada	-4.2	8.8	-	11.7	-
France	-1.8	-	-	12.4	-
U.S.A.	-5.9	-	-	6.5	17.8
Others	-2.4	-	-	6.5	-

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 1.717).
[2]Not available: Mackie *et al* do not report China separately for years of low imports. China, for these years, is contained in the poorest LDCs category.

2.4 Coarse Grains Other than Barley

Exporters' Market Shares

Table 2.8 contains the export quantity and market share data for corn, rye, oats and other feed grains (sorghum, millet, buckwheat, and canary seed). The corn market has expanded in volume. There are only three major corn exporters, the U.S.A., Argentina and France. The average market share data shows the United States dominance of world corn exports. Argentina has been the second largest exporter by volume followed by France.

Table 2.8: World Corn, Rye, Oats and Other Coarse Grain Exports of the Major Exporters, Average Quantity, 1962-1985 and Sub-Periods, 1000 MT (Percent Shares in Brackets)

Grains:	Corn	Rye	Oats	Other Feed Grains
Exporters:				
1962 - 1972:				
Argentina	3628.7 (13.8)	9.7 (2.2)	228.6 (16.6)	1054.2 (18.7)
Australia	--[1]	--	322.2 (22.4)	204.6 (3.1)
Canada	--	160.2 (22.1)	172.1 (11.9)	--
France	1613.3 (5.5)	18.9 (3.3)	83.2 (5.3)	47.3 (0.8)
U.S.A.	13,657.0 (51.7)	121.2 (11.9)	199.7 (13.1)	3683.2 (66.3)
Others	7500.0 (28.9)	545.6 (60.5)	450.4 (30.7)	619.6 (11.1)
1973 - 1981:				
Argentina	5269.1 (8.5)	28.3 (2.4)	169.5 (12.3)	3422.5 (29.3)
Australia	--	--	263.9 (19.4)	679.0 (6.0)
Canada	--	250.1 (29.1)	170.5 (12.2)	--
France	2654.8 (4.4)	50.7 (6.5)	205.3 (15.1)	146.3 (1.3)
U.S.A.	46,209.0 (73.0)	163.4 (12.5)	230.0 (16.1)	6190.5 (54.4)
Others	8165.6 (13.7)	483.7 (49.5)	344.2 (25.0)	1015.0 (9.0)
1982 - 1985:				
Argentina	5977.6 (8.9)	12.5 (1.3)	82.0 (6.6)	4578.6 (34.6)
Australia	--	--	208.4 (15.7)	970.1 (7.2)
Canada	--	483.5 (51.8)	124.2 (10.8)	--
France	4001.8 (6.0)	8.6 (1.2)	240.3 (19.8)	164.3 (1.2)
U.S.A.	46,931.0 (69.9)	10.5 (1.3)	7.9 (0.8)	6658.9 (50.2)
Others	9994.7 (14.9)	415.0 (44.4)	583.7 (46.4)	888.3 (6.7)
1962 - 1985:				
Argentina	4635.3 (10.9)	17.1 (2.1)	181.9 (13.3)	2529.7 (25.4)
Australia	--	--	282.9 (20.2)	510.1 (4.9)
Canada	--	247.8 (29.7)	163.5 (11.8)	--
France	2401.9 (5.2)	29.1 (4.1)	155.2 (11.4)	103.9 (1.0)
U.S.A.	31,409.0 (62.7)	118.6 (10.3)	179.1 (12.2)	5119.4 (59.1)
Others	8165.4 (20.9)	500.6 (53.7)	432.8 (31.2)	812.7 (9.6)

1 -- means this country was an insignificant exporter of that grain.

The rye export market was dominated by Canada because, as revealed by the quantity data, Canada was the only exporter to increase its volume of exports. The rye market overall was rather stagnant as Canada's increased exports were offset by the decrease in volume of all the other exporters. Canada accounted for an average 30% of the rye market.

The volume data in Table 2.8 reveal that the oats market was stagnant and even contracted somewhat over the study period. France and the collective category of other exporters were the only exporters to increase their volumes and market shares of oats exports. Exports of 'other' coarse grains expanded in volume and were dominated by the U.S.A.

Importers' Market Shares

Data for the importing regions' average quantities and market shares of corn, rye, oats and other coarse grains imports are contained in Table 2.9. The richer LDCs have been the fastest growing market segment for corn imports over the three sub-periods. Corn exports to developed countries and Eastern Europe increased in the 1970s but declined slightly in the early 1980s. The share data in brackets reveals that the concentration of corn imports into developed countries has lessened considerably since the 1960s while Eastern Europe and richer LDCs have increased their share of imports.

In the rye market, imports of developed and Eastern European countries fluctuated within the sub-periods. Despite these fluctuations, developed countries have accounted for the largest share of rye imports in the overall study period, with a percent share of 55%. Richer LDCs only became significant rye importers in the 1982-85 sub-period.

Table 2.9: World Corn, Rye, Oats and Other Coarse Grain Imports of the Importing Regions, Average Quantity, 1962-1985 and Sub-Periods, 1000 MT (Percent Shares in Brackets)

Grains:	Corn	Rye	Oats	Other Feed Grains
Exporters:				
1962 - 1972:				
Developed	21,834.0 (83.3)	495.5 (62.7)	1222.3 (85.4)	4313.3 (78.2)
E. Europe	1833.7 (6.4)	330.7 (35.4)	107.7 (5.6)	140.1 (2.6)
China	--[1]	22.4 (1.0)	12.2 (0.9)	--
Richer LDCs	2469.4 (9.2)	6.0 (0.8)	112.7 (8.0)	711.4 (12.6)
Poorest LDCs	261.6 (1.0)	0.8 (0.1)	1.2 (0.1)	444.2 (6.6)
1973 - 1981:				
Developed	34,882.0 (57.4)	362.2 (43.2)	947.9 (67.6)	6663.5 (59.3)
E. Europe	14,481.0 (22.2)	593.8 (54.8)	310.2 (22.9)	1204.7 (9.6)
China	--	--	--	--
Richer LDCs	12,633.0 (19.4)	19.8 (2.0)	128.7 (9.4)	3139.0 (26.7)
Poorest LDCs	627.6 (1.0)	0.4 (0.1)	0.5 (0.04)	446.1 (4.4)
1982 - 1985:				
Developed	32,048.0 (47.7)	541.0 (60.4)	894.3 (72.0)	5414.6 (40.6)
E. Europe	13,319.0 (19.9)	242.7 (24.4)	224.6 (17.2)	2153.2 (16.2)
China	--	--	--	--
Richer LDCs	20,878.0 (31.2)	146.2 (15.1)	127.3 (10.7)	5336.8 (40.5)
Poorest LDCs	795.0 (1.2)	0.2 (0.03)	0.3 (0.03)	355.6 (2.8)
1962 - 1985:				
Developed	28,429.0 (67.7)	453.1 (54.9)	1064.7 (76.5)	5378.2 (64.8)
E. Europe	8490.6 (14.6)	414.7 (40.8)	203.1 (14.0)	874.9 (7.5)
China	--	10.3 (0.5)	5.6 (0.4)	--
Richer LDCs	9365.7 (16.7)	34.6 (3.6)	121.1 (9.0)	2392.6 (22.5)
Poorest LDCs	487.8 (1.0)	0.6 (0.1)	0.8 (0.1)	430.1 (5.1)

[1] Means an insignificant market participant.

Import volumes and shares of oats reveal that developed countries dominated the oats import market with an average share of 76.5% for the twenty-four years prior to 1985. Eastern Europe and richer LDCs increased their market shares of oats imports, but were both still minor participants. In the other feed grains market, developed countries have become a less important market since the 1960s, while Eastern European countries increased their import share slightly and richer LDCs increased their import share substantially.

Exporters' Profiles

The export profiles of the corn exporters are shown in Table 2.10. The general export pattern shows a decreased concentration of exports to developed countries and an increased share of exports to Eastern European and richer LDCs. The United States, the dominant corn exporter, went from exporting 87% of its corn to developed countries in the 1960s to 48% in the early 1980s. For the overall study period, developed countries accounted for an average 70% of all U.S.A. corn exports. Argentina has gone from exporting an average 93% of its corn to developed countries in the 1960s to 24% in the early 1980s. Eastern Europe and richer LDCs have been growing markets for Argentinian corn exports. France is the only exporter to increase its export share to developed countries. All other import markets are insignificant for French corn exports which are firmly concentrated in developed countries.

Export profiles of the other various coarse grains are not presented here because such profiles would only reveal that the same general export pattern found in all the other profiles presented in this chapter also holds for rye, oats and other coarse grains exports. This general export pattern consists of a decreasing share of exports going to developed countries and an increasing share going to the richer LDCs and Eastern European countries.

2.5 Coarse Grain Trade Since 1985

More recent coarse grain and barley trade data, presented in Table 2.11, is not fully comparable to the previous trade data which were based on the calendar year (Jan-Dec) while the more recent data are for the crop year (July-June).

The United States continues to be the dominant exporter of coarse grains in the world market. Changes in U.S. policy have increased that country's market share above the levels that prevailed in the earlier 1980s. It held an average share of almost 60% of coarse grain exports between the 1985 and 1989 crop years. The compound growth data reveal that both Argentina and Australia have experienced negative growth rates in their volume of exports in the later 1980s.

Table 2.12 contains the recent trade data for the major barley exporters. The EC-12 data are not comparable to the category 'France' in the previous tables. The twelve countries comprising the European community account for the largest portion of world barley exports. Canada is the next largest exporter with an average market share of 24% of world barley exports. Australia and the U.S.A. both account for 12% of the market.

Table 2.10: The Export Profile of the Exporters' Corn Exports to the Importing Regions, 1962-1985 and Sub-Periods, Percent Share (Standard Deviations in Brackets)[1]

Importing Regions:	Developed	East Europe	Richer LDCs	Poorest LDCs
Exporters:				
1962 - 1972:				
Argentina	92.9 (5.1)	1.9 (1.8)	5.1 (4.3)	0.04 (0.1)
France	70.5 (45.3)	0.9 (1/6)	0.9 (1.0)	0.5 (0.6)
U.S.A.	86.6 (8.5)	5.4 (7.2)	6.9 (2.6)	1.1 (0.8)
Others	70.1 (5.8)	11.2 (3.5)	17.3 (5.6)	1.4 (0.6)
1973 - 1981:				
Argentina	51.7 (26.3)	31.7 (31.8)	16.2 (8.9)	0.4 (0.2)
France	96.6 (1.8)	0.6 (0.9)	1.0 (0.9)	1.8 (0.8)
U.S.A.	58.3 (9.4)	23.3 (6.8)	17.7 (6.2)	0.7 (0.4)
Others	46.2 (8.5)	13.7 (5.0)	37.4 (10.3)	2.7 (1.1)
1982 - 1985:				
Argentina	24.5 (10.4)	41.4 (17.8)	33.8 (10.3)	0.4 (0.2)
France	96.6 (1.4)	0.4 (0.7)	0.9 (0.5)	2.2 (1.2)
U.S.A.	47.7 (5.3)	20.2 (9.1)	31.3 (7.9)	0.7 (0.4)
Others	40.8 (7.9)	14.4 (4.7)	40.8 (3.7)	4.0 (3.6)
1962 - 1985:				
Argentina	66.1 (31.5)	19.6 (26.6)	14.0 (12.5)	0.2 (0.3)
France	84.6 (32.7)	0.7 (1.2)	0.9 (0.9)	1.3 (1.1)
U.S.A.	69.5 (18.3)	14.6 (11.2)	15.0 (10.2)	0.9 (0.6)
Others	56.3 (14.8)	12.7 (4.3)	28.7 (13.0)	2.3 (1.8)

[1]China is not included as a separate importer in this table, but is contained in the poorest LDCs category.

Table 2.11: World Coarse Grain Exports of the Major Exporters, Average Quantity (Million MT) and Market Share (Percent), 1985/86-1989/90

Exporting Regions:	Argentina	Australia	Canada	U.S.A.	Others
1985/86 - 1989/90					
Avg. Quantity	5.2	2.7	4.3	53.0	23.8
Standard Dev.	2.6	1.2	1.1	11.8	3.0
Minimum	3.2	1.7	3.4	36.4	19.6
Maximum	9.6	4.8	6.0	66.5	27.9
					0.08
Avg. Market Share	6.0	3.0	5.0	59.0	27.0
% Annual C.G.R.[1]	-22.0	-19.0	-	15.7	-

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 2.35).

More recent barley market data of the major importers is contained in Table 2.13. It is clear that these three countries, USSR, Japan and Saudi Arabia, have accounted for an average of almost 60% of barley imports in the five years between 1985 and 1989.

Table 2.12: World Barley Exports of the Major Exporters, Average Quantity (Million MT) and Market Share (Percent), 1985/86-1989/90

Exporting Regions:	Australia	Canada	EC-12	U.S.A.	Others
1985/86 - 1989/90					
Avg. Quantity	2.1	4.3	7.8	2.1	1.3
Standard Dev.	0.9	1.1	1.4	0.9	0.37
Minimum	1.4	3.4	6.2	0.8	1.0
Maximum	3.7	6.0	9.5	3.0	1.9
					0.29
Avg. Market Share	12.0	24.0	44.0	12.0	
% Annual C.G.R.[1]	18.2	-	9.0	-	-

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 2.35).

Table 2.13: World Barley Imports of the Importing Regions, Average Quantity (Million MT) and Market Share (Percent), 1985/86-1989/90

Importing Regions:	Saudi Arabia	USSR	East Europe	Japan	Others
1985/86 - 1989/90					
Avg. Quantity	5.9	3.1	2.1	1.3	5.3
Standard Dev.	1.9	0.6	0.8	0.1	1.2
Minimum	4.6	2.3	1.3	1.2	4.0
Maximum	9.0	3.9	3.3	1.5	6.5
Avg. Market Share	33.0	17.0	12.0	7.0	30.0

[1]Compound growth rate: - means that a compound growth rate was not calculated due to the b coefficient being insignificant at a 90% confidence level (t-statistic < 2.35).

2.6 Conclusions

The initial overview of feedgrain market share revealed several structural features of the world coarse grain and barley markets. In the aggregate feed grain market, corn was by far the most traded grain by volume, followed by barley. The remaining grains, such as oats, rye and sorghum, were minor components of the feed grain market in comparison to corn and barley. Of the major feed grain exporters, the U.S.A. had the largest average share of exports over the study period, followed by Argentina, France, Canada and Australia in descending order of market share. On the import side of the coarse grain market, developed countries have been a contracting market segment while the richer developing countries have been an expanding market segment. The poorest developing countries have not been significant market participants nor was China. Eastern European countries were an expansionary market segment for feed grain imports but were expanding at a slower rate than the richer LDCs.

The statistics for the barley market revealed that of the five major importing regions, richer LDCs were the fastest growing market segment, followed by Eastern European countries. Developed countries declined in importance as barley importers over the twenty-four year study period and accounted for a steadily decreasing average market share of barley imports. China and the poorest LDCs were minor barley market participants. On the export side of the barley market, Canada became the largest exporter by volume, replacing France as the leading barley exporter. The export profile data revealed that while all four barley exporters increased the share of their exports going to richer LDCs, Australia and the U.S.A. have both concentrated their exports to a larger degree in this rapidly expanding market segment than have either Canada or France. Canada, in addition to increasing its market share in richer LDCs, has also concentrated on exporting to the Eastern European market and was the most important barley exporter in this region between 1962 and 1985.

The recent trade data reveal that the United States improved its market share in the later 1980s, and continues to be the dominant exporter in the world coarse grain market. In the barley market, the twelve countries in the European Community have exported the largest average volume and market share of barley recently. Canada is the largest single country barley exporter with an average market share of 24% of world barley exports. On the import side, the barley market has tended to become relatively concentrated with three countries, Saudi Arabia, USSR and Japan accounting for almost 60% of recent barley exports.

3. Constant Market Share Analyses

3.1 Introduction

This chapter presents constant market share (CMS) analyses of the world barley, feed grain, and wheat markets. These analyses are undertaken to determine how the exporters' trade performances have been affected by structural aspects of the world grain markets as revealed for feedgrains in the previous chapter, like choice of market outlets and type of grain exported. The CMS method was chosen because it is a relatively simple procedure that provides significant insight into the competitive and structural aspects of an exporter's market. CMS analysis is well documented in economic literature as an acceptable method of analyzing international trading markets (see for example, Aho and Carney (1980) and Bowen and Pelzman (1980)).

3.2 The CMS Models

CMS analysis is based on the assumption that a country should be able to maintain a constant share in its export market. That is, exports may increase or decrease in absolute terms, but the market share should remain constant. Any changes in market share, therefore, can be attributed to structural elements and the general level of an exporter's competitiveness. CMS analysis decomposes the change in a country's exports between two periods into various 'effects' which capture these structural and competitiveness elements. In this section, only the final form of the models will be presented; detailed descriptions and derivations of the models can be found in Richardson (1971) and Leamer and Stern (1970).

Two different CMS models are used in the analyses. The first model, called the 'full' model because it handles a multi-commodity, multi-country scenario, is contained in Equation 1.

$$\dot{q} = s\dot{Q} + \left[\sum_j s_j \dot{q}_j - s\dot{Q} \right] + \left[\sum_i \sum_j s_{ij}\dot{q}_{ij} - \sum_j s_j \dot{q}_j \right] + \sum_i \sum_j q_{ij}\dot{s}_{ij} \qquad (1)$$

where q = exports of the focus country
Q = world exports
s = world export share of the focus country
i = subscript referring to a particular commodity
j = subscript referring to a particular importing region
dotted variables indicate time derivatives.

The first term on the right-hand side of Equation 1 is called the growth effect. The growth effect can be described as a conditional measure, because the growth effect represents the extent to which the focus country's exports *would* have grown with growth in world trade *if* constant market shares had been maintained. The remaining three terms on the right hand side of Equation 1 measure the actual growth, either positive or negative, of a country's exports relative to world export growth. In other words, the remaining three terms measure the loss or gain of market share between the two time periods.

The second and third terms on the right hand side of Equation 1 are called the market effect and the commodity effect respectively. These two effects measure how a country's export structure affects export growth. The market effect measures how export concentration in relatively fast (slow) growing import markets can cause an individual country's export growth to increase (decrease) relative to total world export growth. The commodity effect measures the same influence but with respect to an individual commodity that may be expanding or contracting relative to total world exports of other commodities. A calculation problem unique to the full model is that the estimation results can be sensitive to the order in which these market and commodity effects are calculated.

The last term in Equation 1 is called the competitive effect. This is the most difficult effect to interpret because the competitive effect is a residual that captures changes in market share not measured by the other effects. The competitive effect measures the influence of market conditions such as exchange rates, product quality, trade barriers, etc. The competitive effect measures a country's general ability to compete, a positive (negative) effect signifying a gain (loss) of market share.

The second CMS model used in this analysis appears in Equation 2.

$$\dot{q} = s\dot{Q} + \left[\sum_j s_j \dot{q}_j - s\dot{Q} \right] + \sum_j q_j \dot{s}_j \qquad (2)$$

This model is used for analysis of single commodity markets and is different from the full model only in that the commodity effect is not calculated and has been deleted. The notation is as previously described and the terms on the right hand side are, in order, the growth effect, the market effect and the competitive effect.

Four CMS analyses were performed for feedgrains. The first analysis is performed on the international barley market using the model in Equation 2. The second analysis also uses the model in Equation 2 and is performed on the aggregate coarse grain market. The main purpose of this second analysis is to determine if it is a valid practice to aggregate coarse grains into a single commodity within the CMS model framework. The final two analyses used the full model represented in Equation 1 and were performed on the coarse grain market. One estimation calculated the commodity effect first and the other calculated the market effect first in order to determine to what extent the model results were affected by the order of calculation problem. The feedgrains data used in the CMS models are from Mackie, Hiemstra and Sayre (1987). The study period of 1962 to 1985 is broken into three sub-periods for analysis. And the 'world' in each model is defined as being the relevant major exporters (i.e. Argentina, Australia, Canada, France and the USA) plus the aggregate category of 'other' exporters. Within each of the analyses, two comparisons are made: 1962-72 compared to 1973-81 and 1973-81 compared to 1982-85. Average data from the sub-periods, rather than single year data, were used for the base and end point comparisons to minimize the sensitivity of the analyses to the index number problem (i.e. the arbitrary choice of base and end years).

A similar set of analyses were also performed to decompose changes in export levels for each of the world's five major wheat exporters. The wheat exporting regions considered are the U.S., Canada, EC, Australia, Argentina and 'other'. The importing regions were the high income industrialized countries; the previously centrally planned Eastern European countries including the USSR; centrally planned Asian countries including China; middle-income developing countries; and low income developing countries. These regional aggregations were based on two previous Farming for the Future research projects, ARCA 84-0634 and 87-0119. A multi-commodity CMS version was applied to trade in different wheat classes but was concluded to be inferior to the single commodity version. Data were from the International Wheat Council, *World Wheat Statistics* and *Market Reports*, various issues. Data on wheat by class were from Canadian Grain Commission *Canadian Grain Exports* and U.S. Department of Agriculture *Grain Market News* and *Grain and Feed Market News*.

3.3 Results of the Barley Market CMS Analysis

Table 3.1 contains the results of the CMS analysis on the world barley market. These results reveal that for the period of 1962-72 compared with 1973-81, Canada experienced the largest growth in barley exports, as indicated by the total change figure. France experienced the next largest growth in barley exports, followed by Australia and the USA. Canada's export performance was enhanced by the general growth of world barley trade and by Canada's relative competitiveness in the barley market. This latter factor allowed Canada to increase its market share of barley trade. But Canada's export concentration in relatively slow growing markets had a negative effect on export growth.

Australia was the only country to register positive influences from all three calculated effects. The largest portion, 58%, of Australia's barley export growth came from factors measured by the competitiveness effect. Forty percent of the export growth was due to the general growth of world barley trade and a very small proportion of export growth was due to Australia's choice of export markets.

Although France had a positive change in barley exports between the two periods, the data in Table 3.1 reveal that this increase was due entirely to the general growth in world barley trade. France's export concentration in the contractionary developed country markets (see the import tables in Chapter 2) had a negative effect on France's barley exports, as did France's general decline in competitiveness. And the USA, despite experiencing a positive export growth due to its rapidly expanding markets, lost a large portion of its market share due to a relative inability to effectively compete in world markets in the early 1980s.

Table 3.1: Results of the Barley Market CMS Analysis, 1000 MT

Exporters:	Total Change	Growth Effect	% of Total	Market Effect	% of Total	Competitive Effect	% of Total
			1973-81 Compared to 1962-72				
Australia	1139.6	460.6	40.4	24.1	2.1	654.9	57.5
Canada	1781.5	1127.0	63.3	-245.9	-13.8	900.5	50.5
France	1339.5	1788.8	133.5	-352.7	-26.3	-96.5	-7.2
USA	191.0	843.0	441.4	218.6	114.5	-870.6	-455.9
Others	1506.2	1738.4	115.4	355.9	23.6	-588.2	-39.0
			1982-85 Compared to 1973-81				
Australia	1609.2	778.3	48.4	525.0	32.6	306.0	19.0
Canada	1158.4	1460.2	126.1	-517.2	-44.6	215.4	18.6
France	347.3	1661.3	478.4	-650.1	-187.2	-664.0	-191.2
USA	355.6	588.8	165.6	1045.8	294.1	-1279.0	-359.6
Others	2722.7	1704.7	62.6	-403.6	-14.8	1421.6	52.2

As already mentioned, Canada and France both had negative market effects and Australia had a small positive market effect. Only the USA (and 'others') show a significant positive influence due to export concentration in rapidly expanding markets. The exporter profile data in Table 2.7 from Chapter 2 reveal that in the 1970s Canada, France and Australia all had over 50% of their exports concentrated in developed countries, an area of slow market growth. In contrast, the USA had over

50% of its exports in the richer developing countries, a relatively rapidly expanding market segment in the 1970s. This CMS analysis reveals that the choice of export markets had an important influence on barley export performance for this period.

For the period of 1982-85 compared to 1973-81, the import market segment made up of richer LDCs was still expanding at a faster rate than any other barley importing region. Australia was able to increase its market concentration in richer LDCs to almost 80%, which had a significant positive influence on the growth of Australian barley exports. Australia's exports were also influenced by the relative competitiveness of Australian barley in world markets, though to a lesser degree than in the previous period.

Canada also managed to increase its market concentration for sales of barley to middle income countries but only to 32%. Canada's continued reliance on markets in developed country markets, and perhaps the Eastern European countries, significantly restricted Canadian barley exports as indicated by the negative market effect. However, Canada was able to increase its share of world barley exports due to being relatively competitive in this market.

As was the case for the previous period, France's reliance on developed country markets significantly restricted its barley export growth, as did France's inability to effectively compete in world markets. Growth in French barley exports in the second comparison period was due solely to the general rise in world trade. The USA, like France, also had a competitiveness problem, but was able to partially offset this negative impact by concentrating more of its exports in the rapidly expanding richer LDC market than previously.

3.4 Results of the Feed Grain Market CMS Analyses

This section of results is presented in two parts. The first part contains the results of the simpler CMS model, which treats feed grains as a single homogeneous commodity, and a discussion of the validity of this level of aggregation. The second part of this section presents the results of the full CMS model which disaggregates feed grains into the individual component grains and calculates a commodity effect. In this part, the discussion will begin with an investigation into which of the two calculation orders between the market and commodity effects produces results that are most consistent with the descriptive statistics in Chapter 2. The remainder of the discussion will then focus on that set of results.

Coarse Grains as A Single Commodity

The results of the simpler model (Equation 2), as applied to the world coarse grain market, appear in Table 3.2. This simpler model assumes that feed grains are a single, homogeneous commodity. But, as revealed by Table 2.2 in Chapter 2, the component coarse grains vary widely in market share and growth rates. Not calculating a commodity effect to explicitly measure the impact of an individual grain's variability results in these impacts being picked up by the competitive effect which in turn may distort the magnitude and sign of the competitive effect.

