

THE UNIVERSITY OF MANITOBA

AN ECONOMETRIC MODEL TO ASSESS THE COSTS OF LABOUR DISPUTES
IN THE CANADIAN GRAIN MOVEMENT SYSTEM

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE.

DEPARTMENT OF AGRICULTURAL ECONOMICS

WINNIPEG, MANITOBA

May, 1978 ✓

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ABSTRACT

AN ECONOMETRIC MODEL TO ASSESS THE COSTS OF LABOUR DISPUTES IN THE CANADIAN GRAIN MOVEMENT SYSTEM

By: Allister Brian Hickson

Major Advisor: O. P. Tangri

The major purpose of this study was to determine the economic costs of labour-management disputes in the Canadian grain movement system. Although this problem had previously been discussed in a descriptive manner, this was the first actual attempt, known to the author, to quantify the losses attributable to these conflicts.

In order to develop an econometric model to determine the costs of the strikes, a brief review of the supply and demand for Canadian grain in both the international market and domestic market was undertaken. The demand for Canadian oats and barley is chiefly domestic, with flax and wheat being marketed internationally.

On the basis of these considerations, a hypothetical model of the grain market was determined. With regards to strikes it was postulated that they would influence the supply of grain in an inverse fashion in the current year. Their impact on the demand for grain was twofold. First, there would be continual losses inversely related to the strike variable. Second, losses of revenue would increase

during periods of abnormally high or low demand. The hypothetical model was analyzed using time series data and stepwise regression to eliminate unnecessary variables. The variables delineated in this manner were subject to econometric scrutiny and formulated into a final model.

On the basis of the final model, the elasticities and revenue losses accruable to strikes in the grain movement system were determined. It was found that labour disputes only influenced the demand for wheat, oats and barley. There was no impact of strikes on supply of any grain nor flax demand. Labour strike elasticities indicated that demand was labour strike inelastic.

Upon calculation of the revenue losses, the amount of revenue lost over the twenty-five years considered in the study was \$2,300,150,000 or \$92,007,000 yearly. Revenue losses were largest during the time period 1966-67 to 1974-75, (\$1,431,076,000), minimal during the period 1958-59 to 1966-67 (\$46,320,000) and substantial during the 1950-51 to 1958-59 era (\$822,754,000). Of the losses, wheat demand revenue losses contributed 68 percent. Oat losses were 30 percent of the total and the final 2 percent were barley demand losses.

Due to these losses it was concluded that the Canadian government must act on an on-going basis to alleviate this problem, ensuring Canada's competitive position in the world grain market. To this end a proposal was submitted to resolve this problem. A council containing

representatives of all industries and unions affected by the strikes would be established. The council would meet regularly and negotiate labour contracts. The terms and conditions of the contract would have to be ratified by a two-thirds majority of the council.

ACKNOWLEDGEMENTS

I would like to acknowledge the support of the following people in performing the analysis for, and writing this thesis:

Dr. Om P. Tangri for acting as my major advisor, lending helpful criticisms and suggestions to earlier drafts and his encouragement through my Graduate studies program;

Dr. D. F. Kraft for serving on my advisory committee and initially inciting me to take my Masters program in Agricultural Economics;

Dr. T. S. Major for providing significant criticisms leading to the final copy of the thesis contained herein;

My parents for their support through my studies;

The people of the annex for the "spirited" time during my year and a half in the program; and

Mrs. L. Hiebert for typing the drafts and the final copy of the thesis.

Finally, I would like to express my gratitude to the Centre of Transportation Studies, University of Manitoba and the Department of Agricultural Economics for their financial support.

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CHAPTER 1

INTRODUCTION

A. Background and the Problem

The Canadian Grain Movement System (CGMS) has seven transshipment points in a bi-modal network. These seven points are: the Pacific Coast, the Prairies, Churchill, Thunder Bay, the Great Lakes, the Lower St. Lawrence and the Maritimes. Bulk shipments of grain are conveyed by rail and boat. The effectiveness of this system can be measured in terms of its responsiveness to international grain markets.

The international market for grains can be characterized as "being much more erratic than domestic consumption patterns. The pattern of grain import requirements in a number of countries depends to a large degree on the variability of indigenous production and grain import policies."¹ Additionally, recent years have witnessed increased competition among major grain exporters (Canada, United States, Australia and Argentina) for these

¹W. E. Jarvis, "Canadian Grain Market Patterns," Proceedings of the World Grains Seminar (Winnipeg: Canada Grains Council, 1973), p. 79.

international markets.² Consequently, the need for an efficient, responsive Canadian transport marketing system is vital if Canadian grain is to remain competitive in the international market.

Due to the multifaceted nature of the grain movement system, the potential for bottlenecks is substantial. Clearly, the effect of such tie-ups is a decrease in Canada's ability to deliver grain to these fluctuating markets. This failure to meet the market demand can only result in reduced incomes to Canadian farmers. Farm incomes fall because of:

- 1) the direct loss of international sales as importers perceive the Canadian grain as an unreliable source of supply,
- 2) the cost of demurrage³ charged against the grain by ships waiting to load,
- 3) the extra storage costs due to the inability to move it through the system, and

² Donald J. Novotny and James P. Reedbeck, Competition for World Wheat Markets and U.S. Exports (Washington: U.S. Department of Agriculture, 1970), pp. 13-18.

³ "Demurrage" refers to the charges assessed by merchant ship owners because their vessels are unable to receive delivery of goods. As established by the Canadian Wheat Board (Annual Report 1974-75) these costs were \$4,486,792.

- 4) the costs of diverting⁴ grain through alternate sectors, due to the occurrence of congestion (caused by labour difficulties) on the previous transportation route.

"The principle bottlenecks in volume capabilities have varied from heavy snowfall in the Rockies, to railway rolling-stock shortages, to labour disputes."⁵ However, the effect of a labour strike is the most significant. Labour strikes are capable of completely suspending the throughput of grain through a sector via either mode. Rolling-stock shortages, weather conditions and 'general' congestion do not completely suspend the movement of grain, but slacken the speed with which it passes through the system from its potential capacity.

Labour strikes on docks are a phenomena which have been decreasing in number, but increasing in duration (measured in lost days) since 1949.⁶ The result of this event has been increased congestion in grain transportation.

⁴The costs of diverting grain to other terminals may be quite significant. For details, see *ibid.*, pp. 64-65.

⁵Keith A. J. Hay and S. R. Hill, Transportation Implications of Canada's Trade with Japan (Ottawa: The Canada-Japan Trade Council, 1975), p. 35.

⁶Mohammed Ahmed, "Dock Strikes and Their Impacts on Canada's Wheat Trade," unpublished Master's Thesis, University of Manitoba, 1977, p. 87.

As a result, analyses of the costs of these strikes in light of the international market must be carried out. The development of a dynamic model to examine these costs will provide information necessary to resolve this problem.

B. Literature Review

Many analyses have been performed on the supply and demand for Canadian grain. However, until recently, minimal research was initiated into the effect of labour disputes on the export of commodities.

Perhaps two of the keynote studies into the world grain market are those of Huff⁷ and Schmitz and Bawden.⁸ The objective of the former research was to develop long run predictions of the effect of Canadian public policy and agricultural policy of importing (and other exporting) nations on the supply and demand for Canadian wheat, in the not too distant future. After briefly reviewing the historical factors influencing supply and demand for wheat, the author hypothesizes an analytical model to explain deviations in the supply and demand for Canadian grain. Using time series data over the time horizon of 1946/47 to

⁷H. Bruce Huff, Marketing of Canadian Wheat: An Economic Analysis with Projections for 1975 and 1980 (East Lansing: Michigan State University, 1969).

⁸Andrew Schmitz and D. Lee Bawden, The World Wheat Economy: An Empirical Analysis (University of California, 1973).

1967/68, three stage least squares⁹ estimates were fitted to the system of equations.

The study by Schmitz and Bawden considerably extended knowledge of the world wheat economy through the use of a spatial equilibrium model. By dividing the demand for wheat into four categories (food, feed, industrial and seed) and the world into fifteen regions a model for demand and supply for wheat in each component was created. With the inclusion of transfer costs, the model was estimated and then a supply-demand matrix for the various regions was constructed.

With the incorporation of certain exogenous factors into the model,¹⁰ the authors were able to predict future wheat trade flows (and prices) amongst the regions considered in the analyses.

While these econometric studies have their merits, they both failed to deal with a critical issue in the supply of and demand for Canadian wheat. Neither study came to grips with the effect of labour-management strife on the supply and demand of Canadian wheat.

⁹A. Zellner and H. Theil, "Three Stage Least Squares: Simultaneous Estimation of Simultaneous Equations," Econometrics, Vol. 30, 1962, pp. 54-58.

¹⁰Among the assumptions were:
i) tariffs existing in the EEC at \$2.90 per bushel, and
ii) shipping costs falling between Canada and the U.K., p. 33.

This issue was first tackled by the Westac¹¹ report on Vancouver port facilities. While largely employing a descriptive analysis, the study attempts to relate the implications of labour disputes for the throughput ability of Vancouver grain terminals.

Through a historical analysis of available data, the research team found that strikes have led to work stoppages, 6 percent of the available working time in the time period 1952-72 and 16 percent over the period of 1972-75.¹² Subsequently, throughput capability has been reduced by this quantity.

Among other findings in the Westac study, the nature of contractual arrangements between port operators and the various unions contributed to this loss of production. The contracts have differing hours of work, pay scales, break times and termination. Consequently, there is an overlap in duties of personnel and significant capacity losses due to union members taking breaks at differing hours (or in fact, working different hours).

¹¹ Emil Bjarnson (Ed.), Operation Aspects of Contractual Arrangements for Vancouver Grain Terminal Grain Handling and an Exploration of Alternatives (Vancouver: Western Transportation Advisory Council, 1975).

¹² Ibid., p. 3.

The analysis of this problem was extended greatly by the research conducted by Ahmed.¹³ By performing a historical analysis, the factors contributing to the frequency of dock strikes were ascertained. These factors¹⁴ were:

- i) the unemployment rate,
- ii) the yearly percentage change in the consumer price index,
- iii) the yearly percentage change in the wage rate, and
- iv) union membership.

Further to this, a model¹⁵ to determine the duration of dock strikes was estimated using ordinary least squares. The average¹⁶ duration of dock strikes was found to be dependant on:

- i) the unemployment rate,
- ii) the consumer price index,
- iii) the proportion of strikes called for non-economic reasons,
- iv) the average number of workers per strike, and

¹³Ahmed, op. cit.

¹⁴Ibid., pp. 58-74.

¹⁵Ibid., pp. 81-90.

¹⁶Where average duration is defined as:

$$\frac{\text{total number of days a dock strike occurs in year } t}{\text{total number of dock strikes in year } t}$$

v) union membership as a percentage of the labour force.

Having determined the factors influencing the duration and frequency of dock strikes, the effect of these strikes on wheat exports was analyzed. Using a variable defined as "the number of lost man-days per 100 workers due to dock strikes,"¹⁷ an econometric model was developed to relate this variable and other pertinent variables (world demand for wheat, export price of Canadian wheat, and export price of U.S. wheat), to the total export of Canadian wheat in a given year. With time series data it was found that the variable indicating the effect of strikes was inversely related to the exports of wheat in a given year, indicating that dock strikes have contributed to the decrease in demand for Canadian wheat.

These analyses of the world wheat market, and Canada's role in this market, have relied chiefly on regression techniques to derive estimates of the influence of the various independent variables on the dependant variable. In light of this progression, regression will also be employed in this analysis.

C. Method of Analysis

The first step of analysis in econometrics is the development of a theoretical model. On the basis of such a

¹⁷Ibid., p. 101.

model, whether it is defined by an independent or interdependent system of equations, time series or cross-sectional observations of the dependant and independent variables are accumulated. Through the use of ordinary least squares¹⁸ or two stage least squares¹⁹ regression of the independent variables on the dependant variable is performed.

Without needlessly deriving either of these techniques, the properties of each technique are noted below.²⁰ Ordinary least square estimates are unbiased, efficient and the best estimate for small samples. Ordinary least squares is employed with independent equation models. If the model contains numerous simultaneous equations, several choices are available to derive estimates of the coefficients. Three of these methods are: limited information maximum likelihood, full information maximum likelihood, and two stage least squares. Of these choices, "two stage least squares has been generally accepted as the most important

¹⁸J. S. Cramer, Empirical Econometrics (Amsterdam: North-Holland Publishing Company, 1971), pp. 89-96.

¹⁹Carl F. Christ, Econometric Models and Methods (New York: John Wiley and Sons Inc., 1966) pp. 431-453.

²⁰A. Koutsoyiannis, Theory of Econometrics (London: MacMillan Press Ltd., 1973), pp. 98-101.

technique for the estimation of overidentified models"²¹ because it is simple to use and removes the bias due to simultaneity in the model.

As this research involves an interdependent, overidentified model, hopefully two stage least squares can be used to obtain coefficient estimates. For small samples sizes, several characteristics of these estimates are important. First, they are biased, but as the sample size increases the bias decreases. The estimates are inconsistent, but become consistent as the sample size increases.

In a model where there are numerous independent variables, stepwise²² regression is often employed to eliminate variables which do not contribute to the explanation of the dependent variable. This procedure operates in the following manner:

- i) On the basis of a correlation matrix, the independent variable with the highest correlation to the dependant variable is regressed upon it.
- ii) Using a partial correlation coefficient, the independent variable with the next highest correlation to the dependant variable, is chosen to be regressed upon it.

²¹Ibid., p. 374.

²²N. R. Draper and H. Smith, Applied Regression Analysis (New York: John Wiley and Sons Inc., 1966), pp. 171-177.

- iii) The procedure then examines the contribution of the first independent variable if it was regressed on the dependant variable after the second.
- iv) If the independent variable is chosen to remain, the next best independent variable (based on its partial correlation coefficient) is entered and the procedure (step iii) repeated.

As the sample employed in this model is somewhat restricted, stepwise regression will be employed to eliminate unnecessary variables.

Having designated the method of analysis employed in this thesis, it will be useful to list some other techniques which may have been applied to this problem.

This list might include ^{*}:

- i) a network analysis approach,²³
- ii) the use of queuing theory,²⁴
- iii) stochastic dynamic programming,²⁵ or
- iv) linear programming.²⁶

²³Frederick S. Hillier and Gerald J. Lieberman, Operations Research, 2nd ed. (San Francisco: Holden Day Incorporated, 1974), pp. 214-248.

²⁴A. Chosal, Some Aspects of Queuing and Storage Systems (New York: Springer Verlag, 1970).

²⁵George L. Vemhauser, Introduction to Dynamic Programming (New York: John Wiley and Sons, Inc., 1967).

²⁶Hillier and Lieberman, op. cit., pp. 15-213.

*A more thorough explanation of these methods is provided on pages 158-162.

D. Objectives of the Study

In light of the problem at hand, the first and foremost objective of this thesis is to estimate the income losses attributable to strikes in the Canadian Grain Movement System. To achieve this objective it is necessary to develop a dynamic model for the production (supply) of Canadian grains, as well as dynamic international demand models. The second objective is to verify whether the effect of labour disputes is different when demand and supply of Canadian grain is high or low. Policies to resolve such conflicts must be tempered with consideration of costs under the two (high and low) levels of demand and supply.

E. Scope and Outline of the Study

As research has just been completed with regards to the frequency, duration and causes of dock strikes,²⁷ this study does not attempt to explain these phenomena. These factors will be taken as constant.

The scope of the previous study is broadened in certain aspects and narrowed with respect to others. The expansion allows rail and dock strikes to influence grain movement and production. It is also improved by including only those dock strikes (and rail strikes) which have an effect on the movement of grain for export.

²⁷Ahmed, op. cit., pp. 57-90.

Furthermore, costs attributable to strikes will only include the first of the aforementioned categories, i.e. the loss of international sales of grain. The effect of the other three costs (demurrage, diversion and storage) may be significant, but it is dubious, at best, to relate them directly to labour disputes.

The time horizon of this research was from the crop years of 1950-1951 to 1974-1975. A longer time horizon (historically) was unacceptable as the information on strikes was insufficient. Additionally, an extended time series would be adversely influenced by food policies implemented during the Second World War.

It is necessary to note the grains to be analyzed. Wheat was the principle export grain over this time period. Oats, barley and flax were also significant. Rye was ruled out as it contributes only a minor amount to grain exports. Rapeseed has only been produced and internationally marketed since 1958-1959, so it was infeasible to consider it in the model. Thus for the remainder of this study, grain will refer to wheat, oats, barley and flax.

Finally, it must be noted that due to financial and time constraints, none of the alternate techniques mentioned earlier (page 10) are feasible to employ at this time. In the future they may form the basis of further research into this problem. Further, in light of these constraints, as well as the rather narrow data base available for this study, it must be stressed that the scope of

this research is limited to modelling the costs of labour disputes, not the world grain economy.

The remainder of this thesis consists of four chapters. Chapter Two is a descriptive chapter of the grain market. The Canadian supply and demand situation, and its role in the international market will be briefly considered. Finally, a theoretical model of the effects of labour disputes on supply and demand for Canadian grain will be described.

The third chapter deals with the analytical model and data base. The specification of the model and the selection of relevant variables will be shown. The final model to calculate costs is also described in that chapter.

Chapter Four deals with the results of this research. Included in this section are the costs of labour disputes in the grain movement system as well as the elasticities of demand and supply with respect to the strike variable.

The final chapter provides a summary of the thesis, and the conclusions derived from the research. A proposal to abate the situation is also presented.

CHAPTER 2

THE GRAIN MARKET

A. International Demand, Supply and Market Characteristics

1. Wheat. The international wheat market consists of five major exporting countries and six importing regions. The five major exporters of wheat are: Canada, the United States, Argentina, Australia and the U.S.S.R. The major importing areas are the United Kingdom, the European Economic Community, Mainland China, India, U.S.S.R. and Japan. Of these, the U.S.S.R. holds a unique position. In most circumstances the Soviet Union is an exporter of wheat to fellow Eastern European countries. However, production failures in the Soviet Union often has led to massive purchases of wheat on the international market.

Outside the Soviet influence, essentially the other four countries meet the world's demand for wheat. Canada, United States, Australia and Argentina supplied 77 percent of the export wheat on average between crop years 1955-56 and 1974-75. This ranged from a high of 86.5 percent to a low of 62.8 percent (Table 2.1). Of this, Canada's share ranged from a high of 26.7 percent (1963-64) to a low of 17 percent (1974-75). What international factors have caused this variability in wheat exports?

Table 2.1

EXPORT OF WHEAT BY LEADING EXPORT NATIONS

Crop Year	Canada (mil. bu.)	Percentage of Total	U.S.A. (mil. bu.)	Australia (mil. bu.)	Argentina (mil. bu.)	World Total (mil. bu.)	Percentage of World Total
1955/56	304	27.4	346	102	112	1110	77.9
1956/57	270	20.6	549	126	99	1311	79.7
1957/58	317	26.6	402	62	78	1191	72.1
1958/59	300	22.8	442	75	103	1316	69.9
1959/60	280	20.6	509	122	78	1359	62.8
1960/61	342	21.7	661	183	71	1577	79.7
1961/62	265	20.8	718	232	86	1657	79.8
1962/63	330	20.5	638	182	66	1608	75.6
1963/64	552	26.7	849	286	102	2070	86.5
1964/65	438	23.3	720	238	163	1881	82.9
1965/66	547	23.8	860	209	292	2296	83.0
1966/67	545	26.3	742	257	112	2070	80.0

(Continued)

Table 2.1 (Continued)

Crop Year	Canada (mil. bu.)	Percentage of Total	U.S.A. (mil. bu.)	Australia (mil. bu.)	Argentina (mil. bu.)	World Total (mil. bu.)	Percentage of World Total
1967/68	336	17.4	753	258	50	1933	72.3
1968/69	306	18.5	552	197	102	1651	70.1
1969/70	346	18.5	617	266	78	1874	69.7
1970/71	435	21.9	740	349	64	1989	79.8
1971/72	504	26.2	621	321	49	1927	77.6
1972/73	577	23.3	1166	204	129	2471	84.0
1973/74	419	18.2	1142	202	44	2301	78.5
1974/75	394	17.0	1041	296	80	2315	78.2
Average	390	22.3	703	196	98	1795	77.0

SOURCE:

Canadian Wheat Board, Annual Report (Winnipeg: Canadian Wheat Board), 1975.

First and foremost are the sporadic nature of the Soviet Union's and Mainland China's participation in the market. During periods of Soviet involvement much more grain is required on the market. Consequently, every country increases its exports. However, large scale Soviet purchases usually are in the form of hard spring wheats. Thus demand for Canadian wheat is intensified,²⁸ being the major producer of high protein wheat.

The second cause of these fluctuations has been (or the lack of) international wheat agreements. During post war reconstruction of Europe, major exporters of wheat became involved in numerous International Wheat Agreements (1946, 49, 53, 56, 59, 62, 65 and 67) with the objective of stabilizing the price of wheat. These agreements guaranteed a certain quota and export price for wheat being marketed to the importing countries, especially the United Kingdom and Western Europe. Therefore, the market share of Canadian wheat remained relatively constant over this time period.

However, other forces entered the market which led to the downfall of the wheat agreements. First, the formation of the EEC and its policy to buy within resulted in

²⁸Soviet purchases from world suppliers were 12 million metric tonnes in 1965-66, 20 million metric tonnes in 1966-67 and 10 million tonnes in 1967-68. Similarly, Canada's share of the market was 23.8 percent, 26.3 percent and 17.4 percent in respective years.

the European market shrinking. At the same time large scale Soviet purchases were occurring, resulting in competition outside the IWC for their purchases. The increase in Japanese consumption was also beginning, with infighting over its market.

As the IWC was being circumvented due to this pressure, for all intents and purposes it collapsed in the middle sixties. With its failure, more competition was evident in the world wheat market, leading to a greater variability in the exporting nations market share.

A third factor in the upheaval of market shares was the "Green Revolution." With the advent of new high yielding wheat and better technology, many Asian countries, notably India and Pakistan, became much more self-sufficient in meeting their food requirements. Their participation in the export market fell. However, occasional crop failure led to foreign aid programs and exogenous shocks to the market.

Finally, the period of the sixties saw almost a doubling of Australian wheat production. With a non-storage policy²⁹ an aggressive price cutting sales program was implemented by their government. Subsequently, Australia's market share increased while the Canadian Wheat Board was trying to maintain price levels.

²⁹Australia sells all its wheat each year, unlike Canada and the United States where stocks are carried over.

The wheat market may be characterized as one with prospects of increased price and market share variability.

2. Flaxseed. Flaxseed and rapeseed are the principle oilseed crops of Canada. Both are primarily grown on the Prairies. Although some flaxseed is crushed domestically, the majority is exported. The primary uses of flaxseed are for cake and linseed oil. Linseed oil is one of the principle constituents of paints, printing inks and varnishes. As well, flaxseed meal and cake are used for livestock feed.

Given the usages of flaxseed, the international market may be characterized as having two outstanding factors: a) interchangeability of products, and b) competition among product substitutes.³⁰ Recent developments have seen increased interchangeability among various vegetable and synthetic oils in industrial production. As well, the oilcake/meal market shows a degree of interchangeability. The usage of linseed cake and meal in animal rations depends on its protein content and price. As cake price rises, substitution among vegetable meals with a similar protein profile and lower price increases, the goal of the animal producer being to optimize the cost of feed rations.

³⁰ A. Pokrant, "An Econometric Analysis of Canadian Flaxseed Exports and Prices," unpublished Master's Thesis, University of Manitoba, 1975, pp. 23-32.

Another component must be considered when discussing the interchangeability of flaxseed products. The availability of substitutes for linseed oil depends on the supply and prices of other condiments required with these substitutes in the manufacturing process. Similarly, this phenomena exists in the flaxseed cake and meal market.

The second outstanding characteristic of the flaxseed market is its competitive aspects. Almost every region of the world is a producer of some type of oil product, whether it be vegetable, mineral, or animal, which can be used for industrial purposes. With all these interchangeable products, competition in the linseed oil market can only be classified as intense.

Domestic production in countries must compete with many of these foreign competitors. Thus domestic prices are dependant on international prices of linseed and its substitutes.

3. Feed Grains. Feed grains are produced throughout the agricultural region (the Prairies and Ontario) of Canada. Barley, oats and corn are the primary grains produced. Of these, oats and barley are mainly grown on the Prairies, with corn being grown in Ontario.

Most western feed grains are used domestically by Eastern Canadian livestock producers. Under the Feed Freight Assistance program, feed shipments from Western Canada to British Columbia, Quebec and the Atlantic

provinces have their freight charge subsidized. While aiding the marketing of Western feed grains, this program has discouraged livestock production in the West,³¹ although it has assisted in meeting competition from American feed corn.

Canadian feed grains, although competing domestically with American corn, are somewhat impeded in entering the U.S. market due to restrictive tariffs and quotas. These tariffs are designed to protect the domestic cereal grain and oilseed industry in the United States.

