University of Alberta

Implications of the NAFTA for Alberta's Cattle and Beef Industries: A Spatial Modelling Approach

by

Christine M. Anderson ©

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

Fall, 1996

ISBN 0-612-18228-2

University of Alberta

Library Release Form

Name of Author: Christine M. Anderson

Title of Thesis: Implications of the NAFTA for Alberta's Cattle and Beef Industries: A Spatial Modelling Approach

Degree: Master of Science

Year this Degree Granted: 1996

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M.M. Veeman

B. Wilkinson

Date Oct 2 1996

Dedication

To my Grandfather

Joseph Francis (Frank) Swan

Who is, and will always be, an inspiration.

ABSTRACT

This study examines the short and intermediate term effects of the North American Free Trade Agreement (NAFTA) on Alberta's cattle and beef industry. A transportation cost minimization, partial equilibrium, linear programming model is developed to model boxed beef trade between Canada, the United States and Mexico. The model is run under seven different scenarios using 1991 as the base year.

The North American market is divided into nine regions, each being represented by a central point. For each of the regions, beef production and consumption is calculated. These values are then used to determine the quantity by which each region in the model is either surplus or deficit. The model calculates the least cost flows of beef from surplus to deficit regions using assumed transportation costs.

The various model scenarios examine the impact on trade flows, of growth in Mexican per capita incomes projected to the year 2010, and the resulting increases in Mexican beef consumption. The model also incorporates projected increases in North American beef production.

The results indicate that under the specified assumptions, in the short to intermediate term, the NAFTA can be expected to have a small but positive impact on Alberta beef producers. In none of the scenarios examined does Alberta export beef to Mexico, however, Alberta does have a locational advantage for exporting beef to the U.S. Pacific region. Increased demand in Mexico will likely be met by exports from the U.S. Central region, which includes the main beef producing states of Colorado, Kansas, and Nebraska. The results also suggest that the current pattern of beef shipments from western Canada to eastern Canada, particularly to the Montreal beef market, is under threat.

Acknowledgements

There are many people who deserve recognition for their help and support which made the completion of this degree possible. I would like to start by thanking the members of my committee. To my supervisor, Dr. M.L. Lerohl, thank-you for your direction and input which kept me on track throughout this somewhat drawn out process. It has truly been a pleasure working with you. To Dr. M.M. Veeman and Dr. B. Wilkinson, thank-you for agreeing to sit on my committee, especially given the short notice. Thank-you for taking the time to challenge me with your insightful comments and questions. Thank-you also to Professor J.R. Unterschultz for chairing my defence.

I also wish to express my thanks to the Alberta Agricultural Research Institute for providing the funding which made this research possible.

A special thank-you to the great support staff in the Rural Economy office and library. To Wendy, Liz and Dawn, thank-you for all your time, help and friendly conversation. Special thanks also to Jim Copeland for ensuring that my thesis made it to the printers on time.

To my family, Jim-Lou, Wendy, Paddy-Jo, Erik, Hannah, Madeline and Andy, thank-you for the support, the encouragement, the laughter, and most importantly, the love. Mom and Dad, I wish that I was eloquent enough to express my heartfelt gratitude for all that you have done for me that helped to make this degree a reality. Thanks for the pep talks, the sounding board, the hugs, the English lessons, and above all, your unfailing love and support which has given me the courage to pursue my dreams. And finally to Don, I couldn't have done it without you. Thanks for not letting me quit, for your incredible patience especially during the times "you just didn't understand", for making me laugh, for "french fry surprise", and for being my best friend. Here's to all the unwritten chapters we have to look forward to.

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I INTRODUCTION

A. Background

1. Agriculture in the NAFTA

On June 11, 1990, the governments of Mexico and the United States announced their intention to pursue bilateral trade negotiations. In early 1991, the Canadian government announced its intention to join in the negotiation of a North American Free Trade Agreement (NAFTA). Formal negotiations between the three countries commenced in Toronto in June, 1991. On August 12, 1992, after fourteen months of negotiations , the NAFTA was concluded and a North American Regional Trade Zone created. The signing of the NAFTA created a market with a population of over 360 million people and a total combined GDP of $7.5 trillion, making it the largest existing free trade area (Loizides & Rheaume, 1993). The NAFTA was implemented on January 1, 1994.

The provisions of the NAFTA call for the tariffication of virtually all non-tariff barriers to trade, and the reduction and eventual elimination of all tariffs among the U.S., Canada and Mexico. The NAFTA has created a continental market for grains, livestock and red meats.

Chapter 7 of the NAFTA outlines the rules for trade in agricultural commodities. It includes trilateral components involving all three countries, as well as two separate bilateral agreements covering U.S.-Mexico and Canada-Mexico trade. Trade between the U.S. and Canada in agricultural commodities remains governed by the Canada-U.S. Free Trade Agreement (FTA).

Of the general provisions included in the NAFTA, those that are of import to agriculture include provisions that clarify and streamline customs administration procedures; principles for governing the operation of national standards affecting trade; improvements to the dispute settlement mechanism of the Canada-U.S. FTA; and the addition of a permanent Commission and Secretariat to offer institutional support.

The bilateral agreement between Canada and Mexico will see all tariff and non-tariff barriers on agricultural trade eliminated, with the exception of those in the dairy, poultry, egg and sugar sectors. Mexico is now exempted from Canadian import restrictions on wheat, barley and their products, beef and veal, and margarine. Tariffs will cease to be a major barrier to trade in agricultural products within the NAFTA region by 1998. Tariffs on many fruit and vegetable products will be phased out over a five or ten year period, while tariffs on the less sensitive horticultural crops have already been eliminated. Mexico replaced import licences with tariffs or tariff rate quotas (TRQ's) on all commodities other than those in the supply managed sectors. These tariffs or TRQ's are to be eliminated over the ten year implementation period.

For the most part, Canada chose to maintain protection on the most politically sensitive agricultural commodities, but will allow the pace of the FTA to determine the opening of the market to Mexican goods. Mexico chose to follow the U.S. strategy of long-term tariff reduction periods for sensitive commodities, as well as the Canadian strategy of excluding its most sensitive commodities from tariff reductions.

Article 703.3 of the NAFTA grants countries the right to invoke "special" safeguards for selected commodities that they judge to be most import sensitive. Agricultural products under special safeguard provisions for Canada include cut flowers, tomatoes, onions, cucumbers, broccoli and strawberries. Under this provision, a country may apply the tariff rate in effect at the time the agreement went into effect or the most-favored-nation tariff rate, which ever is lower, if imports reach a predetermined "trigger" level.

With regards to domestic support, the parities agreed to "endeavour to work towards domestic support measures that would have minimal trade-distorting effects" (Josling & Barichello, 1993). In this way, the provisions for domestic support agreed to during the Uruguay Round of GATT negotiations, will take precedence in this area.

Three provisions outline the use of export subsidies in the NAFTA region. 1) a NAFTA exporting country must give three days notice of its intent to introduce a subsidy on agricultural exports to another NAFTA county, 2) when an exporting NAFTA country believes that another NAFTA country is importing non-NAFTA agricultural goods that benefit from export subsidies, it may request consultations on measures the importing country could take against such subsidised imports, and 3) if the importing country adopts mutually agreed measures to counter that subsidy, the NAFTA exporting county will not introduce its own export subsidy (Government of Canada, 1992).

Another area of importance to agricultural trade is the rules regarding sanitary and phytosanitary (SPS) measures. Under chapter 7 of the NAFTA, each country is allowed to establish the level of sanitary and phytosanitary protection that it considers appropriate. However, these measures must be based on scientific principles and risk assessment, be applied only to the extent necessary to provide a country's chosen level of protection, not result in unfair discrimination or disguised restrictions to trade, and reflect international standards in their design and implementation (Government of Canada, 1992). The NAFTA also sets the harmonization of SPS measures between members as an objective. The provisions of the NAFTA pertaining to sanitary and phytosanitary measures are an improvement of the provisions contained in the Canada-U.S. FTA.

2. The North American Market

The United States accounts for 70 percent of the total population and 87 percent of the regions output of goods and services, making it the dominant economy in North America. Mexico, the smallest and least developed of the three economies, accounts for only about 4 percent of total output but is home to a little less than 1/4 of its population. Canada accounts for 9 percent of North American output and about 7.5 percent of its population (Loizides and Rheaume, 1993).

There is a high level of interdependence between the three North American economies. Eighty percent of Canadian, and 88 percent of Mexican exports are destined for the U.S. , while only 22 percent of U.S. exports are destined for Canada and 7 percent for Mexico (Barichello, 1991). These statistic stress the asymmetrical relationship that exists between the NAFTA partners. The U.S uch more important trading partner for Canada and Mexico than either of those cou .ies is for the U.S..

Trade between Canada and Mexico is relatively important to both countries, but is dwarfed by their trade with the U.S.. Canadian exports to Mexico averaged U.S. $400 million a year between 1986 and 1991 and Canadian imports from Mexico averaged between U.S.$1 and $2.1 billion over the same time period (Loizides & Rheaume, 1993). In comparison, U.S exports and imports to Canada averaged U.S. $72.4 billion and U.S. $81.8 billion a year respectively, between 1986 and 1991. For the same time period, U.S. exports and imports to Mexico averaged U.S. $22.3 billion and U.S. $24.8 billion respectively (U.S. Department of Commerce, 1991).

Agricultural trade between Canada, the U.S. and Mexico was estimated at U.S. $8.8 billion in 1991. This represents approximately 48 percent of Canada's total agricultural trade. In 1989, Canadian agricultural exports to Mexico were valued at $130 million, while Mexican agricultural exports to Canada totalled $90 million (Hufbauer and Schott, 1992). Agricultural trade with Mexico accounts for less than 2 percent each of Canada's total agricultural exports and imports (Grennes, 1991). On the other hand, over 1/3 of Canadian agricultural exports are destined for the U.S.. Canada and Mexico are the second and fourth largest markets for U.S. farm exports.

In recent years, the Canadian beef and cattle industries have become the largest source of farm cash receipts at close to $5 billion a year. In addition, beef has become Canada's largest agricultural export at almost $2 billion a year (Ken Cameron, International Beef Symposium). Because such a large portion of Canada's beef trade occurs within the North American market, the importance of understanding the impact that the NAFTA will have on this sector is evident.

B. Hypothesis

The NAFTA will result in increased imports of beef into Mexico, which will reinforce, but not alter emerging North-South beef trade flows. The Southern United States will remain the primary source of Mexican beef imports. Western Canada is better positioned to meet beef demand in the U.S. Pacific and Northwest regions.

C. Study Objectives

In 1995, Alberta's beef and cattle sector accounted for 38 percent of total farm cash receipts. Given the relative importance of this sector, the objectives of this study are to assess:

1) the impacts of the NAFTA on trade flows of beef in the North American market;
2) the intermediate term effects of Mexican accession to the NAFTA on the beef market in North America;
3) the implications of increased Mexican incomes on beef demand and consumption in Mexico; and
4) the opportunities for Alberta producers to service this market given an increase in demand for beef in Mexico.

D. Plan of Study

A spatial model of the North American beef market was developed to examine the impact of the NAFTA on beef trade flows between Canada, the U.S. and Mexico. The baseline model reflects beef trade between Canada and the U.S. prior to the NAFTA. This baseline model is then altered to reflect a variety of assumptions related to beef trade patterns and beef trade flows in North America in the year 2010.

II BACKGROUND

A: Overview of Mexican Beef and Cattle Sector

1. Mexico's Agriculture Sector

Mexico has approximately 30 million arable hectares of which 23 million are currently cultivated. The remaining 7 million hectares is potential farmland, although much of it is considered marginal at best. In addition to the crop land, there are also some 74 million hectares of rangeland. However, the carrying capacity of this rangeland is extremely variable, because its ability to carry livestock is limited by rainfall. If there is poor rainfall or a drought, as in the past few years, the rangelands can only carry low livestock densities.

Of the 23 million cultivated hectares, approximately 6 million hectares are irrigated, with the remaining hectares being rain dependent. While there is potential for the increased use of irrigation, unreliable supplies of water from rainfall pose a limit to further development.

There are three main constraints to increases in Mexican agricultural production. The first is that 30 percent of the cultivable land is in terrain which inhibits mechanization and therefore must either be worked by hand or with animals. The second is that a significant portion of the cropland is farmed as small ejidos, which have neither the size nor the resources to exploit improved technologies. Finally, water for the irrigated acreage comes almost entirely from surface storage and is therefore dependent on the amount of rainfall available to fill the reservoirs.