Comparing the competitive effects from the simpler model (Table 3.2) to those from the full model (Table 3.4) suggests the presence of distortions in the simpler model due to the high level of aggregation. For example, in the first time period the simple model competitive effect for the USA is negative (-71.7%), while the full model competitive effect is positive (+36.0%). Another example is France, for which the competitive effects have the same negative sign but very different magnitudes: -215.9%, simpler model; -0.2%, full model. Because the competitive effect is basically a residual within a CMS model, the wide difference in the competitive effects between the two models implies that there is a measurable commodity effect which, in the simpler model, is picked up by the competitive effect. It can be concluded that the full model, which separates feed grains into component commodities and calculates the commodity effect, is the superior model for analysis of the world feed grain market.

Table 3.2: Results of the Aggregated Feed Grain Market CMS Analysis, 1000 MT

Exporters:	Total Change	Growth Effect	% of Total	Market Effect	% of Total	Competitive Effect	% of Total
			1973-81 Compared to 1962-72				
Argentina	3968.3	5579.7	140.6	-243.6	-6.1	-1367.9	-34.5
Australia	1559.6	1306.1	83.7	166.1	10.7	87.5	5.6
Canada	2194.7	2110.7	96.2	-897.3	-40.9	981.3	44.7
France	2634.0	4750.8	180.4	3569.0	135.5	-5685.8	-215.9
USA	35,323	21,321	60.4	39,327	111.3	-25,325	-71.7
Others	2399.1	13,010	542.3	21,150	881.6	-31,762	-1323.9
			1982-85 Compared to 1973-81				
Argentina	1761.2	1211.3	68.8	1293.0	73.4	-743.0	-42.2
Australia	1840.8	369.5	20.1	-1199.9	-65.2	2671.3	145.1
Canada	1255.3	552.7	44.0	-929.7	-74.1	1632.3	130.0
France	1705.1	929.9	54.5	-1152.1	-67.6	1927.4	113.0
USA	1171.3	7375.7	629.7	-7847.5	-670.0	1643.0	140.3
Others	4595.9	1890.5	41.1	-2462.1	-53.6	5167.4	112.4

<u>Coarse Grains as Separate Commodities</u>

Having determined that the full model is the appropriate form for CMS analysis of the world coarse grain market, the next step is to determine which of the two possible calculation orders best describes coarse grain trade. As mentioned previously, the full model is often sensitive to the order in which the market and commodity effects are calculated (for further discussion, see Leamer and Stern, 1970, p. 175). To determine which order of calculation best describes world coarse grain trade, a comparison of some descriptive statistics from Chapter 2 and the market effects from the two calculation orders is presented in Table 3.3.

Calculation A appears to be more consistent with the market share data than is calculation B. For example, in the earlier time period, France has the highest market concentration in the contractionary developed country markets. Logically, the market effect for France should reflect this reliance on contractionary markets by being large and negative. The market effect for A is indeed large and negative, while for B it is large and positive. The B market effect is inconsistent with the market share data in this and other examples. (A similar comparison between the A and B commodity effects, not presented in this text, yields the same conclusion: calculation A provides more consistent estimates based on the descriptive statistics in Chapter 2). Calculation B, therefore, will be ignored and the following discussion of the CMS analysis of the world coarse grain market will focus on calculation A, which is the version presented in Table 3.4.

Table 3.3: Comparison of Exporters' Average Market Shares of Coarse Grain Exports[1] and the CMS Market Effects[2], Percent Shares

	Importing Regions			Market Effect (%)	
	Developed	East Europe	Richer LDCs	A	B
Time Period	1973-81			1973-81 Compared to 1962-72	
Exporters:					
Argentina	53.7	28.7	15.5	-51.4	-6.1
Australia	62.2	12.4	25.3	-7.5	10.7
Canada	53.3	34.2	12.4	-14.8	-40.9
France	82.1	10.3	6.6	-51.7	135.5
USA	57.3	21.2	20.2	0.9	111.3
Others	47.0	22.5	28.6	204.9	881.6
	1982-85			1982-85 Compared to 1973-81	
Argentina	32.3	42.2	25.3	-4.1	73.4
Australia	24.9	7.8	66.7	21.4	-65.2
Canada	35.7	33.1	31.1	-36.9	-74.1
France	78.5	6.6	13.9	-59.4	-67.6
USA	45.7	17.4	35.9	96.2	-670.0
Others	42.8	16.2	38.5	15.5	-53.6

[1]From Table 2.7
[2]The A column contains the CMS analysis results of CMS analysis of calculating the commodity effect first; the B column contains the results of calculating the market effect first.

The market effect results in Table 3.4 reveal that, in the earlier comparison period of 1962-72 compared to 1973-81, France and Argentina experienced the largest decline in coarse grain export growth due to market concentration in the relatively slow growing developed country markets. Canada and Australia also experienced declines in export growth due to choice of export markets, but to a lesser degree than either France or Argentina. The U.S.A. actually experienced a positive, though minor, increase in feed grain export growth due to its market concentration.

The commodity effect for the earlier period in Table 3.4 illustrates some interesting features about the world coarse grain market. The descriptive statistics in Chapter 2 revealed that corn, besides being the dominant grain in trade, was also the most rapidly expanding in trade in the 1970s. Exports of barley, rye, oats and other feed grains were growing at a slower rate than corn. The large, negative commodity effects of Australia and Canada reflect the fact that these two countries were not participants in the corn export market. France's commodity composition also restricted its export growth but to a lesser degree than Canada and Australia. France's small share of the corn market probably had a positive influence on its export growth but this was over-shadowed by France's larger export concentration in the other, less demanded coarse grains. The U.S.A.'s dominance of the corn export market had a small but positive influence on U.S.A.'s feed grain export growth.

Table 3.4: Results of the Disaggregated Feed Grain Market CMS Analysis[1], 1000 MT

Exporters:	Total Change	Growth Effect	% of Total	Commodity Effect	% of Total	Market Effect	% of Total	Competitive Effect	% of Total
	1973-81 Compared to 1962-72								
Argentina	3968.3	5579.7	140.6	488.7	12.3	-2040.8	-51.4	-59.4	-1.5
Australia	1559.6	1306.1	83.7	-647.4	-41.5	-116.1	-7.5	1017.2	65.2
Canada	2194.7	2110.7	96.2	-969.2	-44.2	-325.8	-14.8	1379.0	62.8
France	2634.0	4750.8	180.4	-749.6	-28.5	-1362.8	-51.7	-4.5	-0.2
USA	35,323	21,321	60.4	967.3	2.7	330.1	0.9	12,705	36.0
Others	2399.1	13,010	542.3	-491.1	-20.5	4916.7	204.9	-15,037	-626.8
	1982-85 Compared to 1973-81								
Argentina	1761.2	1211.3	68.8	-309.9	-17.6	-71.8	-4.1	931.6	52.9
Australia	1840.8	369.5	20.1	488.7	26.6	394.2	21.4	588.5	32.0
Canada	1255.3	552.7	44.0	901.7	71.8	-463.6	-36.9	264.4	21.1
France	1705.1	929.9	54.5	899.7	52.8	-1013.3	-59.4	888.9	52.1
USA	1171.3	7375.7	629.7	-3076.8	-262.7	1126.6	96.2	-4254.2	-363.2
Others	4595.9	1890.5	41.1	410.9	8.9	713.6	15.5	1580.9	34.4

[1]The results presented are obtained from the CMS model in which the commodity effect is calculated before the market effect.

The competitive effect for the first study period shows that Australia, Canada and the USA were all relatively competitive in the world feed grain market. All three of these countries managed to increase their share of world feed grain exports. Argentina and France both lost a small portion of market share due to a relatively poor ability to compete in world markets. France's only positive influence on export growth came from the general rise in world trade. All of the exporters were significantly affected by the expansion of world feed grain trade.

In the more recent period comparing 1982-85 to 1973-81, the descriptive statistics in Chapter 2 revealed that market conditions changed slightly. The fastest growing market segment was the richer developing countries, followed by Eastern Europe. Developed country markets had a negative growth rate of feed grain imports and were a contractionary market segment. Corn was still the dominant grain in trade but was growing at a slightly slower rate than barley. Barley was the most rapidly expanding component grain in world feed grain exports.

The results of the constant market share analysis in Table 3.4 reflect the trends in world feed grain trade described above. For example, Canada's export growth was influenced most by the commodity composition of its exports. Canada's large share of the rapidly expanding barley market had a significant positive impact on its total feed grain export performance. But, Canada's market concentration had a negative impact on export growth. Although Canada did manage to increase its participation in the richer LDC markets, Canada's continued reliance on the relatively slower growing Eastern European markets and the contracting developed country markets restricted feed grain exports. Canada managed to remain relatively competitive in world markets which helped export growth.

Argentina's export commodity composition, its lack of participation in the barley market and its relatively small share in the corn market, resulted in a negative impact on feed grain exports. Argentina's reliance on the slow growing Eastern European countries also had a negative but relatively insignificant impact on Argentinian coarse grain exports. Argentina's major source of export growth in the early 1980s was its ability to effectively compete in world markets.

Australia had the best feed grain export performance in the early 1980s due to increased participation in the rapidly expanding barley market and in the rapidly expanding richer LDCs market. Australia also increased its market share of world feed grain trade due to its ability to compete in world markets. France was another country whose exports were concentrated in the rapidly expanding barley market and whose export growth was helped by this favorable commodity composition. But, France's persistent reliance on developed country markets again restricted its feed grain exports. France, like Argentina, Australia and Canada, was relatively competitive in world markets which had a positive influence on its export growth.

The U.S.A.'s commodity composition had a large negative impact on its export growth in the early 1980s. Concentrating its exports in the relatively slow growing corn market caused a decline in the overall feed grain exports of the United States. But an increased participation in the rapidly expanding middle income developing countries had a large positive influence on U.S. coarse grain exports. The U.S. was the only country to lose market share from 1982 to 1985 due to its inability to compete in world markets.

3.5 Application of Constant Market Share Analysis for Wheat

The results from applying the single commodity CMS model for wheat for selected periods are given in Table 3.5. These indicate that the United States and Argentina achieved relatively larger increases in wheat exports, and market share increases, relative to other exporters over the later 1970s (comparing results for this time period with those for the earlier 1970s). Although this increase was partly accounted for by the general growth in the world wheat market (the market size affect) the U.S. evidently exhibited a considerable increase in competitiveness in the later 1970s, a feature that was not suggested for any other major exporter except Argentina in that time period. The results of the multiple-commodity model version are in Table 3.6. They suggest that the apparent loss in competitiveness for Canada indicated by the simpler model may be accounted for by a negative commodity composition effect. Apparently Canadian exports in the later 1970s were of slower growing classes of wheat as well as to slower growing markets.

Table 3.5: Results of the Single Commodity Constant Market Share Model, Model 2, Accounting for Changes in Growth of Wheat Exports by Major Exporting Nations, Comparisons for Four Time Periods from 1969/70 to 1987/88

Exporting Regions:	Argentina	Australia	Canada	EC	USA	Other
			Comparing 1975-79 with 1970-74			
Total Change ('000 metric t.)	1,418.8	1,263.8	789.4	734.2	6,783.8	-1,487.4
Market Size Effect ('000 metric t.)	322.2	1,206.9	2,036.2	889.0	3,839.5	1,208.6
(%)	22.7	95.4	257.9	121.0	56.6	81.2
Market Distribution Effect ('000 metric t.)	112.9	165.1	-716.2	395.7	248.0	-204.1
(%)	7.9	13.1	-90.7	53.9	3.7	-13.7
Competitive Effect ('000 metric t.)	984.7	-108.2	-530.6	-550.5	2,696.2	-2,491.9
(%)	69.4	-8.6	-67.2	-75.0	39.8	-167.5
			Comparing 1980-85 with 1975-79			
Total Change ('000 metric t.)	2,969.2	3,598.6	5,343.4	7,775.9	10,356.3	-402.6
Market Size Effect ('000 metric t.)	1,488.8	3,787.6	5,796.8	2,702.9	13,269.8	2,576.8
(%)	50.2	105.3	108.4	34.8	128.1	640.0
Market Distribution Effect ('000 metric t.)	496.7	-127.3	762.3	-829.6	-2,328.4	2,024.3
(%)	16.7	-3.6	14.3	-10.7	-22.5	502.8
Competitive Effect ('000 metric t.)	983.7	-61.7	-1,215.8	5,902.6	-585.1	-5,021.7
(%)	33.1	-1.7	-22.7	75.9	-5.6	-1,247.3
			Comparing 1986-88 with 1980-85			
Total Change ('000 metric t.)	-1,546.2	2,242.2	2,018.2	887.5	-8,640.0	-780.8
Market Size Effect ('000 metric t.)	-381.5	-732.6	-1,111.4	-836.2	-2,431.2	-325.7
(%)	-24.7	-32.7	-55.1	-94.2	-28.1	-41.7
Market Distribution Effect ('000 metric t.)	-180.2	5.8	-603.7	586.1	249.0	-55.0
(%)	-11.7	0.3	-29.9	66.0	2.9	-7.0
Competitive Effect ('000 metric t.)	-984.5	2,968.9	3,733.7	1,137.7	-6,457.8	-400.1
(%)	-63.6	132.4	185.0	128.2	-74.8	-51.2

Table 3.6: Results of the Expanded Constant Market Share Model, Model 1, Accounting for Changes in Growth of Wheat Exports by Major Exporting Nations, Comparisons for Four Time Periods from 1969/70 to 1987/88

Exporting Regions:	Argentina	Australia	Canada	EC	USA	Other
			Comparing 1975-79 with 1970-74			
Total Change ('000 metric t.)	1,418.8	1,263.8	692.8	734.2	6,390.8	-1,487.4
Market Size Effect ('000 metric t.)	314.2	1,179.2	1,892.2	868.6	3,527.6	1,180.9
(%)	22.2	93.3	257.7	125.4	55.6	79.4
Market Distribution Effect ('000 metric t.)						
first calculation[a]	166.8	-26.3	-1,756.1	441.1	236.9	-413.1
(%)	11.8	-2.1	-239.2	63.7	3.7	-27.8
second calculation[a]	-96.5	139.2	79.4	21.2	653.7	-49.2
(%)	-6.8	11.0	10.8	3.1	10.3	-3.3
Commodity Composition Effect ('000 metric t.)						
first calculation[a]	249.8	215.9	-124.8	1,973.1	1,629.1	-1,344.8
(%)[a]	-17.6	17.1	-17.0	284.8	25.7	-90.4
second calculation[a]	13.4	50.3	-1,960.3	2,392.8	1,212.3	-1,708.7
(%)	0.9	4.0	-266.9	345.4	19.1	-114.9
Competitive Effect ('000 metric t.)	1,187.1	-105.0	681.6	-2,548.5	947.5	-910.4
(%)	83.7	-8.3	92.8	367.9	14.9	-61.2
			Comparing 1980-85 with 1975-79			
Total Change ('000 metric t.)	2,969.2	3,598.6	5,569.4	7,775.9	10,557.5	-420.6
Market Size Effect ('000 metric t.)	1,569.5	3,992.9	5,785.1	2,849.4	13,136.6	2,716.4
(%)	52.9	110.9	103.9	36.6	124.4	645.8
Market Distribution Effect ('000 metric t.)						
first calculation[a]	588.9	807.7	1,333.8	-808.5	-2,398.6	2,176.4
(%)	19.8	22.4	23.4	-10.4	-22.7	517.5
second calculation[a]	203.9	-1,188.4	-881.0	-685.9	-286.1	50.3
(%)	6.9	-33.0	-15.8	-8.8	-2.7	-11.9
Commodity Composition Effect ('000 metric t.)						
first calculation[a]	-483.0	-2,245.8	-3,229.4	2,165.2	4,300.5	-4,994.4
(%)[a]	-16.3	-62.4	-58.0	27.8	40.7	-1,187.4
second calculation[a]	-98.1	-249.6	-1,014.6	2,042.6	2,187.9	-2,868.2
(%)	-3.3	-6.9	-18.2	26.3	20.7	-681.9
Competitive Effect ('000 metric t.)	1,293.9	1,043.8	1,679.9	3,569.9	-4,481.1	-319.1
(%)	43.6	29.0	30.2	45.9	-42.4	-75.9

continued ...

Table 3.6 Continued...

Exporting Regions:	Argentina	Australia	Canada	EC	USA	Other
			Comparing 1986-88 with 1980-85			
Total Change						
('000 metric t.)	-1,546.2	2,242.2	2,285.2	887.5	-8,419.0	-780.8
Market Size Effect						
('000 metric t.)	-357.3	-686.2	-1,014.2	-783.2	-2,185.2	-305.1
(%)	-23.1	-30.6	-44.4	-88.2	-26.0	-39.1
Market Distribution Effect						
('000 metric t.)						
first calculation[a]	-334.9	-247.8	-1,010.5	75.7	-490.2	-153.3
(%)	-21.7	-11.1	-44.2	8.5	-5.8	-19.6
second calculation[a]	-257.1	671.6	-333.9	1,615.8	-2,055.5	82.1
(%)	-16.6	29.9	-14.6	182.1	-24.4	10.5
Commodity Composition Effect						
('000 metric t.)						
first calculation[a]	6.7	782.9	2,275.4	259.8	-2,415.9	974.8
(%)[a]	0.4	34.9	99.6	29.3	-28.7	124.8
second calculation[a]	-71.1	-136.5	1,598.9	-1,280.2	-850.6	739.5
(%)	-4.6	-6.1	70.0	-144.2	-10.1	94.7
Competitive Effect						
('000 metric t.)	-860.6	2,393.2	2,034.4	1,335.2	-3,327.7	-1,297.5
(%)	-55.7	106.7	89.0	150.4	-39.5	-166.2

[a] For the first set of calculations, the market distribution effect was calculated first and the commodity composition effect was calculated second. For the second set of calculations, this order was reversed.

Referring again to Table 3.5, by the early 1980's, in comparison with the later 1970s, appreciable increases in market share were evident for the EC. Argentina also continued to achieve market share increases, but this was not the case for the U.S. and Canada. The results of the multi-commodity model version in Table 3.6 suggest, again, that the apparent loss in competitiveness for Canada can be attributed to concentration on exportation of wheat types for which demand growth has been slower. A similar effect may account for the smaller apparent loss in competitiveness for Australia suggested from the single commodity model.

In the later 1980s, until 1987/88, the U.S. continued to lose competitiveness, exhibiting falling export market shares. This also became evident for Argentina. However, the averaging procedure used for the calculations masks the recovery in U.S. export market share in 1987/88. Comparing calculations for that year alone with the two preceding years, indicates a very substantial competitive effect for the U.S. in 1987/88, likely due to the extensive use of the export enhancement plan in that year. The calculated competitive effect for 1987/88, relative to the average of the two preceding years was, for Argentina, -3,538 thousand metric tonnes, for Australia, -9,439 thousand metric tonnes, and for Canada, -2,345. Until 1987/88, therefore, it appears that the grain export subsidy war of the later 1980s did not result in market share losses for Australia and Canada. Evidently, a major effect of the intense price rivalry in world wheat markets in the later 1980s was to drive downwards the level of export prices rather than to change market shares. Relatively minor adjustments in market share, at least until recently, likely reflect the lack of production alternatives to grains in some exporting regions (particularly Argentina and Western Canada) and increased levels of government-funded assistance to grain growers (as in Canada).

In view of the ambiguities that arise from application of the multi-commodity model for wheat, the competitive effects calculated from both models were regressed against year by year changes in market shares. The simpler model was found to show a stronger association with changes in market shares and is therefore preferred for wheat although not for coarse grains.

3.6 Conclusions

The CMS analysis of the world barley market revealed that the structure of an exporter's market outlets had a measurable impact on market performance. Australia and the United States both experienced positive export growth due to concentrating their marketing efforts in the expansionary richer LDCs market segment. The countries with lower concentrations of exports in the richer LDCs, namely Canada and France, actually lost market shares because of their choice of market outlets. The CMS analysis also revealed that Australia and Canada were the only two exporters to consistently register positive barley export growth due to their relatively competitive trading practices.

The CMS analysis of the world coarse grain market also revealed the importance of relative import market growth rates to an exporter's trade performance. As was found for the barley market, those exporters with market outlets concentrated in richer developing countries experienced positive export growth. An added feature of the coarse grain CMS model was the commodity effect, which was calculated to determine the effect on an exporter's market performance of specializing in a particular component grain. The results of the commodity effect indicate that in the 1960s and 1970s, corn exporters experienced positive influences on their export growth, while in the 1980s, barley exporters experienced a similar positive impact to their export performance. The calculated competitive effect revealed that Canada and Australia were relatively competitive throughout the study period. The results also indicate that the United States went from being a relatively competitive country in the earlier period of study (1962-72 compared to 1973-81) to being extremely uncompetitive in the world feed grain market in the earlier 1980s.

As for feedgrains, the structure of exports affected wheat exporters' performance in terms of export growth. Canadian competitiveness has varied, and market growth seems to have been constrained at times by a degree of concentration in slower growing markets and classes of wheat. In the late 1980s the competitiveness of Canada, Argentina and Australia was reduced and that of the U.S. enhanced by application of that country's export enhancement program.

4. Cereal Import Demand in Developing Countries

4.1 Introduction

There have been dramatic changes in the structure of the international grain trade in recent decades. Not only has the volume of grain trade increased, particularly in the 1970s, but also the import shares of the different socio-economic regions have changed. Less developed countries (LDCs) became the fastest growing import market segment, while developed country import markets declined significantly. Cereal imports into the LDCs increased by 5.6 percent per year between the early 1960s and the early 1980s, the LDC share of world cereal imports increasing from 36 to 46 percent in the process (Mellor, 1988). In the 1980s, however, there have been concerns that slower economic growth and high levels of debt, which constrain the financial capacity of many LDCs, may have been limiting LDC grain imports.

The relative importance of various import demand factors is assessed in this analysis through the development and testing of a cross-sectional model of import demand for cereals. Import demand models for food (fine) grains and feed (coarse) grains, the two major sub-components of cereals, are also presented. Too few developing countries import barley on a systematic basis to permit the cross-sectional analysis of import demand for barley. This analysis includes three notable improvements over previous research (Morrison, 1984): the incorporation of dummy variables, an investigation into the effects of income distribution on cereal import demand, and more explicit consideration of collinearity.

Morrison did not incorporate intercept or slope dummy variables into his model to account for possible socio-economic demand differences such as GNP level, religion and geographical location. The importance of including such dummy variables is pointed out by Kennedy (1985, p.74): "in cross-section estimation it is surely unrealistic to assume that the parameters for every individual or every region are exactly the same". Slope dummy variables will therefore be included in this analysis to determine if there are significant qualitative differences in cereal import demand across countries.

The second omission in Morrison's analysis is the issue of income distribution. It has long been argued that income inequality is one of the principal causes of the food problems in LDCs. According to Yotopolous (1985), income distribution influences both the quantity and composition of cereal import demand and the total supply of cereal available for consumption through direct and indirect (i.e. meat products) means. However, the issue of income distribution is often overlooked in the study of cereal import demand in LDCs, despite cereals being a major component of the human diet and LDCs being the fastest growing market segment for cereal imports. Therefore, further analysis of the cereal import demand in LDCs will be conducted with a focus on the issue of income distribution.

The third item of omission is Morrison's failure to report or even speculate on the role of collinearity in the regression results. Collinearity testing will be performed on the variable set prior to estimation as a means of determining if the insignificance of any of the proposed explanatory variables is due to the presence of destructive collinearity in the data set or due simply to the variable being an insignificant explanator of cereal import demand.

4.2 The Model and Data

The factors affecting cereal import demand can be broadly categorized into four groups: development variables, which attempt to quantify the level, growth, and distribution of income and the degree of urbanization in a country; financial capacity variables, which measure a country's ability to afford imports; potential and actual domestic cereal supply, which measure the gap between demand and supply; and socio-economic dummy variables, which quantify structural differences in import demand across countries. These four categories are included in the following single equation import demand model:

$$(1)\quad CM = f(X_1, X_2, X_3, X_4),$$

where: CM = cereal imports

X_1 = vector of development variables (GNP, rGDP, URB)

X_2 = vector of financial capacity variables (LRES, AID, LDBT, TDS, X86, EXP, LACN)

X_3 = vector of domestic grain supply variables (CP, FLUC, DENS)

X_4 = vector of intercept and slope dummy variables.

Price variables are omitted because the analysis is cross-sectional and prices are assumed to be fixed for the year (Christiansen, 1987, p. 5 and Morrison, 1984, p. 21).

Table 4.1 contains a summary of the variables in the model: the definition of the variables and the source of the data. The data in this cross-section of LDCs are for the year 1986, with all lagged variables being from 1985. Per capita data are used for all quantity and value variables in order to eliminate the influence of size from the data set so that larger or more heavily populated countries, such as China, do not have an disproportionate affect on the model results. All of the value variables are measured in units of U.S. dollars per capita. These variables are GNP, LRES, LACN, LDBT, TDS, X86 and MFM. All the volume variables are expressed in units of kilogram per capita, which includes AID, CM, CP, FLUC, FNM, FNP, CSM and CSP.

The sample size of the data set is seventy-four. A complete list of the seventy-four countries entering the regression can be found in Appendix A. Countries are chosen from the categories of low, middle and high-income developing nations as defined in the World Bank *World Development Report* (1988). The sample is limited to those countries located in South America, Africa and Asia and to those countries for which the necessary data are available. In addition, all of the countries are net cereal importers. High-income oil exporters (Saudi Arabia, Kuwait and United Arab Emirates) are excluded from the data set as being atypical developing nations.