Whatever surplus feed grain exists in Canada is exported through the Canadian Wheat Board. With similar markets as wheat (the United Kingdom, Japan and Eastern block countries), the sporadic nature of demand is once again evident. Australia, Argentina and the United States are competitors in this market. Aggressive marketing is also the policy required in this competitive situation in this market.

B. Canadian Demand and Supply

1. Demand. The major uses of Canadian grain on the domestic market are threefold. Grain is used for feed, seed and industrial purposes. Of these the usage of grain

³¹A. G. Wilson, "The Impact of the Feed Freight Subsidy on the Location of Livestock Production," unpublished Ph.D Thesis, University of Manitoba, 1969.

for feed purposes is the most important. Within the context of feed, grain is used for two uses: livestock and human food.

From Table 2.2 it can be seen that the major useage of wheat over the time period 1967/68 to 1975/76 was for export. On the average 418,800,000 million bushels were exported. This ranged from a high of 576,600,000 bushels during the 1972/73 crop year, to a low of 305,800,000 bushels during the 1968/69 crop year. On average exports were 73 percent of domestic production in a given crop year.

Domestic consumption of wheat for feed purposes averaged 136,300,000 bushels per crop year, with a high of 146,600,000 bushels in 1971/72 to a low of 114,200,000 bushels in the 1967/68 crop year. The consumption of grain for food averaged about 26 percent of total production. Compared with the use of wheat for export this was a rather small amount. Wheat was also domestically consumed for seeding in following crop years. On average 30,800,000 bushels are consumed in this manner. This contributes to approximately 1 percent of the total production of wheat during a given year.

While the major proportion of wheat grown in Canada goes into the export market, the converse is true of the two principle feed grains. Oat exports (Table 2.3) averaged a miniscule 6,900,000 bushels over the 1967/68 to 1975/76 crop years. This was a mere 2 percent of total

Table 2.2

SUPPLY AND DISPOSITION OF WHEAT IN CANADA

Crop Year	Production As of August 1	Exports	Feed Use	Seed Use	Other Uses
----- (million bushels) -----					
1967/68	592.9	336.0	114.2	39.4	2.6
1968/69	650.0	305.8	125.6	33.4	5.9
1969/70	671.2	346.5	149.4	16.8	1.6
1970/71	331.6	435.3	143.6	26.1	1.7
1971/72	529.5	503.8	146.6	28.6	1.0
1972/73	533.3	576.6	141.9	31.8	1.3
1973/74	593.7	419.4	137.6	29.1	2.3
1974/75	488.5	394.6	132.5	33.3	3.5
1975/76	627.5	451.4	135.4	39.0	3.8
Average	577.6	418.8	136.3	30.8	2.6

SOURCE:

Canada Grains Council, Statistical Handbook 1977
(Winnipeg: Canada Grains Council), Annual,
pp. 29-31.

Table 2.3

SUPPLY AND DISPOSITION OF OATS IN CANADA

Crop Year	Production As of August 1	Exports	Feed Use	Seed Use	Other Uses
----- (million bushels) -----					
1967/68	301.8	3.6	311.1	19.9	0
1968/69	356.7	2.7	287.2	19.9	.2
1969/70	354.9	5.2	312.1	17.9	.1
1970/71	353.1	13.4	345.2	17.4	0
1971/72	363.5	10.5	343.9	16.1	.1
1972/73	300.2	6.9	314.4	17.4	.1
1973/74	326.9	.8	319.3	16.3	.1
1974/75	254.8	1.4	243.6	15.6	.1
1975/76	289.6	18.2	249.4	15.4	.2
Average	322.4	6.9	302.9	17.4	.1

SOURCE:

Canada Grains Council, Statistical Handbook 1977
(Winnipeg: Canada Grains Council), Annual,
pp. 29-31.

production in a given crop year. On the other hand, domestic consumption of oats for feed use averaged 302,900,000 bushels, with a high of 345,200,000 bushels during the 1970/71 crop year, and a low of 243,600,000 bushels during the 1974/75 crop year. Approximately 94 percent of domestic production was consumed domestically for feed.

A similar situation was evident for barley (Table 2.4). Barley production in Canada averaged 421,100,000 bushels from 1967/68 to 1975/76. Of this, exports averaged 133,000,000 bushels. The highest barley exports were during the 1971/72 crop year (230,600,000 bushels). Lowest exports occurred in 1967/68. While exports were significantly higher than in the case of oats, they only averaged 32 percent of total production. On the other hand, the domestic consumption of barley averaged 60 percent of production over the period 1967/68 to 1975/76.

With regards to flaxseed, exports once again were the most significant component of demand. With a relatively small amount of production compared to other Canadian grains, flaxseed exports are often disregarded in economic analyses. However, flaxseed has been and will continue to be an important export crop. Exports of flaxseed, used primarily for industrial purposes, averaged around 16,100,000 bushels (Table 2.5). This ranged from 25,700,000 bushels (1971/72) to 7,700,000 bushels (1975/76). Average exports were 74 percent of domestic production. The use of

Table 2.4

SUPPLY AND DISPOSITION OF BARLEY IN CANADA

Crop Year	Production As of August 1	Exports	Feed Use	Seed Use	Other Uses
----- (million bushels) -----					
1967/68	252.9	41.4	181.7	14.6	17.0
1968/69	326.1	26.4	199.7	15.3	18.2
1969/70	371.3	88.3	240.7	15.8	18.8
1970/71	408.3	179.6	248.1	22.0	19.4
1971/72	601.6	230.6	298.2	19.7	21.5
1972/73	518.3	165.6	296.7	19.5	19.7
1973/74	469.6	127.5	288.0	19.2	19.5
1974/75	404.3	138.4	244.4	18.5	22.9
1975/76	437.3	199.4	259.5	17.7	22.3
Average	421.1	133.0	250.8	18.0	19.9

SOURCE:

Canada Grains Council, Statistical Handbook 1977
(Winnipeg: Canada Grains Council), Annual,
pp. 29-31.

Table 2.5

SUPPLY AND DISPOSITION OF FLAXSEED IN CANADA

Crop Year	Production As of August 1	Exports	Feed Use	Seed Use	Other Uses
----- (million bushels) -----					
1967/68	9.4	12.6	.5	.9	2.3
1968/69	19.7	13.4	2.2	1.5	2.4
1969/70	28.1	18.6	3.3	2.0	2.5
1970/71	47.9	21.2	4.1	1.1	2.8
1971/72	22.4	25.7	1.9	.9	3.2
1972/73	17.6	19.6	2.7	.9	2.7
1973/74	19.4	15.5	2.0	.9	.8
1974/75	13.8	10.5	2.6	.9	1.7
1975/76	17.5	7.7	3.4	.9	1.2
Average	21.8	16.1	2.2	1.1	2.2

SOURCE:

Canada Grains Council, Statistical Handbook 1977
(Winnipeg: Canada Grains Council), Annual,
pp. 29-31.

flaxseed for feed and industrial purposes averaged 2,200,000 per crop year, respectively. This was 1 percent of domestic production.

In summary, it is clear that the major markets for wheat and flaxseed are the international markets. In the case of wheat, major importers are the United Kingdom, the EEC, China, Japan, India and the U.S.S.R. For flaxseed, Japan and West Europe³² are the major consumers. Thus, flaxseed and wheat are largely subject to the vagaries of international market.

The two feed grains do not fit this scheme. Clearly, feed grains are used primarily in Canada. Within this context, the federal government through its actions and those of the Canadian Wheat Board are able to exert more influence on the market. Such programs as the Feed Freight Assistance are examples of such policy directives.

What factors influence the demand for Canadian grains? Within the context of wheat and flaxseed, one variable of importance is the price of Canadian wheat versus our major competitors product. In this case, the United States is the major competitor. Further, income levels will influence the amount of wheat imported by a country. For flaxseed, production levels in importing regions will also have a major influence on the consumption of flaxseed.

³²Pokrant, op. cit., p. 35.

Within Canada, consumption of oats and barley will chiefly be influenced by three factors. These factors are:

- i) the relative price of oats and barley in Canada,
- ii) the price of American corn, oats and barley, and
- iii) the quantity of livestock in Canada.

These considerations of the demand for Canadian grains in the world and domestic market form the basis of the demand equations to be specified in the following chapter.

2. Supply. Two levels of supply must be distinguished in the Canadian grain economy. This is the supply of grain at the farm level and the supply of grain in the transportation, loading and elevation system.

First, to deal with the supply of grain at the farm level. For the most part, supplies of the four grains considered in this study depend on the same factors, therefore this description will consider them together.

Perhaps the single most important factor in a farmer's decision to seed a grain is the expected price. As price rises, production also rises. However, with grains a problem exists in that prices at seeding time may substantially vary from those at harvest. Thus the price variable may, in fact represent farmers expectations of price rather than actual price. Schmitz³³ has suggested

³³Andrew Schmitz, "Canadian Wheat Acreage Response," Canadian Journal of Agricultural Economics, Vol. 16, No. 2 (June 1968), pp. 79-86.

that this variable may reflect initial payment prices for wheat, oats and barley. Furthermore, the prices of production substitutes may influence production of a grain. For example, if flaxseed prices are high, farmers may shift acreage from wheat to flax, seeking to fulfill their ultimate goal of maximizing their returns per acre of land.

Carryover of a specific grain will also influence the production of that grain in the following year. As carryover from the previous year increases, production (or supply) in the current year will decrease. Two factors contribute to this phenomena. First, as stocks build up on farms, producers will decide to plant fewer acres to the crop in the next year. Stock accumulation on farms occurs as a function of the second factor. Quotas established by the Wheat Board, may also inhibit farmers' production.

Delivery quotas will prevent movement of grain to primary elevators, thus increasing on farm storage. Such a quota may restrict production as farmers alter their seeding pattern as their storage facilities reach capacity.

Weather also plays a crucial role in the production of grain. Conditions of moisture at seeding, precipitation during the growing period and frost free days will reflect themselves in the level of production during a crop year. However, precipitation figures are often misleading as the timing of rainfall is important. For example, heavy rainfalls during spring and autumn may slow seeding and harvesting, while a lack of moisture in midsummer may

inhibit heading out of grain. Thus the quantification of a weather variable is exceedingly difficult.

Government policies may also have a significant impact on farmers' production decisions. A classical example is the LIFT³⁴ program instituted by the federal government for the 1970/71 crop year. Under the auspices of this program farmers were subsidized to keep grain land out of wheat production. The effectiveness of the program can be seen from Table 2.6. Prior to 1970 seeded wheat acreage was between 29,570,000 acres and 24,400,000 acres annually. With the initiation of LIFT seeded wheat acreage dropped to 12,000,000 acres. Subsequent to the end of the program wheat acreage climbed, once again, ranging between 18,885,000 and 23,100,000 acres.

While the LIFT program substantially reduced wheat acreage, little if any, rise can be seen in the acreage allotted to oats and barley. However, seeded flax acreage rose substantially from 2,320,000 acres in 1969 to 3,300,000 acres in 1970.

Technology is another factor which reflects in the production of grain. Through the past three decades, farming has become increasingly technological, with the advent of improved farming methods, better equipment, large scale fertilization and weed control, and higher yielding

³⁴ Lower Inventories for Tomorrow.

Table 2.6

ACREAGE OF PRINCIPLE GRAINS IN WESTERN CANADA
(000's)

Year	Wheat	Oats	Barley	Flaxseed
1965	27,790	5,645	5,741	2,265
1966	29,166	5,422	7,010	1,883
1967	29,570	5,090	7,600	998
1968	28,860	5,340	8,330	1,502
1969	24,400	5,430	8,800	2,320
1970	12,000	5,260	9,300	3,300
1971	18,885	5,315	13,312	1,762
1972	20,800	4,660	11,900	1,320
1973	23,100	5,300	11,350	1,450
1974	21,500	4,800	11,200	1,450

SOURCE:

Canadian Wheat Board, Canadian Wheat Board Annual Report 1975-76 (Winnipeg), annual, Table 1.

disease resistant grains. Such improvements have led to increased supply, through higher yields.

Studies³⁵ have been made that employ acreage as the relevant variable in determining the supply of grain. Usually acreage is determined, then multiplied by some notion of yield (average or otherwise) to determine supply. Certainly, this method yields a measure of supply, but it may in fact be approaching the problem in an incorrect manner. First, what factors really determine acreage? As mentioned above, these variables are prices, carryovers and quotas. Thus, such an approach provides no more information than using them to estimate strictly supply. Furthermore, with the inclusion of a variable for weather and technology, yields of grain are implicitly measured. Thus, supply is directly related to weather and technology without going through the needless step of yield calculation.

Having dealt with grain supply at the farm level, attention must now be focused on the supply of grain in the grain handling system.

The grain handling system is composed of five elements. These elements are:

³⁵Karl D. Meikle, "Acreage Response to Policy Variables in the Prairie Provinces," The American Journal of Agricultural Economics, Vol. 58, No. 3 (August, 1976), pp. 572-577.

- i) the primary elevator system,
- ii) the terminal elevator system,
- iii) the transfer elevator system,
- iv) the rail network, and
- v) the maritime network on the Great Lakes.

Ownership of these components rests with the federal government and the private grain industry. However, control of the grain movement through this system rests primarily with the federal government under the auspices of the Canadian Wheat Board.

The primary elevator system consists of 3,739 elevators, of which 2,032³⁶ are located in Saskatchewan. These elevators purpose is receiving farm production of grain, grading the grain, and inspecting the grain for purity (dockage). Of the grains considered in this study, wheat, oats and barley deliveries to primary elevators are controlled through the Canadian Wheat Board delivery quotas. These quotas allow farmers to deliver a given quality of a particular grain based on acreage allotments. For example, delivery may be five bushels of 1CW wheat per acre. On the other hand, flaxseed may be delivered to primary grain elevators, subject to space availability, at the whim of the particular farmer.

³⁶Canada Grains Council, Statistical Handbook 1977 (Winnipeg), p. 183.

Table 2.7

CANADA'S ELEVATOR SYSTEM

Type of Elevator	Number of Elevators	Total Storage Capacity (000 bushels)
Primary ^a	3,739	332,709
Terminal ^b	25	130,497
Process ^c	30	20,621
Transfer ^d	27	122,329
Total	3,821	606,156

^aA primary elevator stores and ships the grain production of farmers.

^bA terminal elevator receives grain, cleans and inspects it and forwards it to domestic and international buyers.

^cProcess elevators store grain for domestic industrial processing.

^dA transfer elevator is used to store grain for periods of time, then forward grain to export facilities or domestic processors.

SOURCE:

Canada Grains Council, Statistical Handbook 1977 (Winnipeg), annual, p. 183.

Once grain is stored in the primary elevator system, movement of the grain to terminal, transfer and process elevators is accomplished through the rail network system. Rates to be assessed on the movement of this grain were established through the Crow's Nest Agreement³⁷ of 1897. In return for shipping grain at a predetermined tariff, the Canadian Pacific Railway was granted certain concessions³⁸ in the development of a rail line into the Kootenay region of British Columbia. As the cost of moving these products has increased since the time of the Crow's Nest Agreement, the railways have been internally³⁹ subsidizing the movement of grain during the past decade. With revenue shortfalls in the vicinity of \$132,200,000⁴⁰ for 1974, efficiency of grain movement has been substantially reduced.

³⁷Canada Grains Council, Grain Handling and Transportation: The State of the Industry (Winnipeg: Canada Grains Council, 1973) pp. 15-17.

³⁸Among these concessions was a subsidy of \$11,000 per mile of track constructed into the Kootenays.

³⁹Internal subsidization refers to railways charging higher rates on the movement of other commodities to cover revenue downfall on grain.

⁴⁰Carl M. Snavely, Commissioner, The Commission on the Costs of Transporting Grain by Rail (Ottawa: Government of Canada, 1976), p. 214.

To remedy this inefficiency, the Canadian government has initiated several programs to aid the movement of grain. Three responses to this problem have been:

- i) the subsidization of rail movement of grain. In 1974 this amounted to approximately \$40,000,000.⁴¹
- ii) the purchase of hopper cars to speed the loading of grain at primary elevators and the unloading at terminal positions. By 1976 the Canadian government had 6,000⁴² hopper cars in the system; and
- iii) the Hall Commission,⁴³ which recommended abandoning 3,669.2⁴⁴ miles of uneconomic rail lines in Western Canada.

The terminal elevators are the major loading facilities for export grain in Canada. The ability of terminal elevators to receive, clean and load grain on ships is an important component in the supply of grain available for export. The distribution of terminal facilities in Canada is:

⁴¹Ibid., p. 214.

⁴²Canadian Wheat Board, Canadian Wheat Board Annual Report 1974-75 (Winnipeg), annual, p. 45.

⁴³Emmett Hall, Commissioner, Grain and Rail in Western Canada (Ottawa: Government of Canada, 1977).

⁴⁴Ibid., p. 333.

- i) British Columbia -- 5
- ii) Manitoba -- 1
- iii) Alberta -- 3
- iv) Saskatchewan -- 2
- v) Ontario -- 14.⁴⁵

Of these terminals, the ones in British Columbia and Manitoba are used to ship grain to export markets. The terminals at Thunder Bay, Ontario serve two purposes. First, they are used to load grain direct for export. Second, grain is shipped from Thunder Bay via Great Lakes ships to transfer elevators, to be stored and exported at a later date.

The terminal elevators in Saskatchewan and Alberta, are run by the Canadian government through the Canadian Grain Commission.⁴⁶ While these elevators receive and clean grain, they are not true terminals, in the sense that grain must be shipped from them to either British Columbia, Manitoba or Ontario for export.

The final major component of the elevator system are the transfer elevators. Transfer elevators on the Upper and Lower Great Lakes, Upper and Lower St. Lawrence and the

⁴⁵Canada Grain Council, Statistical Handbook (Winnipeg: Canada Grains Council, 1977), p. 183.

⁴⁶Canadian International Grains Institute, Grains and Oilseeds: Handling, Marketing, Processing (Winnipeg: Canadian International Grains Institute, 1975), pp. 22-23.

Maritimes, have a total storage capacity of 124,990,000⁴⁷ bushels. Receipt of grain at these terminals is usually via merchant ships operating on the Great Lakes. However, a small proportion of grain is received via rail.

Finally, a brief description of the Great Lakes Maritime system. The Great Lakes system links landlocked ports in Canada and the United States with the ocean through the St. Lawrence seaway. With regards to grain, the two major ports being Thunder Bay in Canada and Duluth in the United States. Grain movement from Thunder Bay is largely a "backhaul" operation for the iron ore freighters operating between Quebec and steel processing plants in the Mid-western United States.⁴⁸ Thus, the cost of grain movement is somewhat subsidized.

Unfortunately, the Great Lakes system freezes over during winter. The average shipping season lasts between mid April to mid December,⁴⁹ necessitating the movement of export grain to Maritime ports for the duration of the closure.

⁴⁷Ibid., pp. 48-49.

⁴⁸Grains Group, Grain Transportation in Eastern Canada (Ottawa: Government of Canada, 1972), p. II-4.

⁴⁹Canada Grains Council, Statistical Handbook 1977 (Winnipeg: Canada Grains Council, 1977), pp. 204-205.

Having briefly described the grain handling system, the question arises of potential efficiency improvements that can be implemented in the system. Volume moved through the system, and subsequently the availability of grain for export may be improved through any of the following programs:

- " i) improved co-ordination of vessel allocation
- ii) extension of the work week at terminal and transfer elevators
- iii) use of interior elevators
- iv) more flexible cleaning standards."⁵⁰

Of these, the extension of the work week and labour difficulties particularly, will be considered in this study.

C. The Theoretical Effect of Labour Disputes

The effect of labour strikes must be considered on both sides of a supply-demand model for the grain industry. The effect of strikes must first be considered in terms of demand, the demand influence being that disputes often disrupt established methods to move grain to importers. As restrictions increase, importers switch sources of supply, causing demand for Canadian grain to fall.

⁵⁰Canada Grains Council, Grain Handling and Transportation: The State of the Industry (Winnipeg: Canada Grains Council, 1973), pp. 99-101.

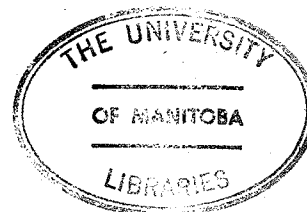
With this basic notion, what can be said about the effect of conflicts during periods of high versus low demand?⁵¹

Consider two scenarios for the case of low demand. First, as purchasers are only demanding a small quantity of grain we would expect the losses to be negligible. At first, this logic appears to explain the effect of strikes in low demand years. This hypothesis may not be correct. What does low demand imply? It implies many choices are available to importers of a grain. As more choices can be utilized by the importer, switching supply sources occurs more readily. Consequently, strikes during low sales periods may lead to switching of supply sources. Thus, the effect of a strike may be rather severe during low export years.

Our conclusion regarding strikes during years of low demand, is really no conclusion. All we know is that demand shifts. Empirical analysis of each grain can only provide the answer.

If this is the result during low demand years, can the same be said for periods of high demand? During such times we arrive at the same conclusion. When grain movement facilities are being taxed to their capabilities, we

⁵¹By high and low demand, it is meant that demand deviates from the long term average. In the empirical analysis exports in excess of one standard deviation (plus and minus) are considered high and low.



would expect labour disturbances to have a more severe effect than the average. Under this reasoning, the shift of the demand curve would be large.

However, the term high demand implies that demand for grain is high among all competitors. Under these conditions every supplier of grain experiences an inability to meet new contracts. Consequently, there is little, if any, possibility for importers of grain to switch suppliers.

Thus, the analysis arrives at the same result as in the case of low demand. The degree of shift in the demand curve for the high demand is unknown. As both cases arrive at the same inconclusion, the difference in the effect of strikes during either condition cannot be distinguished. Therefore in the analysis of demand, it will not be possible to compare low to high demand. However cases of abnormal (both high and low) demand can be compared to normal⁵² demand.

One final note must be made of the demand effect. Due to the contractual nature of grain sales, with terms extending longer than a year, it is expected that demand shifts may be lagged behind the occurrence of strikes. That is, a strike in 1977 may influence demand in 1978.

⁵²Normal demand constituting yearly demands ranging between the mean and plus or minus one standard deviation. Everything outside this range is abnormal demand.

Having dealt with the effect of strikes on demand, their effect on supply of grain must be analyzed. With the occurrence of a strike, segments of the CGMS are disrupted, leading to a decrease in the available grain for export. Consequently, we would expect the supply curve to shift immediately to the left.

The hypothetical effects of strikes are best shown diagrammatically (Figures 2.1 and 2.2). Suppose the initial equilibrium position is point A in Figure 2.1, with price P obtained and quantity Q demanded. With the inclusion of strikes, quantity demanded falls, yielding a new equilibrium at point B, with an associated revenue loss of $PAQ - P'BQ'O$ (Figure 2.1). However, labour conflicts also influence the available supply of grain, causing a supply shift to a new equilibrium at point C, with a revenue loss of $PAQO - P''CQ''O$ (Figure 2.1), yielding a combined total revenue loss of $PAQO - P''DQ'' ' O$ (Figure 2.2).

However, our analysis is not quite so simple. Clearly, the amount of revenue losses depends on the elasticities of the supply and demand curves. As the elasticity of the demand curve increases (i.e. as it becomes perfectly elastic) revenue losses attributable to supply shifts is smaller. Similarly, as the elasticity of the supply curve nears perfect elasticity, losses due to shifts in the demand curve increase.

