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UNIVERSITY OF ALBERTA

A NET REVENUE MAXIMIZATION MODEL FOR ALBERTA BARLEY TRADE WITH THE NORTHWEST UNITED STATES

BY

GISELE M. MAGNUSSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

IN

AGRICULTURAL ECONOMICS

DEPARTMENT OF RURAL ECONOMY

EDMONTON, ALBERTA

SPRING 1991

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M. L. LEROHL, SUPERVISOR

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Abstract

A retrospective revised net revenue, partial equilibrium, linear programming model is developed for feedgrain trade between Alberta and eleven north west states of the United States. The model is run under six different policy scenarios over a five years period, 1984 to 1988.

Alberta is divided into three regions (north, central and south), while the eleven states are divided into two regions (U.S. north and south). Feedgrain requirements and production are calculated for each region using grain consuming animal units and barley equivalents. Each region is able to both import and export feedgrain. As well as the five regions, two export points (Vancouver, British Columbia and Portland, Oregon) are defined. These points can import unlimited volumes of grain but are not permitted to export to any of the regions.

A baseline version of the model is developed, which incorporates Alberta producer payments for rail transportation as set out in the Western Grain Transportation Act, border costs as they existed during the time of the study, and estimates of trucking rates. The baseline scenario is compared to five other scenarios which reflect the following policy changes: i) a closed Canada - U.S. border; ii) Alberta producers paying the full published cost of rail transportation; iii) the removal of all priced border costs; iv) Alberta producers paying the full rail rate as well as the removal of all priced border costs; and v) producers paying the full rail rate, the removal of priced border costs, as well as trucking rates set equal on a per tonne per mile basis to full cost rail rates.

The results suggest that the possibility for increased feedgrain trade between Alberta and the U.S. exists. When the trade flows developed are valued using feedgrain prices based on full cost rail rates, net revenue gains above the no trade scenario are indicated for all models. The increases are at the expense of shipments to Vancouver, are variable among years, and depend upon transportation rates.

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I INTRODUCTION

A. Background

1. Importance of feedgrains in Alberta

During the ten year period 1979 to 1988 Alberta produced an average of 5,825 thousand tonnes of barley, 49 percent of the Canadian average. During this same period barley accounted for nine percent of Alberta's farm cash receipts, for an average of $328 million annually (Canada Grains Council, 1989).

In many areas of Canada a substantial portion of barley production is domestically consumed by the local livestock industry. Groenewegen (1983) estimated that 83 percent of feedgrains are consumed by livestock within the region in which they are produced. In Alberta however, a different situation exists whereby producers must rely on barley exports to market a substantial portion of barley production and generate a major portion of barley value. While approximately two thirds of Alberta's barley is fed domestically the remaining one third is exported. Over the years the eastern Canadian market, which once accounted for a substantial movement of western feedgrains, has shrunk as Ontario and Quebec have become increasingly self-sufficient in feedgrains. The national feedgrain markets that remain, especially those in Atlantic Canada, use corn from the United States as an alternative to western feeds as the share of transportation costs covered by Feed Freight Assistance (FAA) declines. While national barley markets were shrinking, international feedgrain markets were expanding rapidly. However, moving into this arena increased Alberta producers' exposure to the volatility of world markets. Table 1 indicates just how changeable this market can be in terms of volume. The fickleness of buyers, accompanied by declining prices in part due to subsidy wars, suggests that producers should seek to expand their marketing options, both in terms of an increased number of markets as well as more stable markets.

At the same time as the markets shifted, changes occurred within the grain transportation system of Canada. Throughout the 1970's and into the 1980's the share of transportation costs covered by the FFA for feedgrains moving into eastern Canada declined. The introduction in 1984 of the Western Grain Transportation Act (WGTA) increased producers' share of the increased rail

Table 1: Barley production and out-of-country exports, Alberta and Canada, 1984 to 1988.

Year	Production		Exports			
	Alberta '000 T	Canada '000 T	Alberta '000 T	Alberta $ '000	Canada '000 T	Canada $ '000
1984	4,638	10,279	1,745	284,153	3,905	636,118
1985	4,768	12,287	861	123,228	2,231	319,245
1986	7,185	14,569	2,609	247,698	5,986	568,378
1987	6,586	13,957	2,372	195,329	5,444	448,208
1988	5,813	10,212	1,421	143,602	2,796	282,708

Source: Canada Grains Council. *Canadian Grains Industry Statistical Handbook*. Canada Grains Council: Winnipeg. Various years.
Alberta Agriculture, Statistics Branch, a. *Alberta's Agricultural Exports*. Alberta Agriculture: Edmonton.

rates for moving Prairie grain to export position. Also while trucking is rumored to be a financially viable option to rail movement, the WGTA discourages extensive use of the existing trucking system.

Changes in market volume and prices, as well as increased transportation costs coupled with the prospect of the removal of the Crow Benefit due to potential trade conflicts, suggests that Alberta barley producers must consider alternative markets and modes of transportation.

It has been suggested that the barley be marketed in the form of livestock and processed meat products. However, at present the meat and meat products markets are difficult to expand into on an international, or even a national level. With the United States - Canada free trade agreement in place others have suggested that Alberta look to a southern movement of grain. This is a market in which Alberta producers have little experience. Export permit practices, surplus feedgrain production on both sides of the border, and vast feedgrain markets outside of North America have resulted in limited attention paid to the potential for such trade.

2. Northwest United States feedgrain market

The northwest United States, as defined in this work[1], seem a likely place to target Alberta feedgrains. Distances between this region and the corn producing center of the United States are

1 The eleven states covered by the definition of north west United States include: California, Colorado, Idaho, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington and Wyoming.

similar to distances to Alberta. Although generally considered a feed deficit region there is high variability among the states, depending on both grain production and livestock numbers.

One of the largest problems faced when considering the United States as a market for feedgrain is the corn stronghold. This takes the form of a trade barrier in the shape of producer bias against other feedgrains, but this barrier shall be ignored throughout this study. It is assumed that if a grain such as sorghum is accepted on the basis of price and nutrient value (Roy and Ireland, 1975), so too could other feedgrains such as barley.

In 1988, the United States received 114,770 tonnes of the 2,372,484 tonnes of barley Alberta exported. This made it the sixth largest barley export market in terms of mass and fifth largest in terms of value ($12,276,000 of $195,330,000). The ranking remains the same for Canadian barley exports (Alberta Agriculture 1988a). While a substantial amount of this grain is high value malting barley, it is probable that some is destined for feed.

3. Export and transportation barriers

Alberta barley destined for export out of Canada falls under the jurisdiction of the Canadian Wheat Board (CWB). As a designated grain from a designated region all legislation set out in the CWB Act applies to barley destined for the United States. Grain exported from Canada to the United States takes the form of commercial transactions between private exporters and importers, for both non-Board and Board grain purchased by export merchants. All exports of the designated grains, wheat and barley, must be Board grain and must take place through accredited merchants. This non-tariff barrier to export results in costs in the form of lost timeliness for small volume exports, as well as the real costs of hiring someone to do the necessary documentation.

Transportation barriers for Canada - U.S. grain shipments also exist. These are mainly in the form of transportation regulations, specifically in the trucking industry. History has resulted in few north-south railway lines between western Canada and the United States. There exist at most 12 railway entrance points to the United States in the four western provinces, with only one of those in Alberta (Mines and Resources Canada, 1974). This suggests grain moving across the Canada - U.S. border would move by truck. However, within trucking, regulations on backhauls, compounded by the small volumes of grain presently shipped across the border, have resulted in a largely un-priced service. Most cost estimates are probably closer to "guess-timates", rather than competitive prices determined by the market.

4. Problem statement

The purpose of this work is to develop a spatial model incorporating the Alberta barley market and the northwest United States feedgrain market with a view to testing the impact of possible changes to the existing regulations and pricing patterns.

B. Hypothesis

The primary hypothesis is that there exists the potential for the southern movement of feed barley from Alberta to the United States.

C. Objectives

The objectives of this research are:

1) To develop a spatial partial equilibrium model for the Alberta barley market that reflects the current priced regulatory practices in terms of feedgrain exports and the present shipping costs under the Western Grain Transportation Act (baseline study).
2) To illustrate changes in trade flow patterns resulting from regulatory changes in the baseline model to reflect:
    a) a total closure of the border between Canada and the United States.
    b) a continuation of tariff barriers, with a change to full cost shipping for Alberta export grains.
    c) a tariff free Canada - U.S. border, with a continuation of shipping costs under the WGTA
    d) a tariff free Canada - U.S. border, with full cost shipping of export grain.
    e) a tariff free Canada - U.S. border, with full cost shipping of grain, as well as rail competitive trucking costs.
3) To determine the economic feasibility of barley exports from Alberta to the north west United States under the above scenarios.

D. Sources of Data

The majority of the information used in the Alberta portion of the study was obtained from Alberta Agriculture, with special assistance from various individuals within the Economic Services Division.

The majority of data regarding the United States is secondary data from USDA publications, complied by Peter Gamache.

All the data used were from secondary sources, with the majority gathered from government publications.

E. Plan of Study

A baseline model was developed initially which incorporates appropriate policy and transportation costs with regard to the movement of feedgrain between Alberta and the United States. This model was then altered in accordance with the objectives. Such a method of study allowed for a comparison of the potential gains and losses in the past five years as a result of border barriers to trade. Differences in prices between regions that exceed transportation costs could be viewed as the cost imposed on producers by institutional barriers to trade.

II A THEORETICAL BASE

As markets have become increasingly integrated regionally and internationally, problems of pricing and allocation over space have become more pressing but also more complicated. This state is created not so much by integration as by tariff and non-tariff barriers to trade: the remnants of regional independence. Questions as to how changes in these barriers would affect trade flows between regions are hard to answer. Analysis is made difficult by scanty information concerning probable impacts and uncertainty regarding direction and magnitude of the consequences of such changes. Yet this type of knowledge is required in order to plot courses of action that chart the role of trade in the economic development of a region or country.

This chapter develops the theoretical basis upon which the baseline model, and the subsequent simulations, are built. Exploration of various methodologies resulted in the selection of a revised partial spatial equilibrium net revenue maximization, linear programming model to compare static conditions. The theoretical base upon which this decision was made is developed starting with a foundation of spatial equilibrium models as rooted in fundamental trade theory. The remainder of the chapter relies heavily on Takayama and Judge (1971) to lay out the mathematical basis and the required assumptions for the model chosen. The lack of intensive work in this area in the late 70's and throughout the 80's results in the continued usefulness of this work despite it being dated.

Initially the general mathematical non-linear programming model is developed followed by a special case, linear programming. A brief review of competitive equilibrium is then developed. Its relationship to competitive spatial equilibrium, both general and partial, as well as price equilibrium models is covered. This general theory is the foundation upon which linear distribution models, a subset of linear pricing and allocation models, are developed. The general model is explained with the net revenue maximization model being the final extension developed.

A. Spatial Equilibrium Models

Spatial models are theoretical models which explicitly recognize space as a variable. Economic spatial models involve one or more commodities and depict one or more of the following economic activities:

1) regional location and level of production,

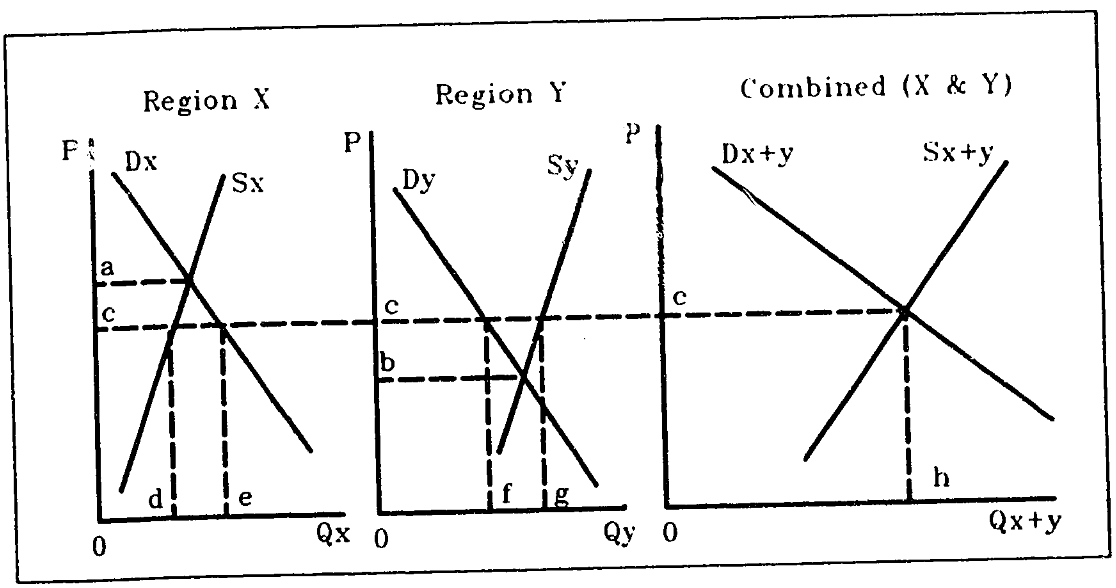
2) shipping patterns of goods,

3) regional levels of consumption of final goods,

4) the relative and/or absolute level of regional prices.

This broad definition includes transportation, activity analysis plant location and spatial equilibrium models. Spatial models can be grouped into two general categorizes according to Bawden "...standard equilibrium formulations using demand and supply relations and activity analysis models involving physical production activities and demand relationships" (1964:1372). The former is the category into which most spatial equilibrium models fall. These models have their roots in the most basic of microeconomic theory.

Figure 1: Trade between two regions without transfer costs.



An introduction to economic theory generally starts with the presentation of individual supply and demand functions. This is expanded to illustrate local market functions. In a market at equilibrium there is a single price and a single quantity. The first two panels of figure 1 show two separate markets in the absence of contact which allows for separate equilibriums. Local equilibriums would result in price *0a* in region X and a lower price, *0b*, in region Y.

Trade is often introduced into this situation in the form of a single commodity moving between two regions without transfer costs. In such circumstances traders would see the opportunity to purchase the commodity for 0*b* in region Y and sell for 0*a* in region X, making a profit of (0*a* - 0*b*) as a result of the price differential. Traders would continue to engage in such arbitrage until such time as there no longer existed a difference in price. Equalization in price would occur as increased supplies in region X decreased local price and decreased supplies available in region Y increased local price. The opening of trade between two regions has the effect of combining supply and demand. The third panel of figure 1 shows this effect by summing horizontally the demand and supply in both regions. The result is a final or 'world' price in equilibrium at 0*c*, and a total 'world' output of 0*n*. The amount *fg* is exported by region Y and the equivalent amount, *de*, is imported by region X at price 0*c*.

Figure 1 suggests that with trade region Y would increase production and decrease consumption of the commodity due to an increase in price, while in region X consumption would increase and production decrease.

Figure 2: The effects of transfer costs (t) on trade and prices.

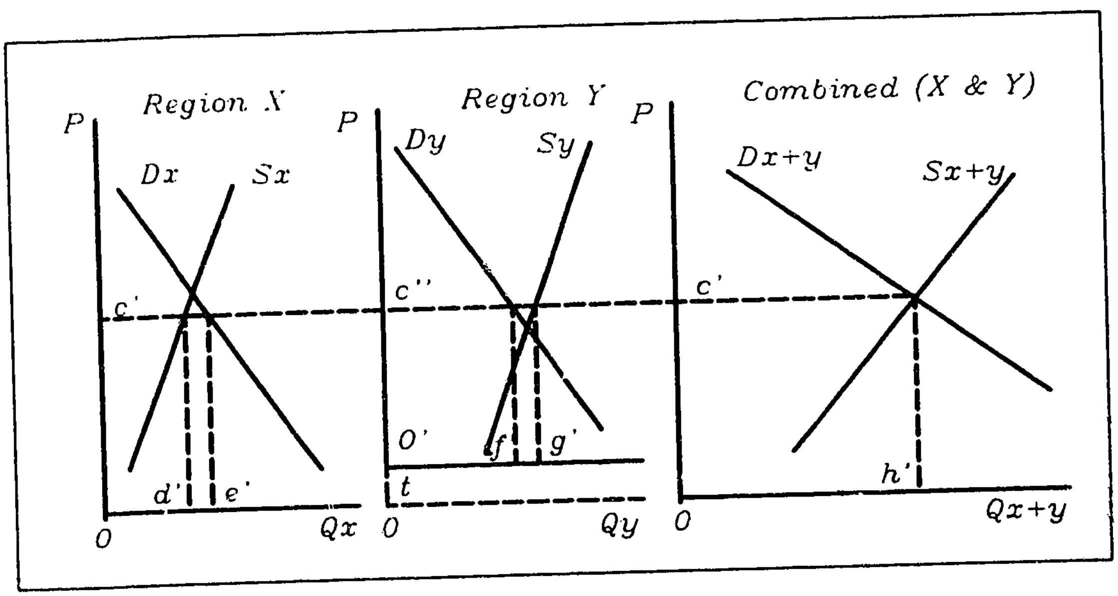


Figure 1 does not show transfer costs when commodities move between markets. Transfer costs are the per unit costs involved in physically moving a commodity from one point to another and include not only transportation costs but legal, tariff and other costs. As a result of transfer costs trade between two spatially separated markets may not reach an equilibrium at the levels suggested by figure 1. Rather, as shown in figure 2 the prices of the commodity will move toward each other until they differ by the transfer cost. At equilibrium the price in region Y, the exporting region, is c'' which is equal to the price in the importing region X, c', minus transfer costs, t. In order to add the supply and demand equations between the two regions, the curves in region Y must be moved upward by $0t$, the per unit transfer cost. This is illustrated in figure 2.