It should be noted that data for the dependent variable, cereal imports, include concessional food aid imports as well as commercial cereal imports (Huddleston, 1984, pp.13-14). Since food aid is being entered into the regression as a separate independent variable, it would be preferable to express the dependent variable, cereal imports, net of food aid. However, cereal imports are measured on a calendar year basis, while the food aid data are measured on a crop year basis (July to June). Therefore, the dependent variable, cereal imports, cannot be expressed net of food aid, which limits the explanatory power of the food aid variable (AID).

Fine grains (FNM) are defined as wheat and rice while coarse grains (CSM) are barley, corn, oats, rye, sorghum and millet. The value of manufactured imports (MFM) is calculated by multiplying the value of merchandise imports and the percent share of other manufactures, both categories being from tables in the *World Development Report*. The category 'other manufactures' includes such items as clothing and electronics.

The intercept dummy variables DSA, DAS and DAF divide the sample set on the basis of geography. Geography is chosen as the division criterion to account for factors such as general weather patterns, resource endowments and cultural differences that may influence tastes and preferences across nations. In addition to the intercept dummies, slope dummy variables will also be entered into the regression once a preliminary set of significant variables is identified. An alternative set of dummy variables divides the seventy-four country sample on the basis of income level. The definition of the income groups can be found in a later section on income distribution.

Table 4.1: Variable Definitions and Data Sources, LDCs

Variable	Definition	Source[1]
POP	1986 population	A (1988)
GNP	1986 GNP per capita, $U.S./capita	A (1988)
rGDP	avg. annual growth rate of GDP, 1980-86	A (1988)
URB	1985 percent urban population of total population	A (1988)
AID	quantity of cereal food aid, kg/capita	A (1988)
LRES	1985 gross international reserves, $U.S./capita	A (1987)
LACN	1985 current account balance, $U.S./capita	A (1987)
LDBT	1985 external public debt, outstanding & disbursed, $U.S./capita	A (1987)
TDS	1986 total debt service on government debt, $U.S./capita	D (1987)
EXP	avg. annual growth rate of merchandise exports, 1980-86	A (1988)
X86	1986 value of merchandise exports, $U.S./capita	A (1988)
CM	1986 gross quantity of cereal imports, kg/capita	B (1987)
CSM	1986 gross quantity of coarse grain imports, kg/capita	B (1987)
FNM	1986 gross quantity of fine grain imports, kg/capita	B (1987)
MFM	1986 value of manufactured imports, $U.S./capita	A (1988)
CP	1985 quantity of cereal production, kg/capita	C (1987)
FLUC	difference between 1985 and 1986 cereal production, kg/capita	C (1987)
DENS	1986 population density on arable land, 1000 persons/ha	C (1987)
DSA	dummy variable for 20 South American countries	
DAS	dummy variable for 18 Asian and Mid-Eastern countries	
DAF	dummy variable for 36 African countries	

[1]A: World Bank, *World Development Report*
B: FAO, *Trade Yearbook*
C: FAO, *Production Yearbook*
D: World Bank, *World Debt Tables*, Vol. II

The final data issue to be discussed is that of collinearity. Collinearity testing is performed on the data set prior to model estimation in order to identify collinear variable combinations which may have destructive influences on the regression results. Collinearity testing of the data set follows the procedure recommended by Belsley, Kuh and Welsh (1980), which uses two conditions, singular values greater than 30 and variance decomposition proportions greater than 0.05 for two or more variable coefficients, to identify potentially destructive collinearity. These collinearity tests will not be presented here, but an example table of test results for several variables appears in Appendix B. The main finding of this collinearity testing is that the variables GNP and LRES (per capita income and international reserves respectively) appear to have a very strong collinear relationship, as indicated by a variance proportion of 0.998. A perfectly collinear variance proportion has a value of 1.00. Therefore, it is expected that the collinear relationship between GNP and LRES will have destructive effects on the regression results.

4.3 Results of the Cereal Import Demand Model

All regressions are estimated using ordinary least squares and a linear functional form. The statistical package used is SHAZAM, Version 6.1. Equation 2 contains the results of the preliminary model before any slope dummy variables were incorporated. T-statistics appear in brackets; t-critical (2-tailed, $\alpha = 0.05$, 60 d.f.) = 2.000.

$$\underset{}{CM} = \underset{(2.04)}{-31} - \underset{(2.29)}{24DAF} - \underset{(7.26)}{86DSA} + \underset{(6.84)}{0.03GNP} + \underset{(3.65)}{0.89URB} + \underset{(5.27)}{1.11AID} - \underset{(3.76)}{0.15CP} +$$

$$\underset{(2.58)}{0.03LDBT} - \underset{(2.15)}{0.24FLUC} \qquad adj.R^2 = 0.83 \tag{2}$$

Of the two alternative income variables, GNP is significant in the regression while rGDP is not. The intercept dummy variables based on income level proved to be insignificant in the regression. Only two of the finance variables are significant in the regression, food aid and lagged government debt. The variable AID, which has two variations, enters the regression best as cereal food aid from July 1986 to June 1987. Both debt variables, lagged government debt and total debt service, are significant in separate regressions, but LDBT, lagged government debt, explains the variation in cereal imports better than does TDS, total debt service. Contrary to expectations, however, the coefficient on the lagged debt variable is positive, i.e. countries with heavier loads of debt per capita tend to import more cereals. This factor is explored further later in this chapter.

Of the remaining finance variables, one of the most surprising results is that LRES, the foreign exchange variable, is insignificant in the regression. Further investigation reveals that LRES is significant in the regression, but only when the variable GNP is omitted. When the two variables GNP and LRES appear in the same regression, LRES has the wrong theoretical sign on the coefficient and is insignificantly different than zero. This result is the consequence of the previously mentioned strong collinearity between these two variables. Therefore, since there exists destructive collinearity between GNP and LRES, LRES is dropped from the regression because this variable is more adversely affected by the collinearity than is GNP. The same destructive collinearity situation applies to X86, the value of merchandise exports. Like LRES, X86 is dropped from the regression due to destructive collinearity with GNP. The other two finance variables, LACN and EXP, are simply insignificant in the regression and so are also dropped.

The geographical intercept dummies indicated that there are significant differences in the level of cereal imports by Asian, African, and South American countries. Slope dummy variables were then introduced to test for significant regional differences in import response as measured by the independent variables. There are six variables in the regression that can have slope dummies: FLUC, CP, URB, AID, GNP, and LDBT. Since slope dummy variables identify whether an independent variable has any regional differences, *a priori* expectations can be formed as to which variables might have regional differences.

Certainly, the cereal production variables FLUC and CP can be expected to have regional differences in one or all regions due to resource endowments, continental weather patterns and other such environmental effects on cereal production. On the other hand, it was assumed that the degree of urbanization (URB) was not measurably different on a regional basis. For the food aid variable, AID, only a slope dummy for Africa is expected to be relevant because food aid as a share of cereal imports has been increasing in Sub-Saharan Africa while for Asia and South America this share has been decreasing (Huddleston, 1984, p.25). In other words, African countries rely more on food aid as a source of cereal imports than do Asian or South American countries.

Due to the heavy concentration of African nations in the low GNP category (23 of the 29 countries with a GNP level of less than U.S. $450 are in Africa), a slope dummy on the variable GNP for Africa should be tried in the regression. No other income category (that is, medium or high income LDCs) has such a regional concentration and so no other GNP slope dummy is reasonable. For the final variable, LDBT, a slope dummy can be created for all three regions because it is plausible that any or all of the regions may have different levels of debt or react differently to external debt when deciding on cereal imports. While in general most LDCs face a debt crisis, this problem has been particularly severe in South America (Holley, 1987, p.9 and Kuczynski, 1988, p.1). Therefore, of the debt slope dummies, it is expected that the one for South America will be significant.

The above discussion serves to identify eight slope dummy variables thought to be relevant to the cereal import demand function. These eight slope dummies, as summarized below, are entered into regressions in various combinations with F-tests applied to assess which combination of variables is significant (see Appendix C for the structure of the F-test).

FLUC.AF: cereal production fluctuations in Africa
FLUC.SA: production fluctuations in South America
CP.AF: cereal production in Africa
CP.SA: cereal production in South America
AID.AF: food aid in Africa
GNP.AF: GNP in Africa
LDBT.AF: lagged debt in Africa
LDBT.SA: lagged debt in South America.

The various F-tests and regressions will not be presented here as the information obtained is relevant only to determine the best set of explanatory variables. Only the results of this best set will be presented in the text of this chapter, and these results appear in Equation 3.

$$\begin{aligned} CM = {} & \underset{(2.72)}{42} - \underset{(2.56)}{41DSA} - \underset{(3.67)}{55DAF} + \underset{(7.31)}{0.023GNP} + \underset{(3.09)}{0.689URB} + \underset{(3.19)}{0.729AID} - \underset{(4.39)}{0.190CP} + \\ & \underset{(4.17)}{0.040LDBT} + \underset{(1.98)}{0.134CP.AF} + \underset{(3.20)}{1.353AID.AF} - \underset{(2.97)}{0.051LDBT.SA} \end{aligned} \qquad (3)$$

and adj. R^2=0.8671. The significant slope dummy variable for government debt in South America indicates that cereal imports in that region are more adversely affected by the level of government debt than are countries in Africa and Asia. The coefficient on LDBT for Africa and Asia is +0.04. This positive value can be interpreted to mean that in Asia and Africa, cereals are given a very high import priority because government debt does not act as a dampening agent. For South America, on the other hand, the value of the coefficient on LDBT is -0.011 (obtained by adding the coefficients for

LDBT and LDBT.SA). The negative relationship between government debt ($U.S./capita) and cereal imports (kg/capita) in South America means that debt has had a significant dampening effect on the amount of grains that can be purchased.

The slope dummy for food aid in Africa has a coefficient value of +2.082 as opposed to +0.792 for South America and Asia (2.082 is obtained from adding the coefficients for AID and the African AID slope dummy). The higher value for Africa can be interpreted to mean that Africa, as expected, does indeed have a higher dependence on food aid as a form of cereal imports than the other two regions. For all three regions, the positive sign on the AID variable coefficient indicates that cereal food aid and cereal imports are complementary goods. More precise information would be obtained if cereal imports could be measured net of food aid, but as pointed out in the Data section, the time frames of the two data sources are incompatible.

The only cereal production slope dummy that is significant is the one for Africa. For South America and Asia, the coefficient on CP is -0.190 while for Africa this value is -0.056. In all regions, domestic cereal production acts as a substitute for cereal imports, but more so in Asia and South America than in Africa. Another point to note is that addition of the slope dummy variables caused the variable FLUC (cereal production fluctuations) to become insignificant in Equation 3 (FLUC was a significant variable in the preliminary regression contained in Equation 2). It appears that the level of cereal production is a more important determinant of cereal imports than is production fluctuations.

Another insignificant slope dummy variable is that of GNP for African countries. This result implies that there is no discernable difference in cereal import behavior between low-income countries and medium or high-income developing countries. The variables GNP and URB (percent urbanization) both have the same effect on cereal imports across all countries: cereal imports increase as GNP levels increase and as urbanization increases.

Two further tests are run on the regression in Equation 3, the Breusch-Pagan test for heteroskedasticity and a Box-Cox test for functional form (see Appendix C for a more detailed description of these tests). The BP test statistic has a value of 15.61 with 10 degrees of freedom and the critical value of $\chi^2 = 18.307$ at the 5% level. The results of this test indicate that there is no significant heteroskedasticity in the regression.

The Box-Cox test results indicate that the best-fitting functional form for all the variables with non-zero observations (the dependent variable CM and two independent variables, GNP and URB) is a square root transformation. But, such a transformation causes several of the untransformed independent variables to become insignificant. In other words, changing the functional form, as suggested by the Box-Cox test, does not improve the explanatory power of the model. Since functional form is determined more by statistical considerations than theoretical, no further attempts to alter the functional form will be made here. Instead, it will only be noted that a linear functional form may not be optimal for this cross-sectional analysis, but is retained as being the next best alternative.

Figure 4.1: Actual and Predicted African Cereal Imports

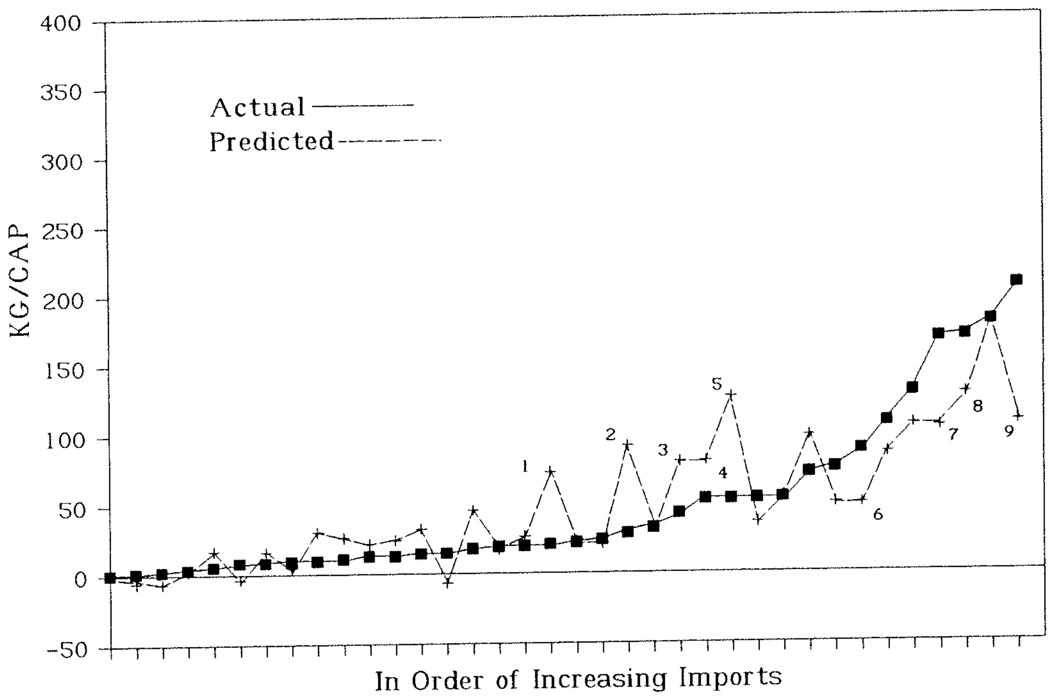


Figure 4.2: Actual and Predicted Asian Cereal Imports

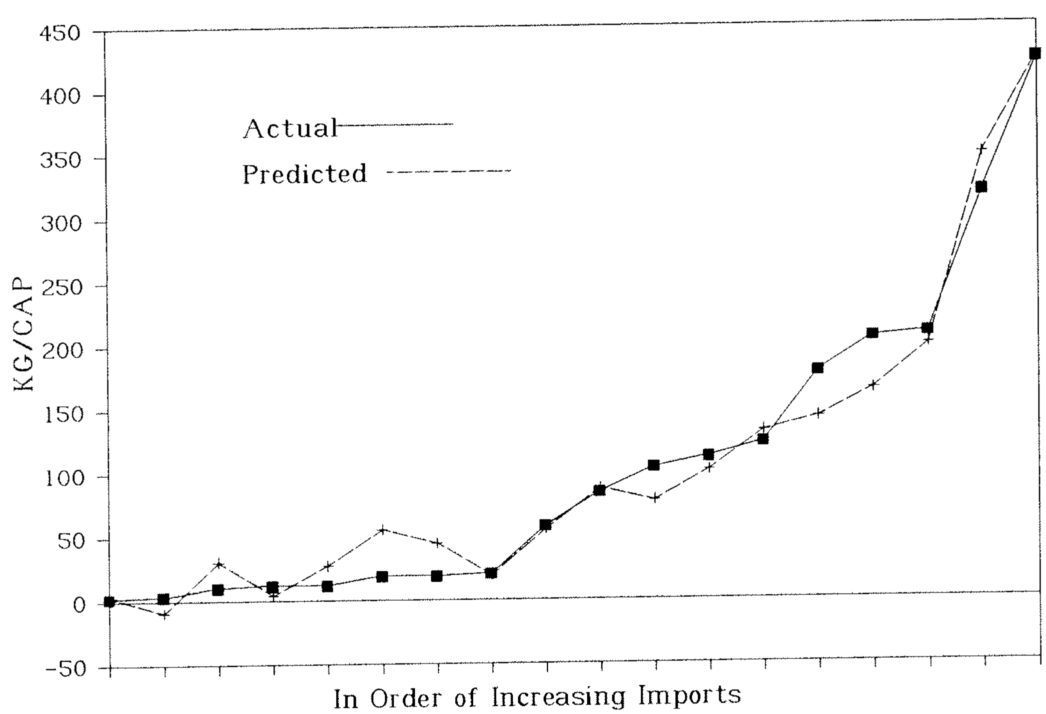
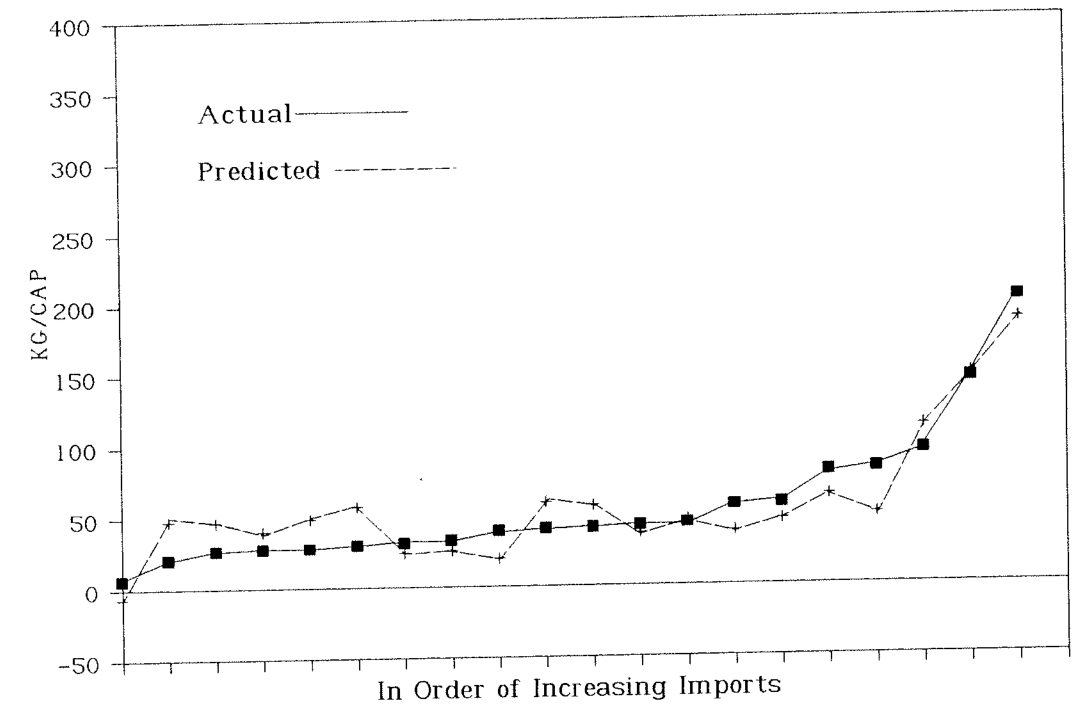


Figure 4.3: Actual and Predicted S American Cereal Imports



Figures 4.1 to 4.3 contain graphs of the actual (solid line) and predicted (dashed line) cereal imports of the three geographical regions. The graphs reveal that cereal imports of two regions, South America and Asia, are predicted quite well from the model while cereal imports for Africa are not so well predicted for certain countries. The African countries least well predicted have been numbered in Figure 4.1 and correspond to the following:

1. Zambia
2. Sudan
3. Congo
4. Somalia
5. Gabon
6. Lesotho
7. Mauritius
8. Egypt
9. Algeria.

There is no unifying characteristic among these countries to suggest a reason for the poorer predictive ability of the model. The countries are spread out across the African continent and come from all three income categories. Therefore, no speculation can be offered as to why the model is unable to accurately predict the cereal imports of these nine African countries.

Elasticities

Table 4.2 contains the estimated cereal import elasticities of demand from the results in Equation 3. The table reveals that all of the elasticities are in the inelastic range. For example, a one percent increase in per capita national income, GNP, causes only a 0.5 percent increase in cereal imports. The elasticities of import demand with respect to the variables AID (food aid), LDBT (government debt), and CP (domestic cereal production) differ between regions, and are calculated using the elasticities with respect to the intercept dummy variables.

Table 4.2: Elasticities from the Import Demand for Cereals in LDCs (Equation 3)

Variable		Elasticity
GNP		0.477
URB		0.407
AID	Africa	0.232
	Asia	0.123
	South America	0.123
LDBT	Africa	0.306
	Asia	0.306
	South America	-0.037
CP	Africa	-0.314
	Asia	-0.449
	South America	-0.449

Cereal imports are slightly more elastic with respect to food aid (AID) for Africa than for Asia or South America. This may reflect Africa's high level of cereal food aid in cereal imports relative to the other two regions. The responses in cereal imports to changes in government debt for both Africa and Asia show positive elasticities, while South American countries exhibit a negative and very inelastic response in cereal imports to government debt. The cereal import elasticities with respect to cereal production (CP) reveal that Africa reduces cereal imports less for each unit of domestic production increase than do either Asia or South America. This may result from Africa's relatively high cereal deficit compared to Asia and South America.

4.4 Further Related Analyses

<u>The Import Demand for Manufactured Goods</u>

As a brief side issue, a regression is run on manufactured imports (expressed in units of U.S. dollars per capita) in order to determine which, if any, of the variables in the cereal import equation also explain imports of manufactured goods. Another reason for this investigation is to determine whether GNP or LRES best explains the variation in manufactured imports. (Recall that for cereal imports, GNP proved to be the superior explanator of the two). A regression is run on manufactured imports using the dependent variables from Equation 3 with the addition of LRES and the deletion of the slope dummy variables and the cereal production variable. The results are:

$$\underset{(0.27)}{MFM = 9} - \underset{(0.38)}{11DAF} - \underset{(2.33)}{81DSA} + \underset{(0.77)}{0.016GNP} - \underset{(0.53)}{0.380URB} + \underset{(0.88)}{0.543AID} +$$

$$\underset{(3.80)}{0.132LDBT} + \underset{(15.44)}{0.531LRES} \qquad adj.R^2 = 0.94 \qquad (4)$$

The results in Equation 4 reveal that only three of the variables are significant, LRES, LDBT and the intercept dummy for South America. GNP has become insignificant due to the destructive collinearity between LRES and GNP. This result indicates that manufactured imports are more dependent on the availability of foreign exchange reserves than are cereal imports which in turn implies that cereals may be given a higher priority over manufactures in imports.

Another regression is run on manufactured imports with the independent variables LDBT and LRES and regional slope dummies for these two variables. The results of the best regression on manufactured imports appear in Equation 5.

$$MFM = \underset{(0.50)}{-3.2} + \underset{(6.66)}{0.156LDBT} + \underset{(79.72)}{0.571LRES} - \underset{(2.58)}{0.120LRES.AF} - \underset{(4.57)}{0.423LRES.SA} \quad (5)$$

and adj. R^2=0.96. These results are estimated with a heteroskedastic consistent covariance matrix because the Breusch-Pagan test indicated the presence of heteroskedasticity. As in the cereal import demand regression, the coefficient on the government debt variable is positive. This result implies that large government debt in LDCs has not been a very strong deterrent to imports of any kind, at least in cross-section. The significant slope dummy variables for LRES indicate that each of the three geographical regions react differently to changes in foreign exchange reserves with respect to demand for manufactured imports. No further tests or refinement of the import demand for manufactured imports will be attempted as this regression is presented merely as a comparison to cereal import demand which is the main focus of this analysis.

The Import Demand for Fine and Coarse Grains

A secondary purpose of this chapter is to determine if cereal imports disaggregated into fine and coarse grain components can be explained by the same independent variables as total cereal imports. It is generally assumed by researchers that fine and coarse grain import demand functions should have different specifications (see for instance Kim, Bolling and Waino, 1987, Marks and Yetley, 1987, and Yotopoulos, 1985), since fine grains are primarily consumed as food grains while a major use of coarse grains is as animal feeds. Therefore, fine grain and coarse grain imports will be estimated using the variables listed in Table 4.1. The results of the 'best' regressions appear in Equations 6 and 7 (fine and coarse grains respectively).

$$FNM = \underset{(2.17)}{25} - \underset{(2.48)}{23DAF} - \underset{(5.01)}{46DSA} + \underset{(3.02)}{0.011GNP} + \underset{(4.10)}{0.831URB} + \underset{(4.67)}{0.743AID} - \underset{(3.20)}{0.094CP} +$$

$$\underset{(4.09)}{0.022GNP.AF} \qquad adj.R^2 = 0.71 \quad (6)$$

$$CSM = \underset{(3.39)}{-7} + \underset{(15.86)}{0.016GNP} + \underset{(4.36)}{0.321AID} + \underset{(13.93)}{0.46LDBT} - \underset{(10.59)}{0.066LDBT.AF} - \underset{(10.90)}{0.053LDBT.SA} +$$

$$\underset{(2.89)}{0.756AID.AF} \qquad adj.R^2 = 0.87 \quad (7)$$

The results in the two above equations reveal that fine grain imports and coarse grain imports require quite different sets of explanatory variables from each other and from total cereal imports. The implication of this finding is that analyzing cereal imports as an aggregate group fails to recognize the apparently different natures of the fine and coarse grain components in total cereal imports. In other words, relevant information specific to a particular type of grain (fine or coarse) cannot be obtained when analyzing cereals as an aggregate group.

A final point of interest from the fine and coarse grain regression is the income elasticities. The elasticity of fine grain imports with respect to income in Asia and South America is 0.26 and in Africa is 0.42. For coarse grain imports the elasticity with respect to income in all three regions is 0.92. As one would expect, the coarse grain imports display a more elastic response to changes in income than do fine grain imports.

