THE ECONOMICS OF BRANCHLINE ABANDONMENT: A CASE STUDY OF WEST-CENTRAL SASKATCHEWAN

A Thesis
Submitted to the College of Graduate Studies and Research
in Partial Fulfillment of the Requirements
for the Degree of Ph.D.

In the
Department of Agricultural Economics
University of Saskatchewan

by
Mohammad Khakbazan
Spring 1999

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SUMMARY OF DISSERTATION

Submitted in partial fulfillment

of the requirement for the

DEGREE OF DOCTOR OF PHILOSOPHY

by

Mohammad Khakbazan

Department of Agricultural Economics
University of Saskatchewan

Spring, 1999

Examining Committee:

Dr. W. Bishopp	~~Dean/Associate Dean~~, Dean's Designate, Chair College of Graduate Studies and Research
Dr. G.G. Storey	Chair of Advisory Committee, Department of Agricultural Economics
Dr. R.S. Gray	Supervisor, Department of Agricultural Economics
Dr. W.H. Furtan	Department of Agricultural Economics
Dr. J.D. Spriggs	Department of Agricultural Economics
Dr. G.A. Sparks	Department of Civil Engineering

External Examiner:

Dr. B. Prentice
Director, Transport Institute
University of Manitoba
66 Chancellors Circle
Winnipeg, Manitoba R3T 5V4

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Department Head
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Saskatoon, Saskatchewan
Canada, S7N 5A8

ABSTRACT

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Supervisor: Dr. R.S. Gray.

In light of the changes that are occurring in the grain handling and transportation industry, one area of major concern in the new deregulated environment is the branch line abandonment and the optimal length of branch lines. The length of branch lines and location of delivery points are two important factors for an efficient transportation system. Production quantity, farmers costs, railway costs, elevator costs and road costs (taxpayers) all can be affected if a railway decides to abandon a branch line.

This thesis examines the costs of alternative branch line configurations with the maximum cap rates in place, and the distributional changes of surpluses (losses) on railways, farmers, grain companies and roads under a regulatory framework (Bill C-101) and the current system. The objective of this study is, first, to use simulation techniques to explore the optimal configuration of a railway branch line system and consequent impacts on railways, farmers, grain companies and roads in a chosen region, and then to comment briefly on the major changes in regulatory rules pertaining to railroads.

The study utilizes a spatial equilibrium model of a particular region in the Western Canadian grain market. The spatial model incorporates cost behavior of various industry components of the grain transportation industry. In the model the interaction of the cost relationships determines the behavior of farmers and the railway. With a given export price, changes in the branch line configuration may affect the returns received by farmers and the railways.

Various configurations of branch lines are simulated. These configurations are developed to determine: 1) the distribution, with branch line abandonment, of losses and surpluses for the parties involved in the grain industry, and 2) the most socially optimal configuration of branch lines. In each scenario, a different length of branch line is abandoned and a comparison is made to answer the above questions.

The results indicate that an increase in transportation cost as a result of line abandonment causes a relatively small decrease in grain produced, and a movement away from higher volume commodities toward lower volume commodities. Increased transport distances to elevators also lead to more truck usage and more damage to the roads in the study region. The overall impact is a loss to producer's welfare, greater cost for roads, and a large gain to the railways.

The least-cost rail configuration is where the *Rosetown* branch line of the CN rail and *Kerrobert* and *Macklin* subdivisions of the CP rail stay open in the region. Thus, current costs suggest that fairly widespread abandonment is cost-reducing from a social perspective. Any reduction in the cost of operation of branch lines, such as short-line operation, would increase the optimal number of branch lines. Similarly, any reduction in trucking costs would reduce the optimal number of branch lines.

This socially optimal configuration differed from the railways' interests within Bill C-101, where profits are maximized with a complete abandonment of the branch lines. Thus, it is in the interest of the railways to have more widespread abandonment compared to what is least costly from a social perspective though CN rail gains almost all the benefits while CP rail do not gain much. Given the assumption that the railways are unlikely to collude, and that CP is unlikely to abandon its track to help CN make more profit, the socially optimal outcome is the most likely outcome given the market dynamics that are in place. However, the difference in efficiency gains between a complete abandonment as compared to a partial abandonment was relatively small especially if one allows for competition between the railways. In a "competitive scenario" the result is essentially the same as the socially optimal configuration.

A $6,000/km penalty for abandonment reduces the railway's incentive for abandonment. If they do not collude, this penalty would result in the socially optimal level of abandonment. If the railways do collude, it would be in CN's interest to abandon all branch lines, even with the penalty in place, but not in CP's interest.

In sum, the model shows that moderate changes in trucking and rail costs yield a range of results. The results indicated that using larger trucks leads to significant redistribution of benefits among the parties involved in the grain industry. The results illustrated that lowering the railway's volume-related cost leads to significant benefits to the railways. Other parties involved in the grain industry can benefit only if railway freight rates decrease – the only "losers" are taxpayers.

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CHAPTER I

INTRODUCTION

1.1 Introduction

In the Canadian grain handling and transportation system, the length of branch lines and location of delivery points are important factors to ensure efficient transportation. Farmer costs, road costs, handling costs and rail costs can all be affected by the branch lines and the operation of delivery points. In recent years, consolidation has been occurring in two processes: a) the abandonment of lower volume railway branch lines, b) the replacement of lower volume primary elevators with new large facilities. The latter often also provide "cleaning", "drying" and other processing services in addition to grain storage and elevation/loading of railcars.

On February 27, 1995, the Government of Canada announced a reform in operating rules and gave new powers to railways that allowed for more rapid abandonment of (low-volume) branch lines. These policy changes affect railways behavior; which in turn affect grain prices, locational advantage, and the overall performance and economic efficiency of the grain marketing system. This thesis examines the incentives and consequences of railways abandoning low volume branch lines. In particular, a model is developed to examine the optimal railway branch line configuration under the existing elevator system. Consolidation of elevators is not addressed by this study, though it is a very important issue.

1.2 Background

In Western Canada, where almost all grain exported is moved by two railways, the costs of grain movement and its component the freight rates charged are important. Prairie farmers rely on the transportation system to carry their grain around the world. If farmers face inefficient or mispriced freight rates, this creates inefficiency at the farm level. Depending on the product and its final destination, there is scope for avoiding part of the deficiency by shifting to more efficient routes or modes of transportation.

Most of Canada's extensive rail network was completed by the 1920s. It was built during a time when the road system was very limited and rail was the dominant mode of transportation. Rail service became a tool of national policy that was used to stimulate the economic development of various regions.

In 1897, the Government of Canada entered an agreement with Canadian Pacific Railway to set maximum freight rates for grain movement in exchange for government assistance in constructing a line through the Crow's Nest Pass of British Columbia (The Crow's Nest Pass Agreement, 1897). These freight rates were extended to all railways and all western grain movement by law in 1925. This statutory requirement forced the railroads to move grain for a set rate indefinitely. The inflexible rate structure reflected the heavy hand of regulation prevalent in the grain economy of Western Canada. Rail regulation imposed severe financial pressure on railroads, and resulted in high costs and relatively inefficient operating performance.

Over time, the costs associated with the transportation of grain rose with inflation and the railroads began to incur losses. By the 1970s the statutory Crow Rate was far below the cost of moving grain. In 1977 only 32% of variable costs were covered by users, 18% by federal branch line subsidies and the remaining 50% was left to the railroads as a loss. As a result, the railroads had an incentive to slow down maintenance on Prairie branch lines. A lack of equipment capacity to move grain to port became severe during the 1970s and led to major delays and a lack of capacity. Demand for wheat exceeded the grain transportation capacity, and grain sales were lost. As a result of this crisis, the Government of Canada along with the Provinces of Saskatchewan and Alberta became involved in the grain transportation industry by providing new hopper cars to improve grain handling and transportation capacity.

In 1983, the Western Grain Transportation Act (WGTA) was introduced in an attempt to increase capacity in the grain transportation sector. Under the WGTA, the Canadian Government paid railways the difference between the cost of moving grain and the freight rates paid by farmers from interior points to the designated points - e.g., Thunder Bay, Churchill, Prince Rupert and Vancouver. Canadian shippers paid only a portion of rail costs for movements covered by the WGTA; the balance was paid directly by the government to the railways on eligible movements. The total volume of the government subsidy was fixed, except for a share of inflation over six percent. A volume cap was applied to total subsidy outlays.

In addition to setting rates and providing a subsidy of about $700 million per year, the WGTA regulated the abandonment of "grain dependent" branch lines. These lines were deemed by the National Transportation Agency to be necessary to the prairie grain sector. Under the WGTA, railway companies could not abandon any of these lines without review by the National Transportation Agency.

Over time the Act was intended to transfer the responsibility of the costs from the government to the grain producers. Despite lower than anticipated inflation since 1983, the government was still responsible for a significant subsidy to the railroads (the producers paid about 1/3 of the freight costs, or $10/tonne).

Efficiency and cost are another major concern in the rail transportation system. Exporters faced intense competition from abroad and demanded a more efficient transportation system. They needed lower rates in order to survive. Canada's railways responded to these new realities with cost-cutting initiatives to improve their productivity. Since 1983, CN Rail and CP Rail have abandoned 20% of their lines. Despite these efforts, inefficiency in the system persists. In 1993, CN Rail and CP Rail carried 93% of their traffic on just 41% of their track. In other words, more than half of the lines known as "low-density branch lines" were hardly used for grain movement even though the high costs of these lines were considered in the railways' costs.

The abandonment of rail branch lines, which would provide some consolidation of the rail line network, has been a constant theme. It is a commonly held view that the achievement of rationalizing the rail network will put Canada's two major railway companies, Canadian Pacific Railway (CPR) and Canadian National Railway (CNR), on better financial footing, and allow them to make more investment in the rail network. These companies have argued that various rail branch lines are uneconomic and a net financial cost to their operations. By allowing for the abandonment of such lines, the government hopes to increase the efficiency of the remaining rail transport system.

One important criticism of railroad regulation prior to recent reform was that regulation reduced rail profits and diverted funds away from investment in high-volume main lines by forcing railroads to keep unprofitable branch lines operating. Restrictions on service cutbacks contributed to the railways' poor financial condition and directly affected the viability of parts of the system. However, the agricultural community's interest in the issue arises from the perception that many low-density branch lines help serve rural areas and agricultural shippers.

On February 27, 1995, the Federal Government announced the demise of the WGTA. They would no longer provide the Crow Benefit to the railroads, and a one time capital payment of $1.6 billion would be made to farmowners as compensation for the loss of the subsidized Crow Rate. Producers would be responsible for paying the regulated rate of shipping grain to the various international markets. The rail sector came under the regulation of the new Canadian Transportation Act (CTA) under Bill C-101. A maximum rate would be set for the next five years by the CTA. The rate would be based on railways' cost structure, which is determined through legislation (the cost of railroads for every mile of branch line abandoned would be reduced by 10,000 dollars). This is to provide some protection for shippers from monopolistic price setting by railroads. Further, this provision has been made to discourage railroads from line abandonment for a five-year period.

Elimination of the WGTA means that shippers pay the full costs of shipping their grain. On average, the shippers' share of the transportation cost would increase by $15.63/tonne based on 1994/95 rates.

1.3 Branch Line Abandonment

Over the years, the regulatory process of abandoning the branch lines has been the subject of intense debate because of the cost and complexity of involved. The National Transportation Agency (NTA) in 1987, made several revisions to the abandonment process. Between 1988 and 1992, each railway was permitted to abandon up to 4% of its total track each year. During that five-year period, CN Rail and CP Rail applied to abandon a total of 7% and 9% of their respective networks. The 4% limit on abandonment expired at the end of 1992. Canada's railways continue to operate many lines with very little traffic. Fifty-nine percent of CN Rail and CP Rail track handles just 7% of their traffic.

Traffic densities (as measured by revenue tonne-kilometers per route kilometer) vary across Canada. It is argued that the rail transportation system on the prairies is more costly than it should be because of the low-density branch lines. A 1991 study by the Senior Grain Transportation Committee estimated that $25.5 million would be saved annually if 2,198 kilometers of grain-dependent rail lines were abandoned.

While it is generally agreed there is excess capacity, there is disagreement about how and where rationalization should occur. In the process of abandonment it is important to address the concerns of farmers, provincial governments, railways, and communities affected by abandonment. On the other hand, some feel that any restrictions on the ability of railways to abandon lines is unfair relative to other modes of transportation; the regulatory process should be as simple and efficient as possible.

There are two different views on how the branch line abandonment should be treated. These two views are briefly discussed below.

1. Unrestricted abandonment should not be permitted at this time because:

- they create hardships for farmers who must find new, possibly more costly and inconvenient routes, and for small communities where rail services are part of the economic and social fabric;

- an "essential rail network" should be established first, to ensure that lines determined in the public interest are not abandoned;

- special programs (e.g. transitional assistance) and transportation alternatives must first be made available to those adversely affected; regulations must also be changed to allow short line railways to easily acquire lines;

- abandonment will lead to more truck traffic, accelerating road damage; this will increase the financial pressures on provincial and local governments to build and maintain roads. These costs are not directly borne by farmers, and are thus external to the market place and will not be reflected in a competitive market place;

- historically, land and cash were granted in exchange for extending rail service to under-developed regions; railways have an obligation to continue serving these regions.

2. No restrictions should be placed on abandonment because:

- railways have long-term financial problems, which must be addressed without delay; they must rationalize their networks to cut costs and this could benefit farmers through lower rates;

- government policies have promoted trucking at the expense of rail; trucks use publicly-funded roads while railways, which also pay fuel and property taxes, provide their own infrastructure;

- land and cash grants were a common incentive payment for the construction of rail lines throughout North America when there was inadequate economic incentive for private sector funding.

1.4 Statement of Problem

It is widely acknowledged that new solutions or new forms of branch lines are needed by the railways and governments to address the operating performance and long-run financial problems of Canada's major railways. Further reforms will structure the opportunity set and thus shape behavior and performance of all components of the grain handling and transportation industry. These changes affect the opportunity set faced by railways, grain producers, grain companies, and grain marketers and grain processing industries. In a feedback loop, these changes affect branch line configuration. Regulatory reform and the resulting change in branch lines and the rate structure could have important implications for grain production and movement within Western Canada. Understanding the issue and its consequences is the first step towards making any decision and setting policy.

This research is motivated by the desire to determine the welfare implications (the costs) of alternative branch line configurations under a regulatory framework (Bill C-101). Specifically, this study compares the efficiency of alternative branch line configurations if the maximum rate cap is in place. The goal is to investigate the possible impacts of abandonment on various groups involved in the grain handling and transportation system.

Efficiency is a key element. Some argue that the world is moving in a globally competitive direction and that if the government moves in this direction, via deregulation, and gives the agents the incentive to freely compete, this will result in a more efficient grain sector, which in turn will increase access to foreign markets and increase the profitability of agriculture. They argue that deregulation will allow railways greater flexibility in setting rates and offering services if railways have no market power. On the other hand, some believe that deregulation is not a good prescription because it will involve monopoly operation of the railways' transportation system. By deregulating the transportation system, monopoly power will lead to higher freight rates and the development of a more costly and inefficient system for producers- hence, there is a need for regulation. The present research should provide an efficiency comparison of the alternative configurations.

The government's role in setting directions and regulations among the components of the grain handling and transportation system is an important issue. This study provides some answers to the question of appropriate regulation. Government may be required to intervene to some extent and exercise some regulation on the railways. It has chosen to do so by the regulation of railway freight rates. In this environment, railways do not have monopoly power because government regulates the railway freight rates with a maximum cap. The other parts of the industry operate in a largely competitive environment. There are many producers producing grain and enough grain companies to create a competitive market. All these elements try to minimize their costs. Road costs are external to the grain market but are affected by grain movement. Central to this problem is to first determine the least cost length of branch line configuration under this market arrangement. If this can be done, the number of elevators, the level of output as well as returns received by farmers, elevator companies, and the railways will be determined.

1.5 Objectives

The objectives of this study are twofold: (a) to comment briefly on the major changes in regulatory rules pertaining to railways, and (b) to use simulation techniques to explore the optimal configuration of a railway branch line system under the existing elevator system and the consequent impacts on railways, farmers, grain companies and roads in a chosen region. The study assumes that the process of abandonment is based on a railway's desire to decide which lines should be identified for abandonment.

The results of this study may assist farmers, railways, and grain companies in making a decision regarding the consequences of abandonment. This study also presents recommendations arising from this branch line study.

1.6 The Organization of the Study

The remainder of the thesis is organized into five chapters. Chapter 2 presents literature review and an historic overview of railway regulation in Canada. Chapter 3 presents the theoretical framework of the grain handling and transportation system and the related assumptions. The specification of the empirical model, data, and the region is described in Chapter 4. An overview of model setting in spread sheet form is also provided in this chapter. Chapter 5 presents the empirical results of the simulation. Finally, Chapter 6 contains a summary and conclusion to the thesis.

CHAPTER II

Literature Review and An Historic Overview of Railway Regulation in Canada

2.1 Introduction

In the 19th and 20th Centuries, many railways received federal and provincial charters to build and operate lines in Canada. These railways, including CP Rail, which completed the first transcontinental line in 1885, played a key role in unifying the country and opening vast frontiers for settlement and development.

Rail movements of grain products has been a focal point of transport policies for over a century in Western Canada. The railway companies were among the first business enterprises to be subjected to regulatory policies and extensive control by the modern state. Initial developments of the railway system and imposed regulation have had a significant impact on the present structure of the system. An understanding of the past helps to make better decisions for the future.

Section 2.2 presents an historical review of grain transportation policies and the structure of the transportation system in Canada. It is intended to provide the reader with a sense of railway policy changes over time and an understanding of the regulatory framework and competitiveness of the transportation system. Section 2.3 reviews literature on transportation issues, particularly the impact of branch line abandonment.

The method of this thesis differs from previous research in that, in general, the simultaneous effect of a change in the grain transportation system will be taken into account. In other words, the effect of a change in one part of the system on the performance of whole system is considered simultaneously. Farmers make their decisions regarding where to deliver their grain by comparing the net price at alternative delivery points. The amounts and types of crops that farmers choose to grow and subsequently deliver depend on the net prices they receive. In most previous studies it is assumed that grain supply is a vertical line and response of farmers to the net price was not considered. In this thesis, production decisions depend on the net prices farmers receive. Unlike many previous studies that assume fixed railways' average branch line costs obtained from aggregate data with no response to change in line abandonment, this thesis takes into account this response and the changes in the railways' average branch line costs.

2.2 An Historic Overview of Railways

A number of studies were used to assemble the following historical picture of Canadian transportation policy. These include Cruikshank (1991), Fulton and Gray

(1997), Karwandy (1992), Harvey (1980), Fairbairn (1984), Grain Handling and Transportation Commission (1977), MacEachern (1978), Policy, Planning and Economics Branch (1978) and the Saskatchewan Transportation Agency (1977).

Canada's first railway, the Champlain and St. Lawrence Railway, began operating in 1836. In the second half of the nineteenth century, Canadians experienced a transportation revolution. Railways acquired the technology to carry more and more freight without corresponding increases in the amount of work performed by their locomotives. Railway companies adopted the latest technological advances in order to remain competitive or gain a marginal advantage over other railways and transportation companies. At the same time, they continued to lay more rails to reach new areas as well as lucrative markets already served by their competitors.

Territorial and technological competition ensured that in each of the final four decades of the nineteenth century, more and more Canadian communities became part of an increasingly efficient transportation system. As the railway network expanded and technology advanced, shippers were able to send goods by rail for longer distances, more cheaply and rapidly, with less handling, and with greater attention to the special transportation needs of their product.

The expansion of the railway network and continual advances in locomotive technology during the closing decades of the nineteenth century posed different kinds of challenges for both shippers and railways. On one side, railways had to decide where and how much to reduce rates in order to maximize traffic revenues while keeping costs to a minimum. In making these choices, they gave little thought to the actual cost of transportation, a fact that frustrated those shippers trying to understand the rate structure. On the other side, merchants, farmers, and manufacturers in all parts of Canada found that the strategies adopted by railways to maximize earnings conflicted with their own business ambitions.

While some shippers continued to rely on private bargaining to acquire favorable rate concessions, during the final decades of the nineteenth century an increasing number of merchants, manufacturers, and farmers turned to their political leaders in an effort to shape rate decisions. They challenged the right of private railways to make choices through their rate-making policies about the pattern of economic development. Business leaders and their political representatives searched for a way to use public power to reconcile freight tariff decisions with their own economic ambitions. Thus, the politics of freight rates produced a gradual but significant transformation of the state's authority over the economy.

The pressures facing railways reflected the industry's peculiar combination of monopolistic and competitive characteristics. For some communities in the nineteenth century, a single railway company provided the only transportation link to markets and suppliers. Others watched as lines that had once competed amalgamated with each other or entered into various types of co-operative arrangements. Increased self-regulation in the 1880s and the merger of smaller lines into the Grand Trunk and Canadian Pacific systems expanded the opportunities for collusion. Although shippers might experience the railway as a monopoly, many forms of competition continued within the industry, particularly for traffic through the eastern seaboard.

The Canadian Pacific's western rate structure provides a unique illustration of the influences that shaped freight rates, since throughout most of the 1880s the company had a virtual transportation monopoly in the west. Railways enjoyed a considerable margin of discretion in setting rates. During the final decades of the nineteenth century, an increasing number of shippers came to believe that the private system of rate-making placed them at a disadvantage and did not adequately respond to their changing economic situation.

Whatever strategy shippers adopted, however, rate decisions involved a process of bargaining and compromise. The private negotiation of freight rates involved political controversy and choice; politics always was a part of rate-making.

The Canadian Pacific Railway (CPR) was established in 1878. Prior to that, other attempts had been made to organize a development plan for the construction of a national railroad. In an 1880 contract between the CPR and the government, the CPR received money and land in exchange for a strong national link. The CPR built the national rail link in exchange for lower project costs and reduced initial development risk.

With the completion of the railroad and the compliance of each party to the terms of the original agreement, the government still recognized that western development was not occurring as hoped. The CPR faced tough competition in Eastern Canada from numerous railways and the seaway system, but used its monopoly position in the west. The monopoly position of rate-setting in the west created strong demand from the Winnipeg merchants to control the monopoly freight rates on products moving in and out of Western Canada.

Freight rate grievances did not necessarily generate demands for regulation by a government agency. The regulation by government emerged as a result of Canadian Pacific's desire to tap the markets and minerals of the booming mining district of southern British Columbia.

In 1896, the CPR and the federal government of Canada were both interested in constructing a rail line into the southern part of British Columbia. The Kootenay area in that part of the province had been discovered to be rich in minerals and the CPR wanted to tap mineral resource traffic. The Canadian Pacific Railway found that in order to acquire public funds, they would have to agree to the kind of regulatory contract that railway promoters often made with local governments. In addition, rail lines from the United States were threatening to penetrate the area from the south and neither the CPR nor the federal government wanted to see the mineral traffic on a U.S. line when a Canadian railway was an alternative.