Figure 2.1

Individual Losses of Revenue Due to Shifts in Supply and Demand

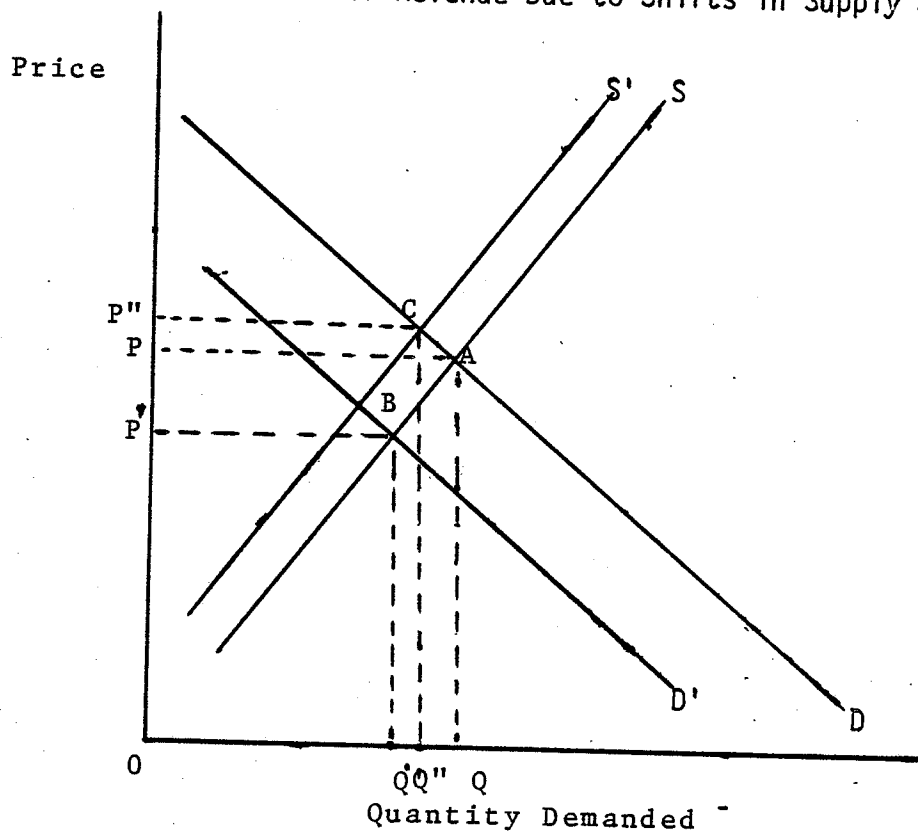
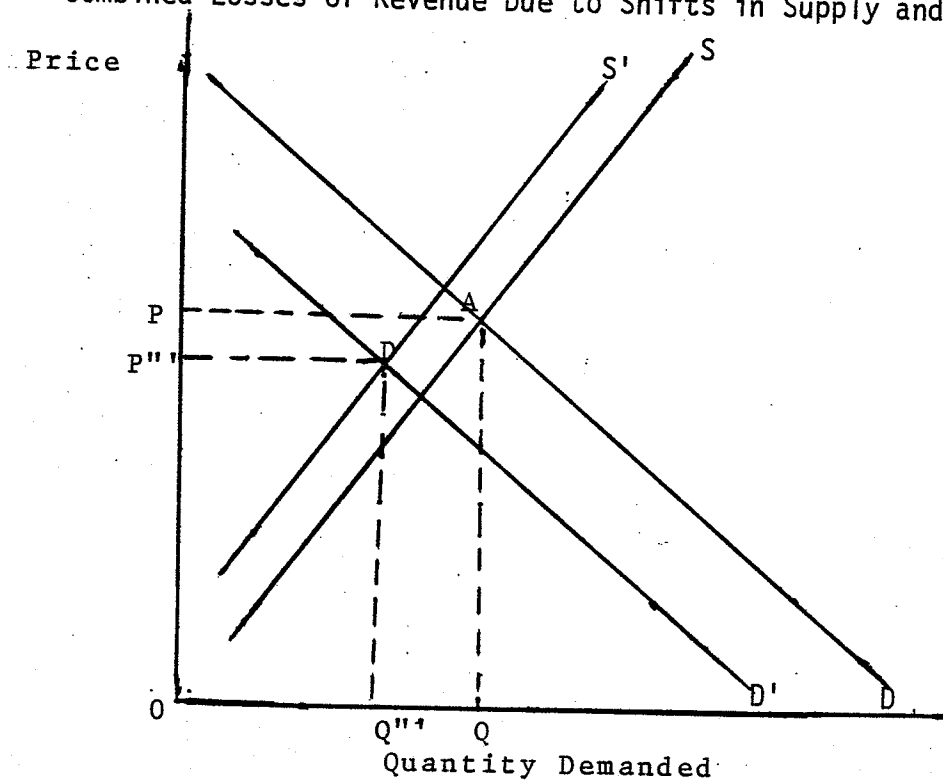


Figure 2.2

Combined Losses of Revenue Due to Shifts in Supply and Demand



D. A Four Sector Model of the Grain Industry

Unfortunately, graphical analysis will have to be abandoned as we approach multidimensional space, as employed in this theoretical model. Thus this model may be somewhat confusing at first appearance. After some thought it will become reasonably simple.

As the amount of each grain produced and exported is vastly different, the impact of strikes on each will be quite different. Consequently, the coefficient of the variable to indicate strikes will differ for each supply and demand equation. Thus, the impact of strikes on the price of each grain will differ.

Consider supply. Each grain is deemed to be supplied in accordance with its price (or price lagged one year). Furthermore, farmers decision to produce a given grain will depend on the price of the other three grains, as well as other supply determining exogenous variables.

The two elements determining demand of concern at this moment are the price of a given grain and the effect of strikes. As well, other exogenous variables play a part in demand determination.

Where the demand curve intersects the supply curve, the price of the grain and the quantity of grain demanded are determined. Depending on the severity of the strike and the demand conditions, each sector's demand and supply curves will shift by differing amounts. Subsequently,

there is a revenue loss of differing magnitude in each sector.

The effect of labour disputes will also have a second round effect. This effect occurs through linkages in the price mechanism. As the price of one grain falls, we would expect production of other grains to rise, as the supply of a grain is inversely related to the prices of the other grains. This will cause a second round price decrease, as supply of other grains increases.

However, this price mechanism will cause further switching back to the original grain(s) because it (they) are more favourable in terms of the others. Thus, a simultaneous equilibrium for all grains is determined.

At this stage, a simple example might clarify any ambiguity in this discussion.

Example A

Suppose we have two grains, wheat and oats, whose supply functions respectively are:

$$2.1 \quad S_w = 1 + 2P_w - P_o - 2L_t$$

$$2.2 \quad D_w = 50 - 2P_w - L_t^{-1}$$

$$2.3 \quad S_w = D_w$$

$$2.4 \quad S_o = 2.4 + 2P_o - P_w - .48L_t$$

$$2.5 \quad D_o = 6 - .5P_o - .26L_t^{-1}$$

$$2.6 \quad S_o = D_o$$

where:

S_w = supply of wheat (000'000 metric tonnes)

S_o = supply of oats (000'000 metric tonnes)

D_w = demand for wheat (000'000 metric tonnes)

D_o = demand for oats (000'000 metric tonnes)

P_o = price of oats (dollars/metric tonne)

P_w = price of wheat (dollars/metric tonne)

L_t = a variable to indicate labour difficulties at time t (rate of lost man-days/worker).

Let $L_t = 0$, $L_{t-1} = 0$, then $P_w = 19.4$,

$$P_o = 9.2,$$

$$S_w = D_w = 30.6,$$

$$S_o = D_o = 1.4.$$

Total revenue from wheat sales	\$ 593,640,000
Total revenue from oat sales	12,880,000
Total revenue	606,520,000

Now let $L_t = 2.5L_{t-1} = 5$, then $P_w = 14$,

$$P_o = 7,$$

$$S_w = D_w = 17,$$

$$S_o = D_o = 1.2.$$

Total revenue from wheat sales	238,000,000
Total revenue from oat sales	8,400,000
Total revenue	246,400,000

Revenue loss from wheat sales	\$ 355,640,000
Revenue loss from oat sales	4,480,000
Total revenue loss	360,120,000

Thus the potential magnitude of strikes can be seen. These revenue losses revert back to farmers in the form of lower Wheat Board prices. In following chapters this analysis will be extended to four sectors.

CHAPTER 3

THE ANALYTICAL MODEL AND SUPPORTING DATA

The purpose of this chapter is to develop a theoretical model, based on the considerations of the second chapter, to assess the costs of labour-management conflicts. A theoretical model will be specified, the variables in the model defined, and the data base used in the thesis presented. Further, the preliminary analysis of the model will be implemented. Finally, the model used to assess the costs of labour disputes in the CGMS is furnished.

A. Specification of the Model^{*}

In Chapter 2 the supply of a grain was described as being dependant upon certain variables. Among these were:

- i) the price of the grain,
- ii) the price of other grains,
- iii) the carryover of the grain,
- iv) weather conditions,
- v) technology, and
- vi) the occurrence of strikes in the crop year.

To this list two other variables may be added. Under the LIFT program farmers were paid to decrease wheat acreages

^{*} Certain variables in this section are products of other studies previously referred to (pp. 4-8)--in particular, the price variables, carryover, and L_t . The remainder are the author's invention.

on the Prairies. Consequently, the influence of this program on the supply of the various grains must be considered. The effect of the acreage of a grain sown must also be incorporated into the model. Clearly, the acreage seeded will affect the production of grain.

At this point a more elaborate analysis of the causal relationships these components exert on the supply⁵³ of grain is necessary. First, consider the effects of price on the supply of grain.

Farmers respond to the price level of a grain by varying the amount of acreage seeded. As the price of a given grain changes it is expected that the amount of acreage seeded will follow a corresponding adjustment. The relationship among the supply of a given grain and competitive grain production is an inverse one. Thus, as the prices of competing grains rise, *ceteris paribus*, it is expected the acreage of a given grain falls. Consequently, prices of competitive grains are inversely related to the production of the given grain.

However, one other factor enters the analysis. Western producers often consider wheat as the "standard" crop to be seeded. This arises out of traditional farming practices as well as the security⁵⁴ a farmer receives

⁵³The supply of grain is measured by the amount marketed by producers in a crop year.

⁵⁴By security it is meant that the farmer need not worry about the price of wheat, as it is out of his control, through the monopoly the Canadian Wheat Board holds on the export market.

through the Canadian Wheat Board's marketing system. Thus, farmers generally compare the prices of other grains to that of wheat, when making the allotment of acreage to a particular grain. The relative prices of grains then become the price variable influencing grain supplies.

What is the influence of carryover of a particular grain on its supply? In the current crop year the carryover will have no effect. This occurs because the farmer does not know the amount of carryover when the acreage allotment decision is made. If the current carryover has no effect, the same is not true for the carryover from the previous crop year. The amount of this carryover is known to the producer. As the amount of stocks rises, a producer will decide to decrease his production of the grain.

Acreage will also influence the supply of a grain. In the current crop year the greater the acreage sown, the greater the amount of a grain⁵⁵ produced. However, the amount of grain produced is not necessarily the same as the supply of grain. As grains are marketed throughout the crop year due to Wheat Board quotas (wheat, oats, barley, flax, rapeseed and sunflower), it is expected that the preceding crop year's acreage of a particular grain will influence marketings in the current crop year. As seeded acreage of a given grain rises in the previous year, the amount of the grain supplied in the current crop year will

⁵⁵Under the same weather and technological conditions.

also rise as farmers respond to quotas, prices, and on farm inventories in light of the current crop years production.⁵⁶

The effect of the LIFT program on supplies must also be hypothesized. The LIFT program was a temporary program implemented by the Federal government, as the carryover of Canadian wheat reached new records in the late 1960's.⁵⁷ Under the plan, farmers were subsidized in taking available acreage out of wheat production for the crop year 1970-71. Thus, under LIFT the supply of wheat fell. However, some farmers switched further (than under LIFT) acreages out of wheat into competitive crops. Thus, the effect of LIFT was to increase the supplies of oats, barley and flax, as well. Using a dummy variable D_t (1 = 1970-71, 0 = otherwise) to indicate this program, it is expected it will be inversely related to the supply of wheat, but positively related to the supplies of oats, barley and flax.

Weather conditions are quite easily dealt with. Obviously a more conducive meteorologic condition produces

⁵⁶Farmers must have sufficient storage space for the current crop, so they must clear off enough of the previous production to suffice current production.

⁵⁷Refer to Table 3.7, giving the carryover of grain in Canada. In 1969-70, the carryover of wheat was 1,008,690,000 bushels. Due to LIFT this fell to 734,154,000 bushels in 1970-71.

a larger supply of grain. However, the quantification of a variable to represent weather is not as easy. A number of climatic factors influence the production of grain. Two of these are precipitation and the duration of the frost free period. However, the amount of precipitation is of little use, since the timing of rainfall is as important as the amount. Large amounts of rain in the fall and spring lead to harvesting and seeding difficulties. Both decrease the quantity and quality of the grain. Yet, if solely the amount of rain is considered, the effect of this unfavourable precipitation will receive the same value as rain spread more evenly through the growing season. In light of these difficulties, a dummy variable will also be used to ascertain the effect of weather on the supplies of grain. If 1 represents times of favourable weather, and 0 unfavourable⁵⁸ conditions, the weather variable will be related to the supply of grain in a positive manner.

Technology has an effect on the supplies of grain. As the technology of farming advances due to improvements in equipment, fertilization methods, pesticides and varieties, yields of grain per acre will rise.⁵⁹ Subsequently,

⁵⁸Unfavourable weather refers to lack of moisture, precipitation at the wrong time during the crop year, and years when the frost free period was short. That is, unfavourable weather (0) contributes nothing to the supply.

⁵⁹R. A. Hedlin and L. R. Rigoux, "Crop Yield Changes in the Prairie Provinces 1958 to 1976," Proceedings, International Society of Soil Sciences Association, 11th ISSA Congress, 1978, Edmonton, Alberta.

the supply of grain increases. However, technology is a difficult variable to quantify. One procedure is to use a linear time trend as a proxy variable to technology.⁶⁰

This analysis will use this convention.

Finally, the effect of labour-management disputes on the supply of grain must be determined. At this point, mention should be made of the measure employed to ascertain the effect of such disputes. A variable to indicate "the severity of strikes"⁶¹ is needed. The measure of severity is the rate of lost man-days per worker involved. Thus a strike of one day by a thousand men will have the same effect as a strike by one man for one day.⁶² In both cases the severity is the same, as movement of the grain through the system is only stopped for one day.

What happens to supply as the rate of lost man-days per worker increases? Elevators cannot receive grain as it cannot be moved through the rest of the system. Delivery quotas fall as the level of inventory in the system rises. Clearly these factors will result in the supply of grain (measured by producer marketings) falling.

⁶⁰Koutsoyiannis, op. cit., p. 270.

⁶¹Ahmed, op. cit., p. 97.

⁶²In the first case, there are 1,000 lost man-days by 1,000 men or the severity (rate of lost man-days per worker) is 1. In the second case, there is 1 lost man-day by 1 man or the severity is 1.

Having assessed the determinants of supply for the model, the components of demand for grain must be ascertained. In the second chapter, a brief analysis of the international and domestic demand for Canadian grain was provided. Based on these findings, the demand equations for grain can be specified.

Once again, prices constitute a major influence on the demand⁶³ for a grain. However rather than price competition among the various grains, as in the case of the supply, price competition between producing countries for the same grain market is the influential variable. As the price of Canadian rises, it is expected that importers will decrease their consumption of Canadian grain, switching to alternate sources of supply.⁶⁴ Similarly, as the price of a competing country's grain rises, importers will demand more Canadian grain, switching from the higher priced competitive grain.

For this thesis, the nation competing with Canada for markets will be the United States. The reasons for choosing the United States are:

- i) its proximity with Canada, with similar types and qualities of grain being produced,

⁶³Demand is defined as the exports outside Canada for wheat and flaxseed and as the domestic consumption for oats and barley.

⁶⁴That is, grain is a normal good.

- ii) the United States is the largest exporter of grain in the world, thus having a significant influence on commodity prices, and
- iii) the availability of accurate, current price data in the United States, while sources of data for other exporters are limited.

The second major influence exerted on the demand for a grain is the effect of 'income type'⁶⁵ effects. It is expected that the effect of higher per capita incomes in Japan, India and Great Britain will be greater demand for wheat. Similarly, as the number of livestock in Canada (measured in terms of dairy cows) rises, the demand for oats and barley will follow. Finally, the amount of building in Japan and Europe will influence the demand for Canadian flaxseed. The more construction in either, the greater the demand for Canadian flaxseed. In the case of Europe, quantifying the number of buildings constructed is an arduous task, so figures for West Germany will be used as a proxy.

Linear time will also be considered in the demand for grain. The purpose of time will be to ascertain any increase in demand (demand and time are positively related)

⁶⁵By this it is meant the effect of higher per capita incomes in nations importing wheat (India, Japan, Great Britain); larger numbers of livestock (measured in terms of dairy cows in Canada) for oats and barley; larger amounts of building, for flax (Japan, West Germany).

due to time related consumption alterations or technological innovations in importing regions.

How do strikes influence the demand for grain? As for supply, it was hypothesized the severity of strikes, measured by the rate of lost man-days per worker employed, will be inversely related to the demand for grain. However, most grain sales occur on a contractual basis. Therefore, strikes will not contribute to a reduction in demand in the current crop year, as importers are "locked in" to their purchases. As Canada is unable to meet the contractual requirements, importers perceive Canada as an unreliable supplier of grain. Consequently, their demand for Canadian grains will fall in future years. That is, the effect of strikes on demand will be lagged at least one year.

In Chapter 2⁶⁶ arguments were presented that the effect of strikes during periods of high and low demand would differ from periods of normal⁶⁷ demand. However, the degree of impact was not known. In light of this problem, a variable to reflect the differences in the strike effect when demand is abnormal⁶⁸ versus normal is included in the

⁶⁶For a better description of these arguments, refer to pages 41-45.

⁶⁷Normal demand ranges between the mean demand plus (high demand) or minus (low demand) one standard deviation.

⁶⁸Abnormal being cases of high and low demand.

model. This variable was determined for each grain using the following method:

- i) determine the mean demand for the grain;
- ii) determine the standard deviation of demand for the grain;
- iii) determine the range of normal demand (mean \pm one standard deviation);
- iv) if the demand for a grain in a particular crop year is normal, assign that year the value 0;
- v) if demand for a grain in a particular crop year is abnormal, assign that year the value of 1; and
- vi) generate the abnormal versus normal demand variable by multiplying the assigned variable (0 or 1) times the rate of lost man-days per worker employed, lagged one year.

This new variable was hypothesized to be inversely related to demand.

Based on these considerations, the following econometric model for the supply and demand of wheat, oats, barley and flax was established:

i) Wheat Market.

$$\begin{aligned}
 QSW_t = & -a_{10} POC_t/PWC_t - a_{11} PBC_t/PWC_t - a_{12} PFC_t/PWC_t \\
 & -a_{13} CW_{t-1} + a_{14} AW_{t-1} - a_{15} D_t + a_{16} W_t + a_{17} T \\
 & -a_{18} L_t + u_1
 \end{aligned}
 \tag{3.1}$$

$$\begin{aligned} QDW_t = & -a_{20} PWC_t + a_{21} PWU_t + a_{22} YI_t + a_{23} YJ_t + a_{24} YB_t \\ & + a_{25} T - a_{26} L_{t-1} - a_{27} Z_t + U_2 \end{aligned} \quad (3.2)$$

$$QSW_t = QDW_t + CW_t \quad (3.3)$$

ii) Feed Grain Market.

Oats

$$\begin{aligned} QSO_t = & b_{10} POC_t/PWC_t - b_{11} PBC_t/PWC_t - b_{12} PFC_t/PWC_t \\ & - b_{13} CO_{t-1} + b_{14} AO_{t-1} + b_{15} D_t + b_{16} W_t \\ & + b_{17} T - b_{18} L_t + U_3 \end{aligned} \quad (3.4)$$

$$\begin{aligned} QDO_t = & -b_{20} POC_t + b_{21} POU_t + b_{22} LN_t + b_{23} T - b_{24} L_{t-1} \\ & - b_{25} Y_t + U_4 \end{aligned} \quad (3.5)$$

$$QSO_t = QDO_t + CO_t \quad (3.6)$$

Barley

$$\begin{aligned} QSB_t = & -c_{10} POC_t/PWC_t + c_{11} PBC_t/PWC_t - c_{12} PFC_t/PWC_t \\ & - c_{13} CB_{t-1} + c_{14} AB_{t-1} + c_{15} D_t + c_{16} W_t \\ & + c_{17} T - c_{18} L_t + U_5 \end{aligned} \quad (3.7)$$

$$\begin{aligned} QDB_t = & -c_{20} PBC_t + c_{21} PBU_t + c_{22} LN_t + c_{23} T - c_{24} L_{t-1} \\ & - c_{25} X_t + U_6 \end{aligned} \quad (3.8)$$

$$QSB_t = QDB_t + CB_t \quad (3.9)$$

iii) Flaxseed Market.

$$\begin{aligned}
 QSF_t = & -d_{10} POC_t/PWC_t - d_{11} PBC_t/PWC_t + d_{12} PFC_t/PWC_t \\
 & - d_{13} CF_{t-1} + d_{14} AF_{t-1} + d_{15} D_t + d_{16} W_t \\
 & + d_{17} T - d_{18} L_t + U_7
 \end{aligned} \tag{3.10}$$

$$\begin{aligned}
 QDF_t = & -d_{20} PFC_t + d_{21} PFU_t + d_{22} PIJ_t + d_{23} PIG_t \\
 & + d_{24} T - d_{25} L_{t-1} - d_{26} V_t + U_8
 \end{aligned} \tag{3.11}$$

$$QSF_t = QDF_t + CF_t \tag{3.12}$$

The variables in this model will be defined in the following section, along with the data base used in the analysis.

B. Definition of the Variables and the Data Used in the Analysis

The model proposed in the preceding section contains numerous variables. It is the purpose of the first part of this section to define these variables. The variables are defined as follows:

In actual practise the equality of supply and demand for each grain is assured by adding the carryover to the quantity demanded of a given grain and using this variable as the dependant variable. That is, QD of a grain in the regression is really QD + carryover. Wherever regressions are performed for the remainder of this thesis, QD is QD + carryover.

- $a_{10} \dots a_{18}, a_{20} \dots a_{27}$ coefficients to be determined by regression for the wheat supply and demand variables.
- $b_{10} \dots b_{18}, b_{20} \dots b_{25}$ coefficients to be determined by regression for the oats supply and demand variables.
- $c_{10} \dots c_{18}, c_{20} \dots c_{25}$ coefficients to be determined by regression for the barley supply and demand variables.
- $d_{10} \dots d_{18}, d_{20} \dots d_{26}$ coefficients to be determined by regression for the flax supply and demand variables.
- $U_1 \dots U_8$ random variation in the model.
- PWC price of wheat (in Canadian dollars per bushel) in Canada. Price is the sum of the initial, interim and final payment for #1 Northern wheat in store at Vancouver or Thunder Bay.
- POC price of #2 Western oats in store at Thunder Bay (in Canadian dollars). Price is the sum of the initial, interim and final payment.
- PBC price of #2 Western 6 row barley in store at Thunder Bay (in Canadian dollars). Price is the sum of the initial, interim and final payment.
- PFC average annual price of #1 flaxseed at the Winnipeg Commodity Exchange.

- QSW producer (farmer) marketings (sales) of wheat
(supply of wheat).
- QSO producer (farmer) marketings (sales) of oats
(supply of oats).
- QSB producer (farmer) marketings (sales) of barley
(supply of barley).
- QSF producer (farmer) marketings (sales) of flax
(supply of flax).
- QDW exports (demand) for Canadian wheat on international
markets.
- QDO exports (demand) for oats in the Canadian domestic
market.
- QDB exports (demand) for barley in the Canadian domestic
market.
- QDF exports (demand) for Canadian flax on international
markets.
- PWU U.S. price of #1 Dark Northern Spring wheat, com-
puted by weighting selling prices by the number of
carlots sold, in Minneapolis (in U.S. dollars).
- POU U.S. price of #2 White oats, based on average daily
quotations weighted by the number of carlots sold,
in Chicago (in U.S. dollars).
- PBU U.S. price of #3 barley, based on average daily
prices weighted by carlots sold, in Minneapolis
(in U.S. dollars).

- PFU U.S. daily average prices of flaxseed, weighted by carlots sold, in Minneapolis (in U.S. dollars).
- AW thousands of acres seeded to wheat on the Canadian prairies.
- AO thousands of acres seeded to oats on the Canadian prairies.
- AB thousands of acres seeded to barley on the Canadian prairies.
- AF thousands of acres seeded to flax on the Canadian prairies.
- CW carryover of wheat in Canada in thousands of bushels.
- CO carryover of oats in Canada in thousands of bushels.
- CB carryover of barley in Canada in thousands of bushels.
- CF carryover of flax in Canada in thousands of bushels.
- L rate of lost man-days per worker employed during strikes;
- i.e. $\frac{\text{Total lost man-days for the crop year}}{\text{Total number of employees involved in the strikes.}}$
- PIJ building construction for dwellings (rooms or suites of rooms in permanent buildings which are intended for habitation by one household and are suitable for occupation by one family) in Japan.
- PIG building construction for dwellings in Germany.
- YI per capita income (in U.S. dollars) in India.

- YJ per capita income (in U.S. dollars) in Japan.
- YB per capita income (in U.S. dollars) in West Germany.
- LN livestock numbers in equivalent dairy cows in Canada.
- W a dummy variable to represent meteorologic conditions (1 = favourable weather, 0 = unfavourable weather).
- D a dummy variable to indicate the effect of the LIFT program on grain production (1 = LIFT in effect, 0 = otherwise).
- T a linear time trend (T = 1 for 1950-51 crop year, T = 25 for the 1974-75 crop year).
- t this subscript indicates the time relationship amongst the variables in the equation. That is, t is the current period and t-1 is lagged one year.
- Z the variable to indicate the effect of strikes during periods of abnormal wheat demand.
- Y the variable to indicate the effect of strikes during periods of abnormal oats demand.
- X the variable to indicate the effect of strikes during periods of abnormal barley demand.
- V the variable to indicate the effect of strikes during periods of abnormal flax demand.