Income Distribution and Cereal Imports

One of the omissions in Morrison's cross sectional analysis of cereal import demand in LDCs was the issue of income distribution. Since income distribution influences both the quantity and composition (food or feed grains) of cereal import demand, an empirical investigation of the impact of income distribution on the demand for cereal imports will improve our understanding of the world food economy. The purpose of this section is to conduct such an investigation.

The cereal import demand in Equation 4 is re-estimated with the addition of two kinds of income variables. One variable is SH, the share of income of the poorest 40% of the population. This variable is a measure of the income distribution within a single country, with the data coming from the World Bank *World Development Report*. An alternative measure of relative income inequality in the distribution of income, the Gini Coefficient, was also used but proved to be a weaker explanator of cereal imports than the income share of the poorest 40 percent. The second kind of additional income variable is a set of slope dummy variables which divides the sample between countries on the basis of low, middle and high GNP. These GNP dummies are initialized using the World Bank definitions of low, middle and high income:

DL = 1 for 7 countries with GNP < U.S. $450; otherwise = 0
DM = 1 for 9 countries with U.S. $450 < GNP < U.S. $1800; otherwise = 0
DH = 1 for 7 countries with GNP > U.S. $1800.

These variables enter the regression as slope dummies for low and middle income countries on the GNP variable (GNP.DL and GNP.DM) and for low and middle income countries on the income distribution variable (SH.DL and SH.DM). The countries are divided into the three categories based on the 1987 data and these divisions are then imposed on the 1984 and 1986 regressions.

The results of the regressions appear in Table 4.3. The model is estimated for data from three different years, 1984, 1986 and 1987, to determine the stability of the results over time. The sample sizes are limited to twenty-three countries due to the availability of data for the variable SH. A complete list of the twenty-three countries including the low, middle and high income designations can be found in Appendix A.

Two tests are run on each regression, the Breusch-Pagan test for heteroskedasticity and the Ramsey RESET test for mis-specification (see Thursby, 1981 for an explanation of this test). The BP test indicates that there is no significant heteroskedasticity in any regression. The RESET tests indicate that the linear functional form is appropriate and that there is probably no mis-specification errors.

Table 4.3: Results of the Cereal Import Demand Regressions Involving Income Distribution (t-statistics in Brackets)

Year	Const	DSA	GNP	GNP.DM	AID	AID.AF	CP	SH	SH.DL	SH.DM
1984	4 (0.12)	-21 (0.78)	0.02 (1.91)	0.04 (1.54)	1.38 (1.53)	1.51 (1.28)	-0.20 (2.64)	10.20 (2.57)	-8.26 (3.70)	-6.75 (2.10)
	adj. R^2=0.77 Tests: BP=7.23; RESET(2)=1.05; RESET(3)=3.71; RESET(4)=2.53									
1986	29 (1.45)	-64 (5.03)	0.03 (3.25)	0.08 (4.19)	1.37 (2.49)	0.04 (3.24)	-0.17 (3.92)	7.35 (3.40)	-7.17 (4.52)	-10.22 (4.49)
	adj. R^2=0.91 Tests: BP=12.0; RESET(2)=0.89; RESET(3)=0.60; RESET(4)=1.14									
1987	-27 (1.15)	-57 (3.90)	0.04 (3.40)	0.06 (3.88)	0.59 (1.04)	2.56 (4.05)	-0.19 (4.49)	10.19 (3.80)	-6.66 (3.07)	-8.09 (3.10)
	adj. R^2=0.93 Tests: BP=10.3; RESET(2)=2.38; RESET(3)=1.90; RESET(4)=1.15									

For the t-statistics: t-critical (2-tailed, $\alpha = 0.05$, 14 d.f.)=2.145 and t-critical (2-tailed, $\alpha = 0.01$, 14 d.f.)=1.761.

The same regression is estimated for all three years and the data in Table 4.3 reveal that the coefficient estimates for most of the variables have remained fairly stable over time. With the exception of the debt variables, the same explanatory variables from Equation 3 are generally significant when the income distribution variables are added to the regression. The 1984 regression has several insignificant variables, even at a 90% confidence level, and explains about 15% less of the variation in cereal imports than do the 1986 and 1987 regressions. Despite the relatively poor results for 1984, this regression does reveal that the income distribution variables, SH, SH.DL and SH.DM are all consistently significant explanators of cereal import demand in LDCs. The remainder of the discussion of the regression results will center on the 1987 equation since the other two earlier equations are presented for comparative stability reasons only.

The 1987 regression results reveal that all of the variables, with the exception of the constant and food aid, are significant at a 95% confidence level. The insignificant food aid variable, AID, can be interpreted to mean that cereal food aid in Asia and South America did not influence cereal imports very much. The significant food aid dummy variable for Africa, AID.AF, means that, as found previously in Equation 3, Africa is relatively more reliant on cereal food aid than are the other two regions.

The significant slope dummy variable on income for countries in the middle income category, GNP.DM, suggests that these middle income countries display a different import demand behavior than do either low or high income countries. This demand behavior appears to be that between the twenty-three countries in the cross-section, middle income countries tend to import more cereals for a given increase in per capita income than do either the low or high income countries. The dummy variable on income for low income countries, GNP.DL, was dropped from the regression due to being insignificant in all three years.

The income distribution variables reveal some interesting within-country and between-countries import demand behavior. First of all, the significant share variables indicate that the income distribution within a country does have an impact on cereal import demand. Improving the equity of income distribution within a country, increasing the share of income of the poorest 40% and thereby reducing the income share of the richer 60%, has a large, positive impact on the demand for cereal imports. This result conforms with evidence that income elasticities of demand by the poor in developing countries are relatively high (Mellor, 1988). Secondly, the significant share slope dummy variables for low and middle income countries reveal that between countries, this improvement in the equity of income distribution will have a different impact on cereal imports on the basis of what level of per capita income that country has attained. In other words, an increase in the income distribution equity of the seven countries with a national per capita income greater than U.S. $1800 has a relatively larger impact on cereal imports than the same increase in equity of the seven countries with national per capita income less than U.S. $450 or the nine countries with national per capita income between $450 and $1800. It can be speculated that this differential impact on cereal import demand is a result of the poorest 40% of the population in high income developing countries having a relatively higher level of income and therefore different cereal demand pattern than the poorest 40% in middle and low income countries. Admittedly, our sample of seven high income LDCs is relatively small, contains several nations with high degrees of inequality, and thus may not be fully representative.

Table 4.4 contains the income and income distribution elasticities for the 1987 regression. The income elasticities reveal that a one percent increase in GNP in middle income countries causes a greater than proportional increase in cereal import demand, probably due to an increase in food grain and meat consumption. This impact on cereal import demand of an increase in income is less than proportional in low and high income LDCs.

Table 4.4: Elasticities for the 1987 Income and Income Distribution Variables

Variable	7 Countries with GNP < $450	9 Countries with $450 < GNP < $1800	7 Countries with GNP > $1800
GNP	0.76	1.12	0.76
SH	1.39	1.25	1.80

The elasticities of cereal imports with respect to the income distribution variable, SH, reveal that at all three income levels, developing countries exhibit a greater than proportional increase in cereal imports due to an increase in the income share of the poorest 40% of their populations. This increase is greatest for the high income countries and smallest for the middle income countries.

4.5 Conclusions

The results of the estimation of the import demand for cereals in LDCs reveal that cereal imports are determined by such factors as domestic cereal production, level of development as measured by income and degree of urbanization, financial capacity as measured by cereal food aid and the level of government debt, and the geographic location of an individual country. Inclusion of regional slope and intercept dummy variables in the cereal import demand model represents a definite improvement over the model used by Morrison.

Cereal food aid appears to be a complementary rather than competitive goal to cereal imports (though this is clouded by the data on cereal imports which are not net of food aid). The relationship between cereal imports and variables postulated to reflect financial capacity was tested. Lagged foreign exchange reserve levels and value of exports were expected to be significantly positively associated with cereal imports. This was the case, although the destructive collinearity that exists between these variables and GNP led to deletion of both financial capacity variables from the model. Lagged levels of government debt were expected to be significantly negatively associated with cereal imports. This was the case for South American countries but not for Asian and African countries. Indeed, the final results, for the sample of 74 countries, suggest that for African and Asian countries, lagged government debt levels have not been a deterrent to cereal imports, at least in cross section.

The secondary regression conducted on the import demand for manufactured goods indicates that manufactured goods are more dependent on the availability of foreign exchange reserves than are cereal imports. This result can be interpreted to mean that cereals are given a higher priority in imports than are manufactures because cereal imports depend less on current liquidity and availability of immediate financing than do manufactured imports.

The secondary regressions conducted on cereal imports disaggregated into food and feed grains reveal that, as speculated by several researchers, food grains and feed grains do appear to require different import demand specifications. This difference in specification indicates that analyzing cereal imports as an aggregate group, while still valid, does impose a rather significant restriction in that grouping together all grains into one commodity abstracts from the different end uses of the various individual grains, which range from direct human consumption to indirect consumption through livestock feed. Researchers should at least be aware of and acknowledge this aggregation problem when analyzing the demand for cereal imports. As expected, our empirical results show that feed grain imports into developing nations display a more elastic response to changes in income than do food grain imports.

The investigation into the impact of income distribution on cereal import demand for a sample of 23 countries reveals that income distribution is an important determinant of the demand for cereal imports in developing countries and that improving distributive equity has a positive effect on cereal imports. The results of analysis including slope dummy variables for GNP and the income distribution proxy, SH, on the basis of different development levels indicate that cereal import response differs across nations with different levels of income. The results from our limited sample support the view that the middle income developing countries have the fastest growing demand for cereal imports. More extensive work on the impact of income distribution needs to be undertaken when data on income distribution in more LDCs is available.

The final conclusion to be drawn from the cereal import demand analysis is that, similar to the cereal aggregation problem, there also appears to be a country aggregation problem. Specifically, the graphs of actual and predicted cereal imports for each region (Figures 4.1 to 4.3) reveal that while the import model predicts cereal imports for Asia and South America quite well, the model does not predict cereal imports in the African countries very well. This result indicates that aggregating African countries with those of Asia and South America, even with the inclusion of dummy variables, may not be a valid procedure. The same variables which explain cereal imports in Asian and South American countries do not explain cereal imports in many African countries very well. There are apparently enough cultural, social and economic differences between Africa and the other two continents to warrant analyzing African countries as a separate aggregate in cross-section from Asian and South American countries.

5. The Import Demand for Barley in the USSR

5.1 Introduction

Cross-section analysis, such as presented in Chapter 4, can be most usefully complemented by intensive time series analyses of specific markets for Canadian grain. The study now turns to a time series analysis of the import demand for barley in the (former) USSR, Canada's most important barley market.

Until 1971, Russia had been a major net exporter of barley in the world market. In 1972, due to crop failures, Russia became a net importer of coarse grains, including barley. Throughout the 1970s and 1980s, due to chronic production fluctuations and an increased demand for meat products, Russia has remained a net importer of barley (except for 1974 and 1977 when Russia was a net exporter). This import demand for barley has increased to the point where Russia alone accounted for 14% of world barley imports in 1987. Russia has become a major barley importer in the world barley market and it is the purpose of this introduction section to reveal the role of Russian barley imports from a Canadian export perspective.

Table 5.1 contains the relevant Canadian and Russian barley trade volume and share data for recent years. The data reveal that Russia has been a major outlet for Canadian barley, although not consistently so. The per cent share of barley exports going to Russia ranged from over 50% in 1981 to 6% in 1985. 1984 and 1985 stand out as low years with less than 10% of barley exports marketed in Russia. For the seven year period of 1981-87, Russia imported more Canadian barley than any other single country, accounting for 27% of total barley exports. In comparison, the next largest market was Japan with a share of 17% of Canadian barley over the seven year period. Table 5.1 reveals that Russia has been a large but volatile barley market for Canada in recent years.

From Russia's perspective, Canada has been a major supplier of barley in the 1980s. Canada's share of Russian barley imports has ranged from a high of over 90% in 1982 to under 5% in 1985. Again, the data reveal the volatility of Canada - USSR barley trade. For the overall period, Canada has supplied 45% of Russia's barley imports.

Two important features of Canada's barley trade with the Soviet Union are revealed in Table 5.1. Firstly, Russia is and has been a major market for Canadian barley exports. This feature alone makes the Russian barley market of interest for analysis. But the second feature, the volatility of the Russian market, makes an economic analysis of the Russian barley import demand function even more imperative. And so, the major purposes of this analysis are to identify the main determinants of barley imports in the USSR and to identify possible sources of the import fluctuations.

Table 5.1: Canada-USSR Barley Trade Data, 1000 MT (Percent Shares in Brackets)

Year	Canadian Exports[1] (% to USSR)	Canadian Exports to USSR[1]	USSR Imports[2] (% from Canada)
1981	4764.3 (54.3)	2585.3	4478.0 (57.7)
1982	5722.0 (42.8)	2451.7	2644.0 (92.7)
1983	5736.5 (16.3)	933.6	1600.0 (58.4)
1984	3905.4 (7.5)	291.0	1400.0 (20.8)
1985	2231.4 (5.9)	131.0	3810.0 (3.4)
1986	5985.7 (34.4)	2058.2	3613.0 (57.0)
1987	5444.0 (14.5)	786.9	3020.0 (26.1)
Total	33,789.2 (27.3)	9237.7	20,565.0 (44.9)

[1]Source: Statistics Canada 65-004, *Exports by Commodities*
[2]Source: FAO, *Trade Yearbooks*

5.2 Previous Research

Three studies of Soviet grain imports will be discussed. These studies have served to shed light on possible explanatory variables and modeling techniques appropriate to the Soviet import market. In addition, the model proposed in one of these studies (Borsody, 1987) has served as a basic blueprint for the general time series model used in this report.

The first study to be reviewed is "Soviet Grain and Wheat Import Demands in 1981-85" by Desai (1982). This study includes a section on the import demand for grains in the Soviet Union which is very policy oriented in approach. Desai uses a dummy variable for 1971 and later to represent the Soviet import policy decision to "import grain to keep inventories of livestock steady" (Desai, p.313) . The problem with this approach to modelling Soviet grain import behavior is the assumption Soviet officials pursue food policy objectives through imports regardless of cost and financial constraints. The large import fluctuations revealed in Table 5.1 seem to contradict this policy assumption. These fluctuations indicate that Soviet officials have been reluctant to rely too heavily on grain imports which in turn implies that official food policy objectives, namely increased availability of meat products, are pursued only when financially possible and not at all costs. Therefore, Desai's policy oriented approach to modelling grain imports in the Soviet Union is rejected as being too simplistic and unrealistic.

Another study that will be reviewed, but whose methodology will not be adopted, is by Zeimetz, Jones and Mohammadi (1986). These authors chose to model Soviet grain imports by using a system of four simultaneous equations. The four dependent variables simultaneously determined are real import expenditures, domestic meat production, feed grain imports and wheat imports. The main reason this model will not be utilized in this report is that the feed grain equation had few significant variables and the lowest explanatory power of the four system equations. It is apparent from the results obtained by Zeimetz *et al* that an alternative import demand specification for feed grains, and specifically barley, is needed.

The final study to be reviewed, and the one on which the time series models in this report are based, is "Forecasting USSR Grain Imports" by Borsody (1987). In contrast to Desai's policy-oriented approach, Borsody's approach to modelling Soviet grain imports "presents alternative explanations of USSR grain imports in which price and other economic considerations are shown to play a principal role in Soviet decision making" (Borsody, p.94).

Borsody's analysis reveals that real price and terms of trade considerations weigh heavily in Russia's cereal import decisions. In other words, Desai's assumption that Soviet officials give the highest priority to political goals when making import decisions is not very valid. Borsody's model, which features economic variables, appears to be a more realistic model than that of Desai whose model features political variables. Therefore, Borsody's import demand specification format will be followed, with a few modifications, in this report.

5.3 The Model and Data

Following Borsody's example, the barley import demand model for Russia will consist of a single equation with a linear functional form. As suggested by Borsody, major explanators entering the regression are the real price of barley imports, domestic barley production lagged one year, and domestic livestock production. In his study, Borsody calculated an export price index using Fisher's 'ideal' formula to use as a price deflator. In this report, the crude petroleum export price index will be used as a deflator because this petroleum index closely parallels Borsody's calculated index and because petroleum is one of the major foreign exchange earning commodities exported by Russia. An alternative deflator will be an index of the world price of gold, since Russia also exports gold as a means of earning foreign exchange.

Other variables not considered by Borsody that will be included in this barley import demand model are the cross price of wheat imports, population, and dummy variables. Dummy variables are included in the model to try and account for the increase in variability of barley trade after 1971, when Russia became a net barley exporter. This increase in variability is illustrated in Figure 5.1, which contains the graph of Russia's net barley imports over time.

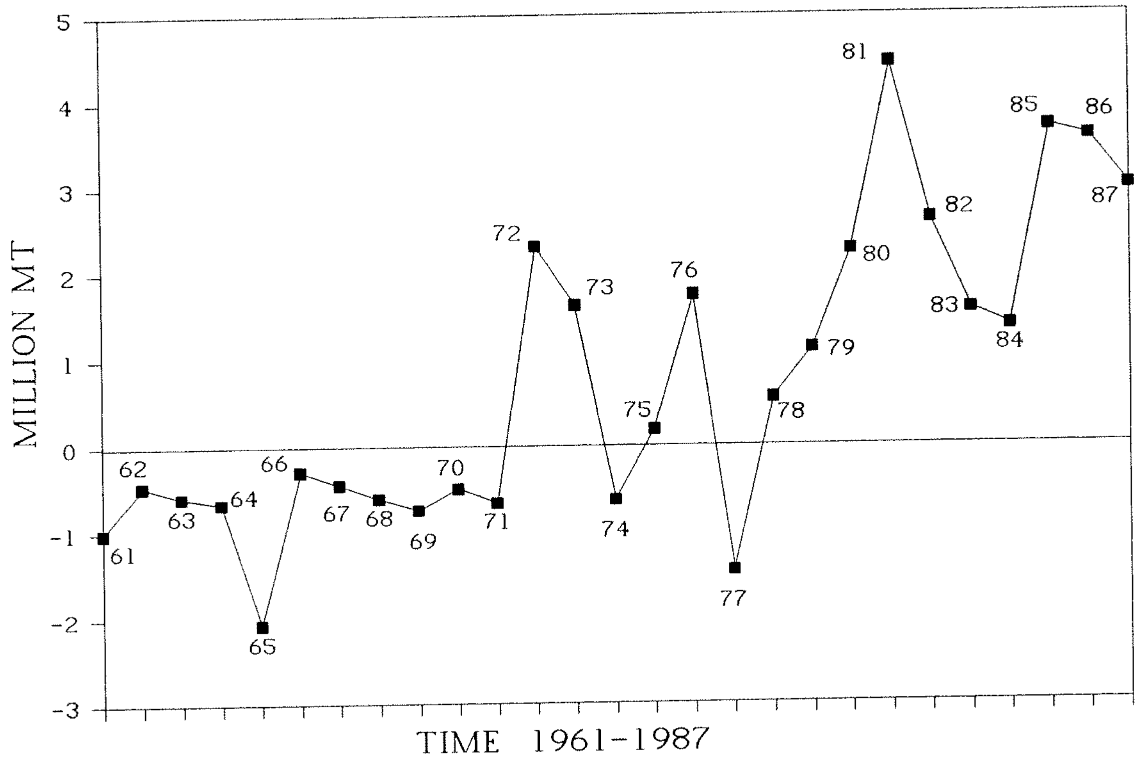
Similar graphs were plotted, but not reproduced here, of the various independent variables to determine if these variables exhibit the same fluctuations as found in Figure 5.1. Slope and intercept dummy variables were then entered into the model for any independent variables displaying such fluctuation patterns. These variables include domestic barley production and the livestock production variables.

Several variables omitted from the import demand model will now be discussed. An income variable, though of theoretical interest, cannot be included in the model as a consistent estimate for income in the Soviet Union could not be found for the entire time series. A hard currency or foreign exchange reserves variable is omitted for the same reason. Another omitted variable is the U.S. dollar-rouble exchange rate. Such an exchange rate variable would be meaningless in this case, because the Russian rouble is not an accepted international currency and the Soviet Union must use hard currency to purchase imports.

Equation 1 contains the model for Russia's barley import demand.

IMPORTS = f(OWN PRICE, WHEAT PRICE, POP., BARLEY PROD., LVSTK PROD.,
BARLEY DUMMY, LVSTK. DUMMY). (1)

Figure 5.1: Net Barley Imports, Russia



Two different levels of barley imports are considered in this study: total barley imports and barley imports from Canada. Total barley imports, in units of 1000 MT, are measured in net terms to account for the fact that prior to the 1970s Russia was a net barley exporter. Data for years when Russia's exports were greater than imports enter the regression as negative numbers (net exports). Barley imports from Canada are measured in gross terms because the focus of this analysis is source specific barley imports and netting out imports would distort the actual amount of imports from that source. Russia's barley exports enter the Canadian regression only for the years when there were no barley imports from Canada and are expressed as negative numbers.

The model is estimated with two variations of domestic livestock production, a livestock output index (1979-81=100) and the volume of beef and pig meat production (1000 MT). The meat production variable is for beef and pig meat because barley is an important grain in both production processes (Woodhams, 1988, p.16). The own price variable is the U.N. world barley export price index and will be entered in current and lagged one year forms. The cross price in this analysis is the price of wheat imports, measured by the U.N. world wheat export price index. Wheat is chosen as the grain for cross price effects because financial constraints may cause Soviet officials to reduce barley imports, a feed grain, in favour of being able to import more wheat, a food grain. All price variables are expressed in real terms with 1980 being the base year.

For the analysis of gross barley imports from Canada, the model in Equation 1 is estimated with one change. This change consists of adding a variable to account for barley imports from other sources, OTHBM. Ideally, OTHBM should be a cross price variable, but such price data are not available for the entire time series. Therefore, OTHBM will be measured in volume terms, in units of 1000 MT.

Table 5.2: Variable Definitions and Data Sources, USSR

Variable	Definition	Source[1]
POP	USSR population, mid-year estimates	E
PETPI	world crude petroleum export price index	B
GOLDPI	world gold price index	F
BM	USSR gross barley grain imports	A
BX	USSR gross barley grain exports	A
NETBM	USSR net barley imports (imports-exports)	A
BPI	real world barley export price index	B
WPI	real world wheat export price index	B
LBPR	USSR barley production, lagged one year	C
CBM	USSR gross barley imports from Canada	D
OTHBM	USSR gross barley imports other than from Canada	
CBPI	real price index of Canadian barley exports to USSR	D
LVIND	USSR livestock output index	C
MTP	USSR beef and pig meat production	C
D1	barley production dummy variable 1=1962,66,68,72,75,76,78,80,81,82,85; else=0	
D2	livestock production index dummy variable 1=1964,73,76,79,80,81; else=0	
D3	beef and pig meat production dummy variable 1=1964,73,76,79,80,81,82,85; else=0	

[1]A: FAO, *Trade Yearbook*
B: U.N., *Monthly Bulletin of Statistics*
C: FAO data tapes (data acquired through correspondence with FAO)
D: Statistics Canada 65-004, *Exports by Commodities*
E: FAO, *Production Yearbook*
F: U.S. Bureau of Mines, *Minerals Yearbook*

A complete list of the definitions of the variables and the sources of data is presented in Table 5.2. All of the quantity data are expressed in units of 1000 MT, except population data which are 1000 people, and all of the index data are based on 1980=100, except the livestock output index data which are 1979-81=100. The sample size of the variables is 27 with the data being from the years 1961 to 1987.

The price variable for the Canadian barley regression (CBPI) is a unit value index calculated by dividing the value of barley exports to Russia by the volume of barley exports to Russia and then dividing this entire time series by the 1980 price. For those years when Canadian barley exports to Russia were zero, a general export price is generated by using the total volume and value figures for Canadian barley exports. This Canadian price is f.o.b., since this is the form in which the Canadian source reports export data. This Canadian barley price index is then deflated by either PETPI or GOLDPI.

The variable OTHBM is calculated by subtracting Canadian barley imports from total barley imports. Although the data for Canadian and total barley imports come from two different sources, OTHBM represents the best estimate of barley imports from other sources and so will be used as such in this analysis.

Collinearity testing on the data reveals that there is a potentially destructive linear combination between population and the livestock production variables. In addition there is also strong collinearity between OTHBM and LBPR, and OTHBM and both livestock production variables.

5.4 Results of the Models

The Demand for Total Barley Imports

The results of estimating the model for total barley imports appear in Equation 2.

$$NETBM = \underset{(4.99)}{-10821} - \underset{(7.37)}{0.120LBPR} - \underset{(4.00)}{2.539BPI} + \underset{(7.27)}{180.20LVIND} + \underset{(4.75)}{1493D2} \quad (2)$$

and adj. R^2=0.87. Three of the variables have been dropped from the model due to being insignificant: population, the cross price of wheat imports and the dummy variable for domestic barley production. Collinearity between the livestock variable and population may be the reason POP is insignificant. The insignificant cross price of wheat imports can be interpreted to mean that there is no significant import competition between barley and wheat. This interpretation is probably not too far wrong given that the volume of barley imports is quite a bit smaller than the volume of wheat imports. Collinearity between the own price of barley imports and the cross price of wheat imports may also be another reason for the insignificant wheat price variable. The insignificant dummy variable for domestic barley production means that the import fluctuations illustrated in Figure 5.1 are adequately explained by domestic production fluctuations as measured by the original barley production variable (LBPR) without need of an additional dummy variable for low production years.

All of the variables in Equation 2 are significant at the 0.05 level and have theoretically correct signs on the coefficients. In addition, a high degree of the variation in barley imports is explained by the variables domestic grain production, domestic livestock output and the real price of barley imports. The dummy variable for livestock production is an intercept dummy. Slope dummy variables are not significant in the total barley import demand regression.

