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AN ECONOMIC ANALYSIS OF CANADA'S BARLEY EXPORT MARKETS

by

MAXINE SUDOL

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled AN ECONOMIC ANALYSIS OF CANADA'S BARLEY EXPORT MARKETS submitted by MAXINE SUDOL in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in AGRICULTURAL ECONOMICS.

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ABSTRACT

The focus of this thesis is the economic characteristics of Canada's barley export market. Descriptive statistics on the international barley market reveal the changing structure of this market. Canada has recently 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 have been expansionary markets while developed countries have imported a decreasing share of Canada's barley exports.

An analysis of the cereal import demand in LDCs reveals that cereal imports in this increasingly important market segment are affected by factors such as financial constraints and structural features of economic development. In addition, the analysis reveals that there are differential responses to these demand determinants based on geographical location.

The main analysis of this thesis consists of time series estimations of barley import demand in four Canadian export markets: Russia, Japan, Colombia and China. The results of estimating Russia's barley import demand reveal 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 Russia's barley import decisions, implying financial constraints are an important aspect of the Russian market.

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

The analysis of Colombia's barley import demand reveals that barley imports are influenced by finance related variables such as barley import price and foreign exchange reserves. Colombia, being a developing country, faces financial constraints that influence import decisions. For China, another developing country, barley imports are affected by the

own price of barley imports and by the cross price of wheat imports, a substitute for barley imports. Domestic barley and hog production also influence China's barley imports.

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Chapter 1

INTRODUCTION

The topic of research in this thesis is the economic characteristics of Canada's barley export market. For several reasons, analysis of Canadian barley exports can be justified. Barley exports are an important outlet for Canada's domestic barley production, accounting for one third or more of a given year's crop distribution. 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 so as to be prepared to take advantage of any export opportunities that may occur.

There are two main objectives to this analysis of Canada's barley markets. The first objective is to obtain a better understanding of Canada's position in the overall international barley trade market with special emphasis on the role of developing country markets as outlets for barley and cereal exports. The second objective is to focus specifically on individual Canadian barley markets and to identify the determinants of barley import demand in those countries.

To accomplish the first objective, descriptive statistics relevant to the international feed grain and barley markets are presented in Chapter 2 of this thesis. These statistics provide background information using average market share and volume data of feed grain and barley trade for the past twenty-four years, with sub-period breakdowns. In particular, the sub-period breakdowns help identify changes in the market share structure both on the import side and the export side of these markets. The statistics are arranged into three kinds of tables. One kind of table contains the market share data of the major feed grain and barley exporters. These exporter data are used to identify the relative importance of the exporters in the world feed grain and barley markets. Another kind of table contains the market share data of the major importing regions. These data reveal which import market segments have been relatively expansionary and which have been contractionary. The final kind of table presents exporter profile data which consist of an individual exporter's relative market share in each of the five 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.

Following the chapter of descriptive statistics is a chapter containing a cross-sectional analysis of the import demand for cereals in developing countries. 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 what structural differences, if any, influence cereal import demand across countries.

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. Also, 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 will be presented as a means of gaining some insight as to the validity of aggregating cereals in import demand analysis.

To accomplish the second major objective of this thesis, namely a more detailed understanding of Canada's international barley markets, the analyses in the remainder of the thesis focus on identifying the determinants of barley import demand in four selected importing countries. Two of the countries, Russia and Japan, are chosen for analysis because of being Canada's two largest markets with 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. This general equation and the basic analytical framework of the time series analyses are discussed in Chapter 4 of this thesis. The actual analyses are then presented in Chapters 5 to 8 for Russia, 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 thesis presents a summary of the conclusions from the various chapters and analyses. In addition, the elasticities from the four time series analyses will be compared and discussed. The final purpose of this summary chapter is to discuss the implications of the various conclusions for Canada's future barley trade.

Chapter 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 chapter is organized into two sections of statistics. The first section covers the aggregate feed grain market and includes a table in which total feed grain exports are decomposed into the component grains to illustrate the relative importance of each grain in world exports. The second section focuses on the barley market. The component grains in the aggregate section include barley, corn, rye, oats,and a collective category of 'other' feed grains (which includes sorghum, millet, buckwheat and canary seed). The study covers a twenty-four year period from 1962 until 1985. The presented statistics were compiled by Xiao Yuan Dong (1987) from data contained in a USDA report by Mackie, Hiemstra and Sayre (1987).

Within the tables, the statistics are arranged into three sub-periods, 1962-72, 1973-81 and 1982-85, as well as the entire study period of 1962-85. The main body of data is presented in the form of average market shares (accompanied by trend and descriptive statistics) which reveal the relative position of a participant in the market, the degree of trade concentration and involvement. There are also tables containing quantity data which are included for the purpose of identifying whether a particular market is growing, remaining constant or contracting.

There are three types of tables presented in this chapter. One type of table presents the export data of the major grain exporting countries and a collective category of all other exporters. These export market data indicate the relative importance and involvement of the exporters in the coarse grain and barley markets. Another type of table presents grain trade data from the import market perspective. These tables reveal the relative importance of a particular importing region as a market for feed grain exports. The third type of table contains exporter profiles of the barley market which describe how a single exporter's total exports have been allocated among the importing regions. The profiles are useful in identifying growing or contracting markets for a particular exporter's barley exports.

The major exporters in the feed grain market are Canada, the U.S.A., Argentina, France, and Australia. A collective category called 'others' contains the remaining, less important coarse grain 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 (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; and the poorest LDCs which includes South Asia, East Africa, and West Africa. A precise list of countries included in each region can be found in Mackie, Hiemstra and Sayre (1987).

2.2 The World Feed Grain Market

Share of Individual Grains

Table 2.1 contains the export quantity data of the individual coarse grains that make up the world feed grain market. The data reveal that exports of three grains, barley, corn and others, have all increased steadily in volume over the 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. The data also reveal that 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, over the entire study period.

The dominance of corn in the world feed grain market is also revealed in Table 2.2 which contains the average market share data of the component grains. Over the twenty-four years between 1962 and 1985, corn has accounted for an average of 65% of all feed grain traded. Barley is 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. Over the sub-periods, the market shares of corn, barley and other feed grains have all remained fairly stable and constant. Rye and oats, both minor grains in the export market, have experienced declining market shares over

Table 2.1: World Feed Grain Exports by Component Grain, Average Quantity and Variability, 1962-1985 and Sub-Periods (1,000 MT)

Feed Grain:	Barley	Corn	Rye	Oats	Others
Time Period		1962 - 1972			
Mean	8,084.8	26,399.0	855.4	1,456.1	5,609.0
S.D.[1]	2,513.4	5,268.5	528.5	313.0	1,616.4
Minimum	5,456.6	19,629.0	446.1	1,076.2	3,653.2
Maximum	13,997.0	37,861.0	2,160.0	2,177.3	8,045.8
C.V.[2]	0.311	0.200	0.618	0.215	0.288
Time Period		1973 - 1981			
Mean	14,043.0	62,623.0	976.2	1,387.3	11,453.0
S.D.	2,095.0	13,043.0	459.1	205.6	1,676.2
Minimum	12,122.0	46,710.0	493.0	1,009.1	8,390.1
Maximum	18,689.0	80,284.0	1,984.6	1,696.5	14,699.0
C.V.	0.149	0.208	0.470	0.148	0.146
Time Period		1982 - 1985			
Mean	20,236.0	67,140.0	930.0	1,246.4	13,260.0
S.D.	2,434.5	1,424.3	205.7	264.3	1,170.8
Minimum	17,729.0	65,475.0	735.7	947.2	11,988.0
Maximum	23,005.0	68,612.0	1,194.3	1,504.7	14,647.0
C.V.	0.120	0.021	0.221	0.212	0.088
Time Period		1962 - 1985			
Mean	12,344.0	46,773.0	913.2	1,395.4	9,075.8
S.D.	5,067.8	20,988.0	451.1	268.5	3,646.5
Minimum	5,456.6	19,629.0	446.1	947.2	3,653.2
Maximum	23,005.0	80,284.0	2,160.0	2,177.3	14,699.0
C.V.	0.410	0.448	0.494	0.192	0.402
Trend Results:		1962-1985			
T.C.[3]	0.058	0.066	0.004	-0.005	0.059
t-statistic	15.700	15.100	0.312	-0.854	10.577
R^2	0.920	0.910	0.004	0.032	0.836
C.G.R.[4]	0.060	0.068	0.004	-0.005	0.061

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient: b in ln(Variable) = a + b(Time)
[4]Compound growth rate: Antilog(b) − 1

Table 2.2: World Feed Grain Exports by Grain Type, Average Market Shares and Variability, 1962-1985 and Sub-Periods (Percent Shares)

Feed Grain:	Barley	Corn	Rye	Oats	Others
Time Period		1962 - 1972			
Mean	18.8	62.3	2.2	3.5	13.2
S.D.[1]	2.5	3.0	1.7	0.6	2.8
Minimum	15.4	58.3	1.1	2.6	10.2
Maximum	22.9	68.6	6.4	4.4	18.8
C.V.[2]	0.134	0.048	0.798	0.159	0.215
Time Period		1973 - 1981			
Mean	15.6	68.9	1.1	1.6	12.8
S.D.	1.1	2.6	6.9	0.4	1.4
Minimum	14.0	65.2	0.6	0.9	10.8
Maximum	17.1	72.9	2.8	2.4	14.9
C.V.	0.063	0.037	6.120	0.264	0.109
Time Period		1982 - 1985			
Mean	19.7	65.3	0.9	1.2	12.9
S.D.	2.0	2.4	0.2	0.3	0.9
Minimum	17.8	62.8	0.7	0.9	12.0
Maximum	21.7	68.3	1.1	1.4	14.1
C.V.	0.104	0.036	0.195	0.207	0.069
Time Period		1962 - 1985			
Mean	17.8	65.3	1.6	2.4	13.0
S.D.	2.6	4.0	1.4	1.1	2.1
Minimum	14.0	58.3	0.6	0.9	10.2
Maximum	22.9	72.9	6.4	4.4	18.8
C.V.	0.145	0.062	0.859	0.468	0.160
Trend Results:		1962-1985			
T.C.[3]	8.36	-2.54	-3.43	6.27	1.71
t-statistic	6.12	-3.68	-0.83	1.33	0.79
R^2	0.90	0.77	0.15	0.31	0.15
C.G.R.[4]	8.72	-2.51	-3.38	6.47	1.73

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient.
[4]Compound growth rate.

the entire study period.

Exporters' Shares

Table 2.3 contains the average market share data of the major feed grain exporters. For the overall study period, the United States was by far the dominant exporter in the world market with an average share of over half of all exports in the study period. Argentina and France together accounted for about one fifth of exports. Canada exported the fourth largest volume of feed grains in the study period 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.

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.

Importers' Shares

The market share data contained in Table 2.4 serve to reveal the import structure of the international feed grain market. In this table, the sub-period breakdowns are of particular interest because the data reveal that there has been a considerable change in the import market shares of the major importing regions over the study period. The market segment made up of developed, high-income countries went from an import share of 80% in the 1960s down to an average share of 45% in the 1980s, having a compound growth rate of -1.6 over the study period. This decline in the import share of the developed countries is due to the fact that their livestock sectors, to which imported feed grains go, are either operating near market capacity (in other words, not expanding appreciably) and/or domestic feed grain production in those countries has grown to fulfill the feed grain requirements.

The declining import share of developed countries was offset mainly by an increasing import market share in the richer LDCs and to a lesser degree by an increasing import share

Table 2.3: World Feed Grain Exports of the Major Exporters, Average Market Shares and Variability, 1962-1985 and Sub-Periods (Percent Shares)

Exporting Regions:	Argentina	Australia	Canada	France	U.S.A.	Others
Time Period			1962 - 1972			
Mean	11.6	2.5	4.0	9.4	44.7	27.7
S.D.[1]	2.7	1.5	2.5	3.9	5.6	4.9
Minimum	7.1	0.8	1.8	2.8	35.0	21.7
Maximum	16.2	5.8	8.2	14.0	56.7	34.3
C.V.[2]	0.228	0.597	0.619	0.416	0.125	0.175
Time Period			1973 - 1981			
Mean	9.8	3.0	4.5	7.7	59.3	15.7
S.D.	2.6	0.9	0.6	2.3	4.4	2.9
Minimum	5.3	1.7	3.5	4.2	52.2	11.6
Maximum	12.9	4.2	5.6	11.7	67.0	21.3
C.V.	0.266	0.307	0.136	0.304	0.074	0.18
Time Period			1982 - 1985			
Mean	10.4	4.4	5.2	8.3	53.8	18.0
S.D.	1.1	2.6	1.9	0.9	2.6	2.3
Minimum	9.6	1.2	2.6	6.9	50.1	16.2
Maximum	12.0	6.9	6.9	9.0	56.0	21.3
C.V.	0.104	0.598	0.373	0.114	0.048	0.127
Time Period			1962 - 1985			
Mean	10.7	3.0	4.4	8.6	51.7	21.6
S.D.	2.5	1.6	1.9	3.1	8.3	6.9
Minimum	5.3	0.8	1.8	2.8	35.0	11.6
Maximum	16.2	6.9	8.2	14.0	67.0	34.3
C.V.	0.234	0.534	0.428	0.356	0.160	0.321
Trend Results:			1962-1985			
T.C.[3]	7.46	17.14	-7.91	6.08	-4.98	8.47
t-statistic	0.993	1.09	-0.92	3.44	-5.76	3.99
R^2	0.20	0.23	0.172	0.75	0.89	0.80
C.G.R.[4]	7.74	18.69	-7.61	6.27	-4.85	8.84

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient.
[4]Compound growth rate.

Table 2.4: World Feed Grain Imports of the Importing Regions, Average Market Shares and Variability, 1962-1985 and Sub-Periods (Percent Shares)

Importing Regions:	Developed	East Europe	China	Richer LDCs	Poorest LDCs
Time Period		1962 - 1972			
Mean	79.8	8.7	0.4	9.5	1.7
S.D.[1]	5.4	4.7	0.8	2.2	1.7
Minimum	64.7	4.9	0.0	6.7	0.6
Maximum	84.0	21.7	2.2	12.9	5.4
C.V.[2]	0.067	0.534	2.22	0.229	0.988
Time Period		1973 - 1981			
Mean	57.1	21.8	0.0	19.8	1.3
S.D.	9.3	5.9	0.0	5.2	0.6
Minimum	42.8	13.4	0.0	12.8	0.5
Maximum	67.7	29.6	0.0	27.5	2.4
C.V.	0.162	0.271	0.0	0.260	0.496
Time Period		1982 - 1985			
Mean	45.0	19.4	0.0	34.5	1.2
S.D.	3.2	4.3	0.0	4.4	0.3
Minimum	42.2	13.9	0.0	29.4	0.8
Maximum	48.4	24.1	0.0	38.3	1.5
C.V.	0.071	0.222	0.0	0.127	0.250
Time Period		1962 - 1985			
Mean	65.5	15.4	0.2	17.5	1.4
S.D.	15.6	8.0	0.6	9.8	1.2
Minimum	42.2	4.9	0.0	6.7	0.5
Maximum	84.0	29.6	2.2	38.3	5.4
C.V.	0.237	0.520	3.353	0.562	0.826
Trend Results:		1962-1985			
T.C.[3]	-1.64	-5.49	0.0	6.09	3.08
t-statistic	-1.14	-0.85	0.0	2.07	0.59
R^2	0.25	0.15	0.0	0.52	0.08
C.G.R.[4]	-1.63	-5.34	0.0	6.28	3.13

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient.
[4]Compound growth rate.

in Eastern European countries. The import market share of the richer LDCs more than tripled from an average of 9.5% in the 1960s to an average of 34.5% in the 1980s with a compound growth rate of +6.3 over the twenty-four year study period. This dramatic increase in feed grain imports of the richer developing countries is due mainly to rising per capita incomes causing an increase in the demand for meat in these countries which has created and fueled an expanding livestock sector. Eastern European countries increased their share of feed grain imports in the 1970s but in recent trade this share has fallen to 19%.

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 were too low to support a livestock sector; food aid and domestic grain production were used instead of imports as major food sources; and foreign exchange restrictions limited the ability of these countries to import much grain. Table 2.4 also reveals that China ceased to import significant amounts of coarse grains after the 1960s. This import decline was probably due to the growth of China's own domestic feed grain sector and a low level of meat production.

2.3 The World Barley Market

<u>Exporters' Market Shares</u>

Tables 2.5 and 2.6 contain the barley exporters' average export quantity and average market share data respectively. The quantity data reveal that all of the major exporters have increased the volume of their barley exports which means that the barley market as a whole has been expanding. The sub-period data reveal that by the early 1980s, Canada had become the largest exporter of barley by volume with just under 4.5 million metric tonnes exported between 1982 and 1985. But, for the overall study period, France had the largest average volume of barley exports due mainly to France's dominance of the market in the 1960s.

The market share data in Table 2.6 are useful in determining the relative market performance of the various exporters. The sub-period breakdown reveals that both Canada and Australia have consistently increased their market shares of total barley trade over the

Table 2.5: World Barley Exports of the Major Exporters, Average Quantity and Variability, 1982-1985 and Sub-Periods (1000 MT)

Exporting Regions:	Australia	Canada	France	U.S.A.	Others
Time Period		1962 - 1972			
Mean	625.1	1,529.3	[illegible]	1,144.0	2,359.1
S.D.[1]	531.9	1,510.2	837.9	553.2	471.3
Minimum	129.2	304.7	945.9	247.0	1,751.9
Maximum	1,880.4	4,565.2	3,738.3	2,185.6	3,519.2
C.V.[2]	0.851	0.988	0.345	0.484	0.199
Time Period		1973 - 1981			
Mean	1,764.6	3,310.8	3,766.9	1,335.0	3,865.3
S.D.	634.0	642.2	897.7	[illegible]	1,260.7
Minimum	795.2	2,507.3	2,354.9	782.6	2,223.3
Maximum	2,653.5	4,572.7	4,922.8	1,721.0	6,035.9
C.V.	0.359	0.194	0.238	0.244	0.326
Time Period		1982 - 1985			
Mean	3,370.9	4,469.2	4,114.2	1,690.4	6,588.0
S.D.	2,184.8	1,591.3	461.0	635.3	1,251.5
Minimum	741.8	2,310.9	3,652.4	991.7	5,204.9
Maximum	5,718.5	5,752.1	4,544.5	2,521.0	7,984.7
C.V.	0.648	0.356	0.112	0.375	0.190
Time Period		1962 - 1985			
Mean	1,510.5	2,687.3	3,210.9	1,306.7	3,628.7
S.D.	1,374.6	1,676.6	1,081.6	511.2	1,780.3
Minimum	129.2	304.7	945.9	247.0	1,751.9
Maximum	5,718.5	5,752.1	4,922.8	2,521.0	7,984.7
C.V.	0.910	0.623	0.337	0.391	0.491
Trend Results:		1962-1985			
T.C.[3]	0.112	0.102	0.045	0.014	0.054
t-statistic	6.524	6.715	6.005	0.938	7.472
R^2	0.659	0.672	0.621	0.039	0.717
C.G.R.[4]	0.118	0.108	0.046	0.014	0.055

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient.
[4]Compound growth rate.