In Mexico, the agriculture sector employs approximately 30 percent of the population. Mexican agriculture is characterized by small family farms which are highly labour intensive. This is in contrast to Canadian and U.S. agriculture which is characterized by large and efficient farms with low labour intensity. There are three main farm types in Mexico. Pequenos propietarios, which are privately owned farms, Communidades, which are village based organizations, and Ejidos, which are small collective farms sanctioned by the government. Fifty four percent of Mexican territory belongs to the ejidos and other semi-collective farms, and 2/3 of the arable ejido land is held in parcels of less than 5 hectares (Hufbauer & Schott, 1992).

The Pacific North, Pacific Central, Central and Gulf regions dominate Mexican agricultural production (Figure 2.1). The Mexican states of Jalisco and Veracruz produce 9.7 percent and 8.5 percent respectively, of the total value of agricultural output. The various land tenure systems lead to a wide distribution of production with subsistence production of crops and livestock occurring in all regions. The areas in which commercial scale private farms are concentrated tend to produce the largest share of production.

Twenty-five percent of Mexico's arable land is located in the central plateaus and approximately 45 percent of Mexico's rural population lives in this region. This area is fertile and tends to receive favourable weather conditions. The Northern area is predominantly arid and semi-arid, but some portions have been developed into productive agricultural regions with the aid of public investment and irrigation. Because of less irrigation development, the Central and Gulf districts of the north have more limited production choices. It is in these areas that much of the Mexican beef and dairy production is located. The climate in this region is suitable for the production of sorghum and dry beans for feed (Paguaga et al. 1991).

2. Mexico's Agricultural Policies

Since the 1980's, Mexico has been actively deregulating its economy and liberalizing trade by progressively reducing tariff and non-tariff barriers. Over the past decade, the Mexican economy has been swiftly transformed from a closed economy with strict government control, to one of the most open economies of the world. The signing of the NAFTA by Mexico was yet another step in the move towards increased liberalization. Former president Salinas implemented a reform package which included: widespread privatisation of government owned institutions, fiscal and monetary restraint, and the liberalization of investment, private industry and the energy sectors (Chambers, 1993).

Figure 2.1
Map of Mexico

Pacific North:
Baja California Norte
Baja California Sur
Sonora
Sinola

North:
Chihuahua
Coahuila
Nuevo Leon

North Central:
Durango
Zacatecas
San Luis Potosi
Aguascalientes

Pacific Central:
Nayarit
Jalisco
Colima
Michoacan

Central:
Guanajuato
Hidalgo
Puebla
Mexico
Distrito Federal
Tlaxcala
Morelos

Pacific South:
Guerrero
Oaxaca
Chiapas

Gulf:
Tamaulipas
Veracruz
Tabasco

Penninsula:
Campeche
Yucatan
Quintana Roo

The Agrarian Reform Act and Article 27 of the Constitution, under which the ejidos system was established, and which grants the government authority to expropriate and redistribute agricultural land, has resulted in a very inefficient agricultural sector. This is evidenced in the fact that although 1/3 of Mexico's population lives in rural areas, it produces only 1/10 tenth of the country's GDP (Hufbauer & Schott, 1992). However, recent government efforts to change this system will allow farmers the right to rent or sell ejido lands in a move to liberalize the land tenure system.

Prior to the mid 1980's, the Mexican government had promoted policies of self-sufficiency in staple food production, and preservation of farm income levels through income assistance to peasant farmers. In order to achieve these goals, the government was forced to rely heavily on price supports for basic food, oilseeds and feed grains, and on input subsidies to promote domestic production. To enforce the price support system, import licences were required for many grain and oilseed products. However, government reform led to the number of agricultural commodities requiring licensing to drop from 317 in 1985 to 57 in 1990 (Hufbauer & Schott, 1992). However, import licences were still required on 60% of agricultural imports in 1991, therefore, the signing of the NAFTA should result in significant market access gains for Canadian agricultural exports.

Another factor impeding trade with Mexico, and one that could not be resolved under the NAFTA, is the lack of an efficient transportation system within Mexico. The Mexican rail system suffers from congestion, there are few storage facilities, roads are in disrepair, and port facilities tend to be inadequate. The lack of an efficient transportation infrastructure results in serious delays and backlogs.

Since becoming a member of the General Agreement on Tariffs and Trade (GATT) in 1986, Mexico has undergone substantial tariff reductions. Consequently, at the time that the NAFTA was negotiated, tariffs between the trading partners ranged from only 4 to 11 percent. Prior to the signing of the NAFTA, non-tariff barriers posed the most significant impediment to trade in agricultural commodities, and in many cases still do. Import licensing was one such non-tariff barrier, but health and sanitary requirements on live animals and animal products was and are a concern. In many cases, strict phytosanitary requirements and lengthy processing procedures for various certificates successfully inhibited agricultural exports to Mexico.

After the financial crisis of the early 1980's, the government of Miguel de la Madrid implemented a policy of "economic realism". Under this policy, government spending and subsidization were considerably reduced. Government policy has since focussed on making agriculture competitive by promoting domestic and foreign private investment, developing new programs for financing agriculture and capitalizing the sector, promoting exports and diversifying economic alternatives. Between 1985 and 1991, Mexican agricultural exports increased by 49 percent (Roxanna Bravo).

3. The Mexican Beef and Cattle Sectors

Trade among the three members of NAFTA in the beef and livestock sectors is generally complementary. Mexico exports mainly feeder cattle to the U.S. and imports mainly livestock products. Canada, on the other hand, exports a larger percentage of slaughter cattle than feeder cattle to the U.S. Live animal imports from Mexico account for 35 percent of total U.S. live animal imports. Livestock product imports from Mexico represent only 1 percent of total U.S. livestock product imports (Rosson et al. 1993). U.S. live animal exports to Mexico account for almost 1/5 of the U.S. total, with cattle exports, valued at $53.8 million, being the most important category . The majority of these live cattle exports are fed cattle for slaughter. Because Canada exports primarily slaughter cattle and beef to the U.S., Canadian producers do not compete directly with Mexican producers in the U.S. market.

There are 125 million hectares of land suitable for raising cattle in Mexico. In 1991, beef production accounted for 42.6 percent of all livestock production, followed by pork (27.7%), poultry (27.7%), goat (1.3%), and sheep (0.9%).

The main beef producing states are Veracruz, Jalisco, Chihuahua, Chiapas, Tobasco and Sonora. Mexican beef producers are represented by 42 regional unions and 1,395 Livestock Associations.

In Mexico, 94 percent of meat produced is destined for domestic consumption

(45% direct consumption and 55% by the processing industry). Mexican meat consumption is a function of price, income levels, availability and cultural factors (Rossen et al, 1991). In 1991, annual per capita consumption of beef and veal in Mexico was about 19 kg per person or 32% of Mexican meat consumption. This represents only 51% of U.S. and 43% of Canadian per capita beef and veal consumption (USDA, 1995). Table 2.1 reveals the trend in per capita beef consumption from 1983 to 1993 for Canada, U.S. and Mexico. Per capita beef consumption decreased about 9 percent in both Canada and the U.S. from 1980 to 1992, but increased almost 13 percent in Mexico during that same period (Dietrich et al. 1995).

Table 2.1: North American Per Capita Beef and Veal Consumption 1983 - 1993

Kilograms/Person/Year
Carcass Weight Equivalent

	Canada	Mexico	U.S.
1984	39.8	16.7	49
1985	40.4	16.6	49.5
1986	40.9	14.4	50
1987	39.4	14.1	48
1988	39.5	15.9	47.3
1989	39.2	26.1	45.3
1990	37.6	21.7	44.2
1991	37	19.5	43.8
1992	35.5	20.2	43.7
1993	34.4	20	42.8

Source: U.S. Department of Agriculture, *World Livestock Situation*, FAS, various issues.

Meats tend to be highly substitutable in Mexico with meat supply and demand fluctuating significantly over time. Price, income levels, product availability and cultural and seasonal factors all contribute to Mexican meat consumption patterns. Increases in both beef and poultry consumption since 1988 can, in part, be explained by the policies of the Salinas Administration to stabilize the economy and promote higher standards of living. In 1990, total meat consumption was 3.5 million metric tonnes, and of this total, beef represented 53 percent.

The distribution system for meat in Mexico has as many as ten intermediaries from farmer to final consumer, including livestock buyers, transportation companies, packers, slaughterhouses, meat markets, butchers and supermarkets. Currently, about 70 percent of meat is sold for consumption through local butchers and meat markets, and the remaining 30 percent through supermarkets.

Three main factors are responsible for the drastic reduction in livestock inventories since 1985. These are: a reduction in federal spending and subsidization in agriculture which led to an increase in meat and livestock by-products imports, elimination of subsidies for soybean and sorghum production in December 1984, and the severe drought of the late 1980's and early 1990's (Rosson et al. 1993).

Favourable prices in the U.S. for feeder cattle were also responsible for the liquidation of herds during the late 1980's and early 1990's. Mexican producers shipped cattle North for finishing in the U.S. thereby further depleting replacement stocks. This northward movement prompted an increase in imports of beef and fed steers to fill the shortfall in domestic beef production. As shown in Table 2.2, Mexican beef imports increased from 40,000 tonnes in 1989 to 130,000 tonnes in 1992.

Table 2.2: Mexican Beef and Veal Summary
1,000 Metric Tonnes (Carcass Weight Equivalent)

	Production	Consumption	Imports	Exports
1988	1754	1768	-	-
1989	2140	2176	40	-
1990	1790	1845	60	-
1991	1580	1696	120	-
1992	1660	1789	130	-

Source: U.S. Department of Agriculture, *World Livestock Situation*, FAS, various issues.

The Mexican cattle industry is comprised of two basic sectors. The first is an internationalized feeder cattle system which produces primarily European breeds and Brahma cross breeds. It is oriented toward export and located primarily in the Northern states. The second is the more traditional extensive grazing industry, located in the South and producing mainly purebred Zebu cattle for domestic consumption. The feeder cattle system of the North is strained by the overgrazed, marginal pasture found in the region. This pasture is typically inadequate to maintain a large herd. Recent years have seen an improvement in the feedlots, with many now being technologically comparable to those in the U.S. and Canada. However, the profitability of these feedlots does not seem to have improved.

Increased beef production in Mexico is further limited by inadequate processing facilities. Mexico currently has fewer than a dozen meat packing plants, accounting for roughly 20 percent of the animals slaughtered (Melton and Huffman, 1993).

The shortage of beef often found in Mexico may be attributed to several factors. One is the inefficient distribution of live cattle and beef from the major producing regions to the major consuming regions. Another are the low levels of disposable consumer incomes in Mexico, which have retarded the development of a strong demand for beef. Retail beef prices are irrelevant to over one-half of the population because 43 million people earn incomes so low that they cannot afford beef even at the low, controlled price of U.S. $2.00/lb. In 1984, 1000 g of beef represented 64 percent of real average daily wages; this increased to 85% of real wages by 1988 (Paguaga et al. 1991).

4. Mexican Policies Affecting Beef Production, Consumption and Trade

Historically, the Mexican beef and cattle industries have been influenced by both consumption and production subsidies, as well as protectionist trade policy. Prior to the recent trend towards privatization, Mexican consumers were subsidized by Compania Nacional de Subsistencias Populares (CONASUPO). This government organization purchased commodities from either domestic or foreign sources and then resold them to consumers, often for less than the purchase price. CONASUPO is now playing a much reduced role in this area. Because of its traditionally high price relative to other protein sources, beef has been considered a luxury in Mexico, with consumption generally restricted to higher income groups. However, the government has insisted on imposing price ceilings on many beef products because beef prices tend to serve as an indicator of prices of other animal products.

Because of high U.S. cattle prices relative to Mexican prices, and domestic price controls, Mexican producers have found it profitable to ship feeder cattle North into the Southern U.S.. In early 1990, in an attempt to combat this flow, the Mexican government imposed an export tax on live cattle. This tax was originally $60 per head, but in 1990 it was reduced to $30 per head. For the 1991/92 marketing year, the tax was $5 per head. The tax was completely eliminated during the 1992/93 marketing year.

The land tenure system has also stood in the way of a profitable and more efficient beef sector. Under the Agrarian Reform Code, the amount of land ranchers could own was restricted to the number of hectares needed to support 500 head of cattle. However, as of February 1992, changes to this act will allow for private ownership of large parcels of land. These changes should prove beneficial to producers who are now able to obtain secure tenure on enough land to increase production.