The most significant variable in the regression is domestic barley production. The negative sign on the coefficient indicates that barley is imported in response to production shortfalls. It appears that Russia is trying to be self-sufficient with respect to barley but is often unable to produce enough barley to meet domestic demand. One possible reason for this inability is that barley yields in Russia have suffered from a lack of research and development which has resulted in average USSR barley yields being a third less than yields in Canada, a country with a climate comparable to Russia (Woodhams, 1988, p.42). The notion that Russia pursues a self-sufficiency policy is reinforced by the negative value on the intercept term. The negative intercept implies that under the right circumstances, as determined by the independent variables in Equation 2, Russia becomes a barley exporter.

There are two significant livestock variables in Equation 2, livestock production and the intercept dummy variable for years of low livestock production. Both of these variables have positive coefficients which is an unexpected result for the dummy variable. Because the livestock dummy variable is an intercept dummy and is keyed to years of low livestock output, the sign on the coefficient should be negative to indicate that when livestock production declines so do barley imports. Apparently, the import reaction to declines in livestock production is not as immediate as first expected. The positive dummy variable coefficient reveals the possible presence of a lag structure in the response of import officials to changes in import demand; there may be a time lag of about one year for import policy to be formulated and implemented in response to livestock production declines. A final note on the livestock variables is that of the two versions considered in this analysis, the livestock output index, LVIND, yields better statistical estimates than does the volume of beef and pig production, MTP, and so LVIND is the version which appears in Equation 2.

The real own price variable in Equation 2 is the U.N. world barley price index lagged one year and deflated by the U.N. world petroleum price index. This lagged form of the price variable produced better statistical results than the current form, and the petroleum price deflator produced better statistical results than the gold price deflator. The presence of a significant import price variable in the regression confirms Borsody's assertion that Soviet officials do react to international market prices. And because this price variable is deflated by the export price index for fuels, an added dimension to the interpretation of the variable is that the Soviets also rely on the ability of their exports, especially petroleum exports, to earn hard currency with which to purchase grain imports. No special significance can be attached to the price variable being lagged one year because this price variable is a general international price index and not specifically the import price of barley for Russia. Therefore, it cannot be concluded that Soviet officials react to lagged price rather than current price. The only valid conclusion that can be drawn from the price variable is that Soviet officials do react to price signals. The fact that the lagged version of the price variable produces better statistical results than the current version is of little actual consequence in this case.

Re-estimation of Equation 2 using per capita data results in poorer statistical estimates and, more importantly, very different elasticity estimates for all of the variables. Therefore, it can be concluded that using per capita data distorts the regression results and this kind of data will not be considered in the remainder of the Russian barley import analysis.

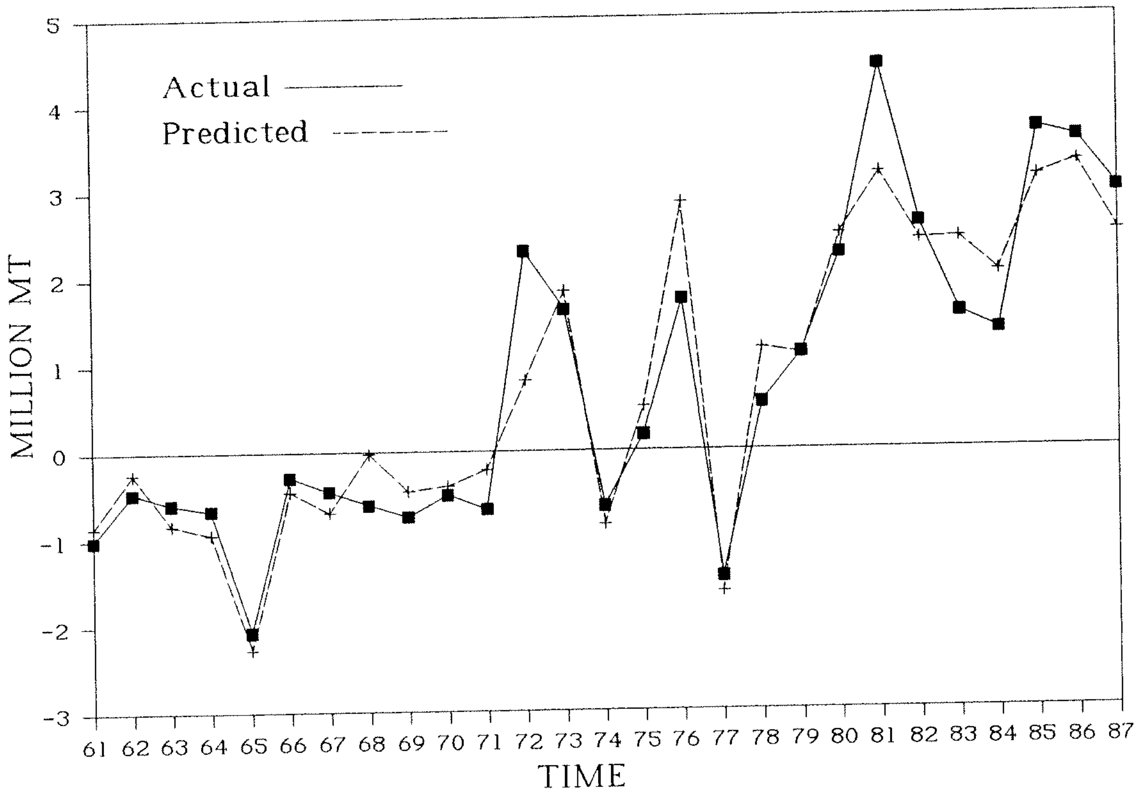
Several tests are run on the model presented in Equation 2. These tests are detailed in Appendix C and will be applied to this and all other remaining regressions in the report. The Breusch-Pagan test indicates that the presence of heteroskedasticity is rejected at the 95% confidence level ($\chi^2 = 4.400$). The Box-Cox functional form test indicates that at a 95% confidence level, the linear functional form is accepted as providing a good fit to the data ($\lambda = 1$: $\chi^2 = 3.84$). The final test on the regression is for autocorrelation. The Durbin-Watson test indicates that the null hypothesis is not rejected (DW = 2.08) which means there is no significant autocorrelation in the regression.

Figure 5.2 is a graph of the predicted values of barley imports generated from the barley import demand model (dashed lines) superimposed on the actual barley imports (solid line). This graph reveals that, in general, the model predicts actual barley imports quite well. There are, however, a few years that stand out as being poorly predicted: 1972, 1981 and 1983. Given the good predictive powers of the model for most years, it can be speculated that unusual circumstances not accounted for in the model caused unusual import patterns in these few years listed. For example, the 1980 USA embargo may have caused Russia to rely heavily on domestic grain stocks in 1980 which then necessitated a larger than usual level of imports in 1981. For 1972, it can be speculated that Russia was still adjusting to large production shortfalls and to becoming a net barley importer. It is unfortunate that data for Russian grain carry-over stocks is not available because such a variable would probably help explain the outlying observations not predicted well by the model.

The Demand for Barley Imports from Canada

The results of estimating the model for barley imports from Canada appear in Equation 3.

Figure 5.2: Actual and Predicted Barley Imports, Russia



$$CANBM = -4058 - 0.078LBPR - 1.641CBPI + 84.41LVIND + 9.811LVIND.D2 \qquad (3)$$
$$(1.59) \qquad (5.05) \qquad (2.61) \qquad (3.31) \qquad (3.19)$$

and adj. $R^2=0.73$. The first feature of note is that the same variables that are significant for the total barley regression are also the best set of explanators for the Canadian barley regression. One difference between the variables is that price in Equation 3 is current rather than lagged. In the Canadian regression, the lagged price variable results in an insignificant coefficient. Since the Canadian price variable is the actual price of Canadian barley exports to Russia, it can be concluded that Soviet officials make import decisions based on the current year price rather than price from the previous year. A second difference between the two regressions is that in Equation 3, the livestock dummy variable enters the regression as a slope dummy rather than an intercept dummy as in the total barley regression (Equation 2).

The only insignificant variable in Equation 3 is the intercept term, which may be due to measuring the independent variable in gross rather than net terms. The other variables in the regression are all significant at a 95% confidence level and have theoretically correct signs on the coefficients. The barley production variable and the livestock production variables can be interpreted in the same manner as for the previous total barley regression.

Re-estimations of Equation 3 using the alternative deflator (GOLDPI) and livestock variable (MTP) produce results of lower predictive power than the variables PETPI and LVIND. In addition, the variables for population, cross price of wheat imports and other barley imports are all insignificant when included in the regression. Collinearity may be a reason why these three variables are insignificant in the regression.

The tests run on Equation 3 indicate that there is no autocorrelation (DW = 2.12), no heteroskedasticity ($\chi^2 = 8.294$) and that the linear functional form is appropriate for this model ($\lambda = 1$: $\chi^2 = 1.702$).

The biggest difference between the two barley regressions is that less of the variation in barley imports from Canada is explained by the variables than for total barley imports. The lower R^2 for the Canadian barley equation is likely due to omitted variables. These omissions might be variables such as barley prices from different export sources or the conditions and duration of trade contracts between Canada and Russia. Unfortunately, such data are not readily available and can only be speculated upon in this text. But even though the basic model explains less of the variation in imports from Canada than it does for total barley imports, the model still explains almost 75% of the variation in Canadian barley exports to Russia using the three variables domestic barley production, livestock production and the real price of barley imports.

Figure 5.3 contains the graph of the predicted barley imports from Canada (dashed line) superimposed on the actual imports (solid line). The graph reveals that, generally, the model fits the data quite well and it is only for certain years, especially 1981, 1982, 1984 and 1985, that the model fails to predict barley imports from Canada.

The barley import elasticities of demand from Equations 2 and 3 are presented in Table 5.3 along with the elasticities from a regression of the U.N. price index for wheat exports, deflated and lagged one year, and domestic wheat production, lagged one year, on total USSR wheat imports. This wheat regression uses the same type of data as the barley regressions and the same basic model. The wheat regression is estimated to obtain a price elasticity for wheat imports comparable to the price elasticities from the barley regressions. The table reveals that while all of the price elasticities are within the elastic range (with values greater than 1.0), the elasticity of wheat imports with respect to price is less elastic than either of the elasticities of barley imports with respect to price. This less elastic response of wheat imports to price changes is expected because barley, being a coarse grain, might be considered inferior to wheat in consumption and also because barley has more substitutes in the livestock sector than wheat has in the food sector.

Figure 5.3: Actual and Predicted Barley Imports from Canada

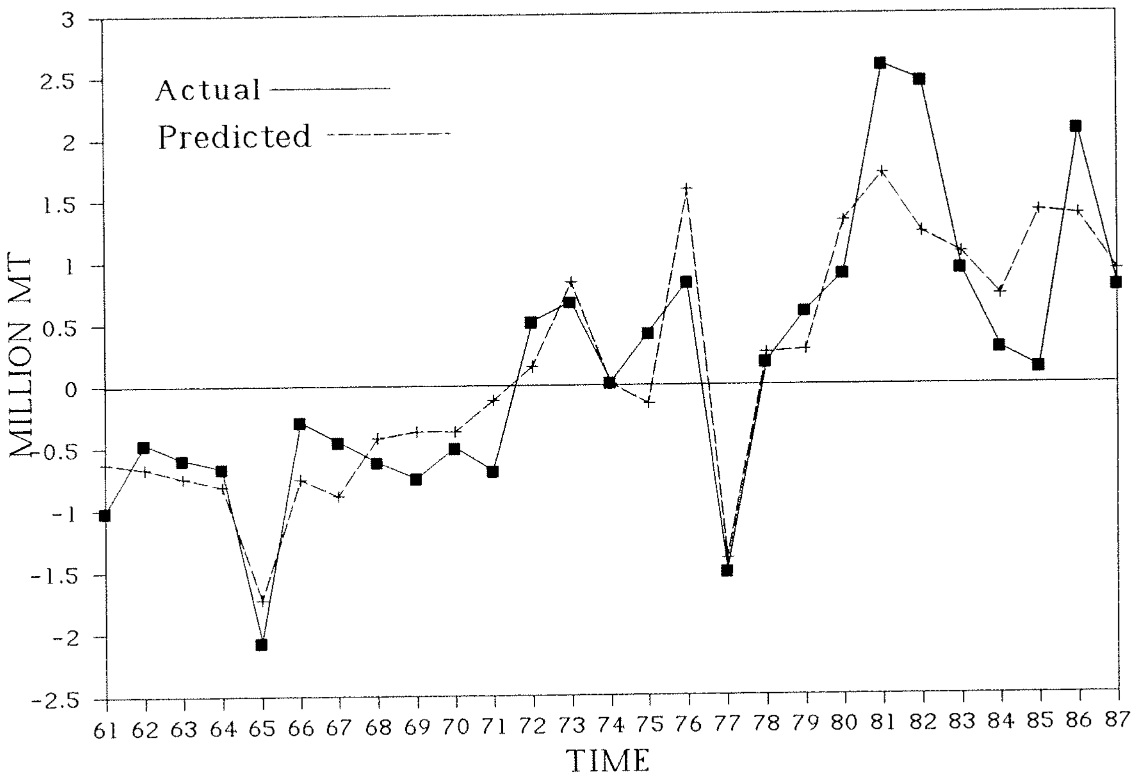


Table 5.3: Elasticities from Various Regressions, Russia			
Variables	Equation 2 Total Barley	Equation 3[1] Canadian Barley	Wheat Imports[2]
Real Import Price	-1.62	-7.09	-1.04
Domestic Barley Production	-6.26	-21.37	-1.54
Livestock Production	23.19	a)57.13 b)58.60	

[1]The two elasticities for Equation 11 are for:
a) all years of high or increasing production
b) years of low production (includes the slope dummy elasticity)

[2]From regressing the real wheat price and own production on wheat imports.

Comparing the two elasticities of barley imports with respect to price reveals that for total barley imports a 1% increase in price causes a 1.6% decrease in imports while for Canadian barley the decrease is 7%. The greater response of barley imports from Canada to a price change is most likely due the presence of competitive substitute sources of barley in the international market. The elasticities with respect to domestic grain and livestock production indicate that barley imports and especially imports from Canada are very responsive to changes in the production determinants. These large elasticities explain, in part, the pattern of large, yearly fluctuations in Russia's barley imports.

5.5 Conclusions

Estimation of the barley import demand in Russia reveals that of the variables proposed in the model, three combine to explain most of the variation in barley imports. These three variables are the real price of barley imports, lagged domestic barley production and livestock output. Additional factors that affect barley imports are the relative price of petroleum which is a measure of Russia's ability to purchase imports and livestock production fluctuations which are measured by the inclusion of a dummy variable keyed to the years of low livestock output. These livestock output fluctuations and the fluctuations in domestic barley production combine to explain Russia's large year-to-year barley import fluctuations quite well.

The results of the regressions reveal that the Soviets import barley only as needed to make up for barley production shortfalls and to maintain livestock output. In other words, it is quite evident that the Soviets have been pursuing a self-sufficiency policy, with barley imports regarded as a residual effect of production shortfalls. Another conclusion to be drawn from the results of the regressions is that despite the command nature of the Soviet economy, Soviet officials do respond to price signals in international markets and in particular the barley trade market. In other words, Russia does not appear to import barley solely on the basis of need or to meet livestock production targets but also on the basis of the relative price of barley imports to petroleum exports.

The final conclusion from the regressions is that the same factors that determine total barley imports also explain, though to a lesser degree, the importation of barley from Canada. In addition, barley imports from Canada exhibit a more elastic response to changes in the explanatory variables than do total barley imports.

Finally, it must be noted that dramatic political and economic changes have occurred in the (former) USSR since the foregoing econometric analysis was completed. It is certainly possible that major structural change in the import demand for barley in the reconstituted USSR may now occur. Nevertheless, many of the historic influences on the import demand for barley in the (former) USSR are apt to re-emerge as important once the initial phases of dislocation and major shortfalls in production and procurement are overcome.

6. The Demand for Barley Imports in Japan

6.1 Introduction

In this chapter the import demand for barley in Japan is analyzed. Japan, being second in importance only to Russia as an outlet for Canadian barley, is also an important market to study with respect to Canadian barley exports. The analysis presented in this chapter covers Japan's import demand for barley from all sources and the import demand for barley from Canada using a single equation import demand model similar to the model used for Soviet import demand. As well, an Almost Ideal Demand System model will be used to estimate Japan's import demand for the various coarse grains to determine if the individual grains are separable in demand and, if so, to identify if a competitive or substitute relationship exists. And because of data availability, an Armington-type assumption will be tested within the AIDS model framework to determine if Japan distinguishes between barley from the three import sources, Canada, Australia and the United States.

In Table 6.1, details of the Canada-Japan barley trade from 1981 to 1987 are presented. Japan is a significant market for Canadian barley, accounting for an average of over 17% of all barley exports from Canada over the entire period. Indeed, after Russia, Japan has been the second largest market for Canadian barley over a sufficient time period for analysis. Also, Japanese barley imports from Canada have been fairly constant around the 700,000 to 900,000 MT mark over the years 1981 to 1987. This consistency and the relatively large volume involved both justify analysis of the Japanese barley market.

Table 6.1 also reveals that for Japan, Canada has been a significant source of barley. For the period of 1981 to 1987, Canada supplied over 55% of all Japan's barley imports. Japanese total barley imports were quite stable over the seven years at between 1.3 to 1.5 million metric tonnes. Consequently, the main purpose of Table 6.1 is to show that both countries have been major markets for the other with regards to barley trade, and that Japan has been, at least recently, a very stable market by volume.

6.2 The Single Equation Import Demand Model and Data

No actual analyses of the Japanese import demand for coarse grains or barley could be found. Therefore, the model used in the previous chapter on Russian barley import demand will also be used for the Japanese analysis. Descriptive literature is used to identify those variables most appropriate for inclusion in the Japanese barley import demand model.

The first item of interest is to determine Japan's marketing mechanism for imported barley. A good description of barley import marketing is provided by Kalmbach, Sharp and Walker (1981, pp.22-23):

> the Ministry of Agriculture, Forestry and Fisheries' (MAFF) Food Agency is the sole importer of barley and thus has a monopoly on both food and feed barley. This is a carryover from the time when barley was primarily a food grain. Now 84% of the imported barley is for feed. The imported feed barley is turned over by the Food Agency to the MAFF Livestock Industry Bureau which allocates the barley for direct feeding in cattle and for formula feeds. The Food Agency purchases the imported barley at one price and sells it at another price. Since 1972 the Food Agency's cost of importing barley has exceeded the sales revenue from barley by an average $14.9 million per year. Since barley is a substitute product for corn and sorghum, the Food Agency import system for barley has the effect of subsidizing imports of Canadian and Australian feed barley at the expense of U.S. corn and sorghum imports.

The above quote serves to identify several variables of possible importance to the demand for barley imports in Japan. First of all, the quote reveals that barley used to be imported as a food grain in Japan but is now imported as a feed grain. This change in usage indicates that a dummy variable coded to account for the implied structural change of barley import demand should be included in the model. In addition, the quote identifies livestock output as an end use variable for barley imports, at least since the usage change. The quote also indicates that both the import prices of wheat and corn

Table 6.1: Canada-Japan Barley Trade Data, 1000 MT (Percent Shares in Brackets)

Year	Canadian Exports[1] (% to Japan)	Canadian Exports to Japan[1]	Japanese Imports[2] (% from Canada)
1981	4764.3 (20.5)	975.9	1568.3 (62.2)
1982	5722.0 (15.3)	876.8	1330.1 (65.9)
1983	5736.5 (17.1)	979.5	1476.9 (66.3)
1984	3905.4 (19.0)	742.8	1566.8 (47.4)
1985	2231.4 (39.4)	880.0	1661.0 (44.7)
1986	5985.7 (12.4)	742.7	1362.7 (54.5)
1987	5444.0 (11.3)	614.9	1247.5 (49.3)
Total	33,789.2 (17.2)	5812.6	10,213.2 (56.9)

[1]Source: Statistics Canada 65-004, *Exports by Commodities*
[2]Source: FAO, *Trade Yearbook*

should be included with slope dummy variables for each to capture any changes in the competitive import response of barley to wheat and corn that may have occurred when barley usage changed from food to feed. It is expected that prior to the structural change, wheat and barley were substitutes in importation and that after the change in use, wheat and barley were no longer significant as substitutes (that is, the coefficient on the wheat import price variable is expected to be insignificant after the usage change). The opposite effect is expected for corn imports, an insignificant cross price coefficient prior to the usage change and a significant coefficient indicating a substitute relationship after the change. The structural dummy variable will be coded to equal 1 from 1972 on and to equal 0 previous to 1972. There are two reasons for choosing 1972 as the year at which to begin the structural change. The first is that the above quote identifies 1972 as the year barley imports began to be subsidized. The second reason is that a table from the same literature source identifies 1972 as the first year when over 70% of the barley consumed in Japan went for feed use (Table 11, p.16).

On the topic of the import subsidy on barley, another source, the Australian Bureau of Agricultural and Resource Economics (1988, p.123), identifies the reason for the import subsidy as being the policy goal of keeping the domestic producer price of barley high in order to sustain agricultural incomes and divert acreage from rice production. Therefore, the domestic producer price of barley will be entered into the model as another possible cross price for barley imports.

Equation 1 contains the basic single equation model of Japanese total barley imports and imports from Canada.

IMPORTS = f(OWN PRICE, CROSS PRICES, INCOME, POP., EXCHANGE RATES, BARLEY PROD., LIVESTOCK PROD., INTERCEPT DUMMY, STRUCTURAL DUMMIES) (1)

The intercept dummy variable is D1, which has been coded to equal one in years of zero barley imports (1960-62 for the total barley equation and 1960-64 for the Canadian barley equation), else zero. The structural dummies are the slope dummy variables created from D2, the structural change dummy variable. Since Japan has an open, market economy, inclusion of exchange rate variables is logical. In addition, Japanese national income data, unlike Soviet income data, is readily available for the entire time series and so is included in the import demand model.

Table 6.2: Variable Definitions and Data Sources, Japan

Variable	Definition	Source[1]
POP	Japanese population, mid-year estimates	E
CPI	Japanese consumer price index, 1980=100	E
EXPI	Japanese export price index, 1980=100	G
JCEX	Canadian dollar-Japanese yen exchange rate	F
JUSEX	U.S. dollar-Japanese yen exchange rate	G
LBPR	Japanese barley production, lagged one year	C
MTP	Japanese beef and pig meat production	C
JBP	real Japanese producer price of barley	B, D
BM	Japanese total barley imports	A
CANBM	Japanese barley imports from Canada	H
CANBP	real barley import price from Canada, f.o.b.	H
CAN	real barley import price from Canada, c.i.f.	A
AUS	real barley import price from Australia, c.i.f.	A
USA	real barley import price from the U.S.A., c.i.f.	A
MP	real price of Japanese maize imports	A
WP	real price of Japanese wheat imports	A
GNP	real Japanese national income	E
D1	dummy variable for years of zero barley imports 1=1960,61,62; else=0	
D2	dummy variable for structural change 1=1972 to 1986; else=0	

[1]A: U.N., *Commodity Trade Statistics*
B: FAO, *Monthly Bulletin of Statistics*
C: FAO data tapes (data acquired through correspondence with FAO)
D: Japan Statistics Bureau, *Japan Statistical Yearbook*
E: Japan Min. of Foreign Affairs, *Statistical Survey of Japan's Economy*
F: Bank of Canada, *Bank of Canada Review*
G: IMF, *International Financial Statistics*
H: Statistics Canada 65-004, *Exports by Commodities*

Table 6.2 contains the variable definitions and sources of the data used in this analysis. All quantity units are expressed in units of one thousand except for income which is in units of one billion. Each variable has 30 observations going from the year 1957 to 1986.

All price and income data are deflated either by Japan's CPI or by Japan's export price index, EXPI. EXPI is a general export price index because no single good could be identified in the literature as particularly important with regards to cereal or barley imports. The Canadian price variable, CANBP, is an f.o.b. value; all other price variables are c.i.f. These price variables will either be converted to Japanese yen which enters the exchange rate into the regression as a conversion factor, or the price variables will enter the regression in U.S. dollars along with the U.S. dollar-yen exchange rate as a separate variable or in Canadian dollars with the Canadian dollar-yen exchange rate as a separate variable. In all cases, the income variable will enter the regression in Japanese yen.

The only problematical variable is JBP, the Japanese producer price of barley. This variable is a combination of two data series from two different sources. Since neither series covers the entire time period, combining the two is the only way to obtain a complete data set for this variable. A comparison (not presented in this text) of overlapping years in the two time series reveals that the series, though not completely compatible, are fairly similar so that combining the two data sets is reasonable given that the alternative is to have no producer price variable. These price data are combined in the following manner: without adjustment of any kind, data from *Japan Statistical Yearbook* for 6-row, rationed barley covering the years 1976-86 are added to the data from *Monthly Bulletin of Statistics* covering the years 1957-75.

The structural dummy variable, D2, will be used to create slope dummy variables in order to determine if the change in use of barley imports also caused a change in economic parameters. Slope dummy variables will be created from such variables as own price, cross price of other grain imports and the domestic producer price of barley, income and meat production.

Collinearity testing of the data reveals that several variable combinations may be adversely affected by collinearity. A few examples of variable pairs that have variance proportions greater than 0.5 are: MTP and GNP, MTP and LBPR, MTP and POP, POP and GNP. In addition, collinearity between all of the various price variables is also indicated by the tests. Basically then, the collinearity tests serve to indicate the distinct possibility that collinearity problems (insignificant coefficients and/or wrong theoretical signs) may arise in the barley import regressions.