Table 2.6: World Barley Exports of the Major Exporters, Average Market Shares and Variability, 1962-1985 and Sub-Periods (Percent Shares)

Exporting Regions:	Australia	Canada	France	U.S.A.	Others
Time Period		1962 - 1972			
Mean	6.9	16.1	30.6	15.2	31.2
S.D.[1]	3.6	11.0	9.4	8.9	0.8
Minimum	2.0	5.6	14.3	3.5	16.3
Maximum	13.4	35.3	45.8	33.1	45.5
C.V.[2]	0.522	0.683	0.307	0.585	0.030
Time Period		1973 - 1981			
Mean	12.7	23.6	26.9	9.7	27.2
S.D.	4.6	3.0	5.8	2.9	6.3
Minimum	6.6	18.1	19.1	5.3	18.3
Maximum	17.6	27.0	35.6	13.8	37.1
C.V.	0.362	0.126	0.215	0.294	0.231
Time Period		1982 - 1985			
Mean	16.0	22.9	20.4	8.4	32.5
S.D.	9.5	10.1	0.9	2.7	3.9
Minimum	4.2	10.8	19.5	4.6	27.8
Maximum	26.6	32.5	21.4	11.0	37.2
C.V.	0.593	0.442	0.043	0.321	0.120
Time Period		1962 - 1985			
Mean	10.6	20.0	27.5	12.0	29.9
S.D.	6.1	9.1	7.9	6.9	7.5
Minimum	2.0	5.6	14.3	3.5	16.3
Maximum	26.6	35.3	45.8	33.1	45.5
C.V.	0.575	0.455	0.287	0.575	0.251
Trend Results:		1962-1985			
T.C.[3]	5.4	4.4	-1.3	-4.4	-0.4
t-statistic	3.513	3.350	-1.569	-3.367	-0.508
R^2	0.359	0.338	0.101	0.340	0.012
C.G.R.[4]	5.5	4.5	-1.3	-4.3	-0.4

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient.
[4]Compound growth rate.

study period. The compound growth rate statistics at the bottom of Table 2.6 reveal that Canada and Australia had positive market share growth rates over the study period, while France and the U.S.A. both experienced negative market share growths.

The table also reveals that in the early 1980s, Canada exported the largest volume of barley with a 23% share of world barley exports. For the overall study period, Canada accounted for an average 20% or one fifth of barley exports. France, once the largest trader by volume, became second in importance to Canada in recent trading, falling from a market share of 31% in the 1960s to a share of only 20% in the early 1980s. 'Other' exporters consistently accounted for roughly one third of barley exports in the sub-periods and for the entire study period.

Importers' Market Shares

Table 2.7 contains the market share data for the major barley importing regions. The barley market on the import side has also 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 study 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.

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

The sub-period data in Table 2.7 reveal the dramatic change the barley import market has undergone. Richer LDCs became the largest market for barley exports and have been a growing market segment. The share of barley imports to developed countries declined and these countries have been a contracting market segment as indicated by the negative compound growth rate. China participated in the barley market to a significant degree only in

Table 2.7: World Barley Imports of the Importing Regions, Average Market Shares and Variability, 1962-1985 and Sub-Periods (Percent Shares)

Importing Regions:	Developed	East Europe	China	Richer LDCs	Poorest LDCs
Time Period		1962 - 1972			
Mean	71.8	16.8	1.3	9.9	0.03
S.D.[1]	9.1	8.9	3.0	2.7	0.02
Minimum	49.9	6.7	0.0	7.0	0.02
Maximum	84.4	39.7	7.4	15.2	0.06
C.V.[2]	0.127	0.529	2.276	0.273	0.667
Time Period		1973 - 1981			
Mean	54.8	27.0	0.0	18.2	0.1
S.D.	8.9	5.1	0.0	5.7	0.1
Minimum	41.0	18.1	0.0	9.4	0.0
Maximum	65.1	32.2	0.0	26.7	0.2
C.V.	0.162	0.187	0.0	0.313	1.163
Time Period		1982 - 1985			
Mean	37.0	19.9	0.0	42.9	0.2
S.D.	8.3	5.6	0.0	8.9	0.3
Minimum	29.6	14.6	0.0	33.3	0.0
Maximum	46.6	27.6	0.0	54.8	0.7
C.V.	0.225	0.279	0.0	0.206	1.364
Time Period		1962 - 1985			
Mean	67.7	14.6	0.0	16.7	1.0
S.D.	16.5	9.2	0.0	9.0	0.3
Minimum	45.0	3.7	0.0	6.3	0.4
Maximum	87.6	28.7	0.0	38.6	1.5
C.V.	0.244	0.630	0.0	0.538	0.330
Trend Results:		1962-1985			
T.C.[3]	-3.5	3.0	4.8	7.4	4.6
t-statistic	-7.830	2.704	2.412	8.594	1.595
R^2	0.736	0.249	0.209	0.771	0.104
C.G.R.[4]	-3.5	3.1	4.9	7.7	4.7

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient.
[4]Compound growth rate.

Table 2.8: The Export Profile of Canadian Barley Exports to the Importing Regions, 1962-1985 and Sub-Periods (Percent Shares)

Importing Regions:	Developed	East Europe	China	Richer LDCs	Poorest LDCs
Time Period		1962 - 1972			
Mean	70.4	4.6	7.5	8.5	0.0
S.D.[1]	16.4	8.6	16.7	9.2	0.0
Minimum	54.9	0.0	0.0	0.5	0.0
Maximum	99.1	29.6	41.4	32.9	0.0
C.V.[2]	0.206	1.870	2.227	1.082	0.0
Time Period		1973 - 1981			
Mean	56.0	31.9	0.0	12.1	0.0
S.D.	14.9	13.1	0.0	6.3	0.0
Minimum	32.1	15.2	0.0	5.0	0.0
Maximum	73.5	59.5	0.0	21.5	0.0
C.V.	0.266	0.411	0.0	0.515	0.0
Time Period		1982 - 1985			
Mean	32.6	35.6	0.0	31.6	0.1
S.D.	6.9	8.5	0.0	9.6	0.3
Minimum	25.6	28.9	0.0	43.1	0.0
Maximum	42.1	47.7	0.0	43.1	0.6
C.V.	0.211	0.238	0.0	0.303	2.140
Time Period		1962 - 1985			
Mean	62.9	20.0	3.4	13.7	0.0
S.D.	22.6	17.6	11.6	11.5	0.1
Minimum	25.6	0.0	0.0	0.5	0.0
Maximum	99.1	59.5	41.4	43.1	0.6
C.V.	0.359	0.880	3.412	0.839	6.000
Trend Results:		1962-1985			
T.C.[3]	-4.3	8.4	0.0	11.1	-4.7
t-statistic	-5.530	1.910	0.0	4.260	-1.560
R^2	0.580	0.140	0.0	0.450	0.100
C.G.R[4]	-4.2	8.8	0.0	11.7	-4.6

[1]Standard deviation.
[2]Coefficient of variation.
[3]Trend coefficient.
[4]Compound growth rate.

Table 2.9: The Export Profiles of the Other Exporters' Barley Exports to the Importing Regions, 1962-1985 and Sub-Periods (Percent Shares)

Importing Regions:		Developed	East Europe	China	Richer LDCs	Poorest LDCs
Exporters:		Time Period:		1962 - 1972		
Australia	Mean	79.6	2.5	2.2	15.7	0.1
	S.D.[1]	12.3	5.7	7.2	10.9	0.1
France	Mean	80.2	14.1	1.7	3.9	0.03
	S.D.	13.0	12.8	4.2	3.2	0.03
U.S.A.	Mean	58.4	14.3	0.0	27.3	0.1
	S.D.	24.3	20.4	0.0	20.2	0.2
				1973 - 1981		
Australia	Mean	52.6	15.8	0.0	31.5	0.1
	S.D.	18.9	14.0	0.0	15.6	0.04
France	Mean	71.2	18.0	0.0	10.8	0.04
	S.D.	13.6	11.7	0.0	9.2	0.1
U.S.A.	Mean	28.0	18.9	0.0	52.9	0.2
	S.D.	16.3	11.0	0.0	9.9	0.5
				1982 - 1985		
Australia	Mean	14.2	7.9	0.0	77.3	0.7
	S.D.	5.7	5.9	0.0	7.8	1.2
France	Mean	59.1	13.4	0.0	27.6	0.01
	S.D.	10.4	12.5	0.0	15.0	0.01
U.S.A.	Mean	25.4	5.8	0.0	68.8	0.0
	S.D.	6.3	2.2	0.0	4.4	0.0
				1962 - 1985		
Australia	Mean	58.6	8.4	1.0	31.9	0.2
	S.D.	27.6	11.2	4.8	25.0	0.5
France	Mean	73.3	15.4	0.8	10.4	0.03
	S.D.	14.6	11.9	2.9	11.6	0.05
U.S.A.	Mean	41.5	14.6	0.0	43.8	0.1
	S.D.	24.6	15.6	0.0	22.0	0.3

[1]Standard deviation.

French barley while exports to Eastern Europe have stagnated around the 15% level. For the U.S.A., Eastern European and developed countries were contracting market segments while richer LDCs were an expanding market segment, accounting for the largest share of recent U.S.A. barley exports at 69%.

Of the four major barley exporters, Australia and the United States had the lowest export concentration in the contracting developed country market and had the largest 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 U.S.A. had a higher concentration of their barley exports in richer LDCs than did Canada. But, Canada had the highest barley export concentration in the East European market which, over the study period, was an expanding market, though growing at a slower rate than the richer developing country market.

2.4 Conclusions

The statistics in this chapter have 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. The statistics also revealed that of the major feed grain exporters, the U.S.A. had the largest average market 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 feed grain market, developed countries have been a contractionary market segment while the richer developing countries have been an expansionary market segment. The poorest developing countries were not 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 developing countries.

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 profile data revealed that while all four barley exporters have 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.

Chapter 3

ANALYSIS OF THE CEREAL IMPORT DEMAND IN LDCs

3.1 Introduction

As part of the background work for this thesis, a cross-sectional analysis of the import demand for cereals in less developed countries (LDCs) is undertaken. The main purpose of this analysis is to gain a general understanding of the determinants of cereal import demand in LDCs, and a secondary purpose is to extend the analysis done by Morrison (1984) in the article "Cereal Imports by Developing Countries, Trends and Determinants". Cereal imports are chosen as the dependent variable in this analysis because too few developing countries import barley to allow for cross-sectional analysis of barley import demand. Instead, a brief section on cereal imports disaggregated into food and feed grains will be presented in order to determine if analyzing cereal imports in aggregate is a valid practice.

Table 3.1 reveals the relevance of studying the cereal import demand of LDCs. In 1970, developing countries accounted for 30% of world cereal imports while developed countries dominated the market with almost 53% of total cereal imports. By 1986 the volume of world cereal trade had doubled and LDCs accounted for 42% of cereal imports while the share imported by developed countries had declined to 33%. Developing countries represent the fastest growing market segment for cereal imports and it is this growth which singles out LDCs as a market segment of special interest for further understanding and analysis.

Another reason for analyzing the cereal import demand of LDCs in cross-section is to extend the analysis done by Morrison. In his paper, Morrison separated his explanatory variables into two categories, long and short term factors. Of the long term factors, GNP per capita and population density on arable land were found to be the best explanators of cereal imports while the only short run factor found to be significant was per capita food aid. There are basically three items of omission in Morrisons's paper that will be included in the analysis presented in this chapter. The first item is Morrison's failure to report or even speculate on the role of collinearity in the regression results. The second item is that Morrison did not incorporate intercept or slope dummy variables into his model to account for possible

Table 3.1: Total Cereal Imports by Socio-Economic Classes, 1000 MT
(Percent Shares in Brackets)

Year	World	LDC	Developed	Centr. Plnnd.
1970	112102	33641 (30.0)	59224 (52.8)	19237 (17.2)
1975	156434	51400 (32.9)	69930 (44.7)	35104 (22.4)
1980	218912	77141 (35.2)	74102 (33.9)	67669 (30.9)
1983	218536	89132 (40.8)	68593 (31.4)	60811 (27.8)
1984	234103	95483 (40.8)	71152 (30.4)	67468 (28.8)
1985	220945	89155 (40.4)	69355 (31.4)	62435 (28.2)
1986	202310	85865 (42.4)	67482 (33.4)	48963 (24.2)

Source: FAO, *Trade Yearbook*

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". The third item of omission in Morrison's analysis is that he failed to enter explanatory variables in alternative forms. For example, several of the variables that were not significant in his regression were measured as percentages rather than as absolute quantities. Morrison did not speculate in his article that the form chosen to measure the variable might be inaccurate and he did not report on exploring other forms of the variables such as per capita quantities. The cross-sectional analysis of cereal import demand presented in this chapter attempts to explore some of the issues outlined above that were omitted in the Morrison paper. In doing so, it is hoped that the determinants of cereal imports in developing countries can be better understood.

3.2 The Model and Variables

The basic demand equation upon which the model for the analysis presented in this chapter is based appears in Equation 1.

1) $CM = f(Y, P_1, P_2, Z)$,

where CM is cereal imports, Y is income, P_1 is own price, P_2 represents cross prices of related goods and Z is a vector of other economic, social and physical determinants. However, since this analysis is cross-sectional, the price variables in Equation 1 can be deleted on the assumption that prices are fixed for the year (Christiansen, 1987, p.5 and Morrison, 1984, p.21). Thus, the Z vector of other import demand determinants takes on a more important role in this cross-sectional analysis than it would in a time series analysis. In order to better organize and explain the variables included in the cereal import demand model, Equation 1 can be re-written as:

2) $CM = f(X_1, X_2, X_3, X_4)$,

where: CM = cereal imports
X_1 = vector of domestic grain supply variables
(CP, FLUC, DENS)
X_2 = vector of development variables
(GNP, rGDP, URB)
X_3 = vector of financial capacity variables
(LRES, AID, LDBT, TDS, X86, EXP, LACN)
X_4 = vector of socio-economic dummy variables.

The variables listed in brackets will be defined in the next three sections. The income variable, Y, from Equation 1 has been included in the variable vector X_2, since income is a level of development variable. The logic behind separating the variables into these four vector categories is as follows: trade can be thought of as a residual activity with import demand being the residual of domestic consumption demand less domestic production which is why domestic grain supply variables comprise one vector; LDCs are recognized as having unique economic features which cause such countries to react to internal and external economic conditions in a manner different to industrialized, rich countries and these unique features are categorized into two vectors, one to account for the level of development of a particular LDC and one to account for a country's ability to finance imports; and the fourth vector contains the previously mentioned dummy variables which are included to account for socio-economic factors across the LDC cross-section. A more detailed description of the individual variables contained in each of the four categories will now be presented.

Domestic Grain Supply Variables

Grain supply variables are an important component of the cereal import demand model because these variables determine the desired level of cereal imports within a country. A basic assumption in this study is that cereal imports are a residual of domestic production shortfall; the less cereal a country is able to produce domestically, the more cereal that country must import to meet demand. The role of grain supply variables in the import demand model is to quantify a country's cereal production capability and therefore establish the country's *desired* level of cereal imports. The development and finance variables then determine a country's *ability* to import cereals.

There are several different aspects to domestic cereal production capability that need to be identified and subsequently quantified by the grain supply variables. One such aspect is that of resource endowment. Simply stated, resource endowment determines a country's physical potential or capacity to produce its cereal requirements and consists of factors such as land, labour and capital. Resource endowments also determine a country's comparative advantage, an economic criterion for establishing the relative efficiency of commodity production and trade between countries. Morrison chose population density on arable land (DENS) as a proxy measure of a country's productive capacity and so this density variable will also be included in this analysis. The expected sign on the coefficient of DENS is positive because as the ratio of population to arable land increases, the ability of a country to produce its cereal requirements decreases which implies that imports must then rise.

An alternative variable to population density is that of actual cereal production (CP), measured as the per capita volume of cereal production lagged one year. Cereal production reflects not only a country's inherent resource endowments, but also factors such as government policy which is another aspect to production capability. Government policies affect cereal production in the sense that policy goals such as equity and security can cause governments to target cereal production increases whether such action is economically efficient or not. The level of cereal production attained by a country in a given year is a reflection of both aspects of production capability, resource endowment and government policy. The expected sign on the coefficient of CP is negative because "for cereals, increased domestic production displaces imports" (Christiansen, 1987, p.5).

Cereal production is also a reflection of a third aspect to the production capability of a country, the impact of exogenous forces. These exogenous forces, such as weather, represent uncontrollable events that impact on a crop in a given year. These impacts are usually short term in effect, although weather conditions such as drought can last several years, and can be devastating in result. "Substantial weather-induced, year-to-year fluctuations in production have caused large variations in the privation of the poor, in prices, and in imports" (Mellor, 1978, p.39). Because of the potential severity of production fluctuations, another variable is added to the set of grain supply variables to specifically measure fluctuation. This variable, FLUC, is defined as the change in current cereal production from that of the previous year (i.e. current production - production lagged one year). The expected sign on this variable is negative because a decrease in production from the previous year (a negative fluctuation) should result in an increase in cereal imports

A final dimension of domestic cereal supply is cereal inventory which is usually measured as carryover stocks of grain. This variable can only be mentioned as a possible explanatory factor in cereal imports because, unfortunately, such carryover stock data are not readily available for LDC's. It is recognized that omission of this potentially important variable might cause misspecification error in the final regression equation.

Development Variables

Development variables attempt to measure structural aspects of developing countries. These structural aspects of an economy indicate the general standard of living of the population which in turn indicates the ability of that population to generate effective demand for cereals. Besides actual population, there are three other aspects to development variables that will be considered in this study, income levels, structural change and income distribution.

Income level variables attempt to measure the features of an economy which endow the population with the ability to demand and purchase basic food staples such as grains and luxury food items such as red meats. One way of measuring this ability, the general level of puchasing power in a country, is national per capita income (GNP). Despite the shortcomings of GNP as a proxy measure for the level of development, GNP is still the most readily available and compatible measure of economic development and so will be used as such in this analysis. A second income-related measure, as calculated and presented by the World Bank, is the growth rate of gross domestic product, rGDP. This growth rate variable will also be used as a potential explanator of cereal import demand.

Tied into GNP is a structural characteristic of development; as a country becomes more industrialized, the income of its population tends to increase. Therefore, the level of industrialization is another feature of an economy which determines the effective demand for cereals. In applied analysis, industrialization is often proxied by urbanization and so in this study, the degree of industrialization in a country will be measured in proxy by the degree of urbanization (URB). The two variables, GNP and percent urbanization, are entered into the regression as respective measures of the income level and the degree of structural change in the developing economy.

The other aspect of development is income distribution. Income distribution is of particular importance for developing countries because it is generally recognized that a significant proportion of the population in many LDCs is too poor to adequately nourish itself. In fact, "in very low income countries, half or more of the population receive inadequate calories...to support a healthy active life" (Mellor, 1978, p.39). Those people at the lower end of the income scale certainly would like to be able to purchase more food but are unable to do so because of income restraints. And so, as pointed out by Yotopoulos (1985, p.466), "the same increase in population would have one effect on the demand for food if it occured among the poor and a different effect among the rich". But income data for the socio-economic groups within a population are not available for most LDCs. Therefore, income distribution can only be mentioned in this thesis as a possible determinant of cereal imports. Income distribution data are too sparse and fragmentary to enter into the regression.

Financial Capacity Variables

Financial capacity variables measure a country's ability to import cereals, its financial constraints. Economic theory indicates that demand is subject to financial constraint but does not specifically state how best to measure that constraint. Since there is no theoretical guidance as to which measure of financial capacity is best, several different variables of financial capacity as identified in the literature will be entered into the regression on a trial and error basis to determine which variable(s) best measure financial constraints to cereal imports in LDCs.