Having defined the variables in the model, the data used to develop regression estimates are contained in Tables 3.1 to 3.13. On the basis of this data, preliminary analysis of the model was performed. The data is analyzed in Appendix A.

Table 3.1

PRODUCER MARKETINGS OF GRAIN
(000's bushels)

Crop Year	Wheat (Qswt)	Oats (Qsot)	Barley (Qsbt)	Flax (Qsft)
1974-75	422,431	40,280	209,224	10,797
1973-74	536,328	39,812	235,051	15,404
1972-73	633,258	32,484	236,816	18,346
1971-72	517,507	32,326	295,467	21,580
1970-71	384,307	58,254	235,899	33,713
1969-70	413,263	20,868	168,423	22,086
1968-69	423,161	41,573	81,766	15,310
1967-68	456,015	30,818	87,305	7,948
1966-67	632,362	38,427	112,740	20,113
1965-66	569,363	51,715	93,886	23,689
1964-65	524,515	41,002	74,975	16,847
1963-64	568,620	49,744	91,943	17,375
1962-63	474,293	88,989	80,477	13,528
1961-62	305,345	28,155	59,329	11,985
1960-61	396,212	37,634	87,898	18,136
1959-60	378,514	24,338	95,591	13,961
1958-59	367,723	39,280	122,838	17,469
1957-58	378,192	58,272	116,866	15,296
1956-57	362,454	69,254	120,661	29,013
1955-56	352,975	71,629	114,460	15,750
1954-55	319,780	70,221	112,568	8,792
1953-54	396,961	90,367	101,397	7,403
1952-53	535,989	119,750	165,036	8,155
1951-52	455,362	133,608	130,336	6,363
1950-51	367,845	102,688	83,414	3,254

SOURCE:

Canadian Wheat Board Annual Report 1974-75
(Winnipeg: Canadian Wheat Board, 1975), Annual,
Table IV.

Table 3.2

EXPORTS OF WHEAT AND FLAXSEED
(000's bushels)

Crop Year	Wheat ^a (QDW _t)	Flaxseed ^b (QDF _t)
1974-75	375,854	10,763
1973-74	400,588	15,751
1972-73	553,242	20,819
1971-72	479,048	27,260
1970-71	410,410	22,487
1969-70	319,535	19,686
1968-69	281,216	13,970
1967-68	311,320	13,721
1966-67	483,456	17,079
1965-66	546,781	19,505
1964-65	368,052	15,682
1963-64	539,637	14,232
1962-63	304,102	12,995
1961-62	326,068	12,451
1960-61	317,568	14,396
1959-60	240,321	12,693
1958-59	257,421	14,626
1957-58	279,912	14,356
1956-57	230,856	22,655
1955-56	272,260	11,583
1954-55	211,288	6,345
1953-54	208,835	5,172
1952-53	329,026	4,060
1951-52	304,722	2,882
1950-51	185,039	4,131

SOURCE:

Canadian Wheat Board, Canadian Wheat Board Annual Report 1974-75 (Winnipeg: Canadian Wheat Board), Annual, Table XI.

^aWheat exports include bagged seed for years 1955-56 to 1974-75.

^bFlaxseed exports include linseed oil for the years 1956-57 to 1974-75.

Table 3.3

DOMESTIC CONSUMPTION^a OF OATS AND BARLEY
(000's bushels)

Crop Year	Barley (QDB _t)	Oats (QDO _t)
1974-75	285,794	257,313
1973-74	326,704	328,342
1972-73	335,887	331,861
1971-72	339,496	360,141
1970-71	289,501	362,674
1969-70	275,280	330,047
1968-69	233,172	307,271
1967-68	212,296	331,067
1966-67	203,695	382,247
1965-66	171,294	387,019
1964-65	160,925	380,742
1963-64	145,275	397,988
1962-63	119,074	399,698
1961-62	124,464	316,599
1960-61	162,208	381,498
1959-60	154,575	369,008
1958-59	154,332	366,375
1957-58	160,310	345,714
1956-57	155,697	356,727
1955-56	162,942	360,170
1954-55	148,742	325,956
1953-54	133,956	361,911
1952-53	137,332	369,695
1951-52	145,969	410,059
1950-51	106,962	299,650

SOURCE:

Canadian Wheat Board, Canadian Wheat Board Annual Report 1974-75 (Winnipeg), Annual Tables IX and XI.

^aIncludes consumption on farms and in commercial applications.

Table 3.4

PRICE OF GRAIN IN CANADA
(Price in Canadian \$ per bushel)

Crop Year	Price of ^a Wheat (PWC _t)	Price of ^b Oats (POC _t)	Price of ^c Barley (PBC _t)	Price of ^d Flax (PFC _t)
1974-75	4.47	1.77	3.24	10.14
1973-74	4.58	1.83	3.10	4.82
1972-73	2.15	1.10	1.55	2.57
1971-72	1.60	.68	.91	2.53
1970-71	1.67	.68	1.01	2.92
1969-70	1.68	.70	.94	3.30
1968-69	1.70	.65	1.06	3.45
1967-68	1.81	.83	1.10	3.00
1966-67	1.99	.83	1.29	2.99
1965-66	2.00	.85	1.29	3.20
1964-65	1.89	.77	1.26	3.19
1963-64	1.97	.69	1.18	3.35
1962-63	1.87	.72	1.13	3.68
1961-62	1.91	.77	1.28	3.11
1960-61	1.80	.74	1.05	3.34
1959-60	1.59	.77	.98	3.02
1958-59	1.60	.70	1.01	3.03
1957-58	1.62	.67	1.03	2.98
1956-57	1.59	.65	1.02	3.60
1955-56	1.61	.80	1.09	3.09
1954-55	1.65	.81	1.11	2.83
1953-54	1.56	.71	1.06	3.29
1952-53	1.82	.74	1.25	4.28
1951-52	1.84	.84	1.29	4.41
1950-51	1.86	.85	1.34	3.71

SOURCE:

Prices of Wheats, Oats and Barley: Canadian Wheat Board, Canadian Wheat Board Annual Report 1974-75, 1970-71, 1961-62 (Winnipeg: Canadian Wheat Board), Annual, Tables XXI, XXII, XXIII; Price of Flax: Statistics Canada, Canada Yearbook (Ottawa: Statistics Canada), Annual, Tables 11:23, 11:24, 41.

(Continued)

Table 3.4 (Continued)

^aTotal realized price (initial, interim and final payment) for #1 Northern wheat, in store at Vancouver or Thunder Bay.

^bTotal realized price (initial, interim and final payment) for #2 Western oats in store at Thunder Bay.

^cTotal realized price (initial, interim and final payment) for #2 Western Grow barley in store at Thunder Bay.

^dAverage price of #1 flaxseed at the Winnipeg Commodity Exchange.

Table 3.5

PRICE OF GRAIN IN THE UNITED STATES
(Price in U.S. \$ per bushel)

Crop Year	Price of ^a Wheat (PWU _t) July 1	Price of ^b Oats (POU _t) July 1	Price of ^c Barley (PBU _t) August 1	Price of ^d Flax (PFU _t) August 1
1974-75	4.54	1.82	3.02	10.12
1973-74	4.65	1.42	2.60	8.28
1972-73	2.63	.89	1.48	3.01
1971-72	1.66	.70	1.16	2.62
1970-71	1.90	.75	1.22	2.63
1969-70	1.83	.62	1.08	2.86
1968-69	1.76	.64	1.16	3.08
1967-68	1.88	.76	1.23	3.20
1966-67	2.01	.77	1.33	3.19
1965-66	1.86	.75	1.32	3.06
1964-65	1.79	.72	1.20	3.09
1963-64	2.34	.66	1.09	3.01
1962-63	2.47	.70	1.11	3.05
1961-62	2.41	.71	1.33	3.57
1960-61	2.16	.69	1.07	3.02
1959-60	2.26	.76	1.09	3.38
1958-59	2.24	.67	1.15	3.01
1957-58	2.40	.68	1.17	3.30
1956-57	2.42	.74	1.20	3.26
1955-56	2.48	.67	1.15	3.19
1954-55	2.68	.77	1.32	3.39
1953-54	2.57	.77	1.40	3.86
1952-53	2.50	.83	1.52	4.08
1951-52	2.50	.89	1.36	4.10
1950-51	2.46	.88	1.46	3.88

SOURCE:

United States Department of Agriculture, Agricultural Statistics (Washington: U.S. Printing Office), Annual, Tables 1, 49, 58, 173.

^aNo. 1 Dark Northern Spring, computed by weighting selling prices by number of carlots sold, as reported in
(Continued)

Table 3.5 (Continued)

Minneapolis Daily Record.

^bCompiled from reports of Chicago Board of Trade, average daily quotations for #2 White oats, weighted by carlot sales.

^cPrice of #3 barley; average daily prices weighted by carlot sales, as reported in Minneapolis Daily Record.

^dPrices are daily averages weighted by carlot sales, compiled from the Minneapolis Daily Record.

Table 3.6

ACREAGE OF GRAIN SEEDED ON THE CANADIAN PRAIRIES
(000 acres)

Crop Year	Wheat	Oats	Barley	Flax
1974-75	21,500	4,800	11,200	1,450
1973-74	23,100	5,300	11,350	1,450
1972-73	20,800	4,660	11,900	1,320
1971-72	18,885	5,315	13,312	1,762
1970-71	12,000	5,260	9,300	3,300
1969-70	24,400	5,430	8,800	2,320
1968-69	28,860	5,340	8,330	1,502
1967-68	29,570	5,090	7,600	998
1966-67	29,166	5,422	7,010	1,883
1965-66	27,790	5,645	5,741	2,265
1964-65	29,080	5,054	5,217	1,916
1963-64	26,996	6,260	5,922	1,629
1962-63	26,237	7,152	5,097	1,396
1961-62	24,629	5,122	5,361	2,051
1960-61	23,900	6,344	6,680	2,481
1959-60	23,970	5,626	7,700	2,026
1958-59	21,480	5,810	9,104	2,526
1957-58	20,881	5,633	9,209	3,462
1956-57	22,064	7,422	8,181	3,010
1955-56	21,964	7,788	9,638	1,809
1954-55	24,707	6,715	7,568	1,148
1953-54	25,517	6,490	8,599	908
1952-53	25,372	7,560	8,145	1,027
1951-52	24,385	8,312	7,530	1,086
1950-51	26,382	7,520	6,205	541
1949-50	26,524	7,355	5,617	290

SOURCE:

Canadian Wheat Board, Canadian Wheat Board Annual Report, 1974-75, 1959-60 (Winnipeg: Canadian Wheat Board), Annual, Table 1.

Table 3.7

CARRYOVER OF GRAIN IN CANADA
(000's bushels)

Crop Year	Wheat	Oats	Barley	Flaxseed
1974-75	295,329	73,402	118,509	8,605
1973-74	385,704	77,379	208,410	7,911
1972-73	365,401	79,679	193,024	7,673
1971-72	583,757	118,257	175,843	16,032
1970-71	734,154	125,373	144,269	25,306
1969-70	1,008,690	148,340	205,078	6,570
1968-69	851,828	128,657	197,383	4,909
1967-68	672,510	81,951	130,917	4,678
1966-67	576,751	114,791	131,751	11,631
1965-66	420,122	127,163	97,753	11,141
1964-65	513,024	130,120	88,776	7,141
1963-64	459,440	179,408	118,270	6,551
1962-63	487,247	150,279	89,245	3,988
1961-62	391,058	79,066	57,824	5,269
1960-61	608,341	115,154	112,557	7,580
1959-60	599,588	100,828	128,470	4,824
1958-59	588,001	129,979	131,153	6,523
1957-58	648,454	156,916	118,165	5,652
1956-57	733,546	211,215	142,779	7,581
1955-56	579,574	119,106	110,948	2,997
1954-55	582,568	125,769	145,910	2,577
1953-54	368,546	144,409	111,666	3,939
1952-53	214,934	108,358	79,504	2,589
1951-52	187,190	95,177	53,496	1,204
1950-51	112,200	44,905	20,355	4,468
1949-50	102,343	60,507	29,669	10,692

SOURCE:

Statistics Canada, Grain Trade of Canada, #22-201
(Ottawa: Statistics Canada), Annual, Tables 92,
93 and 94.

Table 3.8

STRIKES AFFECTING GRAIN MOVEMENT BY CROP YEAR

Crop Year	Union	No. of Workers Involved	Lost Man Days
1974-75	Public Service Alliance of Canada (PSAC)	503	2,450
	Canadian Marine Officers Union	400	15,830
	Canadian Merchant Service Guild	427	15,560
	Canadian Brotherhood of Railway and Transport Workers (CBRTW)	100	100
	CBRTW	5,500	20,950
	Commerce Federation	6,530	75
	Grain Services Union	602	19,870
	Corporation of Great Lake Pilots	46	330
	Locomotive Engineers	787	8,750
	Longshoremen and Warehousemen (CLC-L&W)	3,300	59,400
	I.L.A. Loc. 375	2,400	73,200
	I.L.A. Loc. 1637	320	5,760
	I.L.A. Loc. 375	300	270
1973-74	I.L.A. Loc. 273	750	9,380
	I.L.A. Loc. 1764	130	650

(Continued)

Table 3.8 (Continued)

Crop Year	Union	No. of Workers Involved	Lost Man Days
	Seafarers International (S.I.U.)	200	2,800
	I.L.A.	138	1,180
	C.B.R.T.W. Loc. 334	150	150
	United Transportation Union	300	300
	C.N.R.--Machinists	182	180
	I.L.A. Loc. 1842	100	50
	I.L.A. Loc. 269	3,200	3,200
1972-73	C.L.C.-L&W	290	290
	C.L.C.-L&W Loc. 500	3,000	43,500
1971-72	I.L.A. Locs. 375, 1846, 1739	3,275	127,850
	I.L.A. Loc. 1843	400	350
	C.L.C.-L&W	200	400
	United Transportation Union Loc. 1747	200	200
1970-71	Railway Employees	280	810
	Locomotive Engineers	790	6,980
	Various--C.N.R.	200	200
1969-70	C.L.C.-L&W	3,230	101,510
	C.L.C.-L&W	3,230	19,380
	C.L.C.-L&W (Loc. 500)	100	2,000
	C.L.C.--Merchant Service Guild	1,200	36,000

(Continued)

Table 3.8 (Continued)

Crop Year	Union	No. of Workers Involved	Lost Man Days
1968-69			
1967-68	Seafarers International	5,400	140,790
	I.L.A. Loc. 375	3,000	10,720
	C.B.R.T.W.	1,200	20,750
1966-67	Various--C.N. and C.P.	118,000	766,090
	Various--Pacific Great Eastern Railway	387	5,810
	C.L.C.-L&W	4,180	52,900
	I.L.A. Loc. 1843	1,800	150
1965-66	C.L.C.--Canadian Merchant Service Guild	500	3,930
	I.L.A. Loc. 375	5,000	8,320
	I.L.A. Loc. 1869	290	293
	I.L.A. Various	4,150	115,610
	C.R.B.T.W. Loc. 312	2,391	4,180
	Railway Clerks Loc. 1657	600	3,000
1964-65	Brewery Workers	109	600
	I.L.A. Loc. 1739	3,500	2,500
	Trainmen Locs. 1080, 845	203	1,160
	I.L.A. Loc. 273	1,500	3,210

(Continued)

Table 3.8 (Continued)

Crop Year	Union	No. of Workers Involved	Lost Man Days
1963-64	I.L.A. Loc. 375	2,500	5,000
	I.L.A.--Various	3,800	27,140
	C.L.C.-L&W	2,500	2,500
	I.L.A. Loc. 375	1,800	3,860
1962-63	C.L.C.-L&W	1,700	1,700
1961-62			
1960-61	I.L.A. Locs. 375, 1552, 1657, 1845	2,900	10,250
	Seafarers International	646	2,960
	Seafarers International	190	230
	Brewery Workers	325	4,230
1959-60			
1958-59	L & W	1,300	30,640
1957-58	Corporation of St. Lawrence, Kingston and Ottawa Pilots	52	725
	Masters, Mates and Pilots Loc. 47C	47	6,440
	Locomotive Firemen and Engineers	2,850	6,110
1956-57	Locomotive Firemen and Engineers	2,850	22,800
1955-56	Seamen	53	2,400
	Unlicensed Ships Personnel	2,100	8,000

(Continued)

Table 3.8 (Continued)

Crop Year	Union	No. of Workers Involved	Lost Man Days
1954-55	Bargemen	40	600
	Seamen	328	16,000
1953-54	Seamen	462	8,500
1952-53	Seamen--Vancouver	30	30
1951-52	River Pilots	115	115
1950-51	Seamen	850	2,825
	Non-operating Railway Workers	128,000	650,000

SOURCE:

Derived from Labour Canada, Strikes and Lockouts in Canada (Ottawa: Labour Canada), Annual. This table is specifically derived from the "List of Strikes and Lockouts in Canada" where strikes by less than 100 workers are listed.

Table 3.9

PER CAPITA INCOMES IN IMPORTING COUNTRIES
(U.S. dollars)

Crop Year	India (YI)	Japan (YJ)	United Kingdom (YB)
1974-75	106	3,562	3,072
1973-74	104	3,286	2,868
1972-73	103	2,462	2,503
1971-72	101	1,910	2,254
1970-71	99	1,664	1,991
1969-70	88	1,626	1,976
1968-69	86	1,404	1,866
1967-68	84	1,198	2,003
1966-67	86	1,027	1,952
1965-66	114	929	1,887
1964-65	109	905	1,750
1963-64	90	809	1,603
1962-63	83	593	1,524
1961-62	78	524	1,431
1960-61	81	431	1,569
1959-60	82	377	1,444
1958-59	72	334	1,398
1957-58	66	308	1,369
1956-57	65	292	1,312
1955-56	54	280	1,284
1954-55	59	260	1,158
1953-54	63	235	1,078
1952-53	58	212	988
1951-52	56	192	912
1950-51	54	154	790

SOURCE:

United Nations, Statistical Yearbook (New York: United Nations), Annual, Table 182.

Table 3.10

BUILDING CONSTRUCTION FOR DWELLINGS^a

Crop Year	Japan ^b	West Germany ^c
1974-75	2,301,892	713,619
1973-74	2,150,321	696,438
1972-73	1,807,581	688,361
1971-72	1,463,653	635,797
1970-71	1,484,556	532,054
1969-70	1,346,612	455,825
1968-69	1,201,675	476,170
1967-68	990,158	519,854
1966-67	856,579	572,301
1965-66	842,596	604,799
1964-65	751,429	574,500
1963-64	688,743	604,400
1962-63	586,122	551,800
1961-62	525,963	553,300
1960-61	424,170	543,400
1959-60	380,575	550,800
1958-59	337,989	554,912
1957-58	321,095	488,414
1956-57	308,686	527,766
1955-56	257,388	521,900
1954-55	249,688	498,900
1953-54	246,997	503,100
1952-53	242,514	475,300
1951-52	210,690	402,900
1950-51	358,883	385,300
1949-50	402,375	300,000

SOURCE:

United Nations, Statistical Handbook (New York: United Nations), Annual, Tables 140, 136, 123, 118.

^aDwellings refer to rooms or suites of rooms in permanent buildings which are intended for habitation by one household and are suitable for occupation by one family.

(Continued)

Table 3.10 (Continued)

^bIn the case of Japan, data is in the form of permits issued. Allowing a one year construction period, the number of permits issued in a year will cover the same crop year. For example, permits issued in 1973 will serve for the 1973-74 crop year.

^cIn the case of West Germany, the data is in the form of finished buildings. Thus it will influence the proceeding crop year (allowing a one-year construction period). Thus, the finished buildings in 1973 will serve the 1972-73 crop year.

Table 3.11

LIVESTOCK NUMBERS IN CANADA
(000's)

Year	Milk Cows	Cattle (.51)	Horses (.5)	Hogs (.87)	Sheep and Lambs (.04)	Poultry ^a (.045)	Converted ^b to Milk Cows (LN _t)
1974-75	2,132	13,128	336	5,254	703	247,127	24,715
1973-74	2,080	12,930	338	6,564	784	268,549	26,395
1972-73	2,117	12,010	342	7,022	833	276,629	27,004
1971-72	2,170	11,474	350	6,995	845	259,308	25,985
1970-71	2,255	11,016	354	7,624	851	249,292	25,935
1969-70	2,389	10,437	358	7,114	796	258,663	25,752
1968-69	2,442	9,924	359	5,809	796	233,761	23,288
1967-68	2,489	9,998	360	5,771	829	206,292	22,105
1966-67	2,569	10,128	370	6,070	922	205,740	22,495
1965-66	2,674	10,205	386	5,401	1,006	198,256	21,732
1964-65	2,795	10,465	403	5,147	1,132	178,386	20,884
1963-64	2,845	10,149	431	5,667	1,272	169,415	20,841
1962-63	2,873	9,492	451	5,211	1,346	156,683	19,578
1961-62	2,938	9,128	478	4,981	1,449	142,558	18,639
1960-61	2,987	8,947	511	5,331	1,548	144,503	19,008
1959-60	2,965	8,372	552	5,070	1,607	124,761	17,600
1958-59	2,955	8,103	598	6,519	1,608	129,007	18,928
1957-58	3,028	7,962	661	5,931	1,630	119,343	18,015
1956-57	3,098	8,167	722	4,758	1,628	104,648	16,538
1955-56	3,160	7,851	782	4,731	1,620	96,476	16,077

(Continued)

Table 3.11 (Continued)

Year	Milk Cows	Cattle (.51)	Horses (.5)	Hogs (.87)	Sheep and Lambs (.04)	Poultry ^a (0.45)	Converted ^b to Milk Cows (LN _t)
1954-55	3,151	7,452	832	4,800	1,634	86,159	15,486
1953-54	3,120	7,050	917	4,440	1,636	73,621	14,415
1952-53	3,084	6,722	1,055	3,970	1,592	70,681	13,738
1951-52	3,006	6,147	1,179	5,428	1,534	71,114	14,714
1950-51	2,973	5,390	1,304	4,914	1,461	64,704	13,619

SOURCE:

Milk Cows, Cattle, Hogs and Sheep: Statistics Canada, Livestock and Animal Product Statistics, #23-203 (Ottawa: Statistics Canada, Annual), Tables 1, 2, 4, 70.

Horses: Statistics Canada, Handbook of Agricultural Statistics, Livestock and Animal Products, #21-514 (Ottawa: Statistics Canada, 1975), Table 62.

Poultry: Statistics Canada, Production of Poultry and Eggs, #23-202 (Ottawa: Statistics Canada, Annual), Tables 2, 3, 4, 6.

^aPoultry includes all chickens, turkeys, geese and ducks produced in the crop year.

^bThe number of livestock were converted to the equivalent number of cows using the following relationship:

$$LN_t = 1 (\# \text{ milk cows}) + .51 (\# \text{ cattle}) + .5 (\# \text{ horses}) + .87 (\# \text{ hogs}) + .04 (\# \text{ sheep}) + 0.45 (\# \text{ poultry}).$$

This relationship was determined by W. J. Craddock in Interregional Competition in Canadian Cereal Production (Ottawa: Queen's Printer, 1970), p. 125.

Table 3.12

OTHER VARIABLES

Crop Year	T	W_t^a	L_t^b	D_t^c
1974-75	25	0	10.49	0
1973-74	24	1	10.35	0
1972-73	23	0	13.31	0
1971-72	22	1	31.60	0
1970-71	21	1	6.29	1
1969-70	20	1	20.48	0
1968-69	19	0	0	0
1967-68	18	1	17.94	0
1966-67	17	1	6.63	0
1965-66	16	0	10.47	0
1964-65	15	1	1.41	0
1963-64	14	1	3.64	0
1962-63	13	1	1.00	0
1961-62	12	0	0	0
1960-61	11	0	4.35	0
1959-60	10	0	0	0
1958-59	9	0	23.57	0
1957-58	8	0	4.50	0
1956-57	7	1	8.00	0
1955-56	6	1	4.71	0
1954-55	5	0	17.89	0
1953-54	4	1	18.34	0
1952-53	3	1	1.00	0
1951-52	2	0	1.00	0
1950-51	1	0	5.00	0
AVERAGE			8.35	

SOURCE:

- a) Canadian Wheat Board, Canadian Wheat Board Annual Report (Winnipeg: Canadian Wheat Board), Annual. Derived from the section on weather conditions.

1 = favourable weather, 0 = unfavourable weather.

(Continued)

Table 3.12 (Continued)

-
-
- b) Calculated from the table "Strikes Affecting Movement of Grain by Crop Year" in this chapter.

$$L_t = \frac{\text{total number of lost man-days during crop year } t}{\text{total number of employees involved in these strikes during year } t}$$

- c) A dummy variable to represent the implementation of the LIFT program.
1 = in effect (1970-71), 0 = otherwise.