In the historic "Crow's Nest Pass Agreement" of 1897, the government negotiated the "Crow's Nest freight rates" with the CPR in return for more land and mineral rights. The CPR was to receive a subsidy of $11,000 per mile to assist in building a railway from Lethbridge, Alberta through the Crow's Nest Pass to Nelson, British Columbia for a total subsidy of $3.4 million. The $3.4 million was in the form of land and mineral rights, as well as direct cash payments. For this subsidy, the CPR agreed to reduce the existing freight rates by three to fourteen cents per hundredweight on grain and flour moving from the west to Fort William/Port Arthur and points east thereof, by September 1, 1899, and "for all time." Special rates were given on a range of "settler's goods" shipped west from Central Canada. These included agricultural implements, binder twine, fresh fruit, coal oil, livestock, household furniture and certain building materials. In addition, the CPR turned over some coal-bearing lands to the Government of Canada.

This Crow rate agreement achieved several objectives: it secured mining ventures in British Columbia for Canadian development; it accelerated western settlement and wheat export; and it provided an expanded market for goods manufactured in Central Canada. In addition, for the first time, the federal government adopted the local government strategy of attaching rate-regulatory conditions to a financial subsidy. If it had the political will, the federal government was in a better position to enforce its contract because the railway company could not escape its obligations through an appeal to a higher governing authority. The "Crow" became an integral part of the settlement of western Canada and of the industrialization of eastern Canada.

The Crow's Nest Pass agreement represented a significant development in the nineteenth century regulatory system. Although those who supported competition in the Crow's Nest Pass failed to achieve their objective, the controversy that they generated resulted in the government asserting some measure of control over freight rates on one of Canada's major railways.

The limited contractual obligations negotiated in the Crow's Nest Pass agreement demonstrated that railway promoters still had a fairly strong bargaining position with governments. The Canadian Pacific never really faced a serious rival in negotiating the construction of the Crow's Nest Pass. Moreover, the project was seen to be of considerable importance to the overall health of an economy just emerging from a commercial depression.

While it could hardly be called laissez-faire, Canadian business and political leaders adopted a market-oriented approach to the regulation of railway freight rates in the late nineteenth century. They did not readily abandon the market system in favour of government intervention but rather looked to familiar business mechanisms - competition and contracts - to resolve their freight grievances. The dependence of many of Canada's railways on public assistance provided the means of introducing some controls on private behaviour. Nevertheless, railways continued to enjoy considerable influence and bargaining leverage when it came to dealing with governments (Cruikshank 1991).

Before the establishment of the Board of Railway Commissioners in 1904 (Canada's first national independent regulatory agency) business and political leaders could ask the courts or a special cabinet committee to respond to their freight rate grievances. At the same time, they convinced their political leaders to sponsor the construction of competitive lines and to exchange public financial assistance for rate concessions.

From 1904 onward, the Board of Railway Commissioners provided the central forum for hearing and resolving freight rate disputes. The board, the direct ancestor of both the National Transportation Agency and the Canadian Radio and Telecommunications Commission, served as the institutional model for many subsequent regulatory initiatives. It was established to supervise and alter all rail rates.

Faith in competition continued into the twentieth century, and business and political leaders continued to try to shape railway corporate behavior by creating competition. The belief that competition would regulate railway behavior helped produce an extraordinary amount of duplication within the Canadian railway network during the period of time between the Crow's Nest Pass Agreement and the end of World War I, eventually creating enormous problems for public policy-makers. The Canadian Northern received generous government support to construct branch lines into areas already served by the rival Canadian Pacific in the prairie west. In British Columbia, Canadian Northern promoters were generously assisted by the provincial government to construct a line from Vancouver to the prairie west in order to provide competition for the Canadian Pacific.

Three rail links were built to the west coast and the extensive system of branch lines developed in western Canada. Competition drove these lines to be built in close proximity to one another. By the beginning of World War I, however, it was apparent that excessive capacity had been constructed. The country had a network of railway lines that could not be supported by the traffic available.

The Crow rates were lowered before World War I for competitive reasons and they were suspended during the war because of inflation. In 1919, CN Rail was formed through a merger of several struggling railways. In 1920, the special rate on settlers' goods was abolished, and the rates on wheat and flour were made statutory under the Railway Act at approximately 20 cents per hundredweight (to maintain a distinction, the rates after 1925 have been called statutory rates because their existence comes from the Act of 1925, not the Agreement of 1897). They were extended to cover all of the export ports, making the Crow Rate one of the cornerstones of Canadian transportation policy.

During the next 20 years, a wave of railway failures swept the industry. There were public discussions about forming a single national railway system, but in 1932 the Royal Commission on Railways and Transportation (i.e. the Duff Commission), concerned about creating a monopoly, recommended against it. By the 1930s, the industry had evolved into the present Canadian network, dominated by two transcontinental freight carriers.

By the 1950s the railways were losing money and the railroad conditions had begun to deteriorate. The railways were losing money because trucks had captured all the "in bound" freight to the small communities leaving only grain to haul out in box cars. The lost utilization therefore made the railways unprofitable. In other words, public money to build roads robbed non-grain traffic from the branch lines.

For the period of 1951 to 1977, commissions were appointed during each major crisis in the railway industry and reports were written in line with the mandates of the commissions. The most notable in looking at the Crow Rates included the Turgeon Commission in 1951, the Macpherson Commission in 1967 and the Hall and Snavely Commissions in 1977.

The Turgeon Commission (1951) had been appointed to study the freight rate situations. Subsidization based on the policy of reducing regional freight differences was recommended. The advice in this report seems to have been largely ignored.

The Macpherson Commission (1967) was appointed to look into existing problems and inequities in the system. This commission identified increased competition coupled with very strict regulation as the problems plaguing the railways and made a number of sweeping recommendations. Many of these recommendations were incorporated into the National Transportation Act. This commission also brought into focus the magnitude of the redundancy problem in the branch line network.

The Hall Commission (1977) was appointed to evaluate rail requirements, to evaluate the response of grain producers, elevator companies and communities to changing circumstances; and to evaluate the socio-economic impact of an evolving rail network. The commission made a wide range of recommendations. Some of the principal ones involved adding some track to the protected network, abandoning other track, and referring other track to the Prairie Rail Authority for review and interim management.

Each of the above three commissions concluded that the Crow Rate should be retained because it was essential both for prairie agriculture and the overall interests of Canada.

The same year as the government commissioned the Hall Inquiry, it also commissioned an inquiry into the costs of moving grain by rail under statutory rates, the Snavely Commission. For 1974, the Snavely Commission estimated operating costs for moving Crow grain were $231 million, with statutory rate revenues covering 38%, government subsidies covering 24%, and the balance of 38% left with railways as a loss. The distribution of the coverage of these costs in 1977 were statutory revenues, 32.4%; government, 18.0%; and railways, 49.6%. The farm community was skeptical of these costs and refused to believe that the railways were in fact losing money.

The trend turned towards abandonment of rail lines as railways started to incur greater costs on railway branch lines. These abandonment have been closely controlled, and the railways have been prevented from abandoning a significant mileage of branch line track in western Canada in the interest of local communities' dependence on the service. In light of this regulation, the federal government has provided "branch-line subsidies" to cover the difference between the costs and revenues associated with operating these lines. The federal government has also underwritten the cost of providing modern aluminum and steel hopper cars (as have the Canadian Wheat Board and the governments of Saskatchewan and Alberta).

Despite these efforts, the Canadian railway system continued to operate below par. By the late 1970s grain transportation to the West Coast had become a severe constraint to the grain economy.

The first hint that the federal government was seriously considering abolishing the Crow Rate came in October, 1974. Otto Lang, minister responsible for the Canadian Wheat Board, in an address to the Canada Grains Council, suggested that the Crow was a detriment to both railroads and producers and that change was being considered. The Transportation Agency of Saskatchewan published books and pamphlets outlining "Why The Crow Can't Go" (1977). The agency cited several reasons for retaining the Crow rates, including the increased cost to the prairie economy and prairie grain producers. The Crow was an historic commitment and one of the few benefits western farmers receive, and most of the royal commissions urged retention.

After a decade of increasing inflation, the fixed Crow rates represented diminishing cost coverage. On February 8, 1982, the federal government announced a consultative process whose task was to recommend a common set of principles and a workable framework for a comprehensive approach to the western grain transport system. These were known as the Gilson consultations. A number of their recommendations provided the basis for a new parliamentary act.

The Government of Canada passed the Western Grain Transportation Act (WGTA) in 1983 in response to the continued lack of rail performance. The WGTA was designed to make up the railways' revenue shortfalls created by the statutory rail freight rates. The railways would receive compensatory freight rates that would cover grain handling costs plus an allowance for fixed cost and return on investment. The government would pay the railways the 1981-82 revenue shortfalls in perpetuity. When the WGTA was passed, the inflation rates were so high that the government proportion of rail freight rates was expected to decline to a very small proportion of rail freight costs within a decade. A decade later, after ten years of low inflation, the federal government still paid about 2/3 of the freight costs, or $20/tonne, directly to the railways for eligible grains moving by rail from the prairies.

The annual Crow Benefit, or the amount paid by the federal government, was initially set at $658.6 million. Gilson had recommended that payment initially be made entirely to the railways with a gradually increasing proportion to be paid by the producers until 1989-90, when the split would be 81% producers, 19% railways. The government ignored Gilson's recommendation on payment to the producers under pressure from the Alberta, Saskatchewan and Manitoba Wheat Pools and the Quebec farm lobby groups that feared paying producers directly would encourage them to produce livestock instead of grain for export markets. The provincial governments in Saskatchewan and Manitoba also opposed paying the subsidy to farmers because they anticipated more trucks would be used as rail branch lines were abandoned.

The WGTA followed the Gilson proposals on the sharing of future cost increases, setting a maximum of 3 percentage points of inflation per year to be borne by producers until 1985-86, with any additional cost increases to be borne by the federal government. Beyond 1985-86, producers were to bear the first 6 percentage points of inflation per year. The producer's share of the freight rate would not be permitted to exceed a fixed percentage of the weighted average price of the six major grains. This percentage would increase from 4% in 1984 to 10% in 1988.

Gilson recommended that only canola and linseed oil and meal be brought under the statutory rate provision, but the legislation expanded the list of eligible products to include, in addition to the aforementioned, sunflower seed and oil, corn, mustard seed, canary seed, triticale, dehydrated alfalfa, and peas, beans and lentils and their derivatives. The annual basis changed over time. In 1988-89, the government payment to the railways was $695.1 million or 72% of the total freight charge. As a budget cutting measure in 1993-94, the government's contribution was reduced 52% and in 1994-95 the share declined to 48% of the total freight charge.

The WGTA established the Grain Transportation Agency (GTA) and the Senior Grain Transportation Committee. The GTA had responsibility for promoting system efficiency, monitoring railway performance and investment, and rail car allocation. The Transport Committee was responsible for cost determination and cost forecasting, establishment of the rate scale to apply to the shippers and government, and monitoring of railway investment.

Under the provisions of the WGTA, freight rates for grain were distance related and based on total system costs for moving grain. The actual freight rate at a given shipping point was not based on the costs from that point, but was based on the average costs of all movements in the system. Rates were adjusted at the beginning of each crop year by the National Transportation Authority. Indices, recalculated at four-year intervals, were applied to the actual costs that were incurred by the railways for the movement of grain.

Under Section 38 (1) of the WGTA, the agency was required to perform a costing review every four years in order to determine volume-related costs incurred in the movement of grain as well as line-related costs in respect of the grain dependent branch lines. Together, these costs comprise what are known as "base year" costs.

The Western Grain Transportation Act Provided the possibility of application of the incentive rates, which allow the railway to apply lower freight rates at certain delivery points. This favours loading multiple car units (25+) and reflects the lower cost serving non-branch line points. Application of incentive rates was a departure from the seventy year old crow freight rate scale that only varies with distance and not with volume between delivery points.

Under the WGTA, the method for handling rail branch lines was a mechanism that required railways to undergo long review processes when asking to abandon a line, justifying their costs. The federal government refused to allow abandonment where it subsidized the railway company for losses incurred by continuing to operate a branch line.

During the WGTA era, a small number of lines in the protected network were removed from the network and abandoned. The NTA Review Commission found that uncertainty surrounding the future pattern of branch lines impeded the efficient planing of the entire grain handling system and recommended that rationalization of the prairie branch line structure not be delayed. Direct payment of the entire WGTA subsidy to the railways continued to obscure the true costs of grain transportation from the farm community. Moreover, farmers had to accept the subsidy only for grain transport, they could not choose to keep the subsidy and feed their grain to livestock instead. This greatly reduced the pressure to abandon grain-dependent branch lines, or to change farming practices.

The large losses of both CN Rail and CP Rail in recent years have drawn attention to the vulnerable financial position of the railways. Financial viability is defined as the achievement over time of a rate of return sufficient to attract capital to maintain safe, efficient and effective railway operations. Financial results have improved recently because of traffic increases and some rationalization and restructuring actions taken during the past few years. However, more changes were needed to be made to improve the railways' financial performance.

Budgetary, efficiency, and international pressures were other reasons to eliminate WGTA. The pressure to reduce the growing federal budgetary deficit was perhaps the main motivation behind the repeal of the WGTA. Efficiency reasons to encourage the production of value-added processing in Western Canada was another concern. After the government ignored Gilson's recommendation to pay the producer, Alberta introduced its so-called "Crow offset" program for livestock feeders. This was another subsidy (about $20/tonne) to encourage value-added on the prairies. As cattle were sucked out of Saskatchewan and Manitoba, they also began "Crow offset" subsidies. The Canola crushers were also complaining that paying all the WGTA subsidy to the railways was hurting the processing industry. The U.S. and Canadian governments finally realized that they were exporting jobs with these subsidies to grain exports. This was another major concern for repealing the WGTA. Moreover, in the push to reduce "trade-distorting" subsidies through the GATT process, any and all programs were subject to scrutiny. The freight subsidy was an export subsidy running counter to the spirit of international free trade. The important overall result was that regulatory reform and change in the rate structure will have important implications for flows within the Western Canadian grain market.

A comparison with the U.S. rail system might provide some insights into the structure of the Canadian rail system. Since 1983, expenses per revenue tonne-kilometre declined by 24.1% for US Class I railways, compared to a decline of 6.7% for Canadian carriers. In addition, since 1983, US traffic densities rose by 84% compared to 43% for Canadian railways.

U.S. railways have the following cost advantages:

1. **higher track utilization.** In 1993, U.S. track densities (revenue tonne-kilometres per kilometer of track) were 66% higher than in Canada (with the passage of the Staggers Act in 1980, there was a shift from a high level of government regulation to more market based approach. These changes have affected both the performance of the railways as well as the transportation costs occurring to farmers).

2. **higher productivity.** In 1993, U.S. labour productivity (revenue tonne-kilometres per employee) was 64% higher (lower wage rates in U.S. probably result higher productivity).

3. **lower taxes** on fuel and property. U.S. railways contribute 8.1% of gross revenues to taxes, compared to 14.2% for Canadian railways, according to a 1993 Transportation Association of Canada study.

On February 27, 1995, the Federal Government announced the demise of the WGTA. The proposed reform would no longer provide the Crow Benefit to the railroads and a one-time capital payment of $1.6 billion would be made to farmland-owners as compensation for the loss of the subsidized Crow Rate. These producers would then be responsible for paying the full costs of shipping grain to the various domestic and international markets. The rail sector would fall under the regulation of the recently passed CTA (Canada Transport Act), under Bill C-101.

The 1995 transportation reform proposed freeing railways from a variety of common carrier obligations that resulted in unprofitable services or potentially profitable services at unprofitable rates. Railways were to be allowed much greater freedom to restructure rates and services and to discontinue services by abandoning lines. Researchers had argued that restrictions on abandonment had contributed to the poor financial performance of railways by saddling them with unprofitable services, which also diverted capital spending from more viable routes. In addition, regulatory reform allows for much greater railway flexibility in rate setting and service offerings, if cooperative behavior between railways does not take place.

With the new proposal and with the elimination of the WGTA, the railways fell under the regulation of the Canada Transport Act, containing two noteworthy exceptions: 1) maximum freight rates would be set for the next 5 years by the CTA (this is intended to give captive and small shippers a transition period to look for alternative means of transport), and 2) "grain dependent" branch lines would no longer be protected from abandonment. The CTA also contained provisions for a review of the legislation in 1999 to "determine the efficiency of the grain transportation system and [review] the sharing of efficiency gains between shippers and railway companies" (CTA, section 155).

Elimination of the WGTA means that shippers pay the entire freight rate. On average, the shipper's share of the transportation cost would increase by $15.63/tonne based on 1994/95 rates. Depending on the product and its final destination, there is scope for avoiding part of the increase by shifting to more efficient routes or modes of transportation. Alternatively, farmers could look for local markets, such as livestock feeders or processing plants, and avoid these higher freight charges.

During the recent crop year of 1996-97 grain shipments to the West fell well below planned levels. While poor weather contributed to the disrupted rail flow, other industry participants feel that the railways devoted too few resources to grain movement. The CWB launched legal action against the railways for a lack of performance under the provisions of the CTA. While some farm groups (e.g., the National Farmer's Union) are calling for stronger regulation, others (the Western Wheat Growers) are arguing for a complete deregulation of the railways.

2.3 Previous Studies on Branch Line Abandonment

A large number of studies have been carried out on grain transportation issues, some of which include the impact of branch line abandonment. This section gives the reader an idea of the studies that have been done and the methods of analysis used in these studies.

A study prepared for Grains Group (1971) studied the cost savings of abandonment of some low traffic density rail lines. The research program of the Grains Group was designed to develop relative cost levels in order to indicate those systems with the greatest cost saving potential. The study assumed that when a high cost branch line was abandoned, grain was moved to the next nearest alternative delivery point. Consideration of road costs, elevator costs, and railway costs determine the overall cost saving of grain handing and transportation system.

Tyrchniewicz and Tosterud (1973) developed a model for rationalizing the Canadian grain transportation and handling system on a regional basis. Rationalization as they defined it and as it relates to grain transportation and handling usually refers to the abandonment of uneconomic railway branch lines and the resulting abandonment of country grain elevators located on these branch lines. The overall objective of their study was to develop a framework model within which rationalization of the grain transportation and handling system in western Canada could be analyzed. Specifically, a simulation model was developed to measure the economic impact of alternative rationalization schemes at the regional level on grain producers, country elevator operations of grain handling companies, and the railways. The Stollsteimer plant location model (1963) was the starting point in developing a conceptual framework for analyzing the rationalization of the grain transportation and handling system in western Canada. In essence, the Stollsteimer plant location model provided a basis for determining the number, size, and location of raw material processing plants that minimize the combined collection and processing costs involved in assembling and processing any given quantity of raw material produced in varying amounts at scattered production points (1963, pp. 631-632). Tyrchniewicz and Tosterud modified this model for application to the grain transportation and handling system in western Canada. In summary, the conceptual model was based on the principal of minimizing the total cost of collecting, handling, and distributing grain, subject to certain specified constraints.

A similar study by Baumel, Miller and Drinka (1977) simulated the effect of branch line abandonment in Iowa and calculated benefits and costs of abandonment. In both cases, railway's average costs of branch lines were assumed to be constant and were derived from aggregated data. That is, these costs did not changed with line abandonment for the remaining branch lines. Further, the effects of branch line abandonment on rail costs were not examined. If railroad cost functions had been used, as branch lines were abandoned and traffic was diverted to alternative lines, rail unit and average costs on those retained would change. This redirection could even change the marginal costs of railways.

Tyrchniewicz and Tosterud's simulation model contained a number of other limitations. An important weakness of the model was that it assumed farmers who were diverted to other elevators as a result of rationalization delivered their grain to the nearest delivery point. It followed the usual assumption of location theory that collection costs were minimized by minimizing distance. In reality, however, each farmer has the option of choosing the delivery point, and many farmers choose delivery points for reasons other than minimum distance. The model of this study was a location based study in which supply responds to distance; it failed to consider supply response of farmers as the system rationalized. The effects on roads, which was a very important component of the system, was also ignored in calculation of total cost system. Overall, this model was a first attempt at measuring simultaneously the economic impact of branch line and elevator rationalization on farmers, grain elevator companies, and railways.

Tyrchniewicz, Framingham, MacMillan, and Craven (1978) covered a broad range of grain transportation research issues. The purpose of their study was to assess the impact of the "abandonment" of unremunerative branch lines and statutory grain rates on the agricultural and regional economy of Manitoba. This research was based on a number of prior studies drawn together onto an overall examination of the role of transportation in regional development. A broad range of grain transportation issues were addressed by this study, but it suffered from a lack of in-depth analysis.

The objective of a study by Olsen, Tyrchniewicz and Framingham (1980) was to quantify the impact of changes in statutory grain rates and railway branch line configurations on production patterns and farm income in Manitoba. They used a regional linear programming model as a comparison technique.

A study by Harris (1980) used linear and nonlinear cost functions and simulated alternative scenarios to determine the economic viability of branch lines in the United States. The cost function specified by Harris was also estimated by other authors in an effort to address branch line problems. Specific data on branch line operations were not available and the costs used by Harris and other authors suffered from aggregation problems.

The objective of the paper by Wilson, Tyrchniewicz, and Mason (1981) was to discuss the procedures and results of the estimation of rail branch line cost functions. They used data from branch lines in western Canada with nonlinear and polynomial cost functions to specify and estimate branch line costs. The study considered only cost functions for rail branch line services in western Canada and failed to evaluate the overall performance of the grain handling and transportation system.

The paper by Wilson (1988) addresses the impact of the rail line abandonment and elevator rationalization which took place in Brandon Area of Manitoba. The study was initiated by the University of Manitoba Transport Institute in 1987. In the study particular attention was given to the impact of branch line abandonment and rail rationalization upon communities in the area, and also to the impact upon the tax bases of municipal government. The results of the study reveal that rail line abandonment cannot be held as primarily responsible for the decline in several convenience centers, consolidation of the centers being underway previously. Wilson's findings are consistent with those of Stabler (1985) in his study of trade center viability. Indeed, any decline in the convenience centers appeared related to the centralization of the school system and the greater mobility of the local population associated with an improved road system and almost universal ownership of a personal vehicle. The results also indicated that abandonment caused a change in the direction of flow and in the volume of flow to a particular location. However, any additional traffic arising from the flow of grain or greater hauling distances appears to have had little impact on provincial highway and road construction expenditures. The same situation appears essentially true for highway and road maintenance. The proportion of total rural municipal government expenditures on transportation in the province represented by those municipalities in the Brandon area remained essentially constant during the abandonment period.