The most obvious variable of financial constraint is the amount of foreign exchange reserves available with which to purchase cereal imports. "If a country [does] not have adequate foreign exchange, an increase in demand could not be translated into increased imports" (Christiansen, 1987, p.11). The variable for foreign exchange reserves (LRES) will enter the regression as U.S. dollars per capita, lagged one year. A lagged value is used to avoid the simultaneity problem described below:

> the use of [current values of] exchange reserves in single equation models of grain imports will tend to overstate the responsiveness of imports to changes in foreign exchange where import levels and reserves are simultaneously determined as part of a policy to eliminate the excess demand for foreign currency at the existing exchange rate (Scobie, 1981, p.65).

Another finance related variable is concessional cereal imports or cereal food aid. In her study, Huddleston (1984, p.30) states that "food aid given on a grant basis reduces the foreign exchange cost of imports to zero". She also found that "food aid reduced the total cost of cereal imports in 1976-78 by about a third for low income countries..." (p.31).

Because food aid saves on the amount of foreign exchange necessary to import desired levels of grains, food aid is classified as a financial capacity variable. The specifics of how the food aid variable (AID) is measured will be discussed in the Data section following.

Foreign exchange and food aid are only two possible measures of financial capacity. Shapouri and Rosen (1987, pp.2-11) suggest that variables such as current account balance, export earnings and government debt might also serve as measures of a country's ability to finance cereal imports. Current account balance (LACN) and government debt (LDBT) are both entered into the regression as per capita values lagged one year. In addition, an alternative measure of debt will be entered into a separate regression as TDS, total debt service on government debt. Export earnings will also have two alternative forms: the value of current merchandise exports (X86) and the annual growth rate of merchandise exports (EXP).

Christiansen (1987, p.5) also identifies some possible finance-related variables. "There are four primary macroeconomic variables that can affect agricultural trade and production: prices, interest rates, the real exchange rate, and national income". And, as suggested by Christiansen and adopted in this analysis, three of these variables, price, interest rate and exchange rate, can be assumed fixed for the year of the cross-sectional analysis and therefore excluded from the regression. National income has already been discussed and will enter the regression as per capita GNP.

Dummy Variables

Intercept dummy variables are included in the model to try to account for any socio-economic differences between the LDCs in the cross-section. Two sets of intercept dummies are included separately in the model: one divides the sample on the basis of GNP level and the other on the basis of geographical location. Once it is determined which set of dummies, if either, is significant, slope dummy variables will be examined for those domestic cereal supply, development and finance capacity variables found to be significant determinants of cereal imports.

GNP is chosen as a dummy variable category to account for any effect that different levels of development may have on cereal imports. There are at least three income groups often described in the literature, each having different supply and demand characteristics. One such description is supplied by Mellor (1983, p.241).

> At an early stage of economic growth, people are very poor, desperately wishing to consume more food, yet unable to do so because of low incomes...In this stage, population growth roughly meets its own demand for food ...As development occurs, the population growth rate increases. But, even more importantly, income begins to grow rapidly, and the two together increase the growth rate of demand for food by some 30 percent over the earlier phase. Such a rate of growth in food demand exceeds all but the most rapid known rates of food production growth...It is for this reason that most countries in the high growth, medium-income stage find it necessary to rely upon increasingly rapid growth in food imports to meet much of demand growth... In later stages, of course, population growth rates decline and growth in income begins to have little effect on demand for food...It is in this stage that food imports become unnecessary and agricultural surpluses begin to accrue .

The dummy variables in this analysis divide income into three categories: low, medium and high as defined in the World Bank *World Development Report* (the precise divisions are defined in the Data section). These GNP dummy variables are entered into the regression to determine if low-income countries display different cereal import demand behavior than medium or high-income developing countries.

The second set of dummy variables is based on geographical location. Geography is chosen as a criterion to account for factors such as general weather patterns and resource endowments that may affect domestic cereal production. Geographical dummy variables also measure social differences such as custom and religion that, in part, establish patterns of differing tastes and preferences in consumption across nations.

3.3 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.

Table 3.2 contains a summary of the variables in the model: the definition of the variables and the source of the data. The table reveals that the main source of data is the World Bank *World Development Report* which contair concise summary of compatible economic data relevant to developing countries. Other sources include the FAO *Trade Yearbook* and *Production Yearbook* for 1987.

The sample size of the data set is :venty-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 Development Report*. 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.

A slight problem exists for the variable AID (cereal food aid). The data for food aid are not available on a calenda⁻ year basis but are for July of one year to June of the next. Since the cereal impoıt data are on a calendar year basis, the food aid data do not quite cover the time frame being analyzed. The problem is that FAO cereal import data contain 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. But, the different time frames of the two data series do not allow for this procedure. Instead, two series of food aid data are entered separately into regressions (July 1985 - June 1986 and July 1986 - June 1987), in order to determine which time frame of food aid best explains 1986 cereal imports.

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

Table 3.2: Variable Definitions and Data Sources, LDCs

Variables	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)
CSP	1985 quantity of coarse grain production, kg/capita	C (1987)
FNP	1985 quantity of fine grain production, kg/capita	C (1987)

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

manufactures, both categories being from tables in the *World Development Report*. The category 'other manufactures' includes such items as clothing and electronics.

The two sets of dummy variables entering the regression are as previously identified: division of the sample on the basis of low, middle and high GNP, and division on the basis of geographical location. The GNP dummy variables are initialized using the World Bank definitions of low, middle and high-income developing countries:

LOW = 1 for 29 countries with GNP < U.S. $450; otherwise = 0
MED = 1 for 32 countries with U.S. $450 < GNP < U.S. $1800; otherwise = 0
HGH = 1 for 13 countries with GNP > U.S. $1800; otherwise = 0

The regional dummy variables are initialized as follows:

DAF = 1 for 36 African countries; otherwise = 0
DAS = 1 for 18 Asian and Middle Eastern countries; otherwise = 0
DSA = 1 for 20 South American countries; otherwise = 0.

3.4 Collinearity in the Data Set

This section presents the results of collinearity tests which are run on the data set prior to estimation of the model. The tests are run beforehand in order to identify some of the variables which may cause sign change and significance problems in the regressions. The econometric implications of collinearity in the data set will not be discussed here but can be found detailed in any econometric textbook.

The collinearity tests used throughout this thesis are those recommended by Belsley, Kuh and Welsch (1980). Identifying the presence of potentially destructive collinearity involves 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).

Table 3.3 contains the results of the collinearity tests run on a set of six selected variables plus an intercept term. Only these few of the variables tested are presented in Table 3.3 because the purpose of this section is not to provide an exhaustive list of which variable sets are collinear, but to provide evidence that collinearity of a potentially destructive magnitude does exist in the data set and to give a rough indication of which combinations of

g. annual growth rate of GDP, 1980-86

35 percent urban population of total population

antity of cereal food aid, kg/capita

35 gross international reserves, $U.S./capita

35 current account balance, $U.S./capita

35 external public debt,outstanding & disbursed,$U.S./cap

36 total debt service on government debt, $U.S./capita

g. annual growth rate of mercha[illegible]se exports, 1980-86

86 value of merchandise exports, $U.S./capita

86 gross quantity of cereal imports, kg/capita

86 gross quantity of coarse grain imports, kg/capita

86 gross quantity of fine grain imports, kg/capita

86 value of manufactured imports, $U.S./capita

85 quantity of cereal production, kg/capita

'ference between 1985 and 1986 cereal production, kg/ca

86 population density on arable land, 1000 persons/ha

85 quantity of coarse grain production, kg/capita

85 quantity of fine grain production, kg/capita

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procedures than elimination of a problem variable.

3.5 Results of the Model

All regressions are estimated using ordinary least squares and a linear functional form. The statistical package used is SHAZAM, Version 6.1.

The basic model contains four types of variables: own cereal production, development, finance capabilities and dummy variables. As presented in the Data section, there are several ways each of these types of variables can be measured. Because of the difficulty in getting reliable and compatible data from LDCs there is little *a priori* evidence as to how the variables should be measured. Because of this data difficulty, the search for significant variables in the regression is conducted on a trial and error basis. That is, several forms of each variable type are entered into various regressions until the 'best' set of variables is identified. 'Best' in this case is defined as variables that are significantly different from zero (based on t-tests), have the correct sign on the coefficient, cause an increase in the adjusted R^2 of the regression, and do not cause sign changes or instability in the other regression variables. These conditions are used to identify a preliminary set of variables on which formal econometric tests will later be applied.

Two separate rounds of regressions are run, one with the income level dummy variables and the other with the geographical dummy variables. The best set of preliminary variables with only intercept dummy variables are presented first. Once the best set of dummy variables has been identified, slope dummy variables will be explored. An F-test testing for the restriction that the intercept dummy variables equal zero is used to identify the best set of dummy variables (see Kennedy, 1985, p.63 for this F-test). The preliminary results appear in Equations 3 and 4. (t-statistics are in brackets).

$$\text{3) } CM = \underset{(1.02)}{-29} + \underset{(1.53)}{38LOW} + \underset{(1.70)}{37MED} + \underset{(5.45)}{0.04GNP} + \underset{(3.23)}{0.85AID} - \underset{(2.01)}{0.09CP} + \underset{(2.35)}{0.25TDS} +$$

$$\underset{(2.81)}{4.3rGDP}$$

and adj. $R^2=0.7363$. The t-statistics on the constant and dummy variables indicate that these three variables are not significantly different than zero. The F-test has a value of 1.45 (2 and 66 d.f.), which means that entering dummy variables for the level of income makes no difference to the regression. The significant GNP variable means that cereal imports do change with income level; as income increases so do cereal imports. But the insignificant dummy variables for the low and medium-income categories can be interpreted to mean that the cereal import behavior of low-income countries does not differ significantly from that of medium or high-income developing countries. The income dummy variables are therefore deleted from the cereal import demand model.

Equation 4 contains the best results of the geographical dummy variable regressions.

$$4)\ CM = \underset{(2.04)}{-31} - \underset{(2.29)}{24DAF} - \underset{(7.26)}{86DSA} + \underset{(6.84)}{0.03GNP} + \underset{(3.65)}{0.89URB} + \underset{(5.27)}{1.11AID} - \underset{(3.76)}{0.15CP} +$$

$$\underset{(2.58)}{0.03LDBT} - \underset{(2.15)}{0.24FLUC}$$

and adj. $R^2=0.8302$. The F-test has a value of 27.89 (2 and 65 d.f.), which means that cereal imports are significantly different between the geographical regions Africa, South America and Asia. The intercept dummies for geographical location will therefore be retained in the cereal import demand model.

Of the cereal production variables, only DENS, population density on arable land, is insignificant in the regression by itself and in combination with lagged cereal production and production fluctuations. Of the two income variables, GNP is significant in the regression while rGDP is not. Only two of the finance variables are significant in the regression, food aid and 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.

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 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. This same 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 variables significant in Equation 4 will now be examined for the possible addition of slope dummy variables.

There are five variables in the regression that can have slope dummies: 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 variable 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, there is no reason to expect urbanization (URB) to be measurably different on a regional basis; no one region can be identified as obviously more industrialized than another. 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 low GNP countries are in Africa), a slope dummy on the variable GNP for Africa should be tried in the regression. No other income category 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 served to identify five slope dummy variables thought to be relevant to the cereal import demand function. These five slope dummies, as summarized below, are entered into regressions in various combinations with F-tests applied to assess which combination of variables is significant.

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 5.

$$\text{5) } CM = \underset{(2.72)}{42} - \underset{(2.56)}{41DSA} - \underset{(3.67)}{55DAF} + \underset{(7.31)}{0.023GNP} + \underset{(3.09)}{0.689URB} + \underset{(3.19)}{0.729AID} - \underset{(4.39)}{0.190CP} +$$

$$\underset{(4.17)}{0.040LDBT} + \underset{(1.98)}{0.134CP.AF} + \underset{(3.20)}{1.353AID.AF} - \underset{(2.97)}{0.051LDBT.SA}$$

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 complimentary 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 5 (FLUC was a significant variable in the preliminary regression contained in Equation 4). 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 reinforces the previous finding (Equation 3) 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 5, the Breusch-Pagan test for heteroskedasticity and a Box-Cox test for functional form (see Chapter 4 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 $X^2 = 18.307$ at the 5% level. The results of this test indicate that there is no significant heteroskedasticity in the regression. The results of the Box-Cox test are not so straightforward.

In SHAZAM, when doing a Box-Cox transformation on all of the variables in the regression, only those variables with no zero or negative values are transformed. In Equation 5, three variables meet this criteria, the dependent variable CM, and two independent variables, GNP and URB. The results of a log-likelihood ratio test on restricted and unrestricted transformations ranging from linear to double log indicates that the three mentioned variables shoud be transformed to square roots. But, such a transformation causes several of the 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 change 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, the linear form will be retained as the next best alternative because this form does yield statistically acceptable results.

Figures 3.1 to 3.3 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 3.1 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 poor

Figure 3.1: Actual and Predicted African Cereal Imports

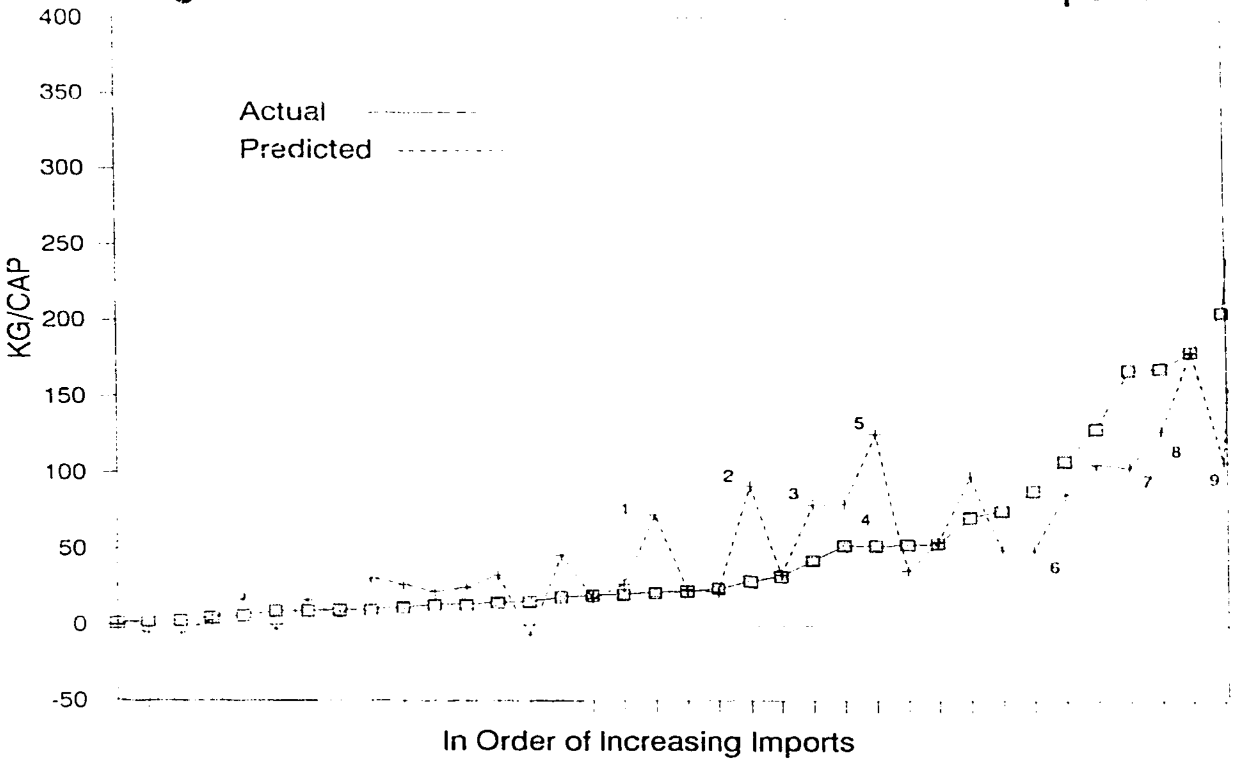
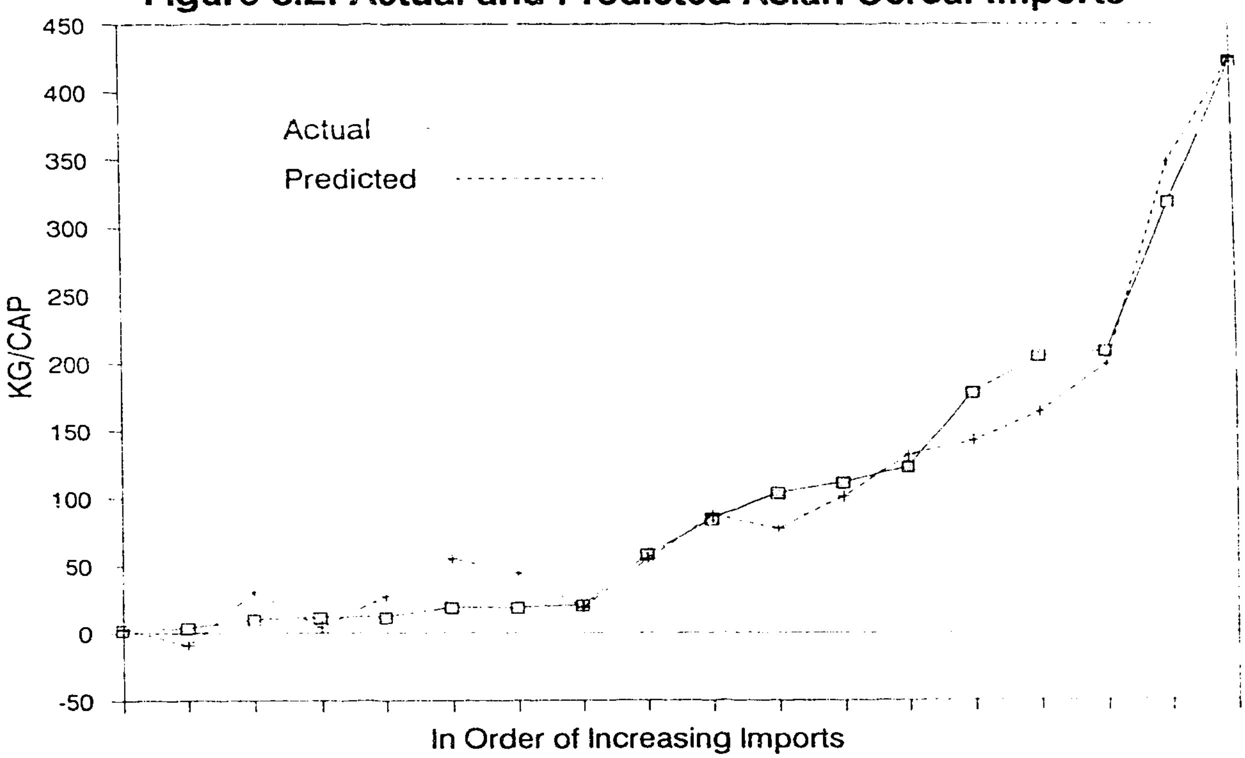
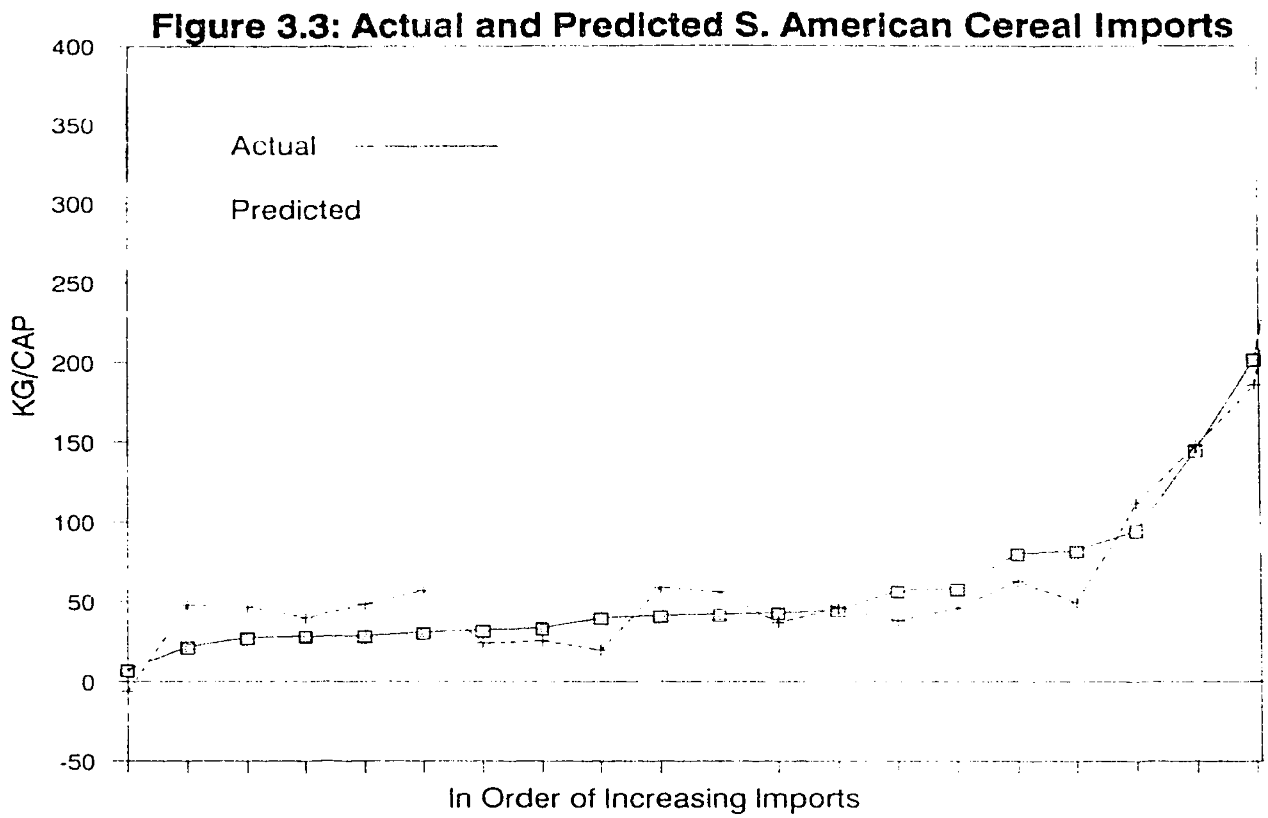


Figure 3.2: Actual and Predicted Asian Cereal Imports





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.