Table 3.13

VARIABLES TO INDICATE THE EFFECT OF STRIKES
DURING TIMES OF ABNORMAL^a DEMAND

Crop year	Wheat Z_t	Oats Y_t	Barley X_t	Flax V_t
1974-75	0**	10.35	10.35	0
1973-74	0	0	13.31	0
1972-73	31.6	0	31.60	31.60
1971-72	6.29	0	6.20	6.20
1970-71	0	0	20.48	20.48
1969-70	0	0	0	0
1968-69	0	17.94	0	0
1967-68	0	0	0	0
1966-67	10.47	0	0	0
1965-66	1.47	0	0	0
1964-65	0	0	0	0
1963-64	1.00	1.00	0	0
1962-63	0	0	0	0
1961-62	0	4.35	0	0
1960-61	0	0	0	0
1959-60	0	0	0	0
1958-59	0	0	0	0
1957-58	0	0	0	0
1956-57	4.71	0	0	4.71
1955-56	0	0	0	0
1954-55	18.34	0	0	18.34
1953-54	1.00	0	0	1.00
1952-53	0	0	0	1.00
1951-52	0	5.00	0	5.00
1950-51	8.35*	8.35*	8.35*	8.35*

*As data for strikes prior to crop year 1949-50 was unavailable, the one and two year lags (L_{t-1} , L_{t-2}) are the mean of L_t from 1950-51 to 1974-75 (8.35).

**A value of 0 does not indicate no demand but the fact that demand was normal and no strikes affected demand during that crop year.

(Continued)

Table 3.13 (Continued)

^aThis variable was developed from the Demand Variables and Strike Variable (L_t). Let M_t , N_t , O_t , P_t be the standard deviation of each demand variable QDW_t, QDO_t, QDB_t and QDF_t respectively. If the mean demands are $\overline{QDW}_t, \overline{QDO}_t, \overline{QDB}_t$ and \overline{QDF}_t , the first standard deviations about the means are:

$$\overline{QDW}_t \pm M_t \quad (M_t = 103,000,000 \text{ bushels})$$

$$\overline{QDO}_t \pm N_t \quad (N_t = 35,000,000 \text{ bushels})$$

$$\overline{QDB}_t \pm O_t \quad (O_t = 71,000,000 \text{ bushels})$$

$$\overline{QDF}_t \pm P_t \quad (P_t = 6,086,000 \text{ bushels})$$

Demands for each grain within the first deviation is considered normal. This is signified by a zero. If demand is outside the range a dummy variable of one is assigned to that year. By multiplying the dummy variable by the strike variable (L_t) lagged one year, then two years, these variables for wheat oats, barley and flax are determined. The variable with the asterisk being a two year lag.

Example for crop year 1972-73:

$$QDW_t = 533,242,000 \text{ bushels.} \quad \overline{QDW}_t = 342,000,000$$

$$M_t = 103,000,000$$

$$QDW_t > \overline{QDW}_t + M_t, \text{ thus the dummy} = 1$$

$$1.(L_{t-1} = 31.6) = 31.6 = Z_t$$

$$^b \text{Standard deviation} = \sqrt{\frac{1}{n} \sum_t (x_t - \bar{x})^2}$$

$$\text{for wheat} = \sqrt{\frac{1}{25} \sum_t (QDW_t - \overline{QDW})^2}$$

C. Preliminary Analysis and the Selection of Variables

Based on the hypothetical model proposed in section B of this chapter, an analysis of its foundations must be performed. As the number of variables in any given equation is large (up to eight) while the size of the sample is small (25 observations), there is a dilemma to the proper method of selecting variables to be included in the final model.

There are several ways of selecting the variables to be included in the final analysis. Among these are:

- " i) choosing all possible regressions
- ii) the backward elimination procedure
- iii) the forward selection procedure
- iv) stagewise regression, and
- v) stepwise regression."⁶⁹

The first must be eliminated as being too cumbersome and time consuming. If there are X_k independent variables, 2^k regressions must be performed to test all possible combinations.⁷⁰ With a minimum of five independent variables in each equation in the hypothetical model and eight dependant variables, testing all possible combinations would require at least 256 ⁷¹ regressions to be performed.

⁶⁹Draper and Smith, op. cit., pp. 163-177.

⁷⁰Ibid., p. 164.

⁷¹ $(2^5) \times 8$.

The backward elimination⁷² and forward selection⁷³ procedures significantly reduce the number of calculations necessary to delineate the independent variables included in the model. However, in both cases, they suffer a deficiency in that the influence of a variable entered or removed on the other independent variables is not considered. For example, the removal of one particular variable may affect the status (in or out of the regression) of other variables. Consequently, coefficient estimates obtained by these procedures may be biased.

The stagewise regression procedure is a procedure which does not yield least squares estimates, therefore lacks the desired properties of unbiasedness, consistency and efficiency. Additionally, the ability of stagewise estimates to make predictions is less than that of least

⁷² Backward elimination regresses all independent variables on the dependant variable, then remove the independent variable whose F values are less than a predetermined norm F^* . The regression is performed again without the eliminated variable of further variables removed if necessary.

⁷³ In the forward selection procedure, the independent variable with the highest partial correlation with the dependant variable is regressed upon it. The partial correlation coefficients for the remaining independent variables are calculated and the highest, once again, is entered. This procedure continues until the partial F of a variable is less than the norm established for entrance (F^*).

squares estimates.⁷⁴ Therefore, stagewise procedure cannot be used.

The stepwise⁷⁵ procedure suffers neither the arduousness of calculating all possible regressions, nor the statistical difficulties of the backward elimination, forward selection and stagewise procedures. Therefore, it was the technique applied to differentiate the independent variables in the hypothetical model.

Each of the equations in the model was analyzed using a stepwise procedure. To perform the calculations, the Biomedical Computer Programs⁷⁶ language was utilized. Using an F value of 1.85⁷⁷ as the cutoff value for the entrance and removal of variables the results of Tables 3.14 to 3.21 were obtained.

Upon examination of the initial results of the analysis, certain independent variables appeared to have relationships contrary to those hypothesized in the model. Among these were:

⁷⁴ Draper and Smith, op. cit., p. 176.

⁷⁵ A description of this procedure is contained in Chapter 1, pages 10 and 11.

⁷⁶ W. J. Dixon (ed.), BMD: Biomedical Computer Programs (Berkeley: University of California Press, 1973), pp. 305-330.

⁷⁷ This value was chosen as for the number of observations (25) and independent variables in each equation (5-8) it represented approximately an F level of 15 percent.

Table 3.14*

WHEAT SUPPLY (QSW_t) 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	PBC _t /PWC _t		578,396.1	.9555	515.8816
2	T		8,379.2	.9682	9.1309
3	D _t		59,483.6	.9720	3.0292
4	CW _{t-1}		-.13	.9753	2.7952

Table 3.15

WHEAT DEMAND (QDW_t) 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	YI _t		6,124.2	.9459	419.2383
2	PWC _t		-655,059.3	.9560	5.2829
3	PWJ _t		349,904.7	.9631	4.2882
4	YB _t		503.7	.9736	8.3660
5	Z _t		-9,863.5	.9789	4.9546

(Continued)

*
Tables 3.14 and 3.15 (Continued)

* It was realized that due to the variation in the magnitude of the coefficients, t-statistics and a normalization procedure would have been useful (Tables 3.14 to 3.21). However, the purpose of this section was to solely delete extraneous variables.

Table 3.16
OATS SUPPLY 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	AO _{t-1}			.8582	145.2357
2	CO _{t-1}		-.28	.9278	22.1532
3	T		-2,917.4	.9371	3.2705
4	D _t		35,344.5	.9475	4.1698
5	PBC _t /PWC _t		122,667.6	.9527	2.1854
6	W _t		10,732.5	.9567	2.2157
7		AO _{t-1}		.9552	1.0892

Table 3.17
OATS DEMAND (QDO_t) 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	LN _t		40.3	.9332	335.1016
2	T		-23,845.9	.9855	82.8041
3	L _{t-1}		-2,660.7	.9879	4.4548
4	Y _t		-3,772.9	.9890	2.1581

Table 3.18
 BARLEY SUPPLY (QSB_t) 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	AB_{t-1}		15.9	.9074	235.1900
2	D_t		112,597.8	.9223	4.4072
3	L_t		2,146.8	.9367	5.0249
4	T		3,417.6	.9420	1.9175
5	CB_{t-1}		-.50	.9488	2.6337

Table 3.19
 BARLEY DEMAND (QDB_t) 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	LN_t		11.3	.9825	668.8247
2	L_{t-1}		3,145.9	.9856	4.7892
3	T		4,887.3	.9877	3.8198

Table 3.20
 FLAX SUPPLY (QSF_t) 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	AF_{t-1}		3.37	.8393	125.3037
2	T		329.3	.8807	7.9914
3	D_t		14,373.5	.9028	5.0089
4	PFC_t/PWC_t		2,634.1	.9202	4.5824

Table 3.21
 FLAX DEMAND (QDF_t) 1

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	T			.8704	161.1672
2	PIG_t		.0517	.8996	6.7027
3	V_t			.9191	5.3023
4	PIJ_t		.0106	.9264	2.0791
5	PFC_t		-4,254.5	.9360	2.9991
6		V_t		.9360	.0056
7		T		.9352	.2481

- i) PBC_t/PWC_t is positively related to QSW_t ,
- ii) D_t is positively related to QSW_t ,
- iii) PBC_t/PWC_t is positively related to QSO_t ,
- iv) L_t is positively related to QSB_t , and
- v) L_{t-1} is positively related to QDB_t .

There are two possible explanations for these phenomena.

First, this may be the actual relationship among these independent variables and their respective dependant variables (ie., the hypotheses in the model are wrong).

Second, this relationship may be the result of spurious correlation.

The possibility of these being spurious was tested by performing the stepwise regression again, but restricting the equations. Performing such an analysis, the results of Tables 3.22 to 3.25 were obtained.

With these modifications, the results for wheat supply, oats supply and barley supply became satisfactory. The revised barley demand determined demand as directly proportional to LN_t . This is clearly an unsatisfactory result, as more variables influence barley demand than solely the livestock numbers (in equivalent dairy cows) in Canada. Thus the original model for barley demand will be utilized in the next stage of the analysis.

An interesting change occurred with regards to the supply of wheat. With the inclusion of the independent variable PWC_t , both problems associated with the original

Table 3.22

WHEAT SUPPLY (QSW_t) REVISED^a

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	PWC_t		18,285.1	.8693	159.6494
2	D_t		-145,270.9	.8698	1.9194
3	AW_{t-1}		11.7	.9491	34.2564
4	T		7,378.8	.9606	6.1592
5	W_t		59,641.7	.9647	2.2795

^aFor the revision of the QSW_t variable, it was decided to use PWC_t as an independent variable. Other grain prices were still in terms of relative wheat prices (POC_t/PWC_t), PBC_t/PWC_t , PFC_t/PWC_t). The rationale for using PWC_t was to explicitly define wheat price for the supply of wheat. The variable PBC_t/PWC_t was restricted from entering the regression.

Table 3.23

OATS SUPPLY (QSO_t) REVISED

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	POC _t /PWC _t		38,019.1	.7857	87.9784
2	AO _{t-1}		15.8	.8772	17.1486
3	CO _{t-1}		-.371	.9295	16.3003
4	T		-1,116.5	.9376	2.7475
5	D _t		35,569.4	.9487	4.2945

Table 3.24
 BARLEY SUPPLY (QSB_t) REVISED

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	AB_{t-1}		17.49	.9074	235.1900
2	D_t		99,852.9	.9223	4.4072
3	T		3,691.2	.9304	2.5503
4	CB_{t-1}		-.46	.9363	1.9545

Table 3.25
 BARLEY DEMAND (QDB_t) REVISED

Step Number	Variable		Regression Coefficient	Multiple R-Square	F Value to Enter or Remove
	Entered	Removed			
1	LN_t		16.1	.97	668.83

model disappeared. The price variable (PWC_t) had a hypothesized positive relationship with supply of wheat. Furthermore, the relationship of the LIFT program signified by the dummy variable D_t , was as originally hypothesized.⁷⁸

As expected, the exclusion of the dependant variable PBC_t/PWC_t , improved results for the oat supply model. Previously, this variable was related in a positive fashion to the supply of oats. With its exclusion, the variable POC_t/PWC_t became the price variable influencing oats supply, as originally hypothesized. Additionally, the dummy variable representing meteorologic conditions (W_t) exited from the model, being replaced by the seeded acreage of oats lagged one year (AO_{t-1}).

Finally, the revised model of barley supply was a vast improvement over the original model. The forced removal of L_t from the model, led to a trivial decrease in the explanatory power of the model. As suspected, the inclusion of L_t , originally, was solely the impact of spurious correlation.⁷⁹

Having completed this analysis, the final model to be econometrically treated became:

⁷⁸ That is D_t is inversely related to QSW_t .

⁷⁹ The multiple R-Square fell from .9488 to .9353.

$$QSW_t = f(PWC_t, AW_{t-1}, T, W_t, D_t) \quad (3.13)$$

$$QDW_t = f(PWC_t, PWU_t, YI_t, YB_t, Z_t) \quad (3.14)$$

$$QSO_t = f(POC_t/PWC_t, AO_{t-1}, CO_{t-1}, T, D_t) \quad (3.15)$$

$$QDO_t = f(LN_t, Y_t, L_{t-1}, T) \quad (3.16)$$

$$QSB_t = f(AB_{t-1}, CB_{t-1}, T, D_t) \quad (3.17)$$

$$QDB_t = f(LN_t, L_{t-1}, T) \quad (3.18)$$

$$QSF_t = f(PFC_t/PWC_t, AF_{t-1}, T, D_t) \quad (3.19)$$

$$QDF_t = f(PIJ_t, PIG_t, T) \quad (3.20)$$

The econometric treatment of these equations involves an examination of coefficient t-values, the F-ratio, the multiple R-square, and the second order econometric criterion.⁸⁰ Among the second order criterion, the model will be tested for multicollinearity and autocorrelation.

The most logical sequence to perform this stage of the analysis was to implement the second order tests first. As the F values to remove or enter the variables and the multiple R-squares were already known from the first stage of this investigation, it was advantageous to carry out the second order tests rather than determining the validity of the model in terms of the first order tests, thus avoiding

⁸⁰It is recognized that the t-values of coefficients in a simultaneous model, using the two stage least squares technique (with a small sample) are biased, so cannot be subjected to a rigorous t-test, as in the case of ordinary least square estimates. Refer to Henri Theil, Principles of Econometrics (New York: John Wiley and Sons, 1971), p. 497.

"backtracking" if the model did not live up to the second order criterion.

The first problem to be dealt with was the problem of multicollinearity. Without going into a needless mathematical exposition, multicollinearity may be defined as "the presence of linear (or non-orthogonal) relationships among the explanatory variable"⁸¹ in a particular econometric equation. The effects of multicollinearity on a model are:

- i) larger standard errors of the coefficients, and
- ii) bias in the estimates of the parameters.⁸²

Due to these two effects, the degree of multicollinearity in a model must be ascertained. There are many possible tests for multicollinearity,⁸³ however most econometricians use a simpler more practical approach of examining the correlation matrices of the independent variables in the equations of the model. If two explanatory variables have a correlation coefficient of .75 (ie., R^2 , 50 percent), multicollinearity exists in that equation.

Correlation matrices for the explanatory variables in the revised model were calculated. These matrices for

⁸¹A. Koutsoyiannis, op. cit., p. 225.

⁸²Ibid., pp. 225-229.

⁸³Ibid., pp. 230-241. Among the tests cited by Koutsoyiannis are: Frisch's Confluence Analysis and the Farrar-Glauber Test.

each equation (Tables 3.26 to 3.35) indicate multicollinearity in every equation. There were several possible methods to resolve the problem of multicollinearity in the model. Respecification of the model was a possible solution. However, upon re-examination of the model and variables, the specification was correct. Increasing the sample size was impossible, therefore the explanatory variables were made orthogonal through the use of the principle components method.

However, the choice of the principle components method⁸⁴ resulted in a further difficulty in the building of the model. No satisfactory technique is available to incorporate estimates of regression coefficients into simultaneous equation techniques, specifically two stage least squares. Thus, the resolution of the problem of multicollinearity would result in biased estimates for the coefficients of the variables, as it would be impossible to use a simultaneous model.⁸⁵ However, the inclusion of multicollinear variables in itself would result in biased estimates for the independent variables.

⁸⁴A mathematical explanation of this method is provided in Appendix B.

⁸⁵It is beyond the scope of this thesis to develop such a technique for a simultaneous model.

Table 3.26

CORRELATION MATRIX--WHEAT SUPPLY

	PWC_t	AW_{t-1}	T	W_t	D_t
PWC	1	.92	.91	.67	.16
AW_{t-1}		1	.73	.71	.20
T			1	.69	.28
W_t				1	.28
D_t					1

Table 3.27

CORRELATION MATRIX--WHEAT DEMAND

	PWC_t	PWU_t	YI_t	YB_t	Z_t
PWC_t	1	.79	.45	.71	.05
PWU_t		1	.07	.42	.02
YI_t			1	.84	.05
YB_t				1	.13
Z_t					1

Table 3.28

CORRELATION MATRIX--OATS SUPPLY

	POC_t/PWC_t	AO_{t-1}	CO_{t-1}	T	D_t
POC_t/PWC_t	1	.98	.95	.86	.19
AO_{t-1}		1	.95	.80	.18
CO_{t-1}			1	.85	.24
T				1	.28
D_t					1

Table 3.29

CORRELATION MATRIX--OATS DEMAND

	LN_t	Y_t	L_{t-1}	T
LN_t	1	.28	.04	.98
Y_t		1	.15	.27
L_{t-1}			1	.10
T				1

Table 3.30

CORRELATION MATRIX--BARLEY SUPPLY

	AB_{t-1}	CB_{t-1}	T	D_t
AB_{t-1}	1	.96	.90	.21
CB_{t-1}		1	.95	.31
T			1	.28
D_t				1

Table 3.31

CORRELATION MATRIX--BARLEY DEMAND

	LN_t	L_{t-1}	T
LN_t	1	.66	.98
L_{t-1}		1	.10
T			1

Table 3.32

CORRELATION MATRIX--FLAX SUPPLY

	PFC_t/PWC_t	AF_{t-1}	T	D_t
PFC_t/PWC_t	1	- .31	- .56	- .05
AF_{t-1}		1	.81	.14
T			1	.23
D_t				1

Table 3.33

CORRELATION MATRIX--FLAX DEMAND

	PFC_t	PIJ_t	PIG_t
PFC_t	1	.82	.84
PIJ_t		1	.69
PIG_t			1

The dilemma was resolved by recognizing the bias evident in two stage least square estimates when a small sample size was used.⁸⁶ Thus, the use of two stage least square estimates would result in two sources of bias in the estimates (one due to sample size and one due to multicollinearity), while scrapping the simultaneous estimation of the model would yield only one source of bias. Consequently, the estimation of the final model was attempted using principal component estimates for ordinary least square determined equations.

The final section of this chapter will be devoted to the attempted model derived through principal components and the final model.

D. Determination of the Final Model

This section will present the final model for the analysis of the cost of labour disputes in the grain movement system. The initial equations⁸⁷ in this section of the thesis were determined using the principal components method. The components for each equation are presented in Appendix C.

⁸⁶ Refer to Chapter 1, p. 10.

⁸⁷ Equations 3.29...3.36.

D.1 The principal component estimates of the coefficients of the model.

The model to which the principal component analysis was applied to is the following:

$$QSW_t = b_{11}PWC_t + b_{12}AW_{t-1} + b_{13}T + b_{14}W_t - b_{15}D_t \quad (3.21)$$

$$QDW_t = -b_{21}PWC_t + b_{22}PWU_t + b_{23}YI_t + b_{24}YB_t - b_{25}Z_t \quad (3.22)$$

$$QSO_t = b_{31}POC_t/PWC_t + b_{32}AO_{t-1} - b_{33}CO_{t-1} + b_{34}T + b_{35}D_t \quad (3.23)$$

$$QDO_t = b_{41}LN_t - b_{42}Y_t - b_{43}L_{t-1} - b_{44}T \quad (3.24)$$

$$QSB_t = b_{51}AB_{t-1} - b_{52}CB_{t-1} + b_{53}T + b_{54}D_t \quad (3.25)$$

$$QDB_t = b_{61}LN_t + b_{62}T + b_{63}L_{t-1} \quad (3.26)$$

$$QSF_t = b_{71}PFC_t/PWC_t + b_{72}AF_{t-1} + b_{73}T + b_{74}D_t \quad (3.27)$$

$$QDF_t = -b_{81}PFC_t + b_{82}PIJ_t + b_{83}PIG_t \quad (3.28)$$

The coefficient estimates as determined by the principal components method are summarized in the following Table 3.36.⁸⁹

⁸⁸All variables are as previously defined, except $b_{11} \dots b_{83}$ which are the regression coefficients of the respective variables.

⁸⁹Refer to Appendices B, C and D for the technique of analysis, the loadings and the coefficients.

Table 3.34

COEFFICIENTS OF THE MODEL DETERMINED BY
PRINCIPAL COMPONENTS

Wheat Supply

$$\hat{b}_{11} = .94(19.5) = 18.33 \quad \hat{b}_{12} = .921(19.5) = 17.9$$

$$\hat{b}_{13} = .80(19.5) = 15.6 \quad \hat{b}_{14} = .74(19.5) = 14.4$$

$$\hat{b}_{15} = .49(19.5) = + 9.6$$

Wheat Demand

$$\hat{b}_{21} = .84(512.1) = + 430.2 \quad \hat{b}_{22} = .67(512.1) = 343.1$$

$$\hat{b}_{23} = .70(512.1) = 358.5 \quad \hat{b}_{24} = .90(512.1) = 460.9$$

$$\hat{b}_{25} = .33(512.1) = 169.0$$

Oats Supply

$$\hat{b}_{31} = .95(.41) = .39 \quad \hat{b}_{32} = .93(.41) = .38$$

$$\hat{b}_{33} = .95(.41) = +.33 \quad \hat{b}_{34} = .90(.41) = .37$$

$$\hat{b}_{35} = .45(.41) = .19$$

Oats Demand

$$\hat{b}_{41} = .83(26.9) = 22.3 \quad \hat{b}_{42} = .62(26.9) = + 16.7$$

$$\hat{b}_{43} = .47(26.9) = + 12.7 \quad \hat{b}_{44} = .85(26.9) = + 22.9$$

(Continued)

Table 3.34 (Continued)

Barley Supply

$$\hat{b}_{51} = .94(1.02) = .96 \quad \hat{b}_{52} = .96(1.02) = + .98$$

$$\hat{b}_{53} = .93(1.02) = .95 \quad \hat{b}_{54} = .54(1.02) = .55$$

Barley Demand

$$\hat{b}_{61} = 1.03(15.6) = 16.1 \quad \hat{b}_{62} = .69(15.6) = 10.8$$

$$\hat{b}_{63} = .82(15.6) = 12.8$$

Flax Supply

$$\hat{b}_{71} = .04(10.2) = .4 \quad \hat{b}_{72} = .79(10.2) = 8.1$$

$$\hat{b}_{73} = .70(10.2) = 7.1 \quad \hat{b}_{74} = .62(10.2) = 6.3$$

Flax Demand

$$\hat{b}_{81} = .95(.02) = + .02 \quad \hat{b}_{82} = .91(.02) = .02$$

$$\hat{b}_{83} = .91(.02) = .02$$

$$QSW_t = 18.33PWC_t + 17.9AW_{t-1} + 15.6T + 14.4W_t + 9.6D_t \quad (3.29)$$

$$QDW_t = 430.2PWC_t + 343.1PWU_t + 358.5YI_t + 460.9YB_t + 168.0Z_t \quad (3.30)$$

$$QSO_t = .39POC_t/PWC_t + .38AO_{t-1} + .33CO_{t-1} + .37T + .19D_t \quad (3.31)$$

$$QDO_t = 22.3LN_t + 16.7Y_t + 12.7L_{t-1} + 22.9T \quad (3.32)$$

$$QSB_t = .96AB_{t-1} + .98CB_{t-1} + .95T + .55D_t \quad (3.33)$$

$$QDB_t = 16.1LN_t + 10.8T + 12.8L_{t-1} \quad (3.34)$$

$$QSF_t = .4PFC_t/PWC_t + 8.1AF_{t-1} + 7.1T + 6.3D_t \quad (3.35)$$

$$QDF_t = .02PFC_t + .02PIJ_t + .02PIG_t \quad (3.36)$$

Unfortunately, the model using principal components fails because the signs on the coefficients are not consistent with those hypothesized in equations 3.21-3.28. Upon changing these signs the estimates of the dependant variables were determined (Appendix E). Clearly, these results would not suffice for the final model. The decision was made to use ordinary least square estimates for the final model.

D.2 The final model⁹⁰

This section presents the final model used to assess the economic costs of labour disputes in the Canadian grain movement system. The t-values for the coefficients are in parentheses beneath their respective coefficients. The Durbin-Watson statistics (d^*) determined the absence or presence of autocorrelation. Although rigorous tests of the statistics could have been applied, an easy rule of thumb used in this analysis, is to reject the presence of autocorrelation if $1.65 < d^* < 2.35$.