6.3 Results of the Single Equation Import Demand Analyses

<u>The Demand for Total Barley Imports</u>

When all of the variables in Equation 1 are entered into the regression, most of the variables are insignificant or have the opposite sign from theoretical expectations. It is apparent from these results that collinearity is causing econometric problems in the equation. Subsequent regressions in which collinear variables are removed result in Equation 2 which represents the best set of explanatory variables for total barley imports.

$$\underset{}{BM} = \underset{(3.04)}{4402} - \underset{(1.27)}{149GNP} + \underset{(6.26)}{95.9GNP.D2} - \underset{(3.22)}{635JCEX} - \underset{(4.69)}{517D1} \qquad (2)$$

and adj. R^2=0.92. GNP is income in Japanese yen, GNP.D2 is the slope dummy variable for income, JCEX is the Canadian dollar-yen exchange rate and D1 is the intercept dummy for zero imports. The deflator found to give the best statistical results is the Japanese CPI which has been used to convert the income and exchange rate variables into real value terms. In addition, the functional form of the regression is linear-log which provides the best statistical fit of the data according to the Box-Cox test run on the linear form ($\lambda = 0$: $\chi^2 = 3.062$; $\lambda = 1$: $\chi^2 = 11.27$). The remaining statistical tests are run on the linear-log regression presented in Equation 2.

The two variables GNP and GNP.D2 indicate that income had different effects on the demand for barley imports between the two periods 1957-71 and 1972-86. The negative coefficient on GNP, statistically significant only at a 25% level, indicates that in the earlier period when barley was used mainly in direct human consumption, barley was considered an inferior grain because as incomes increased the demand for barley imports decreased. Then, after 1972, when barley was used mainly as a feed grain, the increased demand for meat products caused by increasing incomes in turn resulted in an increase in the demand for barley imports, as indicated by the positive coefficient on the slope dummy variable GNP.D2, statistically significant at a 1% level.

Barley imports are apparently quite sensitive to changes in the real Canadian dollar-Japanese yen exchange rate (JCEX) as indicated by the fact that the best regression (Equation 2) has the exchange rate as a separate variable rather than as a conversion factor in the denominator of the income variables. This exchange rate variable, which is in units of Canadian dollar per Japanese yen, has a negative regression coefficient indicating that as the Canadian dollar gets stronger relative to the yen, barley imports tend to go down. Substituting the U.S. dollar-yen exchange rate (JUSEX) for JCEX yields an insignificant coefficient on the variable JUSEX. It is not surprising that JCEX is significant in the regression while JUSEX is not, because Canada is the main source of Japanese barley imports while the U.S.A. is the least important.

The significant dummy variable, D1, for years of zero imports indicates that for the three years 1960, 1961 and 1962, special circumstances must have existed which caused Japan to not import barley. Perhaps the inclusion of the domestic barley production variable would help explain why no barley was imported for the three years, but this production variable, LBPR, yields an insignificant coefficient when entered into Equation 2. The most likely reason for this insignificance is collinearity problems because if LBPR and LBPR.D2 are substituted for GNP and GNP.D2, the barley production variables become significant, but yield poorer predicted values of barley imports than the income variables.

Other variables dropped from the regression due to collinearity problems include own price, the three cross prices for wheat imports, maize imports and domestic barley production, meat production and population. All of these variables are significant in various other regressions with other variable combinations, but Equation 2 represents the set of variables that yields the best predicted values of barley imports. It should also be mentioned that when the real own price variables, BP and BP.D2, are substituted for GNP and GNP.D2, the results indicate that in the earlier period an increase in price caused a decrease in imports (negative coefficient) while after 1972 a price increase was followed by an increase in barley imports (positive slope dummy variable). But, like the barley production variables, the real own price variables yield poorer predicted values of barley imports than the real income variables and BP is not significant when entered into Equation 2. In addition, using per capita data results in poorer statistical estimates with quite different coefficient and elasticity estimates.

The Breusch-Pagan test reveals that there is no heteroskedasticity ($\chi^2 = 6.427$) in the regression results, but the Durbin-Watson test statistic falls within the inconclusive range for positive autocorrelation (DW=1.587). A sixth order partial autocorrelation plot then confirms that there is no significant autocorrelation present in the regression, at least in the first six lags.

The Demand for Barley Imports from Canada

Equation 3 contains the results of the best regression on barley imports from Canada.

$$CANBM = 957 - 0.092GNP + 0.229GNP.D2 - 7.280JCEX - 152D1 \quad (3)$$
$$(4.29) \quad (0.80) \quad (3.55) \quad (3.76) \quad (2.03)$$

and adj. R^2=0.88. The same variables that yielded the best statistical results for total barley imports in Equation 2 also produce the best results in the Canadian barley regression, Equation 3. The main difference is that the functional form of Equation 3 is linear rather than the linear-log form of Equation 2.

For the income variables, the negative coefficient on GNP and the positive coefficient on GNP.D2 reveal that, as for total barley imports, the income effect on barley imports from Canada has changed since 1972 when barley became mainly a feed grain. The income variables are again expressed in Japanese yen and deflated by the Japanese CPI. The real exchange rate variable is expressed in Canadian dollars per Japanese yen.

Two sets of barley price variables are entered into various regressions. The first set includes the Canadian f.o.b. price calculated from the data reported by Statistics Canada. No American or Australian f.o.b. cross prices could be found for inclusion in this set. But because the relative American and Australian barley prices might be a factor in determining barley imports from Canada, a second set of prices from U.N. data sources is also used. This second set of barley prices are all c.i.f. and so are compatible for entry in the same regression. However, neither of the two price sets yield meaningful statistical estimates in the Canadian barley regression. In fact, none of the price variables, own price or cross prices, yield very meaningful or significant results. Collinearity may be a factor in the statistical performance of the price estimates, but another cause may simply be that prices, especially the relative barley prices, are not significant or theoretically consistent demand determinants in the Japanese barley import market. It should also be noted that lagged prices are not entered into any of the regressions and that it is possible that a model incorporating such lags might yield consistent and significant own and cross price estimates. Lagged prices are not considered in this analysis due to lack of prior evidence to suggest the use of lagged prices, and due to time constraints. Hopefully the AIDS model will be able to provide more information on the relevance of price variables in the Japanese barley import market.

The tests on the regression reveal that there is no significant heteroskedasticity ($\chi^2 = 4.618$), there is no significant autocorrelation (DW=2.31) and that, as mentioned already, the linear functional form is appropriate ($\lambda = 1$: $\chi^2 = 0.994$).

Table 6.3: Elasticities from the Single Equation Models, Japan

Variable	Equation 2 Total Barley	Equation 3 Canadian Barley
Real Income[1] Pre-1972	-0.15	-0.24
Post-1972	-0.05 (0.10)	0.19 (0.43)
Real Exchange Rate	-0.65	-1.03

[1]The post-1972 elasticities come from adding the elasticities of GNP and GNP.D2. Elasticities in brackets are for slope dummies only, with GNP = 0.

Table 6.3 contains the barley import elasticities of the variables in Equations 2 and 3. The elasticity of total barley imports with respect to income prior to 1972 is slightly less than zero. The negative sign indicates that barley was considered an inferior good because as incomes increased, barley imports declined. The income elasticity after 1972, while still negative, has shifted towards the positive side of the elasticity scale and is small enough in magnitude to be considered unresponsive to income changes. In other words, after 1972 barley changed from being an inferior good to nearly being a normal good. The elasticities of the Canadian barley with respect to income illustrate this conclusion more dramatically, because barley does become a normal good after 1972 in this analysis. The income elasticity prior to 1972 changes from a value of -0.24 to a value of +0.19 after 1972. This positive elasticity with respect to income after 1972 is evidence of the structural change that occurred in the demand for barley imports due to the change of usage from a food to a feed grain.

The elasticity with respect to the exchange rate reveals that barley imports have been relatively more responsive to changes in the Canadian dollar-Japanese yen exchange rate than to income. The main features of note with regards to the exchange rate elasticities are that Canadian barley is more responsive to changes in the exchange rate than total barley imports, and the elasticity of Canadian barley with respect to the exchange rate is in the elastic range, meaning a change in the exchange rate causes a larger than proportional change in barley imports from Canada. The negative sign on the two exchange rate elasticities simply means that as the Canadian dollar becomes stronger relative to the yen, barley imports tend to decline.

Figures 6.1 and 6.2 contain the graphs of the predicted barley imports (dashed line) superimposed on the actual barley imports (solid line) for total barley imports and for imports of Canadian barley respectively. Figure 6.1 reveals that the total barley import demand function in Equation 2 predicts actual total barley imports quite well. In contrast, Figure 6.2 reveals that the Canadian barley model in Equation 3 does not predict imports from Canada quite as well, particularly for import fluctuations such as between 1973-74, 1980-81, and 1983-84. The model in Equation 3 appears unable to capture the effects of Japan's source specific import behavior which is characterized by the policy decision to diversify imports of barley by source. In other words, Japan is reluctant to rely too heavily on any one source for barley imports. The import demand model in Equation 3 does not explicitly account for this diversification behavior and so fails to predict the fluctuations in barley imports from Canada. But, the model has served to at least form the basis for further research and has identified the necessity of more detailed data for such factors as relative prices and exchange rates, import contracts and agreements, and import policy specific to barley. Perhaps the AIDS model specifications which follow will be able to reveal more information as to the competitive structure between the different sources for Japan's barley imports.

Figure 6.1: Actual and Predicted Barley Imports, Japan

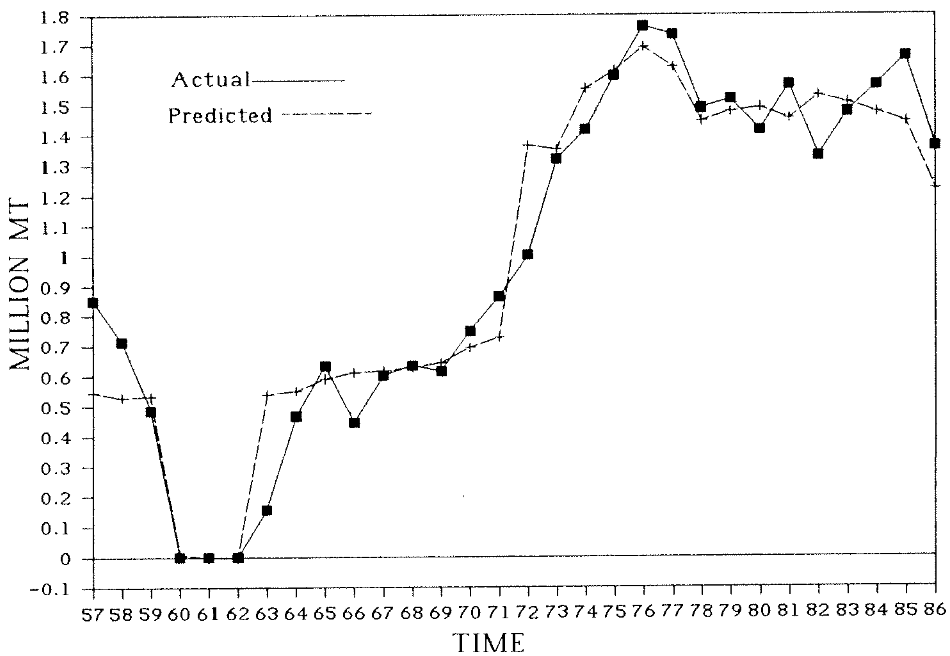
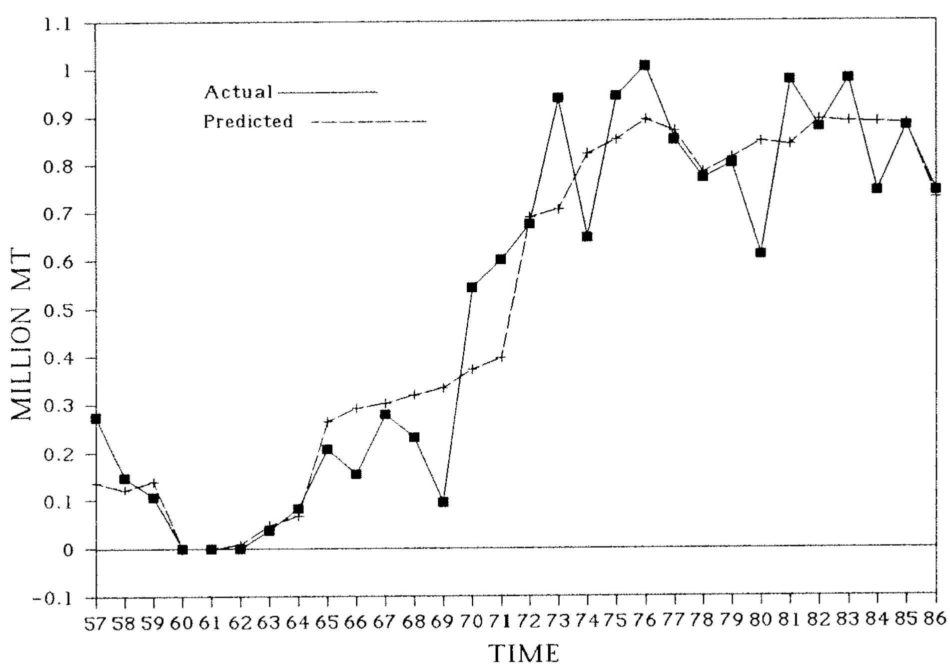


Figure 6.2: Actual and Predicted Barley Imports From Canada



6.4 The LA/AIDS Model of Barley Import Demand

This section of the chapter presents the results of applying an AIDS model to the Japanese market. The LA/AIDS version of the model, with Armington-type assumptions, is applied to Japan's barley import market to determine if Japan, which imports barley consistently from three sources

(Canada, Australia and the U.S.A.), regards these three sources as competitors in the market or as unrelated sources supplying different (separable) products. The methodology followed in this report is taken Winters (1984) and Alston *et al* (unpublished).

Equation 4 contains the AIDS model budget share equations by import source, which forms the basis of this version of the LA/AIDS model. These equations and the restrictions which follow are taken from the original paper by Deaton and Muellbauer (1980a).

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln(M/P), \quad 1 = 1, \ldots, n \tag{4}$$

where w is the budget share, p_j are the import prices of the component coarse grains, M is total expenditure on coarse grains, and P is the price deflator. Restrictions imposed on and implied by the model are:

$$\sum_i \alpha_i = 1; \quad \sum_i \gamma_{ij} = 0; \quad \text{and} \quad \sum_i \beta_i = 0; \tag{5}$$

$$\sum_j \gamma_{ij} = 0 \tag{6}$$

$$\text{and} \quad \gamma_{ij} = \gamma_{ji} \tag{7}$$

The restrictions ensure adding-up, homogeneity and symmetry respectively (Deaton and Muellbauer, 1980a, p.314). In addition, the price deflator P from Equation 4 can be approximated by Stone's index (see Deaton and Muellbauer, 1980a, p.316, for the exact form of Stone's index), which is called the LA/AIDS version of the model. As is standard procedure when working with the adding-up condition, estimation of the LA/AIDS model in this analysis will involve the deletion of one of the share equations.

The import quantity and value data are from U.N. *Commodity Trade Statistics*, and are the import data as reported by Japan. All of the value data are converted to Canadian dollars due to the results from the previous single equation import demand models which indicate that the Canadian exchange rate is important. The sample size is 15, from the years 1972 to 1986. The price data are measured in nominal terms and the expenditure variable is measured in per capita terms and then deflated by the price index P.

The actual results of the LA/AIDS barley import demand employing Armington-type assumptions turned out to be generally inconsistent or insignificant and so will not be presented in this report. The important conclusion to be reached from this analysis is that this particular form of the AIDS model is an inappropriate model for application to the Japanese barley import market.

6.5 Conclusions

The single equation model of the demand for barley imports in Japan yields similar results for total barley and for Canadian barley in that both regressions have the same significant explanatory variables. The demand determinants found to be the best explanators of barley imports are national income and the Canadian dollar-Japanese yen exchange rate. A significant slope dummy variable for income indicates that there was a structural change in the barley import market in Japan after the usage of these barley imports changed from being a food grain to a feed grain around 1972. This structural change was dramatic enough to cause Canadian barley, which was perceived as an inferior good prior to 1972, to be perceived as a normal good in the livestock industry after 1972. Besides the identification of income and the exchange rate as being important determinants of barley imports, this evidence of a strong structural change in the import demand for barley imports is the main conclusion to be drawn from the single equation demand estimations.

The results of the single equation estimations also reveal that the various own and cross price variables, when significant in a regression, do not explain barley imports very well. In most of the regressions, the price variables and slope dummy variables of the prices are insignificant. It can be speculated from these results that price may not be strong factor in the barley import demand market of Japan. Perhaps marketing agreements and contracts play a significant role in this import market. The results presented in this chapter certainly indicate that more detailed data on Japan's international and domestic barley marketing arrangements are necessary if meaningful price estimates are the focus of analysis.

The final conclusion to be drawn from the application of the LA/AIDS model on the Japanese barley import market is that this particular version of the model, which incorporates Armington-type assumptions, is unsuitable for application to the Japanese barley import market, because the variable coefficient estimates are generally not statistically significant.

7. The Demand for Barley Imports in Colombia

7.1 Introduction

The research presented in this chapter is an analysis of the Colombian barley import demand function. Colombia was chosen as a study country for two main reasons. Firstly, Colombia is as an example of a richer developing country. The statistics in Chapter 2 of this report indicate that these richer developing countries represent the fastest growing market segment with regards to coarse grain imports. The importance of developing country markets in world coarse grain trade is a key factor in the choice to include at least one developing nation in the time series analyses. Secondly, Colombia was chosen because it is one of the few developing nations with a reasonable time series of barley imports from Canada. Other developing countries have recently imported far more barley from Canada than has Colombia, but Colombia is one of the few to have imported for enough years to readily accommodate analysis. The purpose of this introductory section is to describe the importance of barley imports to Colombia and to describe the relative importance of Colombian-Canadian barley trade.

Table 7.1: The Share of Colombia's Barley from Domestic Production and Imports[1]

Year	Barley Supply (100 MT)	% Own Production	% Imports
1978	2266	52.5	47.5
1979	1858	73.5	26.5
1980	1482	73.9	26.1
1981	1220	46.2	53.8
1982	1538	36.2	63.8
1983	1460	19.0	81.0
1984	1442	19.6	80.4
1985	1672	36.1	63.9
1986	1734	42.2	57.8
1987	1984	46.2	53.8

[1]carry-over stocks not included in barley supply
Source: FAO, *Production Yearbook* and *Trade Yearbook*

Table 7.1 contains data on the Colombian barley supply from domestic production and imports (carry-over stocks are ignored). The data reveal that for seven of the ten years shown, more than half of the barley supply has been imported. In 1983 and 1984 over 80% of the barley supply came from imports. For the overall period of 1978 to 1987, the total share of barley from imports was 54% and from domestic production 46%. The total volume data in the first column reveal that the supply of barley coming from the two sources, production and imports, has been fairly constant between 140,000 and 200,000 MT. In other words, over the ten years contained in Table 7.1 there has not been a significant increase in the total supply of barley. But for the last four years since 1983, the barley supply has increased steadily from 146,000 MT to 198,400 MT, a slight upward trend. Basically then, the data in Table 7.1 reveal that imports have been a major source of barley for Colombia, at least for the last ten years or so.

Table 7.2: Canada-Colombia Barley Trade Data, 1000 MT (Percent Shares in Brackets)

Year	Canadian Exports[1] (% to Colombia)	Canadian Exports to Colombia[1]	Colombian Imports[2] (% from Canada)
1981	4764.3 (1.4)	65.0	65.7 (98.9)
1982	5722.0 (1.5)	86.0	98.2 (87.6)
1983	5736.5 (1.7)	97.1	118.2 (82.1)
1984	3905.4 (1.3)	49.3	116.0 (42.5)
1985	2231.4 (0.0)	0.0	106.8 (0.0)
1986	5985.7 (0.0)	0.0	100.2 (0.0)
1987	5444.0 (2.0)	110.7	110.7 (100.0)
Total	33,789.2 (1.2)	408.1	715.8 (57.0)

[1]Source: Statistics Canada 65-004, *Exports by Commodities*
[2]Source: FAO, *Trade Yearbook*

Table 7.2 contains data on barley trade between Canada and Colombia from 1981 to 1987. The data indicate that Colombia has not been a very large market for Canadian barley exports, accounting for a period total of just over 1% of Canada's total exports by volume. For two years, 1985 and 1986, Canada did not export barley at all to Colombia. And so, from Canada's perspective, Colombia has been a low volume yet relatively consistent market accounting for a steady share of over 1% of Canadian barley exports.

For Colombia on the other hand, Canada represents a major source of barley imports. For four of the seven years shown in Table 7.2, over 80% of Colombia's barley imports have originated in Canada. For two of those years, 1981 and 1987, Canada effectively supplied all of the imports. For the overall period and despite two years of zero imports from Canada, almost 60% of Colombia's barley imports were from Canada. The other major source of Colombia's barley imports is the United States. France and Argentina have also been barley sources, but only on a minor scale.

7.2 The Model and Data

The model in this analysis of Colombia's barley import demand will be based on the model described in the Russian analysis because no previous literature on Colombian feed or food grain import demand could be found. Variables relevant for inclusion in the Colombian model will be identified from descriptive literature.

The first step is to identify the end use of barley imports in Colombia. Surprisingly, it appears that barley imports are used for beer production rather than as livestock feed as first expected. At least with regards to domestic production, "most of the barley grown is purchased by breweries" (Blutstein *et al*, 1977, p.360). From this observation and because Colombia is one of the top ten beer producers by per capita volumes in the world (only North American and European countries produce more per capita), it can be assumed that barley imports also go largely towards the brewing industry. Therefore, Colombia's domestic beer production is one variable entering the Colombian model.

A World Bank report on Colombia helps determine which variables should be chosen as deflators in the regression. In this report, the on-going problem of inflation in Colombia is singled out as a major policy target (1984, pp.42-50). The report also points out the dominant role of agriculture in exports (p.102). Therefore, one deflator should be a measure of inflation and the most obvious choice here is the Colombian consumer price index (CPI). The second deflator should be the export price index of an important Colombian export commodity. The most obvious choice for this second deflator is coffee, because "coffee is the most important crop in the country, providing a livelihood, directly or indirectly, for an estimated 2 million people. Coffee production contributes about 10 percent to the GDP, and coffee is the major export" (Blutstein *et al*, 1977, p.357).

The cross-sectional analysis in Chapter 2 indicates that variables such as food aid, percent urbanization, national income and government debt are all important determinants of cereal imports in LDC's. Of these four variables, only national income and government debt are available for a long enough time series to be of use in this analysis. These two variables will therefore be included in the Colombian barley import model. The debt variable will be measured in two different forms, one being the absolute level of government debt, lagged one year, and the other form being the change in debt from the previous year.

Equation 1 contains the model that will be used to estimate Colombia's import demand for barley in total and for barley from Canada.

IMPORTS = f(PRICE, INCOME, POP., EXCHANGE RATE, DEBT, BARLEY PROD., BEER PROD., FOREIGN EXCH., DUMMY) (1)

The dummy variable is coded to equal 1 for those years that Colombia did not import any barley. And, because the end use of barley imports is beer production, no cross prices for other grain imports are entered into the model since there are no import substitutes for barley in beer production. The only substitute for barley imports would be domestic barley production, but a producer price for barley is unavailable for the entire time series. For the Canadian model, data on the cross prices of barley from other sources are unavailable and so cannot be entered into the regression.

Definitions of the variables and the sources of data are listed in Table 7.3. The sample size is 21 with the time series being from 1967 to 1987. The quantity and value data are in units of one thousand except for the foreign exchange reserves which are measured in billion U.S. dollars.

All value data expressed in monetary terms have been converted to real terms by either the Colombian CPI or the export price index of coffee. The price data are unit values obtained by dividing the value of barley imports by the volume of barley imports. The total barley price is a c.i.f. unit value expressed in U.S. dollars while the Canadian price is an f.o.b. unit value and is in Canadian dollars. LRES, the foreign exchange reserves variable, will be expressed in U.S. dollars since this is the currency most reserves are held in. The income and debt variables will be entered into different regressions in two currency forms: the first currency will be Colombian pesos with the exchange rate variable entering the regression as a separate variable in units of dollar per peso; the alternative

Table 7.3: Variable Definitions and Data Sources, Colombia

Variable	Definition	Source[1]
POP	Colombian population, mid-year	B
CPI	Colombian consumer price index, all items, 1980=100	B
COFPI	coffee export price index, 1980=100	D
EXCH	real U.S. dollar-Colombian peso exchange rate	D
CCEX	real Canadian dollar-peso exchange rate	D
LBPR	Colombian barley production, lagged one year	C
LRES	real Colombian international reserves, lagged one year	D
GDP	real Colombian gross domestic product, purchaser's values	B
LDEBT	real Colombian government debt	D
DBT	% change in real government debt from the previous year	D
BEER	Colombian beer production	F
BM	Colombian total barley imports	A
TBP	real total barley import price	A
CANBM	Colombian barley imports from Canada	E
CBP	real barley import price from Canada	E
D1	dummy variable for year of zero total barley imports 1=1972; else=0	
D2	dummy variable for zero barley imports from Canada 1=1960,71,72,73,74,75,85,86; else=0	

[1]A: FAO, *Trade Yearbook*
B: U.N., *Monthly Bulletin of Statistics*
C: FAO data tapes (data acquired through correspondence with FAO)
D: IMF, *International Financial Statistics*
E: Statistics Canada 65-004, *Exports by Commodities*
F: U.N., *Industrial Statistics Yearbook*

currency form will be U.S. dollars for total barley imports and Canadian dollars for the Canadian barley regression with the relevant exchange rate entering the regression as a conversion factor, rather than as a separate variable.

Collinearity investigation reveals that there is considerable collinearity between several of the variables. A variance decomposition between the variables POP, GDP, BEER, LBPR, and LRES (population, gross domestic product, beer production, lagged barley production and lagged international reserves respectively) resulted in condition indexes of 200,000 and greater along with variance proportions larger than 0.5. There appears to be a high degree of collinearity between LRES and GDP, LRES and POP, GDP and POP, GDP and BEER, and BEER and LBPR. Possible problems with wrong signs on coefficients and insignificant coefficients may arise in the regressions. Variables with such problems will be dropped from the regression and the model will then be re-estimated.