The Import Demand for Manufactured Goods

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 5 with the addition of LRES and the deletion of the slope dummy variables and the cereal production variable. The results are:

$$\text{6) MFM} = \underset{(0.27)}{9} - \underset{(0.38)}{11DAF} - \underset{(2.33)}{81DSA} + \underset{(0.77)}{0.016GNP} - \underset{(0.53)}{0.380URB} + \underset{(0.88)}{0.543AID} +$$

$$\underset{(3.80)}{0.132LDBT} + \underset{(15.44)}{0.531LRES}$$

and adj. R^2=0.9373. The results in Equation 6 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 7.

$$\text{7) MFM} = \underset{(0.50)}{-3.2} + \underset{(6.66)}{0.156LDBT} + \underset{(79.72)}{0.571LRES} - \underset{(2.58)}{0.120LRES.AF} - \underset{(4.57)}{0.423LRES.SA}$$

and adj. R^2=0.9603. These results are estimated with a heteroskedastic consistent covariance matrix because the Bruesch-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. The first step in this investigation is to re-estimate the cereal import model in Equation 5 using fine and coarse grains (both expressed in units of kg/capita) as separate independent variables. The only other change is to replace total cereal production (and the corresponding production slope dummy) by fine and coarse grain cereal production respectively. Equation 8 contains the fine grain regression and Equation 9 the coarse grain.

$$8)\ FNM = \underset{(0.06)}{2} + \underset{(0.06)}{113DSA} - \underset{(3.21)}{2DAF} + \underset{(2.82)}{0.022GNP} + \underset{(0.26)}{0.120URB} + \underset{(10.68)}{4.786AID} - \underset{(0.58)}{0.056FNP} +$$

$$\underset{(0.78)}{0.015LDBT} - \underset{(4.29)}{3.714AID.AF} + \underset{(0.89)}{0.197FNP.AF} + \underset{(3.18)}{0.113LDBT.SA}$$

and adj. R^2=0.7200,

$$9)\ CSM = \underset{(1.67)}{-17} + \underset{(0.35)}{6DSA} - \underset{(2.68)}{29DAF} + \underset{(2.60)}{0.010GNP} + \underset{(1.33)}{0.288URB} + \underset{(1.20)}{0.254AID} - \underset{(0.78)}{0.044CSP} +$$

$$\underset{(7.72)}{0.073LDBT} + \underset{(1.28)}{0.510AID.AF} + \underset{(1.83)}{0.146CGP.AF} - \underset{(4.50)}{0.076LDBT.SA}$$

and adj. R^2=0.7531. The results in these two equations reveal that neither fine grain imports nor coarse grain imports can be explained by the same independent variables as total cereal imports. In fact, the only variable significant in both the fine and coarse grain regressions is GNP. This result indicates that fine grain imports and coarse grain imports require quite different sets of explanatory variables from each other. One point of interest is that the income elasticity of demand for fine grain imports from Equation 8 is 0.38 and for coarse grains from Equation 9 is 0.50. A more elastic response of coarse grain imports to changes in income is expected, and the simple regressions above support this expectation.

Because the explanatory variables for feed and food grains appear to differ, the next logical step in this investigation is to try to identify which set of variables best explain import demand for each type of grain. The purpose here is to determine how different these specifications are and not to conduct a formal analysis of the import demand for either fine or coarse grains, a task beyond the scope of this study. The only explanatory variables that will be considered are GNP, URB, AID, FNP, CGP, LDBT and the regional dummy variables.

Three variables are found to predict fine grain imports quite well. The variables and the regression results appear in Equation 10.

$$10)\ FNM = \underset{(0.84)}{-5} + \underset{(10.63)}{0.496GNP} + \underset{(8.18)}{0.831AID} - \underset{(3.98)}{0.245AID.AF}$$

and adj. R^2=0.6661. These results are estimated with a heteroskedastic consistent covariance matrix because of the presence of significant heteroskedasticity. The main conclusion from this regression is that fine grains can be adequately explained from the set of variables listed above. In contrast, no satisfactory set of variables from those listed can be found to explain coarse grain imports. The coarse grain regressions display considerable econometric problems such as heteroskedasticity, collinearity, and poor predictive power. The inability of any of the key variables to predict coarse grain imports indicates that the specification for coarse grain import demand is quite different from that of fine grains. Perhaps variables not investigated here, such as foreign exchange reserves and meat production, are required in a coarse grain import demand function.

The final conclusion of this brief investigation into disaggregated cereal imports 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 cereals. This conclusion does not negate the total cereal import demand analysis presented in this chapter; this conclusion indicates only that relevant information specific to a particular type of cereal (fine or coarse grains) is not obtained when cereals are analyzed as an aggregate group.

Elasticities

Table 3.4 contains the elasticities for the cereal import demand function in Equation 5. The table reveals that all of the variabl have elasticities 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 variables AID (food aid), LDBT (government debt), and CP (domestic cereal production) have differing elasticities between regions, and are calculated using the intercept dummy variables.

For food aid (AID), Africa shows a slightly more elastic response to cereal imports than does Asia or South America. This more elastic response by Africa is probably a reflection of Africa's high level of cereal food aid in cereal imports relative to the other two regions. For government debt, both Africa and Asia show a positive elasticity while South America has a negative and very inelastic response to cereal imports. The elasticities for cereal production (CP) reveal that Africa reduces cereal imports less for each unit of domestic production increase than do either Asia or South America. The more inelastic response of Africa's cereal imports to cereal production may be a result of Africa's relative cereal deficit compared to Asia and South America.

3.6 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. Several conclusions can be drawn from these results and from the analysis used to obtain the results. First of all, the analysis shows that of the two sample divisions used to account for socio-economic differences across countries, only the geographic division produced statistically significant estimates. The insignificant income division dummy

Table 3.4: Elasticities from the Import Demand for Cereals in LDCs (Equation 5)

Variables		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

variables can be interpreted to mean that developing countries in the low-income category do not display a measurably different cereal import behavior than developing countries in the medium or high-income category. Significant differences in import levels could only be found on the basis of geographic location. Inclusion of regional slope and intercept dummy variables in the cereal import demand model represents a definite improvement over the model used by Morrison.

Another improvement over Morrison is the collinearity investigation presented in this chapter. Collinearity is shown to be the cause for several theoretically important variables being insignificant in the regression, most notably foreign exchange reserves. In other words, a researcher cannot draw conclusions as to the relevance of a particular economic variable solely on the basis of t-statistics before investigating econometric and data influences such as collinearity.

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.

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 3.1 to 3.3) 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.

Chapter 4

THE TIME SERIES ANALYSES

The four following chapters contain time series analyses of the import demand for barley in four different countries: Russia, Japan, Colombia and China. There are enough common elements among these four analyses to warrant an introductory chapter on the basic time series methodologies. The purpose of this chapter, therefore, is to present relevant technical information common to the time series analyses following this chapter. The first section presents and discusses the general structure of the models used in the analyses with emphasis on variables suggested by economic theory and literature. The second and final section presents and explains the econometric tests that will be applied to the models.

The General Time Series Model

The first step in deciding which type of time series model to use in this thesis is to look at previous literature in order to determine what models other researchers have used when studying the import demand for similar products, feed grains and/or barley, in one of the four countries of interest, Russia, Japan, Colombia or China. But, there appears to be very little research specifically dealing with the import demand for barley or feed grains in any of these four countries. In addition, the few studies that deal with the import demand for feed grains in other countries (for example, the study on Venezuela by Kim, Bolling and Wainio, 1987), required detailed data not readily available to this researcher. Therefore, the structure of the general model will be a single equation model, following the example in two other studies of cereal import demand by Borsody (1987) and by Morrison (1984). The second step is to decide which variables should enter the model.

The general import demand model is based on the identity presented in Equation 1.

1) IMPORTS = DEMAND - DOMESTIC SUPPLY

This identity reveals that there are two types of variables to consider in the model, domestic supply variables and domestic demand variables. Domestic supply is simply domestic production of the imported good, barley. In all regressions, domestic barley production will be measured in units of 1000 metric tonnes and will be lagged one year. The production variable is lagged one year to account for the nature of grain production which generally consists of a single, annual harvest between July and August so that the bulk of grain produced in year t-1 is only available for use in year t. Ideally, a variable for carryover stocks of barley should be entered into the model, but since long time series of such data are not available for any of the four study countries, this aspect of domestic supply will be omitted. And so, the supply side of Equation 1 is measured simply as domestic production. The domestic demand side of Equation 1 is more complex to quantify than supply.

Unlike supply, there is no one variable that can adequately measure the domestic demand for a given product. Instead, demand is composed of the interaction between various economic factors. Demand theory, from any textbook, identifies several variables as important: own price, cross prices of related goods, income and population. All four of these variables will be entered into the general model. Own price, income and population are straightforward and need no further explanation except to say that population will be entered into separate regressions as a single variable and as a per capita conversion factor in the denominator of quantity variables (to determine which method of measurement, absolute or per capita quantities, yields the best statistical results). Cross prices of related goods, on the other hand, need to be defined with respect to which goods will be considered related to barley in this study. In general, maize and wheat will be the only other imported grains considered for cross-price influences on barley imports. For Japan's barley imports from Canada, the price of barley from other sources (Australia and the U.S.A.) will also be considered because such data are available for the entire time series.

In addition to the basic demand theory variables, there are other variables that affect import demand. Two such variables, exchange rates and inflation, are considered important for studies of international trade. With regards to inflation, Arnade and Dixit (1989, p.12) recommend the inclusion of an inflation factor, the CPI, "either as a deflator or as an exogenous variable". Because CPIs are unavailable for two of the four study countries, alternative inflation variables must be found. Borsody (1987), in his study of Russian cereal import demand, used an export price index to deflate prices. Following this example, alternative inflation variables in this thesis will consist of specific export price indexes of important export good(s) for the country of study, as identified from literature. Each analysis will have at least two different inflation variables which will be used as deflators in the regression. The other important variable, exchange rate, will enter regressions either as a conversion factor in the denominator of price and income variables or as a separate variable, depending on which form produces the best statistical estimates.

Another variable in the general model is called 'end use'. The end use variable is added to the model to account for the fact that barley and coarse grains are generally considered to be inputs in other production processes and are not consumed directly as human food to a significant degree in any of the four study countries (with the possible exception of China). The end use of barley and coarse grain imports will be assumed to be livestock production unless the literature indicates otherwise. End use variables will generally be measured in volume terms, and in index terms where relevant. Dummy variables are also included in the general model and will enter an individual country analysis depending on the specific characteristics of that country's import market as identified in the literature. These dummy variables, if present at all, will be slope and/or intercept dummies, again depending on indications from the literature or from other evidence.

And so, combining all of the variables mentioned above yields the general form of the import demand model which appears in Equation 2.

2) IMPORTS = F(OWN PRICE, CROSS PRICE, INCOME, POPULATION,
EXCHANGE RATE, GRAIN PRODUCTION, END USE, DUMMY)

The dependent variable, barley imports, will be measured in volume terms and expressed in units of 1000 metric tonnes. All value variables will be expressed in real terms. Modifications to this general model are made for a specific country by the deletion of variables due to data restrictions and the addition of variables specific to that country as identified in the literature

Econometric Tests on the Time Series Equations

This section presents and explains the various econometric tests that will be performed on the data and regressions of the four time series analyses. Each data set will be checked prior to model estimation for the presence of potentially destructive collinearity. 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.

Preliminary testing for the presence of collinearity will be undertaken on each of the time series data sets. The purpose of this testing is to obtain a general indication of which variable pairs may or may not exhibit destructive collinear effects within the regression. As mentioned in Chapter 3, collinearity testing of the data set will consist of generating singular value and variance decomposition tables. Potentially destructive collinearity is identified by two conditions, singular values greater than 30 and variance decomposition proportions greater than 0.5 for two or more variables (Belsley, Kuh and Welsch, 1980, p.112). For the time series data, these variance decomposition tables will not be presented. Instead, those variable pairs exhibiting strong collinear tendencies will be mentioned in the data section of that chapter, and variables suspected of being insignificant in a regression due to collinearity will be identified as such in the results section. The remaining econometric tests will be performed on the regressions themselves.

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 will be 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 will be considered, and all of the independent variables will 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 will be called the Box-Cox test along with a statement as to which functional form is found to be most appropriate. The relevant lambda restriction and calculated X^2 value will appear in brackets.

The second econometric test performed on a given regression is for the presence of heteroskedasticity. The Bruesch-Pagan test is the method chosen in this thesis 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 Bruesch-Pagan test will be 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 will be re-estimated using a heteroskedastic consistent matrix.

The final 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 $\pm 2/\sqrt{T}$ 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.

This concludes the discussion of the general time series model and the statistical tests to be run on the data and regressions. The analyses of the import demand for barley in the four study countries will now be presented, each in a separate chapter in the order Russia, Japan, Colombia and China.

Chapter 5

THE IMPORT DEMAND FOR BARLEY IN RUSSIA

5.1 Introduction

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 bu 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–Russia barley trade. For tl 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

Table 5.1: Canada-Russia 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.o (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	33789.2 (27.3)	9237.7	20565.0 (44.9)

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

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.

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 presented in the previous chapter.

The first study to be reviewed is "Soviet Grain and Wheat Import Demands in 1981-85" by Desai (1982), followed by Borsody's (1987) "Forecasting USSR Grain Imports". The third study is "Soviet Response to the 1980 U.S. Grain Embargo" by Zeimetz, Jones and Mohammadi (1986).

Desai's study includes a section on the import demand for grains in the Soviet Union which is very policy oriented in approach. In choosing variables to enter in the model, Desai makes two assumptions that are questionable. First, Desai assumes that a policy dummy variable for 1971 and on, which is meant to represent "the policy decision to import grain to keep inventories of livestock steady" (Desai, p.313), is actually measuring that policy and not other factors that have been omitted. The second assumption is that "from 1971, the important consideration is to maintain livestock inventories as it will continue to be in the future. Therefore, price will not have a decisive effect on imports" (Desai, p.320). Here, Desai assumes that Soviet officials give a higher priority to political objectives than to financial constraints. A statistically insignificant coefficient on the price variable seems to support this assumption, but Desai fails to explore any relative price relationships such as terms of trade variables.

The results of Desai's import demand function for the years 1950-1979 are as follows:

$$1)\ IG = \underset{(2.0905)}{7.300} - \underset{(2.9086)}{0.1165}\,QG + \underset{(3.7924)}{0.8831}\,T + \underset{(3.8676)}{10.20865}\,DUMMY$$

and $R^2=0.7985$; IG is million tons of gross grain imports, QG is million tons of domestic grain production lagged one year, T is time and DUMMY is a policy variable equal to one for 1971 and later. The price variable is dropped as being insignificant and meat production and livestock numbers variables are dropped due to collinearity with the time variable. As already mentioned, the time variable is assumed to be capturing the effects of a livestock policy (when in fact this variable may be capturing the effects of other omitted variables). In addition, inclusion of the time variable assumes a steady trend of import demand which, given the variability of Soviet grain imports, seems rather unrealistic. Desai's policy oriented demand function represents one approach to modeling Soviet grain imports. But, although the results of the model are statistically significant, the assumptions behind the policy and time variables are rather limiting and unrealistic.

Borsody (1987) takes a different approach to modeling Soviet grain imports than does Desai. Borsody focuses more on identifying economic factors that affect import demand than on policy goals. He notes that the changing world economy in the 1970s had the end result of "great improvements in both the commodity and income terms of trade of the USSR *vis-a-vis* the DME countries, and the simultaneous sharp drop in the cost of imported grains to the USSR from the world markets in real terms" (Borsody, p.97). Borsody's approach "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).

In order to investigate the effect of Russia's relative buying power in international markets, Borsody constructed price indexes based on Fisher's 'ideal' formula for imports and exports to DME (developed market economy) countries. The export price index was used as the deflator in calculating the real price of cereal imports, and in calculating a terms of trade variable with the import price index. Borsody then estimated the following cereal import demand equations:

$$2)\ IMPQ = \underset{(1.21)}{24.468} - \underset{(1.72)}{0.087}\ PRODQL - \underset{(2.89)}{0.211}\ RCERPRIL + \underset{(2.42)}{0.160}\ SOVTTRD + \underset{(0.95)}{0.165}\ LVSTPRI$$

and $R^2=0.90$,

$$3)\ IMPQ = \underset{(2.40)}{36.864} - \underset{(1.47)}{0.055}\ PRODQL - \underset{(3.51)}{0.237}\ RCERPRIL + \underset{(2.46)}{0.164}\ SOVTTRD$$

and $R^2=0.90$; where IMPQ is gross cereal imports, PRODQL is domestic cereal production lagged one year, RCERPRIL is the real cereal price index (UN cereal export price index deflated by Borsody's calculated export price index for Russia) lagged one year, SOVTTRD is

Russia's terms of trade with DME countries, and LVSTPRI is the livestock production index for Russia. The only difference between Equations 2 and 3 is that the livestock variable is deleted in Equation 3 because of being insignificant in Equation 2.