Autocorrelation was present in only in one equation. That being the demand for barley ($d^* = 1.08$). Consequently, the Cochrane-Orcutt⁹¹ iterative technique was employed to remove the autocorrelation. This led to an improvement in the model in two ways. First, the autocorrelation was removed. Second, as a result of this first factor, the sign on the "strike variable" (L_{t-1}) became as originally hypothesized. The final model is presented in equations 3.37-3.45.

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The author recognizes ordinary least square estimates for a simultaneous model are biased. However, the objective and scope of this thesis is to assess the economic costs of labour strikes, not build an econometric model.

⁹¹J. Philip Cooper and Gary A. Curtis, Econometric Software Package (Chicago: University of Chicago, 1976), pp. B.8.1-B.8.2.

i) The Wheat Market.

$$\begin{aligned}
 QSW_t &= 18286PWC_t + 11.7AW_{t-1} + 7378.7T + 59641W_t - 145270D_t \\
 &\quad (1.633) \quad (5.630)^A \quad (2.238)^A \quad (1.509) \quad (-1.389) \\
 R^2 &= .96 \quad F_{4,20} = 17.67^A \quad d^* = 2.12 \\
 &\hspace{20em} (3.37)
 \end{aligned}$$

$$\begin{aligned}
 QDW_t &= -655192PWC_t + 349973PWU_t + 6122YU_t + 503.8YB_t - 9866Z_t \\
 &\quad (-5.504)^A \quad (4.255)^A \quad (2.804)^A \quad (3.754)^A \quad (-2.226)^A \\
 R^2 &= .66 \quad F_{4,20} = 9.74^a \quad d^* = 1.96 \\
 &\hspace{20em} (3.38)
 \end{aligned}$$

ii) The Feed Grain Market.

$$\begin{aligned}
 QSO_t &= 38019.3POC_t/PWC_t + 16.0AO_{t-1} - .37CO_{t-1} - 116.6T \\
 &\quad (1.478) \quad (2.063)^B \quad (-3.753)^A \quad (-2.544)^A \\
 &\quad +35569.4D_t \\
 &\quad (2.294)^A \\
 R^2 &= .78 \quad F_{4,20} = 17.74^A \quad d^* = 2.06 \\
 &\hspace{20em} (3.39)
 \end{aligned}$$

$$\begin{aligned}
 QDO_t &= 40.3LN_t - 3776.1Y_t - 2660.7L_{t-1} - 23840.6T \\
 &\quad (22.022)^A \quad (-1.469) \quad (-1.942)^B \quad (-9.849)^A \\
 R^2 &= .82 \quad F_{3,21} = 3.2 \quad d^* = 1.67 \\
 &\hspace{20em} (3.40)
 \end{aligned}$$

^ASignificant at $\alpha = .05$ or higher.

^BSignificant at $\alpha = .10$ or higher.

*The first QDB_t equation has autocorrelation, the second was actually employed in the latter analysis.

$$\begin{aligned}
 QSB_t &= 17.49AB_{t-1} - .46CB_{t-1} + 3691.8T + 99857D_t \\
 &\quad (4.599)^A \quad (-1.398) \quad (2.147)^A \quad (2.207)^A \\
 R^2 &= .64 \quad F_{3,21} = 12.42 \quad d^* = 1.67
 \end{aligned}$$

(3.41)

$$\begin{aligned}
 \text{i) } QDB_t^* &= 11.34LN_t + 4887.4T + 31460L_{t-1} \\
 &\quad (6.004) \quad (1.955) \quad (2.242) \\
 R^2 &= .77 \quad F_{2,22} = 37.57 \quad d^* = 1.08
 \end{aligned}$$

$$\begin{aligned}
 \text{ii) } QDB_t &= 12.37LN_t + 6051T - 102.4L_{t-1} \\
 &\quad (2.941)^A \quad (1.873) \quad (-2.121)^A \\
 R^2 &= .86 \quad F_{2,21} = 64.9^A \quad d^* = 1.77
 \end{aligned}$$

(3.42)

iii) The Flaxseed Market.

$$\begin{aligned}
 QSF_t &= 2634.0PFC_t/PWC_t + 3.4AF_{t-1} + 329.3T + 14375.5D_t \\
 &\quad (2.141)^A \quad (2.509)^A \quad (2.255)^A \quad (2.597)^A \\
 R^2 &= .62 \quad F_{3,21} = 7.33^A \quad d^* = 1.66
 \end{aligned}$$

(3.43)

$$\begin{aligned}
 QDF_t &= -4284.5PFC_t + .01PIJ_t + .06PIG_t \\
 &\quad (2.454)^A \quad (1.765)^B \quad (3.859)^A \\
 R^2 &= .79 \quad F_{2,22} = 6.89^A \quad d^* = 1.72
 \end{aligned}$$

(3.44)

^ASignificant at $\alpha = .05$ or higher.

^BSignificant at $\alpha = .10$ or higher.

*The first QDB_t equation has autocorrelation, the second was actually employed in the latter analysis.

CHAPTER 4

RESULTS OF THE ANALYSIS

The purpose of this chapter is to furnish the results of the model derived in the third chapter. Essentially, this chapter contains three sections. The first will present the hypotheses that were confirmed and those abandoned. The second will discuss the coefficients and elasticities of the strike variable. The third section contains the losses of demand and revenue attributable to these labour disputes.

A. Hypotheses of the Model Confirmed and Rejected

Perhaps the most outstanding feature of the analysis in the preceding chapter, was the reduction in the number of variables influencing the various demand and supply equations in the initial model. Variables which were retained had the relationships as originally postulated.

The easiest manner for the separation of acceptable assumptions from those which are not adopted is on an equation by equation basis. This procedure was followed:

a) Equations 3.1 and 3.37. With regards to the supply of wheat, the final model confirmed the dependency of supply on AW_{t-1} , W_t , D_t and T . However, the variables POC_t/PWC_t , PBC_t/PWC_t , PFC_t/PWC_t and L_t were excluded from the model.

Clearly, the decision to seed acreage to wheat, and subsequently, increase the supply of wheat, does not rest on the relative prices of grains. The decision of farmers to plant wheat was determined by the actual price of wheat (PWC_t) indicating that wheat is the "standard" commodity to which producers alter their production of other grains. The impact of strikes on the supply of wheat was not evident. Therefore, it may be concluded that strikes have no effect on the farm supply of grain or the marketing of grain through the Canadian Wheat Board.

b) Equations 3.2 and 3.38. The demand for Canadian wheat in international markets proved to depend on five variables. These were PWC_t , PWU_t , YI_t , YB_t and Z_t . The signs on these variables were also as hypothesized in equation 3.2. Three of the original hypothetical relationships were not evident. Wheat demand did not depend on the per capita income in Japan (YJ_t), the rate of lost man-days per worker lagged one year (L_{t-1}) or linear time (T). Based on the Z_t , strikes influenced wheat demand during abnormal years. That is, purchasers of Canadian wheat switch sources when there are periods of high and low demand for wheat on the international markets. As the impact is lagged one year, the effect of strikes will not be felt until the following abnormal demand year.

c) Equations 3.4 and 3.39. Once again, the effect of labour disputes was not evident in the supply of oats in

the final model. Strikes do not have a large enough impact on Wheat Board policies to cause restrictions in the supply system, and subsequently production of oats.

Other variables rejected in the final model were: PBC_t/PWC_t , PFC_t/PWC_t and W_t . However, confirmation was given to the postulate that the relative price of oats to wheat influences the production of oats. Producers compare oats prices to that of the standard, wheat, when making their production allotments.

d) Equations 3.5 and 3.40. Oats demand was found to depend on four of the original six variables hypothesized. Domestic demand for oats was influenced by the number of livestock in Canada, L_{t-1} , Y_t and time. The price variables had no impact on demand.

Several interesting phenomena are evident from this model. First, the domestic demand for oats does not depend on either the Canadian or U.S. price. The reasons for this phenomena are;

- i) in the short run, farmers do not compare prices when purchasing oats; however, in the long run, livestock production expands or contracts on the basis of the market price of livestock compared to feed grain (input) prices.
- ii) quotas, tariffs and transport costs on U.S. feed grains restrict livestock producers from purchasing American grain.

- iii) purchasers of feed grains are motivated by altruistic motives, buying Canadian grain whenever the price is within a "reasonable" range of American oats.
- iv) the price data used in the analysis may have already been in equilibrium in terms of livestock.

The second phenomena of interest is that the demand for oats is influenced by both L_{t-1} and Y_t . This leads to the conclusion that conflicts always decrease oats demand in the year following a strike. Further to this decrease, a greater decrease will occur in years of abnormally high or low demand. Finally, the relationship of time to demand must be noted as being negative. This does not mean that at some distant time there will be no demand for Canadian oats. It does indicate that some other variable is increasing and with it, demand for Canadian oats. This variable proves to be LN_t .

e) Equations 3.7 and 3.41. The supply of barley depends on four variables, AB_{t-1} , CB_{t-1} , T and D_t . That is, the price variables (POC_t/PWC_t , PBC_t/PWC_t , PFC_t/PWC_t), weather (W_t) and L_t had no impact on the supply of barley. The indication of the exclusion of the price variables is that the production of barley takes place on land not allotted to other purposes (ie., surplus to current production allotments). That is, the price of barley is not

considered in its production, while prices are considered for the other grains. Once again, strikes had no impact on the supply of barley, re-affirming the previous conclusion that strikes do not alter Wheat Board production/delivery quotas and farmers decisions.

f) Equations 3.8 and 3.42(ii). As in the case of oats, LN_t had an important influence on the domestic demand for barley. As theorized the greater the number of livestock in Canada, the greater the demand for barley. The similar relationship of the demand for oats and barley to LN_t is as expected, as they are complementary in feed rations. Throughout time, it is expected that the demand for barley will grow, although the rate of growth is only 6,051,000 bushels per year. The effect of strikes on barley demand (L_{t-1}) is continual. There is not any evidence of a surge in decreased demand for barley during abnormal years (X_t). As well, prices of barley in Canada and the U.S. had no effect on demand. This is consistent with the results for oats demand, occurring for similar reasons.

g) Equations 3.10 and 3.43. As in the three previous supply equations, strikes had no impact on the supply of flax, in contrast to the original hypothesis. Other variables rejected from the final flax supply model were: POC/PWC_t , PBC_t/PWC_t , CF_{t-1} and W_t . The indication being that farmers compare the price of flax to wheat when allotting acreage, but do not consider the relative prices of

oats and barley to wheat, when planting acreage to flax. Carryovers have no impact on flax. Perhaps this phenomenon is due to the relatively small carryover of flax in any given year. The weather variable did not enter into the flax supply equation (as was the case for oats and barley). At first, it was felt the variable may have been mis-specified, but the indication of wheat supply was that it was specified correctly. Therefore, it was concluded that another variable was "picking up" the influence of weather on supply for flax, oats and barley.

h) Equations 3.11 and 3.44. The most outstanding feature of the final equation for flax demand was that strikes had no impact on demand. Two reasons can be suggested for this:

- i) as the quantity of flax exported from Canada was relatively miniscule compared to the other grains, the impact of strikes was negligible, or
- ii) that the impact of strikes is not evident for flax because it is marketed through private traders, unlike oats, barley and wheat which is marketed through the Wheat Board (ie. the Wheat Board is less efficient).

Of the two reasons, there is no evidence to confirm the second, so the first will have to serve as an explanation.

The variables determining the demand for flax were PFC_t , PIJ_t and PIG_t . Flax demand was inversely related to PFC_t and positively related to PIJ_t and PIG_t as expected. Time (T) did not enter the analysis. By studying PIJ_t and PIG_t it is evident that these variables are time related, leading to the exclusion of T.

Having confirmed the original postulates of the model and confirmed the final model, it was necessary to focus attention on the coefficients of these labour disputes.

B. The Elasticities and Coefficients of Labour Disputes

The importance of elasticities in the determination of the cost of strikes was twofold. First, the elasticities provided an indication of the degree of change in demand for the same degree of change in the strike variable. Second, the degree of elasticity (unitary, elastic or inelastic) indicated the nature of the demand curve relative to the strike variable.

Thus, a new type of elasticity was needed. The new elasticity was given the appellation "the labour strife elasticity." Labour strife elasticity was defined as the percentage change in demand given a percentage change in the rate of lost man-days per employee involved in the strikes. In mathematical terms, labour strife elasticity is:

$$E = \frac{\partial QD_t}{\partial L_t} \cdot \frac{L_t}{QD_t} \quad \text{or} \quad \frac{\Delta QD_t}{\Delta L_t} \cdot \frac{L_t}{QD_t}$$

where:

QD = quantity demanded

L_t = rate of lost man-days/worker employee

∂ = partial derivative

Δ = change in (ie., $QD_1 - QD_2$, $L_1 - L_2$)

Two types of labour strife elasticities were distinguishable. There was normal labour strife elasticity (E_i) meaning the elasticity during periods of "normal" demand. Abnormal or "surge"⁹³ labour strife elasticity (ES_i) was the second type. Surge labour strife elasticity was the elasticity of labour management conflicts effects (ie., Z_t , Y_t) on demand during periods of low or high demand periods.

On the basis of these definitions, Table 4.1 indicating the elasticities was calculated using the following formulation:⁹⁴

$$E_i(ES_i) = \hat{b}_j \frac{\bar{L}_t}{\bar{QD}}$$

where:

\hat{b}_j = the estimated coefficient of the respective strike variable

⁹³"Surge" indicating demand has surged downwards or upwards.

⁹⁴Koutsoyiannis, op. cit., pp. 65-66.

Table 4.1

 E_i AND ES_i , ELASTICITIES OF DEMAND

$ES_w = -.038$	$\overline{QDW} = 853,572$ $\bar{Z} = 3.33$ $\hat{a}_{27} = -9866.0$
$E_o = -.030$	$\overline{QDO} = 750,128$ $\bar{L} = 8.35$ $\hat{b}_{24} = -2660.7$
$ES_o = -.010$	$\overline{QDO} = 750,128$ $\bar{Y} = 1.96$ $\hat{b}_{25} = -3776.1$
$E_D = -.003$	$\overline{QDB} = 330,914$ $\bar{L} = 8.35$ $\hat{c}_{24} = -.02.4$

\bar{L} = the mean of the labour strike variable
(L_{t-1} , Z_t or Y_t)

\bar{QD} = the mean of the estimates of the respective demand equations

i = demand for grain of type i . (w = wheat,
 o = oats, b = barley)

These elasticities indicate that demand is inelastic with respect to the labour strike component of demand.⁹⁵ The highest elasticity was the surge labour strife elasticity of wheat demand at $-.038$. That is, a one percentage change in the rate of lost man-days per employee, will result in only a .038 percent fall in demand for wheat during periods of abnormal demand. For oats the labour strife elasticity was $-.03$ and the surge labour strife elasticity was $-.01$. A one percentage change in L_t will result in demand falling by .03 percent. This is supplemented by demand decreasing a further .01 percent when demand for oats is high or low, or a combined decrease of .04 percent for periods of abnormal demand. The demand for barley was the most inelastic with respect to labour conflicts. In its case a 1 percent increase in L_t led to a decrease in demand of only .003 percent.

Having determined the fact that the demand curves of wheat, oats and barley are surge labour and labour strife inelastic, the actual magnitude of the coefficients should be considered.

⁹⁵Inelastic if E or $ES_i < 1$; elastic if E or $ES_i > 1$;
Unitary elastic if E or $ES_i = 1$.

The coefficients of the labour strike variables, L_{t-1} , Z_t and Y_t give the magnitude (in 000's bushels) per rate of lost man-days per worker during periods of normal demand (for oats and barley) and periods of abnormal demand (Z_t for wheat and Y_t for oats).

The largest coefficient was the impact of strikes on wheat demand during periods of abnormal demand. For each lost man-day per worker the loss was 986,600 bushels of wheat demanded. By multiplying the value of Z_t times this loss in bushels, times the price of wheat in the crop year (PWC_t), the cost of strikes on wheat can be determined.

The second largest coefficient was the influence of strikes while oat demand was low or high. For each lost man-day per worker, 377,610 bushels of oats were not sold domestically. Additionally, normal losses of domestic oats exports were 266,070 bushels per lost man-day per worker. Thus, the combined effect during years of abnormal demand was a loss of 643,680 bushels per lost man-day per worker.

The impact of strikes on barley demand was a trivial (relative to wheat and oats) 102,400 bushels per lost man-days per worker. There was no extra effect of labour disputes during periods of abnormal barley demand.

Having determined and discussed the labour strife elasticities of demand and the coefficients of the strike variable, the final portion of this chapter is focused on

the major objective of this thesis. The calculation of the costs of strikes in the Canadian Grain Movement System.

C. The Cost of Strikes in the Canadian Grain Movement System

Calculating the costs of strikes in the movement of grain in Canada was a relatively simple procedure given the results presented in the preceding two sections. Basically, the cost attributable to the strike is the amount demand decreases due to the strikes, times the prevailing price of grain. Alternately, the losses may be calculated by multiplying the coefficient of the strike variable (Z_t , Y_t or L_t) times the prevailing price of the grain, times the value of the strike variable. In either event the results are the same.⁹⁶

The first method was used to determine the results for this portion of the thesis. The quantity demanded with and without inclusion of the strike variable for each grain is contained in Tables 4.2 to 4.6.

⁹⁶In the first case, the revenue loss on grain i (RL_i) is $(QD_i^B - QD_i^A) \cdot P_{i_t}$.

In the second, $RL_i = C_i L_t \cdot P_{i_t}$, but $QD_B - QD_A = C_i L_{ti}$, where:

QD_i^B = quantity of grain demanded before strikes

QD_i^A = quantity of grain i demanded after strikes

P_{i_t} = price of grain i during time t

C_i = labour coefficient for grain i

L_t = actual value of the labour strike variable during t

Table 4.2

DIVERGENCES BETWEEN THE ESTIMATED DEMAND OF GRAIN
WITH AND WITHOUT (') STRIKES
(000's bushels)

Crop Year	\widehat{QDW}_t	\widehat{QDW}_t'	\widehat{QDO}_t	\widehat{QDO}_t'	\widehat{QDB}_t	\widehat{QDB}_t'	\widehat{QDF}_t	\widehat{QDF}_t'
1974-75	856,773	856,773	869,671	936,292	460,845	461,905	19,368	19,368
1973-74	708,178	708,178	971,087	1,006,500	475,466	477,009	23,662	23,662
1972-73	1,091,560	1,403,330	949,349	1,033,430	475,377	478,613	28,492	28,492
1971-72	1,224,470	1,286,530	978,010	994,746	459,109	459,753	43,292	43,292
1970-71	1,179,920	1,179,920	940,624	995,115	450,977	453,074	47,793	47,793
1969-70	1,073,970	1,073,970	990,124	990,124	494,723	444,723	26,266	26,266
1968-69	993,203	993,203	777,733	893,209	405,862	407,699	18,879	18,879
1967-68	995,410	995,410	830,278	847,918	386,099	386,778	18,399	18,399
1966-67	806,225	909,522	838,162	866,019	384,557	385,629	28,710	28,710
1965-66	975,237	989,148	833,903	837,654	369,843	369,987	30,646	30,646
1964-65	937,091	937,091	796,179	805,864	352,904	353,277	22,823	22,823
1963-64	876,903	886,769	800,078	806,515	346,583	346,685	20,783	20,783
1962-63	915,124	915,124	758,000	758,000	324,758	324,758	16,983	16,983
1961-62	790,457	790,457	694,543	722,543	306,459	306,904	17,720	17,720
1960-61	862,930	862,930	739,797	739,797	305,492	305,492	21,976	21,976
1959-60	978,655	978,655	622,726	685,439	279,328	281,742	17,517	17,517
1958-59	880,710	880,710	729,368	741,342	291,923	292,384	21,149	21,149
1957-58	872,555	872,255	685,646	706,932	274,037	274,857	20,008	20,008
1956-57	817,601	864,070	637,261	649,793	249,757	250,240	30,236	30,236
1955-56	790,515	790,515	585,999	633,599	236,562	238,394	14,580	14,580
1954-55	620,486	801,428	563,368	612,165	223,036	224,914	8,922	8,922

(Continued)

Table 4.2 (Continued)

Crop Year	\widehat{QDW}_t	\widehat{QDW}_t'	\widehat{QDO}_t	\widehat{QDO}_t'	\widehat{QDB}_t	\widehat{QDB}_t'	\widehat{QDF}_t	\widehat{QDF}_t'
1953-54	796,217	806,083	568,727	571,388	205,298	205,401	9,111	9,111
1952-53	535,294	535,294	543,828	546,484	190,737	190,840	6,649	6,649
1951-52	471,658	471,658	556,022	588,206	196,545	197,057	4,086	4,086
1950-51	288,467	370,848	492,714	546,461	176,387	177,242	8,599	8,599

Table 4.3

REVENUE LOSSES ATTRIBUTABLE TO LOSSES IN
WHEAT DEMAND

Crop Year	Loss in Wheat Demand (000's bushel)	PWC t	Loss of Revenue (\$ 000)
1974-75	0	4.47	0
1973-74	0	4.58	0
1972-73	311,766	2.15	670,297
1971-72	62,058	1.60	99,293
1970-71	0	1.67	0
1969-70	0	1.68	0
1968-69	0	1.70	0
1967-68	0	1.81	0
1966-67	103,297	1.99	205,561
1965-66	13,911	2.00	27,822
1964-65	0	1.89	0
1963-64	9,866	1.97	19,436
1962-63	0	1.87	0
1961-62	0	1.91	0
1960-61	0	1.80	0
1959-60	0	1.59	0
1958-59	0	1.60	0
1957-58	0	1.62	0
1956-57	44,469	1.59	73,885
1955-56	0	1.61	0
1954-55	180,942	1.65	298,555
1953-54	9,866	1.56	15,391
1952-53	0	1.82	0
1951-52	0	1.84	0
1950-51	82,381	1.86	153,229
Average	32,743		62,539

Table 4.4

REVENUE LOSSES ATTRIBUTABLE TO LOSSES IN OAT DEMAND

Crop year	Normal Losses of Demand (000's bu.)	"Surge" Losses of Demand (000's bu.)	POC _t	Normal Revenue Losses (000's \$)	"Surge" Revenue Losses (000's \$)	Total Revenue Losses (000's \$)
1974-75	27,538	39,083	1.77	48,743	69,176	117,919
1973-74	35,414	0	1.83	64,808	0	64,808
1972-73	84,078	0	1.10	92,486	0	92,486
1971-72	16,736	0	.68	11,380	0	11,380
1970-71	54,491	0	.68	37,054	0	37,054
1969-70	0	0	1.70	0	0	0
1968-69	47,733	67,743	.65	31,026	44,033	75,059
1967-68	17,640	0	.83	14,642	0	14,642
1966-67	27,858	0	.83	23,122	0	23,122
1965-66	3,752	0	.85	3,189	0	3,189
1964-65	9,685	0	.77	7,458	0	7,458
1963-64	2,661	3,776	.69	1,836	2,606	4,442
1962-63	0	0	.72	0	0	0
1961-62	11,574	16,426	.77	8,912	12,648	21,560
1960-61	0	0	.74	0	0	0
1959-60	62,713	0	.77	48,289	0	48,289
1958-59	11,973	0	.70	8,381	0	8,381
1957-58	21,286	0	.67	14,261	0	14,261
1956-57	12,532	0	.65	8,146	0	8,146
1955-56	47,600	0	.80	38,080	0	38,080

(Continued)

Table 4.4 (Continued)

Crop Year	Normal Losses of Demand (000's bu.)	"Surge" Losses of Demand (000's bu.)	POC _t	Normal Revenue Losses (000's \$)	"Surge" Revenue Losses (000's \$)	Total Revenue Losses (000's \$)
1954-55	48,797	0	.81	39,526	0	39,526
1953-54	2,664	0	.71	1,889	0	1,889
1952-53	2,661	0	.74	1,969	0	1,969
1951-52	13,034	18,880	.84	11,175	15,860	27,035
1950-51	22,217	31,530	.85	18,884	26,001	44,885
Average	23,586	47,097		21,410	6,813	28,224

Table 4.5

REVENUE LOSSES ATTRIBUTABLE TO LOSSES IN
BARLEY DEMAND

Crop Year	Loss in Barley Demand (000's bushel)	PBC t	Revenue Losses (\$ 000)
1974-75	1,060	3.24	3,434
1973-74	1,363	3.10	4,225
1972-73	3,236	1.55	5,016
1971-72	644	.91	586
1970-71	2,097	1.01	2,118
1969-70	0	.94	0
1968-69	1,837	1.06	1,947
1967-68	679	1.10	747
1966-67	1,072	1.29	1,383
1965-66	144	1.29	186
1964-65	373	1.26	470
1963-64	102	1.18	121
1962-63	0	1.13	0
1961-62	445	1.28	570
1960-61	0	1.05	0
1959-60	2,414	.98	2,365
1958-59	461	1.01	465
1957-58	819	1.03	844
1956-57	482	1.02	492
1955-56	1,832	1.09	1,997
1954-55	1,878	1.11	2,085
1953-54	102	1.06	109
1952-53	102	1.25	128
1951-52	512	1.29	661
1950-51	855	1.34	1,146
Average	1,060		1,244

Table 4.6

AGGREGATE DEMAND LOSSES OF GRAIN

Crop Year	Demand Losses (000's bushel)	Revenue Losses (\$ 000)
1974-75	67,681	121,353
1973-74	36,777	69,033
1972-73	399,080	767,798
1971-72	79,438	111,259
1970-71	56,588	39,172
1969-70	0	0
1968-69	117,313	77,007
1967-68	18,319	15,388
1966-67	132,227	230,066
1965-66	17,807	31,197
1964-65	10,058	7,927
1963-64	16,405	23,998
1962-63	0	0
1961-62	28,446	22,130
1960-61	0	0
1959-60	65,126	50,654
1958-59	12,434	8,847
1957-58	22,105	15,105
1956-57	59,483	82,523
1955-56	49,432	40,077
1954-55	231,618	340,165
1953-54	12,629	17,389
1952-53	2,763	2,097
1951-52	32,696	27,695
1950-51	136,983	200,060
Average	64,486	92,173

Table 4.7

LOSSES OF REVENUE BY GRAIN BY CROP YEAR PERIODS

Crop Year Periods	Wheat Losses				Oat Losses				Barley Losses			
	\$	Bushels	Percent of Total Losses		\$	Bushels	Percent of Total Losses		\$	Bushels	Percent of Total Losses	
			\$	bushels			\$	bushels			\$	bushels
1966-67 to 1974-75 (inclusive)	975,151	477,121	59	59	436,470	423,317	59	55	19,456	11,988	56	45
1958-59 to 1966-67 (inclusive)	47,258	23,777	3	3	93,584	122,560	16	16	4,177	3,939	12	15
1950-51 to 1958-59 (inclusive)	541,060	317,658	38	38	175,521	221,198	25	29	11,639	10,521	32	40

Revenue losses during the first eight year period averaged \$90,639,000 per crop year, or 99 percent of the twenty-five year average. From crop year 1958-59 to 1966-67 average losses were only \$5,790,000 per crop year. This period saw losses averaging only 6 percent of the twenty-five year average. In the last time period (1966-67 to 1974-75) the impact of labour-management conflicts has been the most severe. Losses over the final nine year period were \$1,431,076,000 or 62 percent of the total losses over the twenty-five year time horizon in the study. Average losses were also quite severe during this period. Average yearly losses of revenue were \$159,008,000 (173 percent of the twenty-five year average).