Rail line abandonment and elevator closures give rise to greater hauling distances on the part of the affected grain producers. Wilson estimated the impact of such abandonment and closures upon producer hauling costs. The imputed extra distance of haul from the closed delivery point to the nearest remaining elevator point was calculated and multiplied by the average deliveries to the closed elevator point over the previous ten years to obtain an indication of the extra hauling requirements. This was in turn multiplied by the formulae developed by Meyer and Sparks (1987) to obtain an estimate of the additional hauling costs associated with the closures. Closure of elevator points on the remaining lines also gave rise to additional hauling costs. In terms of elevator costs, the study indicates that the average handling costs declined over time as a result of branch line abandonment and elevator consolidation.

The Wilson's study reveals that rail line abandonment has given rise to major savings in aggregate. However, these savings have not been equally shared by those affected.

The ADI Limited (1989) study developed a methodology for examining the grain truck traffic changes and subsequent financial consequences that railway branch line closure could have on Saskatchewan's provincial and municipal roadways. The report used a cost based methodology for identifying affected roadways, assigning incremental traffic to these roads, and identifying those roads likely to require upgrading as a result of increased roadway deterioration associated with the incremental traffic. The study failed to examine the overall performance of all the parties involved in the grain handling and transportation industry and just examined at the road impact of branch line closure. A similar study (1988) with the same methodology was carried out to investigate the consequences of branch line abandonment on the road system for the province of Manitoba. Transport Canada (1985) developed a cost model to investigate how changes in the overall grain transportation system could affect the trucking of grain. It also examined the elevator costs and trend towards elevator consolidation.

Heaps, Munro, and Wright (1992) developed a location model of grain production and transportation to analyze welfare relationships between expanded regional grain production and the configuration of a grain transportation system. Their model provided a mathematical treatment of changes in grain yields and production costs during the region's transition from circular elevator catchment areas and some unused space to hexagonal catchment areas which fill the region. The model connected the production decisions of grain farmers with various features of the system used to collect, transfer, and transport grain and also incorporated the interactions between farmers and railways. Their abstract location model emphasized the shape of catchment areas and gave an overview of the transition of catchment areas from circular to hexagonal catchment areas. The Canadian prairies are represented by a grid road system; therefore, circular or hexagonal catchment approaches do not apply for them.

The recent study by the National Transportation Agency (1995) analyzed the full economic costs to the grain handling and transportation system of retaining or abandoning a number of light steel and low volume prairie grain branch lines to determine which lines should be identified for abandonment under a "fast track" abandonment process. The review was led by Marian Robson, Branch Line Advisor, supported by a Secretariat (NTA & GTA), and a consultant (Dr. John Heads). A brief overview of the methodology employed by the Marian Robson study in determining the cost impact on each mode of grain handling and transport system is presented below.

In general, the economic costs were determined by analyzing four elements of the prairie grain handling and transportation system, including the rail, trucking, elevation and road sectors, by:

- identifying the delivery points and elevators on designated branch lines;
- estimating the current volume of grain traffic being trucked to these sites;
- identifying a set of viable alternate delivery points on adjacent rail lines; and
- quantifying the workload and cost differentials of road, rail, trucking and elevation operations which could be expected if the farmers began to truck the equivalent volume of grains from farmgate to alternate elevators.

The study defined "benefits" to be the efficiency gains achieved from a change in the rail infrastructure and/or the elevation and road infrastructure due to a change in the delivery patterns farmers exhibit. The railways identified the set of branch line segments located in Saskatchewan, Manitoba, and Alberta for consideration in the Review. The seventeen segments comprise 535 miles of branch line track, serving 35 country elevators at 25 delivery points. The selection of alternative delivery points by farmers was based on the distance to be trucked, the road system, the topography, the amount of grain currently being handled by that system, and anticipated developments in the areas served by the "abandoned" railway line and the alternate railway lines.

The study used previous available models to calculate the cost impact of retaining or abandoning some selected lines in Saskatchewan, Alberta and Manitoba. A description of the methodology used to calculate the cost impact of each mode of grain handling and transport system follows.

The cost impact on railways of abandoning each of the study lines was primarily the difference between the status quo costs and the alternative costs.

A model developed by the Canadian Grain Commission was used to estimate elevator operating cost savings arising from closure of those elevators on the selected branch lines and to determine the additional costs incurred by the alternate elevators to which the grain would be diverted.

The Trimac Truck Costing model was used to calculate the costs of trucking for the selected lines. This model provides cost estimates for a wide variety of truck types, with various ownership possibilities. With respect to the estimation of the trucking distances, the Saskatchewan Transportation Model (STM), developed by Saskatchewan Highways and Transportation (SHT), was used to calculate an estimate of the distances Saskatchewan producers are hauling grain to the delivery points currently in use, and an estimate of distances these producers would have to haul their grain to the selected alternate delivery points. This model was used by SHT to examine the costs of road impacts likely to arise from the branch line closures. These distances to the current delivery points and the alternate delivery points, weighted appropriately by the tonnages involved, were used in the calculation of the incremental trucking costs for Saskatchewan grain producers. By subtracting the current trucking costs from the alternate trucking costs, the incremental trucking cost for each current and alternate delivery point pair in Saskatchewan could be calculated.

Conceptually, additional road costs caused by branch line and elevator closure was estimated as follows. Firstly, the tonnage of grain diverted from branch lines to roads was determined. Secondly, the additional distance to the alternate elevator was established. Finally, the incremental effect on road costs was estimated.

The Saskatchewan Transportation Model was used to calculate the road costs for the selected lines. The model estimates grain production for each township of 36 square miles in the province, assuming the centroid of the township as the origin for the grain, and then moving the grain to the nearest elevator along the existing road structure.

The STM models the existing flows of grain to the various elevators, adjusting these flows to correspond with the actual elevator receipts as recorded by the Canadian Grains Commission. It then simulates what would happen in the event of specified elevator closures. The STM thus allows estimates of road movements of grain before and after closure. The difference between the before and after average distances is the additional kilometers to be traveled by the average producer as a result of the abandonment of a specific elevator. When these additional road distances were calculated, the municipal road costs were estimated using the Saskatchewan Association of Rural Municipalities (SARM) model. For the provincial roads, Saskatchewan

Highways made claims for the conversion of "T-class" thin membrane roads to paved highways, where they considered it appropriate. To summarize, under the SARM methodology, it is necessary to determine the annual cost of affected road infrastructure per kilometer (for maintenance and capital costs) and then, using relevant traffic counts, determine a cost per tire/km/year. Road impact cost estimates then reflect the product of the diverted grain volumes converted to truck tire trips, the cost per tire trip/km/year, and the incremental hauling distance to alternate points.

The National Transportation Agency study attempted to analyze the full economic costs to the grain handling and transportation system of retaining or abandoning a number of low volume prairie grain branch lines. Similarly, the Saskatchewan Transportation Model examined the costs of road impacts likely to arise from the branch line closures. However, both studies needed to incorporate more "economics" into their models. For instance, the selection of alternative delivery point by farmers in both studies was based on the nearest distance to be trucked. This is not very realistic assumption. The main economic component of the system is that farmers make their decision regarding where to deliver their grain by comparing the net price at alternative delivery points. The amount and types of crop that they choose to grow and subsequently deliver depends on the net price they receive. The net price contains a variety of important components including railway freight charge, elevator handling tariff, distance to elevator and trucking costs. Further, in both studies, supply response components were not incorporated in their models.

A number of other limitations were contained in their model that need to be addressed in future studies. For example, in the National Transportation Agency study it is not clear when branch lines are abandoned and traffic is diverted to alternative lines what will happen to railways' average costs on those retained branch lines. The model used in this study investigated the cost savings of abandonment of some light density rail lines located in Saskatchewan, Alberta, and Manitoba. This model is not useful for studies whose goals are analyzing regional impacts of rail line closures. In summary, a simultaneous effect of a change in one component of the system on other parts of the system can not be visualized in either study.

Fulton and Gray (1997) developed a monopoly profit maximization approach to address the hold-up problem for the grain transportation system. The hold-up problem is created when one party is reluctant to make an investment because of the fear of *ex post* opportunistic behavior of another agent. A typical case of *ex post* opportunistic behavior is where Agent A has an agreement with Agent B to purchase a flow of service from some idiosyncratic investment which Agent B has made. The idiosyncratic nature of the investment means the value of this investment in some alternative use is much lower than it is producing the service for Agent A. The specificity of this asset also means that, once the investment is made, Agent A has the ability to undervalue the output or service flow, knowing that Agent B's investment costs are sunk. Agent B, knowing that Agent A will behave in this manner, under invests in the idiosyncratic asset (including not investing at all). As a consequence, the investment is held-up-- not undertaken-- even though the investment would be profitable if the appropriate transfer price for the service could be determined (Williamson).

The hold-up problem creates an issue for rail transportation in two fundamental ways. Railways require long uninterrupted corridors to operate. Historically these corridors were provided to the railways through large government land grants and through the power of eminent domain. The possibility of a new railway being established today without the aid of government eminent domain seems very remote. Given the amount of land a new railroad would have to purchase, profit levels would have to be very attractive to provide a railway with the incentive to purchase another railbed to a destination such as the West coast. Most importantly, if the profit levels were attractive, land owners could extract these profits from the railway by refusing to sell their land at any price less than the residual profits of the railway. Assuming both the land owner and the railway are effective bargainers, each landowner will hold-out for half of the total rent the railway will be able to earn if it was operating. As long as there are more than two landowners, the railway will not be able to pay this amount for land and still earn a profit on its railway. As a consequence, potential entrants will not enter the industry. This hold-up problem creates very effective barrier to entry (Fulton and Gray).

A second way in which the hold-up problem creates an issue for rail transportation is that, as a result of the barriers to entry, the potential for the use of market power by the railway is considerable. Fulton and Gray in their model show that the use of market power by the railway leads to underinvestment by farmers in their farming operations. The problem is really one of contractual incompleteness and *ex post* opportunistic behavior.

Fulton and Gray conclude that one important hold-up problem is created where a railway exercises monopoly power in setting price level. When a farmer makes an investment decision in period 0, the farmer considers the price level that will be imposed by the railway in period 1. Since the railway cannot credibly commit in period 0 to set the rail rate at competitive level in period 1, the farmer modifies his/her investment decision in period 0 in anticipation of the *ex post* opportunistic behavior by the railway in period 1. The exercise of monopoly power leads to a hold-up problem, in this case, a lower level of investment than would otherwise occur.

The market power of the railway may result in another hold-up problem in the case of branch lines. As they showed, a railway with monopoly power will be unable to capture the full amount of the savings incurred by farmers. The result is that, in some situations, the railway may find it advantageous not to maintain a branch line, even when it is efficient from the system perspective to do so. Their results suggest not only that branch line maintenance may be an issue when a railway has monopoly, they also suggest that regulated fright rates may also not solve the problem. For instance, if freight rates are not allowed to rise above some predetermined cap, then the hold-up problem for branch lines could be exacerbated. The railway would have no incentive to invest in a branch line. Even without a strict freight cap, a hold-up problem can exist. Unless the railway can obtain the full cost saving of the farmers in the freight rate increase, the potential for hold-up will exist.

Other studies have used simulation techniques widely in analyzing the prairie grain sector. For instance, simulation has been used to study the optimal configuration of the country elevator system (Ash and Yagar 1977), the effects of changes in Crow freight rates and branch line system length on grain production costs for different sized farms (Fleming and Uhm 1982), and so on. These studies are important in investigating the overall performance of the grain handling and transportation system. However, since they are not directly related to this study, they will not be reviewed here.

2.4 Conclusion

Rail line transportation, specifically the grain transportation system, has been a major topic since the time of the settlement of western Canada. Since 1897, there have been various royal commissions, special agreements between governments and railways, legislative efforts, studies and discussions on this topic. Throughout these years there have been many hard struggles to establish a competitive railway transportation system. Cruikshank (1991) concludes:

> The history of freight rate regulation does not prove that all these different reform proposals are misguided and doomed to failure, or that they should be abandoned in favour of some ideal model from the past. History cannot refute, although it certainly cannot be shown to confirm, the value or correctness of any of these prescriptions. What the freight rate struggles of the past do seem to demonstrate are the limits of all regulatory regimes - including the market. No single set of reforms, no one type of institutional structure can, or should be expected to, resolve complex economic problems or contain the social conflicts that are part of a competitive economy. It is precisely for this reason that freight rate controversies led to the development of regulatory pluralism. The conflicts between railways and their customers shifted back and forth between various arenas, the offices of private and public railway managers, the hearing-rooms of the Board of Railway Commissioners, the cabinet chambers in Ottawa and in various provincial capitals, and the halls of various legislatures, leaving in their wake a haphazard set of initiatives and institutions.

> The history of regulation offers a perspective on the plurality of strategies that have been adopted to allocate scarce resources in our society. The history of regulation is a story of limits. Regulation involves the attempt to draw limits - between the public and private allocation of resources, and between various public decision makers.

An extensive body of work has been carried out on transportation issues, but not many studies are available in terms of branch line abandonment. Most of the methods that have analyzed the impact of branch line abandonment followed the usual location theory. What distinguishes this study from previous studies is that the performance of the parties involved in the grain handling and transportation system is assessed simultaneously when abandonment of branch lines takes place. Farmers make their decisions by comparing the net prices they receive, and supply and railway average costs respond to a change in the system.

CHAPTER III

THE THEORETICAL FRAMEWORK

3.1 Introduction

This chapter provides a theoretical background to the grain handling and transportation system. The discussion of production costs, trucking costs, elevator costs, railway costs, and road costs is presented. Properties of the cost functions are also described.

3.2 The Model

The key element in this study is to understand how the branch line system could be rationalized within a regulated freight rate structure. This study develops and utilizes a detailed spatial equilibrium model describing portion of the Western Canadian grain market. The spatial model incorporates profit-maximizing behavior, where grain producers deliver to locations that yield the highest net price of grain and have a supply response to changes in price. The model is used to analyze the impact of alternative market arrangements on the structure of the branch line network, elevators, and the grain industry. The results of simulations are used to measure the welfare impact of various configurations and find the optimal configuration of a railway branch line system for movement of grain from a particular region of prairies to the export point.

Government intervention and regulation have historically played a vital role in the Prairie grain transportation system. Consequently, the designs of policies that improve the industry's performance have received considerable research attention.

Simulation techniques are an attractive method for examining the effects of different policies under varying industry and market conditions. They permit objective evaluation of alternative policies in a complex and important economic setting. Other studies have widely used these techniques in analyzing the Prairie grain sector. As discussed in Chapter 2, simulation has been used to study the optimal configuration of the country elevator system (Ash and Yagar 1977), the effects of changes in Crow freight rates and branch line system length on grain production costs for different sized farms (Fleming and Uhm 1982), the effects of progressive abandonment of a regional branch line system on the costs of collecting and handling grain (Tyrchniewicz and Tosterud 1973), and so on. A simulation method is also used in this study to investigate the impact of various policy regimes on the Prairie grain transportation system.

A brief overview of the methodology employed in determining the cost impact of each mode of the grain handling and transport system is presented below. The methods used to derive the catchment areas are described in more depth in later sections of the study. However, a number of important issues, principles and assumptions should be discussed at the outset.

3.2.1 Overview of the Theoretical Model

The solution of the model is derived as follows. First, the total number of elevators and farms (townships) in the region is identified. Second, the distance between each farm (center of township) to all the elevators is estimated. The trucking cost equation (Equation 4) allows to compute the trucking cost for each farm to different elevators. To begin with, it is assumed that the elevation charge (*EC*) is the same for all elevators, and farmers deliver their grain to the nearest elevators. The predicted catchment area for each elevator and its respective delivered output can now be found. Comparison of the predicted delivered output with the actual output received by the elevator yields a residual. By changing *EC* for each elevator, this residual can be minimized and the catchment area for the elevator can be estimated. The basic catchment area computed in this manner is then used to analyze the impact of various transportation policies.

Grain farmers are assumed to be profit-maximizers who grow grain on farms with the same production function. The grain is brought to country elevators by trucks. Each elevator receives grain from all the farms located in its catchment area. From there it is delivered to the railway for shipment to an export point. Farmers' grain production decisions are based on grain production costs, the cost of transporting grain from farms to elevators, the elevation costs, and the world price of grain less freight rates of grain from elevators to the export point (farm gate price).

The model incorporates several major assumptions to facilitate the analysis. There are:

1. Grain production cost functions are quadratic and have non-zero fixed costs.
2. Trucking costs are a linear function of distance.
3. Farmers and the railway are each rational profit maximizers.
4. Commercial trucking rates for various truck types (five axle trucks or greater) and distances were averaged to compute the per tonne/kilometer of trucking cost in the model (trucking rates were provided by the Saskatchewan Department of Agriculture and Food, Table 3.2). This averaging may slightly underestimate or overestimate the trucking costs, but it would not change the overall optimal configuration of railway branch lines.
5. It is assumed that elevator companies have no market power. They play a passive role in the grain handling and transportation system and charge a tariff irrespective of changes in branch line configuration and volumes handled. In effect, there are only two active sectors, farmers and the railways. When a line is abandoned, all the grain elevators located in that line will be closed. The grain is redirected to open elevators on remaining lines.
6. Rail freight rates are regulated.
7. A fixed proportion of grain production is hauled to elevators. Farmers respond to a grain price change by producing less or more grain; however, a fixed proportion of this grain volume is shipped to export destination. For example, if initial production is 100 tonnes, assuming 75% of these go for export, then 75 tonnes are shipped to world market and 25 tonnes remain in the region for farm use and domestic use. If grain

price increases, producers may increase production to 140 tonnes. Of this still 75%, 105 tonnes, is hauled to elevators, and 25%, 35 tonnes, remains in the region for farm and domestic use. Domestic use includes feeding livestock and local processing plants.

This thesis assumes that the world price (P_w) is an exogenous variable since it is assumed that Canada is a small market player. However, if world prices for grain increase in such way that they overcome the higher transportation costs for the farmers, farmers still produce the same or higher level of grain.

The interaction of the cost relationships determines the behavior of farmers and the railway. With a given export price, changes in the branch line configuration affect the returns received by farmers and the railways. Actual decisions are governed by the particular policy regime which is in force.

3.2.2 Grain Farmers' Decisions

Railway customers are farmers who face competition at home and abroad. Canada's railways play a major role in determining the competitiveness of the country's exports. Rail costs can account for 40% of the delivered price of some bulk commodities. Shipper demands for lower rates have been strengthened by the *National Transportation Act, 1987 (NTA, 1987)*, which gave shippers an improved bargaining position vis-à-vis the railway.

Grain farmers are assumed to be profit-maximizers who choose their grain yields so that marginal revenue and marginal cost are equal.

3.2.2.1 Grain Production Costs

The form of the grain production cost equations was chosen as follows:

$$C_G = a + bt^2 \tag{3.1}$$

$$AC_G = \frac{(a + bt^2)}{t} \tag{3.2}$$

$$MC_G = 2bt \tag{3.3}$$

where C_G is the total cost per square kilometer of grain production, AC_G is the average cost of grain production per tonne, MC_G is the marginal cost of grain production per tonne and t is the yield in tonnes per square kilometer. Given this cost function, the grain supply curve is illustrated in Figure 3.1. For any price less than $\bar{p}$, production would be zero.

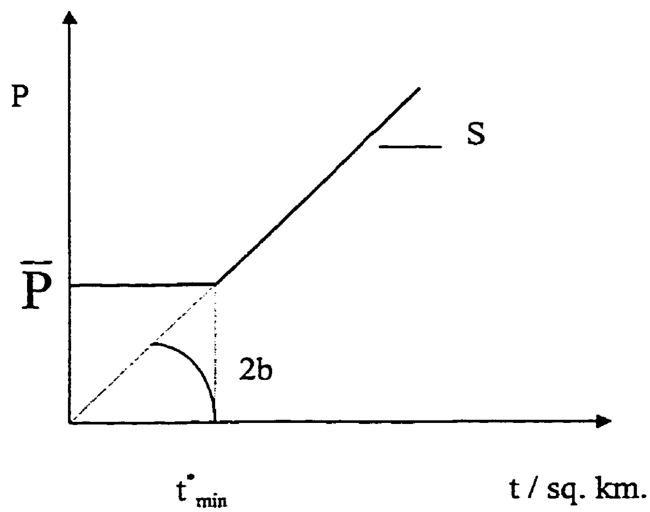


Figure 3.1. Grain Supply Curve.

3.2.2.2 Trucking Costs

Canada's railways face strong competition from the trucking industry, which has grown dramatically since the 1950s. In Canada, railways carry half the tonnage moving by surface transport. However, they earn just over one-third of the revenue because higher-value goods moving by truck are charged higher freight rates. The trucking industry is able to offer greater flexibility to handle fluctuating volumes and to provide door-to-door services required by shippers.

Yields chosen by farmers are influenced by the cost of trucking. Optimal grain yields decline as distance from elevator locations increases because the cost of transporting grain by truck from the farm to the country elevator is distance-dependent. The equation for the cost of trucking is defined as follows:

$$AC_T = EC_i + VC_T = EC_i + gd \tag{3.4}$$

where AC_T is average cost per tonne to transport grain by truck; EC_i is the elevation costs offered to farmer i; VC_T is the variable cost per tonne; g is cost per tonne-kilometer; and d is the distance between the farm and the country elevator in kilometers.

A widely known model in Canada for costing the use of trucks is the Truck Costing Model developed by Trimac Inc. In Trimac trucking cost, the average cost per tonne-kilometer of operating a truck in the Prairies is:

$$Cost = C_1 + C_3 + C_8 + t(C_2 + C_4 + C_{10}) + \frac{C_5}{d} + \frac{(C_6 + C_7 * i)e^{-.23t} + C_9}{a}$$

where 't' is the age of the vehicle in years.

'd' is the one-way haul distance from farm to selected elevator, in kilometer.

'i' is the interest rate (%).

'a' is the annual distance traveled for all trips in kilometers.

And C_i's are average unit cost components for each truck type and province. These are defined as follows:

C_1 is the basic fuel cost component of operating either a gasoline or diesel powered truck. (cents/tonne km)

C_2 is the additional energy consumption cost component which varies with the age of the vehicle. (cents/tonne km)

C_3 is the wages cost element for the driver of the vehicle and those labor costs involved with maintaining the vehicle. (cents/tonne km)

C_4 is the labor cost component relating to maintenance/ repair costs which vary with the age of the vehicle. (cents/tonne km)

C_5 is the labor cost associated with the individual trip, for cleaning, loading and unloading time. (cents/tonne)

C_6 is the cost component for expenses directly relating to vehicle ownership or purchase costs. (cents/tonne)

C_7 is the debt service cost component for interest on loans or an opportunity cost estimate, both based on the depreciated book value of the vehicle. (cents/tonne)

C_8 is the cost of repairs component related to parts which have prices that are not age sensitive such as lubricate, etc. (cents/tonne km)

C_9 is the annual operating cost for all other overhead items such as insurance, licenses, etc. (cents/tonne)

C_{10} is the maintenance/repair cost associated with parts prices which vary with the age of the vehicle. (cents/tonne km)

The Trimac model provides cost estimates for a wide variety of truck types, with various ownership possibilities. For a given vehicle type and size, trip characteristics such as quantity to be moved, length of haul, payload, empty return ratio, load and unload times, hours and days of vehicle availability, etc. and certain unit costs such as fuel and labor, are input and the model provides detailed estimates of the costs in total dollars and on a per tonne basis.