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.

The third study to be reviewed is by Zeimetz, Jones and Mohammadi (1986). Both the model and the focus of this analysis are different from that of the previous two studies. Zeimetz *et al* had the specific goal of determining the effect on Soviet grain imports of the 1980 U.S. embargo. Another difference is that this model estimates net feed grain imports rather than gross cereal imports as the other two models did.

The model consists of a system of four equations: an aggregate import exchange equation, a domestic meat production equation, a net feed grain import equation, and a net wheat import equation. Only the results of the feed grain equation will be presented here.

$$4)\ FGI = \underset{(3.91)}{-34.680} - \underset{(0.35)}{6.66}\,TFGO + \underset{(6.24)}{5.26}\,DMP + \underset{(0.47)}{0.06}\,M - \underset{(7.95)}{0.40}\,DOFG - \underset{(1.93)}{4175}\,EMBARGO$$

and $R^2 = 0.67$; where FGI is net feed grain imports, TFGO is the feed grain price divided by the oil price, DMP is domestic meat production, M is hard currency import expenditures (deflated), DOFG is domestic feed grain production (lagged one year), and EMBARGO is a dummy variable equal to 1.0 in 1980 and 0.4 in 1981. The variables DMP and M are both dependent variables in two of the other system equations.

An interesting feature of this model is the price variable. The authors, like Borsody, recognize that the relative price of grain imports to fuel exports may be an important financial aspect to grain imports. But, in this model the price variable is insignificant. Another interesting feature of the model is the relatively low R^2 for the net feed grain equation. Although three of the variables are significant, only 67% of the variation in feed grain imports is explained by the three. This result indicates that an alternative feed grain equation is necessary and perhaps a different model as well. The main information obtained from this study is that domestic meat and coarse grain production are important factors in the coarse grain import demand function, and that net imports may be a better dependent variable than gross imports.

5.3 The Model and Data

Two different levels of barley imports are considered in this study. The first level of analysis deals with the import demand function for total net barley imports and the second level deals with gross barley imports from Canada. Total barley imports 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 will 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 to net 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.

Of the variables listed in the general time series model in Chapter 4, income and the exchange rate will be omitted. An income variable, though of theoretical interest, is omitted because no consistent estimation of Soviet net material product for the entire time series could be located. The exchange rate variable is excluded because Russian roubles are not an accepted international currency and Russia relies on exports to earn foreign currency with which to purchase imports. Therefore, an exchange rate variable in the case of Russia is meaningless. The other variables in the general model, namely own price, cross price, population, domestic grain production and an end use variable will all be included in the model of Soviet total barley imports. The end use variable will be livestock production. In addition, the possibility of including dummy variables in the regression will be explored.

As already discussed in the literature section, use of a dummy variable for 1971 and later (when Russia became a significant barley importer) is not very reasonable because the reasons for employing such a variable are not clear; Desai's addition of a dummy variable for 1971 and later on the grounds of "dietary improvement policy" abstracted from other economic factors, such as the change in terms of trade pointed out by Borsody, that also affected grain imports. Therefore, the dummy variable for 1971 and later will not be used in this analysis of Russian barley import demand. Instead, since the literature does not provide any other clues as to which dummy variables are reasonable, graphs of the data for the variables net barley imports, domestic barley production, domestic livestock output index and real own price will be plotted and examined for the presence of discernable trends.

Figure 5.1 contains the graph for Russia's net barley imports. This graph reveals that after 1971, when Russia became a net barley importer, the variability of barley trade increased. This increase in variability, that is, the large year-to-year barley import fluctuations, justifies the inclusion of dummy variables to try to capture the effects of the increased variability. Both slope and dummy variables will be entered into the barley import demand model and these dummy variables will focus on fluctuations in the independent variables that correspond to the import fluctuations. The graphs of these independent variables are examined for the presence of similar fluctuation features which can then be entered into the model as dummy variables.

Figure 5.2 is the graph of Russia's domestic barley production, lagged one year. The most prominent feature of this graph is that the import fluctuations in Figure 5.1 are quite closely paralleled by fluctuations of opposite direction in the production graph. These two graphs indicate that a dummy variable for the years of low domestic barley production, which correspond roughly to years of high imports, should be entered into the equation.

Figure 5.3 contains the graph for the index of domestic livestock production. Comparing this graph to the import graph reveals that for years of declining livestock production, the import graph shows peak levels and then trough levels in the following year. A dummy variable for the years of low livestock production will be added to the regression.

Figure 5.1: Net Barley Imports, Russia

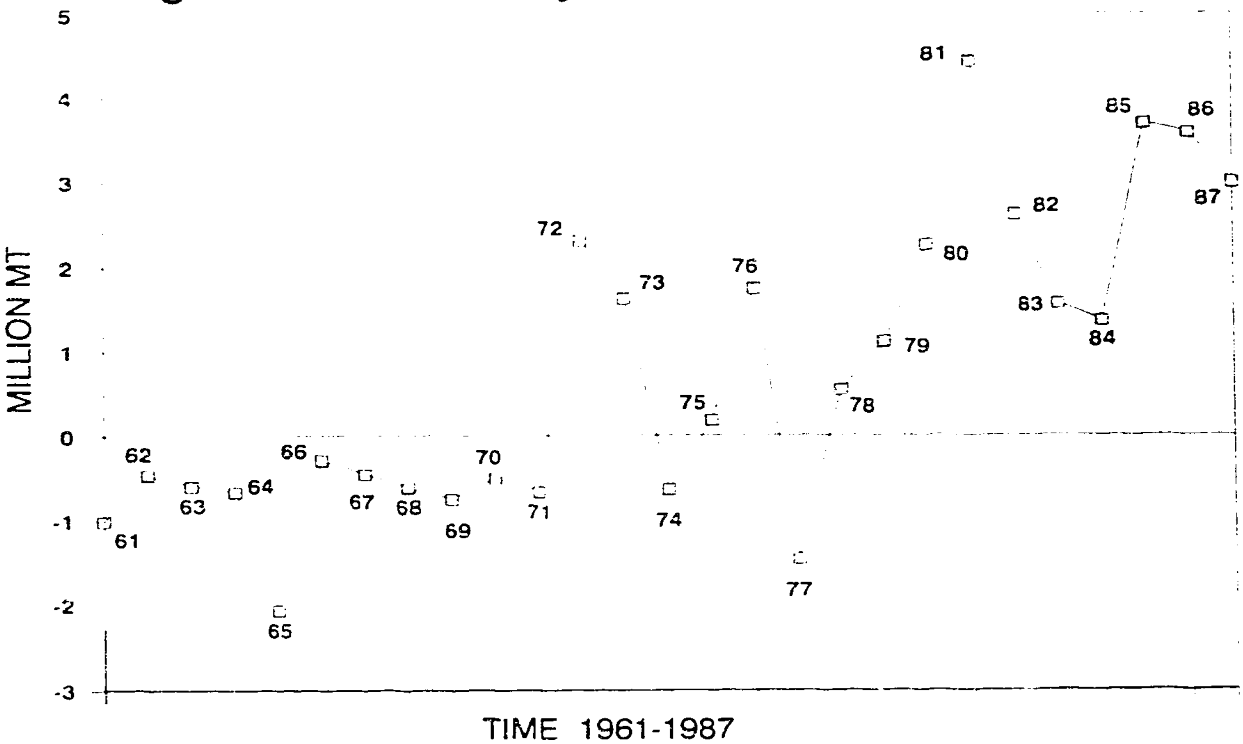


Figure 5.2: Domestic Barley Production, Russia

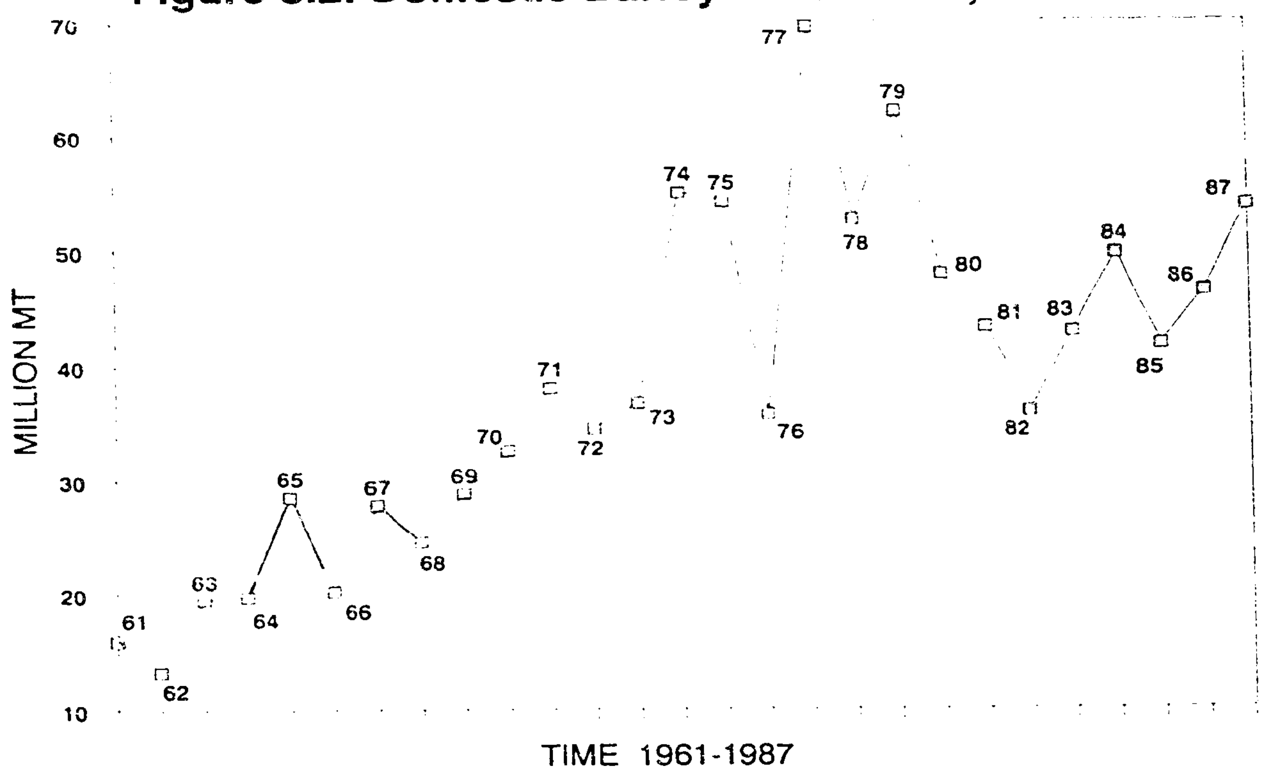


Figure 5.3: Index of Domestic Livestock Output, Russia

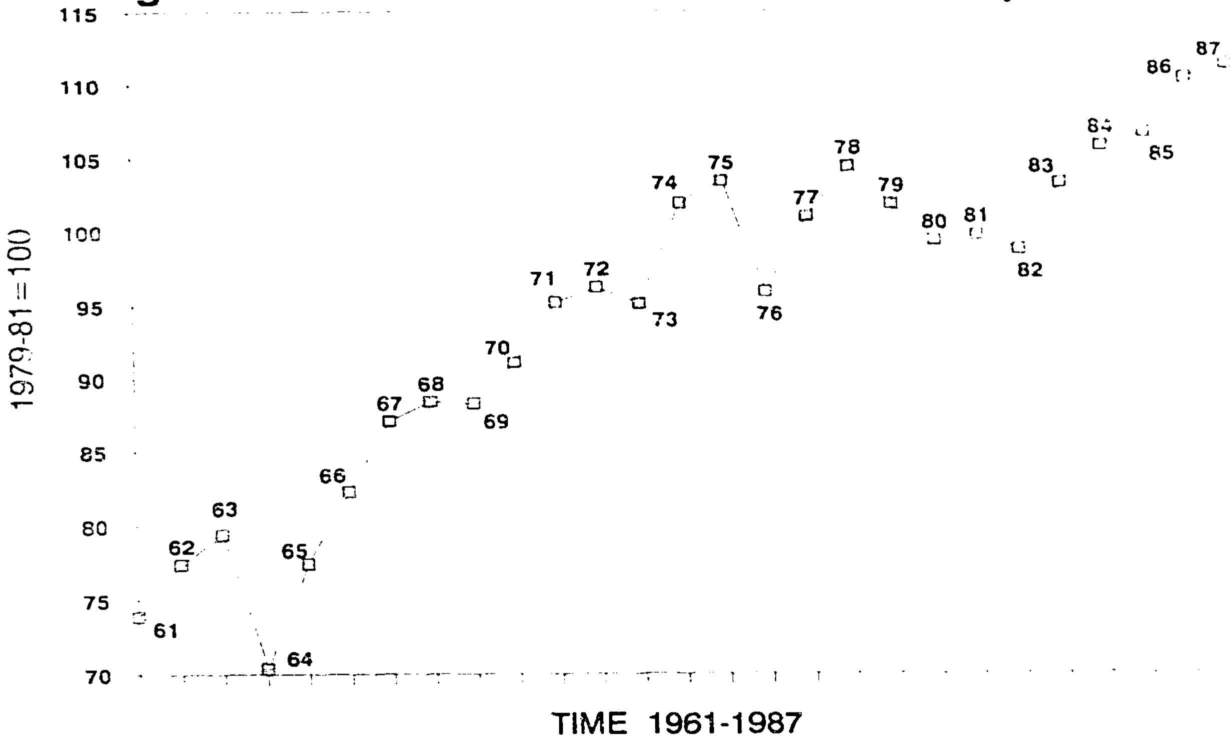
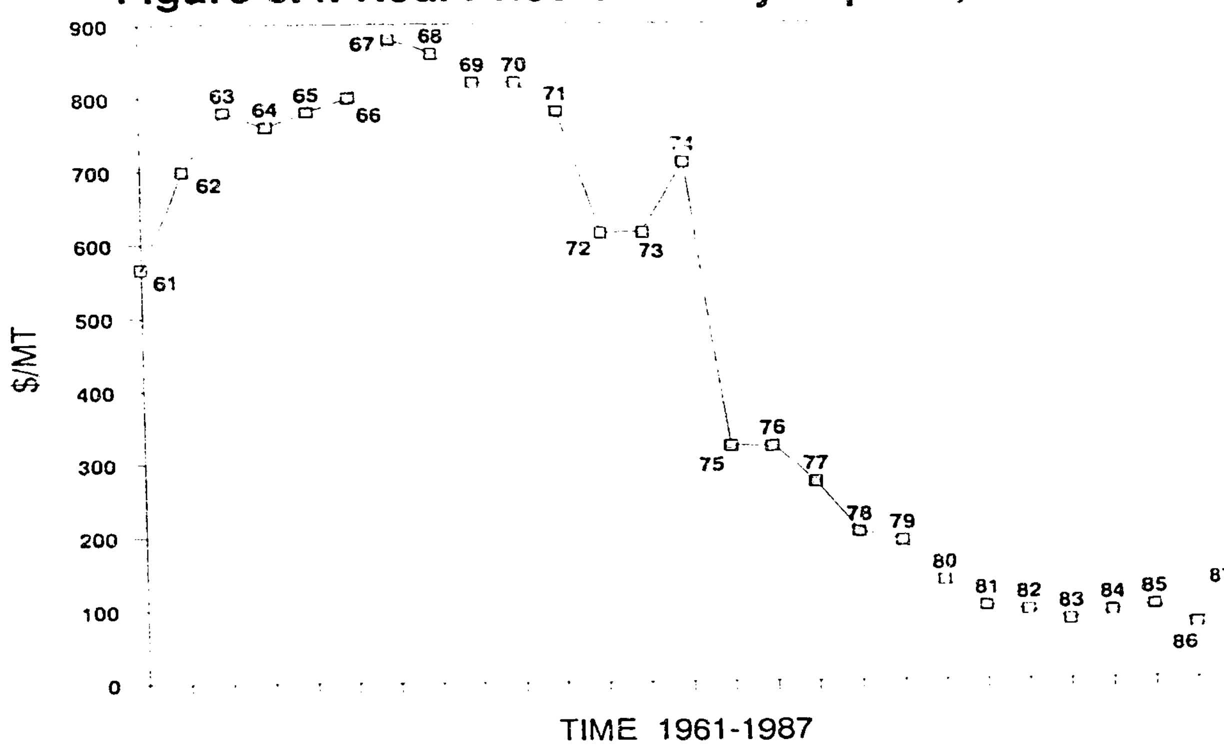


Figure 5.4: Real Price of Barley Imports, Russia



The final graph is that of the real price of barley imports which is shown in Figure 5.4. There are no discernable corresponding patterns between the price and import graphs and so no dummy variable for import price is entered into the model.

The model to be estimated for net barley imports in Russia is as follows:

5) IMPORTS = f(OWN PRICE, CROSS PRICE, POP., BARLEY PROD., LVSTK. PROD., BARLEY DUMMY, LVSTK. DUMMY).

The model will be 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 will be 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. The two deflators used in this analysis are the U.N. export price index for fuels (PETPI) and a gold price index (GOLDPI). These two indexes are chosen because gold and petroleum are both important foreign exchange earners for Russia. In addition, PETPI closely resembles Borsody's export index due to the large proportion of fuel exports in Russia's recent exports. A CPI deflator cannot be employed in this analysis because a reliable estimate of such an index is not available for Russia.

For the analysis of gross barley imports from Canada, the model in Equation 5 will be 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.