7.3 Results of the Model

The Demand for Total Barley Imports

Equation 2 contains the results of the best regression of total barley import demand in Colombia.

$$BM = \underset{(18.53)}{156} + \underset{(4.30)}{0.686LRES} - \underset{(5.51)}{16.42TBP} - \underset{(2.77)}{9.481EXCH} - \underset{(8.02)}{0.644LBPR} - \underset{(3.71)}{38D1} \qquad (2)$$

and adj. R^2=.93. All of the variables are significantly different than zero and have the correct expected signs on the coefficients. In addition, 93% of the variation in Colombian barley imports is explained by the four variables: real price of imports, domestic barley production, international reserves and the real U.S. dollar-peso exchange rate.

Three variables omitted from Equation 2 due to collinearity effects are income, beer production and population. In other regressions of different variable combinations these three variables become significant. It can be speculated that the constant term in Equation 2 is picking up the effect on barley imports of these three omitted variables because the value of the constant term is quite large and the t-statistic indicates strong correlation to barley imports. The dimension of the constant term would probably not be so large if the omitted variables could be entered into the regression. But due to collinearity problems, these otherwise significant variables had to be deleted from the set of relevant variables. The model as outlined in Equation 1 is probably theoretically correct, but, econometrically, Equation 2 represents the best set of determinants of Colombian barley imports.

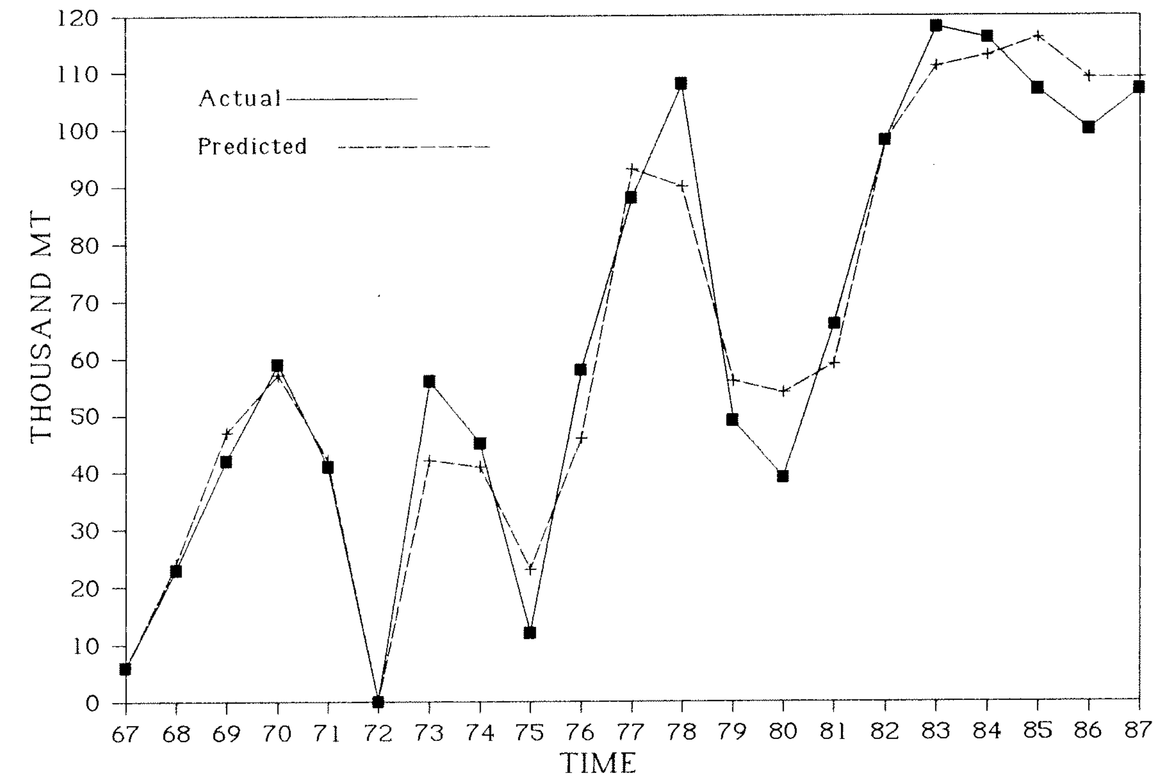
The significant dummy variable indicates that unusual import conditions did exist in 1972 because the model would have predicted barley imports in that year to be around 40,000 MT when actually no barley was imported. But, investigation into possible causes for this occurrence did not reveal any clues as to why no barley was imported by Colombia in 1972. Perhaps if barley inventory data were available the zero imports in 1972 could be better explained.

Several alternative regressions are run using the two different deflators, the two different debt variables, the two different currency forms of income and debt, and per capita data. The results of these alternatives are described here but the actual equations will not be presented. Of the two price deflators, the coffee export price index yields better results than the Colombian CPI. Equation 2 contains data deflated with the coffee price index. The income and debt variables, measured either in U.S. dollars or Colombian pesos, are not significant in the regression, and the alternative regression using per capita data yields statistically inferior estimates to those presented in Equation 2. Equation 2 represents the best estimates of the Colombian barley import model.

The results of the tests performed on the regression will now be presented. The Breusch-Pagan test reveals that at a 95% confidence level the presence of heteroskedasticity is rejected ($\chi^2 = 3.612$). The Durbin-Watson test statistic falls approximately in the middle of the inconclusive range for negative autocorrelation (DW=2.383). Since the Durbin-Watson test is inconclusive, an alternative measure of autocorrelation is obtained from a partial autocorrelation plot. A sixth order partial plot reveals that there is no significant autocorrelation in the regression, at least for the first six lags. The Box-Cox test for structural form indicates that a linear functional form is acceptable for the regression in Equation 2 ($\lambda = 1$: $\chi^2 = 6.14$).

Figure 7.1 contains the graph of actual barley imports (solid line) with the model's predicted barley imports superimposed (dotted line). The graph reveals that the model does fairly well at predicting Colombia's barley imports. Some exceptions are 1973, 1978 and 1980. Actual imports might be greater than predicted in 1973 due to the zero imports in 1972 causing grain inventories to be reduced and in need of replenishment, unusual circumstances that the model is unable to predict.

Figure 7.1: Actual and Predicted Barley Imports, Colombia



<u>The Demand for Barley Imports from Canada</u>

Using the Canadian barley volume, price and exchange rate data, the model in Equation 1 is estimated. The results of the best set of explanatory variables appears in Equation 3.

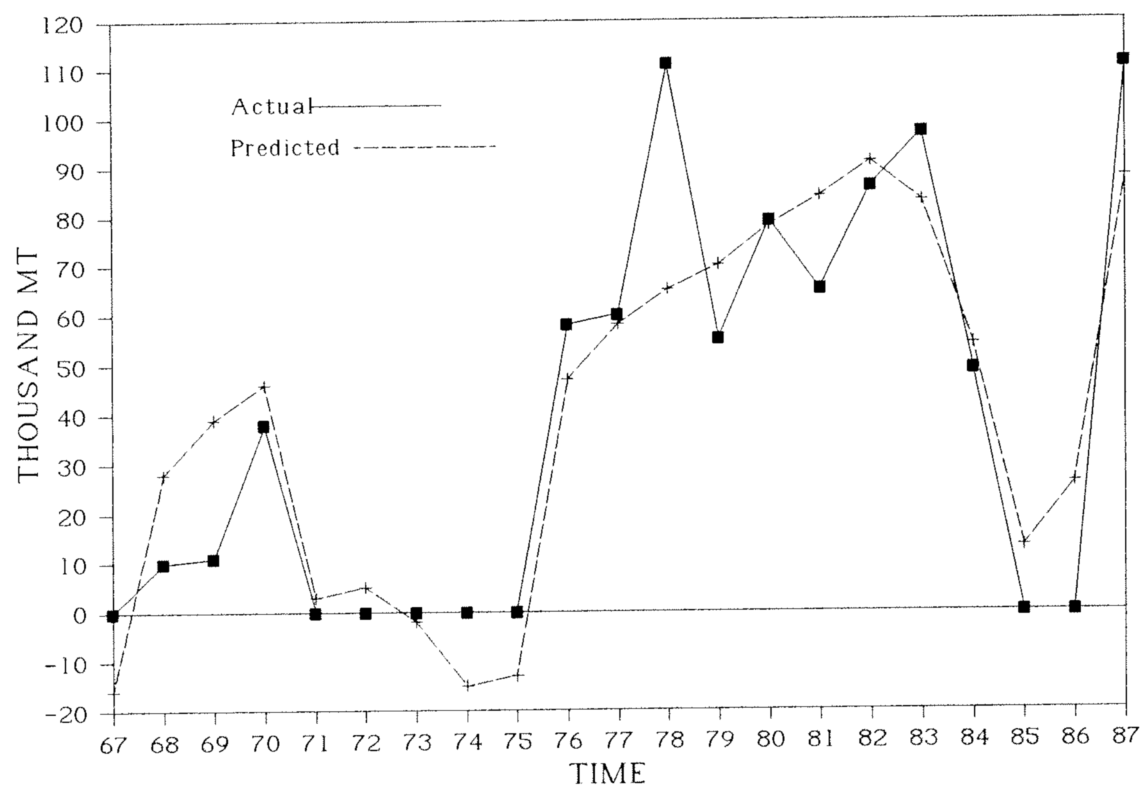
$$\underset{}{CANBM} = \underset{(4.74)}{68} - \underset{(2.28)}{16.39CBP} + \underset{(3.91)}{1.030LRES} - \underset{(4.29)}{43D1} \qquad adj.R^2 = 0.77 \qquad (3)$$

All of the variables are significant at the 95% confidence level and have the expected signs. The real price variable, CBP, is expressed in Canadian dollars while the real foreign exchange reserves variable, LRES, is expressed in U.S. dollars. As in the total barley regression, the deflator found to give the best statistical results in the Canadian barley regression is COFPI, the Colombian coffee export price index. This significant deflator indicates that Colombia relies on coffee exports to generate the foreign exchange with which to purchase barley imports. In addition, the three variables CBP, LRES and the dummy variable for zero imports combine to explain over 75% of the variation in barley imports from Canada.

Two variables from the total barley regression (Equation 2) are no longer significant for Canadian barley: LBPR, domestic barley production and EXCH, the U.S. dollar-peso exchange rate. Nor is the Canadian dollar-peso exchange rate significant in the Canadian barley regression. Domestic barley production is not significant in any of the regressions on import volume of Canadian barley, which indicates that there is little or no correlation between barley imports from Canada and Colombia's barley production. On the other hand, the exchange rate variables EXCH and CCEX are both significant in regressions when the price variable is omitted, which indicates that collinearity between CBP and the exchange rates might be the reason why the exchange rates are insignificant in the regression.

Besides the deletion of the apparently significant exchange rate variables from the regression due to collinearity with the price variable, another possible reason for the low explanatory power of the Canadian barley model relative to the high power of the total barley model is the omission of the cross prices of barley imports from competing import sources. Besides 1972 when Colombia did not import any barley at all, there are seven other years when Colombia did not import barley from Canada, but relied solely on other import sources. The rather obvious willingness of Colombia to substitute other sources for Canada implies there have been relevant reasons for doing so. Economic theory suggests that the major reason for such substitutions should be relative prices. Therefore, omission of such data (due to unavailability) is very likely a reason the Canadian model fails to predict Colombia's barley imports from Canada very well. Figure 7.2, which plots the actual (solid line) versus predicted (dashed line) barley imports from Canada, provides visual support to the above substitute argument. The graph reveals that for the majority of poorly predicted years, the model has over-predicted the amount of barley Colombia imported from Canada. This over-prediction tendency of the Canadian barley model is another indication that the relative prices of competitor's barley to Canadian barley may be an important factor, because for every over-predicted year, Colombia was actually importing more barley from a source other than Canada.

Figure 7.2: Actual and Predicted Barley Imports from Canada



Tests on the regression indicate that there is no heteroskedasticity ($\chi^2 = 1.288$)and the linear functional form is appropriate ($\lambda = 1$: $\chi^2 = 0.580$). The Durbin-Watson statistic indicates that there is no significant first order autocorrelation (DW=1.88).

The elasticities from the two models are contained in Table 7.4. All of the elasticities have values within the inelastic range. The elasticities for the Canadian barley variables are more elastic than the corresponding total barley import variables. This relatively more elastic response of Canadian barley to changes in own price and foreign exchange reserves is due to there being more substitutes for Canadian barley (other import sources) than there is for barley in total (other brewing grains). In addition, the inelastic price elasticities support the assumption that barley imports are used in beer production because if barley were being used as a feed grain rather than as an input into the brewing industry, then the import price elasticity would probably be in the elastic range.

Table 7.4: Elasticities from the Two Models, Colombia

Variables	Equation 2 Total Barley	Equation 3 Canadian Barley
Real Import Price	-0.66	-0.80
Real Foreign Exchange Reserves	0.20	0.49
Real Exchange Rate	-0.13	
Domestic Barley Production	-0.85	

The responsiveness of total barley imports to a change in the amount of real foreign exchange reserves is very inelastic with a 10% change in reserves causing a change of about 2% in barley imports. This inelastic response indicates that barley is given a fairly high priority on the import list because availability of foreign exchange does not effect barley imports drastically. For Canadian barley this response is slightly greater with a 10% change in reserves causing a 5% change in barley imports from Canada.

The dependence of Colombia on barley imports is evidenced by the inelastic response of these imports to domestic barley production. A 1% increase in barley production causes only a 0.8% drop in total barley imports, a less than proportional response. This inelastic responsiveness of barley imports to production was expected as a result of Colombian trade policy which has favoured imports at the expense of production (Garcia Garcia, 1981, p.49).

7.4 Conclusions

The results of the analysis of Colombia's import demand for barley indicate that financial variables such as price of imports, the exchange rate, the amount of foreign exchange reserves and the relative price of Colombia's coffee exports all influence the amount of barley Colombia is willing to import. Barley imports exhibit a fairly inelastic response to all of these financial variables. The response of total imports to changes in domestic barley production is more elastic than for the financial variables, but is still less than 1.0 and in the inelastic range.

For barley imports from Canada, the analysis reveals that the price of Canadian barley and the level of foreign exchange reserves are both significant determinants of import demand. Canadian barley imports, like total barley imports, show a fairly inelastic response to these two financial demand determinants. In addition, from the results of the Canadian model it can be reasonably speculated that competitive import sources have a significant impact on the level of barley Colombia imports from Canada.

8. The Demand for Barley Imports in China

8.1 Introduction

The purpose of this chapter is to attempt a simple analysis of the Chinese barley import market. Only a simple analysis can be undertaken because of severe data limitations with regards to China. But, despite the data restrictions, China is still of interest for analysis because of China's tremendous potential as an important grain import market. Carter and Zhong concluded from their study on grain production and consumption in China that "for many reasons, the Chinese government would like to reach a level of self-sufficiency in grain. However, under current circumstances, grain self-sufficiency is not likely to be reached in the 1990's, unless a major technological development is made in the near future" (1988, p.107). In other words, it is expected that China's demand for cereals, including barley, will exceed production capabilities for at least the next decade.

China currently has the largest population of any single country in the world with an estimated 1.15 billion people. This figure represents over one-fifth of the world population. In addition to a large population, China is also on the verge of entering the middle-income, high-growth stage of economic development which, according to Mellor (1983, p.241), is characterized by a more rapid growing demand for cereals for food and feed purposes than can be met by domestic production. The combination of a large population and an increasing per capita income make China one of the potentially most significant grain import markets in the world.

Table 8.1: Canada-China Barley Trade Data, 1000 MT (Percent Shares in Brackets)

Year	Canadian Exports[1] (% to China)	Canadian Exports to China[1]	Chinese Imports[2] (% from Canada)
1981	4764.3 (1.6)	76.5	353.5 (21.7)
1982	5722.0 (0.02)	1.0	508.6 (0.2)
1983	5736.5 (1.4)	82.9	481.4 (17.2)
1984	3905.4 (0.7)	26.1	430.5 (6.1)
1985	2231.4 (0.0)	0.0	368.6 (0.0)
1986	5985.7 (4.8)	285.4	477.1 (59.8)
1987	5444.0 (5.4)	291.7	536.2 (54.4)
Total	33789.2 (2.3)	763.6	3155.8 (24.2)

[1]Source: Statistics Canada 65-004, *Exports by Commodities*
[2]Source: FAO, *Trade Yearbook*

China imported barley from Canada from 1961 to 1964 and then did not import again until 1981. Thus, an analysis of China's barley imports from Canada will not be undertaken in this chapter, just an analysis of total barley imports. But, it is still important to get an idea of the magnitude of these recent barley imports with respect to both Chinese imports and Canadian exports because of the potential for future growth in the Chinese barley import market. Table 8.1 contains data on Canadian-Chinese barley trade. The data reveal that while China has been a relatively small market for Canadian barley from a Canadian perspective, Canada has been an important source of barley for China in recent years. More than half of China's imports, for example, came from Canada in 1986 and 1987. China also imports significant amounts of its barley from Australia. Table 8.1 serves to illustrate that very recently Canada has become a major source of barley for China and given the potential of market growth in China, the relevance of attempting to analyze China's barley import market becomes evident.

This chapter is organized into three further sections. The first section contains a description of the model and data used to estimate China's barley import demand. The next section presents and discusses the results of the model estimations. The final section provides a brief summary of the results of the import demand analysis.

8.2 The Model and Data

As was the case for Japan and Colombia, no previous time series studies of China's barley or feed grain imports could be found. Therefore, the same basic model used throughout the time series analyses will also be applied to the Chinese barley import market. This model appears in Equation 1, followed by a discussion of the variables chosen and omitted.

IMPORTS = f(OWN PRICE, WHEAT PRICE, INCOME, POP., BARLEY PROD., LVSTK. PROD., POLICY DUMMY, CULTURAL REV. DUMMY). (1)

The import price of wheat is included as a cross price for barley imports because, at least in the 1960s and early 1970s, coarse grain imports were an inferior substitute for wheat imports, "purchased primarily when grain imports [were] large and foreign exchange pressures severe or wheat unavailable at desired delivery schedules or prices" (Surls, 1978, p.655).

Two dummy variables are included in the import demand model in an attempt to account for qualitative aspects of China's barley import environment. The first aspect is the possible structural shift in barley imports caused by a new era of policies introduced in 1978, an era characterized by a Chinese economy more open to the world economy. In addition, the Chinese government initiated a price policy aimed at improving the incentives for domestic agricultural production with the ultimate goal being the improvement of diets. Pressure was on the government to increase the supply of food to consumers, both through increased domestic production and increased grain imports. This 1978 policy change signalled a new era of economic incentives and foreign trade, and the policy dummy variable is included in the model to determine if barley imports previous to 1978 are significantly different than imports after 1978 due to these policy changes. The policy dummy variable will enter the regression both as an intercept variable and as slope dummy variables.

The second dummy variable attempts to measure the effect on barley imports of past periods of political instability. The Cultural Revolution, which occurred between 1966 and 1969, was a time of intense political turmoil. The disruption to China's domestic economic activity in industry and agriculture may have caused an interruption in trading activities. The Cultural Revolution dummy variable is included in the model to determine if this period of political unrest had any impact on China's barley import demand and will enter the regression only as an intercept variable.

Several potentially important variables have been omitted from the barley import demand model in Equation 1. The importance of these variables was identified in the cross-sectional analysis of cereal import demand in LDCs. Two such variables, cereal food aid and foreign exchange reserves, are not included in the model due to insufficient data. Another variable, government debt, is omitted from the model because, although China is a developing country which would usually imply the presence of a debt problem, China has historically been quite reluctant to borrow from foreign sources (World Bank, 1983, p.461). China is one of the few developing countries in which government debt is not an important economic factor and so no debt variable is needed in the import demand model.

Table 8.2: Variable Definitions and Data Sources, China

Variable	Definition	Source[1]
POP	Chinese population, mid-year estimates	B
PETPI	crude petroleum export price index, 1980=100	B
RPI	rice export price index, 1980=100	B
INC	real Chinese net material product	E
WP	real price of wheat imports	A
WPI	real wheat export price index, 1980=100	B
BM	Chinese gross barley imports	A
LBPR	Chinese barley production, lagged one year	C
BP	real barley import price	A
BPI	real barley export price index, 1980=100	B
LVIND	Chinese livestock output index, 1979-81=100	C
PIG	Chinese number of pigs	D
D78	policy dummy variable: 1=1978 to 1987; else=0	
DCR	Cultural Revolution dummy variable 1=1966,67,68,69; else=0	

[1]A: FAO, *Trade Yearbook*
B: U.N., *Monthly Bulletin of Statistics*
C: FAO data tapes (data acquired through correspondence with FAO)
D: FAO, *Production Yearbook*
E: IMF, *International Financial Statistics*

Table 8.2 contains a list of the variables, definitions of the variables and sources of the data. All quantity data are measured in units of one thousand except income which is in millions of yuan. The data set has 27 observations, covering the years 1961 to 1987.

All monetary data are expressed in real terms using two alternative deflators, the export price of rice and the export price of petroleum. These two deflators are chosen because of the importance of both commodities in China's exports and because a Chinese consumer price index is unavailable for use as a price and income deflator. "China's grain exports consist almost entirely of rice, which is the largest bulk export item. China has consistently ranked among the world's top rice exporters" (Surls, 1982, p.189). Since agricultural exports make up the bulk of Chinese exports (at least in the 1960s and 1970s agricultural exports dominated), and rice was the dominant export within agricultural exports, it is reasonable to use the export price of rice as a deflator in the regression. The alternative deflator is to use the export price of petroleum. "An important change in the commodity composition of China's exports in the 1970s was the emergence of oil as a major export item" (World

Bank, 1983, p.423). China became a net exporter of oil in 1972 and as early as the late 1960s had already substantially decreased its net oil imports. Therefore, a petroleum price index will be used as an alternative deflator to the rice price.

There are two types of real price variables which will enter separate regressions: a c.i.f. unit value price (calculated by dividing total value by total imports), and a general export price index. Both price types will also be entered into regressions in current and lagged one year forms.

There are also two types of livestock production variables. One type is the index of livestock output in China. The second type is the number of hogs in China. This second livestock variable is offered as an alternative to the livestock output index because

> The hog is the most important animal in China's livestock sector. Pork provides the bulk of meat production, and exports of live hogs, pork and hog products have been an important part of agricultural exports...[In addition], emphasis on hog inventory numbers for evaluating farm performance contributed to excessively slow turnover of hogs (Surls and Tuan, 1982, pp.423-424).

This quote indicates that hogs may be a more important outlet for barley imports than poultry or ruminant production, and that the number of hogs is a more useful measure than pig meat production.

The final data issue to be discussed here is data quality because one of the most important and widely recognized aspects of analyzing Chinese grain trade behavior is the quality of the data being analyzed.

> The quality of Chinese statistical series has varied widely through time for historical reasons. Unlike many developing countries where statistical collection has made steady, if slow, progress, Chinese statistical collection has both advanced and regressed. The rudiments of a national system were established in 1952 with the formation of the State Statistical Bureau (SSB), and subsequently destroyed during the Great Leap Forward, (1958-1961) when statistics were declared "a weapon of class struggle." Although the Chinese statistical system recovered to a certain extent during the early 1960s, it was dealt a staggering blow during the Cultural Revolution, especially the first stage (1966-1969), when responsibility for record keeping was withdrawn from professionals and charged to cadres, whose promotions depended on the records in their own ledgers (Stone, 1982, pp.205-206).

Consequently, the quality of Chinese statistical data should be recognized as one limitation to any analysis of Chinese activities.

One example of this data quality problem is that the FAO Chinese barley import data include Taiwan's barley imports along with the imports of mainland China. But, cross-checking with other data sources (USDA and United Nations) for selected years reveals that the majority of these barley imports actually go to mainland China. Therefore, the FAO barley import data will be used in the regression analysis, despite including Taiwan's data. This brief discussion about Chinese data quality is presented to acknowledge that data problems exist and that econometric results may suffer as a consequence.

8.3 Results of the Barley Import Demand Model

When all of the variables in the model are entered into the regression, the result is that none of the variables are significantly different than zero. Collinearity problems between the variables are probably the cause of this result. Re-estimations result in Equation 2, which contains the results of the best regression for barley import demand in China.

$$BM = -306 - 213DCR - 234BPI + 155WP + 0.003PIG - 0.133LBPR \quad (2)$$
$$\quad (0.52) \quad (1.85) \quad (2.87) \quad (3.64) \quad (1.93) \quad (2.88)$$

and adj. R^2=0.5556. Although the coefficients for the two variables DCR and PIG (Cultural Revolution dummy and number of pigs respectively) are insignificant at a 95% confidence level, the coefficients are significant at a 90% confidence level which is still an acceptable level. Only 55% of the variation in barley imports is explained by all of the explanatory variables. The low explanatory power of the model may be due to several factors: the quality of data for China; collinearity problems; and/or misspecification errors. Nevertheless, the model still reveals several features about the Chinese barley import market.

The negative coefficient on the Cultural Revolution dummy variable (DCR) reveals that this period of political and social upheaval did result in a large reduction of barley imports. Without the dummy variable, the model would have over-estimated barley imports by about 200,000 metric tonnes. The other dummy variable, for the 1978 policy change, is insignificant in the regression either as an intercept dummy or as slope dummies. This result implies that China's barley imports have not undergone a significant structural change due to the economic reforms begun in 1978.