Changes to the Mexican beef carcass grading system have also been implemented. The purpose of the new system is to facilitate the marketing of high valued marbled steaks at high prices. The new grading system, which is on par with the current U.S. system, should allow Mexican cattlemen to receive higher returns for grain fed cattle. This may prove to be an incentive for producers to modernize their operations.

B. The North American Beef Market

The North American beef and live cattle markets are highly integrated. The United States sources more than half of its live cattle imports from Mexico, with Canada supplying the rest. In 1991, Canada accounted for 47 percent of U.S. imports of live cattle and calves by quantity. However, although Mexico accounts for the largest share of U.S.

imports by quantity, Canada accounts for 62 percent of the value of these imports compared with only 38 percent from Mexico. This is because Canada exports a larger percentage of higher valued slaughter animals than does Mexico.

In recent years, about two thirds of U.S. imports of Canadian cattle have entered the U.S. market as slaughter cattle. U.S. imports of live cattle weighing 320 kgs or more from Canada more than tripled from 1987 - 1991, increasing from 205,000 animals in 1987, to 664,000 animals in 1991 (U.S. International Trade Commission, 1993). The majority of these imports were destined for immediate slaughter.

The U.S. imports primarily feeder cattle from Mexico. Imports of animals weighing 90 kgs or more, but less than 320 kgs, account for virtually all U.S. imports of live cattle from Mexico.

The past several years has seen a significant decrease in the East - West movement of cattle across Canada. Since 1981, beef production and slaughter has become concentrated in Western Canada. Between 1987 and 1991, beef production in Western Canada rose from [illegible] percent of total Canadian production to 61 percent. This same period saw the share of animals slaughtered in Central Canada decrease from 45 percent to 39 percent, while the share of cattle slaughtered in the prairie provinces increased from 42 percent to 54 percent (United States International Trade Commission, 1993).

These shifts can be attributed to two main factors. The first is the deregulation of the Canadian trucking industry in the mid 1980's. The new system made it more profitable for Canadian processors to truck slaughter cattle from Western Canada into the Northwestern United States, than to transport cattle into Eastern Canada.

The second reason has to do with the expansion and modernization of the slaughter industry in Western Canada. The security of market access provided by the Canada-U.S. FTA may have been a factor behind the decision of companies like Cargill and Lakeside (now IBP) to set up highly modernized meat packing/processing plants in Alberta. While new and large volume facilities were opening up in Southern Alberta, many of the older slaughter plants in Central Canada were being closed, thus opening up the market for importing beef produced in the U.S. Midwest. This is evidenced in the increase in exports of beef and veal from the Midwest and Eastern United States to Central Canada in the past decade. U.S. exports of beef and veal to Canada increased from 37 million pounds (carcass wt eq.), valued at $59 million in 1987, to 257 million pounds, valued at $389 million, in 1991 (U.S. International Trade Commission, 1993).

The only remaining barrier to the emerging North-South trade pattern is that of government grading regulations. Although Canada and the U.S. use exactly the same methods for grading beef quality, U.S. regulations require that boxed choice Canadian beef sold into the U.S. must be sold at a "no-roll" discount.[1] Also, Canadian regulations require U.S. select beef must be sold into Quebec as "USDA" beef and into Ontario as "ungraded" beef, which severely restricts retail sales.

A recent study on the impact of grade equivalency on beef and cattle trade between the U.S. and Canada concluded, that the lack of grading system equivalency amounts to a 3 percent tariff on the value of Canadian carcass beef destined for the U.S., and a 5 percent tariff on U.S. beef destined f Canada. If this barrier were removed, the North American packing industry would opera nore efficiently and the volume of U.S. beef exports to Canada and of Canadian beef exports to the U.S. would increase. Canada would export an additional 27,000 tons of beef to the U.S., and U.S. exports of beef to Canada would increase by approximately 32,000 tons (Hayes et al. 1996).

Canada is a net importer of beef and veal. Total Canadian imports of beef and veal from all sources rose by 36 percent, from 298 million pounds (carcass wt. eq.) in 1987, to 463 million pounds in 1991. Beef and veal imports as a share of consumption rose from 13 percent in 1987 to 21 percent in 1991 (U.S. International Trade Commission, 1993). In 1991, the United States accounted for 54 percent of total Canadian imports of beef and veal making it Canada's number one source of these commodities.

The United States is Canada's principal export market for beef and veal, accounting for 95 percent of total Canadian beef and veal exports in 1991. U.S. imports of all beef and veal from Canada increased from 190 million pounds in 1987, to 223 million pounds (carcass wt. eq.) in 1991. However, since the signing of the Canada-U.S. FTA in 1988,

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1 The lack of grading system equivalency forces Canadian packers to sell select quality beef at no-roll prices in the U.S. (Hayes et al, 1996).

the trade balance for all beef and veal, which had been negative for the U.S. prior to this, became positive for the years 1990-1991 (U.S. exports to Canada exceeded U.S. imports from Canada for 1990-1991). Therefore, although Canada has increased its exports of to the United States significantly, imports of beef and veal from the U.S. have been increasing more than proportionately. The majority of the beef and veal imported from Canada during 1987 - 1991 was fresh, chilled or frozen, with imports of prepared or preserved beef and veal averaging only 1 million pounds per year.

As stated previously, the beef and cattle markets in Canada and the U.S. are highly interrelated. This is due not only to the close proximity of the two markets, but also the relatively open border between the two countries. Also, because U.S. beef and veal production is roughly 12 times as great as Canadian production, and the U.S. cattle herd is about nine times larger, Canada's beef and cattle markets tend to be dominated by the U.S. beef and cattle markets. Prices for Canadian beef and cattle tend to be heavily influenced by changes in the U.S. market, and prices in the two countries tend to move together due to the close proximity between the two markets.

Table 2.3 summarizes the flows of cattle and beef in the North American market for the years 1981 to 1991.

Table 2.3: Selected Cattle and Beef Trade Statistics

	LIVE CATTLE (HEAD) Exports to U.S. from:		BEEF F/C/F (TONNES) Exports to U.S. from:		Canadian Imports from:			LIVE CATTLE (HEAD) U.S. Imports from:			
Year	Alberta	Canada	Alberta	Canada	U.S.	Other	Total	Mexico	Canada	Other	Total
1981	N/A	N/A	N/A	N/A	N/A	N/A	N/A	321,027	324,941	13,229	659,197
1982	64,799	484,010	30,573	82,583	9,130	47,651	56,781	509,685	494,512	310	1,004,507
1983	65,261	367,767	17,889	59,631	10,773	47,219	57,992	561,746	358,976	85	920,807
1984	105,208	384,927	18,971	78,388	20,336	57,517	77,853	390,270	362,904	264	753,438
1985	115,056	359,149	27,238	86,228	19,754	55,963	75,717	476,481	358,657	880	836,018
1986	108,756	233,868	22,973	77,279	19,752	55,955	75,707	1,086,915	246,796	1,678	1,335,389
1987	112,510	251,424	23,677	69,124	28,126	64,231	92,357	937,910	262,091	483	1,200,484
1988	226,947	481,935	23,622	69,730	45,524	73,461	118,985	844,220	487,518	468	1,332,206
1989	143,728	413,157	29,718	80,340	57,479	65,636	123,115	873,550	584,732	1,133	1,459,415
1990	274,445	868,868	33,928	84,421	76,209	73,057	149,266	1,261,204	873,791	5	2,135,000
1991	299,934	904,081	35,769	86,317	96,570	72,738	169,308	N/A	N/A	N/A	N/A

Source: Statistics Canada
FATUS (USDA)
Statistics Branch, AAFRD

III LITERATURE REVIEW

A. Related Research

Trade liberalization induces two kinds of economic effects. The first are static or resource allocation effects which occur as a result of price changes induced by trade liberalization. The second are dynamic effects which occur through increased competition, economics of scale, enhanced investment opportunities, and productivity growth. Many of the models used to predict the impact of the NAFTA on the Canadian economy, and on the agriculture sector specifically, are static models. A problem associated with using static models, is that such models cannot capture the dynamic world of international trade (Rempe et al. 1993).

Studies on the impact of the NAFTA on Canada's agriculture sector can be classified into three broad categories: studies where an aggregate agricultural sector is included in an economy wide model (general equilibrium), studies which specifically model agriculture and various sectors within agriculture (partial equilibrium), and studies which are primarily descriptive in nature.

1. Applied General Equilibrium Models

Applied general equilibrium (AGE) models are the most common analytical tool used to predict the effect of the NAFTA on real income, wages, imports, exports and other related macroeconomic variables. AGE models are designed to capture all the implications, throughout the economy, of policy changes or shocks to the economic system (Rempe et al, 1993). Most AGE models are static or single year models to which policy changes are introduced to a baseline scenario. AGE models show the effects of a policy change after the adjustments in the economic system are complete.

A paper by Watson (1993) compares the results from three different studies in which economy-wide models, which include the Canadian agriculture sector, are used to measure the economic impacts of the NAFTA on Canada, the U.S. and Mexico. The three studies evaluated in Watson's paper are by: Harris and Cox; Brown, Deardorff, and Stern; and the U.S. International Trade Commission (USITC). The Harris and Cox model measures the impact of the NAFTA on both the size of trade flows and the various countries' share of each others import markets. The Brown, Deardorff and Stern (BDS), and USITC models use changes in import and export volumes as a measure of the possible impacts of the NAFTA on the three trading partners. Although there are significant differences between the three studies in the modelling of various policy and liberalization scenarios, all three studies conclude that Canada, the U.S. and Mexico would experience small increases in GDP and average wages as a result of the NAFTA.

Table 3.1 summarizes Watson's assessment of the three studies regarding the estimated impacts of NAFTA on Canada's agriculture sector. The main results of the studies as summarized by Watson are as follows: First, the studies predict increases in trade flows, both exports and imports, among the three countries. Second, as the results in Table 3.1 indicate, the Harris and Cox model also predicts no change in Canadian agricultural import shares as a result of the NAFTA. Because Canada and Mexico currently trade very little, Mexican exports to Canada would have to increase substantially before they would have the same effect as even a small percentage increase in U.S. exports.

Table 3.1: Results of Applied General Equilibrium Analysis on the Canadian Agricultural Sector

	Harris & Cox (1992)*	Brown, Deardorff & Stern (1992)*	USITC (1991
	(Percentage Point Change)		
Canadian Import Shares			
United States	0		
Mexico	0		
U.S. Import Shares			
Canada	-0.2		
Mexico	2.54		
Canadian Imports from Mexico		-5.5	93.1
Canadian Exports to Mexico		7.5	145
U.S. Imports from Canada		4.2	12.2
U.S. Imports from Mexico		1.8	38.9

* As cited by Watson, 1993.

Source: Watson, W.G.1993. "The Economic Impact ot the NAFTA". C.D. Howe Institute Commentary.

Third, both the BDS and USITC models predict increases in Canadian agricultural exports to both the U.S. and Mexico, however, the two models differ with respect to predicted changes in Canadian imports from Mexico. The BDS model predicts a decrease in Canadian imports from Mexico, while the USITC model predicts a substantial increase in imports from Mexico. This difference may be attributed to the importance placed on economies of scale and intra-sectoral specialization in the USITC model. Both models show agriculture as being one of the biggest sectoral gainers in terms of increased trade flows.

An advantage of using AGE models is that interactions among broad sectors can be shown explicitly. A disadvantage is the loss of detail about individual commodities and commodity specific policies as a result of aggregation. Partial equilibrium analysis is a tool often used to examine the impacts of policy changes on specific commodities within a sector.

2. Partial Equilibrium Models

Partial equilibrium analysis is used to study the economics of a single market. In partial equilibrium all prices, other than the price of the good being studied, are assumed to be fixed or exogenous to the model. This differs from general equilibrium where all prices are variable and equilibrium requires that all markets clear (Varian, 1978).

There are numerous partial equilibrium studies which examine the effects of the NAFTA on the Agriculture sector, as well as, individual commodity impacts. The four studies that I found which related most directly to this research topic are by Rosson et al (1993), O. Onianwa (1995), Melton & Huffman (1993), and Dietrich et al (1995).