The following example of cost structure for moving grains locally, using producer owned trucks, was developed by Trimac Consulting Services.

Table 3.1. Cost Structure for Producer Owned Trucks.

Origin	Destination	Trailer Type	Quantity	No. of Trips	Total Distance	No. of Power Units	$/km	$/hr	$/tonne
Farm	Avg Dist 26 km	2 ax farm	1,500	175	9,100	1	0.90	21.07	5.46
Farm	Avg Dist 26 km	3 ax farm	1,500	116	6,032	1	1.46	30.73	5.88
Farm	Avg Dist 26 km	5 ax semi-farm	1,500	61	3,172	1	3.71	59.86	7.84
Farm	Avg Dist 26 km	tridem farm	1,500	46	2,392	1	4.79	71.72	7.64
Farm	Avg Dist 26 km	7 ax farm	1,500	41	2,132	1	5.89	88.28	8.38
Farm	Avg Dist 26 km	super-B farm	1,500	35	1,820	1	7.42	103.70	9.01
Farm	Avg Dist 52 km	2 ax farm	3,000	349	36,296	1	0.56	19.71	6.75
Farm	Avg Dist 52 km	3 ax farm	3,000	231	24,024	1	0.75	24.55	6.04
Farm	Avg Dist 52 km	5 ax semi-farm	3,000	122	12,688	1	1.38	36.49	5.85
Farm	Avg Dist 52 km	tridem farm	3,000	91	9,464	1	1.70	42.22	5.37
Farm	Avg Dist 52 km	7 ax farm	3,000	82	8,528	1	1.97	48.83	5.60
Farm	Avg Dist 52 km	super-B farm	3,000	69	7,176	1	2.43	56.83	5.81

Source: Grain Trucking in Western Canada - Trimac Consulting Services.

Note that at 26 km, the average hauling distance, for a producer hauling 1500 tonnes of grain annually, the most economical configuration is the 2 axle truck. As distance increases, and as volume of grain to be hauled increases (larger farms and longer distances), the lowest cost straight truck configuration (for a producer who does not wish to operate a tractor-trailer or other combination) is a three axle truck. By going to a 5 axle semi configuration, transport costs per tonne are lowered further (Trimac Consulting Services, 1997).

The following average commercial trucking (five axle trucks or greater) rates for various distances are provided by Saskatchewan Department of Agriculture and Food. The commercial trucking estimates provided by the Trimac Consulting Services are similar to these cost.

Table 3.2. Average Commercial Trucking Rates for Various Distances.

Distance	Cost/Tonne	Cost/Bushel (wheat)
25 km (15 miles)	4.10	.11
40 km (25 miles)	4.90	.13
80 km (50 miles)	6.70	.18
120 km (75 miles)	8.65	.24
160 km (100 miles)	10.70	.29
240 km (150 miles)	14.30	.39
320 km (200 miles)	18.00	.49
480 km (300 miles)	25.00	.68

Source: Saskatchewan Department of Agriculture and Food (FarmFacts, 1995).

Figure 3.2 shows the relative costs of commercial trucking rates and farm truck total costs. The farm truck costs are based on hauling 1500 tonnes of grain per year. Commercial trucking rates are lower than any of the farm truck total costs. Two axle farm trucks are the lowest cost of the farm trucks up to approximately 25 km because of the low fixed costs. Five axle farm trucks have a higher fixed cost per tonne that results in higher total costs for the short haul but lower than 2 and 3 axle trucks for the long haul. The five axle farm trucks can not achieve the efficiencies of commercial truckers when hauling only 1500 tonnes per year (FarmFacts, 1995).

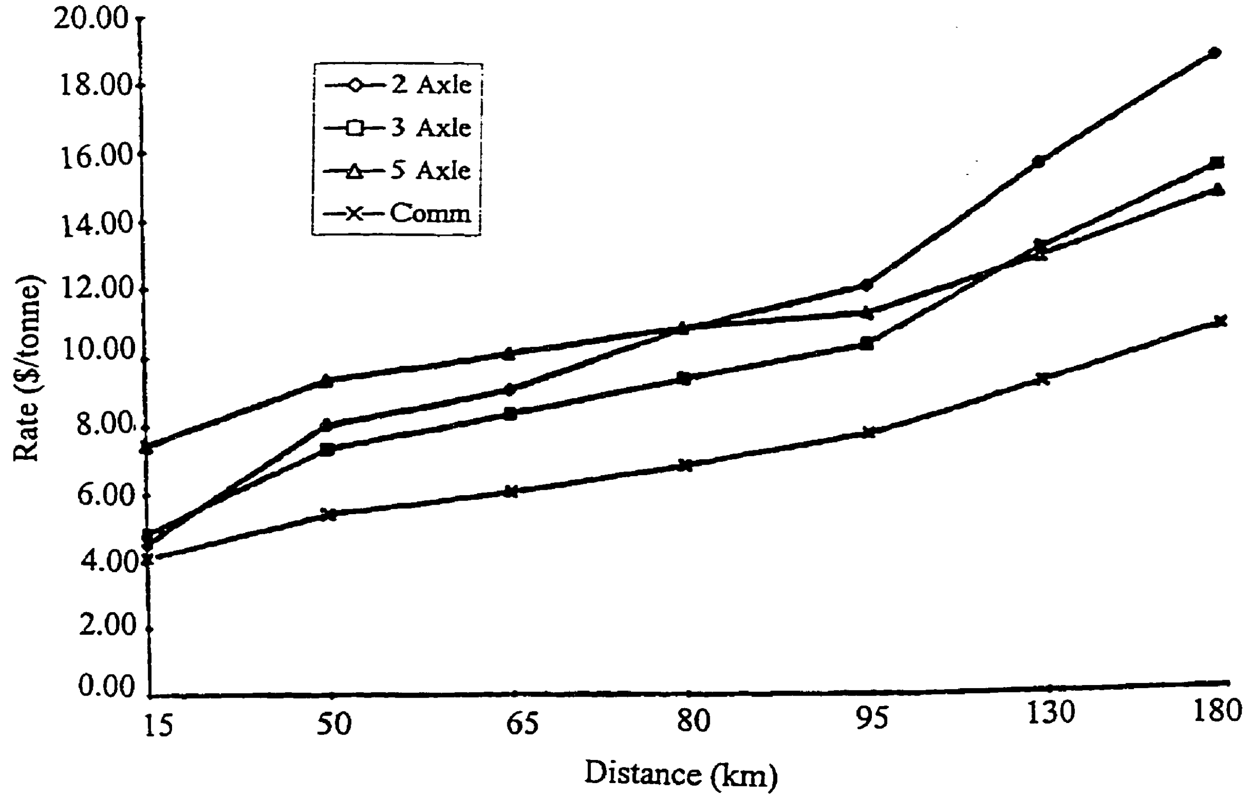


Figure 3.2. Commercial Truck Rates and Farm Truck Total Costs *(Source*: Saskatchewan Department of Agriculture and Food, FarmFacts, 1995).

The Trimac trucking model relies more on accounting rather than regression. Trucking cost is not broken down for fixed and variable charges. Average costs are probably the most accessible, marginal costs would be tough to find. In addition, differences exist in regulations in dealing with farm versus commercial trucking (i.e., farm truck inspection requirements are much less stringent than those for commercial operations). Finally, though farm vehicles hauling to market are supposed to use commercially taxed diesel, often enough the farmer is using (farm fuel) tax rebated fuel on highways.

Due to complex mixture of trucking costs and data limitation, for analytical purposes of this study, the above trucking cost model were averaged for different truck types. This averaging may slightly underestimate or overestimate the trucking costs, but it would not change the overall optimal configuration of railway branch lines.

There are several basic types of information needed in order to estimate the trucking cost equation. This basic information includes:

- the amount of grain being delivered to the current delivery points,
- the amount of grain that is delivered to each of the alternate delivery points from the current delivery points,
- the distances the grain is currently being hauled, and
- the distances the grain would have to be hauled should the alternate delivery point be used.

The study uses a three-step approach in order to estimate the incremental costs of trucking grain. First, it estimates the costs of hauling grain to the current delivery point from the producer's farm (center of township). Second, it estimates the costs that would be incurred in hauling the same volume of grains from the same townships to an alternate delivery point that might be used in the event that the current delivery point is closed. Finally, by subtracting the current haul costs from the alternate haul costs, it estimates the incremental costs.

The minimum grain yield at which farmers are willing to grow (t^*_{min}) can be derived by equating AC_G and MC_G and solving for t.

$$t^*_{\min} = (\tfrac{a}{b})^{.5} \tag{3.5}$$

Actual grain yields often exceed the global minimum yield but are never lower because a rational farmer would not grow grain at yields where the average variable cost exceeds the marginal cost. The cost of grain delivered at the elevator depends on the farmer's distance from the elevator, elevation cost, freight rates, and grain yields (t). Individual farmers choose their grain yields so that the marginal cost of grain production is equal to the farm price; which is to say that the following relationship between yield and distance is satisfied.

$$t(d) = \frac{(P_w - f_r - EC_i - gd)}{2b} \tag{3.6}$$

where P_w is the world price of grain, f_r is the freight rates, and $t(d)$ is the yield in tonnes per square kilometer of the profit-maximizing farmer located d kilometers from the elevator. By assumption $t(d)$ must be greater than or equal t^*_{min}. A farmer receiving P_w

per tonne must pay f_r, the trucking cost of *EC* and *gd* (variable with distance). Therefore, farmers will increase yields until:

$$P_w - f_r = MC_G + EC_i + gd \tag{3.7}$$

or, by rearranging Equation (3.7),

$$P_F = P_w - f_r - EC_i - gd$$

where P_F is the farm price. Individual producers will choose their grain productions so that $P_F = MC_G$.

3.2.2.3 Grain Supply Curves

The general formula for the supply of grain in a catchment area is:

$$Q_j = K\sum_{i=1}^{m} t_{ij}(d) \tag{3.8}$$

Q_j is grain volume in tonnes in each elevator (*j*) catchment area, *K* is six by six square mile township, and *i* and *j* represent the townships and the catchment areas in the study region, respectively. Note that the number of townships in each catchment area is different. Substituting (3.6) for *t(d)* in the equation (3.8) leads to the following formula for the regional supply curve:

$$Z = \sum_{j=1}^{n} Q_j = K\sum_{j=1}^{n}\sum_{i=1}^{m} t_{ij}(d) \tag{3.9}$$

3.2.2.4 Total Delivered Cost

The equation for the regional average cost of grain production is developed from (3.1) by dividing the total cost of grain production in each catchment area by the area's grain output. Total delivered cost from each township at the grain elevator (TC_D) at distance d has two components: grain growing cost (TC_G) and trucking costs (TC_T), generated from (3.1) and (3.4). Together with (3.4), which gives the optimal yields depending on distance from the elevator, it can be seen that the costs of these yields are:

$$TC_G(d) = K(a + \frac{(P_w - f_r - EC_i - gd)^2}{4b}) \tag{3.10}$$

Multiplying (3.4) with (3.6) we have:

$$TC_T(d) = K(AC_T * t(d)) = K\{\frac{(P_w - f_r)(EC_i + gd)}{2b} - \frac{(EC_i + gd)^2}{2b}\} \tag{3.11}$$

$$TC_D(d) = TC_G + TC_T = K\{a + \frac{(P_w - f_r)^2}{4b} - \frac{(EC_i + gd)^2}{4b}\} \tag{3.12}$$

Total delivered cost TC_D for the region is then:

$$TC_D = \sum_{j=1}^{n} TC_{Dj}(d) \tag{3.13}$$

These total-cost equations include both grain growing and trucking costs. If the road costs are added to these costs, they can be taken as social costs.

3.2.3 Elevator Decisions

In general, two arguments can be put forward with regard to elevator closure. The first is that elevators are competing for business and they will reduce the rate of consolidation to maintain market shares, but at greater cost. Therefore, a forced consolidation will lead to greater cost savings. The alternative argument is that grain companies can currently choose to rationalize their system. They will do so in the least cost manner. If they are constrained by branch line abandonment, then the costs cannot fall as much. A higher cost is associated with the first case because a higher number of elevators are operated. A lower cost obtains in the second case because fewer elevators operate under this scenario. Clearly, these two lines of reasoning result in opposite cost effects. Since the magnitude and direction of elevator decisions within our modeling framework is not clear, grain elevator decisions were assumed to have zero effect in this model.

3.2.3.1 Alternate Delivery Points

The selection of alternate delivery points and the amount of grain received from each origin point would be based on the relative advantage one alternate point might have in terms of a lower rail rate-to-port, the distance costs for trucking, and the elevation cost. Thus, alternate delivery points are chosen based upon only their distance, elevation costs, and freight rates. Then, estimates are made of the share of the diverted grain that each alternate delivery point would receive.

3.2.4 Railway Decisions

Most traffic in Western Canada consists of bulk commodities, ideally suited and often captive to railways. This type of traffic is expected to achieve only modest growth. In 1993, shippers for several bulk commodities exported from Western Canada predicted growth rates of less than 2% annually. With limited revenue growth expected, there is pressure to continue raising productivity to improve the financial performance and outlook of the railways (Western Transportation Advisory Council, 1994).

Recent policy reform was supposed to reduce grain transportation costs as railways abandon unprofitable branch lines, upgrade remaining lines, and restructure rates so as to provide incentives to shippers to use less costly shipping methods. This all depends on deregulation leading to more competition among railways.

A description of the methodology employed by this study to determine the costs associated with the abandonment of the branch lines follows.

3.2.4.1 Railway Cost Hypothesis

Railway costs are an important component of the model. Railways make decisions in such a way that maximizes their benefits. The railway cost model is complex in that:

(1) it has two parts - mainline and different types of branch line from a cost point of view; and

(2) the other components of the model interact in several ways with the branch line part of the railway cost model.

3.2.4.2 Railway Total Branch Line and Main Line Costs

The average cost of transporting a tonne of grain from the country elevator to the port is the sum of three separate costs: mainline cost, volume-related branch line costs, and line-related branch line costs. Volume-related costs vary with the volume of traffic and consist of two main components: (i) service units, which are defined simply as measures of the amount of work done; and, (ii) unit costs, which are determinations of the standard dollar amounts to be applied to each unit of work performed. Volume costs are calculated by multiplying service units by unit costs. Volume-related costs are derived from train-related and car-related workloads, and these have been incorporated into the movement of cars being costed. Line-related costs are fixed and are present on branch lines regardless of traffic level and can be avoided only if the line is abandoned. These costs consist of track and roadway maintenance, depreciation and cost of capital (i.e. ownership), and property taxes associated with the line.

Total railway branch line costs (TRBC) and total railway main line costs (TRMC) are described mathematically as follows.

$$TRBC = i(L_{NW}) + \nu \sum_{m=1}^{M} \sum_{j=1}^{n} D_{jm} Q_{jm} \tag{3.14}$$

$$TRMC = \varphi \sum_{m=1}^{M} L_m^p Z_m \tag{3.15}$$

where φ is the mainline volume-related cost of transporting grain per tonne; i is the branch line line-related maintenance cost per kilometer of grain-dependent branch line; ν is the average volume-related cost of transporting a tonne of grain over a kilometer of grain-dependent branch line; D_{jm} is the distance of branch line from elevator j to connection point m; Q_{jm} is grain for movement from elevator j to connection point m; L_m^p is length of main line from connection point m to the port; L_{NW} is the total length of the branch line network; and Z_m is grain shipped on the main line from connection point m to the port. Together, these two costs comprise the total railway cost (TRC), or mathematically:

$$TRC = TRBC + TRMC = i(L_{NW}) + v\sum_{m=1}^{M}\sum_{j=1}^{n} D_{jm}Q_{jm} + \varphi\sum_{m=1}^{M} L_m^p Z_m \tag{3.16}$$

where:

$i\,L_{NW}$ is the total fixed cost (TFC), and

$v\sum_{m=1}^{M}\sum_{j=1}^{n} D_{jm}Q_{jm} + \varphi\sum_{m=1}^{M} L_m^p Z_m$ is the total variable cost (TVC).

It can be seen from this cost function that any adjustment in the length of branch line could affect the railway costs and consequently market equilibrium. Even though the form of the cost function is simple, it provides a means to examine changes in the branch line network.

The following simple example is given to illustrate how a railway's average and marginal costs of transporting a tonne of grain from the country elevator to the port are estimated in the present study. Suppose the branch line X is given from delivery point A to connection point m in Figure 3.3.

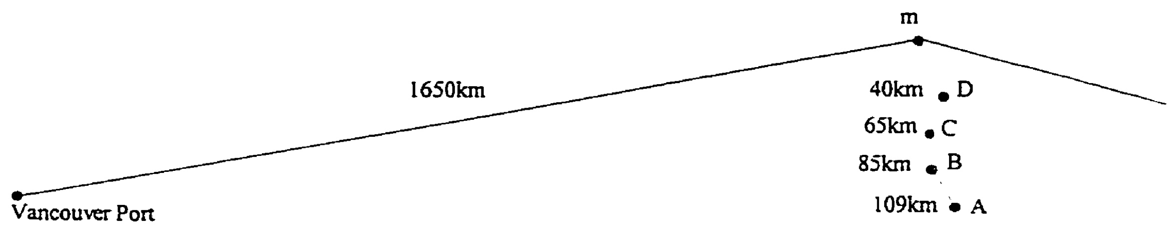


Figure 3.3. Railway Main Line and Branch Line.

Assume the total length of the branch line from A to m is 109 kilometer and information for delivery points in the branch line is given in Table 3.3.

Table 3.3. Length and Grain Volume of Assumed Delivery Points.

Delivery Points	D_{jm} (km)	Q_{jm} (Tonne)	$D_{jm}*Q_{jm}$
A	109	36771	4008039
B	85	40555	3447175
C	65	37221	2419365
D	40	57521	2300840
			12175419

Assume the mainline volume-related cost (φ) is 1.2 cents, the branch line volume-related cost (v) is 1.8 cents, and the branch line line-related cost per kilometer of grain-dependent branch line (i) is \$9420. Therefore, the total cost of branch line is obtained as follows.

$$TRBC_X = iL_{NWX} + v \sum_{j=1}^{4} Q_{jm} D_{jm} = (109*9420) + (0.018*12175419) = \$1245938.$$

The average cost per tonne/kilometer for this branch line would be

$$AC_X = TRBC_X / \sum_{j=1}^{4} Q_{jm} D_{jm} = 1245938 / 12175419 = 0.102332.$$

The total cost of shipping 40,555 tonne of grain from delivery point B to the port is therefore estimated as follows.

$TRC_B = (AC_X*D_{jm}*Q_{jm}) + \varphi* L_m^P *Q_{jm} = (0.102332*85*40555) + (0.012*1650*40555) =$

$807139.

If this total cost divided by grain movement on that point, average cost of shipping one tonne of grain from that delivery point to the port is estimated.

$AC_B = (0.102332*85) + (0.012*1650) = \$28.50.$

The marginal cost at this point is calculated as follows.

$MC_B = (0.018*85) + (0.012*1650) = \$21.33.$

It should be clear that if a branch line is connected to other branch line(s), the cost of the other branch line(s) has to be considered in railway's cost analysis of delivery points.

3.2.4.3 Railway Behavior

The railway lines hypothetically can be broken into three broad categories of lines.

1. Mainline rail. This type of rail is characterized by high traffic and low per-tonne cost. Under the maximum rate setting this portion of grain traffic produced profits for the railway (Figure 3.4).

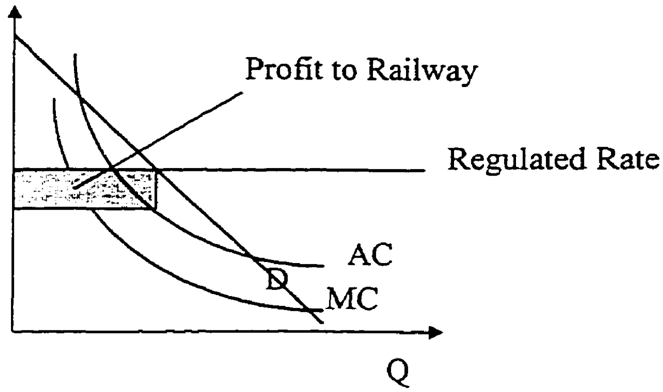


Figure 3.4. Mainline Rail under the Maximum Rate Setting.

Figure 3.4 shows that because of the large volumes of grain moving over the line the cost of moving the grain is lower than the regulated rate, thus profits equal to the shaded area are obtained on main line rail.

2. Low cost branch lines. These branch lines have lower traffic than a mainline but enough traffic such that costs are approximately equal to the regulated rate, so no loss or profit accrues to these lines (Figure 3.5).

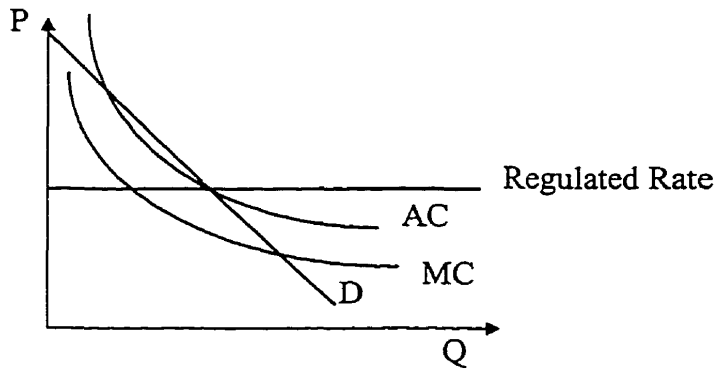


Figure 3.5. Low-Cost Branch Lines under the Maximum Rate Setting.

The situation for low-cost branch lines can be illustrated in Figure 3.5. From this diagram it can be shown that there are no losses or profits associated with this type of line. There is enough volume moving over these lines so that the per-tonne cost is slightly below or just equal to the regulated rate.

3. High-cost branch lines. These are branch lines characterized by low traffic, costs above the regulated rate, and the only reason they were kept operating was due to regulation guarding the abandonment of "grain dependent branch lines" (Figure 3.6).