A comparison of figures 1 and 2 illustrates that transfer costs result in a decline in the volume of trade from levels without transfer costs, at similar price levels. It is upon this basic of microeconomic theory, equilibrium in trade, that the remainder of this chapter is developed.

B. Mathematical Programming and Spatial Equilibrium

The construction of a general theory of location and space has challenged economists since Ricardo outlined a simple theory which explained the pattern and benefits of trade. As early as 1838 Cournot stated in his *Investigations into the Mathematical Principles of the Theory of Wealth* the condition for a spatial equilibrium solution: "It is clear that a good which is mobile will move from the market where its value is lower to the market where its value is higher, until differences of values are not larger than transportation costs" (Quoted in Weinschenck et al, 1969: 16). Cournot's statement suggests a world with at least two regions and transfer costs. However, most work in the area of general equilibrium theory, the foundation stone of a general theory of location and space, has involved one location or zero transfer costs. In the late 40's and early 50's the activity analysis model of production and allocation developed by Koopmans, Dantzig and others opened a new approach to the analysis of spatial pricing and allocation problems. And yet as recently as 1951 Enke could not find a mathematician who could solve a three region, one commodity model except through iteration (1951:41). In order to overcome this problem Enke designed a 'simple' electrical circuit that he used to solve the following case:

"There are three regions trading a homogeneous good. Each region constitutes a single and distinct market. The regions of each possible pair of regions are separated--but not isolated--by a transportation cost per physical unit which is independent of volume. There are no legal restrictions to limit the actions of the profit-seeking traders in each region. For each region the functions which relate local production and local use to local price are known, and consequently the magnitude of the difference which will be exported or imported at each local price is also known. Given these trade functions and transportation costs, we wish to ascertain:

(1) the net price in each region,
(2) the quantity of exports or imports for each region,
(3) which regions export, import, or do neither,
(4) the aggregate trade in the commodity,
(5) the volume and direction of trade between each possible pair of regions" (Enke, 1951: 41).

Enke used linear 'trading' functions which defined the quantity of exports (E_i) as a function of local prices (P_i) minus the price at which local production equalled local use (A_i). That is:

$$E_i = b_i(P_i - A_i)$$

The general equilibrium conditions were i) 'world' exports must equal zero, when imports are considered negative exports, and ii) the price in the importing regions must equal the price in exporting regions plus transportation costs. The first condition allows for a closed system, while the second is the basic rule of spatial equilibrium models.

A solution to a four region model was illustrated by an electrical circuit diagram which incorporated resistors, rectifiers and reverse batteries. While it was suggested that such a system was easy to build and offered quick solutions, for a non-electrician doubt remained especially for increased numbers of regions and commodities (Enke, 1951).

Samuelson (1952) converted Enke's general non-normative problem of partial equilibrium among spatially separated markets into an extremum problem using linear programming which contained Koopmans' (1949) minimum transportation cost problem as a special case. In order to do this Samuelson created an artificial measure, the net social pay-off (NSP), defined as the sum of the social pay-off in each region minus total transportation costs. Social pay-off was defined as the algebraic area under a region's excess-demand curve, which is equal in magnitude but opposite in sign to the area under the excess-supply curve. Equilibrium occurred when NSP was at a maximum.

Samuelson added a further assumption to Enke's model: domestic supply curves in each region must cut domestic demand curves from below as prices rise so excess-supply curves are never falling. This assumption was required to ensure that a maximum position for the NSP function existed and was unique. Samuelson, in laying out his general model, suggested that net importing regions would never export and net exporting regions would never import. It was a matter of regional definition that would make this observation hold. The opposite of Samuelson's NSP optimizing problem would be to minimize the sum of consumer and producer rents (Samuelson, 1952).

Takayama and Judge (1964) extended Samuelson's work with derived 'net social payoff' functions and given supplies and requirements to include linear price dependant supply and demand functions to define a 'quasi-welfare' function. Over the years this work was expanded into quadratic programming. Others incorporated time, more than one commodity and international trade questions into the general model.

1. The general non-linear programming model

Many economic problems, including spatial partial equilibrium questions, can be cast in the framework of linear or non-linear programming problems. As linear problems are a special case of non-linear problems, non-linear programming was discussed first.

The general non-linear programming problem is to find a vector $\bar{x} \geq 0$ that maximizes $f(x)$ subject to the restrictions $g(x) \geq 0$ and $x \geq 0$. This is usually solved by first transforming the system into Lagrangean form:

$$\phi(x, \rho) = f(x) + \rho' g(x)$$

where

$$\rho = \begin{bmatrix} \rho_1 \\ \rho_2 \\ \cdot \\ \cdot \\ \cdot \\ \rho_m \end{bmatrix} \geq 0$$

and solve for the saddle value problem which is to find $(\bar{x}, \bar{\rho})$ that forms a saddle point for the Lagrangean. A pair of vectors $(\bar{x}, \bar{\rho})$ are called a saddle point of $\phi(x, \rho)$ in $x \geq 0, \rho \geq 0$ if $\bar{x} \geq 0, \bar{\rho} \geq 0$ and $(x, \bar{\rho}) \leq \phi(\bar{x}, \bar{\rho}) \leq \phi(\bar{x}, \rho)$ for all $x \geq 0$ and $\rho \geq 0$.

The Kuhn-Tucker conditions provide the necessary and sufficient conditions for $(\bar{x}, \bar{\rho})$ to be the saddle point of $\phi(x, \rho)$. As well, the dual non-linear programming solution shows that i) if a solution exits for the primal or dual problem, a solution exists for the other; ii) the maximum of the primal problem is equal to the minimum of the dual; and iii) the x that maximizes the primal is the same x that minimizes the dual (Takayama and Judge, 1971:12-17).

2. Linear programming

As was stated earlier the linear programming (LP) problem is a special case, or subset, of the non-linear model. In this case the objective function is linear, that is $f(x) = c'x$ where $c = (c_1, c_2, \ldots, c_n)'$. The c_i's are constants, and the constraints form a linear inequality system. As was stated for the non-linear problem, there exist primal and dual problems represented by:

a) LP primal problem

Find $\bar{x}$ that maximizes $c'x$

subject to: $Ax \leq b$

$x \geq 0$

where A is an $(m \times n)$ matrix, and

b is an $(m \times 1)$ vector.

b) LP dual problem

Find $\bar{\rho}$ that minimizes $b'\rho$

subject to: $A'\rho \geq c$

$\rho \geq 0$

where c is a $(n \times 1)$ vector.

While spatial equilibrium problems can be defined using the more general non-linear programming method, for much of the empirical work in economics the linear method results in acceptable results given existing data limitations. The results of this programming however, must be used within a specific context. In economic analysis the concept of competitive economic equilibrium assumes a central role, in both general and partial spatial equilibrium systems (Takayama and Judge, 1971:21-23).

3. Competitive spatial equilibrium

General competitive spatial equilibrium may treat space as continuous as in 'location economics', or as being formed by discrete subspaces as is done in traditional trade theory. The majority of the work concerning trade uses discrete subspaces and considers an economy of n regions or countries with each represented by a point i or j; $i, j = 1, 2, \ldots, n$. A general competitive spatial equilibrium is said to be attained if the following conditions hold:

(1) Market equilibrium

a) i) Consumers and producers are price takers.

ii) There is a unique transportation cost between any two points.

b) i) Total consumption plus exports must be less than or equal to domestic production plus initial endowments plus imports.

ii) The supply of transportation 'outputs' must be greater than or equal to that required to move exports or imports.

c) Locational price equilibrium

For there to be efficient pricing and allocation of commodities over space in equilibrium the price in the importing region must be equal to the price in the exporting region plus per unit transportation costs. If the price in the export region is greater than or equal to that in the importing region there will be no trade flows.

(2) Consumer equilibrium

Consumers must maximize individual utility functions for consumption efficiency.

(3) Producer equilibrium

Producers must maximize profit from production within the production possibilities frontier for production efficiency.

(4) Balance of payments equilibrium

Each country within the system must have a general or overall balance of payments.

The partial competitive spatial equilibrium is a subset of the general equilibrium described above. The same conditions must be satisfied although there are some changes. The condition for consumer equilibrium assumes a specific income distribution system. As well there is no formal condition for a balance of payments within each country, however it is required that there be a balance over all the economies considered within the problem (Takayama and Judge, 1971:28-31).

4. Spatial price equilibrium

In economic policy analysis options are compared on the basis of Pareto superiority conditions. The goal is to have to choose from the set of Pareto optimum options. A Pareto optimum condition exists when welfare is increased and no group is made worse off.

At a competitive equilibrium within a spatial economy a Pareto optimum is attained when conditions (2) and (3) above, consumer and producer equilibriums, are met. The conditions for a Pareto optimum can not be met when only a part of an economy is being analyzed. One is no longer able to maximize the welfare of the entire society, and in fact many of the variables of such a function are considered known. This results in a partial equilibrium situation defined as a spatial price equilibrium. Such an equilibrium requires only a market equilibrium that has i) homogenetity for market demand and supply prices for all commodities and regions; ii) no excess demand or excess supply possibilities; and iii) a locational price equilibrium. These can be interpreted in the same way as the requirements for a market equilibrium in a competitive equilibrium. This definition, however, does not include either consumer or producer equilibrium conditions which form the core of Pareto optimality. Various approaches to solving problems in this category have been developed (Takayama and Judge, 1971:31-35).

(a) Net quasi-welfare approach

One such means, the 'net quasi-welfare' approach, was credited to Samuelson (1952), but is described here using Takayama and Judge (1971). Rather than generating individual consumption and supply quantities, total regional supplies, endowments and demands are calculated. A regional quasi-welfare function in terms of these regional values is then assumed. It is further assumed that these regional or community quasi-welfare functions are additive, the sum being a 'total quasi-welfare' function W. Unit transportation costs are fixed and are totalled over all routes and commodities as $T'X$ which is assumed to be of a common measure with W. The difference between the two,

$$W - T'X = NW$$

is named 'net quasi-welfare', and is maximized. With these specifications the spatial price equilibrium can be expanded. The conditions would include a market equilibrium and locational price equilibrium as before, but also regional producer and consumer equilibriums. These regional equilibriums replace the individual equilibriums for the competitive spatial equilibrium above, but there is no balance of payments condition defined. Such a definition results in a "community" Pareto optimum (Takayama and Judge, 1971:35-38).

By using a community welfare function the net quasi-welfare approach is integrable. However, there are cases where this will not be so.

(b) Maximum net revenue approach

A set of price and quantity relationships will not always result in an integrable case. This means the conditions for a spatial price equilibrium defined for the net-quasi-welfare approach may not be satisfied. To overcome this, conditions for a non-integrable spatial price equilibrium are defined which include: i) a market equilibrium; ii) an optimum consumption equilibrium; and iii) an optimum production equilibrium.

These conditions allow for the use of yet another approach, the maximum net revenue approach. The objective is to maximize:

Net Revenue = total revenue - (total production costs + total transportation costs)

If the functions used are integrable then the two solutions, net quasi-welfare and net revenue, will be the same. This shows that the net quasi-welfare maximization approach, differing slightly from Samuelson's (1952) net social payoff model, is a special case of the spatial net revenue maximization approach. This second approach can be used for problems that are outside the bounds of the net quasi-welfare maximization approach (Takayama and Judge, 1971:35-38).

C. Linear Distribution Models

The most simplified of mathematical programming models are linear distribution models. These models are applicable to the analysis of spatial price and allocation problems in discrete space. The simplest of these involve one commodity and several regions. The problem is to:

> Find the set of shipments consistent with restrictions on regional supply and demand that maximizes returns to suppliers and permits the commodity to be delivered to consumers at a minimum total transportation cost.

This defines the problem in two parts, a transportation minimization section and a revenue maximization section.

1. Transportation minimization model

For the transportation minimization problem, a subset of the whole, there are several conditions which must hold. The most important of these conditions is that the differential between the market price in the demand region and that in the supply region must be equal to the unit transportation cost for the zero profit condition of competitive equilibrium to hold. The dual of transportation minimization is to maximize the total excess value in the demand regions over the value in the supply regions.

There are several extensions of the basic transportation model. One case is where total regional supplies and demands are not equal. To solve this problem dummy demand or supply regions, in the form of costless storage, are introduced to remove the excess. Storage costs can also be introduced as quasi-transportation costs to the fictitious regions.

Other extensions are production and transport cost minimization models. In this instance unit costs involved in making the commodity available in the demand region, above transport costs, are included separately. This extra cost may take the form of extraction costs, processing costs, or export subsidies or tariffs. The objective is to minimize joint total cost (Takayama and Judge, 1971:47-60).

2. Net revenue maximization

One further extension is a net revenue maximization model. In this case unit demand prices, production cost and transportation costs are all used. The objective function is to maximize net sectoral revenue (NSR):

max NSR = *total sectoral revenue - (total production and transport costs)*

$$= \sum_{i=0}^{n}\sum_{j=0}^{n} p_{ji} x_{ij} - \sum_{i=0}^{n}\sum_{j=0}^{n} (c_{ij} + t_{ij}) x_{ij}$$

$$= \sum_{i=0}^{n}\sum_{j=0}^{n} (p_{ji} - c_{ij} - t_{ij}) X_{ij}$$

subject to:

$$\sum_{i=0}^{n} x_{ij} = y_j,\ j = 0, 1, 2, \ldots, n$$

$$-\sum_{j=0}^{n} x_{ij} = -x_i,\ i = 0, 1, 2, \ldots, n$$

$$\sum_{i=0}^{n} x_i = \sum_{j=0}^{n} y_j = \sum_i \sum_j x_{ij} = \sum_j \sum_i x_{ij}$$

$$x_0 = \text{max of} \left(0, \sum_{j=0}^{n} y_j - \sum_{i=0}^{n} x_i\right)$$

$$y_0 = \text{max of} \left(0, \sum_{i=0}^{n} x_i - \sum_{j=0}^{n} y_i\right)$$

$$t_{0j} = t_{i0} = 0$$

where

y = demand region, $j = 0, 1, 2, \ldots, n$

x = supply region, $i = 0, 1, 2, \ldots, n$

p_{ji} = price, $j, i = 0, 1, 2, \ldots, n$

c = per unit cost of production

t = per unit cost of transportation.

This implies a rather unusual economic situation where quantity demanded is fixed, although the price for which the commodity is received may vary depending upon the source. As well the quantity produced is fixed, although the cost of production may vary depending on the destination.

An interesting feature of this model is that it allows an individual region to both export and import. This is possible if there is a significant premium for the imported commodity, or if production or transportation costs are subsidized for exports from the producing region. For this non-standard situation to arise the following mathematical condition must hold:

$$(p_{ij} - p_{ii}) + (p_{ji} - p_{jj}) \geq (c_{ji} - c_{jj}) + (c_{ij} - c_{ii}) + (t_{ji} - t_{jj}) + (t_{ij} - t_{ii})$$

If $p_{ji} = p_{jj}$ and $c_{ij} = c_{ii}$ for all i and j then the objective function basically is reduced to the pure transportation cost minimization model as aggregate revenue and production costs are fixed. Although even then a non-standard solution could arise if a transportation subsidy existed (Takayama and Judge, 1971:60-61).

III MODEL DESCRIPTION

Linear programming models (LP) assume a linear objective function and linear constraints. The quantity of a commodity demanded in a consuming region and the amount available in producing regions are fixed. The objective of the transportation model, a typical LP model, is to minimize total transportation costs. The outcome is a system of commodity flows from the producing to the consuming regions. As each region has supply and demand constraints the spatial equilibrium condition is satisfied. Linear programming models are simple to use, easy to understand and are computer efficient, but they do have limitations. The main limitation is that the assumption of fixed supply and demand can not be recognized. As a result the solutions of LP models must be considered conditional, rather than glob... optimal solutions.

Quadratic programming models, a subset of non-linear programming models, overcome this limitation by using demand and supply functions for each region. In the past quadratic programs were considered large and unwieldy; the development of computer algorithms changed that. However, quadratic models have large data requirements which make larger models difficult to formulate and use due to a lack of available information.

It was the large data requirement, especially for demand equations, that lead to the adoption of a revised linear programming transportation model in the form of a net revenue maximization model. When dealing with a primary input such as feedgrains, a truly price responsive quadratic programming model would require information regarding the demand for the final good, livestock products, as suggested by Fox (1955). Such information on demand is beyond the scope of the present study.