The revenue losses attributable to strikes were also disaggregated on a grain basis. The total and average yearly losses of revenue for each grain is as follows:

i) Wheat	Total Surge	\$1,563,475,000	818,556,000 bu.
	Average Surge	62,539,000	32,473,000 bu.
ii) Oats	Total Normal	\$535,250,000	589,650,000 bu.
	Average Normal	21,410,000	23,856,000 bu.
	Total Surge	\$170,325,000	177,425,000 bu.
	Average Surge	6,813,000	7,097,000 bu.
	Total	705,575,000	767,075,000 bu.
	Average	28,223,000	30,953,000 bu.
iii) Barley	Total Normal	\$35,272,000	26,448,000 bu.
	Average Normal	1,410,800	1,060,000 bu.

Of the total loss of revenue (\$2,300,150,000) losses of revenue attributable to wheat were highest being 68 percent of the total losses. Oats followed at 30 percent

of the total losses. The remaining 2 percent was attributable to losses of barley demand. The immense annual revenue losses attributable to wheat are \$62,539,000 or 32,473,000 bushels on average over the twenty-five crop years. However, the average over the years when wheat demand was affected by strikes rises dramatically. Over the nine years when demand for wheat was abnormal, and strikes occurred in the previous year, losses of revenue averaged \$173,719,000 (90,202,000 bushels) per crop year. The surge effect for oats was miniscule in comparison at only \$28,388,000 (29,571,000 bushels) per crop year.

On the basis of a delineation on a crop year basis, losses of revenue attributable to each grain are contained in Table 4.7. From this table it is once again evident that each grain follows the same historical trend of revenue loss as the aggregate.

Losses of wheat revenue went from 38 percent to 3 percent to 59 percent of the total losses through the cycle, starting in crop year 1950-51. Oats demand revenue losses started at 25 percent of the total (1950-51 to 1958-59), fell to 16 percent and rose again to 59 percent in the final 9 years. In terms of bushels the same pattern for oats demand persisted. Finally, the pattern repeats itself for barley. Bushels of barley demand lost was 40 percent of the total during crop years 1950-51 to 1958-59. This fell to 15 percent of the total during the crop years 1958-59 to 1966-67. From 1966-67 to 1974-75 (inclusive)

bushels of barley demand lost was 45 percent of the total. Although the figures differ slightly, the same pattern occurs for barley revenue.

With the determination of the labour strife elasticities, the labour strike coefficients, the amount and pattern of revenue losses attributable to labour management disputes in the grain movement system, the policy implications of the problem can now be considered. This, with a summary and the conclusions drawn from this research is the charge of the final chapter.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This chapter summarizes the findings of the previous four chapters, and presents the conclusions (policy implications) of the research. The limitations of the study are presented, as well as proposals for further research.

A. Summary

The study was divided into four chapters, the first being introductory in nature. The problem considered was the impact of labour strikes on the Canadian grain movement system. To these ends it was decided to formulate a demand-supply model of the Canadian grain economy.

Upon reviewing the literature of such models, it was plain that all previous models had omitted the strike variable in the analysis of supply and demand for Canadian grain. These studies focused on developing a supply model with separate determinants of seeded acreage of grain and yields of grain. This technique was not employed in this project, as it was felt that the inclusion of these determining variables in the model implicitly performed the estimation of both equations in a single equation. The Ahmed⁹³ and Westac⁹⁴ studies were the first to consider the

⁹³Ahmed, op. cit.

⁹⁴Bjarnson, op. cit.

effect of strikes on the demand for grain. The first study developed a model for the impact of strikes on the international demand for Canadian wheat through the use of regression. Unfortunately, an attempt was not made to estimate revenue losses attributable to dock strikes. The latter study was largely descriptive. The objective of the Westac report was to determine reductions in terminal elevator throughput as a result of labour-management conflicts at the port of Vancouver. Again, losses in revenue attributable to these stoppages were not calculated.

As none of the previous studies used labour strikes as an independent variable in the determination of supply and demand for grains, one of the prime objectives of the analysis was to include this variable in the model. Based on the re-formulated model, a second objective was to determine the losses of revenue attributable to labour conflicts in the grain movement system. Finally, the final objective was to formulate a proposal to deal with this problem.

Unfortunately, the data base available for the analysis was quite restricted. Reliable data on strikes influencing the movement of grain was available only from crop years 1950-51 to 1974-75. As well, data over this time period was available for only wheat, oats, barley, flaxseed and rye. Rye was not included in the analysis as it was a relatively small percentage of Canadian grain production and exports. The scope was also restricted to the

assessment of costs attributable to shifts of the supply and demand curves. Other costs such as grain diversion charges, extra storage charges and demurrage were not included.

Chapter 2 provided a descriptive analysis of the international and domestic markets for Canadian grains. The theoretical effects of strikes on these markets were proposed in the final section of the chapter.

The international market for wheat was described as being under the most competitive pressure. Essentially five countries: Canada, United States, Australia, Argentina and the U.S.S.R. compete for the world wheat markets. The major markets for wheat being Great Britain and West Europe, China, Japan and India. Of the competitors, the U.S.S.R. holds a unique position of solely supplying the Eastern European block of countries.

The world wheat market has become increasingly competitive. One reason for this competition has been the so-called "Green Revolution" in India and other Asian countries, substantially reducing their excess demand. Further, better milling technology has allowed the increased use of lower wheat grades in flour making. In light of these changes, the market for high protein wheats has become more restricted and competitive.

The outstanding feature of the international feed grain market is the competitive nature of American corn, in the international market. American corn is the trendsetter

of price in this market. Canadian oats and barley compete directly with American (and quite often Argentinian) corn for international markets. The amount of Canadian exports into export markets is relatively small with respect to the amount of oats and barley used domestically.

Flaxseed is primarily used in the form of linseed oil for industrial purposes, but flaxseed cake and meal may be used as livestock feed. The principle importers of flaxseed are Western Europe and Japan. The major characteristic of these markets is the degree of interchangeability of linseed oil with other oil products. As prices of flaxseed rise, importers shift their purchases to other types of oils, such as tung oil. Consequently, the demand for flaxseed depends, in part, upon the availability of alternate oils. The chief suppliers of flaxseed to the Western European and Japanese markets are Canada and the United States.

The Canadian grain situation was also scrutinized in the second chapter. First, the demand for Canadian grain was considered. The demand for wheat and flaxseed is primarily for export. On average 73 percent of Canadian wheat is sold internationally. Flaxseed exports were 74 percent of domestic production. On the other hand, most Canadian feed grains are consumed in the domestic market. The domestic demand for oats and barley was 94 percent and 60 percent of production, respectively, on average (1967-68 to 1975-76).

With regards to supply, two distinguishable levels were evident. The first being the level of supply at the farm level and the second, the level of supply in the grain movement system.

Farm supply depends on six factors. Farmers alter their expectations and seeding pattern on the basis of:

- i) the expected price of the grains,
- ii) the carryover of grain,
- iii) quotas,
- iv) the meteorologic conditions,
- v) government policies (ie., the LIFT program), and
- vi) the technology of production.

The Canadian grain movement system consists of the elevator system, the rail network, and the Great Lake Maritime system.

The elevator system consists of three types of facilities. Primary elevators receive farm marketings of grain, grade the grain and ascertain the amount of impurities in the grain. Transfer elevators are used to receive grain from primary elevators, store it, then transship it to terminals or local processors. Most transfer elevators are concentrated in the Great Lakes and St. Lawrence to facilitate winter shipping while the St. Lawrence seaway is closed. Terminal elevation facilities are the loading and cleaning points for the export of Canadian grain (except those on the Prairies).

The interconnection between the numerous elevators in the system is accomplished through the rail network and the Great Lake Maritime system. The outstanding characteristics of these two systems are: the inefficiency of the rail system due to revenue shortfalls in the rail movement of grain and the subsidization of lake movement of grain from Thunder Bay to Eastern ports as it is a "back-haul" operation to the movement of commodities (iron ore primarily) westward.

The final portion of Chapter 2 postulated the impact of labour-management disputes on the demand for and supply of Canadian grain. It was hypothesized that labour disputes would decrease the supply of grain in the current year. This occurs as the supply system becomes "backlogged" as strikes hinder the movement of grain. Consequently, farmers are unable to deliver grain. The impact of strikes on demand was hypothesized to be lagged one year. This relationship occurs due to the contractual nature of grain sales. In the current year importers can not change their purchases of Canadian grain. However, in the longer term, the demand for grain will fall as purchasers switch to more reliable suppliers of grain.

In Chapter 3, the factors considered in Chapter 2 were used to specify a hypothetical model. The model related the supply of each of the four grains to their price relative to wheat (ie., POC_t/PWC_t), the acreage of the particular grain sown in the preceding crop year, the

carryover of the individual grain in the previous year, meteorologic conditions, the implementation of the LIFT program in 1970-71 and labour disputes.

The variable to delineate the impact of labour strikes on supply and demand was defined as the rate of lost man-days per employee. This variable was developed for each crop year by summing the number of lost man-days during the crop year and dividing by the total number of employees involved in the labour disputes. It was felt that such a variable provided an indication of the severity with which labour-management conflicts affect both the supply and demand for a grain.

The impact of labour disputes on supply was deemed to be a negative one. As the rate of lost man-days in the crop year rose, it was expected that the supply of grain in the crop year would fall. Restrictions in the grain movement system due to the strikes, would cause congestion in the movement system, curtailing the supply of grain, as the Wheat Board altered its delivery quotas and farmers changed their expectations.

The demand for a grain was hypothesized to depend on: its price, the U.S. price of the grain, per capita incomes for wheat, livestock numbers for oats, building construction for flax, labour disputes and linear time representing changes in consumption patterns.

The impact of disputes on demand was more complicated than in the case of supply. It was postulated that

labour disputes in the current year would lead to expectations of purchasers changing in the following year. Purchasers would perceive Canada as an unreliable source of supply, so would switch to alternate sources of supply. Consequently, the demand for Canadian grain would fall in the next year.

Additionally, the impact of strikes on demand during low and high demand periods was desired. To these ends, a new variable was developed. This variable was determined by ascertaining abnormal demand (greater than one standard deviation from the mean) and giving such years a dummy assessment of 1. By multiplying these dummy variables times the appropriate rate of lost man-days yielded the new variable. This new variable was hypothesized to be inversely related to the demand for grain.

On the basis of this hypothetical model, a preliminary analysis of the model was performed using stepwise regression. Using this technique, variables unnecessary in the model were eliminated. It was then hoped that two stage least squares could be employed to determine a final model to assess the costs of labour strikes in the grain movement system.

Unfortunately, multicollinearity was present in the model. Thus, the method of principal components was employed on the equations. The results of such an analysis also proved unsatisfactory. Therefore, ordinary least square estimates were employed to obtain the final

estimates of the model. The final model was presented in the final section of Chapter 3.

The fourth chapter addressed itself to the results of the analysis. The first section dealt with the hypotheses confirmed and rejected in the final model. Without going into details, the hypotheses of significance confirmed were:

- i) labour strikes only influence wheat demand during periods of abnormal demand (variable Z_t),
- ii) labour disputes influence the demand for oats during both periods of normal and abnormal demand (variables L_{t-1} and Y_t),
- iii) labour strikes influence demand for barley during normal years. There is no increased effect during periods of abnormal demand, and
- iv) labour strikes did not affect the supply of each grain or the demand for flax.

After presenting an analysis of the hypotheses, the elasticities of demand with regards to labour strikes were determined. Two types of elasticities were determined, these being the elasticity when demand is normal and the elasticity when demand is abnormal. The first being the "labour strife elasticity of demand (E_i)" and the second, the "surge labour strife elasticity (ES_i)."

Upon calculation of these elasticities, it was determined that demand was relatively inelastic with regards to labour disputes. The percentage decrease in

demand was significantly less than a percentage increase in L_{t-1} , Y_t or Z_t . The elasticities were as follows:

- i) $ES_{\text{wheat}} = - .038$
- ii) $E_{\text{oats}} = - .030$
- iii) $ES_{\text{oats}} = - .010$
- iv) $E_{\text{barley}} = - .003.$

The coefficients of the labour dispute variable were also discussed. In terms of magnitude, the largest coefficient (.986600) was found on wheat demand. An increase of Z_t by 1 led to wheat demand falling by 986,600 bushels during periods of abnormal demand. Oats demand losses followed, with normal losses being 377,610 bushels and losses during abnormal demand periods of 266,070 bushels. Barley demand losses were smallest at 102,400 bushels for every increase in L_t .

Based on this information, the costs of strikes in the grain movement system were calculated. Total losses accruable to labour disputes were \$2,300,150,000 (1,608,125,000 bushels of grain) over the twenty-five year time period. Average losses were \$92,007,000 (64,325,000 bushels) per year.

The losses in revenue attributable to labour conflicts were analyzed over the twenty-five year period. The term of the study was divided into three distinct periods:

- i) crop years 1950-51 to 1958-59,
- ii) crop years 1958-59 to 1966-67, and
- iii) crop years 1966-67 to 1974-75 (inclusive).

Losses during the first period were 99 percent of the twenty-five year average, at \$90,639,000 per year on average. During the second period the severity of labour disputes declined. Average losses were only \$5,790,000 per crop year or 6 percent of the long run average. The last nine years saw the greatest impact of strikes. Losses averaged \$159,008,000 per crop year or 173 percent of the twenty-five year average.

The next stage of the analysis of the cost of strikes was to determine revenue losses on a grain basis. As expected from the size of its coefficient, the losses of wheat demand were the greatest. Total losses of wheat sales revenue were \$1,563,475,000 (818,556,000 bushels) over the twenty-five years. This was 68 percent of the total losses in revenue. Oat demand losses followed wheat at 30 percent of the total losses (\$705,575,000 or 767,075,000 bushels). Barley brought up the rear at 2 percent of the total losses.

The surge effect of wheat demand losses further emphasized the impact of strikes on wheat sales. During the nine years of abnormal demand for wheat, losses of revenue were \$173,719,000 (90,202,000 bushels) on average. Oat surge losses were a miniscule \$28,388,000 (29,571,000) in comparison.

Finally, the cost of strikes on a grain basis were disaggregated on the previously mentioned time basis. Again the most recent time period displayed the highest losses of

grain revenue losses. Losses during this period averaged 59 percent, 59 percent and 56 percent for wheat, oats and barley, respectively, of the twenty-five year average. This fell to 3 percent, 16 percent and 12 percent of the total during the period 1958-59 to 1966-67. The remainder occurred in the final time period.

Having summarized the procedure and results of the research in this thesis, attention must now be focused on a brief conclusion to this research. Then, a possible resolution to this problem and suggestions for further research will be presented.

B. Conclusions

On the basis of the preceding analysis, certain conclusions may be drawn. Of these, perhaps the first and foremost is the fact that it is feasible to use the variable 'rate of lost man-days per worker employed' in the determination of the impact of strikes on the demand for Canadian grain. The relationship between the loss of demand and labour disputes is clearly proven.

The impact of such disputes differs vastly for each grain. The most significant effect was felt by wheat demand, then oats demand and barley demand. Of interest is the fact that no effect could be ascertained for flax, the only non-Board grain included in the study.

It must be concluded that strikes will only influence demand for wheat during years of abnormal demand. Strikes

affect oat demand during normal years, with an extra impact during years of abnormal demand. There was no significant increase in the impact of strikes on barley demand during periods of abnormal demand.

Labour-management conflicts had no direct influence on the supply (measured by producer marketings) of grain. This may be due to the "sheltering" the Wheat Board provides for producers of board grains. Alternately, it may be due to the substantially storage capacity of the grain movement system. Due to this reserve of capacity, farmers are not impeded in delivering their grain. Finally, it may be due to the fact that strikes simply do not affect farmers' expectations when they plant grain. However, strikes may indirectly influence the supply of grain as inventories of grain rise as sales are reduced. As the carryover of a particular grain rises, farmers decrease the amount of seeded acreage, and subsequently, the supply of grain in the following year.

In either case, (the direct or indirect effect) these are questions to be answered by further research.

The immense size of the revenue losses attributable to labour disputes leads to only one conclusion. That is, some sort of governmental action must be implemented to reduce these losses and protect farm incomes. Due to the lagged nature of the change in demand to changes in the strike rate, short term government programs such as legislating employees back to work, are ineffectual in the long

run. Importers of Canadian grain react in following years to strikes in Canada by lowering their expectations of the reliability of the Canadian market, thus decreasing their demand for Canadian grain.

Of these grains, wheat is the most significantly affected. In light of the increasingly competitive nature of the wheat market, it must be concluded that Canada's position in this market has been (and will be) in jeopardy due to the unreliable nature of Canadian supplies. Clearly, reassurances to international importers of Canadian wheat must be provided if Canada is to increase or at least maintain its market share.

The impact of strikes has been greatest during the last nine years of the study. On the basis of this result, it must be concluded that, if unchecked, the losses will continue to increase and severely affect farm incomes in the future.

In light of these conclusions, especially the last three, a proposal to eliminate (or decrease) these costs and return importer confidence to the Canadian grain market is submitted in the succeeding section.

C. A Proposal to Alleviate the Impact of Strikes in the Canadian Grain Movement System⁹⁵

At first glance one is tempted to suggest that the revenue losses attributable to strikes resulted from labour

⁹⁵The author recognizes this proposal solely as a brief, pedestrian solution to the problem. A more in-depth proposal is the subject of future research and beyond the scope of this thesis.

unionization. The results of such a thought can only be government intervention into the collective bargaining process, through legislative enforcement of work.

Little can be said of such a notion, as proposed in the Ahmed⁹⁶ study. At best, it can only be seen as a classical case of "wrongheadedness." Who is really at fault when a strike occurs? Both partners in the dispute are at fault, thus neither labour nor management must be penalized (or if they must, both must be equally penalized). Compulsory work clearly only penalizes labour. The morale of the labour force will be adversely affected by compulsory work. This, in turn, will penalize management through lower productivity.

A much more feasible solution forwarded by many observers of the situation is to impose government conciliation or arbitration upon the participants. This solution is much more feasible than the legislative approach. Unfortunately, it is not without its flaws. Once conciliation or arbitration is imposed on a conflict, resolution of the underlying conflict is unlikely. Merely a smoothing over of differences occurs, with the issue really causing the difficulty remaining unresolved. Even if the issue is "settled," one side or the other (or both) can have the impression of being shortchanged. Under such circumstances,

⁹⁶Ahmed, op. cit., p. 120.

it can be seen that conciliation and arbitration may only aggravate management-labour tension, increasing conflicts in the near future.

Having eliminated most of the commonly forwarded propositions to resolve these labour conflicts, a much more viable solution will now be proposed.

First and foremost, consideration should be given to having common termination dates of contracts among dock workers' unions and their employers. Thus, the sporadic nature of shutdowns on the docks due to differing contract dates may be eliminated. Furthermore, union consolidation on the docks should be stepped up, until there are perhaps six different bargaining units Canada-wide. The rationale for this is to attempt to standardize operating conditions on a national basis.

With this union syndication achieved, the crux of the solution may now be forwarded. A council could be established among the various unions, the two railways, the major grain companies (including the Wheat Board) and an appropriate number of farm representatives. The purpose of this council would be to:

- i) standardize wages, hours of work, etc. for various categories of workers at all points in the handling system. That is, dock workers in Halifax would have the same benefits as Vancouver workers, except for the cost-of-living differentials;

ii) meet regularly (or even sit permanently) to discuss all matters pertaining to labour tensions with respect to grain movement;

iii) begin negotiations on the new contract with all parties represented, at least one month before the termination of the current contract;

iv) to ratify a new contract by a two-thirds majority; and

v) elect a chairman, with the aid of the federal government, to chair all meetings. This chairman would be given the power to impose an arbitrary settlement if the conflict exists longer than two weeks after the termination of the contract.

The advantages of such a solution are many. Among these are the fact that no group, union, grain company or farmer, would be able to "gang-up" on the unions, as a two-thirds vote of ratification is required. Furthermore, problems in management-labour communication will be brought to light continually rather than in a conflict situation. Thus, resolution of contracts will occur more rapidly. Workers within the whole system would be treated equally, lessening tension as workers perceive members of their group in other parts of the country as better off. All members affected by the conflicts including farmers, would be brought to bear upon the resolution, as they should be. Finally a mechanism to force a solution is provided rather than waiting for government inaction.

Critiques of such a proposal will quickly point out that the administration of such a council will be costly. The cost of the council is irrelevant, as it would be difficult to perceive its costs being significant weighed against averages losses due to strikes of \$92,007,000. Certain objections that union consolidation is impossible might be made. However, union unification has been continuing since unionization started. A natural process is only being speeded-up.

Finally, one further facet of this proposal must be noted. More grain should be shipped through ports where the rate of lost man-days is low. Churchill is such a port, being strike-free for the duration of the study period. Opponents of this scheme might argue that the capacity of Churchill is only about 35,000,000 bushels per year. However, as the Westac⁹⁷ report notes, capacity restrictions on facilities are largely restrictions on cleaning capacity. With pre-cleaned grain, the throughput capacity of Churchill may be substantially increased. Thus the proposal to clean grain at Yorkton⁹⁸ as proposed by the

⁹⁷ Bjarnson, op. cit., pp. 21-22.

⁹⁸ Hall, op. cit., p. 212.

the Hall Commission for shipment through Churchill, would indeed, be beneficial to the grain industry.

D. Limitations of the Study

Perhaps the stiffest limitation encountered in this analysis was the paucity of reliable strike data. Particularly previous to 1956 data was very sparse and sketchy, and therefore, of limited reliability. The inclusion of data for 1950 for a twenty-five year time period, was felt to be pushing the data to its limit.

As a result of the restricted data base, further complications presented themselves throughout the model. First, the nature of the model called for the use of two stage least squares (or other methods to estimate an over-identified model) to determine the coefficients of the model. Unfortunately, with such a restricted sample size estimates obtained via this method would be biased. In the final model this problem was alleviated somewhat, by the use of ordinary least square estimates. Using such estimates for a simultaneous model, in themselves, introduced bias into the estimates. However, they were employed as they were most consistent with the estimates obtained from the use of stepwise regression.