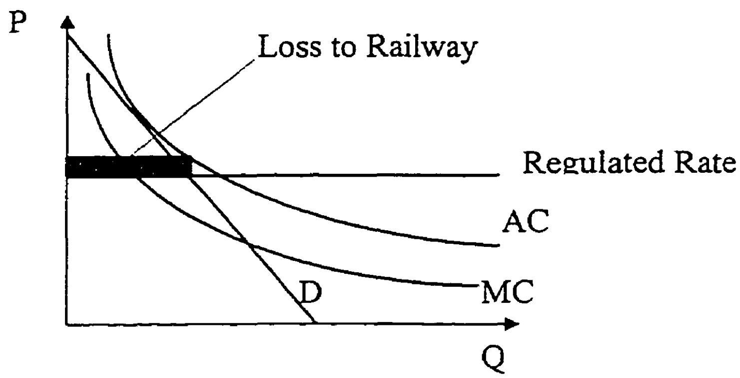


Figure 3.6. High-Cost Branch Lines under the Maximum Rate Setting.

High-cost branch lines are depicted in Figure 3.6. It can be seen that losses occur in this sector and are equal to the shaded area. In this analysis it is assumed that the high cost line is due solely to low volumes moving on the line and not due to light steel lines.

Due to the objective of the WGTA, the rate was set such that profits on mainline rails would just cover losses on high-cost branch lines. Essentially, the WGTA was to provide the railways with a normal rate of return (zero economic profit).

The railway is a profit-maximizer where the railway's profit maximization is regulated and is subject to constraints, which are maximum rates. The maximum the railway can charge the farmers for this grain is f_r^{Max}, where:

$$f_r^{Max} = P_w - C_R - EC - VC_T - AC_G \tag{3.17}$$

This does not mean that railways charge f_r^{Max}; it is just the maximum the railway is allowed to charge. Under this circumstance, all the rents go to the railways and farmers produce a zero profit. On the other hand, in a status quo of railway price regulated situation, the freight rate is equal to the average cost of the railway; there is no rent to the railway.

3.2.5 Market Equilibrium

The effects of different market situations on railway behavior are analyzed in this section. The potentially influential participants in decisions concerning grain production and branch lines are farmers, commercial trucks, railways, grain companies, value-added processors, and the government. The behavior of the various participants in grain production, collection, and transportation is influenced by cost relationships and by interaction between the different participants. The objective of each participant is to maximize its economic rent, or economic surplus.

3.2.6 Types of Economic Surplus

There are six types of economic surplus that might be associated with the production, collection, and transportation of grain. Three of these, consumer surplus, producer surplus (which occurs because of differences in inputs or technology), and elevator surplus, are excluded by the assumptions of the model.

Two of the remaining types of surplus, *Locational production surplus* and *Regional production surplus,* are varieties of production surplus. Production surplus occurs when the marginal cost of growing grain is greater than the average cost. Locational production surplus occurs because trucking costs cause farmers' grain yields to decrease as distance from the elevator increases (indirect impact on revenue and then input usage). It is assumed that higher yields occurring at locations near the center bring higher production surplus than lower yields occurring at locations towards the periphery.

Regional production surplus is the residual production surplus after account has been taken of the locational production surplus. Unlike locational production surplus, regional production surplus is the same on all land and is assumed to be equal to zero.

The last type of surplus is transportation surplus. This is the difference between the freight rate for grain and the sum of the costs of railway transport. In a regulated market in the supply of railway transportation, there is a possibility that this rent would be zero. This depends on the nature and efficiency of regulation.

The overall surpluses are defined to be the efficiency gains achieved from a change in the road and rail infrastructure due to a change in the delivery patterns farmers exhibit. For example, when all delivery points on a line close, the related rail operation ceases. As a result, the farmers deliver elsewhere and the surplus assets of this part of the network are recovered and reallocated to more efficient use for grain handling and transportation. If a change in the delivery system reduces total trucking, elevation, road maintenance, and rail operating costs for the region, a system surplus has been created equal to the net decrease in costs. It is clear that what may be savings to one sector of the industry may be a cost increase for others.

The above surpluses can be computed for the region using the following formulas. The profits of a farmer located at distance *d* from an elevator are:

$$\Pi_{Fi}(d) = K(P_w - f_{rj})t_{ij}(d) - TC_D(d) \tag{3.18}$$

Locational surplus (S_{LN}) is given by:

$$\sum_{j=1}^{n}[(P_w - f_{rj})Q_j - TC_D] - S_{RG} \tag{3.19}$$

where S_{RG} is the regional production surplus and it is assumed to be zero. Equation 3.19 says that the total locational surplus is the summation of all the farmers locational surpluses defined by Equation 3.18. The transportation surplus is given by:

$$S_T = \sum_{j=1}^{n} Q_j(f_{rj} - VC_{Rj}) - FC_{Rj} \tag{3.20}$$

Finally, total social surplus in the present study is the sum of these two surpluses plus elevator surplus as well as road surplus (loss) borne by the public, and is given by:

$$S_s = S_{LN} + S_T + S_{RD} + S_E \tag{3.21}$$

where S_S is the total social surplus, S_{RD} is the road surplus, and S_E is the elevator surplus. More explanation of the road cost will be given in the next section. It should be noted that the term "social surplus (or social cost)" used in this thesis considers only the four mentioned surpluses. Community impacts and other costs associated with branch line abandonment were not considered in this thesis.

A railway tries to maximize its profits by obtaining as much of the total surplus as possible.

$$S_T = \sum_{j=1}^{n} Q_j (f_r - VC_R) - FC_R \tag{3.22}$$

This is maximized when $MR_R = MC_R$, where

$$MR_R = f_r - VC_R \tag{3.23}$$

The comparative static of the equilibrium would be the response to an increase in the cost parameters such as *a, b, g, i, v, M*, and *EC*.

3.3 Summary

This chapter has provided theoretical background for the grain handling and transportation system. The study developed a detailed spatial equilibrium model of a particular region in the western Canadian grain market. The spatial model incorporated cost behaviors of various industry components of the grain transportation industry. The discussion of production costs, trucking costs, elevator costs, railway costs, and road costs were also described in this chapter. In the simulation model the interaction of the cost relationships determined the behavior of farmers and the railways. With a given export price, changes in the branch line configuration may affect the returns received by farmers and the railways.

CHAPTER IV

REGION, DATA AND EMPIRICAL SPECIFICATION

4.1 Introduction

The previous chapters presented the background and the theoretical framework that was necessary to model the grain handling and transportation system in the study region. The present chapter provides a description of the region, the data and the specification of the empirical model. In particular, it deals with the development of the empirical model that is used to search for the welfare analysis of various branch line configurations in the grain handling and transportation industry in the next chapter.

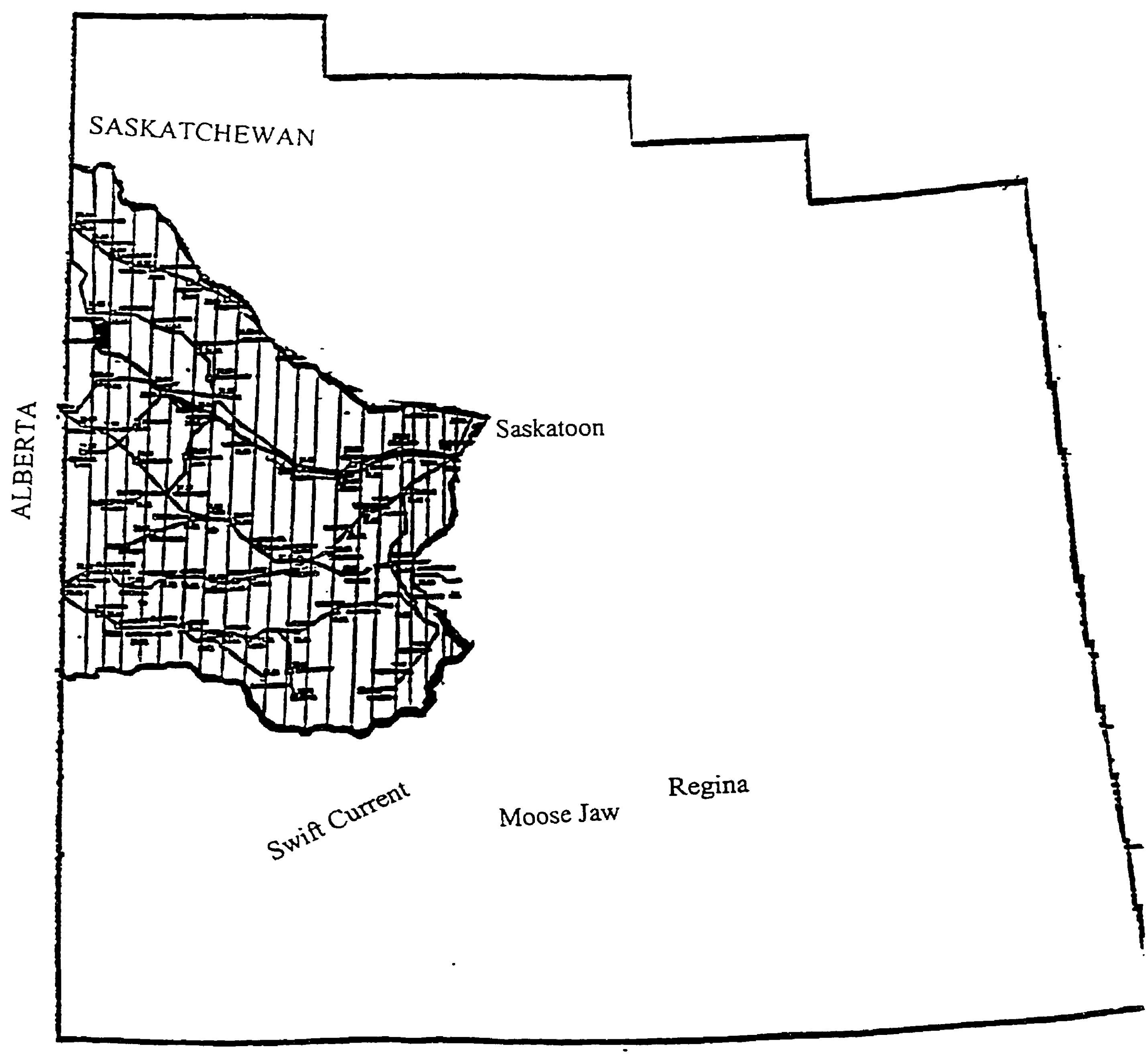
A detailed description of the study region along with maps is presented in Section 4.2. Section 4.3 describes the data and the sources of these data. Section 4.4 illustrates a general overview of the empirical model. This section prepares readers to understand the results in the next chapter. Finally, Section 4.5 provides a summary of the chapter.

This study considers grain as a grouped product. This means major agricultural products such as wheat (whole variety), barley (different types), oilseed and other grains are aggregated into one final product. This final commodity is produced by the farmers in each township of the study region and then is routed to the delivery point, or points, and finally shipped to the export destination. Even though all the agricultural crops are grouped into a single product, wheat, followed by barley, are the dominant crops.

4.2 The Region

The region is located in the west-central portion of Saskatchewan between the North and South Saskatchewan Rivers. The region comprises about one-fourth of the province's farm land. The study region is surrounded by the North and South Saskatchewan Rivers in such a way that movement into or out of the region is confined to a few bridges in the area. Hence, interregional shipments are ignored except for the area close to the bridges.

Map 4.1 illustrates the geographic boundary of the region. This area produces approximately 4,363,697 tonnes per year of grain and historically, about 75 percent of the production has been destined for export markets. The rest stays in the region for processing and other usage. The crop districts 7, 7A and 7B, and parts of crop districts 3B, 6B and 9B are located in this area. All three major soil zones - Brown Soil Zone, Dark Brown Soil Zone and Black Soil Zone - are found from the bottom of the region to the top.

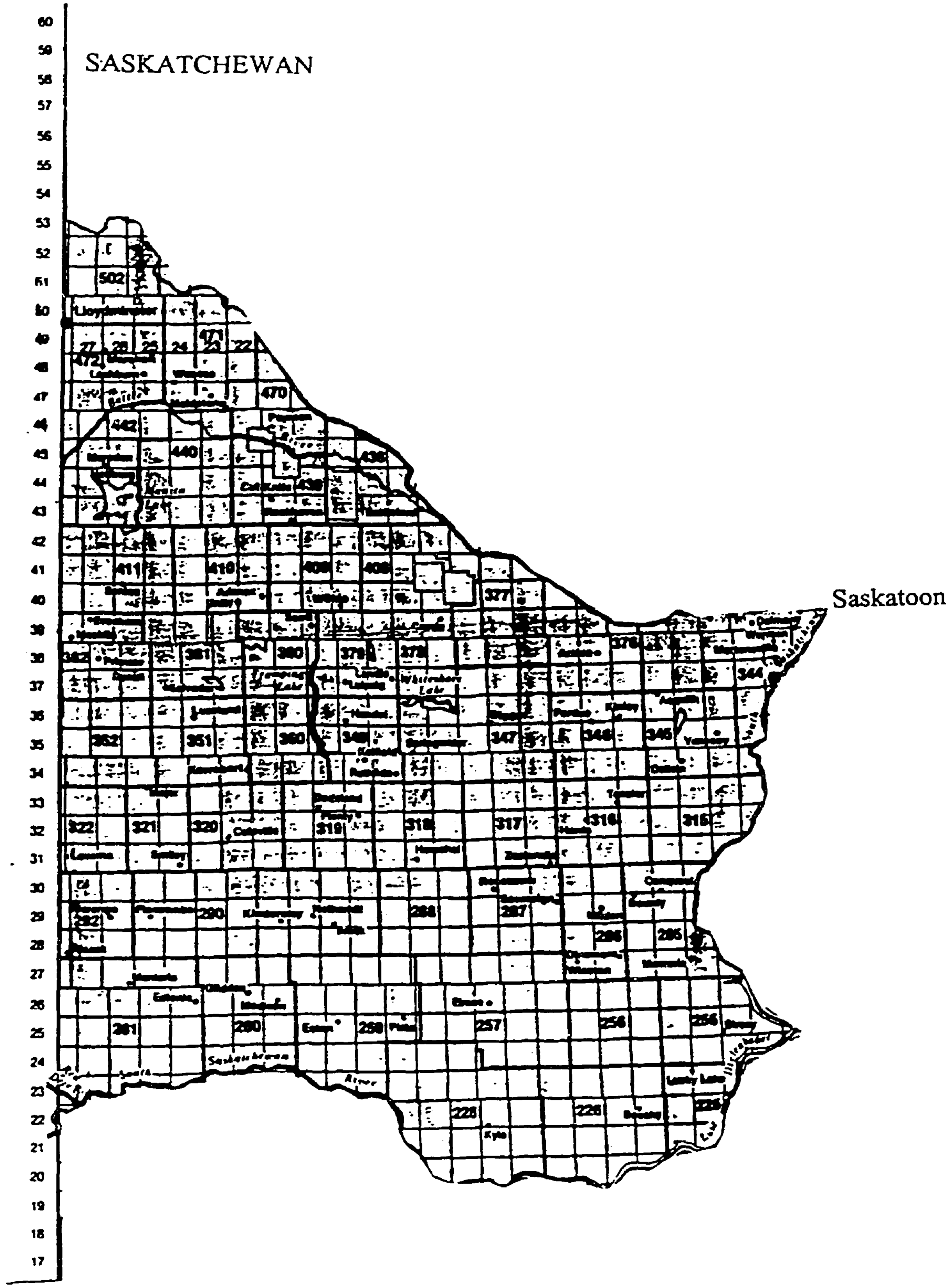


Map 4.1. Geographic Boundary of the Study Region.

A network of roads connects each farm to various delivery points. Each delivery point serves a catchment area. Farmers deliver about 75% of their grain to the elevator or elevators for transport on the railway. The catchment areas are different shapes and sizes. Finally, the elevators are located on both branch lines and mainlines, but most are placed along branch lines.

There are 540 townships representing farms and 90 delivery points located in this region (Maps 4.1 and 4.2). Boundary adjustments have been made for those townships located on the far side of the region. In essence, farmers produce grain and ship it to the delivery points for export. All export grain is routed to Vancouver.

Rail is the dominant mode of transportation used by farmers to ship their grain to the export destination. The study region is served by the two major railways, CN and CP. In the north portion, rail service is provided by CN and the southern part is served by CP. However, the main lines belonging to both railways cross in the north of the region in an east-west direction. A network of branch lines connects the country elevators to these mainlines. In general, the CN system serves the northern part of the area and CP system serves the south. Only rail and truck transport are available in the region. Trucking is used to ship grain from farm to the delivery points and rail is used to deliver the grain to export destination.



Map 4.2. Farms (Townships) in the Study Region.

The study region has a duopoly rail transportation market. However, the activity of each of the railways within the region is in such a way that each one has a potential "local" monopoly. Farmers in the intermediate proximity to the rail line, might be subject to this "local" monopoly power. In the case of a region, the abandonment of rail lines follow a duopoly model. To the extent that regulated freight rates inhibit competition, and other regulations impede abandonment, it may appear to be a "regulated" monopoly. How members of "regulated" monopoly act is a subject of duopoly theory.

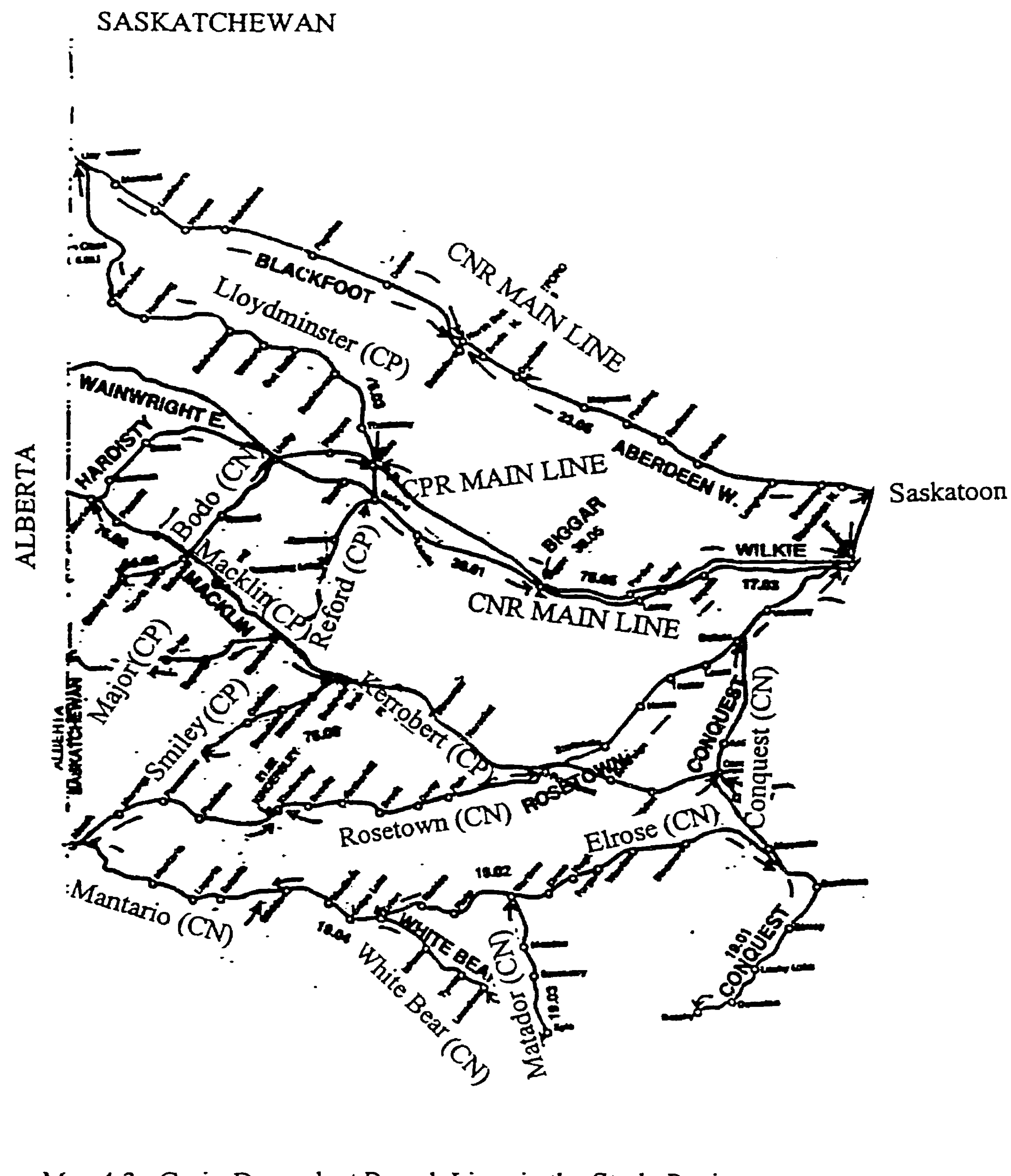
4.2.1 Branch Lines Selected for Review

A set of thirteen branch line segments were identified for consideration in this thesis. In total these thirteen segments comprise a total of 2,194,900 tonnes of grain products, serving at a total of 62 delivery points (Table 4.1). These branch lines are identified on Map 4.3.

Table 4.1. Grain Volume in each Branch Line of the Study Region in Crop Year 1994-95 (Tonne).

Branch Lines	Grain Volume in each Branch Line	Number of Delivery Points	Average Grain Volume Per Delivery Point	Branch Line Total Cost Per Tonne-Kilometer (Cents)
Lloydminster	247,200	7	35314	7.35
Bodo	40,200	3	13400	35.70
Reford	34,000	1	34000	7.76
Smiley (Dodsland)	40,800	2	20400	34.70
Conquest	185,400	6	30900	11.10
Matador	91,400	2	45700	35.70
White Bear	42,000	2	21000	35.70
Mantario	144,600	4	36150	33.70
Macklin	144,500	2	72250	6.65
Rosetown	526,400	16	32900	4.80
Major(Coronation)	44,600	2	22300	35.70
Kerrobert	281,200	6	46867	11.10
Elrose	372,600	9	41400	11.10
Total	2,194,900	62	35402	

Source: Saskatchewan Highways and Transportation, CP Railway and Author's Calculations



Map 4.3. Grain-Dependent Branch Lines in the Study Region.

4.3 The Data

An extensive data gathering effort was involved because the analysis includes all major costs associated with the export grain marketing system. Considerable emphasis was placed on estimating accurate transportation cost parameters.

The data used in the analysis came from different sources, including Saskatchewan Highways and Transportation, Crop Insurance data and various grain industry officials. However, the majority of the data used in this study were obtained from the Geographic Information System (GIS) database maintained by Saskatchewan Highways and Transportation. Part of the data on the distances produced by Saskatchewan Highways and Transportation were based on a mile measurement and the other part on kilometers. For ease of analysis all data were converted to a kilometer base.