In the Rosson et al paper, the impacts of the NAFTA on US-Mexican meat trade are examined using estimated import demand elasticities. Import demand elasticities are defined as:

$$e_{d,imp} = e_{pr} \, [(e_d * x_d) - (e_s * x_s)]$$

where e_{pr} = price transmission elasticity, assumed equal to 1 under NAFTA; e_d = Mexican total demand elasticity; x_d = ratio of Mexican total demand to imports; e_s = Mexican domestic supply elasticity; and x_s = ratio of Mexican domestic supply to Mexican imports.

The results of this study conclude that the short-run demand for beef, primarily processed meats and offals, in Mexico could be quite high. With a 5 percent decrease in the price of beef, and a subsequent 10 percent increase in Mexican incomes, Mexican beef and veal imports could increase from 35 thousand tonnes to 177.4 thousand tonnes. Rosson also predicts that export of higher value beef products are likely to increase only moderately. However, as the Mexican market develops due to increased incomes and tourist trade, U.S. exports of higher quality beef are likely to expand.

This conclusion is supported in Onianwa's paper "*The Potential for High-Value Agricultural Products Under the NAFTA: The Case of Beef in Mexico and Canada*". A system-wide approach to import allocation is used to estimate the export potential of U.S. beef products (unprocessed, semi-processed and highly processed) to Mexico and Canada. The results indicate that increases in Mexican income would stimulate increased beef imports. The own price elasticities calculated for beef products in Mexico are -0.52, -0.29, and -0.34 for bulk, semi-processed and highly processed beef respectively. In this case, bulk beef refers to live cattle exported for slaughter, semi-processed products consist of all fresh/chilled/frozen beef and highly processed products include prepared and preserved beef.

The paper by Melton and Huffman (1993) examines the impact of the NAFTA on long-term adjustments in U.S.-Mexican beef production and trade. Complex aggregate supply and demand equations are estimated using regression analysis. The compete model is composed of a set of stock and flow equations for quantities, and a set of price and cost equations. The paper concludes that in the short-run, the elimination of trade barriers will result in increased exports of Mexican feeder cattle to the U.S., and increased imports of U.S. beef into Mexico. The model predicts that Mexico could be expected to increase its short-run beef imports from the U.S. by about 2.4 billion pounds or tenfold from current levels. The results also indicate that in the longer-run, technology transfers that reduce Mexico's cost of beef production could result in Mexico becoming a net beef exporter to the U.S..

The study by Dietrich et al (1995) uses a North American Beef Trade (NABT) model to analyze the impact of the NAFTA on the competitiveness of beef fabrication, packaging and trade within the U.S. Canada and Mexico. The NABT model is a large multidimensional trans-shipment model which separates the NAFTA countries into 41 trading regions. The objective of the model is to allocate beef among the three fabrication/packaging systems (boxed beef, vacuum packaged beef, and portion control/HRI beef) in order to minimize total costs of transforming, packaging and distributing beef to the consumers in the 41 regions. Factors generating change in the North American beef industry are identified as: productive potential of the cattle and beef industries, growth in population and per capita incomes, changes in regional wage rates, the rate of technology adoption, and changes in industry infrastructure.

The model concludes that increased beef demand in Mexico due to growth in population and income, without compensating increases in beef production,will result in increased imports from the U.S.. In the short-term, the model suggests that the Texas-Oklahoma Panhandle and Colorado has a locational advantage for meeting this increased demand. However, the model also shows that Alberta has a locational advantage for shipping boxed beef and HRI beef to the U.S. Pacific Northwest and West Coast. These results indicate, that while there may not be great potential for increased Canadian beef exports to Mexico, the NAFTA may result in increased Alberta exports, as beef is drawn out of the Southern U.S. into Mexico. The NABT model also indicates that beef deficit markets in Eastern Canada could realize cost savings by importing HRI beef from the U.S. Northern Plains states and Nebraska. This could result in a further expansion of the trend towards North-South flows as opposed to East-West.

The study also concludes that increased production in the major producing areas of the U.S. will have a minor impact on the optimal beef distribution routes, other than volume increases. However, if Alberta were to increase beef production this would result in increased competition by Alberta in the U.S. Pacific Northwest and West Coast beef markets.

B. Theoretical Background

1. Basic Trade Theory

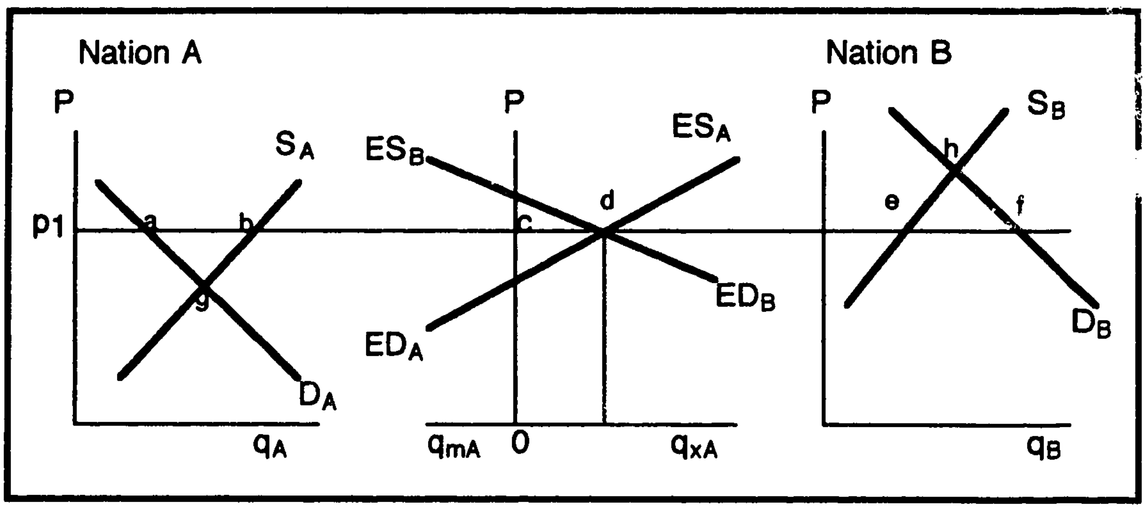
Adam Smith was one of the first economists to recognise that trade between countries need not be a "zero sum game", where, if one player wins, all the others must lose. According to Smith's theory of "absolute advantage", countries benefit by specializing in the production of goods in which they have an absolute advantage, and importing goods in which they have an absolute disadvantage (Yarbrough & Yarbrough, 1994: 37). A country is said to have an absolute advantage in the production of a good if its production costs are lower than other countries' at prevailing prices and exchange rates (Houk, 1986: 8).

In 1817, David Ricardo introduced his theory of "comparative advantage". According to Ricardo, a country need not have an absolute advantage in the production of a good in order to achieve economic gains from trade. Comparative advantage is based on differing production conditions among countries, or in other words, differing opportunity costs. Countries should import products for which the international price is less than the domestic opportunity cost of producing the good, and export those commodities for which the international price is higher than the domestic opportunity cost.

If a country has a comparative advantage in the production of a good, relative to another country, then trade will result in economic gains. Gains from trade arise from two sources, gains from exchange and gains from specialization. Gains from exchange are a result of consumers being able to access a larger and more diverse bundle of goods and services at lower overall prices than in the absence of trade. Gains from specialization result from a country's resources being more efficiently allocated among industries in order of comparative advantage (Houk, 1986).

In a two-country one-commodity world, where transfer costs are assumed to be zero, equilibrium exists where the excess supply (ES_A) of country A is equal to the excess demand (ED_B) of country B. This equilibrium is illustrated in figure 3.1. In isolation, equilibrium is at point *g* in A and point *h* in B. If trade is allowed to occur, prices in A will increase and prices in B will decrease until the equilibrium price P_1 is reached. The tendency of prices to equalize across freely trading areas is referred to as "the law of one price" (Houck, 1986: 36). When price is equal to P_1, the quantity of exports from A, (ab) is exactly equal to the quantity of imports into B, (ef).

Figure 3.1
Two Region One Commodity Equilibrium

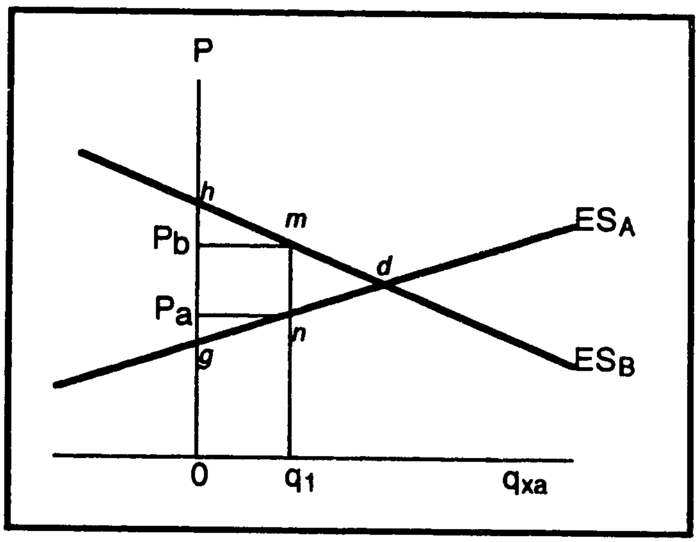


Source: Houk, 1986: 36

When transfer costs are included in the model, this equilibrium changes. Transfer costs are the per unit costs involved in physically moving a commodity from one market to another and include not only transportation costs, but also tariff and other transaction costs. In this two country one commodity scenario, prices will move towards each other until they differ only by the transfer cost. As illustrated in figure 3.2, if the total transfer costs are equal to the value *mn*, then in equilibrium the domestic prices in the two nations will differ by this amount. The price in Nation A (P_a) is *mn* units lower than the price in Nation B

(P_b), therefore, $P_a + mn = P_b$. When transfer costs are introduced into the model, equilibrium is reached when the trade volume equals $0q_1$, or where the difference in the two prices is exactly equal to *mn*. If the transfer costs increased to a point where they were equal to or exceeded the value *gh*, then there would be no incentive to trade because the transfer costs would be equal to, or exceed the difference between the two isolation prices (Houk, 1986: 37).

Figure 3.2
Effects of Transfer Costs on Equilibrium



Source: Houk, 1986: 37

C. Spatial Equilibrium Theory

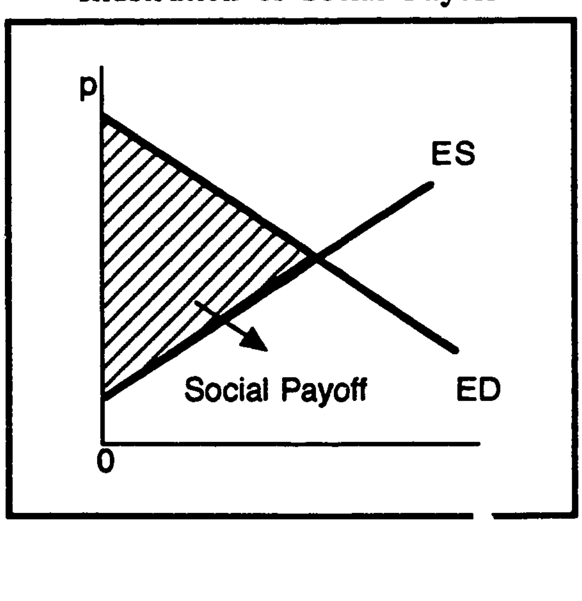
Since Ricardo first introduced his theory of comparative advantage, economists have struggled to incorporate location and space into economic models. In classical general equilibrium theory, factors and producers, products and consumers, are treated as if they are all located at one point, or as if transportation costs are zero. Spatial equilibrium models explicitly recognise space as a determinant of economic activity.

The problem of equilibrium among spatially separated markets was described by Enke in 1951:

> "There are three (or more) regions trading a homogeneous good. Each region constitutes a single 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 price are known, and consequently, the magnitude of the difference which will be exported or imported at each local price is also known" (Judge & Wallace, 1958: 802).

In 1952, Paul Samuelson converted Enke's non-normative problem into a maximization problem in which the objective was to maximize the Net Social Payoff subject to a set of linear constraints. Samuelson defined Net Social Payoff as: NSP = Social Payoff in 1 + Social Payoff in 2 - Transport cost. Social payoff is then defined as either the algebraic area under a regions excess demand curve or above its excess supply curve, as illustrated in figure 3.3 (Samuelson, 1952). This problem was solved using linear programming techniques. Samuelson also demonstrated how the NSP maximization problem contained within it Koopmans' (1949) minimum transportation cost problem.