Figure 5.3: Index of Domestic Livestock Output, Russia

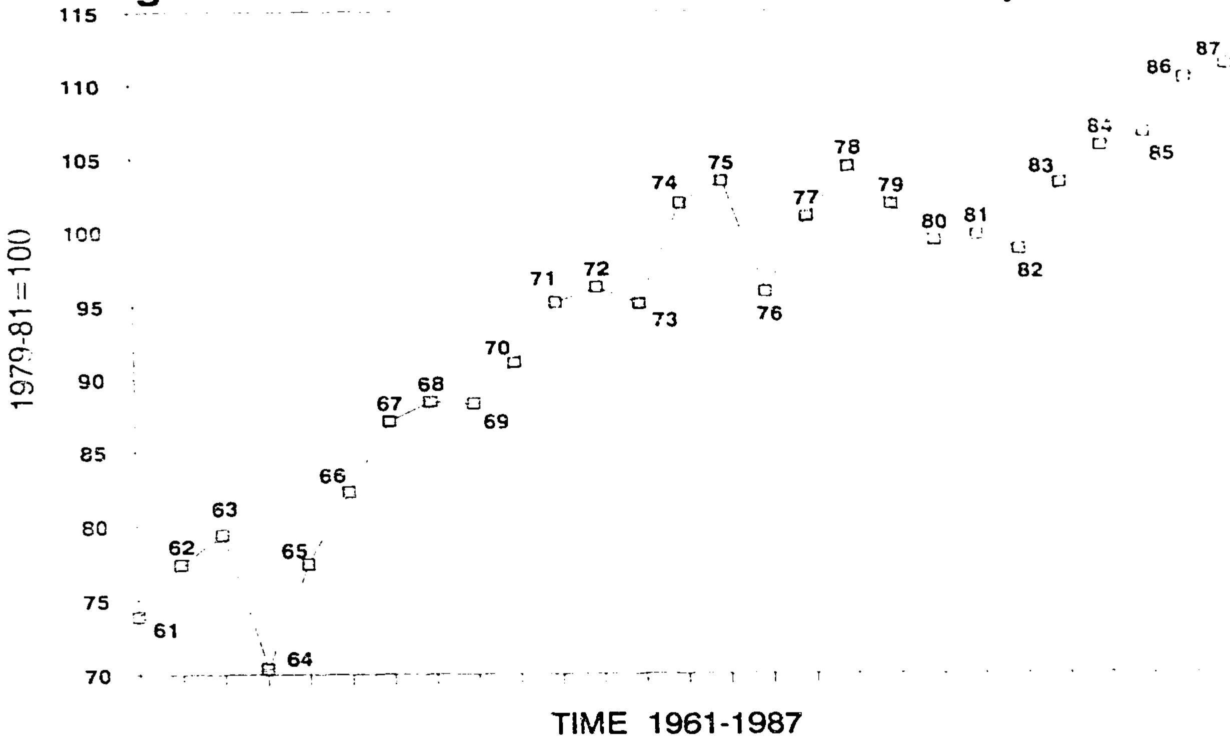


Figure 5.4: Real Price of Barley Imports, Russia

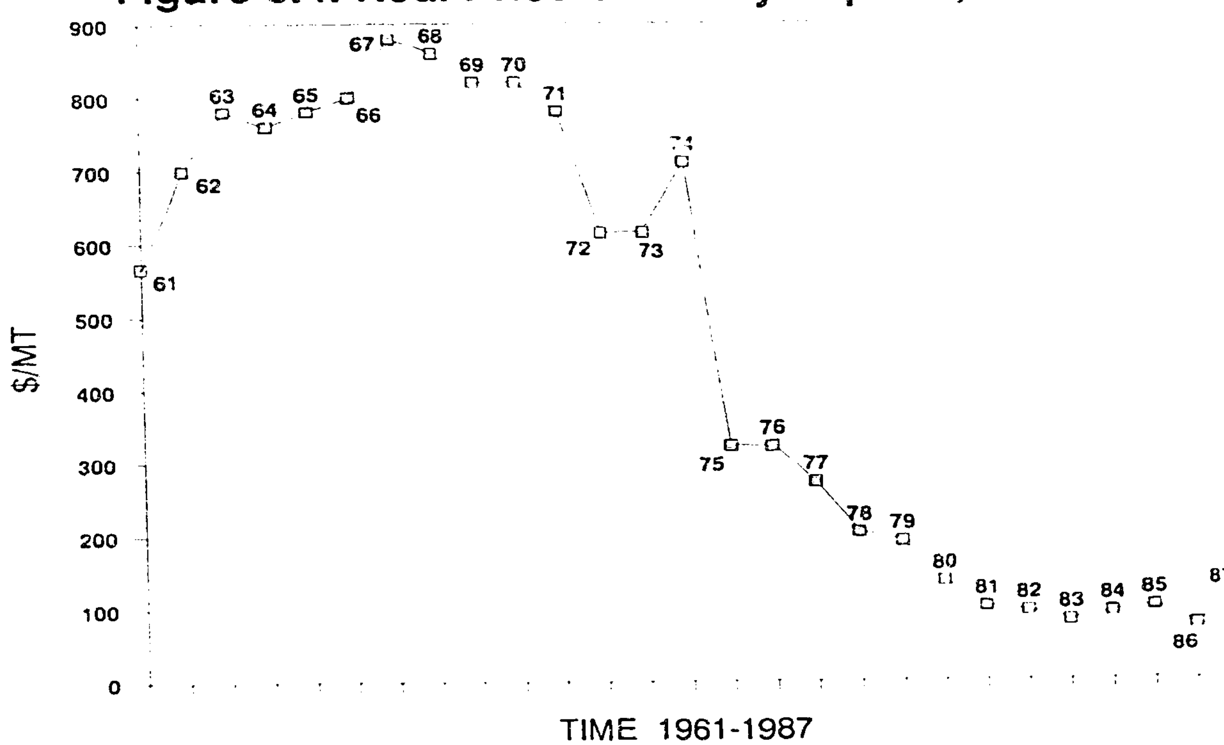


Table 5.2: Variable Definitions and Data Sources, Russia

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*

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 6.

$$\text{6) NETBM} = \underset{(4.99)}{-10821} - \underset{(7.37)}{0.120\text{LBPR}} - \underset{(4.00)}{2.539\text{BPI}} + \underset{(7.27)}{180.20\text{LVIND}} + \underset{(4.75)}{1493\text{D2}}$$

and adj. $R^2=0.8736$. 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 6 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 6, Russia becomes a barley exporter.

There are two significant livestock variables in Equation 6, livestock production and the intercept dummy variable for years of low livestock production. Both of these variables have positive coefficients which is unexpected since the dummy variable should, logically, have a negative sign 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 a 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 6.

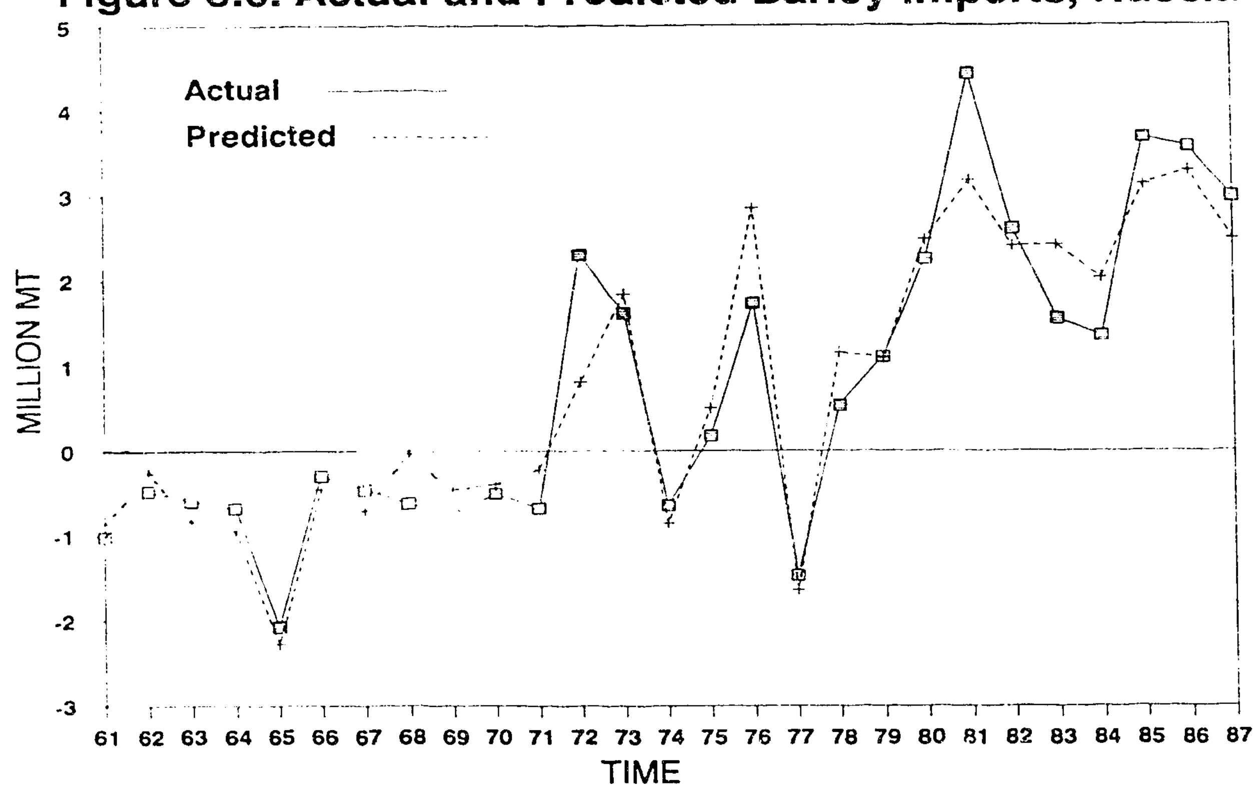
The real own price variable in Equation 6 is the U.N. world barley price index lagged one year and deflated by the U.N. world petroleum price index. This lagged form of the price variable produced better statistical results than the current form, and the petroleum price deflator produced better statistical 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 officals 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 6 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 6. The Breusch-Pagan test indicates that the presence of heteroskedasticity is rejected at the 95% confidence level ($X^2=4.400$). 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 ($\lambda=1$: $X^2=3.84$). 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 5.6 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 neccesitated 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 carryover stocks is not available because such a variable would probably help explain the outlying observations not predicted well by the model.

Figure 5.6: Actual and Predicted Barley Imports, Russia



The Demand for Barley Imports from Canada

The results of estimating the model for barley imports from Canada are presented in Equation 7.

$$7)\ CANBM = \underset{(1.59)}{-4058} - \underset{(5.05)}{0.078LBPR} - \underset{(2.61)}{1.641CBPI} + \underset{(3.31)}{84.41LVIND} + \underset{(3.19)}{9.811LVIND.D2}$$

and adj. $R^2=0.7293$. 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 7 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. However, since the data used in this analysis are measured on an annual basis, this conclusion does not mean that within a given year there are no monthly or quarterly price lag reactions. This analysis does not address within-year behaviour, only between-year behaviour. A second difference between the two regressions is that in Equation 7, the livestock dummy variable enters the regression as a slope dummy rather than an intercept dummy as in the total barley regression (Equation 6).

The only insignificant variable in Equation 7 is the intercept term, which may be due to measuring the independent variable in gross rather than net terms. But this insignificant intercept is not too important because at a level of 80% confidence (a lower but still acceptable level) the intercept is significantly different than zero. 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 7 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.

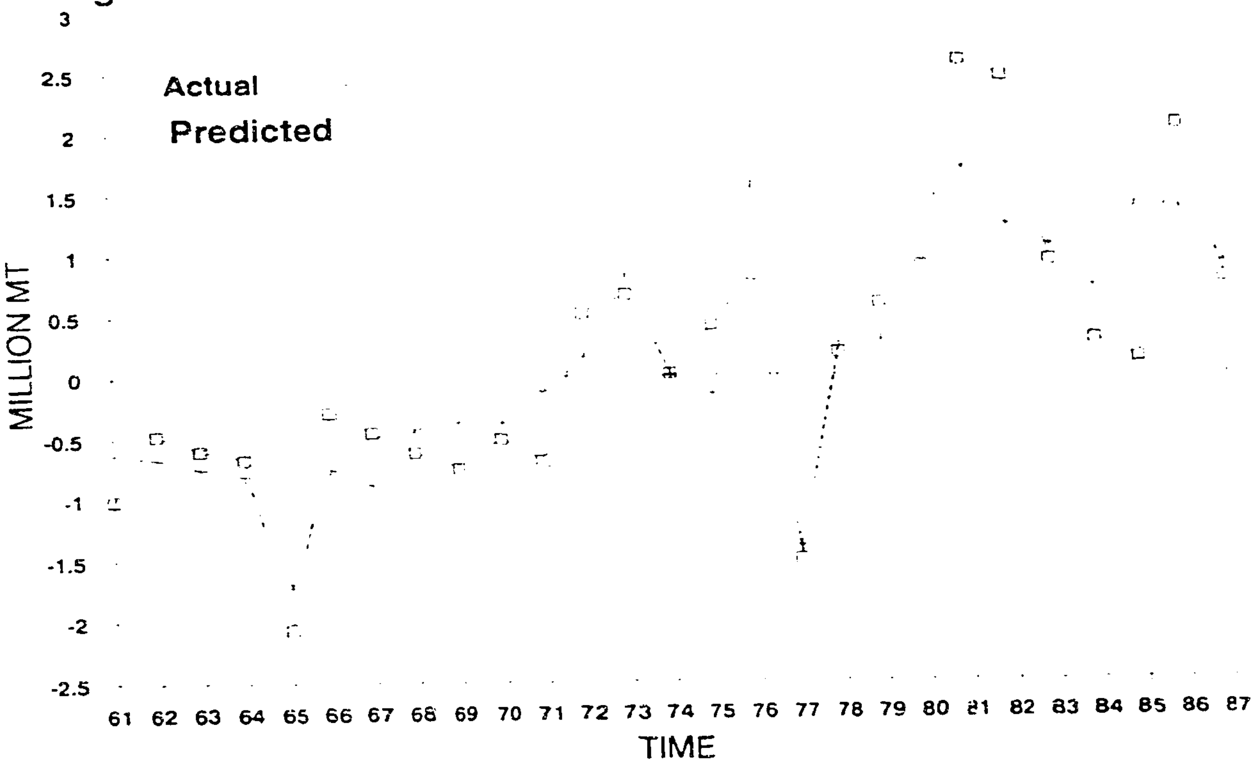
The tests run on Equation 7 indicate that there is no autocorrelation (DW=2.12), no heteroskedasticity ($X^2=8.294$) and that the linear functional form is appropriate for this model ($\lambda = 1$; $X^2=1.702$).

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 5.7 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 elasticities for Equations 6 and 7 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 wheat import price elasticity is less elastic than either of the barley import price elasticities. This less elastic response of wheat imports to price changes is expected because barley, being a coarse

Figure 5.7: Actual and Predicted Barley Imports from Canada



grian, 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.

Comparing the two barley price elasticities 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 for 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.

Table 5.3: Elasticities from Various Regressions, Russia

Variables	Equation 9 Total Barley	Equation 10[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[1]	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.

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.

Chapter 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 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. In addition, because of data availability, a model distinguishing barley imports by source will be attempted in order to determine if Japan views Canadian barley as a different commodity than Australian or American barley. For this latter purpose, following Alston *et al* (unpublished), an Armington-type assumption will be tested within an Almost Ideal Demand System framework.

Table 6.1 contains details of the Canada-Japan barley trade from 1981 to 1987. The data reveal that 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. And so, 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.

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	[illegible]4.0 (11.3)	614.9	1247.5 (49.3)
Total	33789.2 (17.2)	5812.6	10213.2 (56.9)

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

6.2 Previous Research and Literature

No actual analyses of the Japanese import demand for coarse grains or barley could be found and so the literature search for this chapter consists of a review of descriptive literature. This 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 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 are substitutes in importation and that after the change in use, wheat and barley are no longer significant as substitutes ([illegible], the coefficent 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 to begin the structural change at: 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.

Another variable suggested by Kalmbach *et al* is national income. "Barley is not only a feed grain, but is also an inferior food grain. Thus as income levels in Japan have continued to increase, the use of barley as a food grain has declined significantly" (p.15). Therefore, an income variable will be included in the model along with a slope dummy variable for income. The remaining variables entering the barley import demand model have not been specifically identified by literature about Japanese grain trade, but are entered in the model as suggested in the general model discussion contained in Chapter 4 of this thesis. These other variables will be described in the data and model sections following.

6.3 The Data

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 prices 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 particularily important with regards to cereal or barley imports. The Canadian price variable, CA[illegible] 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 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

Table 6.2: Variable Definitions and Data Sources, Japan

Variable	Definition	Source[1]
POP	Japanese population, mid-year estimates	F
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*

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.

6.4 The Barley Import Models and Results

Two kinds of models are used in the analysis of Japan's barley import demand, the single equation demand model for barley imports in total and from Canada and an Almost Ideal Demand System model which distinguishes barley imports by source of origin (Canada Australia and the U.S.A.). The model and results of the single equation demand analysis wi be presented in Part A of this section f[illegible] by the AIDS model in Part B.

PART A: SINGLE EQUATION IMPORT DEMAND MODEL

Equation 1 contains the basic single equation model of Japanese barley imports.

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

The cross prices will include the import price of wheat and maize, and the Japanese domestic producer price of barley. 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. Equation 1 is the basic model used for both total barley imports and barley imports from Canada. The structural dummies are the slope dummy variables created from D2, the structural change dummy variable.

The Demand for Total Barley Imports

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.

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

and adj. $R^2=0.9196$. 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 ($\lambda=0$: $X^2=3.062$; $\lambda=1$: $X^2=11.27$). 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. dc[illegible]r–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 Ca[illegible]he 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 Bruesch-Pagan test reveals that there is no heteroskedasticity ($X^2=6.427$) 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.

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

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

$$3)\ CANBM = \underset{(4.29)}{957} - \underset{(0.80)}{0.0922GNP} + \underset{(3.55)}{0.229GNP.D2} - \underset{(3.76)}{7.2800CEX} - \underset{(2.03)}{152D1}$$

and adj. $R^2=0.8812$. 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 Statisitcs 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 [illegible] be a factor in determining barley imports from Canada, a second set of prices fr[illegible] data sources is also used. This second set of barley prices are all c.i.f. and so are com[illegible] 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 ($X^2=4.618$), there is no significant autocorrelation ($DW=2.31$) and that, as mentioned already, the linear functional form is appropriate ($\lambda=1$: $X^2=0.994$).

Table 6.3 contains the elasticities of the variables in Equations 2 and 3. The income elasticity for total barley imports prior to 1972 is rather inelastic and has a negative sign. 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

Table 6.3: Elasticities from the Single Equation Models, Japan

Variables	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.

being an inferior good to nearly being a normal good. The income elasticities for the Canadian barley regression 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 income elasticity 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 exchange rate elasticity 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 Canadian barley exchange rate elasticity is slightly greater than 1.0, which puts this elasticity in the elastic range so that 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 6.1: Actual and Predicted Barley Imports, Japan