A. An Overview of the Model

This study was undertaken as an exercise in positive economics. Positive economics deal with questions of "what is" or "what has been". Friedman suggests the task of positive economics is to "... provide a system of generalizations that can be used to make correct predictions about the consequences of any change in circumstances" (1953: 4). Normative economics deal with questions of "what ought to be". Decisions in normative economics, while involving the moral values of the decision makers, should be based on predictions generated by studies in positive economics.

While this is a study based in positive economics the goals are much more specific than those put forth by Friedman. The objective of this study was to develop a model for the feedgrain market of Alberta and eleven north west states in the United States that was sufficiently detailed as to suggest trade flows under several scenarios. In order to minimize the amount of guess work required in terms of exogenous variables it was decided a retrospective model would be used rather than a forecasting model. In such a system it is assumed that past policies and physical relationships among variables, which are not endogenized in the model, remain unchanged.

The basic plan of the model follows. Five regions were defined. Each of these regions produced a known quantity of feedgrain within the years studied. Within the United States feedgrain consisted of both corn and barley production. In Alberta feedgrain was defined as barley, due to differences in feeding patterns between barley and oats. During the same period each region had a pre-determined feedgrain requirement. This quantity is calculated based on the number of livestock in the region during the year in question. As well as the five regions two export ports were defined. These ports could only accept grain from the other five regions and are unable to act as suppliers within the model.

The objective function was to maximize the 'net' revenue to the whole of the five producing regions. 'Net' revenue was calculated using the barley market price within each region minus transportation costs and any direct border costs (tariffs and customs fees) for international movements of grain. As this calculation did not include cost of production, it was not a true net revenue value. It was assumed however, that cost of production, being a sunk cost, was not relevant to producers after the crop had been produced. It was assumed a cost of production value would have been relevant when making production decisions and hence considered in determining annual production which was taken as fixed.

B. The Baseline Scenario

The purpose of a baseline version of the model is to have a base series of values to compare the results from the other scenarios with. In a retrospective study it is desirable to have the baseline series represent the actual situation during the time period examined. However, the baseline analysis does not have to accurately depict what occurred in the times examined, and in some instances it may be desirable that it is not an accurate depiction of what did happen.

The baseline scenario was an attempt to model the trading environment that existed in the five years examined. However, the degree to which the model could reflect the actual feedgrain movements was strongly tempered by the requirement that a five year time period be examined. It may have been possible to include cost variables that reflected non-tariff trade barriers, and make the model describe what happened in one year. This however, would not have been particularly relevant or useful.

The model was based on a revised net revenue maximization model. Production and requirement values were exogenous to the model. The main assumptions of the model include constant per unit transportation costs between regional pairs, and total requirements for all regions must be equal to the production of all regions. This was made possible by the use of export ports which acted dummy demand regions "consuming" all excess supply. This was required as the five regions defined are as a whole a net surplus area. The objective of the model is to maximize total net revenue. That is:

$$\max NR = \sum_{i=0}^{n} \sum_{j=0}^{n} p_{ji} x_{ij} - \sum_{i=0}^{n} \sum_{j=0}^{n} (b_{ij} + t_{ij}) x_{ij}$$

$$= \sum_{i=0}^{n} \sum_{j=0}^{n} (p_{ji} - b_{ij} - t_{ij}) x_{ij}$$

subject to:

$$\sum_{i=0}^{n} x_{ij} = y_j, \; j = 0, 1, 2, \ldots, n$$

$$-\sum_{j=0}^{n} x_{ij} = -x_i, \; i = 0, 1, 2, \ldots, n$$

$$\sum_{i=0}^{n} x_i = \sum_{j=0}^{n} y_j = \sum_{i} \sum_{j} x_{ij} = \sum_{j} \sum_{i} x_{ji}$$

$$x_0 = \max \text{ of} \left(0, \sum_{j=0}^{n} y_j - \sum_{i=0}^{n} x_i \right)$$

$$y_0 = \max \text{ of}\left(0,\ \sum_{i=0}^{n} x_i - \sum_{j=0}^{n} y_j\right)$$

$$t_{0j} = t_{i0} = 0$$

where y = demand, $j = 0, 1, 2, \ldots, n$

x = supply, $i = 0, 1, 2, \ldots, n$

p = price, $i, j = 0, 1, 2, \ldots, n$

b = priced border transfer costs, $i, j = 0, 1, 2, \ldots, n$

t = per unit transportation costs, $i, j = 0, 1, 2, \ldots, n$

As a whole the five regions defined had a net surplus of feedgrains. This meant the fifth equation would not hold. To overcome this, and to close the system, two export ports were defined. These ports were considered residual demand points. Takayama and Judge (1971) specify dummy supply and demand equations as:

$$x_\theta = \max \text{ of}\left(0,\ \sum_{j=0}^{n} y_j - \sum_{i=0}^{n} x_i\right)$$

$$y_\theta = \max \text{ of}\left(0,\ \sum_{i=0}^{n} x_i - \sum_{j=0}^{n} y_j\right)$$

and $t_{\theta j} = t_{i\theta} = 0$

As the above uses dummy regions to represent on site storage, modifications had to be made. In the model the two export points were only allowed to accept grain and were not able to ship it to the regions. As well, transportation values were not costless as the grain had to be physically moved to the export ports.

Increased realism could have been achieved by allowing for feedgrain suppliers outside the defined regions, for example Iowa corn, as well as interprovincial movements of Alberta barley. However, if the system was to remain closed the data requirements to include these situations would have been enormous.

1. Definition of regions

A total of five supply and demand regions, as well as two export ports, were defined within the model. Within Alberta three regions were demarcated as illustrated in figure 3: Alberta North, Alberta Central, and Alberta South. These regions were largely determined by geography and the census division breakdowns by which statistical information was made available. The choice of a regional center was based on a centralized location within the region, and the importance of the site as a center for grain movement and/or livestock production. The dispersed nature of agriculture in northern Alberta lead to a choice based largely on the size of the center. Grande Prairie was the largest center in the agricultural region of northern Alberta. Red Deer was selected as the regional point for central Alberta due to its role as an agricultural center. In southern Alberta, Calgary was chosen as the regional point due to the levels of livestock feeding in the vicinity.

Figure 3 also shows how the eleven northwest states of the United States were divided into two regions: U.S. North[2] and U.S. South[3]. The eleven states were divided into two regions based on an average feedgrain surplus or deficit position over the five years the model examined. The division worked well to group the states, except for Wyoming. The five states defined as surplus continually had high levels of excess feedgrain production. Wyoming, while on average a surplus state, had a variable level of excess production. For three of the five years it was in a surplus position, but for two of the five years it was in a feedgrain deficit position. On the basis of this observation it was decided Wyoming did not fit well with the other U.S. north states and was included in the U.S. south region.

Due to the vast area encompassed by each U.S. region and the large differences in agricultural production patterns between states the choice of regional points within the two regions proved more difficult than in Alberta. The choice of Great Falls, Montana for the northern surplus region was a result of the availability of a consistent barley price series. The choice of Stockton, California for the U.S. south region was based partly on the availability of a price series, but also because California had the largest feedgrain requirement of any of the eleven states examined.

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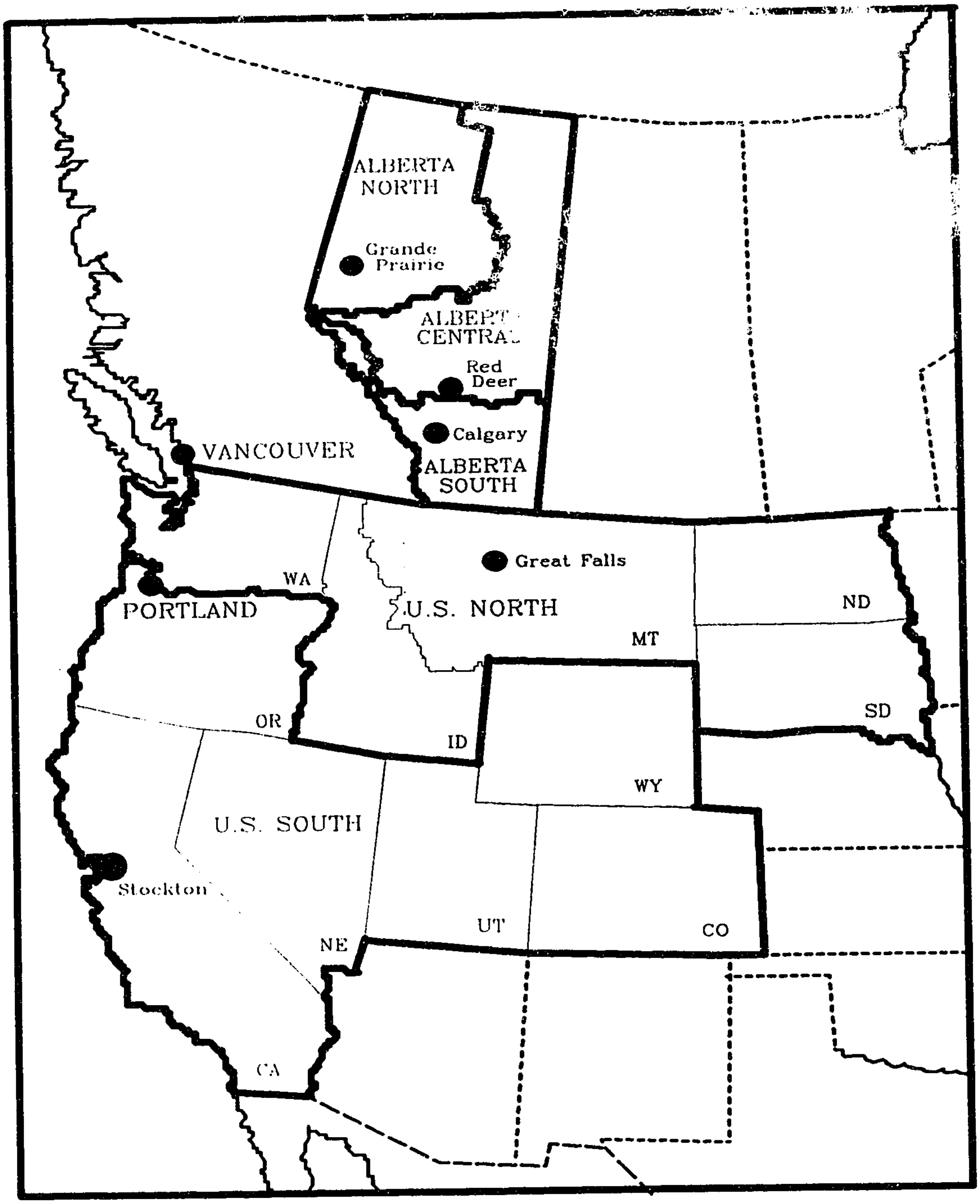
2 U.S. North consisted of five states: Idaho, Montana, North Dakota, South Dakota and Washington.

3 U.S. South consisted of six states: California, Colorado, Nevada, Oregon, Utah and Wyoming.

Figure 3: The regions and regional trade points as defined in the study.



The choice of the export ports was based on location, and relative size compared to other potential choices. This resulted in the choice of Vancouver, British Columbia for Alberta export movement and Portland, Oregon for export movement out of the U.S. north region.

The discrete nature of linear programming work requires that each region be defined by a single point. It was assumed that transfer costs from other parts of the region to the central point would be costless. Given the large physical areas of the regions defined in the this study this was rather unrealistic. One way to overcome this limitation would have been to set an average transfer cost for movement within the region to the central point. This cost could have been defined as a cost of production or marketing and would vary between regions. Another option would be to include this same cost with the cost of transportation between the discrete points. These options would have made the definition of regions of varying size more reasonable. However, data on average internal transfer costs was not readily available so neither of these options were used.

2. Calculation of regional production

Within each region the annual production of feedgrains was determined. For the Alberta regions Census Division data for barley was used as reported in the Agriculture Statistical Yearbook (Alberta Agriculture, Statistics Branch). This information was consolidated into values for the three regions earlier defined.

Calculations for the two U.S. regions were more complex and were completed by Peter Gamache. In order to make the values comparable between regions a common basis was required; for this study corn was converted to a barley equivalent. The conversion was based on a factor of 90 percent, the pound for pound feeding value of barley when compared to corn. The feedgrain values for each state, as published by the USDA, were then consolidated into two regional sets of values.

3. Calculation of regional requirements

In order to make the various types of livestock which can be fed barley or corn comparable a measure called the grain consuming animal unit (GCAU), as developed by Allen and Hodges (1974), was used. This unit made cattle and hogs, the main consumers of high energy, low fiber feeds such as barley and corn, additive.

Cattle and hog numbers for each region, as of a specific date which depended on the type of livestock in question, were obtained. For the Alberta regions Statistics Canada's 1990 conversion factors (Statistics Canada, Agriculture Statistics Division) for Alberta were used. These factors directly convert livestock numbers to tonnes of feedgrain consumed. While these values were actually designed to be used with livestock output figures (i.e. including livestock slaughtered) this information was not available for Census Divisions within the province. This resulted in total requirement values for Alberta being considerably lower than those estimated by Alberta Agriculture.

Allen and Hodges' (1974) method of converting numbers of livestock into tons of feedgrain consumed was used by Peter Gamache for the two U.S. regions. This method started by defining a grain consuming animal unit as equivalent to the average quantity of feed concentrates consumed by a milk cow. To estimate feeding rates for a specific kind of livestock in a specific state a state feeding factor was applied to the base unit. The feed units that had been calculated represented the feeding value of feeds in terms of corn equivalents. These were converted to actual tons by using a conversion factor based on the type of livestock. These values were then converted to tonnes of barley equivalents using barley's 90 percent conversion value from corn, and a physical conversion factor to convert form tons to tonnes (Allen and Hodges, 1974: 188).

The largest assumption was that livestock numbers on a single date were the only animals fed, or were an adequate representation of the true values for the year. It was assumed that no animals changed classification or were slaughtered before the end of the year, and that there were no imports into the region after the specified date. GCAUs determine an annual value for feedgrain consumption, based on the average amount of time the specific animals would be on fed within an average year. Abnormal years could result in these values being high or low, although one would assume that this would average out over a number of years.

4. Net revenue calculation

$$\text{NR maximization} = \sum_{i=0}^{n} \sum_{j=0}^{n} (p_{ji} - b_{ij} - t_{ij}) x_{ij}$$

To maximize overall net revenue, revised net revenue values are required for the objective function. The original equation, defined in the previous chapter, showed the need for a market price, cost of production values and transportation costs. As was previously explained the cost of production is assumed to be a factor in decision making in the determination of production, but not in the determination of marketing. In the revised net revenue calculation used the price of cross-border movements that were priced, as opposed to unpriced non-tariff barriers, were included to illustrate possible trade flow changes resulting from changes in trade policy.

(a) Market prices

For the three regions of Alberta the Canadian Wheat Board (CWB) initial price minus the prevailing rate for rail transport to Vancouver was used as the local market price. This was done under the assumption that producers had three main choices as to where to market their barley. Under a relatively open quota the producer could sell to the Board, to local feedgrain users, or to the Non-Board cash market. As the Board price was set and known throughout the year producers would not willingly sell at a price below the initial price minus transportation costs. While other price series were available to farm operators, such as the Winnipeg Commodity Exchange cash quote or the Alberta Grain Commission's local feed prices, these tend to be linked to the CWB price. The CWB net initial price effectively acted as a floor on feedgrain prices on the prairies.

The "market" price for Vancouver was deemed the CWB initial price. It was this price that producers faced when considering sales to the CWB which would land in Vancouver. As producers have no means by which to determine whether there will be a final payment, it is the initial price that should influence sales. It was not necessary to determine a sale price for feedgrain in Vancouver as the export ports were not allowed to sell to the other regions.

In the northern region of the United States an average annual price was generated using weekly barley price quotes. Weekly prices were made available by the Market Analysis Branch, Alberta Agriculture for Portland, Oregon and Great Falls, Montana. For Stockton, California an annual average price was generated using average monthly cash bids as reported in *Grain and Feed Market Review* (USDA).

The ideal method of determining a feedgrain price in the southern United States would have been to use a blended corn-barley price, as corn is overwhelmingly the most important feedgrain in the region. Using the ratio of corn to barley fed a blended feedgrain price could be determined based on the prevailing market prices for these grains. The inability to find such a ratio lead to the abandonment of this idea.

(b) Transportation costs

The transportation cost between each Alberta region and Vancouver was taken as the published rail cost (Alberta Agriculture, Production Economics Branch). In the baseline model only the relevant producers share of the full cost was used, reflecting the WGTA rail subsidy.

Between the three regions in Alberta, the two U.S. regions and the two export ports, trucking rates were used. These rates were based on an average of 1988 tariff rates quoted by Nabi Chaudhary, Alberta Agriculture. There was no official transportation price series for cross border movement of grain, and even unofficial price series did not appear to have a time series. In order to utilize those values supplied by Mr. Chaudhary for the five years prior to 1988, the tariff values were reduced by 2.6% annually. This value reflects the average difference between the transportation index and the Consumer Price Index (Statistics Canada, 1988) during the years examined.