Figure 3.3
Illustration of Social Payoff



1. Assumptions:

There are several simplifying assumptions which need to be made in order to solve spatial equilibrium models using linear programming techniques. These are:

1) Perfect competition, firms are profit maximizers,
2) Supply and demand regions are represented by a single fixed point,
3) Regional demands are represented by known linear demand functions, and regional supplies are predetermined for the given time period,
4) All regions are connected by transport costs that are independent of direction and volume of trade,
5) The product is homogeneous and consumers are indifferent to source of supply,
6) Price is the only factor assumed to influence regional consumption,
7) Foreign imports and exports are assumed negligible,
8) For any time period total production must equal total consumption,
9) Both production and consumption can take place in all regions, and there is no transportation cost associated with product consumed where it is produced,
10) No negative shipments, and
11) No cross-hauling; deficit regions cannot export and surplus regions cannot import.

The major types of information that spatial models can provide include: efficient shipping patterns, regional production and resource allocation; forecasts of shipping patterns, regional production, resource allocation, regional consumption and prices; and the effects of changes in exogenous variables such as price supports, production controls, and population distribution on the model (Bawden, 1964).

According to Bawden (1964), spatial models can be classified into two main groups: standard equilibrium (SE) formulations using demand and supply relations, and activity analysis (AA) models using production activities and demand relationships.

> "The principal difference between the two groups is their treatment of the production process. The standard equilibrium models rely on explicitly supply functions, while the activity analysis models implicitly generate their own supply relationships" (Bawden, 1964: 1374).

Bawden suggests that spatial models which incorporate comparative statics are useful tools for evaluating government policies.

The strength of spatial equilibrium models is that they allow for comparative statics to be used to predict how variables will change in response to data changes. This allows the researcher to examine a wide variety of policy scenarios. In the case of predicting possible impacts of trade liberalization under the NAFTA, it is possible to examine several different scenarios by simply changing the model parameters.

2. Limitations of Spatial Equilibrium Models

There are several limitations associated with spatial equilibrium models. Weak empirical content can often be a problem with these models. This can result from data deficiency, specification error, simultaneous equation bias, or validation. The specification of freight rates within a model is an example of the weak empirical content problem. Most spatial models assume a constant transportation cost between all regions. This assumption does not adequately reflect the real world situation where variable freight rates exist between regions. Also, reliable data on freight rates can be difficult to find, leaving the researcher to make "guesstimates" from the available data.

The assumption of homogeneity can also be a problem when there are substantial differences such as different harvesting periods, different production processes, and different levels of production risk between the trading regions. There is a question as to whether it is empirically accurate to equate intensively produced beef from Canada and the U.S. to extensively produced beef from Mexico.

Another problem associated with spatial equilibrium analysis is the aggregation problem. This problem arises from the assumption of regions being represented by a single point rather than a continuum of points. Therefore, it is necessary to find the breakdown of regions that will minimize the error resulting from this problem.

D. Linear Distribution Models

Linear distribution models are mathematical programming models which can be used to solve spatial price and allocation problems. The most basic of these are single commodity, multi-region models. The linear distribution model is defined as follows:

Find the set of shipments, consistent with the regional supply and demand restrictions, that will maximize returns to the suppliers and permit the commodity to be distributed to the consumers at a minimum total transportation cost.

There are several assumptions which must hold in order to solve the single commodity, multi-region transportation cost minimization problem. These are: regions are geographically contiguous, a homogeneous product, demand and supply are predetermined, consumers are indifferent to the source of supply, total demands for the product over all regions are equal to or less than the total supplies from all the producing regions, and transportation cost per unit shipped is constant, (varrying only with distance shipped), and is independent of the total quantity shipped.

In solving for optimal trade flows of beef, the objective would be to find the routing of beef from the surplus regions, to the deficit regions such that aggregate transportation costs are minimized. This problem can be expressed by the following set of mathematical equations.

$$\text{Minimize} \quad \sum_{j=1}^{m}\sum_{i=1}^{n} X_{ij}C_{ij} \qquad (1)$$

subject to:

$$\sum_{j=1}^{m} X_{ij} = a_i; \quad i = 1,\ldots,n. \qquad (2)$$

$$\sum_{i=1}^{n} X_{ij} = b_j; \quad j = 1,\ldots,m \qquad (3)$$

$$\sum_{i=1}^{n} a_i = \sum_{j=1}^{m} b_j \qquad (4)$$

and

$$X_{ij} \geq 0 \quad \text{for all } i,j \qquad (5)$$

Where: X_{ij} = quantity of product shipped from the i^{th} surplus region to the j^{th} deficit region

C_{ij} = per unit transportation cost

a_i = total excess supply in region i

b_j = total excess demand in region j

By specifying that excess supply equal excess demand, (equation 4), this problem has special characteristics with respect to its solution. 1) a feasible solution exists, 2) the feasible solution contains at most (n+m-1) positive X_{ij}'s, 3) if a_i and b_j are integers, then every feasible solution has integral values, and 4) a finite minimum solution always exists but may not be unique (Takayama & Judge, 1971).

This basic model can be extended to examine a variety of scenarios. The condition that total excess supply equal total excess demand is often too restrictive in modelling real world trade flows. When this is the case, a dummy variable (an additional supply or demand region) can be introduced into the model to receive the excess supply or demand. The dummy variables represent costless storage.

It is also possible to extend the model to include more than simply transportation costs. These could include production, extraction, processing, tariff or other transaction costs. The objective then is to minimize total cost of making the product available in the demand region.

E. Linear Programming

Linear programming (L.P.) provides a means for describing economic problems in terms of a mathematical model. There are three main components to every linear programming problem: 1) an objective, 2) alternative methods or processes for attaining the objective, and 3) resource or other restrictions. The basic structure of an L.P. problem involves the optimization of an objective function subject to a set of linear restraints. The term linear refers to the straight line relationships existing in the problem. Only variables in the first power represent linear relationships.

Linear programming provides normative answers to optimization problems. Normative answers indicate courses of action that ought to be taken, given the objective and the various restrictions. Normative economics does not try to explain why agents act the way they do, or why they make choices that differ from the ideal or normative course of action. Therefore, linear programming cannot be used to explain structural relationships or human behaviour.

This study estimates optimal trade flows of beef between regions in the North American market under various scenarios. Linear programming provides the framework by which these optimal flows are calculated. As suggested by Heady and Candler (1958) linear programming is an effective method by which to specify spatial equilibrium patterns in the flow of agricultural products, and indicate optimum interregional patterns of resource use (Heady and Candler, 1958).

There are five basic conditions that must hold in order for a sufficiently precise solution to be calculated. These are: 1) additivity, 2) linearity, 3) divisibility, 4) finiteness, and 5) single valued expectations. The linearity assumption implies that both the objective function and the resource constraints must be specified in a linear form. The additivity assumption is met if, when two or more resources are used, their total product is equal to the sum of their individual products.

> "The total amount of resources used by several enterprises must be equal to the sum of the resources used by each individual enterprise." (Heady & Candler, 1960: 17).

Divisibility requires that the factors used and the commodities produced be infinitely divisible. Even though .75 of a cow may not exist in the real world, it must be allowed to exist in the linear programming world. The finiteness assumption requires that there be bounds on the number of alternative activities and restrictions in the model. If an infinite number of alternatives were allowed to exist, then it would not be possible to calculate an optimal solution. By single-valued expectations, it is assumed that the resource supplies, input-output coefficients, and prices are known with certainty.

Although these restrictions appear very limiting, in practice, linear programming models can be made quite general. The curvature of the classical production function can be approximated by increasing the number of finite processes or activities. The linearity assumption does suggest constant returns to scale. However, if there are increasing returns to scale, this can be approximated by setting limits or restrictions on the range over which certain production coefficients may apply. In other words, different processes can be used at different points along the scale function. The additivity assumption does not directly permit a complementary relationship between any two processes. However, the complementary range may be approximated by increasing the number of processes over the complementary range.

As with most analyses, the results obtained from linear programming are only as good as the data used for the analysis. The objective of a researcher using linear programming, is to ensure that the restraints and processes of the real world are adequately portrayed in the mathematical model. The greater the difference between the actual problem and the one represented by the mathematical problem, the less applicable will be the results obtained.

IV MODEL DESCRIPTION

A. Overview of Model

A transportation model was developed to analyze the impacts of the NAFTA on Alberta's cattle/beef sector. GAMS (Generalized Algebraic Modelling System) software was used to solve the linear transportation cost minimization problem. The objective of the model was to minimize total transportation costs between nine regions subject to linear demand and supply constraints. The output of the model was a set of commodity flows from surplus to deficit regions within the North American market.

The linear programming transportation problem was defined as:

$$\text{Minimize} \quad \sum_{j=1}^{m} \sum_{i=1}^{n} X_{ij} C_{ij} \qquad (1)$$

subject to:

$$\sum_{j=1}^{m} X_{ij} = a_i; \quad i = 1, \ldots, n. \qquad (2)$$

$$\sum_{i=1}^{n} X_{ij} = b_j; \quad j = 1, \ldots, m \qquad (3)$$

$$\sum_{i=1}^{n} a_i = \sum_{j=1}^{m} b_j \qquad (4)$$

and

$$X_{ij} \geq 0 \quad \text{for all } i,j \qquad (5)$$

Where: X_{ij} = quantity of beef shipped from the i^{th} surplus region to the j^{th} deficit region

C_{ij} = per unit transportation cost (scaler)

a_i = total excess supply of beef in region i

b_j = total excess demand for beef in region j

This study is a partial equilibrium analysis and, therefore, does not examine the effects of NAFTA on other sectors of the economy, or other commodities within the agriculture sector. For example, the impacts on pork and chicken consumption given increased Mexican incomes are not considered. The model is also static, with the baseline scenario estimated using 1991 data.

The North American market is a net importer of beef. In order to meet model restrictions beef production and consumption numbers were adjusted[2] so that total demand equalled total supply. This was necessary to meet the strict equality restriction, equation 4.

This problem can be addressed by introducing a dummy variable into the model. The dummy variable, in this case an additional surplus area, would supply imports from outside the NAFTA region once North American supplies were exhausted. The primary reason for not taking this approach, is that the location of the extra surplus region in the model (ie, East coast versus West coast) would likely alter the estimated trade flows. Therefore, in order to isolate the impact of increased Mexican beef demand on the North American market, a dummy variable was not included in the model. Also, this study is concerned with trade in boxed beef, and the majority of Canadian and U.S. beef imports from non-NAFTA countries are of manufacturing quality beef.

B. Data Requirements

1. Definition of Regions

The North American market is divided into nine separate regions. Each of the nine regions is represented by a single point, in this case a centrally located city, for the purposes of determining transportation costs. The cities were also chosen on the basis of size, and the relative importance of the city as a site for beef production or consumption. Consumption and production for each of the regions is then calculated to determine whether the region is a surplus (ie. production > consumption) or deficit (ie.production <

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2 Regional deficit quantities are reduced by a constant percentage to meet equality constraints. Therefore, the North American deficit is shared equally across all regions. See Appendix B.

consumption) region. Table 4.1 summarizes the nine regions and their appointment as either a surplus or deficit region.

Table 4.1
Model Regions and Central Points

Region	Central Point	Surplus/Deficit
Canada West	Calgary, Alberta	Surplus
Canada East	Montreal, Quebec	Deficit
North Central	Helena, Montana	Surplus
Central	Denver, Colorado	Surplus
South Central	Dallas, Texas	Surplus
Pacific	San Francisco, California	Deficit
North East	New York, New York	Deficit
South East	Atlanta, Georgia	Deficit
Mexico	Mexico City, Mexico	Deficit

At each of these points, supply and demand is assumed to be fixed. Regional supply is defined as equal to regional production, and regional demand is defined as equal to regional consumption.

2. North American Production

Canadian regional beef and veal production for 1991 is calculated by converting the number of animals slaughtered per province, into a beef retail weight equivalent using the appropriate conversion factors. First, the total number of head slaughtered per province is converted to a carcass weight equivalent using the 1991 average dressed weight (Statistics Canada, Cat. No. 23-203). Next, the retail weight equivalent is calculated using the conversion factors 0.73 for beef and 0.89 for veal (Eales, 1994). Provincial totals are then added to calculate total regional production.

United States regional production is calculated in much the same manner. The number of animals slaughtered by state is converted first to a carcass weight equivalent using an average dressing percentage of 60%, which is low enough to include veal with beef (Gietz, 1994). Carcass weight is then converted to retail weight using USDA conversion factors (beef = 0.70, veal = 0.83).