The data on production volumes for various townships (representative of the farms) in the region were obtained from Saskatchewan Highways and Transportation. Total production for the region is specified as the sum of total production in each township. It is therefore equal to exports and domestic consumption. Next, the total production of the region was adjusted to obtain the net export for the transportation model. It is assumed that about 27 percent of total production went into the domestic market. This percentage is calculated based on the actual 1994-95 grain volume of the region to the export destination (Saskatchewan Highways and Transportation reported 26% for Saskatchewan in 1992). The rest is shipped to the export destinations.

Information on the capacity and the number of grain elevators was also obtained from Saskatchewan Highways and Transportation. In addition, elevator numbers and their ten year average volume received as well as received volume for crop year 1995-1996 were extracted from in publications of the Canadian Grain Council (1995). Further, data on grain production cost are taken from Saskatchewan Agriculture and Food Crop Budgets publication.

Data provided by both CP rail and personal contacts with relevant sources were considered to estimate rail cost parameters. A cost function was developed to calculate the fixed and the variable costs associated with all single point-to-point movements. Line-related and volume-related costs are different for each particular type of branch line. Rail costs reported for the main line include only volume-related costs because of the difficulty in estimating fixed costs for the main line[1].

The commercial trucking (five axle trucks or greater) analysis revealed that per-tonne cost parameters were influenced by distance of haul. For this reason, it is recognized that two trucking cost functions are appropriate: one function for trip distances less than or equal to 480 kilometers, the other for distances in excess of 480

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[1] Fixed costs of the main lines are difficult to estimate because these lines are used not only for grain movement but also for other uses. Exclusion of the fixed cost underestimates railways' transportation costs which then underestimates the total costs of the grain handling and transportation system. However, the overall impact does not change the conclusion of this study.

kilometers. However, since the major trucking distances in the study area do not exceed more than 480 kilometers, only one trucking cost function was specified for the purposes of the study. An average of eight cents per tonne per kilometer was assumed for trucking cost. This was obtained from *Farm Facts* published by the Saskatchewan Agriculture and Food Department. It is calculated based on different commercial trucking costs for different distances (as discussed in assumption four in Section 3.2.1 and Section 3.2.2.2).

Saskatchewan Highways suggests the annual maintenance cost for grain movement works out to an average of 5 cents per tonne mile or 3 cents per tonne kilometer for the province. This study uses this estimate to compute the road damage costs. The 3 cents per tonne kilometer cost multiplied by the distance from the center of the township to the delivery point multiplied by its production volume is the road cost for a particular township. This thesis also assumes 10.89 dollars per tonne elevation cost for each delivery point, and this has been taken from the 1996 Van Vliet Publication Series of Department of Agricultural Economics, University of Saskatchewan. This tariff is what AgPro Grain charged for wheat shipped in the 1995-1996 crop year.

The data in the thesis is limited to the study region. In many cases, this data needed to be adjusted and organized to ensure the data would be consistent with the assumptions of the model. Hence the estimation and simulation is limited to this region and any general conclusion has to be avoided, even though the results provide a good perspective of the grain handling and transportation system in Canada.

4.4 The Specification of the Model

Recall from Chapter 1 that the main objective of this research was to find the optimal branch line configuration under the existing elevator system to minimize total shipping and handling costs for the movement of grain from production origins to the Vancouver port. Because of a high degree of interdependence among the elements of the grain marketing system, a cost-minimizing model was developed to represent the entire system. The main principles in the model are: 1) farmer production and trucking costs, 2) rail transportation costs, 3) elevators costs, and 4) road costs.

Figure 4.1 illustrates the main components of the grain handling and transportation system. Those dash lines indicate effects that do exist in the grain handling and transportation problem. The solid lines indicate the focus of this research. As is shown, there are six components in this model: government, railways, grain companies, farmers, and world demand for grain. The decisions of government as well as world demand for grain and other effects are exogenous relative to the other three elements of the market. Effects such as shipping grain to the U.S. border are ignored.

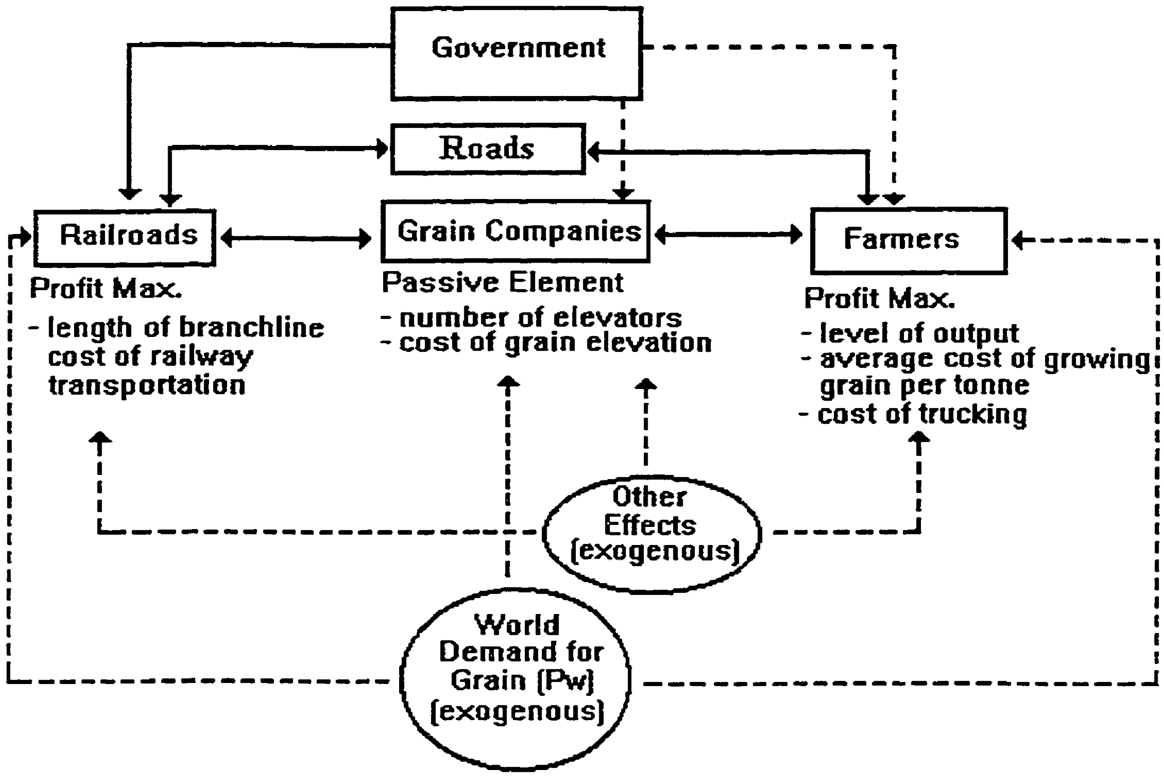

Figure 4.1. The Components of Grain Handling and Transportation System.

A simulation model was designed to analyze the impact of alternative transportation policies on the market structure of the study region's grain industry. The theoretical framework for this simulation model was explained in Chapter 3. This section explains how the problem was set up in a spreadsheet. The Excel program was chosen for this objective because it is able to measure simultaneous changes in all the above components of the system by changing only one sector. This section is divided into seven subsections to explain how the model was set up.

4.4.1 Catchment Areas for the Delivery Points

Table 4.2 is summarized from the applied spreadsheet and used to describe this subsection. This table illustrates trucking and elevation costs, freight rates, production and the distances from the center of each township to the delivery points per tonne kilometer. The numbers in the left margin of the table indicate row numbers in the spreadsheet. The capital letters on the top of the table indicate the column numbers of the spreadsheet. The table reads similarly as an Excel spreadsheet. For instance, cell B1 refers to the cell located in the second column and first row of the table.

As stated earlier, the study region has 90 delivery points. In the table these delivery points are indicated from B2 to CM2. There are 540 townships denoted in cells A7 to A546. Cells B3 to CM3 contain the elevation costs charged by each grain company at each particular delivery point. Grain companies charge the same price no matter where they are located. Row 4 contains implicit elevation costs. Implicit elevation costs, in brief, include the willingness of a farmer to deliver her/his grain to a particular delivery point. A farmer may prefer to deliver her/his grain volume to a particular delivery point. These costs may also contain those explicit costs not captured by the model. The implicit elevation costs are used to calibrate the catchment areas in the model (more explanation of the implicit elevation costs is provided in the following pages where calibration of catchment areas is discussed. Row 5 in the table is the regulated freight rates offered to farmers at each delivery point. For example, the rate in Wilkie is $31.23. Finally, cells B7 to CM456 comprise the distances from the center of each township to each of the delivery points. For instance, cell B7 indicates that it is 285 kilometers from the center of township #5168 to the delivery point at Alsask.

Table 4.2. Trucking and Elevation Costs, Freight Rates, Production and the Distances from Center of Townships to the Delivery Point or Points (Per Tonne/Kilometer).

Row	A	B	C	D	...	CK	CL	CM
1	Trucking Cost Per Tonne/KM	0.08						
2	Delivery points	Alsask	Asquith	Baldwinton	...	Wilkie	Wiseton	Zealandia
3	Elevation Cost	10.89	10.89	10.89	...	10.89	10.89	10.89
4	Implicit Cost	0.487	2.1	-0.195	...	-0.209	0.152	0.815
5	Freight Rates	30.41	32.42	32.42	...	31.23	33.42	33.42
6	Implicit Rates	0	0	0	...	0	0	0
7	Township#5168	285.39	63.45	244.27	...	185.63	157.47	121.98
8	Township#5169	288.57	66.63	222.06	...	172.30	160.65	125.15
9	Township#5302	264.67	42.73	217.26	...	162.21	136.74	101.25
10	Township#5303	273.42	51.48	213.67	...	161.65	145.50	110.00
. . .	. . .	. . .	. . .	. . .	... ...	. . .	. . .	. . .
543	Township#8532	6.63	246.23	214.33	...	195.64	191.78	170.88
544	Township#8533	3.51	236.09	204.19	...	185.50	190.60	160.74
545	Township#8534	22.59	239.35	200.02	...	182.52	193.85	164.00
456	Township#8535	38.49	236.14	185.79	...	172.66	202.60	172.75

Table 4.3 illustrates transportation and road costs, production, and exports for the townships in the region. Cells B2 to CM540 in Table 4.3 contain the transportation and elevation costs of townships to all the delivery points in the region per tonne kilometer. Each cell in the B2 to CM540 range was calculated based on the values presented in Table 4.2. For instance, the cost in cell B538 for township number 8532 was calculated as follows from Table 4.2:

B538 = (B1*B543) + SUM(B3 to B6)

$$42.317 = (0.08 * 6.63) + (10.89 + 0.487 + 30.41 + 0) \quad (4.1)$$

Column CP in Table 4.3 includes the data on production for each township provided by Saskatchewan Highways and Transportation. Historically, approximately 73% (1994-95) of the region's grain production was shipped to the export destination. Therefore, 73% of each cell in Column CP are the respective township's export volume that is routed to the world market. The rest of Table 4.3 is explained in other subsections. For now, this report will explain how the catchment areas for each delivery point were obtained.

Table 4.3. Transportation and Road Costs, Productions, and Exports for each Township and the Region (Dollar/ Tonne/Kilometer).

Row	A	B	C	D	...	CK	CL	CM	CP
1	TSH/DP	Alsask	Asquith	Baldwinton	...	Wilkie	Wiseton	Zealandia	Prodt.
2	Township#5168	64.618	50.486	62.656	...	56.761	57.059	54.883	9725
3	Township#5169	64.872	50.740	60.880	...	55.694	57.313	55.137	10818
4	Township#5302	62.960	48.828	60.496	...	54.888	55.401	53.225	6736
5	Township#5303	63.660	49.528	60.208	...	54.842	56.101	53.925	7306
. . .	. . .	. . .	. . .	. . .	... ...	. . .	. . .	. . .	. . .
538	Township#8532	42.317	65.108	60.261	...	57.561	59.804	58.795	2271
539	Township#8533	42.067	64.297	59.450	...	56.750	59.710	57.984	3517
540	Township#8534	43.593	64.557	59.116	...	56.512	59.970	58.245	2896
541	Township#8535	44.866	64.301	57.978	...	55.724	60.670	58.944	3097

Table 4.3 (Continued...). Transportation and Road Costs, Productions, and Exports for each Township and the Region (Dollar/ Tonne/Kilometer).

Row	CQ	CR	CT	CU	CX	CY	CZ	DA	DB	DC
1	Export	P_w	Yield/h	Pre Y/h	Prodn.	Export	T t/km	TTC	RC	TRC
2	7108.9	269.65	1.05523	1.05523	9725	7108.9	45.83	325854	0.726	5165
3	7907.9	269.65	1.17382	1.17382	10818	7907.9	45.56	360282	0.622	4922
4	4923.9	269.65	0.73090	0.73090	6736	4923.9	44.26	217956	0.137	672
5	5340.6	269.65	0.79275	0.79275	7306	5340.6	45.25	241690	0.508	2713
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
538	1660.0	269.65	0.24641	0.24641	2271	1660.0	41.83	69442	0.199	330
539	2570.9	269.65	0.38161	0.38161	3517	2570.9	45.05	115829	0.504	1295
540	2116.9	269.65	0.31423	0.31423	2896	2116.9	45.11	95508	0.527	1116
541	2263.9	269.65	0.33604	0.33604	3097	2263.9	45.88	103867	0.814	1842
542								1.42E+08		1687083

Table 4.4 provides the optimal delivered volumes from each township to the alternative delivery points. Cells B542 to CM542 of this table contains total received volume by each delivery point.

Table 4.4. Delivered Volumes, Rail Costs and Profits, and Elevator Revenues (Dollar/Tonne).

	A	B	C	D	...	CK	CL	CM	CN
1	TSH/DP	Alsask	Asquith	Baldwin.	...	Wilkie	Wiseton	Zealandia	Total
2	5168	0	0	0	...	0	0	0	
3	5169	0	0	0	...	0	0	0	
4	5302	0	0	0	...	0	0	0	
5	5303	0	0	0	...	0	0	0	
.	.	.	.	.	...	.	.	.	
.	.	.	.	.	...	.	.	.	
.	.	.	.	.	...	.	.	.	
538	8532	1660	0	0	...	0	0	0	
539	8533	0	0	0	...	0	0	0	
540	8534	0	0	0	...	0	0	0	
541	8535	0	0	0	...	0	0	0	
542	Total	7061	22062	36771	...	85058	26427	11897	3189821
543	Total 1994/96	7400	21600	33800	...	75600	22800	10600	3189821
544	Diff. %	4.57	2.14	8.80	...	12.51	15.91	12.24	
545	Rail TC	173870	441209	738800	...	1623178	608414	259558	66411610
546	Rail AC				...				
547	Rail MC				...				
548	Freight Rates	30.41	32.42	32.42	...	31.23	33.42	33.42	
549	R. Profit				...				
550	Elevator Revenue	80337	286586	393266	...	908505	291812	139262	33170128

For instance, township 8532 delivers 1660 tonnes of grain to the Alsask delivery point. This volume, and all the cells from B2 to CM541, were calculated as follows from Table 4.3:

$$B538 = \text{If}\,(B538 = \text{MIN}\,(B538 \text{ to } CM538), CQ538, 0) \quad (4.2)$$

This formula finds the least cost in Row 538 in Table 4.3. If the chosen cell is the minimum, it will deliver the export volume from column CQ in Table 4.3 for this particular township to the minimized cost delivery point.

At first, when all the delivery points charge a fixed elevation tariff ($10.89) the simulated delivered volumes were significantly different from the actual received volume in 1994-95 crop year. A macro program was written and run to minimize the differences between simulated and reported delivery volumes by changing the implicit elevation costs in Row 4 of Table 4.2. Originally, all the cells in this row were zero; the macro program changed them in such a way that the catchment area for each delivery point was achieved, or the differences between the received volume configured by the model and the actual received volumes by each delivery point in 1994-95 were minimized. The cells in Row 544 in Table 4.4 present the percentage differences between these two volumes. These differences are not zero because a township hauls all grain to one delivery point, making the response to changes in implicit tariff somewhat lumpy. Overall, the percentages mentioned are less than ten percent, which is far less that the unadjusted minimum transport cost used by Saskatchewan Highways and Transportation.

It is necessary to mention one final note before moving on to the next subsection. The total delivered volume obtained under the study model and based on the crop year 1994-95 (comparison year) has to be equal. In fact, the model at first forced these two to be equal. This was a required precondition for calibration of catchment areas; otherwise, the calibration job was impossible. Suppose, the total actual delivered volume for the region is 100 tonnes and the total delivered volume of the region obtained under the study model is 150 tonnes. Then, in calibrating of catchment areas, the difference between the actual delivered volume and predicted delivered volume for each delivery point can not be compared because total delivered volume and actual delivered volume are not equal for the region. As illustrated in Table 4.4, the cell CN542 is equal to the cell CN543.

4.4.2 Farmers' Elevation and Transportation Costs

The least-cost cells presented in Table 4.3 can be used to estimate farmers' elevation and transportation costs. To obtain this cost, the least-cost value in each row in Table 4.3 was simply multiplied with corresponding export volumes for that particular township. This is discussed more in the supply response subsection.

4.4.3 Road Costs

The decision of farmers to deliver the grain is based on the cost that has to be paid, but the road damage is not considered in farmer decisions. The least-cost cells were calculated without bringing this cost into the model. After the model decided where and how much to deliver to each delivery point, road costs have to be calculated. To figure this out in a systematic way another matrix of delivery points and townships was opened. Table 4.5 presents the procedure of estimating the road costs for the region. The formula presented in each cell of Table 4.5 finds the road costs after the model decides where to deliver their grain

Table 4.5. Road Cost Caused by each Township (Per Tonne Kilometer).

	A	B	C	D	...	CK	CL	CM
1	TSH/DP	Alsask	Asquith	Baldwinton	...	Wilkie	Wiseton	Zealandia
2	5168	0	0	0	...	0	0	0
3	5169	0	0	0	...	0	0	0
4	5302	0	0	0	...	0	0	0
5	5303	0	0	0	...	0	0	0
.	.	.	.	.	...	.	.	.
.	.	.	.	.	...	.	.	.
.	.	.	.	.	...	.	.	.
538	8532	0.199	0	0	...	0	0	0
539	8533	0	0	0	...	0	0	0
540	8534	0	0	0	...	0	0	0
541	8535	0	0	0	...	0	0	0

As was stated earlier, Saskatchewan Highways and Transportation estimated three cents per tonne kilometer for the average road cost in Saskatchewan. This estimate is used in the above formula to calculate the road costs. In general, the road cost is obtained from the product of three cents and the volume shipped to each delivery point and the road distance.

Cell DB538 and all the cells in Column DB in Table 4.3 were calculated based on Table 4.5 as follows:

$$DB538 = MAX(B538 \text{ to } CM538) \quad (4.3)$$

The product of this cell and the volume shipped to the delivery point provides the road cost caused by this particular township.

4.4.4 Supply Response

It was stated in Chapter 3 that production cost is a function of yield and yield itself is a function of world price, freight rate, elevation tariff, and the distance of farm from the delivery point; supply is a function of the farm price. However, the cells in Column CP in Table 4.3 that provide production volume for each township, are fixed; the supply curve is a vertical line. With a vertical supply all the impacts on price are irrelevant, therefore the grain production is insensitive to any change - it is essentially static.

To correct the model and incorporate supply response to distance change or changes in any other factors such as freight rate or elevation tariff, the supply function for each township was adjusted to respond to the above factors. The following formula was introduced in each cell of Column CX in Table 4.3 to correct the supply response:

$$Supply_{new\ situation} = Supply_{current\ situation} * (P_{new\ situation} / P_{current\ situation})$$

where P here is the farm price. This formula assumes the supply elasticity is equal to one. This formula is generated from the following supply elasticity:

$$\varepsilon = \frac{\partial y}{\partial p}\frac{p}{y}$$

if $\varepsilon = 1$, then

$$\partial y = y\frac{\partial p}{p}$$

where,

$\partial y = Supply_{new\ situation}$,

$y = Supply_{current\ situation}$,

$\partial p = P_{new\ situation}$, and

$P = P_{current\ situation}$.

Deduction of elevation and transportation costs from world price results in the farm price. The cells in Column CR in Table 4.3 indicate the average world price per tonne. The world price is exogenous and all farms face the same world price. This data was taken from Canadian Grains Council (1995). If the cells in Column CX are multiplied by 73%, the export quantities or Column CY will be generated.

To correct our model from step one up to this stage, wherever Column CQ (export volume) was used, it has to be substituted by Column CY.

Two more columns in Table 4.3 have yet to be explained: Columns DA and DC. Columns DA is transportation and elevation costs, and column DC is road costs. Column DA is obtained by multiplication of Columns CZ by CY, and Column DC is obtained by multiplication of Columns DB by CY. Cell DA542 in Table 4.3 represents total farmers' transportation and elevation costs for the study region, and Cell DC542 represents total road costs in the region.

4.4.5 Railway Costs

The form of the railway cost function was explained in Chapter 3. Exactly the same form was followed in this subsection to set up the railway cost function. For each segment of the rail branch lines a different cost was estimated. The following example, which represents rail cost for the Dodsland branch line, helps illustrate the branch lines cost estimation. Subdivision Dodsland is 45.44 kilometers long with two stations, Coleville at kilometer 28.56 and Smiley at kilometer 45.44, which originate 18,780 tonnes and 14,780 tonnes of grain export, respectively. The cost function for this subdivision was estimated as follows:

$$Cost_{Dodsland} = 45.44*9420.28 + 0.018*(45.44*14780 + 28.56*18780) \quad (4.4)$$

where

9420.28 = the average line related cost per kilometer for grain-dependent branch lines,

14780 = total export volume at Simley delivery point,

18780 = total export volume at Coleville delivery point,

0.18 = volume related cost per tonne-kilometer.

Line-related costs do not vary with the volume of grain shipped. Therefore, on lines where the volume of traffic is low, the line-related costs significantly affect total cost. If Equation 4.4 is divided by (45.44*14780 + 28.56*18780), the average per tonne-kilometer for this particular branch line can be calculated. This average per tonne-kilometer cost is a function of the volume. If the export volumes of the delivery points located in the branch line change, the average cost per tonne-kilometer also changes. This is an important factor in branch line abandonment because in the process of abandonment, if the volume of a line moves to another line, the average cost per tonne-kilometer of the receiving line declines. If the same procedure was used to estimate the cost of other branch lines, a rail cost function can be developed from each delivery point to the export destination.

Only the volume-related cost per tonne-kilometer for the main line was available. It was assumed that the volume-related cost on the branch line ($0.018) was approximately 38 percent higher. This percentage was chosen based on expert opinions[2] in this area because actual branch line volume-related costs were not available. The branch line volume-related cost per tonne-kilometer, as was stated earlier, is assumed to be the same for all branch lines.