The more desirable method of determining such rates would have been the use of trucking rates as quoted by trucking companies that haul grain along the routes described. Contact with several trucking companies lead to little useful information. The lack of movement along many of the Canada - United States routes examined made any prices quoted very specific to route, backhaul availability, and several other factors. The collection of a rate series between major Canadian and American centers may be a project of merit as trucking is increasingly seen as a viable alternative to rail movement over certain products.

(c) Priced border costs

Only priced, or tariff, border costs were included in the various net revenue calculations. The tariff rates used were published rates for the years in question.

For movement from Canada to the United States until 1987 the tariff was $0.075 per bushel or $3.44 per tonne (OECD, 1987). In 1987 the rate dropped to $0.05 per bushel or $2.27 per tonne (Agriculture Canada, 1987). In 1986 The United States instituted user fees which were 0.22% ad valorem (Menzie and Prentice, 1987) but in 1987 these fees dropped to 0.17% ad valorem (Agriculture Canada, 1987).

The border costs for movement of barley from the United States into Canada were only in the form of tariffs. Prior to 1987 the rate was $0.072 per bushel or $3.31 per tonne (OECD, 1987). In 1987 the rate dropped to $0.05 per bushel or $2.27 per tonne (Agriculture Canada, 1987).

An initial attempt was made to include non-tariff barriers in the model in the form of an additional cost. The intent had been to bring the trade flow results closer to those that existed in the years examined. The main non-tariff barriers perceived by the author were the Canadian Wheat Board export and import permit requirements. It was felt that if a consistent value would be placed on the CWB permit requirements it would be reasonable to include the associated non-tariff costs. However, as well be shown later in this study, the costs were very volatile with no pattern perceived between the years. It was decided su a variable would add little to the dy.

(d) Summary

The baseline scenario of the study model did not accurately portray what did happen in the Alberta and north west United States feedgrain markets between 1984 and 1988. The inability of the author to incorporate non-tariff barriers to trade, as well as state, provincial and federal policies that influence the workings of the market, made the baseline version of the model, at best, an incomplete picture. However, the results offered a base with which to compare the other versions of the model.

Five other versions of the model were used to illustrate the effects from changes to the parameters of several variables. The differences between the baseline scenario and the five other scenarios are described below.

C. The No Trade Scenario

The no trade version of the model was developed to show the difference in trade flows between a system with a closed border and a system where the border is open, but tariff barriers exist. This scenario used the same net revenue, production, requirement and transportation values as the baseline scenario. However, trade was restricted to the country of origin.

In order to achieve a closed border two separate simulations were run for each year. These simulations maximized revised net revenue individually within each country. The situation that actually existed in the Alberta and United States feedgrain markets between 1984 and 1988 was some where between the baseline scenario and the no trade scenario.

D. The Full Cost Scenario

For the full cost version of the model the only changes made to the baseline version were in the rail rates between the three Alberta points and Vancouver. In this scenario producers were required to pay the full cost of rail transportation which was taken as the published statutory rates. All other variables remained as in the baseline version of the model.

E. The Tariff Free Border Scenario

In the tariff free border version of the model it was assumed that the WGTA remained in effect while all priced border costs were removed. This was the scenario envisioned by some under the Free Trade Agreement. All other variables remain as in the baseline version of the model.

F. The Full Cost and Tariff Free Border Scenario

The simulation in which full cost rail rates and a tariff free border occurred illustrated the situation whereby farmers were required to pay the full cost of rail transportation, while the Canada-United States border was free of tariffs and associated costs impediments. Market prices, trucking rates, and regional production and requirement volumes remain as in the baseline version of the model.

G. Both and Rail Competitive Trucking Scenario

The final version of the model was the most far reaching simulation attempted in this study. In this simulation Alberta producers paid the full cost of rail movement, all priced border costs were removed, and the trucking rates were made competitive with the rail rates. Competitive meant that the per tonne per mile trucking rate was set equal in each year to the average per tonne per mile rail rate. This rail rate was the average over the three Alberta to Vancouver routes under full cost rail rates. As Vancouver could only handle large volumes of grain if hauled in by rail, rail rates were used between the three Alberta regions and Vancouver. As all the other points could handle grain brought in by truck, trucking rates were used.

This scenario was examined to determine the potential impact on barley trade if the rumor that trucking grain was economically competitive with rail movement was correct. While the information available did not substantiate this rumor there was a high probability that the trucking rates used were from the high end of the price spectrum, as opposed to being average values.

IV RESULTS

The results obtained by running each of the six versions of the model for each of the five years, 1988 to 1984, are presented in this chapter. It must be remembered all are simulation results. None of the models presented were able to portray accurately the state of affairs over the years examined. The scenarios closest to reality are the baseline and no trade versions of the model.

Each of the six scenarios described in the previous chapter were run for the five year period 1984 to 1988 using a revised net revenue maximization model. The baseline scenario incorporated i) producer rail rates as set out under the WGTA for barley movement between the three Alberta regions and Vancouver; ii) the tariff and customs fees that existed at the United States - Canada border in the years examined; and iii) trucking rates between all points based on published trucking tariff rates. The no trade scenario used the same assumptions as the baseline model, but closed the border to feedgrain trade between Alberta and the United States. The full cost scenario used the final two assumptions of the baseline model but used the full published rail rates for grain movement between the three Alberta points and Vancouver. The tariff free border scenario incorporated WGTA producer share rail costs, published trucking tariff rates and the removal of tariff and customs fees for Canada - United States border crossings. The fifth scenario incorporated both full cost rail rates and the removal of tariff and customs fees from the border, but continued to use published trucking tariff rates. The final scenario relaxed all the assumptions of the baseline model: full cost rail rates were used, tariff and customs fees were removed from the border, and rail competitive trucking rates were used.

The results from the six simulations tend to confirm informed opinion regarding likely consequences under various policy scenarios. Under the baseline version of the model, which depicted a scenario close to what actually occurred during the period but without non-tariff barriers, the Alberta and United States markets remained relatively separate. While there was the occasional movement of barley from Alberta to the United States, the volumes were small. The difference between the baseline and no trade scenarios were relatively minor.

When the situation was changed so that tariff barriers remained but, Alberta producers were required to pay the full published cost of rail movement, there was a slight shift in trade flows. A smaller amount of the extra barley produced in Alberta was shipped to Vancouver. Instead much of the production was shipped to the northern United States which in turn increased shipments to Portland.

When the situation was reversed so that tariff barriers were removed while Alberta barley producers paid the producers share of rail rates as set out in the WGTA, trade flows remained similar to those in the baseline scenario.

When the model was run so that tariff barriers were removed and producers had to pay the full cost of rail shipments, the results were similar to the full cost scenario. It seems that in most years the impact of full cost rail rates overpowered any shifts in trade flows due to the removal of tariff barriers.

The final simulation, which was the same as the fifth except trucking rates were equalized with full cost rail rates, showed the largest changes in trade flows from the baseline scenario. The indication was that all the Alberta barley that was once headed for Vancouver would move through Portland instead.

A. The Baseline Scenario

An average of 16 percent of northern Alberta barley production was required to satisfy local requirements, which left an average of 84 percent of production for shipment out of the region. In four of the five years the full amount was shipped to Vancouver for export. In 1984 similar volumes were shipped to both central and southern Alberta, with no shipments to Vancouver.

In central Alberta an average of 56 percent of regional production was required to meet local feedgrain requirements. In two of the five years all extra barley went to Vancouver. In 1984 all the extra barley produced was shipped to Great Falls, Montana. In 1985, while the majority of extra barley produced was shipped to Vancouver, three percent of production was shipped to Calgary. In 1988 the majority of extra production was shipped to Vancouver, although six percent of annual production was shipped to Great Falls.

In southern Alberta an average of 76 percent of regional production was need to satisfy regional requirements. In 1984 and 1985 all the barley produced within the region was needed to meet a part of total regional livestock feed requirements. Increased production from 1986 through to 1988 allowed for regional exports. In 1986, 1987 and 1988 all the extra production was shipped to Vancouver.

The five northern states in the United States had the most varied shipping pattern. An average of 43 percent of feedgrain production was used to satisfy regional requirements; 28 percent was shipped to the U.S. south region and 30 percent was shipped to Portland for export.

The six southern states were a sharp contrast to the four other regions being the only perpetually deficient region examined. Every year 100 percent of production was required to satisfy part of the regional feedgrain requirements.

Table 2: Trade flows under the baseline scenario, with tariff barriers to trade and Alberta producers paying the WGTA producers share of rail rates for 1988 to 1984, in tonnes.

Destination:		Source:					Total Consumption
		ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH	
ALBERTA NORTH	1988	126,967					126,967
	1987	118,998					118,998
	1986	118,454					118,454
	1985	107,893					107,893
	1984	111,133					111,133
ALBERTA CENTRAL	1988		1,657,502				1,657,502
	1987		1,578,957				1,578,957
	1986		1,834,133				1,834,133
	1985		1,464,949				1,464,949
	1984	236,168	1,304,885				1,541,053
ALBERTA SOUTH	1988			1,267,856			1,267,856
	1987			1,196,201			1,196,201
	1986			1,160,176			1,160,176
	1985		102,498	1,065,000			1,167,498
	1984	384,699		875,000			1,259,699
U.S. NORTH	1988		199,057		4,861,257		5,060,314
	1987				5,401,750		7,273,093
	1986				7,889,482		7,889,482
	1985				8,028,677		8,028,677
	1984		1,726,115		6,250,090		7,976,205
U.S. SOUTH	1988				3,723,681	6,125,315	9,848,996
	1987				4,141,285	5,775,791	9,917,076
	1986				4,295,388	6,212,822	10,508,205
	1985				4,668,631	6,598,119	11,266,750
	1984				4,503,053	6,419,697	10,922,747
PORTLAND, OREGON	1988						
	1987				6,758,285		
	1986				5,649,500		
	1985				4,638,572		
	1984				5,232,507		
VANCOUVER, B.C.	1988	562,033	1,839,498	359,144			
	1987	674,502	1,640,441	1,146,599			
	1986	727,546	2,085,867	1,256,824			
	1985	495,107	1,532,533				
	1984						
Total Production	1988	689,000	3,497,000	1,627,000	8,584,938	6,125,315	
	1987	793,500	3,450,000	2,342,800	16,301,323	5,775,791	
	1986	846,000	3,920,000	2,417,000	17,834,370	6,212,822	
	1985	603,000	3,100,000	1,065,000	17,335,885	6,598,119	
	1984	732,000	3,031,000	875,000	15,985,648	6,419,697	

B. The No Trade Scenario

The results from the no trade scenario were similar to that of the baseline scenario. Northern Alberta had barley requirements equivalent to 16 percent of local production. In all five years examined, 1988 to 1984, all excess production was shipped to Vancouver for export.

In central Alberta, over the five years examined, an average of 48 percent of regional production was required to satisfy regional requirements. In two years, 1984 and 1985, small volumes of the excess production were shipped to southern Alberta to cover that region's feedgrain deficit. In those two years the remainder of central Alberta's excess barley production was shipped to Vancouver. In three of the five years, 1986 to 1988, all excess production was shipped to Vancouver. Vancouver shipments accounted for an average of 50 percent of central Alberta's barley production between 1984 and 1988.

Southern Alberta needed an average of 76 percent of regional barley production to satisfy part of its regional feedgrain requirements. However, in 1984 and 1985, this value was 100 percent as the region was in a feedgrain deficit position. In the remaining years examined, 1986 to 1988, all excess production was shipped to Vancouver.

In the U.S. north region an average of 48 percent of regional feedgrain production was required to fulfill regional feedgrain requirements. Over the five years examined an average of 28 percent of production was shipped to the U.S. south region; shipments were made to the south in all years. A further 25 percent of production was shipped to Portland for export. However, shipments to Portland were only made in four of the five years, 1984 to 1987. In 1988 the two U.S. regions were a net deficit area in feedgrains. This resulted in all extra feedgrain production from the U.S. north region being shipped to the U.S. south region. Even then there was not enough feedgrain to satisfy the south's 1988 requirements. In this instance there was no feasible linear programming solution as the scenario did not allow for feedgrain shipments from outside the two U.S. regions.

In all five years examined the U.S. south was a feedgrain deficit region. Hence, in all years 100 percent of production remained in the region to partly satisfy regional requirements.

Table 3: Trade flows under the no trade scenario, with no cross border trade and Alberta producers paying the WGTA producers share of rail rates for 1988 to 1984, in tonnes.

Destination:		Source:					Total
		ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH	Consumption
ALBERTA NORTH	1988	126,967					126,967
	1987	118,998					118,998
	1986	118,454					118,454
	1985	107,893					107,893
	1984	111,133					111,133
ALBERTA CENTRAL	1988		1,657,502				1,657,502
	1987		1,578,957				1,578,957
	1986		1,834,133				1,834,133
	1985		1,464,949				1,464,949
	1984		1,541,053				1,541,053
ALBERTA SOUTH	1988			1,267,856			1,267,856
	1987			1,196,201			1,196,201
	1986			1,160,176			1,160,176
	1985		102,498	1,065,000			1,167,498
	1984		384,699	875,000			1,259,699
U.S. NORTH	1988				5,060,314		5,060,314
	1987				7,273,093		7,273,093
	1986				7,889,482		7,889,482
	1985				8,028,677		8,028,677
	1984				7,976,205		7,976,205
U.S. SOUTH	1988				3,524,624	6,125,315	9,848,996
	1987				4,141,285	5,775,791	9,917,076
	1986				4,295,388	6,212,822	10,508,205
	1985				4,668,631	6,598,119	11,266,750
	1984				4,503,053	6,419,697	10,922,747
PORTLAND, OREGON	1988						
	1987				4,886,942		
	1986				5,649,500		
	1985				4,638,572		
	1984				3,506,392		
VANCOUVER, B.C.	1988	562,033	1,839,498	359,144			
	1987	674,502	1,871,343	1,146,599			
	1986	727,546	2,085,867	1,256,824			
	1985	495,107	1,532,553				
	1984	620,867	1,105,248				
Total Production	1988	689,000	3,497,000	1,627,000	8,584,938	6,125,315	
	1987	793,500	3,450,000	2,342,800	16,301,323	5,775,791	
	1986	846,000	3,920,000	2,417,000	17,834,370	6,212,822	
	1985	603,000	3,100,000	1,065,000	17,335,885	6,598,119	
	1984	732,000	3,031,000	875,000	15,985,648	6,419,697	

C. The Full Cost Scenario

This model illustrated the effect if Alberta producers paid the full cost of rail transportation. Northern Alberta required an average of 16 percent of regional barley production to satisfy regional requirements. In two of the five years, 1985 and 1986, all shipments of extra barley went to Vancouver for export. In 1984 similar volumes of barley were shipped to central and southern Alberta. In 1987 and 1988 all excess barley production from northern Alberta was shipped to central Alberta.

For central Alberta the average amount of barley production which stayed in the region was 39 percent. In 1984, 1987 and 1988 all extra barley production was shipped to Great Falls, Montana. In 1985 three percent of production was shipped to Calgary, while 49 percent went to Great Falls. In one year, 1986, that all the extra barley produced in the region was shipped to Vancouver.

In southern Alberta an average of 67 percent of production remained within the region. In 1984 and 1985 all production was required within the region. In 1986 all extra production was shipped to Vancouver, while in 1987 all extra barley was shipped to Portland. In 1988 the extra barley was shipped to Great Falls.

The northern United States had a varied shipment pattern with an average of 35 percent of regional feedgrain production used for regional requirements, 28 percent was shipped to Stockton, and 37 percent shipped to Portland for export.

One hundred percent of the feedgrain produced in the U.S. south region remained within the region to partly satisfy regional requirements.

Table 4: Trade flows under the full cost scenario, with tariff barriers and Alberta producers paying the full cost of rail transportation for 1988 to 1984, in tonnes.

Destination:		Source:					Total
		ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH	Consumption
ALBERTA NORTH	1988	126,967					126,967
	1987	118,998					118,998
	1986	118,454					118,454
	1985	107,893					107,893
	1984	111,133					111,133
ALBERTA CENTRAL	1988	562,033	1,095,469				1,657,502
	1987	674,502	904,455				1,578,957
	1986		1,834,133				1,834,133
	1985		1,464,949				1,464,949
	1984	236,168	1,304,885				1,541,053
ALBERTA SOUTH	1988			1,267,856			1,267,856
	1987			1,196,201			1,196,201
	1986			1,160,176			1,160,176
	1985		102,498	1,065,000			1,167,498
	1984	384,699		875,000			1,259,699
U.S. NORTH	1988		2,401,531	359,144	2,299,639		5,060,314
	1987		2,545,845		4,727,248		7,273,093
	1986				7,889,482		7,889,482
	1985		1,532,553		6,496,124		8,028,677
	1984		1,726,115		6,250,090		7,976,205
U.S. SOUTH	1988				3,723,681	6,125,315	9,848,996
	1987				4,141,285	5,775,791	9,917,076
	1986				4,295,388	6,212,822	10,508,205
	1985				4,668,631	6,598,119	11,266,750
	1984				4,503,053	6,419,997	10,922,747
PORTLAND, OREGON	1988				2,561,618		
	1987			1,146,599	7,432,787		
	1986				5,649,500		
	1985				6,171,125		
	1984				5,232,507		
VANCOUVER, B.C.	1988						
	1987						
	1986	727,546	2,085,867	1,256,824			
	1985	495,197					
	1984						
Total Production	1988	689,000	3,497,000	1,627,000	8,584,938	6,125,315	
	1987	793,500	3,450,300	2,342,800	16,301,323	5,775,791	
	1986	846,000	3,920,000	2,417,000	17,834,370	6,212,822	
	1985	603,000	3,100,000	1,065,000	17,335,885	6,598,119	
	1984	732,000	3,031,000	875,000	15,985,648	6,419,697	

D. The Tariff Free Border Scenario

In this scenario priced border costs were removed, but producers continued to pay rail rates subsidized by the WGTA. Northern Alberta used an average of 16 percent of regional barley production to satisfy local feedgrain requirements. In 1984 all extra barley produced was shipped in the form of similar volumes to Calgary and Red Deer. In the other four years, 1985 to 1988, all extra barley produced in the region was shipped to Vancouver for export.