The small sample size imposed further restrictions on the final model. The possible resolution of multicollinearity in the final model by increasing the sample size was impossible. The use of principal components as a

solution yielded unsatisfactory results. Therefore, the final model incorporates a degree of multicollinearity in its coefficient estimates of the structural parameters.

On the basis of the limitations of this model, some alternate techniques to analyze the problem will be presented in the next section.

E. Suggestions for Further Research

In order that more research may be carried on in the future into this field, a new analytical technique must be implemented. Thus, some analytical methods which may be more appropriate to this problem will now be presented.

E.1 Alternate possible techniques to analyze the problem. Of the numerous analytical techniques which may be employed in the future, four of the most prominent are:

- i) a stochastic programming model,
- ii) a linear programming (transshipment) model,
- iii) a network analysis model, and
- iv) a queuing model.

Each of these techniques will be briefly discussed in the following paragraphs.

Dynamic programming is a technique by which the optimal solution to a stepwise decision is made. The procedure is to find a recursive relationship between the final solution and the initial stage. More specifically, the problem at hand may be pictured as a stochastic dynamic programming problem.

A simple scheme of such an analysis may be as follows. First, the probability distribution of strikes (and their severity) could be derived for each of the seven sectors and modes in the Canadian grain movement system. Grain moves through the system on a sequential basis. That is, the movement of grain through the next sector and mode depends on the selection of the previous sector and mode. The cost of movement via each sector and mode is readily available.

The model could be derived where costs, modal and sectoral choices, restrictions on capacity and the labour strike variable were included. The optimal policy of grain movement (and its costs) could then be determined without strike interruption. The optimal transportation technique with strikes could also be determined. The difference in costs between the two results would be the cost of strikes. Such a model is advantageous for two reasons. First, it provides a more disaggregated picture of the grain transportation system. Second, it is an ongoing model which can choose the optimal policy in a given year.

The second alternative would be to consider the problem in a linear programming format. The appropriate technique in this case would be in terms of a transshipment problem. Essentially, the "transshipment problem" is a technique for selecting the minimum cost of moving goods from their source to their destination through a series of storage and warehouse (transshipment) points.

The transshipment points would be the primary, transfer and terminal elevator system. The cost of movement of grain from one point to the next could be determined. Such costs would include movement, elevation, storage and cleaning costs. How would the costs of strikes be determined under such a system?

The easiest manner would be to make it impossible to move the grain through the section of the system involved in the dispute. This could be accomplished through making the cost of movement through that mode excessive (perhaps via the "Big M" method). Thus an alternate movement system would be derived. The cost difference between this alternate and the previous system would represent the cost of strikes.

The third alternative would be to consider the problem in terms of a network analysis. The grain movement system is clearly a network of rail lines and lake shipping routes. A model to assess the costs of strikes using a network model would be similar to that of a transshipment model.

Once again, the costs of movement of grain through the various arcs connecting the modes (the elevators in the system) could be determined. The most optimal method of movement through the system, subject to flow restrictions, would yield the minimum cost of grain movement in Canada.

The probability distribution of strike occurrences and duration could be then introduced into the model. When

strikes occur, the appropriate nodes and arcs in the system could be closed. The least cost alternate system could then be ascertained. By taking this, minus the original allocation, the cost of strikes could be determined.

The final alternative in which the question of labour strikes and grain movement could be considered, is in the form of a queuing model. Under such a model, the demurrage and extra storage charges attributable to labour conflicts could be derived.

First, a study of the arrival times and the service times of boats and rail cars, at terminal elevators would have to be implemented. This would likely require a sample survey of the terminal elevators. Having obtained these statistics, the distribution of interarrival (the time between arrivals) and service times could be established. The length of queues at facilities, and the waiting time for service could be calculated on the basis of the model.

The influence of strikes on such a model would result in the service time becoming infinite because no vehicles could be serviced. Consequently, the duration of the waiting time for trains and ships wishing to load or unload could be resolved. As demurrage is directly related to this time, the cost of strikes in terms of demurrage could be calculated. Further, the length of time the grain

is stored, in excess of the normal time, could be related to strikes. This increased time, and subsequent cost, would be related to labour strikes.

Having presented possible other techniques of analysis which could be applied to this research in the future, some factors which require future research must now be considered.

E.2 Areas of future research. Although this project has answered the question of the cost of labour strikes in the Canadian grain movement system, further extensions of this research can be foreseen. Among these, three major expansions are the following:

i) a combination of the model to explain strikes developed by the Ahmed⁹⁹ thesis and the aggregate loss model in this study, in a simulation model;

ii) a comparison of the American system and Canadian grain movement system, comparing the frequency, duration and the effect of strikes. If there is a difference, why does it exist? and

iii) a study of the economics of increased utilization of Churchill as an export port. This might include likelihood of strikes in the future, the costs of expansion and the market for grain at Churchill. Although the Hall

⁹⁹Ahmed, op. cit., pp. 81-90.

Commission recommended the increased use of Chruchill, it did not adequately study the implications of its recommendations.

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APPENDICES

APPENDIX A

Table A-1

A BRIEF ANALYSIS OF THE DATA USED IN THIS ANALYSIS

Variable	Mean	Standard Deviation	Maximum	Minimum	Range
QSW _t	446,911	94,014	633,258	305,345	327,913
QSO _t	56,460	30,172	133,608	20,868	112,740
QSB _t	132,574	62,693	295,467	59,329	236,138
QSF _t	15,693	7,076	33,713	3,254	30,459
QDW _t	341,461	103,271	553,242	185,039	368,203
QDO _t	352,790	35,545	410,059	257,313	152,746
QDB _t	193,830	72,434	339,496	106,962	232,534
QDF _t	13,972	6,211	27,260	2,882	24,378
PWC _t	1.99	.78	4.58	1.56	3.02
POC _t	.85	.30	1.83	.65	1.18
PBC _t	1.30	.58	3.24	.91	2.33
PFC _t	3.59	1.47	10.14	2.53	7.61
POC _t /PWC _t	.43	.04	.51	.35	.16
PBC _t /PWC _t	.65	.05	.73	.56	.17
PFC _t /PWC _t	1.83	.33	2.40	1.05	1.34

(Continued)

Table A-1 (Continued)

Variable	Mean	Standard Deviation	Maximum	Minimum	Range
PWU _t	2.42	.72	4.65	1.66	2.99
POU _t	.81	.26	1.82	.62	1.20
PBU _t	1.37	.46	3.02	1.07	1.95
PFU _t	3.72	1.72	10.12	2.62	7.50
AW _t	24,143	3,857	29,570	12,000	17,570
AO _t	6,043	1,047	8,312	4,660	3,652
AB _t	8,188	2,154	13,312	5,097	8,215
AF _t	1,811	747	3,462	541	2,921
CW _t	518,717	207,213	1,008,690	112,200	896,490
CO _t	118,627	36,183	211,215	44,905	166,310
CB _t	124,482	47,308	208,410	20,355	188,055
CF _t	7,094	4,971	25,306	1,204	24,102
PIJ _t	813,460	625,590	2,301,892	210,690	2,091,202
PIG _t	545,276	81,926	713,619	385,300	328,319
YI _t	82	19	114	54	60
YJ _t	2,199	6,211	3,164	1,540	1,624
YG _t	1,679	575	3,072	790	2,282

(Continued)

Table A-1 (Continued)

Variable	Mean	Standard Deviation	Maximum	Minimum	Range
LN_t	20,139	4,294	27,004	13,619	13,385
Z_t	3.33	7.37	20.48	0	20.48
Y_t	1.88	4.36	17.94	0	17.94
X_t	3.62	7.87	13.31	0	13.31
V_t	3.87	8.00	31.60	0	31.60
T	13.00	7.36	25	1	24
W_t	.52	.51	1	0	1
D_t	.04	.2	1	0	1
L_t	8.88	8.51	31.60	0	31.60

APPENDIX B

A MATHEMATICAL EXPOSITION OF THE PRINCIPAL COMPONENT TECHNIQUE

Given a model

$Y = f(x_1 \dots x_k)$, where $x_1 \dots x_k$ are correlated amongst
one another.

That is, the correlation matrix is:

	x_1	$x_2 \dots x_k$
x_1	1	1....1
x_2		1....1
\vdots		\vdots
\vdots		\vdots
x_k		1

a) The objective is to transform this into an orthogonal matrix displaying no correlation amongst the independent variables.

ie.

	x_1	$x_2 \dots x_k$
x_1	1	0....0
x_2		1....0
\vdots		\vdots
\vdots		\vdots
x_k		1

b) Each principal component ($Z_1 \dots Z_k$) becomes a function of the independent variable times their respective loadings (a_{11} , etc.).

$$Z_1 = a_{11}x_1 + a_{12}x_2 \dots a_{1k}x_k$$

$$\begin{aligned}
 Z_2 &= a_{21}x_1 + a_{22}x_2 \dots a_{2k}x_k \\
 &\vdots \\
 Z_k &= a_{k1}x_1 + a_{k2}x_2 \dots a_{kk}x_k
 \end{aligned}$$

c) The loadings (a_{ik}) are determined so that the principal components are orthogonal and the first component maximizes the amount of variance it absorbs.

d) Thus, each loading is usually determined in the following method where r_{ik} is the correlation coefficient between variables i and k .

$$\begin{array}{cccc|c}
 & x_1 & x_2 \dots x_k & & \\
 x_1 & r_{11} & r_{12} \quad r_{1k} & & \sum_k r_{1k} \\
 x_2 & r_{21} & r_{22} \quad r_{2k} & & \sum_k r_{2k} \\
 \vdots & \vdots & \vdots \quad \vdots & & \vdots \\
 \vdots & \vdots & \vdots \quad \vdots & & \vdots \\
 x_i & r_{i1} & r_{i2} \dots r_{ik} & & \sum_k r_{ik} \\
 \hline
 & \sum_i r_{i1} & \sum_i r_{i2} \dots \sum_i r_{ik} & & \sum_{ik} r_{ik}
 \end{array} \quad i = k$$

For the first principal component:

$$\begin{aligned}
 a_{11} &= \frac{\sum_i r_{i1}}{\sqrt{\sum_{ik} r_{ik}}} & a_{12} &= \frac{\sum_i r_{i2}}{\sqrt{\sum_{ik} r_{ik}}} & a_{1k} &= \frac{\sum_i r_{ik}}{\sqrt{\sum_{ik} r_{ik}}}
 \end{aligned}$$

e) The eigen value for each component is then determined:

$$E = \sum_k a_{1k}^2 = a_{11}^2 = a_{12}^2 \dots + a_{1k}^2$$

f) The latent root determines the importance of the principal component, through the following formula:

$$\left(\frac{E}{\# \text{ of independent variables}} \right) 100$$

g) Computation of the second then follows. The correlation table must be recalculated as follows:

Subtract the original correlation coefficient (r_{ik}) from the product of the loadings attributed to the i^{th} and k^{th} variable in the first principal component.

The new correlation table is:

	x_1	$x_2 \dots \dots \dots x_k$
x_1	1	$r_{12} - a_{11}a_{12}$ $r_{1k} - a_{11}a_{1k}$
x_2	$r_{21} - a_{11}a_{12}$	1 $r_{2k} - a_{12}a_{1k}$
\vdots	\vdots	\vdots
\vdots	\vdots	\vdots
\vdots	\vdots	\vdots
x_k	$r_{k1} - a_{11}a_{1k}$	$r_{k2} - a_{12}a_{1k} \dots \dots \dots 1$

Return to step d to calculate the second principal component.

The maximum number of principal components that can be calculated equals the number of dependent variables. Before the advent of computer programs to calculate the components (and perform the regression) stopping rules were

invoked to determine the number of components to be extracted. Of the Kaiser's criterion was most commonly employed. This criterion stated that when $E > 1$ that principal component was retained.

Having determined the principal components, the regression is performed as follows:

$$\begin{aligned} \text{h) Let } Z_1 &= a_{11}x_1 \dots a_{1k}x_k \\ &\vdots \\ Z_k &= a_{k1}x_1 \dots a_{kk}x_k \quad \text{be the components.} \end{aligned}$$

Multiply each loading times the appropriate value of its independent variable. Then, sum this for each principal component for each observation of the independent variable. If there were 10 observations in the sample there would be 10 Z_1 's, 10 Z_2 's, ... 10 Z_k 's each being the sum of the corresponding $a_{ik}x_k$.

i) Let $Y = f(Z_1 \dots Z_k)$ or $Y = C_1Z_1 + C_2Z_2 \dots C_kZ_k$ and find the least square estimates for C_1 (\hat{C}_1), C_2 (\hat{C}_2), ... C_k (\hat{C}_k).

$$\text{j) Originally } Y = b_1x_1 + b_2x_2 \dots b_kx_k + u$$

$$\text{now } Y = C_1Z_1 + C_2Z_2 \dots C_kZ_k + m$$

$$\text{or } Y = C_1(a_{11}x_1 + a_{12}x_2 \dots + a_{1k}x_k) +$$

$$C_k(a_{k1}x_1 + a_{k2}x_2 \dots a_{kk}x_k)$$

or

$$Y = (\hat{C}_1 a_{11} \dots + \hat{C}_k a_{k1}) x_1 +$$

$$(\hat{C}_1 a_{12} \dots + \hat{C}_k a_{k2}) x_2 \dots (\hat{C}_1 a_{1k} + \hat{C}_k a_{k2}) x_k$$

but

$$Y = b_1 x_1 + \dots b_k x_k$$

Therefore:

$$\hat{b}_1 = \hat{C}_1 a_{11} \dots + \hat{C}_k a_{k1}$$

$$\hat{b}_k = \hat{C}_1 a_{1k} + \hat{C}_k a_{kk} .$$

where $\hat{C}_1 \dots \hat{C}_k$, $a_{11} \dots a_{k1} \dots a_{1k} \dots a_{kk}$ are known.

APPENDIX C

DETERMINATION OF LOAD FACTORS AND PRINCIPAL
COMPONENTS FOR EACH EQUATION

WHEAT SUPPLY

	PWC_t	AW_{t-1}	T	W_t	D_t	$\sum_k r_{ik}$
PWC_t	1	.92	.91	.67	.16	3.66
AW_{t-1}		1	.73	.71	.20	3.56
T			1	.20	.28	3.12
W_t				1	.28	2.86
D_t					1	1.92
$\sum_i r_{ik}$	3.66	3.56	3.12	2.86	1.92	15.12

$$\sqrt{15.12} = 3.888$$

$$a_{11} = .94 \quad a_{12} = .92 \quad a_{13} = .80 \quad a_{14} = .74 \quad a_{15} = .49$$

$$E = 3.16$$

Invoking Kaiser's criterion principal components are extracted until $E > 1$.

Therefore the first principal component is only extracted.

$$Z_{1t} = .94 PWC_t + .92 AW_{t-1} + .80 T + .74 W_t + .49 D_t$$

$$Y = \hat{C}_{1t} Z_{1t} \quad QSW_t = C_1 Z_{1t} + u$$

Estimated by Ordinary least squares (OLS) $C_1 = 19.5$

(Continued)

WHEAT DEMAND

	PWC _t	PWU _t	YI _t	YB _t	Z _t	$\sum_k r_{ik}$
PWC _t	1	.79	.45	.71	-.05	2.90
PWU _t		1	.07	.42	.02	2.30
YI _t			1	.84	.05	2.41
YB _t				1	.13	3.10
Z _t					1	1.15
$\sum_i r_{ik}$	2.90	2.30	2.41	3.10	1.15	11.86

$$\sqrt{11.86} = 3.443$$

$$a_{11} = .84 \quad a_{12} = .67 \quad a_{13} = .70 \quad a_{14} = .90 \quad a_{15} = .33$$

$E = 2.56 > 1$ stop extracting components

$$Z_{1t} = .84 PWC_t + .67 PWU_t + .70 YI_t + .90 YB_t + .33 Z_t$$

$$Y = C_1 Z_{1t}$$

$$\widehat{QSW}_t = \widehat{C}_1 Z_{1t} \quad \widehat{C}_1 = 512.1$$

from OLS.

OATS SUPPLY

	POC _t /PWC _t	AO _{t-1}	CO _{t-1}	T	D _t	$\sum_k r_{ik}$
POC _t /PWC _t	1	.98	.95	.86	.19	3.98
AO _{t-1}		1	.95	.80	.18	3.91
CO _{t-1}			1	.85	.24	3.99
T				1	.28	3.79
D _t					1	1.89
$\sum_i r_{ik}$	3.98	3.91	3.99	3.79	1.89	17.56

$$\sqrt{17.56} = 4.191$$

$$a = .95 \quad a = .93 \quad a = .95 \quad a = .90 \quad a = .45$$

(Continued)

$E = 3.682 > 1$ stop extracting component

$$Z_{1t} = .95 \text{ POC}_t / \text{PWC}_t + .93 \text{ AO}_{t-1} + .95 \text{ CO}_{t-1} + .90 T + .45 D_t$$

$$\widehat{\text{QSO}}_t = \widehat{C}_1 Z_{1t} \quad \widehat{C}_1 = .41 \quad \text{from OLS.}$$

OATS DEMAND

	LN_t	Y_t	L_{t-1}	T	$\sum_k r_{ik}$
LN_t	1	.28	.04	.98	2.30
Y_t		1	.15	.27	1.70
L_{t-1}			1	.10	1.29
T				1	2.35
$\sum_i r_{ik}$	2.30	1.70	1.29	2.35	7.64 $\sqrt{7.64} = 2.76$
$a_{11} = .83 \quad a_{12} = .62 \quad a_{13} = .47 \quad a_{14} = .85$					

$E = 2.0 > 1$ stop extracting components

$$Z_{1t} = .83 \text{ LN}_t + .62 Y_t + .47 L_{t-1} + .85 T$$

$$\widehat{\text{QDO}}_t = C_1 Z_{1t} + u_1 \quad \widehat{\text{QDO}}_t = \widehat{C}_1 Z_{1t} \quad \widehat{C}_1 = 26.9 \text{ from OLS.}$$

BARLEY SUPPLY

	AB_{t-1}	CB_{t-1}	T	D_t	$\sum_k r_{ik}$
AB_{t-1}	1	.96	.90	.21	3.17
CB_{t-1}		1	.95	.31	3.22
T			1	.28	3.13
D_t				1	1.80
$\sum_i r_{ik}$	3.17	3.22	3.13	1.80	11.32 $\sqrt{11.32} = 3.365$
$a_{11} = .94 \quad a_{12} = .96 \quad a_{13} = .93 \quad a_{14} = .54$					

(Continued)

$E = 2.96 > 1$ stop extracting components

$$Z_{1t} = .94 AB_{t-1} + .96 CB_{t-1} + .93 T + .54 D_t$$

$$QSB_t = C_1 Z_{1t} + u_1 \quad \widehat{QSB}_t = \widehat{C}_1 Z_{1t} \quad \widehat{C}_1 = 1.02 \quad \text{from OLS.}$$

BARLEY DEMAND

	LN_t	L_{t-1}	T	$\sum_k r_{ik}$	
LN_t	1	.66	.98	2.64	
L_{t-1}		1	.10	1.76	
T			1	2.08	
$\sum_i r_{ik}$	2.64	1.76	2.08	6.48	$\sqrt{6.48} = 2.546$
$a_{11} = 1.03 \quad a_{12} = .69 \quad a_{13} = .82$					

$E = 2.2 > 1$ stop extracting components

$$Z_{1t} = 1.03 LN_t + .69 L_{t-1} + .82 T$$

$$QDB_t = C_1 Z_{1t} + u_1 \quad \widehat{QDB}_t = \widehat{C}_1 Z_{1t} \quad \widehat{C}_1 = 15.6 \quad \text{from OLS.}$$

FLAX SUPPLY

	PFC_t/PWC_t	AF_{t-1}	T	D_t	$\sum_k r_{ik}$
PFC_t/PWC_t	1	-.31	-.56	-.05	.08
AF_{t-1}		1	.81	.14	1.64
T			1	.23	1.48
D_t				1	1.32
$\sum_i r_{ik}$.08	1.64	1.48	1.32	4.52
$\sqrt{4.52} = 2.136$					
$a_{11} = .04 \quad a_{12} = .79 \quad a_{13} = .70 \quad a_{14} = .62$					

(Continued)

$E = 1.5 > 1$ stop extracting components

$$Z_{1t} = .037 \text{PFC}_t / \text{PWC}_t + .79 \text{AF}_{t-1} + .70 T + .62 D_t$$

$$\text{QSF}_t = C_1 Z_{1t} + u_1 \quad \widehat{\text{QSF}}_t = \widehat{C}_1 Z_{1t} \quad \widehat{C}_1 = 10.2 \text{ from OLS.}$$

FLAX DEMAND

	PFC_t	PIJ_t	PIG_t	$\sum_k r_{ik}$
PFC_t	1	.82	.84	2.66
PIJ_t		1	.69	2.51
PIG_t			1	2.53
$\sum_i r_{ik}$	2.66	2.51	2.53	7.70 $\sqrt{7.70} = 2.774$

$$a_{11} = .95 \quad a_{12} = .91 \quad a_{13} = .91$$

$E = 2.57 > 1$ stop extracting components

$$Z_{1t} = .95 \text{PFC}_t + .91 \text{PIJ}_t + .91 \text{PIG}_t$$

$$\text{QSF}_t = C_1 Z_{1t} + u \quad \widehat{\text{QSF}}_t = \widehat{C}_1 Z_{1t} \quad \widehat{C}_1 = .02 \text{ from OLS.}$$

APPENDIX D

REGRESSION COEFFICIENTS OF THE PRINCIPAL COMPONENTS
($\hat{Y} = \hat{CZ}$)

Wheat Supply

$$\widehat{QSW}_t = 19.5 Z$$

Wheat Demand

$$\widehat{QDW}_t = 512.1 Z$$

Oat Supply

$$\widehat{QSO}_t = .41 Z$$

Oat Demand

$$\widehat{QDO}_t = 26.9 Z$$

Barley Supply

$$\widehat{QSB}_t = 1.02 Z$$

Barley Demand

$$\widehat{QDB}_t = 15.6 Z$$

Flax Supply

$$\widehat{QSF}_t = 10.2 Z$$

Flax Demand

$$\widehat{QDF}_t = .02 Z$$

APPENDIX E

Table E-1

ESTIMATES OF THE DEPENDANT VARIABLES
USING PRINCIPAL COMPONENTS
(000's bushels)

Crop Year	QSW _t	QDW _t	QSO _t	QDO _t	QSB _t	QDB _t	QSF _t	QDF _t
1974-75	419,505	1,456,690	-28,173	550,201	-176,649	398,295	11,868	19,368
1973-74	377,784	1,361,870	-29,313	587,891	-162,275	425,410	10,812	23,662
1972-73	342,972	1,188,230	-44,109	601,264	-145,457	435,400	14,368	28,492
1971-72	218,067	1,076,850	-46,905	578,882	-120,893	418,708	26,757	43,292
1970-71	442,978	955,949	-55,797	577,611	-176,679	418,043	18,857	47,793
1969-70	523,877	944,765	-48,154	573,811	-169,629	414,863	12,251	26,266
1968-69	536,727	893,276	-30,034	518,361	-110,511	375,374	8,182	18,879
1967-68	529,399	955,632	-42,715	492,445	-111,829	356,192	15,307	18,399
1966-67	504,426	931,082	-47,455	501,117	-82,450	362,500	18,379	28,710
1965-66	527,797	913,394	-48,832	484,239	-74,875	350,105	15,559	30,646
1964-65	489,990	848,571	-67,596	465,234	-100,744	336,463	13,238	22,823
1963-64	476,208	773,465	-55,896	464,404	-75,414	335,730	11,353	20,783
1962-63	447,021	734,604	-28,894	436,291	-46,883	315,372	16,626	16,983
1961-62	433,768	689,765	-42,504	415,247	-94,877	300,288	20,084	17,720
1960-61	435,020	754,501	-37,189	423,626	-108,220	306,169	16,410	21,976
1959-60	389,832	697,387	-48,488	391,954	-109,228	283,742	20,432	17,517
1958-59	378,951	672,314	-50,964	421,831	-97,499	304,904	27,969	21,149
1957-58	400,395	656,679	-79,556	401,450	-120,640	290,230	24,319	20,008
1956-57	398,579	629,240	-43,494	368,578	-90,594	266,402	14,632	30,236
1955-56	448,322	612,899	-46,500	358,154	-124,048	259,109	9,297	14,580
1954-55	462,986	553,693	-53,855	344,992	-92,240	249,586	7,355	8,922

(Continued)

Table E-1 (Continued)

Crop Year	QSW _t	QDW _t	QSO _t	QDO _t	QSB _t	QDB _t	QSF _t	QDF _t
1953-54	460,353	521,286	-39,388	321,350	-63,731	232,143	8,307	9,111
1952-53	442,438	477,902	-33,961	306,276	-40,915	221,231	8,776	6,649
1951-52	478,086	442,086	-14,656	327,930	-12,361	236,975	4,376	4,086
1950-51	481,195	383,640	-20,803	303,436	-21,309	219,369	2,345	8,599