The own price of barley imports, BPI, is another significant explanator of barley imports, and has the expected negative sign on the coefficient. The best measure of this price variable turned out to be the general barley export price index (rather than the unit value of barley imports). The price of barley imports is apparently an important factor in China's barley import decisions. Another important price in the import decision is the cross price of wheat imports, WP, measured as the unit value of wheat imports. The coefficient on this cross price variable has a positive sign which confirms the observation that coarse grain imports, barley in this case, and wheat imports are substitutes. But whether these two grains are substitutes in use, as suggested by Surls, or compete for scarce foreign exchange reserves is not clear from the results of this particular model. Further research into the exact nature of the competitive relationship between barley and wheat imports is needed to answer this question. Both pice variables are deflated by the petroleum export price index. The alternative deflator, the rice export price index, also produces significant results, but of lower explanatory power than the petroleum index.

The significant livestock variable indicates that barley imports may have been used more for animal feed than for direct human consumption. In addition, the variable for the number of pigs results in better statistical estimates than does the livestock output index which is an indication that barley may be used more in the hog industry than in other livestock production processes like poultry, eggs and beef. The significant domestic barley production variable indicates that barley imports decrease when domestic production increases. This result implies that, to a certain extent, China does pursue a policy of barley self-sufficiency.

Besides the intercept and slope dummy variables for the 1978 policy change, the only other insignificant variable in the regression is that of aggregate income, as measured by net material product. This result can be interpreted to mean that rising incomes in China have not yet had a very large influence on barley import demand, but such an interpretation can only be tentative due to the quality problems associated with Chinese data. The income variable may be insignificant because of being an inaccurate representation of aggregate income in China.

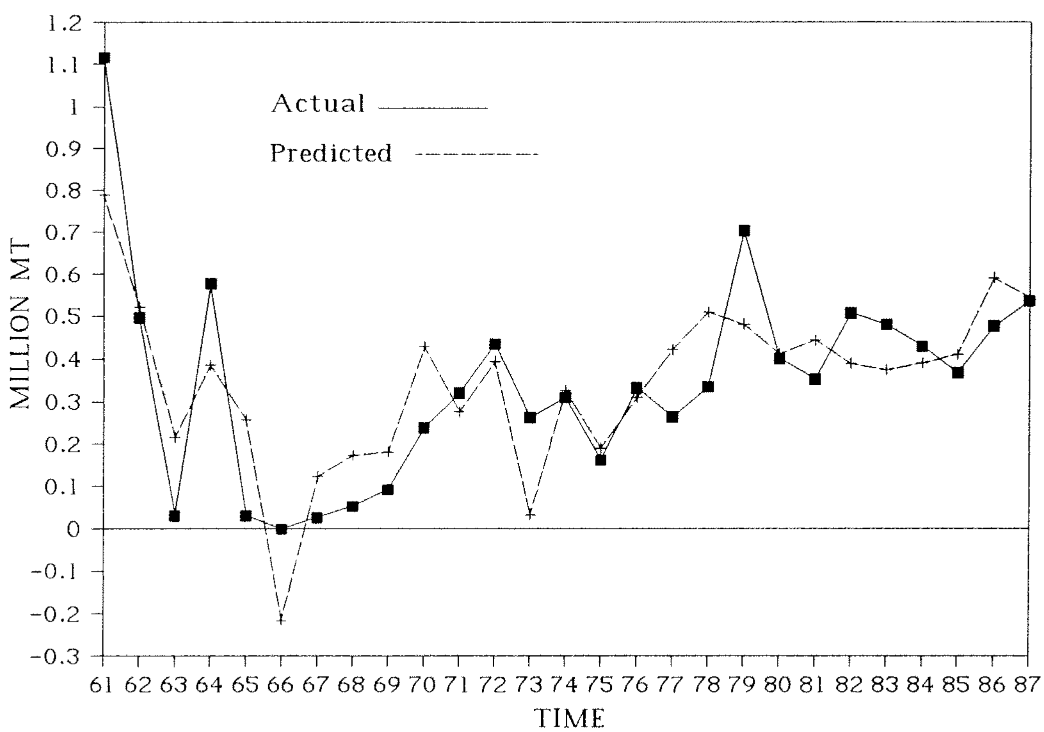
Tests on the barley regression indicate that there is no heteroskedasticity (BP: $\chi^2 = 4.445$) and that the linear functional form is appropriate ($\lambda = 1$: $\chi^2 = 0.344$). The Durbin-Watson statistic falls in the inconclusive range for negative autocorrelation. A partial autocorrelation plot (not reproduced here) reveals that, at least for the first six lags, there is no significant autocorrelation.

The elasticities calculated from the barley import demand model are contained in Table 8.3. All of the elasticities are in the elastic range of response, indicating that barley imports are quite sensitive to changing market conditions. The magnitudes of the elasticities indicate that both the own price of barley imports and the cross price of wheat imports have had the largest impact on barley imports. A one percent change in either price causes a change of over 3% in barley imports, though of opposite direction. In contrast, a 1% change in domestic barley production has less than half the effect of a similar own or cross price change.

Table 8.3: Elasticities from the Barley Model, China

Variables	Elasticities
Real Own Price	-3.03
Real Cross-Price of Wheat Imports	3.74
Number of Pigs	2.50
Domestic Barley Production	-1.24

Figure 8.1: Actual and Predicted Barley Imports, China



The graph of the actual (solid line) and predicted (dashed line) barley imports appears in Figure 8.1. The graph reveals that the import demand model predicts the general pattern of actual barley imports quite well, but that specific, individual year imports are not well predicted for certain years. One reason for the poor predictive power of the model for certain years may be that China's barley import policy has been affected by forces specific to those individual years that are not part of an overall import trend. Further research and/or more accurate data may result in better barley import estimates than have been produced in this analysis.

8.4 Conclusions

This simple barley import demand analysis reveals that the price of barley imports is a main determinant of China's import demand, despite the fact that China has a command economy where price is generally assumed to be of secondary importance to policy objectives. The significant cross price variable for wheat imports indicates that financial constraints cause Chinese officials to substitute wheat for barley depending on relative import prices of the two kinds of grains. The significant Cultural Revolution dummy variable indicates that past political instability within China has resulted in significant barley import reductions, which implies that the political stability within China is an important factor for exporters to monitor. Barley imports have also been influenced by domestic barley production which has acted as a substitute source of barley. Finally, the analysis also indicates that the number of pigs is an important determinant of barley import demand which implies that the end use of barley in China has probably been more for animal feed than for direct human consumption.

9. Summary and Conclusions

The subject of this report has been the analysis of Canada's feedgrain and foodgrain export markets. The focus has been on economic factors affecting export markets for barley. In Chapter 2, detailed statistics of Canada's role in the international barley market were presented. Within the world coarse grain market, barley is second in importance only to corn. And within the world barley market, Canada is the dominant exporter while less developed countries (LDCs) have recently become the largest import market segment. Canada's exporter profile data revealed that the richer developing and Eastern European countries have been high growth markets for exports of Canadian barley. This suggests that export marketing efforts continue to focus on these market segments. Although the premium market segment is likely to continue to be that for malting barley in beverage production, the largest market use for barley is as a feedgrain.

The constant market share analyses in Chapter 3 were undertaken to determine the effect of the structural features of the world coarse grain and barley markets, as well as the world wheat market, on the export performance of the major feedgrain and foodgrain exporters. The CMS feedgrains analyses revealed that those exporters with a large market concentration in the richer developing countries tended to display positive export growth rates, suggesting emphasis on marketing efforts be directed at this sgement. Although corn used to be imported at an increasing rate, it now appears that barley is a more rapidly expanding component of world feedgrain trade. With wheat, Canadian exports have tended to be more concentrated in less rapidly growing wheat markets and classes than has been the case for major competitors. Canada's wheat export performance has varied over time. As was also the case for Argentina and Australia, Canada's export competitiveness fell substantially in the late 1980s relative to the US, clearly a result of the US export enhancement subsidy program.

The analyses in Chapters 2 and 3 identified the growing importance of LDC markets to barley trade and indicated the necessity for more detailed analysis of cereal import demand in developing countries. One approach to more detailed analysis was presented in Chapter 4 which contains cross-sectional estimations of import demand for cereals in seventy-four LDCs.

The main cross-sectional analysis in Chapter 4 revealed that there are significant regional import demand differences across LDCs. Asian countries display a measurably different response to certain economic factors than do countries of South America or countries of Africa. Of the three regions, Africa displays the greatest import demand diversity. The model predicts import demand in Asian and South American countries very well, but somewhat less well in African countries.

The regression results identified the main determinants of cereal import demand in LDCs to be income, the degree of urbanization, cereal food aid, domestic cereal production and lagged government debt. High levels of government debt appear to have inhibited cereal importation in South America, but not in Asia and Africa. In all three continental regions, particularly in Africa, there is a positive relationship between food aid and cereal imports. It proved difficult to isolate the role of financial capacity variables such as lagged foreign exchange reserves or the level of exports in our multi-variate import demand equations because of serious collinearity problems between such variables and GNP. Nevertheless, these financial capacity variables, taken alone, were negative influences. The fact that cereal import demand in developing countries is dependent on financial capacity indicates that it is in the interest of Canadian barley exporters to improve and extend the financial stability of developing country markets through such means as credit and foreign aid. However, it should be noted that cereal imports appear to be less affected by financial constraints than other imports such as manufactured goods.

The remaining variables in the cereal import demand function such as income and urbanization reflect structural aspects of developing country economies. Income and the degree of urbanization reflect a country's ability to generate effective demand for cereals. The implication here is that as developing countries become increasingly affluent and economically stable, the demand for cereal imports will increase, at least in the short to medium run. The ability to understand these development trends and their relationship to cereal import demand will have serious consequences on a cereal exporter's marketing performance in these developing countries. The significant domestic cereal production variable indicates that a country's comparative advantage in cereal production, modified by policy goals and exogenous environmental factors, has a major impact on that country's level of cereal import demand. Developing countries with a comparative disadvantage in cereal and barley production relative to Canada may prove to be the most advantageous markets to target for increased cereal exports because of their import potential relative to better endowed developing countries.

Secondary cross-sectional regressions in which cereal imports are disaggregated into food and feed grains revealed that when treated as separate commodities, food and feed grains apparently need somewhat different demand specifications. An important empirical result is that feedgrain imports are more sensitive to income changes than foodgrain imports such as wheat.

The final issue examined in the LDC cross-sectional analyses was the effect of income distribution on cereal import demand. The results of this twenty-three country analysis revealed that improvements in income distribution in LDCs would considerably stimulate import demand. Increasing the income share of the lowest 40% of the population within a country results in a greater than proportional increase in cereal import demand, regardless of whether that country is in the low, middle or high income category of development. This income distribution analysis has served to identify the positive impacts on cereal imports that can be expected when countries enter the middle income stage of development and when countries are able to increase the equity of their internal income distributions. It appears from these results that exporters will benefit from policies that encourage trends of income growth and income equity in developing nations.

Having completed the general analyses described above, the focus of the research then turned to more detailed analyses of Canada's barley export markets, in the form of time series analyses of the import demand for barley in specific countries of importance to Canada. Russia and Japan were chosen for analysis because of being amongst the largest of Canada's barley export markets. Colombia was chosen as an example of a developing country market and China, also a developing country, was chosen for its potential as an important future market for Canadian barley.

The results of the barley import demand analysis in the (former) USSR revealed that the major variables affecting import demand in the Soviet Union are domestic barley production, domestic meat production and the relative price of barley imports to Russian petroleum exports. In addition, it was determined that the historic import fluctuations so characteristic of Russia's barley import behavior can be attributed mainly to fluctuations in Russia's domestic barley and meat productions.

These research results give rise to several implications with respect to Canada's future barley trade with a reconstituted USSR. First of all, it appears that the major force behind the import demand for barley in the (former) USSR was the dynamic relationship between two conflicting pressures within the Russian economy: the rising demand for meat products and the preference for feed grain self-sufficiency. The fluctuations in meat production were due not to a lack of demand (as evidenced by the now infamous Russian meat queues), but more to a reliance on domestic feed grain production, rather than imports, to sustain meat production. These conflicting pressures imply that there is still scope for expansion in the Russian livestock sector, but that this expansion may continue to be erratic as long as barley imports are considered to be a last resort alternative to production shortfalls rather than as a permanent policy tool for expanding meat production. Certainly, Canadian barley exporters cannot rely on Russia being a future major market unless recent political reforms in

Russia lead to policy changes that emphasize the role of barley and feed grain imports in expanding the livestock sector. If such were to be the case, then Canadian exporters could be more confident in their marketing efforts to the Soviet Union. The significant price variable indicates that Russian officials do respond to price signals which implies that price competition with other barley exporters may be one way to ensure Canada's future market participation in Russia.

Of course, the dramatic political economic events in the USSR since August, 1991 -- after this empiricial work was completed -- underscore the fraility of economic analyses and econometric modelling whenever radical change and large shocks occur. Canadian barley export policy, so far as the USSR is concerned, will have to be even more flexible in the face of great uncertainty in the Soviet market. In the short run, given the dislocation and food shortages in the Soviet economy coupled with credit help from Canada, Canadian barley exports to the USSR are likely to expand. For the longer run, however, the USSR may finally be embarking on the changes which might see it becoming increasingly self-sufficient in grains. Only time will tell.

The analysis of Japan's barley import demand revealed that national income and the Canadian dollar - Japanese yen exchange rate are two main determinants of Japanese barley import demand. Care must be taken to maintain Canada's favored position in the Japanese barley import market, since Japan lacks the land base from which to attempt barley self-sufficiency, at least on the basis of economic efficiency. Given the importance of Japan as a market for Canadian barley and Japan's policy of import source diversification, it is unfortunate that investigation into relative barley price relationships was inconclusive so that no inferences can be made on the subject of Canada's barley export price policy in Japan.

Colombia's barley import demand was found to be influenced quite strongly by finance related variables such as the real U.S. dollar - Colombian peso exchange rate, the level of real foreign exchange reserves and the relative price of barley imports to coffee exports. The analysis also revealed domestic barley production to be a determinant of barley imports. The dominance of financial variables in Colombia's import demand function was expected because the earlier cross-sectional analysis of developing countries identified the importance of such factors in cereal import demand. The implication of these results for barley exporters is that import growth in Colombia, and LDCs in general, can only be expected to occur if financial constraints are reduced. These financial constraints can be reduced through the effort of exporters by such methods as foreign aid, credit arrangements, debt forgiveness, and providing LDCs with easy trading access to developed country markets to allow LDCs the means of economic development through export earnings. The barley import demand analysis for Colombia also revealed that all of the calculated import demand elasticities fall within the inelastic range. This inelastic response of Colombian barley imports to financial and domestic barley production forces implies that barley is considered to be a relatively important import commodity in Colombia since changes in demand determinants cause little reaction in the level of imports. This inelastic response can also be attributed to the end use of barley imports being beer production in Colombia, because barley has few if any substitutes in this use.

For China, import demand analysis was conducted only on total barley imports. The results of this analysis revealed that barley import demand in China is dependent on such factors as the price of barley imports, the price of wheat imports, the number of pigs, and domestic barley production. The results indicate that wheat imports act as a substitute for barley imports, probably due to financial constraints. The implications for exporters is that export price policy in the Chinese market should be a primary concern, and that efforts to extend credit and/or foster economic development in China, thereby increasing China's ability to finance barley imports, could result in China becoming one of the largest markets of the future for barley imports. This future potential of the Chinese barley market is also indicated by the significant livestock variable, which implies that barley is used as a feed grain in China and that as incomes in that country rise as a result of economic development, the demand for meat will also rise resulting in the need for expanded barley imports. Another feature of the barley import demand analysis was the finding that political instability in China has, in the past, caused major interruptions in barley imports. This feature of China's import demand implies that exporters should consider China to be an unstable import market as long as the potential for major political unrest remains a possibility.

One purpose of this summary chapter is to present and discuss the elasticities calculated from the import demand for total barley in all four of the study countries. Table 9.1 contains these elasticities. The purpose of presenting this comparison of elasticities is to identify relative responses to demand determinants between the countries. Only the elasticities for the total barley regressions are presented, and these are for only three variables, real own price of barley imports, domestic barley production and the real exchange rate. There are not enough similar variables in the Canadian barley analyses for comparison between countries.

Table 9.1: A Comparison of Elasticities from the Total Barley Import Demand Equations of the Time Series Analyses[1]

Variable	USSR	Japan	Colombia	China
Real Own Price	-1.62		-0.66	-3.03
Real Exchange Rate		-0.65	-0.13	
Barley Production	-6.26		-0.85	-1.24

[1]A blank space means the variable is not in that country's equation.

The own price elasticities reveal that China's barley imports show the most elastic response to own price followed by the USSR and then Colombia. Colombia has the only price elasticity less than 1.0 and so displays the only inelastic import response to price changes. It is not surprising that Colombia's price elasticity is inelastic because Colombia uses barley imports for beer production (a process with few barley substitutes) while Russia and China use barley more as a feed grain for meat production (a process with several barley substitutes). China's price elasticity is the most elastic due perhaps to the fact that China relies more on substitute feed grains such as maize and sorghum than does the USSR. All three countries display the negative price responses expected on theoretical grounds.

Only two countries, Japan and Colombia, had meaningful elasticity estimates for exchange rate variables. Both countries have elasticities of barley import demand with respect to exchange rates in the inelastic range with Colombia's being the more inelastic. Colombia's relatively more inelastic import response to changes in the exchange rate may again be a reflection of Colombia's relatively larger reliance on barley imports due to fewer available substitutes in the end use production process. The negative values on these elasticities mean that as the domestic currency falls in value relative to the dollar (that is, the value of the exchange rate variable increases), imports become relatively more expensive and are therefore reduced.

The third and final set of barley import demand elasticities in Table 9.1 relate to domestic barley production. These elasticities reveal that the USSR displays the most elastic import response to domestic barley production changes and Colombia displays the most inelastic. The large dimension of the Russian production elasticity reflects that country's relatively stronger reliance on domestic production and self-sufficiency policy goals. The inelastic response of Colombia's barley imports with respect to production is an indication of Colombia's reliance on imports as an important source of barley.

In conclusion, then, the elasticities presented in Table 9.1 reveal the relative diversity of import demand responses between countries and serve to illustrate the effect that diverse policy goals and end use of imports can have on a country's relative barley import response to changes in economic conditions. The time series analyses of the four countries presented in Chapters 5 through 8 also revealed that country specific characteristics, policies and economic climates have a profound effect on the import demand conditions of an individual country which underlines the need to analyze import demand on an individual country basis.

Finally, our empirical analysis in this study lends strong support to Mellor's contention (1988) that the fortunes of the developed and the developing nations are closely intertwined in the world food economy. The pace at which poor nations can develop, both through increasing income levels and improving income distribution, significantly influences their cereal imports and, concomitantly, cereal exports from rich nations such as Canada. A successful conclusion to the Uruguay Round negotiations of the General Agreement of Tariffs and Trade and efforts to improve the economic situation of developing countries will benefit the Canadian grain producing and exporting sector.

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11. List of Publications Arising from the Project to February 1992

Sudol, Maxine. 1990. "An Economic Analysis of Canada's Barley Export Markets." M.Sc. Thesis, Department of Rural Economy, University of Alberta, Edmonton, 132 pp.

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Veeman, T.S., M. Sudol, M.M. Veeman, and X.Y. Dong. 1991. "Cereal Import Demand in Developing Countries." Contributed paper selected for and presented at the XXI International Conference of Agricultural Economists, Tokyo, Japan, 11 pp. (To be published in M. Bellamy and B. Greenshields (eds.), Proceedings Volume of Contributed Papers, Gower Publishing Company for the International Association of Agricultural Economists, forthcoming).

12. Appendix A

1) LDC Countries Included in the 74 Country Sample for the Cross-Sectional Analysis in Chapter 4. Listed in order of increasing GNP:

1. Ethiopia
2. Burkino Faso
3. Nepal
4. Bangladesh
5. Malawi
6. Zaire
7. Mali
8. Madagascar
9. Uganda
10. Burundi
11. Tanzania
12. Togo
13. Niger
14. Benin
15. Somalia
16. Central African Republic
17. Rwanda
18. China
19. Kenya
20. Zambia
21. Sierra Leone
22. Sudan
23. Haiti
24. Pakistan
25. Lesotho
26. Ghana
27. Sri Lanka
28. Mauritania
29. Senegal
30. Liberia
31. Yemen PDR
32. Indonesia
33. Yemen AR
34. Philippines
35. Morocco
36. Bolivia
37. Zimbabwe
38. Nigeria
39. Dominican Republic
40. Cote D'Ivoire
41. Honduras
42. Egypt
43. Nicaragua
44. Thailand
45. El Salvador
46. Botswana
47. Jamaica
48. Cameroon
49. Guatemala
50. Congo
51. Paraguay
52. Peru
53. Turkey
54. Tunisia
55. Ecuador
56. Muaritius
57. Colombia
58. Chile
59. Costa Rica
60. Jordan
61. Syria
62. Brazil
63. Malaysia
64. Mexico
65. Uruguay
66. Panama
67. Korea
68. Algeria
69. Venezuela
70. Gabon
71. Oman
72. Trinidad and Tobago
73. Israel
74. Singapore

2) The 23 Country Sample Used in the Income Distribution Analysis of Chapter 4.

Low Income	Middle Income	High Income
Bangladesh	Philippines	Malaysia
Tanzania	Egypt	Mexico
India	Cote D'Ivoire	Brazil
Kenya	El Salvador	Panama
Zambia	Turkey	Korea
Sri Lanka	Chile	Venezuela
Indonesia	Peru	Trinidad and Tobago
	Mauritius	
	Costa Rica	

13. Appendix B

Table B.1 contains the results of collinearity testing done on several selected variables from the cross-sectional analysis in Chapter 4.

Table B.1: Results of the Collinearity Test on Six Selected Variables

Condition Indexes	Variance Proportions						
	Const	CP	AID	URB	GNP	LDBT	LRES
1.0	0.143	0.0	0.0	0.0	0.0	0.0	0.0
25.8	0.045	0.0	0.847	0.0	0.0	0.0	0.0
88.5	0.423	0.0	0.0	0.596	0.0	0.0	0.0
323.5	0.339	0.819	0.0	0.0	0.0	0.0	0.0
748.4	0.0	0.115	0.024	0.141	0.0	0.0	0.348
1199.2	0.020	0.065	0.0	0.252	0.0	0.436	0.0
5964.1	0.026	0.0	0.114	0.0	0.998	0.564	0.648

14. Appendix C

This appendix contains a description of some of the econometric tests performed on the cross-sectional cereal import demand analysis and the four time series barley import demand analyses.

The first step in the import demand analyses is to check each data set, prior to model estimation, for the presence of potentially destructive collinearity. Collinearity testing in all cases follows the procedures suggested by Belsley, Kuh and Welsch (1980), in which the presence of potentially destructive collinearity is identified by the combination of two conditions: singular values greater than 30 (which identifies how many linear combinations are present), and variance decomposition proportions greater than 0.5 for two or more variable coefficients (which identifies which pair(s) of variables may have a collinearity problem).

The model regression itself, in addition to the presentation of the adjusted R^2 and t-statistics as an indication of the significance of the regression and individual coefficients respectively, will then be tested for appropriate functional form and for the presence of heteroskedasticity and autocorrelation.

The first econometric test to be run on a given regression is the test for functional form. The basic functional form of all the regressions is linear unless this test indicates otherwise. The functional form test consists of a likelihood ratio test using the log of the likelihood function derived from a Box-Cox transformation of the regression. The unrestricted likelihood function is obtained from the Box-Cox regression which allows lambda (λ) to be any value. The restricted likelihood function is obtained from the Box-Cox regression which restricts $\lambda = 1$ (linear functional form) or $\lambda = 0$ (linear-log, log-linear or log-log functional forms). Only linear and log forms are considered, and all of the independent variables have the same lambda value. The critical value is determined from the chi-square distribution with the degrees of freedom equal to the number of variables in the regression excluding the constant. In the text, this test is called the Box-Cox test and appears along with a statement as to which functional form is found to be most appropriate. The relevant lambda restriction and calculated χ^2value appear in brackets.

The second econometric test performed on a given regression is for the presence of heteroskedasticity. The Breusch-Pagan test is the method chosen in this report to test for heteroskedasticity. The mechanics of the test are outlined in Johnson, Johnson and Buse (1987, p.304). The computed test statistic has a chi-square distribution. The critical value is taken at the 0.05 level with degrees of freedom equal to the number of independent variables excluding the constant term. The result of the Breusch-Pagan test are presented in the text by stating whether heteroskedasticity is present or not followed by the computed test statistic in brackets. If heteroskedasticity is found to be present in the regression results, the equation is re-estimated using a heteroskedastic consistent matrix.

A third test performed on the regression is the Durbin-Watson test for autocorrelation. This test is used as an indication of first order positive or negative autocorrelation. The mechanics of the test are outlined in Johnson, Johnson and Buse (pp.311-313), and the critical *d* values are taken from tables at the 0.05 level. Since with the Durbin-Watson test it is possible to have an inconclusive test result, a secondary test for such cases will be employed. This secondary test consists of obtaining a sixth order partial autocorrelation plot. A significant level of autocorrelation exists only if one or more of the rho (ρ)values calculated from the partial autocorrelation plot exceeds the critical ρ value for significant levels of autocorrelation. This critical rho value is determined by using the formula $\pm \frac{2}{\sqrt{T}}$ as suggested by Judge *et al* (1988, p.685). The value of the Durbin-Watson test statistic will be presented in the text in brackets along with a statement as to whether the test accepts or rejects autocorrelation or is inconclusive. In the case of inconclusive results, the text will then state whether the partial autocorrelation plot indicates the presence of a significant level of autocorrelation or not. The calculated ρ values from the plot will not be listed.

The final test to be discussed here is the F test. The structure of this test can be found in Kennedy (1985, p.63). This test is used in this report to test the effect on a regression of adding (or deleting) variables, usually slope and intercept dummy variables. The calculated F statistics are not presented in the report text; only the outcome of the test is reported (that is, whether the variables significantly affect the regression results).