In central Alberta an average of 46 percent of regional barley production was required to satisfy regional feed requirements. In 1984, 1987 and 1988 the barley extra to that requirement was all shipped to Great Falls. In 1985 the majority of extra production was shipped to Vancouver, while three percent of production was sent to Calgary. In 1986 all extra regional production went to Vancouver.

Southern Alberta averaged 67 percent of regional barley production required to help satisfy regional feedgrain requirements. In 1984 and 1985 there was no barley produced extra to local requirements. In 1986 and 1988 all extra production was shipped to Vancouver, while in 1987 all extra barley was shipped to Stockton, California.

In the U.S. north region an average of 41 percent of feedgrain production stayed in the region, 27 percent was shipped to Stockton and 33 percent shipped to Portland for export.

In the six southern United States states considered 100 percent of feedgrain production remained within the region in all years.

Table 5: Trade flows under the tariff free border scenario, with the removal of priced border costs and a continuation of producer payments as under the WGTA for 1988 to 1984, in tonnes.

Destination:		Source: ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH	Total Consumption
ALBERTA NORTH	1988	126,967					126,967
	1987	118,998					118,998
	1986	118,454					118,454
	1985	107,893					107,893
	1984	111,133					111,133
ALBERTA CENTRAL	1988		1,657,502				1,657,502
	1987		1,578,957				1,578,957
	1986		1,834,133				1,834,133
	1985		1,464,949				1,464,949
	1984	136,168	1,304,885				1,541,053
ALBERTA SOUTH	1988			1,267,856			1,267,856
	1987			1,196,201			1,196,201
	1986			1,160,176			1,160,176
	1985		102,498	1,065,000			1,167,498
	1984	384,699		875,000			1,259,699
U.S. NORTH	1988		1,839,498		3,220,816		5,060,314
	1987		1,871,343		5,401,750		7,273,093
	1986				7,889,482		7,889,482
	1985				8,028,677		8,028,677
	1984		1,726,115		6,250,090		7,976,205
U.S. SOUTH	1988				3,723,681	6,125,315	9,848,996
	1987			1,146,599	2,994,686	5,775,791	9,917,076
	1986				4,295,388	6,212,822	10,508,205
	1985				4,668,631	6,598,119	11,266,750
	1984				4,503,053	6,419,697	10,922,747
PORTLAND, OREGON	1988				1,640,441		
	1987				7,904,884		
	1986				5,649,500		
	1985				4,638,572		
	1984				5,232,507		
VANCOUVER, B.C.	1988	562,033		359,144			
	1987	674,502					
	1986	727,546	2,085,867	1,256,824			
	1985	495,107	1,532,553				
	1984						
Total Production	1988	689,000	3,497,000	1,627,000	8,854,938	6,125,315	
	1987	793,500	3,450,300	2,342,800	16,301,323	5,775,791	
	1986	846,000	3,920,000	2,417,000	17,834,370	6,212,822	
	1985	603,000	3,100,000	1,065,000	17,335,885	6,598,119	
	1984	732,000	3,031,000	875,000	15,985,648	6,419,697	

E. The Full Cost and Tariff Free Border Scenario

This version of the model showed the potential impacts from removing priced border costs and requiring Alberta farmers to pay the full cost of rail transportation. Under this scenario an average of 16 percent of northern Alberta barley production was required to satisfy regional feedgrain requirements. In 1984 the extra production was spilt between Red Deer and Calgary. In 1985 and 1986 all extra barley was shipped to Vancouver. In 1987 and 1988 all extra barley production was shipped to Red Deer.

In central Alberta barley shipments from the north meant an average of only 39 percent of barley production was required to fulfill regional requirements. In 1985 three percent of annual production was shipped to Calgary, while 49 percent went to Great Falls. In 1984, 1986, 1987 to 1988 all barley production above that required locally was shipped to Great Falls, Montana.

In southern Alberta an average of 67 percent of local barley production was needed to satisfy regional feedgrain requirements. In 1984 and 1985 this value was 100 percent. In 1986 all extra production was shipped to Vancouver, while in 1987 the extra went to Stockton. In 1988 the extra barley production was shipped to Great Falls.

In the five northern U.S. states an average of 34 percent of regional feedgrain production was needed to help satisfy regional requirements, 26 percent of production was shipped to Stockton, and 40 percent went to Portland. In every year feedgrain was shipped to both destinations.

In the U.S. south region an average of 100 percent of the feedgrain produced was used within the region. In every year all feedgrain production was used in the region.

Table 6: Trade flows under the full cost and tariff free border scenario, with the removal of priced border costs and Alberta producers paying the full cost of rail transportation for 1988 to 1984, in tonnes.

Destination:		Source:					Total Consumption
		ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH	
ALBERTA NORTH	1988	126,967					126,967
	1987	118,998					118,998
	1986	118,454					118,454
	1985	107,893					107,893
	1984	111,133					111,133
ALBERTA CENTRAL	1988	562,033	1,095,469				1,657,502
	1987	674,502	904,455				1,578,957
	1986		1,834,133				1,834,133
	1985		1,464,946				1,464,949
	1984	236,168	1,304,885				1,541,053
ALBERTA SOUTH	1988			1,267,856			1,267,856
	1987			1,196,201			1,196,201
	1986			1,160,176			1,160,176
	1985		102,498	1,065,000			1,167,498
	1984	384,699		875,000			1,259,699
U.S. NORTH	1988		2,401,531	359,144	2,299,639		5,060,314
	1987		2,545,845		4,727,248		7,273,093
	1986		2,085,867		5,803,615		7,889,482
	1985		1,532,553		6,496,124		8,028,677
	1984		1,726,115		6,230,090		7,976,205
U.S. SOUTH	1988				3,723,681	6,125,315	9,848,996
	1987			1,146,599	2,994,686	5,775,791	9,917,076
	1986				4,295,388	6,212,822	10,508,205
	1985				4,668,631	6,598,119	11,266,750
	1984				4,503,053	6,419,697	10,922,747
PORTLAND, OREGON	1988				2,561,618		
	1987				8,579,386		
	1986				7,735,367		
	1985				6,171,125		
	1984				5,232,507		
VANCOUVER, B.C.	1988						
	1987						
	1986	727,546		1,256,824			
	1985	495,107					
	1984						
Total Production	1988	689,000	3,497,000	1,627,000	8,854,938	6,125,315	
	1987	793,500	3,450,300	2,342,800	16,301,323	5,775,791	
	1986	846,000	3,920,000	2,417,000	17,834,370	6,212,822	
	1985	603,000	3,100,000	1,065,000	17,335,885	6,598,119	
	1984	732,000	3,031,000	875,000	15,985,648	6,419,697	

F. Both and Rail Competitive Trucking Rates Scenario

This simulation modelled full cost rail rates, a tariff free border and rail competitive trucking rates. Under this scenario there were no barley shipments to Vancouver.

Northern Alberta used an average of 16 percent of regional barley production to satisfy local feedgrain requirements. In 1984 all the extra production was shipped to Stockton, California. In 1985 seventeen percent of production was shipped to Calgary, while 65 percent went to Portland for export. In 1986 to 1988 all extra barley production was shipped to Portland.

In central Alberta an average of 48 percent of regional barley production was used to satisfy regional feedgrain requirements. In 1984 forty two percent of annual production was shipped to Calgary and eight percent went to Portland. In the years 1985 to 1987 all extra production was shipped to Portland for export. In 1988 thirty six percent of the annual production was sent to Calgary, six percent to Great Falls, an 11 percent to Portland.

Southern Alberta used an average of 52 percent of barley production to partly fulfill feedgrain requirements. In 1984 and 1988 one hundred percent of local production was shipped to Portland. In 1985 one hundred percent of production was used locally. In 1986 and 1987 all barley production above that required locally was shipped to Portland.

The northern United States region had a varied shipping pattern with shipments to both Stockton and Portland in every year but 1988. An average of 47 percent of feedgrain production was used locally, 26 percent was shipped to Stockton and 27 percent sent to Portland. In 1988 there were no shipments to Portland.

In all years the southern United States region required 100 percent of regional production to help partly satisfy regional feedgrain requirements.

Table 7: Trade flows under the rail competitive trucking scenario, with trucking rates equal to full cost rail rates, the removal of priced border costs, and Alberta producers paying the full cost of rail transportation for 1988 to 1984, in tonnes.

Destination:		Source:					Total
		ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH	Consumption
ALBERTA NORTH	1988	126,967					126,967
	1987	118,998					118,998
	1986	118,454					118,454
	1985	107,893					107,893
	1984	111,133					111,133
ALBERTA CENTRAL	1988		1,657,502				1,657,502
	1987		1 578,957				1,578,957
	1986		1,834,133				1,834,133
	1985		1,464,949				1,464,949
	1984		1,541,053				1,541,053
ALBERTA SOUTH	1988		1,267,856				1,267,856
	1987			1,196,201			1,196,201
	1986			1,160,176			1,160,176
	1985	102,498		1,065,000			1,167,498
	1984		1,259,699				1,259,699
U.S. NORTH	1988		199,057		4,861,257		5,060,314
	1987				7,273,093		7,273,093
	1986				7,889,482		7,889,482
	1985				8,028,677		8,028,677
	1984				7,976,205		7,976,205
U.S. SOUTH	1988				3,723,681	6,125,315	9,848,996
	1987				4,141,285	5,775,791	9,917,076
	1986				4,295,388	6,212,822	10,508,205
	1985				4,668,631	6,598,119	11,266,750
	1984				4,503,053	6,419,697	10,922,747
PORTLAND, OREGON	1988	562,033	372,585	1,627,000			
	1987	674,502	1,871,343	1,146,599	4,886,942		
	1986	727,546	2,085,867	1,256,824	5,649,500		
	1985	392,609	1,635,051		4,638,572		
	1984	620,867	230,248	875,000	3,506,392		
VANCOUVER, B.C.	1988						
	1987						
	1986						
	1985						
	1984						
Total Production	1988	689,000	3,497,000	1,627,000	8,854,938	6,125,315	
	1987	793,500	3,450,300	2,342,800	16,301,323	5,775,791	
	1986	846,000	3,920,000	2,417,000	17,834,370	6,212,822	
	1985	603,000	3,100,000	1,065,000	17,335,885	6,598,119	
	1984	732,000	3,031,000	875,000	15,985,648	6,419,697	

G. The Net Revenue Results

1. Original results from the scenarios

The total net revenue for all five regions considered illustrates the steady decrease in nominal net revenue from 1984 to 1988. It is notable that this is a trend that appears in all six simulations, suggesting that changes in policy could not have offset these declines.

Table 8 lists the total net revenue over all five regions for each year, as well as ranks each scenario within each year. When the scenarios are ranked in each year there is no consistent pattern. In two of the five years, 1985 and 1986, three of the scenarios had the same total net revenue value. In 1985 the baseline, no trade, and tariff free border scenarios had the second highest net revenue value. In 1986 the same three tied with the highest net revenue value of the six scenarios. The rail competitive trucking scenario had the highest net revenue value of the six scenarios in three of the five years, while the baseline scenario ranked first in two of the five years. The tariff free border scenario ranked second in three of five years, while the no trade scenario ranked second in two of the five years. The scenario that included both full cost rail rates and a tariff free border ranked fifth in three of the five years, and sixth in two of the five years. The full cost scenario ranked last in three of the five years.

Table 8: Total net revenue values and ordering of total net revenue for all six scenarios for 1988 to 1984, in millions of nominal Canadian dollars.

Scenario:	Year: 1988		1987		1986		1985		1984	
	$ '000,000	order	$ '000,000	order	$ '000,000	order	$ '000,000	order	$ '000,000	order
Baseline	2,380	4	3,004	1	3,263	1	3,524	2	3,978	3
No Trade	2,382	3	2,998	2	3,263	1	3,524	2	3,955	4
Full Cost Rail	2,300	6	2,925	4	3,106	5	3,446	6	3,926	6
Tariff Free Border	2,385	2	2,861	5	3,263	1	3,524	2	3,984	2
Full Cost & Tariff Free	2,307	5	2,785	6	3,110	6	3,451	5	3,932	5
Rail Comp. Trucking	2,438	1	2,935	3	3,257	4	3,584	1	4,067	1

Table 9: Regional net revenue results for all scenarios for 1988 to 1984, in thousands of nominal Canadian dollars.

Region:	Year	Scenario:					
		BASELINE	NO TRADE	FULL COST	TARIFF FREE	BOTH	RAIL COMP. TRUCKING
ALBERTA NORTH	1988	54,314	54,314	27,958	54,314	27,958	59,375
	1987	52,411	52,411	21,130	52,411	21,130	60,184
	1986	77,840	77,840	59,787	77,840	59,787	67,710
	1985	62,471	62,471	51,695	62,471	51,695	58,722
	1984	58,109	70,067	45,358	58,109	45,358	90,863
ALBERTA CENTRAL	1988	275,992	274,480	267,678	293,003	273,610	220,860
	1987	282,137	226,857	280,535	248,471	234,736	242,499
	1986	359,503	359,503	271,342	359,503	250,025	322,217
	1985	319,534	319,534	253,845	319,534	259,117	316,591
	1984	314,613	287,303	290,851	320,551	296,789	247,849
ALBERTA SOUTH	1988	128,435	128,435	102,333	128,435	103,220	176,383
	1987	154,976	154,976	126,564	140,128	113,596	164,253
	1986	222,606	222,606	171,970	222,606	171,970	204,019
	1985	110,441	110,441	91,771	110,441	91,771	91,771
	1984	83,834	83,834	68,985	83,834	68,985	126,963
ALBERTA TOTAL	1988	458,742	457,229	397,969	475,752	404,788	456,618
	1987	489,524	434,244	428,229	441,010	369,462	466,936
	1986	659,949	659,949	503,099	659,949	481,782	593,946
	1985	492,446	492,446	397,311	492,446	402,583	467,084
	1984	456,556	441,204	405,194	462,494	411,132	465,675
	Avg	**511,443**	**497,014**	**426,360**	**506,330**	**413,949**	**490,052**
U.S. NORTH	1988	948,165	951,154	928,312	935,451	928,312	1,007,818
	1987	1,700,908	1,750,124	1,683,168	1,606,145	1,602,213	1,654,460
	1986	1,654,439	1,654,439	1,654,439	1,654,396	1,679,219	1,713,945
	1985	1,951,925	1,951,925	1,968,476	1,951,925	1,968,476	2,036,996
	1984	2,268,266	2,260,741	2,268,266	2,268,266	2,268,266	2,348,509
U.S. SOUTH	1988	973,558	973,558	973,558	973,558	973,558	973,558
	1987	813,578	813,578	813,578	813,578	813,578	813,578
	1986	948,884	948,884	948,884	948,884	948,884	948,884
	1985	1,080,046	1,080,046	1,080,046	1,080,046	1,080,046	1,080,046
	1984	1,252,804	1,252,804	1,252,804	1,252,804	1252,804	1,252,804
U.S. TOTAL	1988	1,921,723	1,924,712	1,901,870	1,909,009	1,901,870	1,981,376
	1987	2,514,486	2,563,702	2,496,746	2,419,723	2,415,791	2,468,038
	1986	2,603,323	2,603,323	2,603,323	2,603,323	2,628,103	2,662,829
	1985	3,031,971	3,031,971	3,048,522	3,031,971	3,048,522	3,117,042
	1984	3,521,070	3,513,545	3,521,070	3,521,070	3,521,070	3,601,313
	Avg	**2,718,515**	**2,727,451**	**2,714,306**	**2,697,019**	**2,703,071**	**2,766,120**
TOTAL NET REVENUE	1988	2,380,465	2,381,941	2,299,839	2,384,761	2,306,658	2,437,994
	1987	3,004,010	2,997,946	2,924,975	2,860,733	2,785,253	2,934,974
	1986	3,263,272	3,263,272	3,106,422	3,263,272	3,109,885	3,256,775
	1985	3,524,417	3,524,417	3,445,833	3,524,417	3,451,105	3,584,126
	1984	3,977,626	3,954,749	3,926,264	3,983,564	3,932,202	4,066,988
	Avg	**3,229,958**	**3,224,465**	**3,140,667**	**3,203,349**	**3,117,021**	**3,256,171**

In Table 9 the total net revenue values in Table 8 are broken down into values for each region. The total net revenue values in Table 9 are not identical to those in table 8 due to rounding. One immediate observation was that the two U.S. states, both individually and combined, are much larger in terms of net revenue than all three Alberta regions combined. This occasionally leaded to net revenue results for the United States overshadowing Alberta results. This could have lead to a bias against policy simulations that could have benefitted the Alberta regions.