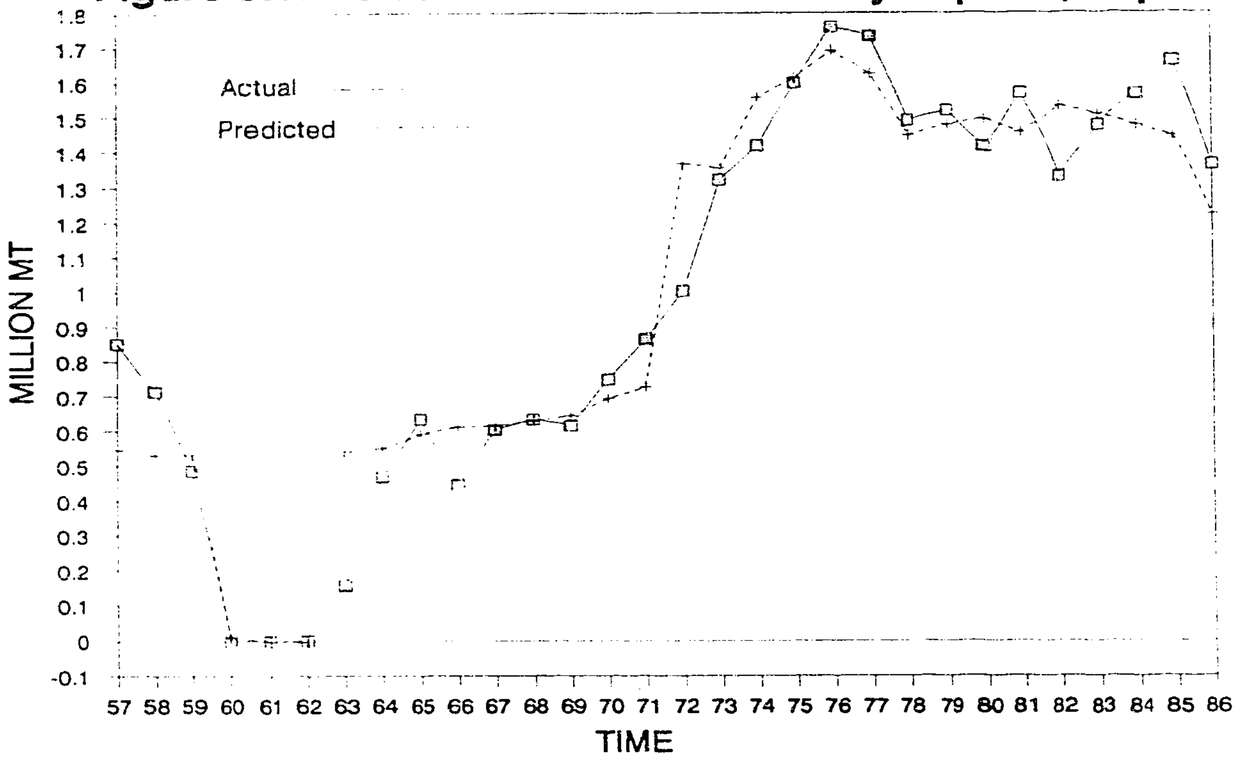


Figure 6.2: Actual and Predicted Barley Imports from Canada

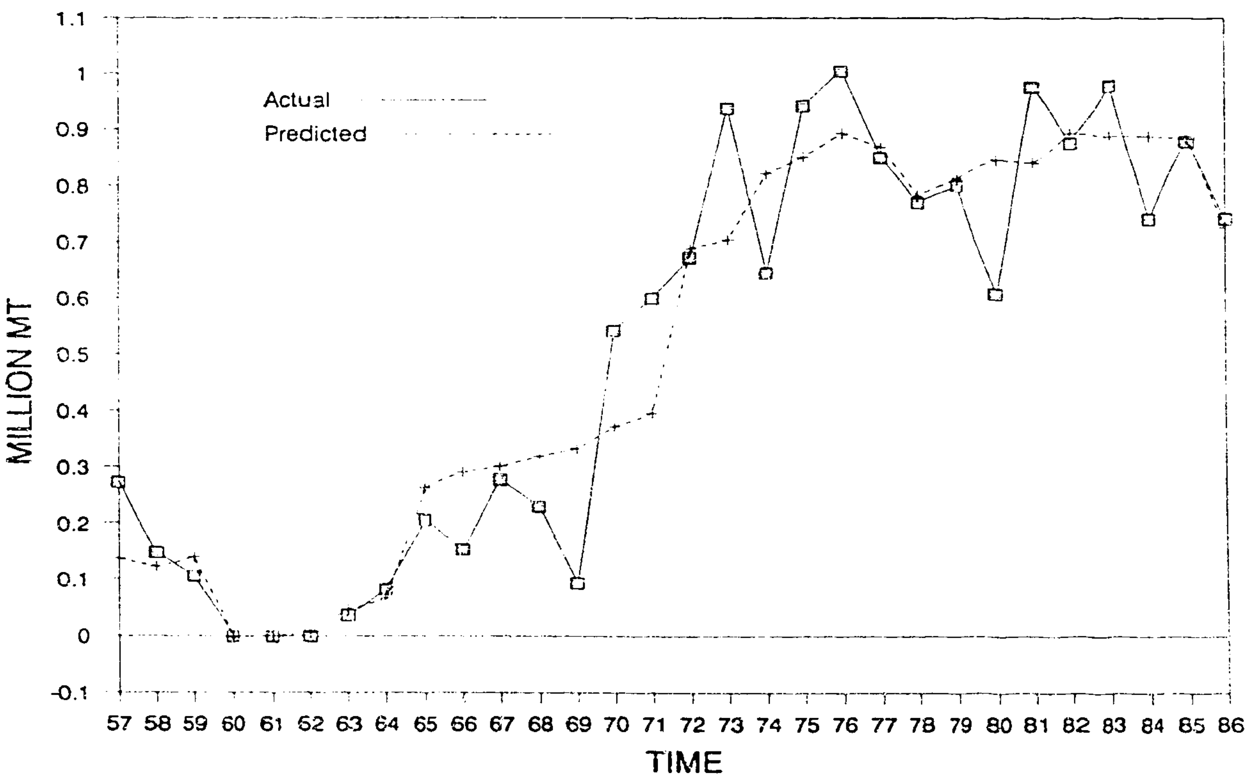


Figure 6.2 reveals that the Canadian barley model in Equation 3 does not predict imports from Canada quite as well, particularily for import fluctuations such as between 1973–74, 1980–81, and 1983–84. The model in Equation 3 appears unable to capture the effects of Japan's source specific import behavior 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.

PART B: ALMOST IDEAL DEMAND SYSTEM MODEL

This section of the chapter presents the results of applying an AIDS model to the Japanese barley import market. The AIDS model is specified only for the Japanese market in this thesis because Japan is the only country of the four countries being studied for which the necessary data are available. The main reason for applying a model such as AIDS, in a form which distinguishes imports by source, is 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 products (separable). In addition, domestic barley production will be tested for separability with barley imports.

The technique employed in this thesis to test for separability of the import sources is taken from Winters (1984). In his paper, Winters suggests excluding one of the barley sources from the total share grouping and then adding the log of the price of the excluded source to the share equations of the other sources. If the price of the excluded source has a significant variable coefficient (according to the t-statistic), then that source is non-separable from the other sources (see Winters for a more detailed description of this test). Following Winters' example, the first separability test will be applied to domestic production versus imports. If domestic production is non-separable from imports, then this production will be included in the total share of barley for the remainder of the separability tests which test for separability of each of the three import sources.

Although Winters (p.12) acknowledges that his particular form of the separability test is less formal than other tests, Winters' form will still be used in this study because of being a slightly easier form to apply. If the application of Armington-type assumptions within the AIDS framework provides an adequate estimation of Japan's barley import demand, then more formal separability tests will be performed. The AIDS model will now be briefly outlined.

Equation 4 contains the specification of the budget share of imports from a given source, which forms the basis of this version of the AIDS import demand model. This equation and the following restrictions are taken from the original paper by Deaton and Muellbauer (1980a) and further details on the theory and analytics of adding an Armington-type assumption can be found in Winters (1984) and Alston *et al* (unpublished).

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

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

5) $\sum_i \alpha_i = 1; \sum_i \gamma_{ij} = 0;$ and $\sum_i \beta_i = 0;$

6) $\sum_j \gamma_{ij} = 0;$ and

7) $\gamma_{ij} = \gamma_{ji}$.

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). As is standard procedure when working with the adding-up condition, estimation of the AIDS model in this analysis will involve the deletion of one of the share equations. The specifics of the data and application of the AIDS model to the Japanese barley market will now be discussed.

The import quantity and value data are from U.N. *Commodity Trade Statistics*, and are the import data as reported by Japan. The source of data for the domestic price and production of barley are both listed in Table 6.2. All of the value data are converted to Canadian dollars due to the results from the previous single equation import demand model which indicate that the Canadian exchange rate is important. And, because the single equation import demand estimation also indicates that in the early 1970s there was a distinct break in the pattern of barley imports (when usage of barley switched from food to feed), the AIDS model will be limited to data from 1972 to 1986. This data limitation is employed rather than including a dummy variable because, like the income variable in Equations 2 and 3, the elasticity of the price variables probably changes after 1972 and an intercept dummy variable would not capture this elasticity change. It is not clear from the literature that addition of slope dummy variables, which would capture the change effect, is valid within the AIDS framework. The only alternative solution is to limit the data set. 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. And finally, in 1973 Japan imported some barley from France, but this event will be ignored because the amount imported from France is insignificant relative to total imports (France's share that year was only 6%).

Table 6.4 contains the results of testing for separability between barley imports and domestic barley production. The three share equations are for barley imports only, and of the three import sources, U.S.A. is chosen as the share equation for deletion. The remaining two share equations are estimated using the SURE technique and with the appropriate restrictions imposed. The t-statistics, which are presented in brackets, reveal that none of the variables in

Table 6.4: Results of the Test for Separability of Barley Imports and Domestic Barley Production (t-statistics in Brackets)[1]

Import Source	Constant	Own Price	Cross Price	Producer Price	Expenditure
Canada	-0.513 (0.84)	0.055 (0.13)	-0.045 (0.10)	-0.054 (0.89)	-0.272 (2.12)
Australia	1.074 (1.22)	-0.237 (0.42)	-0.045 (0.10)	-0.004 (0.05)	0.168 (0.91)

[1]The critical value of t ($\alpha=0.05$, d.f.$=11$) is 2.20

either equation are significant at a 95% confidence level. The insignificant coefficient on domestic price suggests that barley produced domestically is a separable product from barley imported from other sources. In other words, domestic barley is apparently seen as a distinct and different good to barley imports. But, this conclusion must be modified to account for the fact that none of the other price and expenditure variables are significant. This lack of statistically significant variable coefficients may be due to such factors as collinearity between the price variables, or perhaps due to the complex nature of Japanese barley pricing. As described in the literature section, there are at least three barley price levels in Japan: the world price at which imports are purchased; the domestic producer price, which is above world prices; and the domestic re-sale price of barley imports, which is apparently below the world price (and therefore below the producer price too). It can be speculated that to properly test for the separability of domestic and imported barley using the AIDS model, the re-sale price of imported barley should be substituted for the actual import price. Unfortunately, the re-sale price of imported barley on the domestic market is unavailable to this researcher at this time. Another distinct possibility is that a completely different model is needed to account for the complex structure of barley price schedules in Japan. The results of the test for separability between domestic and imported barley from the AIDS model have been presented here in order to identify the need for further research in this area with the proper data and/or model. The results of the separability tests between the import sources will now be presented and discussed.

Table 6.5 contains the results of the separability tests for the three import sources. Because there are three import sources, excluding one of the sources to test for separability leaves two share equations, and when one of the two share equations is dropped due to the adding-up condition, the separability test reduces to a single equation system which is estimated using OLS.

Looking at the fourth column of Table 6.5, which contains the coefficient of the excluded country price variable, reveals that separability is rejected for Australia versus Canada and the U.S.A., rejected for Canada versus Australia and the U.S.A. and not rejected for the U.S.A. versus Canada and Australia. In other words, the price of barley imports from Canada and from Australia influence imports from the other sources, but the price of U.S. barley does not affect barley imports from Canada and Australia. The insignificance of the U.S. price is probably due to the fact that the U.S. is a minor participant in the Japanese barley import market rather than to U.S. barley being perceived as a distinct product from Canadian and Australian barley. Overall, the results of the separability tests indicate that Japan does not perceive barley from the different sources to be different products. Therefore, it can be speculated that Japan imports barley consistently from three different sources rather than relying on one source or the lowest priced source because of such factors as long-term import contracts and the policy decision of import source diversification. Another possibility is that the Armington-type assumption in the context of an AIDS model framework is unsuitable for application to the Japanese barley import market. Certainly, all of the excluded country price coefficients have the wrong theoretical sign. In addition, the own price variable in the third test in Table 6.5, which is for the two main import sources, Canada and Australia, is insignificant and has the wrong theoretical sign. The insignificance of this latter variable combined with the wrong signs on the excluded country price coefficients indicate that the Japanese barley market may not be a well behaved demand system in that price variables do not produce theoretically consistent estimates.

Table 6.5: Results of the Tests for Separability of the Three Import Sources (t-statistics in Brackets)[1]

Countries Included	Constant	Own Price	Excluded Country Price	Expenditure
Canada and U.S.A.	1.494 (2.86)	-0.405 (3.51)	-0.177 (4.09)	-0.049 (0.56)
Australia and U.S.A.	4.363 ((4.26)	-0.582 (2.19)	-0.398 (3.66)	0.303 (2.39)
Canada and Australia	-0.321 (0.49)	0.136 (0.23)	-0.037 (0.54)	-0.249 (2.12)

[1]The critical value of t (α=0.05, d.f.=12) is 2.18

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 conclusions to be drawn from the application of the AIDS model on the Japanese barley import market are that the import sources appear to be non-separable in demand, and that the minor import source, the U.S.A., appears to have little price influence in the import market. The separability test between imports and domestic production is inconclusive due to missing data. In addition, it is quite probable that this particular version of the AIDS model, which incorporates Armington-type assumptions, is unsuitable for application to the Japanese barley import market, because the price elasticity estimates are generally not well behaved with respect to classical demand theory.

Chapter 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 is 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 thesis 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 is 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 contains data on the Colombian barley supply from domestic production and imports (carryover 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 toal 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 7.1: The Share of Colombia's Barley from Domestic Production and Imports[1]

Year	Barley Supply (100MT)	% 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]carryover stocks not included in barley supply
Source: FAO, *Production Yearbook* and *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

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*

sources, but only on a minor scale.

7.2 Literature and Previous Research

There does not seem to be any research published in English dealing specifically with Colombian grain imports, food or feed. Therefore, the model in this analysis will be based on the general model described in Chapter 4 with the relevant variables being identified from descriptive literature.

The first step of the literature search 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. Unfortunately, this assumption can not be confirmed by looking at Canadian export data because the source for this data does not divide barley exports to Colombia into feed and malt categories. But, indirect confirmation is contained in the World Bank report on Colombia which describes maize and sorghum as "animal feed substitutes with strong cross-price elasticities in supply and demand" (World Bank, 1984, p.112). Barley is never identified as an animal feed in this or any other literature source. Therefore, this analysis of Colombian barley import demand will assume beer to be the end use of barley imports.

The World Bank report also 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 (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 3 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 study by Garcia Garcia (1981) points out several interesting features of Colombian trade policy. "During the last 30 years, Colombia has relied on differential exchange rates, tariffs, and quantitative restrictions" (p.39) to discourage excessive agricultural imports. He also points out that:

> a consistent goal of agricultural policy in Colombia has been to obtain self-sufficiency in agricultural production in general and in food production in particular (p.48).

Thus, the extent to which barley imports have been discriminated against or not is an important consideration. Garcia Garcia uses the nominal rate of protection to try and quantify production protection (calculated by: (domestic price/internation price) - 1). He concludes that for barley between the years 1953-1978, trade policies imposed a tax on domestic production and that as a result, "production was far smaller than it would have been with free trade" (p.49). In addition, his Table 9 (p.50) reveals that starting in 1972, domestic barley production had a negative nominal rate of protection due to overvaluation of the peso. The study points out that Colombian barley production has not been subsidized by the government, but has actually been taxed. But, since Garcia Garcia's data set goes only to the year 1978 and domestic producer prices for barley are unavailable, this aspect of the barley market can not be incorporated into the import model. It can only be noted here that, as illustrated in Table 7.1, barley imports have been promoted at the expense of barley production. Barley production will still be entered into the model, but is expected to have a smaller effect on barley imports relative to such countries as Russia and Japan.

A study by Kim on Mexican corn imports is very relevant to the Colombian situation. "This study examines formally the effects of Mexican government price policies and financial constraints on grain import demand" (Kim, 1986, pg.1). Kim then used a social utility maximization framework within which to solve the problem (pp.9-10) The same basic model is used to study feed grain import demand in Venezuela (Kim, Bolling and Wainio, 1987). It would be interesting to use the analytical framework in these two studies on the Colombian barley import market in order to investigate how domestic price affects Colombia's barley imports, but, as already mentioned, detailed price data for Colombia are not readily available. Instead, the general time series model outlined in Chapter 4 of this thesis will be used along with other variables mentioned in this section to analyze the determinants of Colombian barley import demand.

7.3 The Model

In the previous section, important determinant variables specific to developing countries and to Colombia were identified from previous research and other literature. These variables, combined with the variables considered important from the general model in Chapter 4, make up the model of Colombian barley import demand. This model is presented in Equation 1.

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

The model will be used for both the total barley import demand and the import demand for Canadian barley. Two variables added to the general model specifically for Colombia are debt and foreign exchange reserves. The debt variable will be measured in two different forms, one being the absolute level of government debt (lagged) and the other being the change in the debt from the previous year. The dummy variable to be entered into the total barley model is for one year, 1972, when Colombia did not import any barley. For the Canadian barley model the dummy variable is coded to one for several years (see Table 7.3) when Colombia did not import barley from Canada. And, because the end use of barley imports is beer production, no cross prices are entered into the model since there are no import substitutes for barley in beer production. The only substitute would be domestic barley production, but a producer price for barley is unavailable for the entire time series. For the Canadian model, data for the cross prices of barley from other sources are unavailable and so cannot be entered into the regression.

7.4 The Data

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

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*

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 [illegible] 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 currency form will be U.S. dollars for total barley imports and Canadian dollars for the 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.

7.5 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.

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

and adj. $R^2 = .9348$. All of the variables are significantly different than zero and have the correct expected signs on the coefficients. In addition, almost 94% 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 occurance 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.

A final note on the regression results is that domestic production has a negative sign on the coefficient which indicates that despite the tax imposed on production by Colombia's trade policies, domestic barley production is still a substitute for barley imports.

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 Bruesch-Pagan test reveals that at a 95% confidence level the presence of heteroskedasticity is rejected (X^2=3.612). The Durbin-Watson test statistic falls appoximately 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 acceptible for the regression in Equation 2 (λ=1: X^2=6.14).

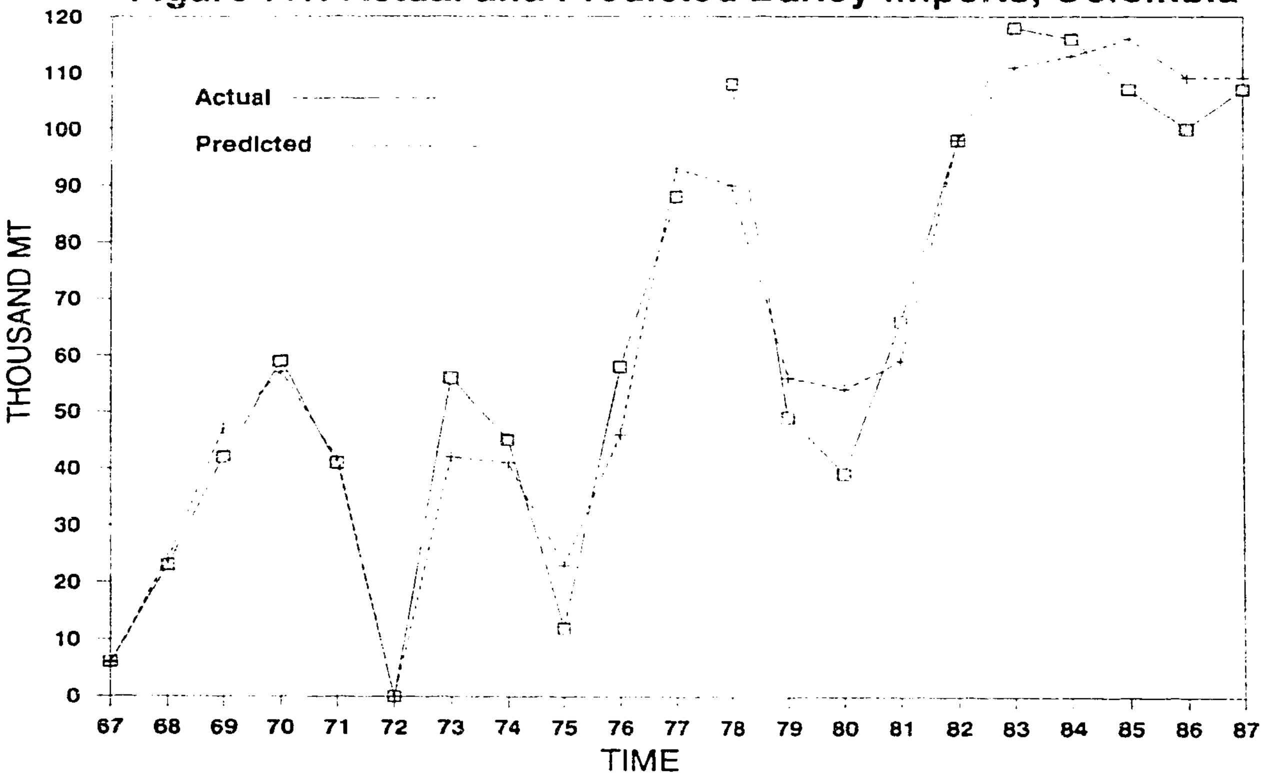
Figure 7.1 contains the graph of actual barley imports (solid line) with the model's predicted barley imports superimposed (dotted line) The graph reveals that the model does fairly well at predicting Colombia's barley imports. Some exceptions are 1973, 1978 and 1980. Actual imports might be greater 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.