The difference between Canadian and U.S. carcass to retail conversion factors for beef and veal, can likely be attributed to different processing methods employed in the two countries.

Retail weight was chosen as an appropriate production measurement because boxed beef is the predominant packaging/distribution system for beef in the U.S. and Canada. In Canada, boxed beef accounts for approximately 70 percent of commercial beef production (CITT, 1993). In the U.S., the twenty largest U.S. beef companies distribute more than 90 percent of their beef as boxed beef (Dietrich, 1995).

In the model, Mexico is represented as one region with Mexico City being the central point. Therefore, it was not necessary to calculate beef production for each of the Mexican states. Instead, total Mexican beef production numbers for 1991 are used (USDA, 1993). Since almost 80 percent of commercial beef production in Mexico is sold as carcass beef (Dietrich, 1995), production totals are measured using carcass rather than retail weight. Another factor in choosing to use a carcass rather than retail weight equivalent, was the lack of available data on Mexican carcass to retail weight conversion factors.

3. North American Consumption

To calculate Canadian consumption on a regional basis, provincial population is multiplied by per capita beef and veal consumption numbers. In 1991, Canadian per capita consumption of beef was 23.5 kg/person (retail weight), and 1.5 kg/person for veal (Statistics Canada, 1994). Provincial totals are then added to determine regional consumption.

United States consumption figures are calculated in the same manner. State population totals are multiplied by per capita consumption to yield total beef and veal consumption. State totals are then combined to yield regional totals. In 1991, U.S. per capita consumption of beef and veal was 30.3 kg/person and 0.45 kg/person (retail weight) respectively (USDA, 1994).

To calculate Mexican consumption for the baseline model, 1991 census numbers are multiplied by per capita beef and veal consumption. In 1991, Mexican per capita consumption of beef and veal was 19.5 kg/person (carcass weight) in total (USDA, 1993).

Part of this analysis required an estimate of Mexican beef and veal consumption in the year 2010, assuming increased income as a result of the NAFTA. To do this required two things, a forecast of Mexican population in the year 2010, and an estimate of the income elasticity for beef. The Mexican population growth rate is assumed to be 1.85 percent per year over the 1991 to 2010 period. This is slightly lower than the current Mexican growth rate of 2 percent per year, but coincides with estimates published in other statistical references (Euromonitor, 1995 pg 224).

An income elasticity for beef of 0.95, as estimated by Roberts & Mielke (1986), is used in the model. Rosson et al. (1991) also use this income elasticity in their analysis of the impacts of NAFTA on U.S.-Mexican meat trade. This estimate of income elasticity for beef in Mexico seems reasonable given that the income elasticity for beef in Canada and the U.S. has been estimated at 0.22 (Johnson et al, 1984; Senauer et al, 1991). Given Engel's Law[3], one would expect the income elasticity in Mexico to be significantly higher than in either Canada or the U.S., given the disparities in income between the three NAFTA partners. An income elasticity of 0.95 implies that for every 1 percent increase in income, the quantity of beef demanded will increase by 0.95 percent. For example, if Mexican incomes were to increase by 15 percent, beef consumption would increase by 14.3 percent.

Table 4.2 summarizes regional production and consumption as calculated for 1991.

[3] According to Engel's Law, as incomes increase, the proportion of income spent on food decreases (Senauer et al, 1991). One implication of this law is that as incomes rise, people will switch from grains to livestock products as a source of protien.

Table 4.2
Regional Beef Production and Consumption - 1991

Region	Production ('000 tonnes)	Consumption ('000 tonnes)	Surplus/Deficit ('000 tonnes)
Canada West	344	210	134
Canada East	207	511	-304
Pacific	467	1233	-766
North Central	572	249	323
Central	3802	568	3234
South Central	1312	998	314
North East	1017	2873	-1856
South East	244	1830	-1586
Mexico*	1580	1624	-44
Total	9545	10096	-551

Source: Study results
* carcass wt. equivalent

Between 1986 and 1992, Mexican disposable income increased by 13.8 percent (Dietrich et al. 1996). During the same period, Canada and U.S. disposable income increased by 0.8 percent and 8.5 percent respectively. In 1992, per capita disposable income in Mexico was less than one-sixth that of the U.S. and about one-fifth that of Canada. The percent increases in Mexican income used in the study, 15, 20 and 25 percent respectively, were arbitrarily chosen as a plausible range over which incomes could increase by the year 2010[4]. Even with a 25 percent increase in Mexican incomes, they would still be less than one-fifth that of the U.S. and about one-fourth that of Canada.

4. Transportation Costs

In a transportation cost minimization model, transfer costs can include not only the

[4] However, given the recent economic crisis in Mexico, actual increases in income may be closer to the lower than the higher estimate.

cost of physically moving the commodity from one point to another, but also such costs as tariffs and other quantitative border measures. In 1991, beef trade between Canada, the U.S. and Mexico was, for the most part, tariff free. Therefore, the transfer cost in this model includes only the per unit cost of shipping boxed beef from the surplus to deficit areas. A survey done by the Transportation Branch of Alberta Agriculture in 1993, found that the average cost of shipping refrigerated beef between the U.S. and Canada was approximately $1.35 Canadian per mile, based on an average truck load of 45,000 lbs. There were no reliable estimates of the trucking costs involved in shipping boxed beef from Canada to Mexico. Due to the infrequency of such shipments, costs are usually calculated on a per load basis. In fact, prior to 1993, Canada's beef trade with Mexico was comprised almost entirely of frozen offals. Given the data limitations, the study uses $1.35 per mile as the per unit transportation cost.

C. Model Descriptions

Seven separate scenarios are designed to measure the impact of the NAFTA on North American beef trade. The models are designed to represent how an increase in Mexican incomes, as a result of the NAFTA, may affect current trade flows. They are also designed to indicate any possible opportunities for Canadian beef producers in Mexico as a result of increased beef demand. Models 3-7 are intended to capture possible long-term effects of the NAFTA and are based on Mexican production and consumption estimates for the year 2010.

As stated previously, the North American market is deficit in total beef production (551 '000 tonnes in 1991). Because the model requires that excess demand equals excess supply, or in this case, that total surplus equals total deficit, the regional deficit amounts had to be adjusted down to meet the equality constraints.

Model 1:

Model 1 represents the pre-NAFTA trade scenario. 1991 production and consumption numbers are used to model trade flows between the U.S. and Canada. Mexico is not included in this baseline model. Tariffs on beef between the U.S. and Canada are zero, and under the Canada-U.S. FTA both countries are exempt from each others meat import laws, therefore, transfer costs are taken to be equal to the per unit transportation cost.

Model 2:

Model 2 is assumed to represent the post-NAFTA scenario. This model contains all of the assumptions of model 1, but now Mexico is included as an additional deficit region. Again, no border costs are included (ie. tariffs are zero).

Model 3:

In this scenario, the year is assumed to be 2010 and Mexican population is assumed to have increased to 118 million people. Mexican incomes are assumed to have increased by 15 percent, the result being an increase in Mexican beef consumption of 14.3 percent. Canadian and U.S. production and consumption are held constant. Any increase in their population is assumed to be offset by decreasing per capita consumption of beef and veal in the U.S. and Canada.

Model 4:

Model 4 contains the same assumptions as model 3, but in addition to a 15 percent increase in Mexican incomes, the model also assumes a 15 percent increase in Mexican beef and veal production. This is to examine the impacts of possible increases in efficiency/capacity of the Mexican beef industry as a result of the NAFTA (ie. technology transfers).

Model 5:

In this scenario, Mexican incomes and total North American beef and veal production have increased by 15 percent. Canadian and U.S. consumption are held constant at 1991 levels. Regional production numbers for Canada, the U.S. and Mexico are all increased by 15 percent. Then, the quantity by which each region is either surplus or deficit is calculated, and these numbers are incorporated into the model.

Model 6:

This scenario assumes a 20 percent increase in Mexican incomes with no increase in Mexican production. Canadian and U.S. production and consumption totals are held constant at 1991 levels.

Model 7:

In this scenario Mexican incomes are assumed to have increased by 25 percent with no increase in Mexican production. Canadian and U.S. production and consumption totals are held constant.

V Results

The results obtained by running the seven versions of the model are presented in this chapter. The models representing pre- and post-NAFTA trade scenarios were not able to accurately recreate 1991 trade flows of beef between Canada, the U.S. and Mexico. This is primarily due to the simplifying assumptions employed in the models. In choosing a cost minimization methodology to model trade flows, one automatically assumes that transfer costs are the primary driving factor behind trade. Obviously, this assumption does not capture the real world situation where a variety of factors such as consumer preferences, non-tariff barriers, and government policy all play significant roles in determining trade patterns.

Each of the seven scenarios described in the previous chapter were run using a transportation cost minimization model. The pre-NAFTA scenario attempted to recreate trade patterns between surplus and deficit regions in Canada and the U.S. Production and consumption quantities were derived from 1991 statistical data. The total transfer cost minimized in the model included only the per unit cost of transporting boxed beef between surplus and deficit regions. Due to the Canada-U.S. FTA, which was implemented in 1989, trade in beef products was tariff free in 1991. The second model includes Mexico as a deficit region in the North American beef market. Statistical data for 1991 were used to calculate Mexican beef production and consumption. The third scenario forecasts Mexican consumption and production in the year 2010 given a 15 percent increase in Mexican incomes. The fourth scenario assumes that both Mexican income and beef production have increased by 15 percent. The fifth scenario examines the impact of a 15 percent increase in Mexican incomes, along with a 15 percent increase in total North American production. Scenarios six and seven assume a 20 and 25 percent increase in Mexican incomes respectively, with North American production and Canada and U.S. consumption held constant.

The results from the seven scenarios tend to agree with other studies conducted on the impact of the NAFTA on North American beef production, consumption and trade. These suggest that trade liberalization with Mexico is unlikely, in itself, to lead to significant changes in current trade patterns. The main force which Mexico is likely to exert on the North American market is the impact of increased incomes on the demand for beef in Mexico. The NAFTA is expected to have a relatively modest impact on Mexican beef production within the next 10 to 20 years (Melton and Huffman, 1993).

A. Model 1

Table 5.1 summarizes the results of the pre-NAFTA scenario. The results are representative of 1991 beef trade between Canada and the U.S. As the results indicate, Alberta has a locational advantage for supplying the U.S. Pacific region. Under this scenario, the entire surplus quantity of beef from Western Canada is shipped to the Pacific region. The deficit region of Canada East is entirely supplied by the U.S. Central region. These results support the recent trend towards an increase in North/South trade flows. The Pacific region is also supplied by the U.S. North Central and South Central regions. Along with shipments to Eastern Canada, the large surplus in the Central U.S. states is also distributed between the Northeast and Southeast deficit regions.

Table 5.1
Model 1 - 1991 Canada/U.S. Beef Trade Flows
('000 Tonnes)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)			269	
Pacific (San Francisco)	134	323		222
Northeast (New York)			1644	
Southeast (Atlanta)			1321	92

B. Model 2

In this scenario, Mexico is added as an additional deficit region to the North American beef market. The results from this model can then be compared to the results from Model 1 to determine the impacts, if any, on beef flows between Canada and the U.S. as a result of including Mexico in the model. In 1991, Mexican beef production totalled 1,580 thousand tonnes and Mexican beef consumption totalled 1,624 thousand tonnes creating a deficit of 44 thousand tonnes. This full amount is not reflected in the model results due to adjustments made to satisfy the equality restrictions. As table 5.2 indicates, the trade flows estimated in Model 1 are not significantly impacted by the inclusion of Mexico. The Mexican market is supplied entirely by the Central U.S., and Western Canada maintains a locational advantage in serving the U.S. Pacific region.

Table 5.2
Model 2 - 1991 North American Beef Trade Flows
('000 Tonnes)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)			266	
Pacific (San Francisco)	134	323		215
Northeast (New York)			1629	
Southeast (Atlanta)			1300	99
Mexico (Mexico City)			39	

C. Model 3

In this scenario, estimates of Mexican population, and beef consumption and production in the year 2010 are incorporated into the model. The model also assumes that Mexican incomes have increased by 15 percent. Given an income elasticity for beef of 0.95, the result is an increase in Mexican beef consumption to 2,642 thousand tonnes. Assuming that North American production remains constant at 1991 levels, the result is an increase in the the Mexican beef production deficit to 1,062 thousand tonnes. The total North American deficit has increased by 18.2 percent from model 2. As table 5.3 indicates, even this large increase in Mexican beef demand is not sufficient to alter the overall pattern of trade flows estimated in the previous two models. The U.S. Central region maintains it locational advantage for servicing the Mexican market. Although an increase in Mexican beef demand would create increased competition for beef supplies within the U.S., part of the increased deficit would be met by offshore imports from countries such as Australia. In 1995, almost 80 percent of U.S. manufacturing beef imports were from Australia and New Zealand (Marsh and Peck, 1996).