The cells in Row 545 of Table 4.4 indicate the cost that the railway incurred at each delivery point. Summation of all the cells in Row 545 (cell CN545) in Table 4.4 provides the total railway cost in the region.

4.4.6 Elevator Costs

The elevator cost is calculate by multiplication of the differences in Row 3 and 4 (elevation costs) in Table 4.2 by Row 542 (received volume at each delivery point) in Table 4.4. This is presented in Row 550 of Table 4.4. Summation of all the cells in Row 550 (cell CN550) provides the total elevation costs in the region.

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[2] This percentage was formulated after discussion with Ken Perlich from Department of Saskatchewan Agriculture and Food, Richard Gray from University of Saskatchewan, and Jim Vercammen from University of British Columbia.

4.4.7 Total Cost

The total cost of the grain handling and transportation system in the study region is calculated by adding cell DA542 (farmers' transportation and elevation costs) in Table 4.3, cell DC542 (road costs) in Table 4.3, cell CN545 (railway costs) in Table 4.4 and cell CN550 (elevator costs) in Table 4.4. This is used in the next chapter to compare alternative configurations of the grain handling and transportation system in the region.

Before ending this section, as the reader may realize, two of the advantages of the model are its simplicity and its simultaneity. Any change in the model has an impact on other parts of the system and the model measures these impacts. One limitation of the model is exclusion of elevator's cost behavior. The model assumed elevators play a passive role in the grain handling and transportation system and charge the same tariff irrespective of changes in branch line configuration and volumes handled. This problem can be corrected by introducing a cost function for elevators in the model. Another limitation of the model is "implicit elevator costs". These costs were used to estimate a more precise form of catchment areas. If these costs can be explicitly identified for each township, a better form of catchment area can be obtained for the grain handling and transportation model.

4.5 Summary

This chapter has described the specification of the empirical model[3], the data, and the study region to estimate the effect of branch line abandonment on various participants in the grain handling and transportation system. Chapter 5 provides results of alternative branch line abandonment. Implications and comparisons of different scenarios of branch line abandonment are also made in this chapter.

[3] The full specification of all excel formulae and macros are available in the Van Vliet Chair, Department of Agricultural Economics, University of Saskatchewan.

CHAPTER V

EMPIRICAL RESULTS

5.1 Introduction

Chapter 1 addressed various problems involved in the grain handling and transportation system. Chapter 2 reviewed the historical regulations involved in transportation of grain in Canada. Chapter 3 provided a theoretical model of the grain transportation industry. Chapter 4 developed an empirical framework needed to perform cost analysis under various branch line configurations. This chapter analyzes the results of the simulations and presents a welfare analysis of different branch line configurations.

Section 5.2 presents the characteristics of the current scenario of the grain transportation system. The comparison of the alternative branch lines under Bill 101 without the $10,000 per mile penalty on the fixed cost as a result of abandonment is presented in Section 5.3. Section 5.4 presents the results of the railways' cost with various branch line configurations under Bill 101 with a $10,000 per mile penalty on the railway fixed cost. Finally, Section 5.5 provides a conclusion to the chapter.

Four main assumptions were made in analyzing welfare impacts of different railway policies toward branch line abandonment: 1) trucks (five axle trucks or greater) were used to deliver the grain from the farm to the elevators in the region (as discussed in assumption four in Section 3.2.1 and Section 3.2.2.2), and shipping grain to the export destinations is by railway; 2) freight rates are regulated equal to the maximum rates, but railways are given the power to abandon the lines; and, 3) grain is moved to the delivery points located on the branch lines and the main lines, and from there is shipped to the port of Vancouver, finally, 4) incentive rates were not considered for multiple car spots.

Incentive rates were not considered in this analysis because the outcomes are too unpredictable. In the Van Vliet publication (1996) Vercammen illustrates a scenario where there are two elevators in a particular region. Elevator H is located on a comparatively high cost branch line and elevator L is located on a comparatively low cost main line. The railway's actual cost of transporting grain from elevator H to the port is $40 per tonne and from elevator L to the port is $20 per tonne. Farmers are assumed to be evenly distributed throughout the growing region. If the railway freight charge is the same at both elevators ($30 rate cap) then one half of the farmers will deliver to elevator H and one half to the elevator L. Vercammen argues that the railways can increase its profits by maintaining a $30 per tonne freight charge at elevator H and lowering the freight charge at elevator L. If the freight charge is lowered by $2 per tonne at elevator L, some of the farmers who previously delivered to elevator H now deliver to elevator L because the $2 per tonne freight savings more than offsets their increased trucking cost.

Assume that after the incentive rate has been offered, one third of total regional production is delivered to elevator H while two thirds is delivered to elevator L.

The average cost of transporting the grain is now (1/3)*40 + (2/3)*20 = 26.7 dollars per tonne. Therefore, the incentive rate has decreased the railway's average cost of hauling the grain from the region by 30 - 26.7 = 3.30 dollars per tonne. The revenue to the railway after offering the incentive rate is (1/3)*30 + (2/3)*28 = 28.7 dollars per tonne. Therefore, the incentive rate results in profits of 28.7 - 26.7 = 2.0 dollars per tonne.

The problem with Vercammen's argument is that he assumes a fixed average cost for high cost branch line and low cost main line. However, when grain is redirected from the high cost branch line to the low cost main line, the average railway cost for each of these lines will change because these costs are a function of volume movement on these lines. Vercammen assumed these costs fixed even after redirection of grain. A missing point in Vercammen's analysis is that, after using incentive rates, the average railway cost in high cost branch line (H) goes up and the average railway cost in low cost main line (L) declines. Depending on which of these are dominate, railway in overall may lose or benefit from using incentive rates. For example in the model, when incentive rates was used for *Conquest* branch line (with low average cost) and *Matador* branch line (with high average cost), the CN railway experienced a rise in its total costs, a result opposite to Vercammen's analysis.

5.2 Characteristics of the Current Grain System

Table 5.1 illustrates the received volumes based on the 1994-1995 crop year and the model for the delivery points located in the study region. Comparison of the elevator's received volume in 1994-95 with the model output indicates that less than 10% of differences exist between the actual delivered volumes (1994-1995) and the delivered volumes yielded by the model (Figure 5.1). This appears to be accurate, and is far less than the unadjusted minimum transport cost model used by Saskatchewan Highways and Transportation.

As was stated earlier, to determine the catchment area for the elevators, the total export volumes in 1994-1995 has to be equal to the total export volumes configured by the model. Table 5.1 shows that these two are equal. Farmers exported a total of 3,189,823 tonnes of grain from this region to the world market.

Table 5.1. Actual (1994-1995) and Predicted Received Volumes in Each Delivery Point in the Study Region (Tonne).

Delivery Points	Actual Received Volume (1994-95)	Estimated Received Volume	Percentage Difference
ALSASK	7400	7061	4.6
ASQUITH	21600	22062	(2.1)
BALDWINTON	33800	36771	(8.8)
BATTLEFORD	55200	68269	(23.7)
BEADLE	15400	13889	9.8
BEECHY	54200	46910	13.5
BIGGAR	28700	33173	(15.6)
BIRSAY	16700	16408	1.7
BROCK	56400	49188	12.8
CACTUS LAKE	20600	21502	(4.4)
COLEVILLE	25500	18781	26.4
CONQUEST	21400	22817	(6.6)
CUTKNIFE	35200	31940	9.3
DALMENY	43700	45687	(4.5)
D'ARCY	10000	10387	(3.9)
DELISLE	48900	56124	(14.8)
DELMAS	16700	19863	(18.9)
DENHOLM	8279	6052	26.9
DINSMORE	77500	75234	2.9
DODSLAND	39200	35811	8.6
DUNBLANE	7400	7860	(6.2)
EATONIA	41900	20557	50.9
ELROSE	63000	56052	11.0
ESTON	81100	72246	10.9
FISKE	30600	27866	8.9
FLAXCOMBE	21200	19297	9.0
HARRIS	40700	42172	(3.6)
HERSCHEL	82100	84685	(3.1)
HUGHTON	22800	20261	11.1
KERROBERT	60000	54789	8.7
KINDERSLEY	114400	92978	18.7
KINLEY	20700	21217	(2.5)
KYLE	72800	69448	4.6
LACADENA	26400	24009	9.1
LANDIS	98500	103729	(5.3)
LANGHAM	17200	17045	0.9
LAPORTE	50900	48771	4.2
LASHBURN	69200	103521	(49.6)
LAURA	14200	17778	(25.2)
LENEY	17200	19379	(12.7)
LLOYDMINSTER	81100	86830	(7.1)
LUCKY LAKE	61000	60139	1.4
LUSELAND	127900	150470	(17.6)
MACKLIN	51500	54329	(5.5)

MACRORIE	24700	23333	5.5
MADISON	33100	30101	9.1
MAIDSTONE	60900	67126	(10.2)
MAJOR	25900	23494	9.3
MANTARIO	26900	17629	34.5
MARENGO	67700	60165	11.1
MARSDEN	47300	54310	(14.8)
MARSHALL	47700	49353	(3.5)
MAYMONT	35000	57072	(63.1)
MILDEN	42600	39009	8.4
NEILBURG	34200	30594	(10.5)
NETHERHILL	9600	7634	20.5
NORTH BATTLEFORD	5810	3186	45.2
PAYNTON	11400	16043	(40.7)
PERDUE	38300	58852	(53.7)
PINKHAM	8800	10716	(21.8)
PLATO	28100	18596	33.8
PLENTY	46600	51416	(10.3)
PRIMATE	16600	15137	8.8
RADISSON	27400	32654	(19.2)
REFORD	18200	15015	17.5
RICHLEA	38900	40996	(5.4)
ROCKHAVEN	69200	83571	(20.8)
ROSETOWN	56400	60037	(6.4)
SALVADOR	17400	15007	13.8
SANCTUARY	18600	10669	42.6
SASKATOON	51200	58566	(14.4)
SCOTT	26700	32350	(21.2)
SENLAC	16200	12096	25.3
SMILEY	15300	14781	3.4
SOVEREIGN	10700	9037	15.5
SUPERB	18700	17932	4.1
TESSIER	14100	15119	(7.2)
THACKERAY	9500	7596	20.0
TRAMPING LAKE	34000	36911	(8.6)
TYNER	15600	14047	10.0
UNITY	23900	25718	(7.6)
WILBERT	18000	17212	4.4
WILKIE	75600	85058	(12.5)
WISETON	22800	26428	(15.9)
ZEALANDIA	10600	11898	(12.2)
TOTAL	3189823	3189821	

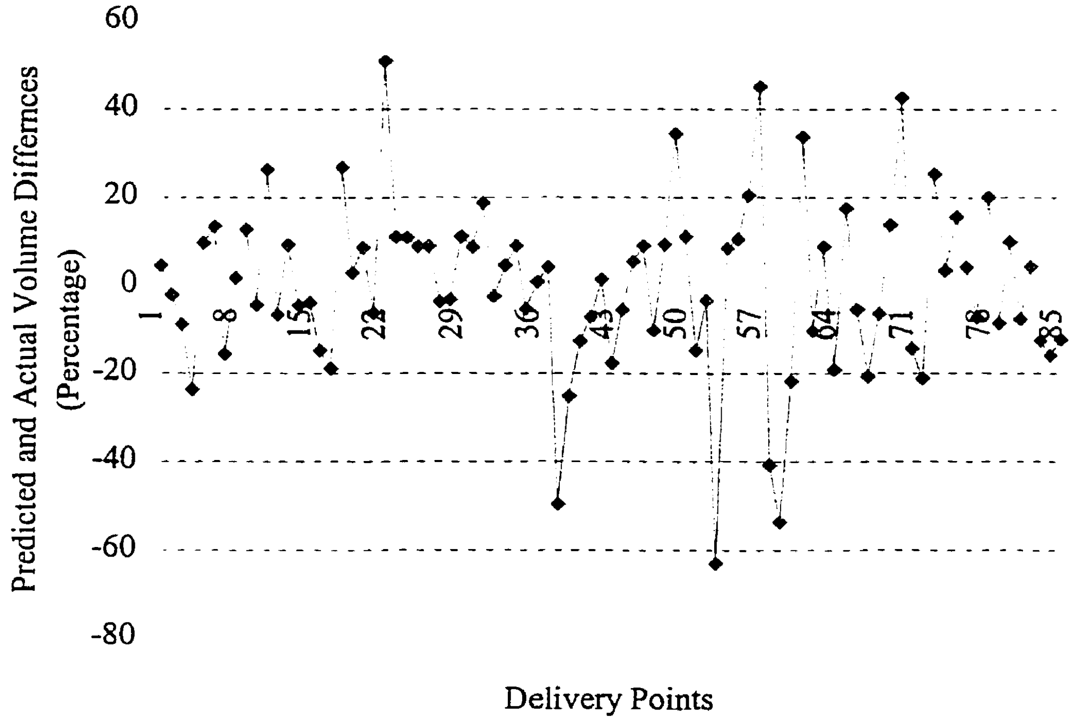

Figure 5.1. Difference between the Actual and Predicted Received Volume in Delivery Points.

Table 5.2 and Figure 5.2 compare the actual versus the predicted grain volumes on the branch lines in the study region. As illustrated in these table and figure, the model provides relatively good approximation of actual movement on the branch lines in the region.

Table 5.2. Comparison of the Actual Versus the Predicted Grain Volumes on the Branch Lines in the Study Region (Tonne).

Subdivision	From - To	Kilometer	Actual Volume in 1994-95	Predicted Volume	Percentage Difference
Lloydminster (CP)	Lloydminster - Wilkie	106.16	247200	261994	(6.0)
Bodo (CN)	Cactus Lake - Unity	64.64	40200	21502	46.5
Reford (CP)	Kerrobert-Wilkie	32.76	34000	36911	(8.6)
Smiley (Dodsland) (CP)	Smiley - Dodsland	45.44	40800	33561	17.7
Conquest (Top) (CN)	Macrorie - Delisle	73.14	46100	46150	(0.1)
Conquest (CN)	Beechy - Macrorie	77.76	139300	131317	5.7
Matador (CN)	Kyle - Wartime	46.28	91400	80117	12.3
White Bear (CN)	Lacadena - Eston	38.72	42000	38056	9.4
Mantario (CN)	Eatonia - Alsask	53.44	144600	86956	39.9
Macklin (CP)	Kerrobert - Macklin	74.24	144500	235402	(62.9)
Rosetown (CN)	Alsask - Saskatoon	264.48	526400	454513	13.7
Majot (Coronation) (CP)	Major - Kerrobert	34.5	44600	41426	7.1
Kerrobert (CP)	Conquest - Kerrobert	128.32	281200	249976	11.1
Elrose (CN)	Glidden - Macrorie	174.08	372600	339914	8.8

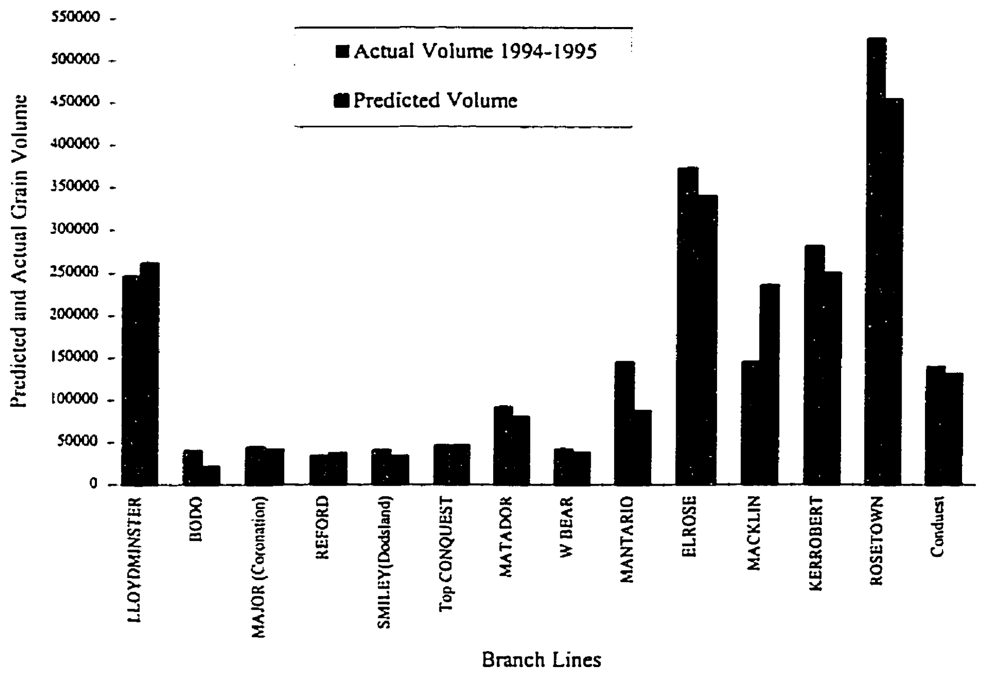

Figure 5.2. Comparison of the Actual Versus the Predicted Grain Volumes on the Branch Lines in the Study Region (Tonne).

Table 5.3 presents the regulated freight rates, the estimated elevation tariff, and the total, average and marginal costs of rail transportation. At each delivery point the maximum freight rates are offered to the farmers. The rate is exogenous to the railway's decision and is regulated by the government. However, as the results indicate, in order to have a good approximation of the catchment areas, the tariff charged by each elevator is slightly different than the actual tariff. In the real world, there are some factors other than just the elevation tariff that influence farmers' elevator choice. Since this thesis did not take into account those factors, the tariffs at each delivery point were adjusted to match the received volumes configured by the model with the received volume in 1994-1995.

The procedure to estimate the costs was explained in the previous chapter. The estimated railway's average costs (as Table 5.3 and Figure 5.3 indicate) in some delivery points are greater than the regulated freight rates and in some delivery points are less than the regulated rates. In accordance with prior expectations, the results of the model indicate that the average total cost is higher than the marginal cost in all the delivery points on the grain-dependent branch lines under the current situation. This is because the fixed cost reflects a large portion of the total cost in those lines. The total cost to the railways of moving 3,189,821 tonnes of grain from the study region to the Vancouver port is estimated to be $80,050,246.

It should be noted that the study region is just one small part of whole prairie agriculture. For this region, the regulated freight rates cover the railway's average costs. However, this may not be true for some other regions in the prairies. Even in the case where regulated rates cover railway's average total costs, railways can maximize their benefits by abandonment of high cost branch lines because the volume of abandoned branch lines is redirected eventually to the main lines or to the lower average cost branch lines (in the assumptions of the model, the possibility of shipping grain directly to U.S. market or to the Vancouver port by truck was ruled out).

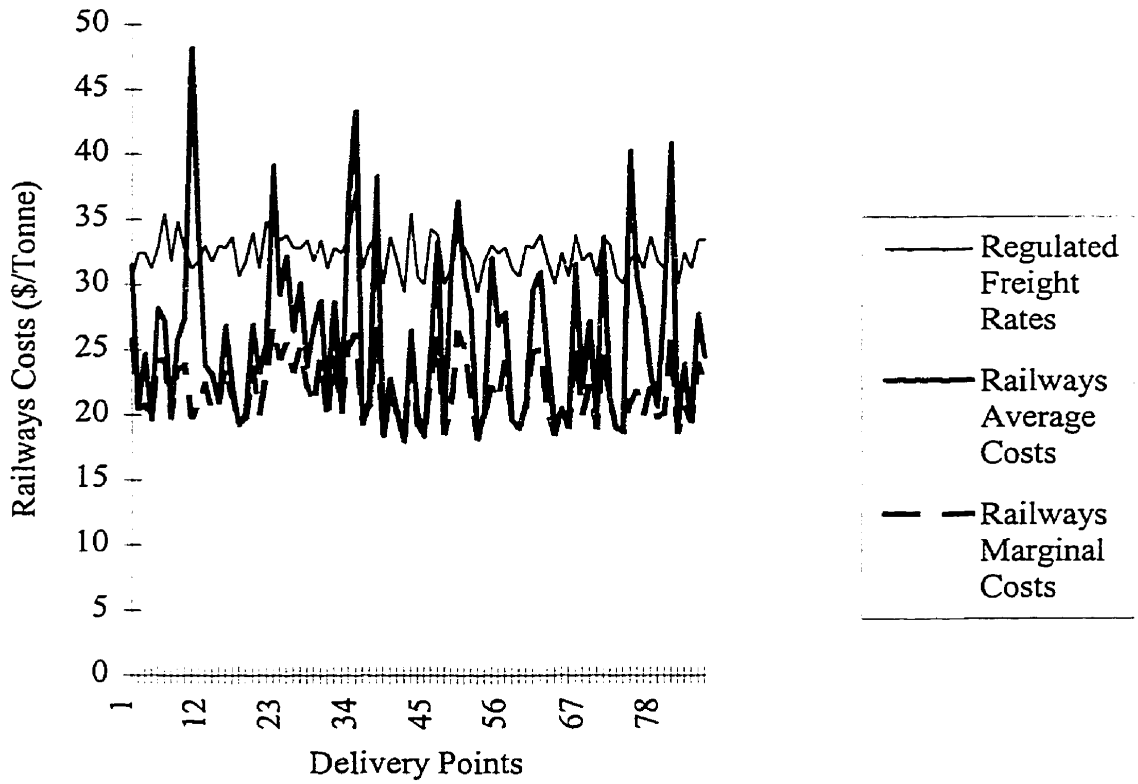

Figure 5.3. Marginal and Average Costs and Regulated Freight Rates.

Table 5.3. Regulated Rates, Estimated Elevation Tariffs, and Estimated Railway costs in Each Delivery Points ($/Tonne).