The Demand for Barley Imports from Canada

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.

$$\text{3) } CANBM = \underset{(4.74)}{68} - \underset{(2.28)}{16.39CBP} + \underset{(3.91)}{1.030LRES} - \underset{(4.29)}{43D2}$$

Figure 7.1: Actual and Predicted Barley Imports, Colombia



and adj. $R^2=0.7735$. 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.

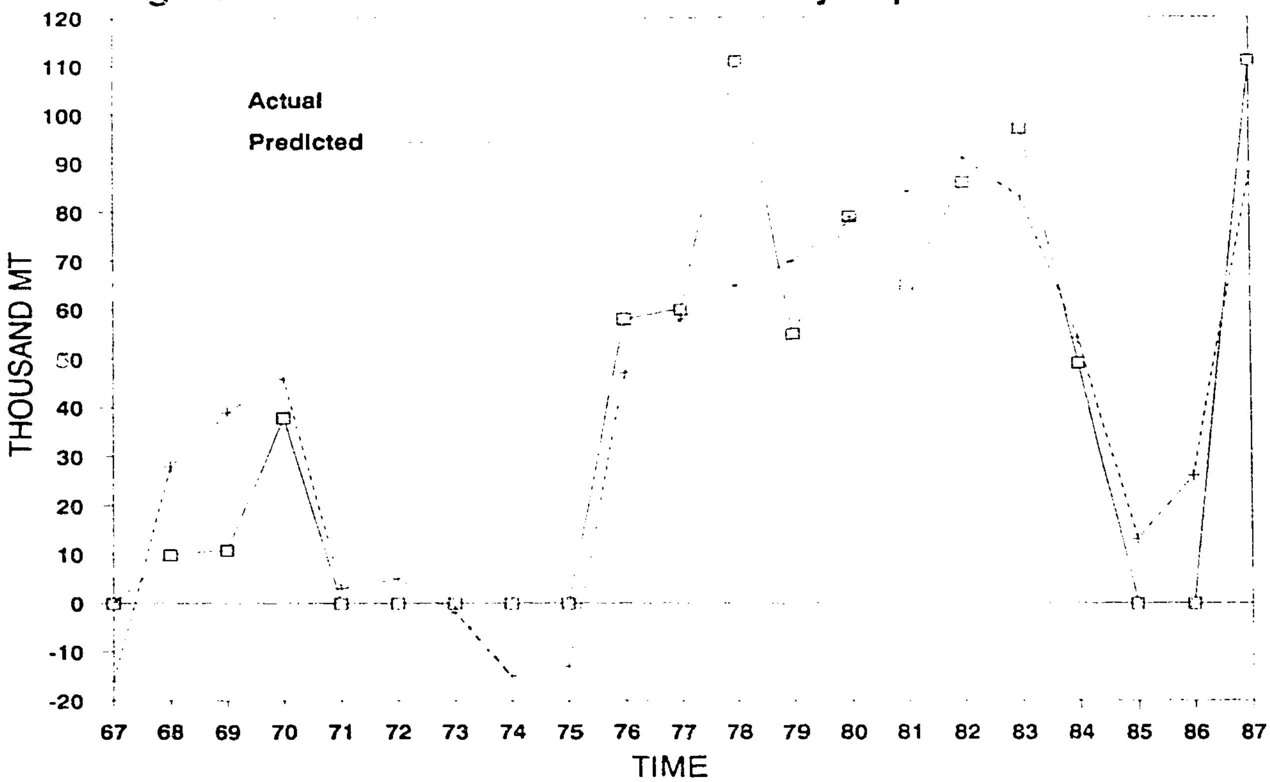
Two variables from the total barley regression (Equation 2) are no longer significant for Canadian barley: LBPR, domestic barley production and EXCH, the U.S. dollar-peso exchange rate. Nor is the Canadian dollar–peso exchange rate significant in the Canadian barley regression. Domestic barley production 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.

Tests on the regression indicate that there is no heteroskedasticity ($X^2=1.228$) and the linear functional form is appropriate ($\lambda=1$: $X^2=0.580$). 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 less than 1.0 and so fall within the inelastic range. The elasticities for the Canadian barley variables are both less inelastic than the corresponding total barley import

Figure 7.2: Actual and Predicted Barley Imports from Canada



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 (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 more elastic (that is, have a value greater than 1.0). One reason why barley as a feed grain would have a more elastic import response to own price change than does barley as a beer input is that there are far more substitutes for barley in the livestock industry than there are in the brewing industry.

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 availablity of foreign exchange does not effect barley imports

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	—

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 low responsiveness of barley imports to production was expected as a result of Colombian trade policy which has favoured imports at the expense of production (see the literature section of this chapter).

7.6 Conclusions

The results of the anlaysis 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.

Chapter 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 1.1 billion people in 1987. This figure represents almost one quarter 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.

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,

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*

Canada has been an important source of barley for China in recent years. More than half of China's imports have come 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 four further sections. The first section contains a description of the factors influencing China's barley import demand, followed by a section on the import model and data. The next section presents and discusses the results of the model estimations. The final section provides a brief summary of the import demand analysis results.

8.2 Previous Literature

This section of Chapter 8 provides a descriptive analysis of the possible determinants of barley imports in China. One of the objectives of this description is to reveal the complicated policy environment surrounding agriculture and grain trade in which policy focus and priorities often changed. Another objective is to identify variables for entry into the econometric analysis.

One of the most important and widely recognized aspects of analyzing Chinese grain trade behaviour 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. Another data problem is that for several variables considered important in this import analysis, a complete time series of data is not available. Many of these data have only been released by the Chinese government since about 1977. But, as also observed by Stone (p.206), "in spite of these problems Chinese statistical data are still very useful and are undoubtedly superior to those of the majority of developing countries". The purpose of this brief discussion about Chinese data is to acknowledge that data problems exist and that econometric results may suffer as a consequence.

The publication *China, A Country Study* (Bunge and Shinn, 1981) provides an overview of China's general economic policies (pp.161-206) that will be briefly summarized here. Between 1961 to 1965,

> faced with economic collapse... the government sharply revised the immediate goals of the economy and devised a new set of policies to replace those of the Great Leap Forward. Top priority was given to restoring agricultural output and expanding it at a rate that would meet the needs of the growing population (pp.172-173).

In other words, grain self-sufficiency became a major policy objective. Then between 1966 to

1969 came the Cultural Revolution which was a time of intense political turmoil. The disruption to economic activity in industry as well as agriculture may have caused an interruption to trading activities. Therefore, a dummy variable for the four years 1966, 1967, 1968 and 1969 will be included in the model of barley import demand.

The next policy period, 1970 to 1974, was marked by a return to systematic growth in both industry and agriculture. Then came another brief time of political turmoil, 1974-1976 when the Gang of Four endeavored to obtain political control. The disruption in this case was felt mainly within the communist party and so no dummy variable will be entered for this period.

Then in 1978 came a new era of policies which was characterized by a Chinese economy more open to the world economy. In addition, the government initiated a price reform 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 available to consumers whose incomes were steadily increasing. Besides domestic production, the government increased the supply of food by increasing the amount of agricultural imports, especially grains. This 1978 policy change signalled a new era of economic incentives and foreign trade. As such, a dummy variable will be entered into the regression coding the years of 1978 and later with a value of one. The assumption behind this dummy variable is that coarse grain imports previous to 1978 were significantly different than imports after 1978 due to the policy changes.

As for the determinants of barley trade, the literature provides many possibilities. First of all, one of the major agricultural policy objectives that has remained fairly consistent is the desire to be self-sufficient in grain production (Surls, 1978, p.654). Therefore domesticbarley production is likely to be a major factor in determining the level of barley imports. But, production shortfalls have not always resulted in increased imports and grain rationing has been an alternative policy tool to importing (OECD, 1985, p.67). And so, domestic barley production, while considered important, may not be as influential on imports as expected.

Another determinant of imports that literature provides is the end use of barley imports. According to Surls (1978, p.655), with regards to grain imports in the 1960s and early 1970s,

> it...appears that coarse grains are an inferior substitute for wheat and have thus far been purchased primarily when grain imports are large and foreign exchange pressures severe or wheat unavailable at desired delivery schedules or prices.

This quote indicates that a variable for wheat imports should be included in the barley import model, at least to determine if wheat and barley imports have been substitutes.

In more recent years (the late 1970s and early 1980s), an increasing amount of coarse grain imports have been used in the livestock sector to produce meat (OECD, p.75). And, "China's future grain imports will...largely depend on the amount of grain used for livestock production whereby feed grain required for pig, poultry and egg production will have the major impact" (OECD, p.78). With regards to barley use in particular, "imports of barley have also shown a marked increase for use as feed...and for brewing purposes. Beer consumption has been increasing rapidly, especially among young people" (OECD, p.75). A variable for beer production in the barley import demand equation would be most useful to investigate the effect on imports of increased demand and production of beer, but unfortunately such a variable is unavailable in a long enough time series.

Variables for livestock production, on the other hand, are readily available. The problem becomes which type of livestock variable to use. Surls and Tuan (1982, pp.423-424) help identify a useful variable.

> 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.

This quote indicates that the best way to measure a livestock variable would be to concentrate on hogs rather than poultry or ruminants, and that the number of hogs would be a more useful measure than pig meat production. The number of hogs, therefore, is the main livestock variable to be used in the import demand regressions. In addition, to maintain continuity with the other three time series analyses, an index of livestock production will also be tried in the regressions as an alternative measure to number of hogs.

Because a Chinese consumer price index is unavailable for use as a price and income deflator, alternative measures are identified from the literature. One such deflator is the price of rice exports. "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 is the dominant export within agricultural exports, it is reasonable to use the export price of rice as a deflator in the regression. An 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.

The final variable to be considered in this literature section is that of government debt. Although China is a developing country which would normally indicate that a debt variable might be significant, the literature reveals that China has historically been quite reluctant to borrow from foreign sources and accumulate foreign debt (World Bank, 1983, p. 461). Therefore, no variable for government debt [illegible] be considered in this analysis of China's barley import demand.

8.3 The Model and Data

Equation 1 contains the basic model of Chinese barley import demand.

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

Several variables which may be relevant but cannot be included in the model (such as foreign exchange reserves, food aid and beer production) are omitted due to insufficient data. It can only be noted here that these omitted variables are still considered to be possible determinants of barley import demand.

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

A slight problem exists with the FAO barley import data because these 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.

There are two types of 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 have a current and lagged form, and two alternative deflators are used to convert all prices to real terms, a petroleum export price index and a rice export price index. The aggregate income variable, measured as net material product, also enters the regression in real terms.

Slope dummy variables are created for the meat variables, the wheat price variable, and the income variable. The purpose of entering slope dummy variables into the regression is to determine if the policy change in 1978 created any structural differences with respect to barley imports. The meat variables are chosen for the slope dummies because, as revealed in the literature section, barley may only recently have been used to a significant degree in the livestock sector. The wheat price variable is chosen for another slope dummy because in the 1960s and 1970s barley may have been an inferior substitute for wheat as food grain and after 1978 this relationship may have changed as barley became used more as a feed grain. The income variable has a slope dummy in order to determine if the policy changes in 1978 have made the government more sensitive to the demand pressures of a population experiencing rising incomes. It is expected that prior to 1978 income had little influence on the command

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*

economy of China in which grain self-sufficiency was emphasized.

8.4 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 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.

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

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 variables. The low explanatory power of the model may be due to several factors: the quality of data for China; collinearity problems; misspecification errors. But, 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 import policy change 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 (see the literature section), 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.

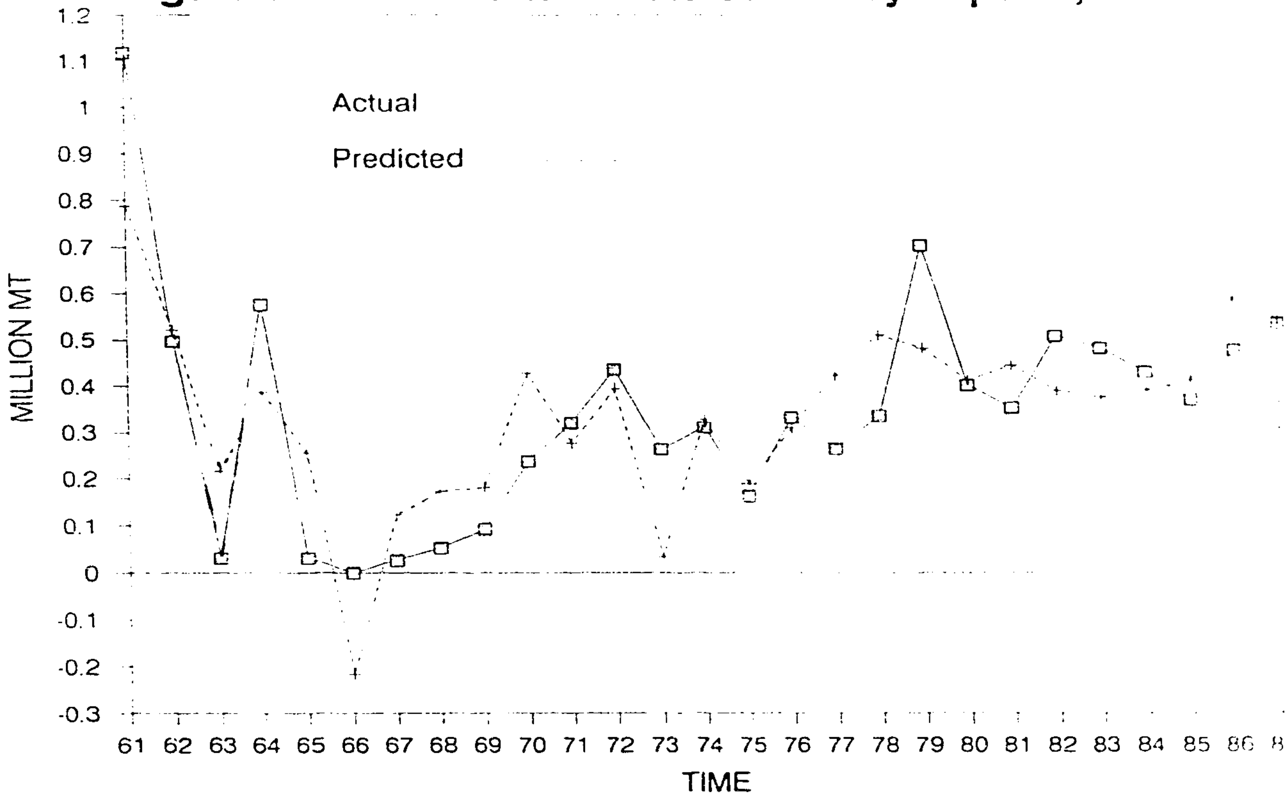
The significant livestock variable indicates that barley imports may have been used more for animal feed than for direct human consumption. In addition, the variable for the number of pigs results in better statistical estimates than does the livestock output index which is an indication that barley 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: $X^2=4.445$) and that the linear functional form is appropriate ($\lambda=1$: $X^2=0.344$). 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 graph of the actual (solid line) and predicted (dashed line) barley imports appears in Figures 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.

Figure 8.1: Actual and Predicted Barley Imports, China



The elasticities calculated from the barley import demand model are contained in Table 8.3. The table reveals that 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.

8.5 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.

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

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.

Chapter 9

SUMMARY AND CONCLUSIONS

The purpose of this final chapter is to provide a brief summary of the major conclusions from the various analyses presented in this thesis along with a discussion of the implications of these conclusions for Canada's future barley exports. Another purpose of this final chapter is to present a comparison of the estimated variable elasticities between the four time series analyses. This comparison is undertaken as a method of putting the results of the time series analyses into perspective with respect to the overall barley market.

The focus of this thesis has been the analysis of Canada's barley export market. Chapters 2 and 3 provided general, background information on Canada's role in the international barley market and on the import demand for cereals in LDCs, a market segment of special interest in this thesis due to import demand growth potential. The descriptive statistics in Chapter 2 revealed that 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 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. The implication of these findings for future exports is that Canada should continue to concentrate marketing efforts on the expansionary market segments, the Eastern European and the richer developing countries. Canada should also investigate the possibility of expanding the general use of barley as a feed grain, perhaps as a substitute for corn. An interesting research topic, which was beyond the scope of this thesis, would be to determine the extent to which corn and barley substitute as feed grains and as imports.

The descriptive analysis in Chapter 2 helped to identify the growing importance of LDC markets with respect to barley trade and to indicate the relevance of a more detailed analysis of cereal import demand in developing countries. This more detailed analysis was presented in Chapter 3 which contains a cross-sectional estimation of import demand for cereals in LDCs.

The analysis in Chapter 3 revealed that there are significant regional import demand differences across LDCs. Asian countries display a measureably 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 as indicated by the inability of the model to predict the import pattern of African countries very well. The implication of this result is that analyzing African countries in cross-section may not be a very valid practice because of the considerable demand diversity displayed by these countries. Further research in the area of African import demand is necessary for a better understanding of why the model predicts import demand in Asian and South American countries well but not 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 government debt. Of these five variables, two represent finance capabilities of developing countries. 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 three variables in the cereal import demand function all 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. This conclusion implies that 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 quite different demand specifications. This result indicates the need for further research into the validity of aggregating the food and feed grain components into total cereal import demand.

The focus of the thesis then turned to 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 Russian barley import demand analysis revealed that the major variables affecting import demand in Russia 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 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 Russia. First of all, it appears that the major force behind the import demand for barley in Russia is 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 are 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.

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. The relative exchange rate variable indicates that not only is Canada a major source of Japanese barley imports, but also the frame of reference on which imports from alternative sources are based. The implication for Canadian officials here is that care must be taken to maintain Canada's favored position in the Japanese barley import market, especially since Japan lacks the land base from which to attempt barley self-sufficiency, at least on the basis of economic efficiency. Finally, 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. Further research is needed in this area using more detailed price data than was available to this researcher.

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 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, coule 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 both the barley import demand analysis was the finding that political instability in China has, in the past, caused major interuptions 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.

The final 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 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.

The own price elasticities reveal that China shows the most elastic response followed by Russia 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 Russia. A final note on the price elasticities is that all three countries display the negative price responses expected on theoretical grounds.

Only two countries, Japan and Colombia, had meaningful estimates of exchange rate variables. Both countries display exchange rate elasticities 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 the elasticities mean that as the domestic currency falls in value relative to the dollar in question (that is, the value of the exchange rate variable increases), imports become relatively more expensive and are therefore reduced. These inelastic exchange rate elasticities indicate that exchange rate policy does not have a very large impact on barley trade which implies that Canadian export authorities, while remaining aware that exchange rates do influence barley trade, need not be overly concerned about the size of that influence.

The third and final set of elasticities in Table 9.1 relate to domestic barley production. These elasticities reveal that Russia 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. Colombia's inelastic production elasticity is another indication of Colombia's reliance on imports as an important source of barley.

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

Variables	Russia	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.

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. These elasticities were presented in order to emphasize the need for Canadian barley export officials to identify import demand determinants, such as the end use of barley imports, in order to be able to understand and anticipate future export opportunities. 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.

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APPENDIX A

LDC Countries Included in the Cross-Sectional Analysis (Chapter 3)

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. Mauritius
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