Table 5.3
Model 3 - 2010 North American Beef Trade Flows
('000 Tonnes)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)			217	
Pacific (San Francisco)	134	323		93
Northeast (New York)			1332	
Southeast (Atlanta)			923	221
Mexico (Mexico City)			762	

D. Model 4

This scenario includes all of the basic assumptions of model 3, but in addition to a 15 percent increase in Mexican incomes, Mexican beef production is increased by 15 percent as well. It is reasonable to assume an increase in Mexican beef production given the likelihood that the NAFTA will result in technology transfer between Mexico and the two more developed NAFTA countries. With a 15 percent increase in Mexican beef production, the total North American beef deficit increased by 14.6 percent to 5,344 thousand tonnes. The total amount of beef shipped to Mexico from the central U.S. declined by 144 thousand tonnes.

Again, the trade patterns remained basically unchanged. However, in comparing the results from model 4 to those from model 3, it is interesting to note, that while the quantity of beef shipped to Atlanta from the Central U.S. increased by 74 thousand tonnes, the quantity of beef shipped to Atlanta from the Southern U.S. decreased by 24 thousand pounds. The 15 percent increase in Mexican beef production resulted in a redistribution of beef supplies between the U.S. Central and South Central regions and the deficit Pacific and Northeast regions. In model 3, the South Central region shipped 30 percent and 70 percent of total regional surplus to the Pacific and Southeast regions respectively. In model 4, the quantity of beef shipped from the South Central region to the Pacific increased to 37 percent, while the quantity of beef shipped to the Southeast region declined to 63 percent.

Table 5.4 summarizes the results of model 4. Western Canada ships 100 percent of surplus beef supplies to the Pacific region, and the entire Mexican deficit is met with shipments from the U.S. Central region.

Table 5.4
Model 4 - 2010 North American Beef Trade Flows
('000 Tonnes)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)			228	
Pacific (San Francisco)	134	323		117
Northeast (New York)			1391	
Southeast (Atlanta)			997	197
Mexico (Mexico City)			618	

E. Model 5

This model is designed to estimate the impact of a 15 percent increase in Mexican incomes, combined with a 15 percent increase in North American beef production. To accommodate the increase, production numbers for each of the nine regions are adjusted upwards from 1991 levels. The 15 percent increase in beef production was not sufficient to change any of the net deficit regions into net surplus regions, so the structure of the model remained the same with four surplus and five deficit regions. Canadian and U.S. beef consumption is held constant at 1991 levels. With a 15 percent increase in total North American beef production, the total beef surplus equalled 4,910 thousand tonnes, and the total beef deficit equalled 5,036 thousand tonnes.

The least cost distribution routes remain the same as estimated in model 2. In comparing model 5 to model 4, the quantity of beef shipped to each of the deficit regions increases in all but one instance. The quantity of beef shipped from the South Central region to the Pacific region declines by 33 thousand tonnes. The South Central region ships proportionately more beef to Atlanta as compared to model 4. In model 4, 37 percent of the total surplus from the South Central region is shipped to the Pacific region and the remaining 63 percent is shipped to the Southeast region. In model 5, only 16 percent of the total surplus is shipped to the Pacific region with the remaining 84 percent being shipped to the Southeast region. Table 5.5 summarizes the results of model 5.

Table 5.5
Model 5 - 2010 North American Beef Trade Flows
('000 Tonnes)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)			266	
Pacific (San Francisco)	186	409		84
Northeast (New York)			1660	
Southeast (Atlanta)			1075	426
Mexico (Mexico City)			804	

F. Models 6 and 7

In models 6 and 7, Mexican income is increased by 20 and 25 percent respectively, holding North American beef production constant at 1991 levels. Beef consumption in the U.S. and Canada was also held constant at 1991 levels. As in the previous models, regional deficit totals were adjusted proportionately to maintain the equality restriction. In both models, the increase in Mexican beef demand resulted in the difference between the total surplus and the total deficit for the North American market to increase to 29 and 31 percent respectively. In model 6, a 20 percent increase in Mexican incomes resulted in a deficit of 823 thousand tonnes of beef. A 25 percent increase in Mexican incomes resulted in this deficit increasing to 883 thousand pounds.

Again, the least cost distribution routes for both models remain unchanged from models 2 through 5. Even with the increased Mexican demand for beef, the Canada West region does not ship to Mexico. In comparing models 6 and 7 to model 3, a trend in the distribution of beef from the surplus areas to the deficit areas becomes evident. As tables 5.6 and 5.7 indicate, as Mexican demand increases, beef shipments from the South Central region are diverted from the Pacific to the Southeast region. This is to compensate for the increased quantities of beef being shipped from the Central region to Mexico. In model 3, the South Central region shipped 30 percent of its total surplus to the Pacific region. In model 7, this percentage decreased to only 23 percent.

Table 5.6
Model 6 - 2010 North American Beef Trade Flows
('000 Tonnes)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)			214	
Pacific (San Francisco)	134	323		82
Northeast (New York)			1307	
Southeast (Atlanta)			890	232
Mexico (Mexico City)			823	

Table 5.7
Model 7 - 2010 North American Beef Trade Flows
('000 Tonnes)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)			210	
Pacific (San Francisco)	134	323		72
Northeast (New York)			1282	
Southeast (Atlanta)			859	242
Mexico (Mexico City)			883	

G. Comparison Between Various Models

Table 5.8 summarizes comparisons between the various model scenarios. From the table, trends in the pattern of beef flows in the North American market are evident. First, as the demand for beef in Mexico increased, supplies are drawn away from the Pacific region. This suggests a potential for increased beef exports from Alberta to this region, as excess supplies from the Central U.S. are drawn into Mexico.

Second, increased demand for beef in Mexico is exactly offset by decreased supply to the Canada East, Northeast and Southeast regions. The reduction in shipments to the Southeast region from the Central region is compensated by an increase in shipments from the South Central region.

The only model in which shipments from from the South Central region to the Pacific region did not decrease is model 4, where both Mexican beef consumption and production were increased. This result implies that increased exports from Alberta to the

Pacific region would face competition if Mexican production were to increase without subsequent increases in Canadian and U.S. production.

The results also indicate that beef flows from the Canada West and North Central regions are insensitive to changes in Mexican beef production and consumption.

Table 5.8
Summary of Comparisons Between the Model Scenarios
('000 Tonnes)

Trade Flows	Model 4 vs. Model 3	Model 5 vs. Model 3	Model 6 vs. Model 3	Model 7 vs. Model 3
Canada West - Pacific	0	52	0	0
North Central - Pacific	0	86	0	0
Central - Canada East	11	49	-3	-7
Central - Northeast	59	328	-25	-50
Central - Southeast	74	152	-33	-64
Central - Mexico	-144	42	61	121
South Central - Pacific	24	-9	-11	-21
South Central - Southeast	-24	205	11	21

H. Summary of Results

There are three main inferences that can be drawn from the above results. The first is that the direction of shipments within North America is insensitive to likely changes in production or consumption in Mexico of the amounts indicated. This insensitivity is reflected in the marginal values[5] calculated in each model under the various scenarios. Beef exports from Alberta appear destined for the Pacific United States under each of the scenarios listed, and California appears the main magnet.

The second, is that the current pattern of shipment of beef from Western Canada to Eastern Canada, in particular the Montreal beef market, is under threat. The models suggest that a least-cost shipment pattern will place increasing pressure on Canadian packers to ship to the U.S. As a result, the pressures may also increase for a portion of the Canadian beef kill to take place in the U.S., in order to serve the U.S. market and to take advantage of the U.S. grading system for beef sold in the U.S.

Lastly, the forecast pattern of flows relies upon limited if any change in the economies of feeding animals in Canada versus the U.S. There seems little reason, however, to believe that the advent of NAFTA, and in particular the addition of Mexico to the previous trade arrangement between Canada and the U.S., will significantly alter the relationship for feeding cattle in Canada versus the U.S. Thus, the results are based on the expectation that changes in beef and cattle shipments between Canada and the U.S. will continue to follow historical patterns.

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5 In GAMS, marginal values represent the opportunity cost of shipping one unit of boxed beef to an alternate deficit region (see Appendix C). In this study, marginal values can also be used to measure the sensitivity of the model to changes in the transportation cost. The closer to zero a marginal value comes, the more sensitive the model is to changes in the constant.

VI SUMMARY AND INFERENCES

On January 1, 1994, the North American Free Trade Agreement was implemented by Canada, the United States and Mexico. For the most part, the NAFTA simply extended the market access provisions of the Canada-U.S. FTA to Mexico. Mexico has not historically been a major market for Canadian exports. Therefore, Canada's primary objective in pursuing the NAFTA was the preservation and enhancement of the Canada-U.S. FTA. Other objectives included: achieving barrier free access to the Mexican market on equal or equivalent terms as the U.S., and maintaining Canada's reputation as an attractive investment location. Upon implementation, the NAFTA created a continental market for beef and cattle, effectively eliminating the few remaining quantitative barriers to trade. The NAFTA is representative of the growing world trend towards increased trade liberalization through the negotiation of multilateral and regional free trade agreements.

The cattle and beef industries comprise the largest portion (by value) of Alberta's agri-food sector. In 1994, the value of Alberta's beef exports was $386 million, or 11 percent of total agricultural exports. Of that total, beef exports to the U.S. were valued at $354 million or 92 percent of total beef exports (Marketing & Statistics Branch, AAFRD, 1996). In comparison, Alberta's beef exports to Mexico were valued at only $1 million in 1994. Given the relative importance of this industry to the continued prosperity of the Agriculture sector, the need to understand how the NAFTA may impact Alberta's beef industry is evident.

This study is intended to assess the potential impacts of increased trade liberalization on agricultural trade patterns among Canada, the U.S. and Mexico. The study also examines what the possible impacts of increased Mexican beef demand would be on these trade flows in the short and intermediate term. The primary hypothesis of the study is that the NAFTA will likely have a minimal effect on beef trade patterns in the North American market. In order to test this hypothesis, a transportation cost minimization model was developed to estimate the least cost shipping routes and quantities. The results of this study indicate that the benefits of increased trade liberalization to Alberta's beef producers, as a result of the NAFTA, are likely to be modest but positive.

Increases in Mexican beef demand, due to growth in population and income, are unlikely to have a direct impact on Alberta beef producers through increased exports to Mexico. However, the NAFTA will likely result in increased market opportunities for Alberta in the U.S. Pacific Northwest, as U.S. beef is drawn from the southern and central U.S. into the Mexican market. In the short to intermediate term, the U.S. will remain Western Canada's primary export market for beef in the NAFTA region.

Declining per capita beef consumption in Canada and the U.S. will likely result in static or declining demand over the next few decades. In contrast, Mexican per capita beef consumption has been, and will likely continue, to increase steadily over the next ten to fifteen years. Mexico's relatively high income elasticity for beef suggests that as incomes rise, the demand for beef will also increase. Given Mexico's increased beef consumption potential, but with a likely slower growth rate in beef production due to resource and technology constraints, the model results suggest that Mexico will become more dependent upon imports to meet its growing beef demand. The results indicate that, with a 25 percent increase in income, Mexico would import 45 percent of total beef consumption. This figure likely overestimates the actual results. However, it does support the conclusion that Mexico will remain a net importer of beef in the short to intermediate term.

The results of the models also indicate that the U.S. Central region has a locational advantage, by way of proximity and lower transport costs, for exporting beef to Mexico. Alberta has a greater locational advantage for shipping excess supplies to the Pacific region, than it does to either Mexico or the deficit Canada East region. This suggests that the current trend towards increasing North-South trade flows will only be reinforced by the NAFTA. However, the degree to which this takes place is largely dependent upon whether Canada and the U.S. reach an agreement on beef grading equivalency. As long as Canadian packers must sell into the U.S. market at a discount, the incentive to ship boxed beef into Eastern Canada will remain, despite the inefficiencies of doing so. Another factor which is not accounted for in this model, is the demand for Alberta beef in Eastern Canada. One reason that Western Canada continues to ship carcass beef to Eastern Canada, especially Montreal, is that consumers in that market have shown a stated preference for Alberta beef. A transportation cost minimization model can not adequately capture consumer tastes and preferences, which also play an important part in this market.