Careful examination of Table 9 reveals that there were few consistent changes within each scenario in terms of net revenue. In Alberta in 1985 and 1986 the baseline, no trade and tariff free border scenarios all tied to be ranked number one in terms of provincial net revenue. Both the baseline and tariff free scenarios were ranked number one in Alberta in three of the five years. The no trade scenario ranked number one in two of the five years. The rail competitive trucking scenario ranked number one in one of the five years. The full cost scenario ranked sixth in three of the five years and fifth in the other two years. The scenario with both full cost rail rates and a tariff free border ranked fifth in three of the five years, and sixth in two of the five years.

By contrast, in the United States it was the rail competitive trucking scenario that outshone all the other simulations. In four of the five years modelled the rail competitive trucking scenario ranked number one. The net revenue results from the remaining scenarios give a less clear picture. The scenario with both full cost rail rates and a tariff free border ranked second in three of the five years, while the full cost scenario ranked third in three of the five years. The tariff free border scenario ranked fourth in two of the five years, while the no trade scenario was ranked from one to six over the five years.

2. Results using a consistent set of prices

When the results from the six scenarios, as shown in Table 8, were compared there was some confusion. The use of full cost rail rates in three of the scenarios resulted in dramatic drops in Alberta feedgrain prices. This drop was due to the method by which the prices were calculated. The different prices used to evaluate each version of the model made it difficult to compare results in monetary terms. The WGTA rate structure, and the way the model was formulated, indicated that the status quo would have been most beneficial to Alberta farms from a net revenue point of view.

The net revenue results were standardized by evaluating all the trade lows generated by the six scenarios using a single set of prices for Alberta feedgrain. The price series used was that calculated under full cost rail rates. This form of evaluation meant the net revenue values would not change for the United States regions, as their feedgrain prices were not effected by Alberta's rail transportation costs and they never shipped grain to Alberta. However, some of the Alberta, and hence total, net revenue values did change. The total net revenue values for the full cost, full cost and tariff free, and full cost, tariff free and rail competitive trucking rate scenarios would not change as the Alberta feedgrain price already incorporated full cost rail rates. The total net revenue values for the six scenarios, evaluated using Alberta feedgrain prices calculated using full cost rail rates, as well as the ranking for these values, are shown in Table 10. A complete regional breakdown is in Appendix E.

Table 10: Total net revenue values and ranking of total net revenue, evaluated using Alberta feedgrain prices calculated using full cost rail rates, for all six scenarios for 1988 to 1984, in millions of nominal Canadian dollars.

Scenario:	Year: 1988		1987		1986		1985		1984	
	$ '000,000	order	$ '000,000	order	$ '000,000	order	$ '000,000	order	$ '000,000	order
Baseline	2,255	5	2,897	3	3,106	3	3,437	4	3,926	4
No Trade	2,252	6	2,846	4	3,106	3	3,437	4	3,873	6
Full Cost Rail	2,300	3	2,925	2	3,106	3	3,446	3	3,926	4
Tariff Free Border	2,297	4	2,779	6	3,106	3	3,437	4	3,932	2
Full Cost & Tariff Free	2,307	2	2,785	5	3,110	2	3,451	2	3,932	2
Rail Comp. Trucking	2,438	1	2,935	1	3,257	1	3,584	1	4,067	1

When the total net revenue results were ranked in each year the full cost, tariff free, and rail competitive scenario ranked first every year. The full cost and tariff free scenario ranked second in four of the five years. The remaining four scenarios were less consistent. In 1984, 1985, and 1986 several of the scenarios had the same total revenue values. This was verified by examining the differences in trade flow patterns between the models, there were few changes in those years.

V DISCUSSION

For Alberta barley producers faced with several policy options the bottomline is the potential increase in income. Presumably producers would be indifferent to two situations that yielded the same income - one with large volume sales at low prices, and one with small volume sales at high prices. To the farmer it is the final return that is important. However, this study does not present the income effects of the various scenarios. The values shown in chapter four are revised net revenue values; the costs of production were not removed. To evaluate the superiority of the various policy scenarios based on these values may be erroneous.

In chapter three this study was defined as a study in positive economics. Studies in positive economics are supposed to show what happened, and explain why, as opposed to passing judgement on the various policy options. Such decisions are in the realm of normative economics and as such require moral judgements, best made by those affected.

In the previous chapter the results from six scenarios of a revised net revenue maximization model were presented. There was no attempt to compare the results of the six scenarios. This chapter describes the differences between the results from the baseline version of the model and the five other scenarios. The trade volumes are compared to actual trade volumes. As well, the differences that exist between the six scenarios, in trade volume and net revenue terms, are presented. A discussion is then undertaken of possible reasons for differences between the model results and actual trade patterns, and reasons for differences between the scenarios.

A. A Comparison of Differences in Trade Volumes

Table 11 shows the annual out-of-province barley shipments from Alberta. Both the actual volumes and the volumes calculated from the model are presented. Over the five years examined the model estimated shipments that were 101 percent of actual shipments. This ranged from estimated shipments that were 60 percent of actual shipments in 1984, to estimated shipments 128 percent of actual in 1986.

In Table 12 the actual volumes and values of barley shipments from Alberta to the United States from 1984 to 1988 are presented. Over the five year period an average of 84,760 tonnes of barley, with an average value of $11,044,600, was shipped from Alberta to the whole of the United States. Canadian records did not distinguish between malt and feed barley, nor was it possible to get

Table 11: Alberta's annual out-of-province barley exports, both actual shipments and model estimates, from 1988 to 1984.

Year	Actual Exports[1] - '000 tonnes -	Estimated Exports[2] - '000 tonnes -	Estimated/ Actual - % -
1984	2,885	[illegible]	60
1985	1,738	2,0[illegible]	117
1986	3,192	4,070	128
1987	3,421	3,462	101
1988	2,733	2,761	101
Average	2,794	2,809	101

1 - Source: Alberta Agriculture, Statistics Branch. *Alberta's Agricultural Exports*. Various years.
2 - Total out-of-province export estimates are the same for all scenarios and are calculated as total Alberta production minus total Alberta requirements.

records for only the eleven states from the model. The shipments ranged form a low of 32,134 tonnes in 1985 to a high of 174,543 tonnes in 1988, which was a drought year for much of the United States.

Table 12: Alberta barley shipments to the United States from 1988 to 1984.

Year	Volume - tonnes -	Value - $ '000 -
1984	52,835	10,601
1985	32,134	7,372
1986	49,517	7,083
1987	114,770	12,276
1988	174,543	17,891
Average	84,760	11,045

Source: Alberta Agriculture, Statistics Branch. *Alberta's Agricultural Exports*. Various years.

Table 13 presents the total volume of shipments, and the five year average shipments, from Alberta to the eleven states as calculated under the six scenarios. The results presented in chapter four suggested that there existed the potential for shipments of feed barley from Alberta to the northwest United States. Even the baseline scenario, where barriers to exports existed in the form of discriminatory transportation pricing and tariff barriers, indicated that approximately two million tonnes of barley could have moved from Alberta to the United States over the five year period; an average of 385,034 tonnes per year.

Table 13: Estimated barley shipments to the United States from Alberta under the six scenarios of the model from 1988 and 1984.

Scenario:	Total Shipments - tonnes -	5 Year Average - tonnes/ year -
Baseline	1,925,172	385,034
No Trade	0	0
Full Cost	9,711,787	1,942,357
Tariff Free	6,583,555	1,316,711
Both	11,797,654	2,359,531
Rail Comp. Trucking	14,277,131	2,855,426

Differences between actual barley shipments to the United States and the values estimated by the model for the eleven north west states were the result of several assumptions within the model. The model allowed for only two sources of feedgrain: Alberta and the north west United States. This excluded feedgrains from the corn belt of the United States from entering the eleven state area. However, other than in 1988 when both U.S. regions were feedgrain deficit, the Alberta barley shipments were not a response to American feedgrain requirements. In four of the five years the eleven state area was a feedgrain surplus area.

Under several of the scenarios the model suggested that large volumes of grain would move to the United States from Alberta. This was at the expense of shipments through Vancouver to the rest of the world. The fact that such large differences existed between what did happen and what the model estimated would suggest that there were forces in effect not included in the model. The most likely explanations would be price barriers or institutional rigidities.

The most probable type of price barrier that would limit barley movement from Alberta to the United States would be a tariff barrier. However, tariffs were included in the model and were small. Another potential price barrier would be in the form of exorbitant transportation costs. It may be that trucking rates were much higher than those modelled. This however, was not borne out in conversations with Cliff Weber of the Agricultural Transportation Branch, Alberta Agriculture. He suggested consistent, long-haul trucking rates for barley would probably be lower than the trucking rates used in all but the rail competitive trucking scenario. One final price barrier may have been the American prices used for barley. It may have been that the prices used were much higher than what the majority of feed barley exporters would actually have faced.

There are several possible sources of institutional rigidities which were not included in the model. The Canadian Wheat Board required export permits to export grain to the United States during the time examined, and the requirement continues. There did not seem to be an absolute set of rules on how the C.W.B. determined to whom it would grant permits. Conversations with C.W.B. officials left the impression that the Board was very wary of losing the premium malt barley market it had developed. As well, it seemed the Board was determined not to allow exports that would result in trade retaliation by the United States Department of Agriculture (USDA)[4]. Other potential institutional rigidities may have existed in the transportation portion of the model. Trucking regulations exist on both sides of the border that restrict the free flow of commodities. As well, trucking routes may not have existed during the time examined. It takes time, and large consistent volumes, for trucking routes to become established.

B. A Comparison of Differences in Net Revenue Values

1. Original net revenue values

The intent of this study was to compare the potential impacts of several policy changes. One way this was done was to compare the net revenue, or monetary, results of the six scenarios of the model. This comparison is based on the outcome of the baseline model, considered the most consistent with the situation during the five years examined, 1984 to 1988. Tables 14 and 15 illustrate the dollar value and percent differences between the baseline scenario and the other five scenarios from the net revenue maximization model.

Initial examination showed that the rail competitive trucking model averaged an increase in net revenue of $26,139,000 per year over the baseline scenario. All the other scenarios indicated average declines in net revenue compared to the baseline simulation. In the instance of the full cost and 'both' scenarios this made intuitive sense as transportation costs within the system are dramatically increased. As well, in the case of the no trade scenario the lack of higher priced

4 The conversation was with several commissioners of the Canadian Wheat Board in March of 1991. The conversation was not identified as an interview so individuals were not identified, and quotes were not used.

United States markets for Alberta barley suggested a decline in net revenue. In the case of the tariff free scenario the results were difficult to explain intuitively. This was in part due to the use of several feedgrain price series, which clouded and confused the results.

In Table 16 the average annual net revenue of Alberta barley producers estimated under the six scenarios is listed. The scenarios were ordered for two things. In the third column the scenarios were ordered, from largest to smallest, based on the average annual estimated net revenue for Alberta barley producers. In the last column the scenarios are ordered, from largest to smallest, based on the estimated average annual volume of barley shipments from Alberta to the eleven state area. The correlation between the two measurements was negative, but minimal. It is notable that the baseline, tariff free and no trade scenarios which were the top three in net revenue terms were the bottom three in terms of exports to the United States. At the same time the rail competitive trucking, full cost and both full cost and tariff free scenarios which were ranked at the bottom three in terms of net revenue were the top three in terms of exports to the United States.

Table 14: Differences in original net revenue values between the baseline scenario and the five other scenarios for Alberta, the U.S. and the total system for 1988 to 1984, in thousands of nominal Canadian dollars.

Scenario:	Region:	Year: 1988	1987	1986	1985	1984	5 Year Average
NO TRADE	Alberta	-1,513	-55,280	0	0	-15,352	-14,429
	U.S.	+2,989	+49,216	0	0	-7,525	+8,936
	Total	+1,476	-6,064	0	0	-22,877	-5,495
FULL COST	Alberta	-60,773	-61,295	-156,803	-95,135	-51,362	-85,083
	U.S.	-19,853	-17,740	0	+16,551	0	-4,209
	Total	-80,626	-79,035	-156,850	-78,584	-51,362	-89,291
TARIFF FREE BORDER	Alberta	+17,010	-48,514	0	0	+5,938	-5,113
	U.S.	-12,714	-94,763	0	0	0	-21,496
	Total	+4,296	-143,277	0	0	+5,938	-26,609
BOTH	Alberta	-53,954	-120,062	-178,167	-89,863	-45,424	-97,494
	U.S.	-19,853	-98,695	+24,780	+16,551		-15,444
	Total	-73,807	-218,757	-153,387	-73,312	-45,424	-112,937
RAIL COMP. TRUCKING	Alberta	-2,124	-22,588	-66,003	-25,362	+9,119	-21,391
	U.S.	+59,653	-46,448	+59,506	+85,071	+80,243	+47,605
	Total	+57,529	-69,036	-6,497	+59,709	+89,362	+26,213

Table 15: Percent differences in original net revenue values between the baseline scenario and the five other scenarios for Alberta, the U.S., and the total system for 1988 to 1984.

Scenario:	Region:	Year: 1988	1987	1986	1985	1984	5 Year Average
NO TRADE	Alberta	-0.3	-11.3	0	0	-3.4	-2.8
	U.S.	+0.2	+2.0	0	0	-0.2	+0.3
	Total	+0.1	-0.2	0	0	-0.6	-0.2
FULL COST	Alberta	-13.2	-12.5	-23.8	-19.3	-11.2	-16.6
	U.S.	-1.0	-0.7	0	+0.5	0	-0.2
	Total	-3.4	-2.6	-4.8	-2.2	-1.3	-2.8
TARIFF FREE BORDER	Alberta	+3.7	-9.9	0	0	+1.3	-1.0
	U.S.	-0.7	-3.8	0	0	0	-0.8
	Total	+0.2	-4.8	0	0	+0.1	-0.8
BOTH	Alberta	-11.8	-24.5	-27.0	-18.2	-9.9	-19.1
	U.S.	-1.0	-3.9	+0.9	+0.5	0	-0.6
	Total	-3.1	-7.3	-4.7	-2.1	-1.1	-3.5
RAIL COMP. TRUCKING	Alberta	-0.5	-4.6	-10.0	-5.2	+2.0	-4.2
	U.S.	+3.1	-1.8	+2.3	+2.8	+2.3	+1.8
	Total	+2.4	-2.3	-0.2	+1.7	+2.2	+0.8

Table 16: Average annual net revenue for Alberta barley producers estimated from various policy scenarios, in thousands of nominal Canadian dollars.

Scenario:	Average Estimated Net Revenue - $ '000 -	Net Revenue - order -	Shipments to U.S. - order[1] -
Baseline	511,433	1	5
No Trade	497,014	3	6
Full Cost	426,360	5	3
Tariff Free	506,329	2	4
Both	413,827	6	2
Rail Comp. Trucking	490,052	4	1

1 - Ordering was according to average annual volume of estimated shipments to the U.S. as illustrated in Table 13, in decending order.

2. Net revenue values using a consistent price series

To overcome the confusion associated with the use of several price series the original trade flows for the six scenarios were valued using a single price series that incorporated full cost rail rates. This meant the baseline scenario trade flows and the trade flows form full cost scenario were valued using an identical price series. The difference in the net revenue value could then be attributed solely to differences in trade flow patterns. The differences in net revenue between the baseline trade flows valued using full cost rail rates and the other five models trade flows values using full cost rail rates are illustrated in Table 17.

The difference in average net revenue between the baseline scenario and the full cost scenario, when both were valued using full cost rail rates, was an annual increase of $16,386,000. This difference was attributable to differences in the trade flows estimated for the two scenarios. That is, when only one price series was, that with full cost rail rates, the trade patterns illustrated in Table 4 resulted in a higher net revenue for Alberta barley producers compared to the pattern illustrated in Table 2.

The results of the no trade scenario illustrated a decrease in net revenue when compared to the baseline scenario, which allowed for cross border movements. The average decrease of $21,429,000 per year was, again, due solely to differences in trade patterns.

In the instances of the remaining three models, the tariff free model, the model with full cost rail rates and a tariff free border, and the rail competitive trucking rates model, the results are less clear. The removal of tariff cost, a change in trucking rates and changes in trade patterns all interact to make it difficult to isolate differences due to individual changes.

In Table 19 the average annual net revenue of Alberta barley producers estimated with a single full cost rail rate price series for the six scenarios is listed. The scenarios were ordered for two things. In the third column the scenarios were ordered, from largest to smallest, based on the average annual estimated net revenue for Alberta barley producers. In the last column the scenarios are ordered, from largest to smallest, based on the estimated average annual volume of barley shipments from Alberta to the eleven state area. There was a strong positive correlation in the ordering. It is notable that in all cases except the full cost and 'both' scenarios the ordering were identical. For the two scenarios mentioned the order between net revenue and shipments to the United States were reversed.