A. Weaknesses

In this study, beef is considered to be a homogeneous, or undifferentiated product. Although this is an accurate characterization of much of the market, including most of the Mexican beef mark[illegible]oes not allow for examination of the potential for exports of higher quality beef [illegible]cts. Canada has an international reputation as a producer of high quality beef. In many offshore markets, the growth in Canadian exports is primarily due to industry's ability to target niche markets such as the hotel, restaurant and institutional (HRI) market. Currently, this market in Mexico is served by U.S. sources. Although the majority of Canada's beef exports to Mexico are offals, there may be opportunities to expand exports of higher value beef products, such as HRI beef. Studies show that the packing industry in Alberta is competitive with the U.S. (CITT, 1993), therefore, it can be assumed that Alberta packers can be price competitive in the Mexican market. To the extent that NAFTA contributes to higher per capita incomes in Mexico, the demand for higher quality beef products will also increase. Although the U.S. may have a locational advantage in this market, the extent to which Canadian packers increase their market share of the HRI market, is dependent upon the commitment of Canadian industry to capitalize on its reputation for high quality grain fed beef, and the realization that this is a market with potential.

In an effort to simplify the model, slaughter and feeder cattle flows were not included. Time series data indicate that the sources of feeder and slaughter cattle in the North American market have remained fairly constant, with Mexico exporting primarily feeder cattle, and Canada exporting primarily slaughter cattle to the U.S. market. Therefore, it is reasonable to assume that, in the intermediate term, the NAFTA will not result in significant changes to these patterns. However, the the planned expansions of the

IBP and Conagra/Excel packing plants in southern Alberta, will likely impact the flow of slaughter animals from Western Canada into the U.S. market. By the end of 1996, both IBP and Excel plan to be in a position to fabricate all animals slaughtered at their facilities. When completed, Alberta will have added fabrication capacity for 2.1 million animals. This additional capacity is equivalent to about 600,000 tons of boxed beef (Hayes et al., 1996). The increase in slaughter and fabricating capacity will likely lead to a decrease in slaughter cattle exports to both Eastern Canada and the U.S., and may eventually lead to an increase in imports of feeder cattle from the Northwest United States.

The future of beef consumption in Mexico could also be influenced by the consumption effects of price changes for beef, as closer integration occurs with the beef market in the U.S. and Canada. This is a factor not explicitly explored in this study, largely because the expectation is that those changes will tend to be moderate in relationship to income effects on consumption. Even the existence of significant increases in per capita consumption due to rising Mexican incomes is unlikely to change markedly the price of beef within North America.

This can be illustrated in the following manner: as of 1990, Mexico accounted for 14 percent of beef disappearance in the three-country region. Assuming the most optimistic income increase scenario for Mexico (scenario 7 in which incomes increase by 25 percent), Mexican per capita consumption would rise by 23 percent, given the high income elasticity estimated to exist in that market. However, the overall North American disappearance of beef (with population constant) would rise by only 3 percent. Were this shift in demand reflected in some combination of price increases and quantity increases, the effects would be modest indeed. USDA suggests a price elasticity of demand for beef in Mexico and the rest of the world in the vicinity of -3 (Liapis et al. Appendix Tables). If the magnitude of changes forecast occurs over a period of 10-15 years, as is likely, the consequences of prices or volumes will be difficult to separate from on-going forces.

B. Recommendations for Further Study

As trade liberalization leads to the reduction and eventual elimination of tariffs in the North American market, the use of non-tariff barriers, such as technical regulations and sanitary and phytosanitary (SPS) measures, as means to restrict trade will undoubtably increase. The Canadian and U.S. markets for cattle and beef are highly integrated and have been for a number of years. Therefore, the real access issues are not tariff or quantitative measures, but rather the non-tariff barriers which exist on both sides of the border. This model could be enhanced by including an estimate of the costs associated with non-tariff barriers, such as grading equivalency, in the calculation of total transfer costs. Although some work has already been done in this area (Hayes et al, 1996), there is a need for further study of the estimation of the costs associated with non-tariff barriers.

The model could also be expanded to estimate regional beef demand elasticities for Canada, the U.S. and Mexico. This was not done due to data limitations, especially that of prices for retail beef, and income in Mexico. In addition to estimating the demand for beef in Mexico, another area where further research could be done, is in estimating Mexico's beef production capabilities. This study does not explicitly study the implications of technology transfer on the future productive capacity of the Mexican beef and cattle industries.

An issue which is not examined in this study, but may be the subject of future research, is the market for breeding livestock associated with the modernization of the Mexican beef herd. The ongoing drought in Mexico has resulted in the liquidation of a large portion of the Mexican beef herd. Consequently, Mexico is showing increasing interest in importing beef genetics, including live animals, embryos and semen, to rebuild and improve beef herds. This is essentially a "seed stock" market, and like the market for premium beef cuts, it is one in which there is some prospect that differences between the typical Canadian versus U.S. beef herd can represent market opportunity. This analysis does not anticipate significant change in the growth pattern of Mexican beef production in the years prior to 2010, especially the pattern suggesting net flows of feeder animals to the U.S., and net flows of beef into Mexico. Nevertheless, an increasing focus on beef herd productivity and on North American standards of beef quality may create opportunities in livestock genetics to assist breed improvement, already apparently underway in Mexico.

In general, there is a need to continue to examine the implications and impacts of both domestic and international policies on the Canadian agriculture sector. Thc continued prosperity of Alberta's agriculture sector is increasingly dependent on exports. Therefore, it is important to both examine and understand the implications of such trade related policies as: Chile's accession to the NAFTA; and developments in multilateral trade agreements, such as the World Trade Organization (WTO) and the Asia Pacific Economic Cooperation (APEC).

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APPENDIX A: Description of Regions

Table 1: Breakdown of Regions Into States and Provinces

Regions	States/Provinces
Canada West	British Columbia, Alberta, Saskatchewan, Manitoba, NWT, Yukon
Canada East	Ontario, Quebec, Newfoundland, Nova Scotia, P.E.I., New Brunswick
Pacific	Alaska, Oregon, Washington, California, Hawaii
North Central	Idaho, Montana, Wyoming, Minnesota, North Dakota, South Dakota
Central	Colorado, Nevada, Utah, Iowa, Kansas, Missouri, Nebraska
South Central	Arizona, New Mexico, Oklahoma, Texas, Arkansas, Louisiana
Northeast	New England, Illinois, Indiana, Wisconsin, Michigan, Ohio, New Jersey, New York, Pennsylvania
Southeast	Delaware, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Mississippi, Kentucky, Tennessee, Florida, Georgia

Table 2: Distances Between Central Points
Distance in Miles

	Montreal	San Francisco	New York	Atlanta	Mexico City
Calgary	2269	2113	1815	1705	2842
Helena	1324	1098	1235	1753	2291
Denver	2404	2934	1771	1552	1746
Dallas	2266	2030	1398	795	1138

Source: Rand McNally Road Atlas, 1977, pg2.

Figure 1: Map Illustrating Regions and Central Points Used in the Model

APPENDIX B

Table 1: Regional Surplus and Deficit Quantities used in Models - Actual and Adjusted

	Model #1		Model #2		Model #3		Model #7	
SURPLUS AREAS:	1991		1991		2010			
CANADA WEST	133.87		133.87		133.87			
NORTH CENTRAL	323.51		323.51		323.51			
CENTRAL	3234.46		3234.46		3234.46			
SOUTH CENTRAL	313.82		313.82		313.82			
TOTAL '000 MT	4005.67		4005.67		4005.67			
DEFICIT AREAS:		Adjusted		Adjusted		Adjusted		
CANADA EAST	303.6715	269.1731	303.67	266.55	303.67	217.94		
PACIFIC	766.0358	679.0141	766.04	672.39	766.04	549.79		
NORTH EAST	1855.47	1644.689	1855.47	1628.66	1855.47	1331.67		
SOUTH EAST	1593.833	1412.771	1593.83	1399.00	1593.83	1143.89		
MEXICO			44.00	39.06	1062.00	762.20		
TOTAL '000 MT	4519.011	4005.647	4563.01	4005.66	5581.01	4005.49		
	Model #4		Model #5		Model #6		Model #7	
SURPLUS AREAS:	2010		2010		2010		2010	
CANADA WEST	133.87		185.51		133.87		133.87	
NORTH CENTRAL	323.51		409.32		323.51		323.51	
CENTRAL	3234.46		3804.86		3234.46		3234.46	
SOUTH CENTRAL	313.82		510.62		313.82		313.82	
TOTAL '000 MT	4005.67		4910.3'		4005.67		4005.67	
DEFICIT AREAS:		Adjusted		Adjusted		Adjusted		Adjusted
CANADA EAST	303.67	227.58	272.59	265.79	303.67	213.85	303.67	209.83
PACIFIC	766.04	574.10	695.95	678.59	766.04	539.46	766.04	529.32
NORTH EAST	1855.47	1390.56	1702.87	1660.38	1855.47	1306.66	1855.47	1282.09
SOUTH EAST	1593.83	1194.48	1539.54	1501.13	1593.83	1122.41	1593.83	1101.31
MEXICO	825.00	618.29	825.00	804.42	1169.00	823.23	1278.00	883.07
TOTAL '000 MT	5344.01	4005.01	5035.95	4910.30	5688.01	4005.61	5797.01	4005.62

APPENDIX C

Table 1: Marginal Values Calculated for Model 1
(in dollars)

Model 1				
Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Cent (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)	35,649.46	40,279.26		40,940.66
Pacific (San Francisco)			9,722.58	
Northeast (New York)	47,488.52	76,259.42		25,397.76
Southeast (Atlanta)	54,697.78	125,004.6		

Table 2: Marginal Values Calculated for Model 2
(in dollars)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)	35,649.46	40,279.26		40,940.66
Pacific (San Francisco)			9,722.58	
Northeast (New York)	47,488.52	76,259.42		25,397.76
Southeast (Atlanta)	54,697.78	125,004.6		
Mexico (Mexico City)	117,067.8	147,756.76		9,854.86

Table 3: Marginal Values Calculated for Model 3 (in dollars)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)	35,649.46	40,279.26		40,940.66
Pacific (San Francisco)			9,722.58	
Northeast (New York)	47,488.52	76,259.42		25,397.76
Southeast (Atlanta)	54,697.78	125,004.6		
Mexico (Mexico City)	117,067.8	147,756.76		9,854.86

Table 4: Marginal Values Calculated for Model 4 (in dollars)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)	35,649.46	40,279.26		40,940.66
Pacific (San Francisco)			9,722.58	
Northeast (New York)	47,488.52	76,259.42		25,397.76
Southeast (Atlanta)	54,697.78	125,004.6		
Mexico (Mexico City)	117,067.8	147,756.76		9,854.86

Table 5: Marginal Values for Model 5
(in dollars)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)	35,649.46	40,279.26		40,940.66
Pacific (San Francisco)			9,722.58	
Northeast (New York)	47,488.52	76,259.42		25,397.76
Southeast (Atlanta)	54,697.78	1,250,004.6		
Mexico (Mexico City)	117,067.8	147,756.76		9,854.86

Table 6: Marginal Values for Model 6
(in dollars)

Deficit Regions	Surplus Regions			
	Canada West (Calgary)	North Central (Helena)	Central (Denver)	South Central (Dallas)
Canada East (Montreal)	35,649.46	40,279.26		40,940.66
Pacific (San Francisco)			9,722.58	
Northeast (New York)	47,488.52	76,259.42		25,397.76
Southeast (Atlanta)	54,697.78	1,250,004.6		
Mexico (Mexico City)	117,067.8	147,756.76		9,854.86

Table 7: Marginal Values for Model 7
(in dollars)

Deficit Regions	Surplus Regions			
	35,649.46	40,279.26		40,940.66
Canada East (Montreal)			9,722.58	
Pacific (San Francisco)	47,488.52	76,259.42		25,397.76
Northeast (New York)	54,697.78	1,250,004.6		
Southeast (Atlanta)	117,067.8	147,756.76		9,854.86
Mexico (Mexico City)			762	