Table 17: Differences in net revenue values between the baseline scenario and the five other scenarios when all the original trade flows are valued using full cost rail rates, for Alberta, the U.S. and the total system for 1988 to 1984, in thousands of nominal Canadian dollars.

Scenario:	Region:	Year: 1988	1987	1986	1985	1984	5 Year Average
NO TRADE	Alberta	-6,065	-99,818	0	0	-46,213	-30,420
	U.S.	+2,989	+49,216	0	0	-7,525	+8,936
	Total	-3,076	-50,602	0	0	-53,738	-21,483
FULL COST	Alberta	+64,281	+46,172	0	-7,479	0	+20,594
	U.S.	-19,853	-17,740	0	+16,551	0	-4,209
	Total	+44,428	+28,432	0	+9,072	0	+16,387
TARIFF FREE BORDER	Alberta	+54,528	-23,083	0	0	+5,938	+7,476
	U.S.	-12,714	-94,763	0	0	0	-21,496
	Total	+41,814	-117,846	0	0	+5,938	-14,019
BOTH	Alberta	+71,100	-12,595	-21,367	-2,207	+5,938	+8,183
	U.S.	-19,853	-98,695	+24,780	+16,551	0	-15,444
	Total	+51,247	-111,290	+3,463	+14,344	+5,938	-7,259
RAIL COMP. TRUCKING	Alberta	+122,930	+84,879	+90,847	+62,294	+60,481	+84,286
	U.S.	+59,653	-46,448	+59,506	+85,071	+80,243	+47,605
	Total	+182,583	+38,431	+150,353	+147,365	+140,724	+131,891

Table 18: Percent differences in net revenue values between the baseline scenario and the five other scenarios when all the original trade flows are valued using full cost rail rates for Alberta, the U.S., and the total system for 1988 to 1984.

Scenario:	Region:	Year: 1988	1987	1986	1985	1984	5 Year Average
NO TRADE	Alberta	-1.8	-26.1	0	0	-11.4	-7.5
	U.S.	+0.2	+2.0	0	0	-0.2	+0.3
	Total	-0.1	-1.7	0	0	-1.4	-0.7
FULL COST	Alberta	+19.3	+12.1	0	-1.8	0	+5.1
	U.S.	-1.0	-0.7	0	+0.5	0	-0.2
	Total	+2.0	+1.0	0	+0.3	0	+0.5
TARIFF FREE BORDER	Alberta	+16.3	-6.0	0	0	-1.5	+1.8
	U.S.	-0.7	-3.8	0	0	0	-0.8
	Total	+1.9	-4.1	0	0	+0.2	-0.4
BOTH	Alberta	+21.3	-3.3	-4.2	-0.5	+1.5	+2.0
	U.S.	-1.0	-3.9	+0.9	+0.5	0	-0.6
	Total	+2.3	-3.8	+0.1	+0.4	+0.2	-0.2
RAIL COMP. TRUCKING	Alberta	+36.8	+22.1	+18.1	+15.4	+14.9	+20.8
	U.S.	+3.1	-1.8	+2.3	+2.8	+2.3	+1.8
	Total	+8.1	+1.3	+4.8	+4.3	+3.6	+4.2

Table 19: Average annual estimated net revenue values for Alberta barley producers using original trade flows valued using full cost rail rates, in thousands of nominal Canadian dollars.

Scenario:	Average Full Cost Net Revenue[1] - $ '000 -	Net Revenue - order -	Shipments to U.S. - order[2] -
Baseline	405,766	5	5
No Trade	375,401	6	6
Full Cost	426,360	2	3
Tariff Free	413,242	4	4
Both	413,947	3	2
Rail Comp. Trucking	490,052	1	1

1 - Values taken from Appendix E.
2 - Ordering was according to average annual estimated shipments to the U.S. as illustrated in table 13, in decending order.

C. Analysis

Whenever one models potential commodity movements using programming, linear or otherwise, the results must be taken with a bit of skepticism. At best the results can be considered broad generalizations, at worst mere guesses. With a small leap in faith, as the author of this study, I suggest that the results be taken as generalizations as to the potential for feedgrain trade between Alberta and the United States, under various policy scenarios. As generalizations or broad estimates there are several factors that could result in changes to the model outcomes. Bailey (1972) lists several such factors for his transportation minimization model. There are also factor inherent in the design of the model which, if changed, could alter the outcomes.

In 1972 Bailey used a transportation minimization model to estimate interprovincial feedgrain movements on the prairies. His suggestions of factors that could effect the outcome of the model are also applicable to this study. In the case of simple transportation models estimates are considered the minimum values required to satisfy regional requirements. Bailey suggests factors such as pricing policies, carryover and contingency, logistics, and data aggregation could result in the minimum values obtained in his prairie province feedgrain model increasing (1972:77). Some of these could also explain increases and decreases in the results from the models of this study.

Bailey suggested that producers could develop markets for grain by price discounting through partially incurring transportation costs. In the models of this study it is assumed producers incur all transportation costs, as set out in the individual model. As this is the case for producers of most raw materials, such as feedgrains, it seems a reasonable assumption. This would give producers less leeway for price discounting. However, given the large differences in prices between Alberta and the United States there might still be room for negotiation. It must be remembered that as this is a net revenue maximization model price discounting would not likely result in changes in trade flows.

In his model Bailey allowed for carryover for seed use, but suggested larger volumes may be held for contingency purposes reducing grain available for use. In this study there was no allocation for carryovers for any purpose. Considering that the main use for barley is livestock feed and the inelastic nature of livestock feed requirements in the very short term it does seem reasonable to allow for some carryover. This could easily be incorporated into the model by changing local or regional requirements to allow for carryover. If the carryovers were incorporated into the model several changes could take place. The U.S. south region would have become even more a feedgrain deficit region than initially modelled, thus requiring larger imports. It is also possible that the Alberta south region would have been in a deficit position more often. While these occurrences would likely not have greatly effected the flow patterns, smaller overall movements would have resulted in smaller differences in net revenues.

Bailey suggested that, due to the disperse nature of stocks for feedgrain and the lack of information in the non-Board feed market, cross regional movement may occur to satisfy large volume consumers who wish to avoid the logistical problems of assembling small lots. In this study the same situation would most likely have occurred between the three Alberta regions. Within the United States regions the large size of the regions would rarely result in this situation.

Bailey's final point is that by specifying a single central regional point local movement near the borders of the regions is discounted. This is a strong point for this study due to the large area covered by each of the five regions. The justification for opening the United States - Canada border to trade in feedgrains has been small, localized demand. This study is ill suited to represent such cases. The regional boundaries in this study were arbitrarily defined, as a result there is no reason why areas on the edges of regions would not perceive prices more conducive to trade than the prices at the regional center points. However, to overcome this omission would require a continuous series of prices at all points within and between regions, or many smaller regions. Considering the difficulty in obtaining price series even for the few points used in this study it would be a daunting task to expand the pricing points.

In this study some of the regions act as both importers and exporters during the same time period. In a simple transportation minimization model this should not occur, however in a net revenue maximization model it is feasible. If there is a significant premium for the imported commodity or if transportation or production costs are subsidized on exports it is possible for a region to both import and export a commodity. For this non-standard situation to arise the following condition must hold:

$$(p_{ij} - p_{ii}) + (p_{ji} - p_{jj}) \geq (c_{ji} - c_{jj}) + (c_{ij} - c_{ii}) + (t_{ji} - t_{jj}) + (t_{ij} - t_{ii})$$

However, even if the condition does not hold the non-standard situation may occur if a transportation subsidy exits.

In this study there are multiple examples of regions acting as both importers and exporters in the same time period. It is not reasonable to suggest that this is the result of a production subsidy as production costs are not incorporated. Border costs, used instead of production costs, could be considered a subsidy on domestic production rather than export production. As well, it does not seem probable that this non-standard situation is the result of an import premium as local prices for domestic production were used. However, it is possible that a transportation subsidy was built into the models, even when there was an attempt to remove the visible WGTA subsidy.

A quick calculation of the non-standard situation condition suggests that it does not hold for the models on years where a non-standard situation occurs. As there is not suppose to be a transportation subsidy built into the trucking rates this is not unexpected. The answer for this non-standard situation may then lie in the unintended presence of a transportation subsidy in the trucking rates to all points. To find out the validity of this explanation would require a better trucking rate series.

Another possible explanation for the non-standard situation may lie in the complete separation of pricing systems between Canada and the United States. A comparison of the prices in Appendix A suggests that while general upward and downward pressures are similarly transmitted to both export ports (Vancouver and Portland) the prices differ by much more than transportation costs would dictate. These differences in prices appear to lead to a non-standard situation. The explanation may be couched in terms of an import premium for Alberta barley entering the United States.

D. Weaknesses

There are several weaknesses inherent in this study. The models of this study do not incorporate supply and demand functions and hence can not represent changes in the structure of the Alberta barley market under the various scenarios. Without feedback loops into supply and demand through prices one is unable to model changes in production to reflect the changes in policy.

As well, this study assumes non-discrimination within the feedgrain industry. The dominance of corn within the United States livestock feeding industry is not likely to crumble overnight. It seems probable that the availability of large volumes of feed barley would depress the local prices used in this study. To accommodate this change would require price responsiveness in the form of supply and demand functions.

One can also question the validity of using regions of such vastly different sizes within the models. Whether or not these regions represent the 'grain sheds' for the pricing points used is questionable. However, limited price data makes further divisions difficult.

Perhaps the biggest weakness of this study is the trucking rate structure used. A lack of available information resulted in the use of prices that are questionable. The lack of a transportation supply and demand loop also means that changes in structure are not transmitted to the trucking industry. The rates used in five of the models are published tariff rates, set at a time when small, intermittent volumes are shipped. If large, steady volumes of a good are moved rates should be adjusted to account for decreases in average per unit costs.

VI SUMMARY AND RECOMMENDATIONS

A. Summary

Recent GATT negotiations have once again raised the issue of what to do with the subsidy that western Canadian grain producers receive in the form of the Crow Benefit. It has become increasingly clear to all involved that the rest of the world considers the Crow an export subsidy and as such it is subject to the wrath of trade negotiations and sanctions. While a multitude of suggestions have been raised as how to keep the subsidy in place without the trade implications, there is also talk of an outright removal of the Crow Benefit. This could have profound impacts on Alberta grain farming, especially in the low cost feedgrain sector.

The call for reduced agricultural subsidies has been accompanied by talk of increased trade. It was in this atmosphere that the Canada - United States Free Trade Agreement was negotiated. Many hoped that the Free Trade Agreement would be an example for the Uruguay Round of the GATT negotiations, especially for the agricultural sector. At this time it does not seem to have worked. The outcome of this latest round of GATT negotiations in the area of agriculture remains unclear. But within Canada there is talk of domestic changes that would allow for a reduction of sector specific subsidies and an increase in trade.

As these international events are taking shape Alberta barley producers are facing changes in incomes. Market shifts have seen the large eastern feedgrain markets of the 50's and 60's all but dry-up. When the Canadian Wheat Board entered the international feedgrain market trade was expanding rapidly; today the market is volatile and heavily distorted by export subsidies. As market volumes fluctuate the price for barley has shown a downward trend. This coupled with suggestions of increased producer payments for rail transportation indicates Alberta producers should be seeking out new markets.

This study looked at the potential for trade with eleven northwest states of the United States. The primary hypothesis was that there existed the potential for a southern movement of Alberta feed barley into the United States. In order to test this hypothesis a retrospective revised net revenue, partial spatial equilibrium, linear programming model was developed.

The model maximized revised net revenue in each of the five years 1984 to 1988 over the five regions examined [5]. Net revenue was defined as market price minus transportation costs and priced border costs. Each region had pre-determined feedgrain production and requirement volumes measured in barley equivalents. By maximizing overall net revenue trade flows were generated. In order to meet the requirements of a closed system for partial equilibrium two export ports, Vancouver, British Columbia and Portland, Oregon, were designated to accept grain but were not allowed to ship to the five regions.

The baseline model incorporated the producers cost of rail transportation under the WGTA, the border costs that existed in the years examined, and estimated trucking rates. The five other simulations looked at trade flows when i) no trade between countries was allowed; ii) producers had to pay the full cost of rail transportation; iii) border costs were removed; iv) producers had to pay the full cost of rail movement and the border was free of priced barriers; and v) producers had to pay the full cost of rail transportation, the border was tariff free, and trucking rates were the same as full cost rail rates on a per tonne per mile basis.

The results suggest that the five regions would have been best off with the final scenario. This however, was at the expense of the export port of Vancouver which would not be used for Alberta barley. In the other simulations the results were highly dependant on the year modelled. In most instances changes in trade flows from Alberta were at the expense of flows to Vancouver. There did exist the potential for movement of Alberta barley into the United States, even under the baseline model. This indicates that barley exports are restricted under present regulation.

The trade flows developed using the net revenue maximization program were also examined after being valuated at full cost rail rate prices. These results were more consistent. The indication was that once distortions due to different price series were removed, all trade flow patterns, except those from the no trade model, resulted in increases in net revenue for Alberta barley producers. On average increased barley shipments to the United States increased Alberta's net revenue from barley.

5 The five regions and their respective central points are: Alberta north (Grande Prairie), Alberta central (Red Deer). Alberta south (Calgary), U.S. north (Great Falls, Montana), and U.S. south (Stockton, California).

There are several areas of this model that are questionable. The area that contains the most uncertainty is the price information. For the United States points the cash bids used as prices are likely at the high end of the price spectrum. This would bias the results toward a southern movement of barley.

At the same time the Canadian prices are at the low end of the feed barley price spectrum, biasing results against shipments to Canadian points. By using the CWB initial price minus transportation costs one is, by definition, using the floor price in open quota years. How to remedy this problem and use a price that better reflects the price producers receive raises its own problems. While there do exist local non-board prices, the share of barley production that finds its way into the market at these prices is not known. A composite regional price may better reflect prices received by producers, but would also incorporate the increase in Alberta price due to the Crow Benefit Offset program.

The use of the CWB initial price as the Vancouver export price is also troublesome. While this is the price producers actually see it seems probable that most are partly basing marketing decisions on expected interim and final payments.

There is also problems with the trucking rates used. At best these could be labelled as educated guesses. The use of published Canadian tariff rates to the United States is questionable, especially as the best scenario is assumed: that is, backhauls available, full and regular trips. etc.. The use of an average annual deflator was also questioned. However, the values generated were surprisingly close to those calculated using the average full cost rail rate.

Perhaps the largest question concerning this model is the validity of using a revised net revenue linear programming model to begin with. To assume that production costs are not relevant in marketing choices seems reasonable. To suggest that feedgrain producers in Alberta and the eleven states would maximize net revenue to the exclusion of other markets does not seem reasonable. However, the only way to overcome this problem would be to expand the model to include the rest of Canada and the United States, which was not possible in this study.

B. Recommendations for Further Study

One area of model expansion that would add to the results would be the inclusion of supply and demand equations for feedgrains. This would allow the model to change feedgrain production in response to prices. As well by including final demand for the products of feedgrains, livestock products, changes could also be made in livestock numbers. This was not done due to data limitations especially that of prices for the final product of feedgrains, livestock products. The large variety of livestock products would require a composite price based on feedgrain use shares.

A further expansion, as previously mentioned, would be to expand the model to include more regions. This would be especially useful for the United States where a vast source of corn is available in the mid-east, outside of the model as presently specified.

A final area that warrants further study is that of trucking rates. There appears to be no accurate price series for cross-border hauling. Perhaps a survey in this area would help alleviate this problem.

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APPENDIX A

Table 1a: Canadian Wheat Board initial prices for 1 C.W. Barley, basis in store Vancouver, using the August to July crop year, in nominal Canadian dollars per tonne.

Crop Year	Initial Price - $/ tonne -
1983/84	95.00
1984/85	110.00
1985/86	110.00
1986/87	80.00
1987/88	60.00
1988/89	120.00

Source: Canada Grains Council. *Statistical Handbook*. 1989.

Table 1b: Canadian Wheat Board initial prices for 1 C.W. Barley, basis in store Vancouver, calculated using a January to December year, in nominal Canadian dollars per tonne.

Year	Initial Price - $/ tonne -
1984	101.25
1985	110.00
1986	97.50
1987	71.67
1988	85.00

Table 2: Average cash bids for #2 Barley in Portland, Oregon; Great Falls, Montana; and Stockton, California, in nominal Canadian dollars per tonne.

Year	Portland, Oregon	Great Falls, Montana	Stockton, California
1984	167.80	139.14	195.15
1985	144.97	109.22	163.69
1986	123.43	85.94	152.73
1987	125.43	104.96	140.86
1988	136.21	116.96	158.94

Sources: Market Analysis Branch, Alberta Agriculture.
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APPENDIX B

Table 1: Distances and transportation costs used for the model in 1988.

DISTANCE IN KILOMETERS

	Grande Prairie, AB	Red Deer, AB	Calgary, AB	Great Falls, MT	Stockton, CA	Portland, OR	Vancouver, B.C.
Grande Prairie, AB	0	587	719	1,239	3,119	1,994	1,768 1,268[1]
Red Deer, AB	18.78[2]	0	145	665	2,545	1,420	1,194 1,389[1]
Calgary, AB	22.90[2]	5.89[2]	0	520	2,400	1,275	1,049 1,228[1]
Great Falls, MT	52.91[3]	28.40[3]	33.00[5]	0	1,880	1,246	1,415
Stockton, CA	133.18[3]	108.67[3]	90.00[6]	57.00 (90-33)	0	1,102	1,576
Portland, OR	85.14[3]	60.63[3]	60.00[5]	27.00 (60-33)	30.00 (90-60)	0	506
Vancouver, B.C.	5.81[4]	6.13[4]	5.71[4]	60.42[3]	67.30[3]	21.61[3]	0

COSTS IN DOLLAR PER TONNE

1 - Distance by rail.
2 - Calculated using the standard TRIMAC trucking model (commercial, domestic).
3 - Calculated using $0.0427 per kilometer, the average value of the figures obtained from Nabi Chaudhary, Alberta Agriculture, July 1989.
4 - The producers share of rail rates under WGTA.
5 - Actual values obtained from Nabi Chaudhary, July 1989.
6 - The value from Chaudhary for movement from Calgary to Santa Monica, CA was $90.00 per tonne for 1,500 miles. The distance from Calgary to Stockton, CA was calculated at 1,491 miles so the same value was used.

Table 2: Average January to December annual values for producers share of rail rates under WGTA for Grande Prairie, Red Deer, and Calgary, Alberta to Vancouver, B.C., in nominal Canadian dollars per tonne.

Year	Grande Prairie	Red Deer	Calgary
1984	5.53	5.84	5.44
1985	6.40	6.76	6.30
1986	5.49	5.79	5.40
1987	5.62	5.92	5.52
1988	6.17	6.51	6.06

Source: Alberta Agriculture, Production Economics Branch and Alberta Economic Development and Trade, Transportation Services. *Statutory Grain Freight Rates from Alberta to Vancouver/ Prince Rupert and Thunder Bay*. Various years.

Table 3: Average January to December annual values for full cost rail transport under WGTA for Grande Prairie, Red Deer, and Calgary, Alberta to Vancouver, B.C., in nominal Canadian dollars per tonne.

Year	Grande Prairie	Red Deer	Calgary
1984	22.82	24.05	22.41
1985	24.27	25.58	23.83
1986	26.83	28.28	26.35
1987	28.21	29.72	27.70
1988	27.88	29.38	27.37

Source: Alberta Agriculture, Production Economics Branch and Alberta Economic Development and Trade, Transportation Services. *Statutory Grain Freight Rates from Alberta to Vancouver/ Prince Rupert and Thunder Bay*. Various years.

Table 4: The rail competitive trucking rates used in the rail competitive trucking scenario, in nominal Canadian dollars per tonne per kilometer.

Year	Trucking Cost - $/ tonne/ km -
1984	0.0178
1985	0.0190
1986	0.0210
1987	0.0220
1988	0.0218

Note: Vancouver can only accept grain by rail while other points can accept large volumes by truck.

Table 2: Average January to December annual values for producers share of rail rates under WGTA for Grande Prairie, Red Deer, and Calgary, Alberta to Vancouver, B.C., in nominal Canadian dollars per tonne.

Year	Grande Prairie	Red Deer	Calgary
1984	5.53	5.84	5.44
1985	6.40	6.76	6.30
1986	5.49	5.79	5.40
1987	5.62	5.92	5.52
1988	6.17	6.51	6.06

Source: Alberta Agriculture, Production Economics Branch and Alberta Economic Development and Trade, Transportation Services. *Statutory Grain Freight Rates from Alberta to Vancouver/ Prince Rupert and Thunder Bay*. Various years.

Table 3: Average January to December annual values for full cost rail transport under WGTA for Grande Prairie, Red Deer, and Calgary, Alberta to Vancouver, B.C., in nominal Canadian dollars per tonne.

Year	Grande Prairie	Red Deer	Calgary
1984	22.82	24.05	22.41
1985	24.27	25.58	23.83
1986	26.83	28.28	26.35
1987	28.21	29.72	27.70
1988	27.88	29.38	27.37

Source: Alberta Agriculture, Production Economics Branch and Alberta Economic Development and Trade, Transportation Services. *Statutory Grain Freight Rates from Alberta to Vancouver/ Prince Rupert and Thunder Bay*. Various years.

Table 4: The rail competitive trucking rates used in the rail competitive trucking scenario, in nominal Canadian dollars per tonne per kilometer.

Year	Trucking Cost - $/ tonne/ km -
1984	0.0178
1985	0.0190
1986	0.0210
1987	0.0220
1988	0.0218

Note: Vancouver can only accept grain by rail while other points can accept large volumes by truck.

Table 5: Price indexes used to determine deflator for trucking costs, 1981 = 100.

Year	CPI all items	CPI transportation	Difference
1983	117.2	119.8	2.6
1984	122.3	124.8	2.5
1985	127.2	130.8	3.6
1986	132.4	135.0	2.6
1987	138.2	139.9	1.7
Average			2.6

Source: Statistics Canada. *Canadian Economic Observer, Historical Statistical Supplement, 1987.* Catalogue 11-210, Volume 2. July 1988.

APPENDIX C

Table 1: Border costs for barley entering Canada from the United States.

Year	Tariff - $/ tonne -
1984	3.31
1985	3.31
1986	3.31
1987	2.27
1988	2.27

Sources: Agriculture Canada. *Canada - U.S. Free Trade Agreement and Agriculture: An Assessment*. 1987.
Menzie, E.L. and B.E. Prentice. "Formal and Informal Barriers to Trade in Agricultural Products, Canada - United States." *Canadian Journal of Agricultural Economics*. 1987.
OECD. *National Policies and Agricultural Trade Country Study Canada*. 1987.

Table 2: Border costs for barley entering the United States from Canada.

Year	Tariff - $/ tonne -	User Fee - *% ad valorem* -
1984	3.44	0
1985	3.44	0
1986	3.44	22
1987	2.27	17
1988	2.27	17

Sources: Agriculture Canada. *Canada - U.S. Free Trade Agreement and Agriculture: An Assessment*. 1987.
Menzie, E.L. and B.E. Prentice. "Formal and Informal Barriers to Trade in Agricultural Products, Canada - United States." *Canadian Journal of Agricultural Economics*. 1987.
OECD. *National Policies and Agricultural Trade Country Study Canada*. 1987.

APPENDIX D

Table 1: The differences between the five scenarios and the baseline scenario for 1988, in tonnes.

Destination	Model	Source: ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH
ALBERTA NORTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA CENTRAL	no trade					
	full cost	+562,033	-562,033			
	tariff free					
	both	+562,033	-562,033			
	trucking					
ALBERTA SOUTH	no trade					
	full cost					
	tariff free					
	both					
	trucking		+1,267,856	-1,627,000		
U.S. NORTH	no trade		-199,057		+199,057	
	full cost		+2,202,474	+359,144	-2,561,618	
	tariff free		+1,640,441		-1,640,441	
	both		+2,202,474	+359,144	-2,561,618	
	trucking					
U.S. SOUTH	no trade				-199,057	
	full cost			-359,144		
	tariff free					
	both					
	trucking					
PORTLAND, OREGON	no trade					
	full cost				+2,561,618	
	tariff free				+1,640,441	
	both				+2,561,618	
	trucking	+562,033	+372,585	+1,627,000		
VANCOUVER, B.C.	no trade		+199,057			
	full cost	-562,033	-1,640,441	-359,144		
	tariff free		-1,640,441			
	both	-562,033	-1,640,441	-359,144		
	trucking	-562,033	-1,640,144	-359,144		

APPENDIX D

Table 1: The differences between the five scenarios and the baseline scenario for 1988, in tonnes.

Destination	Model	Source: ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH
ALBERTA NORTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA CENTRAL	no trade					
	full cost	+562,033	-562,033			
	tariff free					
	both	+562,033	-562,033			
	trucking					
ALBERTA SOUTH	no trade					
	full cost					
	tariff free					
	both					
	trucking		+1,267,856	-1,627,000		
U.S. NORTH	no trade		-199,057		+199,057	
	full cost		+2,202,474	+359,144	-2,561,618	
	tariff free		+1,640,441		-1,640,441	
	both		+2,202,474	+359,144	-2,561,618	
	trucking					
U.S. SOUTH	no trade				-199,057	
	full cost			-359,144		
	tariff free					
	both					
	trucking					
PORTLAND, OREGON	no trade					
	full cost				+2,561,618	
	tariff free				+1,640,441	
	both				+2,561,618	
	trucking	+562,033	+372,585	+1,627,000		
VANCOUVER, B.C.	no trade		+199,057			
	full cost	-562,033	-1,640,441	-359,144		
	tariff free		-1,640,441			
	both	-562,033	-1,640,441	-359,144		
	trucking	-562,033	-1,640,144	-359,144		

Table 2: The differences between the five scenarios and the baseline scenario for 1987, in tonnes.

Destination	Model	Source: ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH
ALBERTA NORTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA CENTRAL	no trade					
	full cost	+674,502	-674,502			
	tariff free					
	both	+674,502	-674,502			
	trucking					
ALBERTA SOUTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
U.S. NORTH	no trade		-1,871,343		+1,871,343	
	full cost		+674,502		-674,502	
	tariff free					
	both		+674,502		-674,502	
	trucking		-1,871,343		+1,871,343	
U.S. SOUTH	no trade					
	full cost					
	tariff free			+1,146,599	-1,146,599	
	both			+1,146,599	-1,146,599	
	trucking					
PORTLAND, OREGON	no trade				-1,871,343	
	full cost			+1,146,599	+674,502	
	tariff free				+1,146,599	
	both				+1,821,101	
	trucking	+674,502	+1,871,343	+1,146,599	-1,871,343	
VANCOUVER, B.C.	no trade		+1,871,343			
	full cost	-672,502		-1,146,599		
	tariff free			-1,146,599		
	both	-672,502		-1,146,599		
	trucking	-672,502		-1,146,599		

Table 3: The differences between the five scenarios and the baseline scenario for 1986, in tonnes.

Destination	Model	Source: ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH
ALBERTA NORTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA CENTRAL	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA SOUTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
U.S. NORTH	no trade					
	full cost					
	tariff free					
	both		+2,085,867		-2,085,867	
	trucking					
U.S. SOUTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
PORTLAND, OREGON	no trade					
	full cost					
	tariff free					
	both				+2,085,867	
	trucking	+727,546	+2,085,867	+1,256,824		
VANCOUVER, B.C.	no trade					
	full cost					
	tariff free					
	both		-2,085,867			
	trucking	-727,546	-2,085,867	-1,256,824		

Table 4: The differences between the five scenarios and the baseline scenario for 1985, in tonnes.

Destination	Model	Source: ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH
ALBERTA NORTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA CENTRAL	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA SOUTH	no trade					
	full cost					
	tariff free					
	both					
	trucking	+102,498	-102,498			
U.S. NORTH	no trade					
	full cost		+1,532,553		-1,532,553	
	tariff free					
	both		+1,532,553		-1,532,553	
	trucking					
U.S. SOUTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
PORTLAND, OREGON	no trade					
	full cost				+1,532,553	
	tariff free					
	both				+1,532,553	
	trucking	+392,609	+1,635,051			
VANCOUVER, B.C.	no trade					
	full cost		-1,532,553			
	tariff free					
	both		-1,532,553			
	trucking	-495,107	-1,532,553			

Table 5: The differences between the five scenarios and the baseline scenario for 1984, in tonnes.

Destination	Model	Source: ALBERTA NORTH	ALBERTA CENTRAL	ALBERTA SOUTH	U.S. NORTH	U.S. SOUTH
ALBERTA NORTH	no trade					
	full cost					
	tariff free					
	both					
	trucking					
ALBERTA CENTRAL	no trade	-236,168	+236,168			
	full cost					
	tariff free					
	both					
	trucking	-236,168	+236,138			
ALBERTA SOUTH	no trade	-384,699	+384,699			
	full cost					
	tariff free					
	both					
	trucking	-384,699	+1,259,699	-875,000		
U.S. NORTH	no trade		-1,726,115		+1,726,115	
	full cost					
	tariff free					
	both		-1,726,115		+1,726,115	
	trucking		-1,726,115		+1,726,115	
U.S. SOUTH	no trade					
	full cost					
	tariff free					
	both				+3,506,392	-3,506,392
	trucking					
PORTLAND, OREGON	no trade				-1,726,115	
	full cost					
	tariff free					
	both		+1,726,115		-5,232,507	+3,506,392
	trucking	+620,867	+230,248	+875,000	-1,726,115	
VANCOUVER, B.C.	no trade	+620,867	+1,105,248			
	full cost					
	tariff free					
	both					
	trucking					

APPENDIX E

Table 1: Regional net revenue results for all six scenarios when original trade flows are valued using full cost rail rates for 1988 to 1984, in thousands of nominal Canadian dollars.

Region	Year	BASELINE	NO TRADE	Model: FULL COST	TARIFF FREE	BOTH	RAIL COMP. TRUCKING
ALBERTA NORTH	1988	39,356	39,356	27,958	39,356	27,958	59,375
	1987	34,486	34,486	21,130	34,486	21,130	60,184
	1986	59,787	59,787	59,787	59,787	59,787	67,710
	1985	51,695	51,695	51,695	51,695	51,695	58,722
	1984	45,358	57,41[illegible]	45,358	45,358	45,358	90,863
ALBERTA CENTRAL	1988	200,568	194,503	267,678	255,096	273,610	220,860
	1987	244,558	144,740	280,535	210,892	234,735	242,499
	1986	271,342	271,342	271,342	271,342	250,025	322,217
	1985	261,324	261,324	253,845	261,324	259,117	316,591
	1984	290,851	232,585	290,851	296,789	296,789	247,849
ALBERTA SOUTH	1988	93,764	93,764	102,333	93,764	103,220	176,383
	1987	103,013	103,013	126,564	113,596	113,596	164,253
	1986	171,970	171,970	171,967	171,970	171,970	204,019
	1985	91,771	91,771	91,771	91,771	91,771	91,771
	1984	68,985	68,985	68,985	68,985	68,985	126,963
ALBERTA TOTAL	1988	333,688	327,623	397,969	388,216	404,788	456,618
	1987	382,057	282,239	428,229	358,974	369,462	466,936
	1986	503,099	503,099	503,099	503,099	481,782	593,946
	1985	404,790	404,790	397,311	404,790	402,583	467,084
	1984	405,194	358,981	405,194	411,132	411,132	465,675
	Avg	**405,766**	**375,346**	**426,360**	**413,242**	**413,949**	**490,052**
U.S. NORTH	1988	948,165	951,154	928,312	935,451	928,312	1,007,818
	1987	1,700,908	1,750,124	1,683,168	1,606,145	1,602,213	1,654,460
	1986	1,654,439	1,654,439	1,654,439	1,654,439	1,679,219	1,713,945
	1985	1,951,925	1,951,925	1,968,476	1,951,925	1,968,476	2,036,996
	1984	2,268,266	2,260,741	2,268,266	2,268,266	2,268,266	2,348,509
U.S. SOUTH	1988	973,558	973,558	973,558	973,558	973,558	973,558
	1987	813,578	813,578	813,578	813,578	813,578	813,578
	1986	948,884	948,884	948,884	948,884	948,884	948,884
	1985	1,080,046	1,080,046	1,080,046	1,080,046	1,080,046	1,080,046
	1984	1,252,804	1,252,804	1,252,804	1,252,804	1,252,804	1,252,804
U.S. TOTAL	1988	1,921,723	1,924,712	1,901,870	1,909,009	1,901,870	1,981,376
	1987	2,514,486	2,563,702	2,496,746	2,419,723	2,415,791	2,468,038
	1986	2,603,323	2,603,323	2,603,323	2,603,323	2,628,103	2,662,829
	1985	3,031,971	3,031,971	3,048,522	3,031,971	3,048,522	3,117,042
	1984	3,521,070	3,513,545	3,521,070	3,521,070	3,521,070	3,601,313
	Avg	**2,718,515**	**2,727,451**	**2,714,306**	**2,697,019**	**2,703,071**	**2,766,120**
TOTAL NET REVENUE	1988	2,255,411	2,252,335	2,299,839	2,297,225	2,306,658	2,437,994
	1987	2,896,543	2,845,941	2,924,975	2,778,697	2,785,253	2,934,974
	1986	3,106,422	3,106,422	3,106,422	3,106,422	3,109,885	3,256,775
	1985	3,436,761	3,436,761	3,445,833	3,436,761	3,451,105	3,584,126
	1984	3,926,264	3,872,526	3,926,264	3,932,202	3,932,202	4,066,988
	Avg	**3,124,280**	**3,102,797**	**3,140,667**	**3,110,261**	**3,117,021**	**3,256,172**