Delivery Points	Regulated Freight Rates ($/Tonne)	Estimated Elevation Tariff ($/Tonne)	Total Cost of Railways	Average Cost of Railways ($/Tonne)	Marginal Cost of Railways ($/Tonne)
ALSASK	30.41	11.38	222299	31.48	25.67
ASQUITH	32.42	12.99	452522	20.51	20.51
BALDWINTON	32.42	10.70	908986	24.69	20.73
BATTLEFORD	31.23	11.20	1342232	19.66	19.66
BEADLE	32.82	8.45	391948	28.22	24.20
BEECHY	35.45	8.69	1574115	27.25	24.24
BIGGAR	31.82	13.19	666254	20.08	19.84
BIRSAY	34.86	10.12	472088	25.87	23.48
BROCK	32.82	8.28	1348804	27.42	23.84
CACTUS LAKE	31.23	11.25	1036712	48.21	19.90
COLEVILLE	31.82	9.64	637445	33.94	20.69
CONQUEST	33.01	11.83	543525	23.82	22.37
CUTKNIFE	31.82	10.59	741256	23.21	20.39
DALMENY	33.01	10.71	961136	21.04	21.04
D'ARCY	32.82	9.39	279189	26.88	23.60
DELISLE	33.67	11.37	1249728	22.27	21.52
DELMAS	30.63	13.54	382670	19.27	19.27
DENHOLM	31.82	9.10	120484	19.91	19.91
DINSMORE	34.01	9.42	2027547	26.95	23.61
DODSLAND	31.23	10.57	834664	23.31	20.17
DUNBLANE	34.86	10.15	213508	25.40	23.23
EATONIA	33.82	9.97	804507	39.14	26.64
ELROSE	33.42	9.99	1640551	29.27	24.41
ESTON	33.82	6.97	2325249	32.19	25.40
FISKE	32.82	9.75	738110	26.49	23.42
FLAXCOMBE	32.82	8.64	581078	30.11	25.06
HARRIS	33.42	11.45	1003267	23.79	22.21
HERSCHEL	31.82	11.00	2256845	26.65	20.88
HUGHTON	33.42	10.28	583433	28.80	24.25
KERROBERT	31.23	10.09	1158609	21.15	19.72
KINDERSLEY	32.82	7.69	2665497	28.67	24.41
KINLEY	32.42	12.28	431279	20.33	20.33
KYLE	33.63	8.67	2531705	36.46	25.44
LACADENA	37.24	5.38	1040642	43.34	26.10
LANDIS	31.23	11.86	2013307	19.41	19.41
LANGHAM	33.01	10.96	356053	20.89	20.89
LAPORTE	33.82	10.45	1867325	38.29	26.53
LASHBURN	30.04	11.04	1904119	18.39	18.39
LAURA	33.67	11.79	405098	22.79	21.76
LENEY	31.82	12.32	391877	20.22	20.22
LLOYDMINSTER	29.44	11.62	1563607	18.01	18.01
LUCKY LAKE	35.45	9.11	1851130	26.45	23.80
LUSELAND	30.63	9.97	3039222	20.20	19.26

MACKLIN	30.04	11.11	998480	18.38	18.38
MACRORIE	34.26	10.26	575891	24.68	22.84
MADISON	33.82	7.52	1002548	33.31	25.79
MAIDSTONE	30.04	12.76	1253251	18.67	18.67
MAJOR	31.23	10.26	722968	30.77	20.34
MANTARIO	33.82	9.12	641424	36.39	26.29
MARENGO	32.82	7.87	1849819	30.75	25.34
MARSDEN	31.82	10.72	1523850	28.06	21.48
MARSHALL	29.44	12.09	899912	18.23	18.23
MAYMONT	31.82	11.07	1152766	20.20	20.20
MILDEN	33.01	11.05	1249989	32.04	22.02
NEILBURG	32.42	9.99	824668	26.96	21.24
NETHERHILL	32.82	9.33	212499	27.84	24.03
NORTH BATTLEFORD	31.23	11.04	62543	19.63	19.63
PAYNTON	30.63	13.63	304454	18.98	18.98
PERDUE	33.01	11.14	1219792	20.73	20.73
PINKHAM	32.82	9.36	317470	29.63	24.84
PLATO	33.82	8.36	575930	30.97	24.99
PLENTY	31.82	10.86	1255211	24.41	20.41
PRIMATE	30.04	11.29	284597	18.80	18.58
RADISSON	32.42	10.20	668401	20.47	20.47
REFORD	30.63	11.80	287400	19.14	19.14
RICHLEA	33.82	7.56	1293546	31.55	25.19
ROCKHAVEN	31.82	10.21	1851865	22.16	20.16
ROSETOWN	32.42	11.66	1631365	27.17	22.13
SALVADOR	30.63	10.70	295955	19.72	19.03
SANCTUARY	33.63	9.75	358467	33.60	25.08
SASKATOON	33.01	11.15	1241514	21.20	20.91
SCOTT	30.63	11.47	615406	19.02	19.02
SENLAC	30.04	13.52	226283	18.71	18.71
SMILEY	31.82	10.27	594579	40.23	20.99
SOVEREIGN	32.42	12.51	276336	30.58	21.71
SUPERB	31.23	10.08	500478	27.91	20.15
TESSIER	33.67	11.29	351269	23.23	21.96
THACKERAY	31.82	9.54	156852	20.65	19.82
TRAMPING LAKE	31.23	11.38	1052807	28.52	20.16
TYNER	37.24	5.30	573252	40.81	25.94
UNITY	30.04	13.66	487424	18.95	18.73
WILBERT	32.42	10.69	411118	23.89	20.54
WILKIE	31.23	10.68	1664798	19.57	19.57
WISETON	33.42	11.04	732267	27.71	23.87
ZEALANDIA	33.42	11.71	291180	24.47	22.52
TOTAL			80050246		

The costs per tonne-kilometer for the branch lines located in the study region were estimated with the model, and these results are presented in Table 5.4. Table 5.4 also shows the length and location of each branch line. To facilitate analysis of branch line abandonment in the next section, the Conquest branch line (CN line) was further divided into two segments: Conquest from Beechy to Macrorie, which was about 88 kilometers long, and Conquest (top) from Macrorie to Delisle, about 73 kilometers long (this is a logical configuration from the railway's perspective).

The estimated per tonne-kilometer costs for the rail network considered here are very close to the per tonne-kilometer cost provided by CP Rail. For example, CP Rail estimated the Lloydminster subdivision per tonne-kilometer cost to be equal to $0.074, which is very close to the $0.079 estimated by the model. Similarly, the reported cost of $0.35 for the Dodsland subdivision is very close to the estimate of $0.37. As mentioned in Chapter 4, the quantity shipped on a particular branch line can significantly affect the magnitude of this cost for that line. Figure 5.4 and Figure 5.5 demonstrate the relative weight of the branch lines in terms of share of transportation cost to the port and the length of branch lines, respectively. Reader can compare the relative magnitude of the branch lines in the study region from Figure 5.4, Figure 5.5 and the branch line estimated cost column in Table 5.4.

Table 5.4. Estimated Costs per Tonne-Kilometer for Branch Lines.

Subdivision	From - To	Kilometer	Branch Line Estimated Cost Cents Per Tonne/ Kilometer	Branch Lines Cost ($)	Main Line Cost ($)	Total Cost ($)
Lloydminster	Lloydminster - Wilkie	106.16	7.99	1,290,711	5,127,882	6,418,593
Bodo (CN)	Cactus Lake - Unity	64.64	45.61	633,945	402,767	1,036,712
Reford (CP)	Kerrobert-Wilkie	32.76	27.32	330,374	722,433	1,052,807
Smiley (CP)	Smiley - Dodsland	45.44	37.24	449,801	0	449,802
Conquest (Top) (CN)	Macrorie - Delisle	73.14	3.30	1,515,006	0	1,515,006
Conquest (CN)	Beechy - Macrorie	77.76	11.41	869,692	0	869,692
Matador (CN)	Kyle - Wartime	46.28	14.28	498,870	0	498,870
White Bear (CN)	Lacadena - Eston	38.72	28.82	389,052	0	389,052
Mantario (CN)	Eatonia - Alsask	53.44	14.32	575,775	0	575,775
Macklin (CP)	Kerrobert - Macklin	74.24	3.86	1,351,824	10,298,534	11,650,358
Rosetown (CN)	Alsask - Saskatoon	264.48	3.94	4,533,748	24,614,644	29,148,392
Majot (CP)	Major - Kerrobert	34.5	27.90	347,413	0	347,413
Kerrobert (CP)	Conquest - Kerrobert	128.32	9.73	1,533,951	0	1,533,951
Elrose (CN)	Glidden - Macrorie	174.08	5.27	2,490,758	0	2,490,758

Source: Saskatchewan Highways and Transportation, and author's calculations.

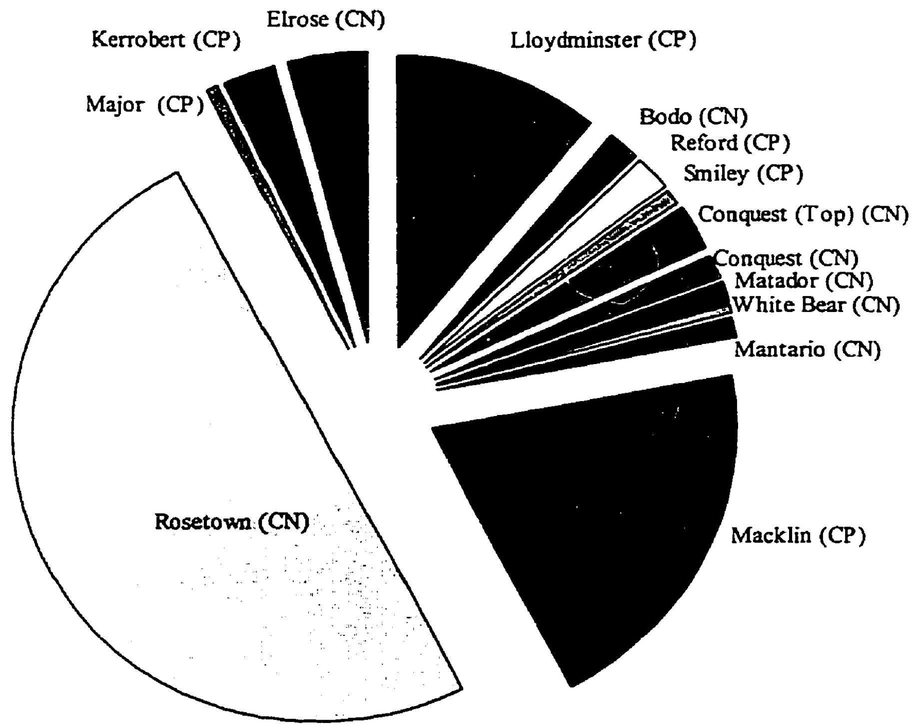

Figure 5.4. Branch Line Share of Transportation Cost to the Port.

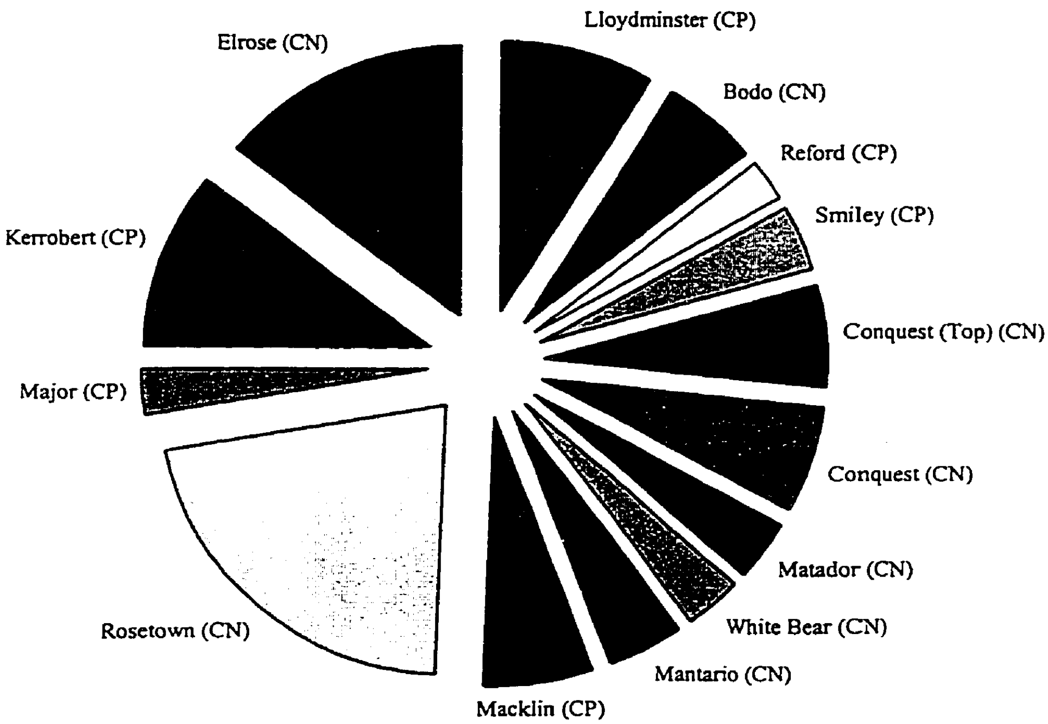

Figure 5.5. Comparison of the Length of Branch Line in the Study Region.

5.3 Branch Line Abandonment (Bill C-101 with No Penalty)

Single or combinations of the branch lines were abandoned in the simulation to analyze the impacts of various branch line abandonments on supply response. The results are illustrated in Table 5.5. Elevators are indicated in the left margin of the table and on the top abandoned branch lines are indicated. Total export and export changes are shown in the bottom of the table. If a branch line is abandoned, the grain volume moves to the next least-cost delivery points. To see where this grain volume is redirected, compare the branch line abandonment situation with the current situation in first column of this table.

From Table 5.5 a relatively small decrease in grain export is observed attributable either to the decrease in farm prices or the increase in transport costs as a result of branch line abandonment. In general, the change in production is not very significant. Rational responses would probably include a shift away from lower valued crops to higher valued commodities. It should be noted that in calculating this response, freight rates were assumed to be regulated and the supply elasticity was set equal to one.

Table 5.5. Supply Response to the Branch Line Abandonment and Grain Distribution.

Delivery Points	Abandoned Branch Lines									
	Current Situation	Bodo	Smiley	White Bear	Matador	Major	Reford	Lloyd-Minister	Conquest	Mantario
ALSASK	7061	7061	7061	7061	7061	7061	061	7061	7061	7061
ASQUITH	22062	22062	22062	22062	22062	22062	22062	22062	22062	22062
BALDWINTON	36771	36771	36771	36771	36771	36771	36771		36771	36771
BATTLEFORD	68269	68269	68269	68269	68269	68269	68269	84596	68269	68269
BEADLE	13889	13889	13889	13889	13889	13889	13889	13889	13889	13889
BEECHY	46910	46910	46910	46910	48016	46910	46910	46910		46910
BIGGAR	33173	33173	33173	33173	33173	33173	33173	33173	33173	33173
BIRSAY	16408	16408	16408	16408	16408	16408	16408	16408		16408
BROCK	49188	49188	49188	49188	49188	49188	49188	49188	49188	49188
CACTUS LAKE	21502		21502	21502	21502	21502	21502	21502	21502	21502
COLEVILLE	18781	18781		18781	18781	18781	18781	18781	18781	18781
CONQUEST	22817	22817	22817	22817	22817	22817	22817	22817	22817	22817
CUTKNIFE	31940	31940	31940	31940	31940	31940	31940		31940	31940
DALMENY	45687	45687	45687	45687	45687	45687	45687	45687	45687	45687
D'ARCY	10387	10387	10387	10387	10387	10387	10387	10387	10387	10387
DELISLE	56124	56124	56124	56124	56124	56124	56124	56124	56124	56124
DELMAS	19863	19863	19863	19863	19863	19863	19863	19863	19863	19863
DENHOLM	6052	6052	6052	6052	6052	6052	6052	6052	6052	6052
DINSMORE	75234	75234	75234	75234	75234	75234	75234	75234	116338	75234
DODSLAND	35811	35811	35811	35811	35811	35811	35811	35811	35811	35811
DUNBLANE	7860	7860	7860	7860	7860	7860	7860	7860		7860
EATONIA	20557	20557	20557	20557	20557	20557	20557	20557	20557	
ELROSE	56052	56052	56052	56052	61108	56052	56052	56052	56052	56052
ESTON	72246	72246	72246	72246	72246	72246	72246	72246	72246	72246
FISKE	27866	27866	27866	27866	27866	27866	27866	27866	27866	27866
FLAXCOMBE	19297	19297	34028	19297	19297	19297	19297	19297	19297	44791
HARRIS	42172	42172	42172	42172	42172	42172	42172	42172	42172	42172
HERSCHEL	84685	84685	84685	84685	84685	84685	84685	84685	84685	84685
HUGHTON	20261	20261	20261	20261	20261	20261	20261	20261	20261	20261
KERROBERT	54789	54789	73514	54789	54789	54789	54789	54789	54789	54789
KINDERSLEY	92978	92978	92978	92978	92978	92978	92978	92978	92978	142839
KINLEY	21217	21217	21217	21217	21217	21217	21217	21217	21217	21217
KYLE	69448	69448	69448	82231		69448	69448	69448	124590	69448
LACADENA	24009	24009	24009		91801	24009	24009	24009	24009	24009
LANDIS	103729	103729	103729	103729	103729	103729	103729	103729	103729	103729
LANGHAM	17045	17045	17045	17045	17045	17045	17045	17045	17045	17045
LAPORTE	48771	48771	48771	48771	52984	48771	48771	48771	48771	
LASHBURN	103521	103521	103521	103521	103521	103521	103521	227012	103521	103521
LAURA	17778	17778	17778	17778	17778	17778	17778	17778	17778	17778
LENEY	19379	19379	19379	19379	19379	19379	19379	19379	19379	19379
LLOYDMINSTER	86830	86830	86830	86830	86830	86830	86830	90361	86830	86830
LUCKY LAKE	60139	60139	60139	60139	61471	60139	60139	60139		60139
LUSELAND	150470	156308	150470	150470	150470	178500	164579	150470	150470	150470
MACKLIN	54329	59957	54329	54329	54329	54329	54329	59780	54329	54329
MACRORIE	23333	23333	23333	23333	23333	23333	23333	23333	57213	23333

MADISON	30101	30101	30101	30101	30101	30101	30101	30101	30101	30101
MAIDSTONE	67126	67126	67126	67126	67126	67126	67126	67126	67126	67126
MAJOR	23494	33524	23494	23494	23494		23494	23494	23494	23494
MANTARIO	17629	17629	17629	17629	17629	17629	17629	17629	17629	
MARENGO	60165	60165	60165	60165	60165	66250	60165	60165	60165	71766
MARSDEN	54310	54310	54310	54310	54310	54310	54310		54310	54310
MARSHALL	49353	49353	49353	49353	49353	49353	49353	49353	49353	49353
MAYMONT	57072	57072	57072	57072	57072	57072	57072	57072	57072	57072
MILDEN	39009	39009	39009	39009	39009	39009	39009	39009	39009	39009
NEILBURG	30594	30594	30594	30594	30594	30594	30594		30594	30594
NETHERHILL	7634	7634	7634	7634	7634	7634	7634	7634	7634	7634
NORTH BATTLEFORD	3186	3186	3186	3186	3186	3186	3186	3186	3186	3186
PAYNTON	16043	16043	16043	16043	16043	16043	16043	25596	16043	16043
PERDUE	58852	58852	58852	58852	58852	58852	58852	58852	58852	58852
PINKHAM	10716	10716	10716	10716	10716	10716	10716	10716	10716	10716
PLATO	18596	18596	18596	43773	18596	18596	18596	18596	18596	18596
PLENTY	51416	51416	51416	51416	51416	51416	51416	51416	51416	51416
PRIMATE	15137	15137	15137	15137	15137	15137	15137	15137	15137	15137
RADISSON	32654	32654	32654	32654	32654	32654	32654	32654	32654	32654
REFORD	15015	15015	15015	15015	15015	15015	28877	15015	15015	15015
RICHLEA	40996	40996	40996	40996	40996	40996	40996	40996	40996	40996
ROCKHAVEN	83571	83571	83571	83571	83571	83571	83571		83571	83571
ROSETOWN	60037	60037	60037	60037	60037	60037	60037	60037	60037	60037
SALVADOR	15007	15007	15007	15007	15007	15007	15007	15007	15007	15007
SANCTUARY	10669	10669	10669	10669		10669	10669	10669	10669	10669
SASKATOON	58566	58566	58566	58566	58566	58566	58566	58566	58566	58566
SCOTT	32350	32350	32350	32350	32350	32350	41241	63433	32350	32350
SENLAC	12096	12096	12096	12096	12096	12096	12096	17520	12096	12096
SMILEY	14781	14781		14781	14781	21898	14781	14781	14781	14781
SOVEREIGN	9037	9037	9037	9037	9037	9037	9037	9037	9037	9037
SUPERB	17932	17932	17932	17932	17932		17932	17932	17932	17932
TESSIER	15119	15119	15119	15119	15119	15119	15119	15119	15119	15119
THACKERAY	7596	7596	7596	7596	7596	7596	7596		7596	7596
TRAMPING LAKE	36911	36911	36911	36911	36911	36911		36911	36911	36911
TYNER	14047	14047	14047		14047	14047	14047	14047	14047	14047
UNITY	25718	25718	25718	25718	25718	25718	25718	63806	25718	25718
WILBERT	17212	17212	17212	17212	17212	17212	17212		17212	17212
WILKIE	85058	85058	85058	85058	85058	85058	85058	112165	85058	85058
WISETON	26428	26428	26428	26428	26428	26428	26428	26428	26428	26428
ZEALANDIA	11898	11898	11898	11898	11898	11898	11898	11898	11898	11898
TOTAL EXPORT	3189821	3189815	3189717	3189725	3189204	3189628	3189771	3187878	3188631	3189820
EXPORT DECREASE		-6	-105	-96	-617	-193	-50	-1943	-1190	-1

Table 5.5 (Continued...). Supply Response to the Branch Line Abandonment and Grain Distribution.

Delivery Points	Abandoned Branch Lines								
	Current Situation	Smiley& Kerrobert	W.Bear; Matator	Smiley& Kerrober t&Bodo	W.Bear; Matador; Conquest	W.Bear& Matador; Conquest; Mantario	W.Bear& Matador; Conquest ;Mantari o&Elrose	W.Bear& Matador; Mantario &Elrose	W.Bear& Matador; Mantario& Elrose& Both Conquest
ALSASK	7061	7061	7061	7061	7061	7061	7061	7061	7061
ASQUITH	22062	22062	22062	22062	22062	22062	22062	22062	22062
BALDWINTON	36771	36771	36771	36771	36771	36771	36771	36771	36771
BATTLEFORD	68269	68269	68269	68269	68269	68269	68269	68269	68269
BEADLE	13889	13889	13889	13889	13889	13889	21429	21429	21429
BEECHY	46910	46910	48400	46910	0	0	0	93392	0
BIGGAR	33173	33173	33173	33173	33173	33173	33173	33173	33173
BIRSAY	16408	16408	16408	16408	0	0	0	16408	0
BROCK	49188	77038	49188	77038	49188	49188	287865	258937	289160
CACTUS LAKE	21502	21502	21502	0	21502	21502	21502	21502	21502
COLEVILLE	18781	0	18781	0	18781	18781	18781	18781	18781
CONQUEST	22817	22817	22817	22817	22817	22817	28800	28800	0
CUTKNIFE	31940	31940	31940	31940	31940	31940	31940	31940	31940
DALMENY	45687	45687	45687	45687	45687	45687	45687	45687	45687
D'ARCY	10387	10387	10387	10387	10387	10387	10387	10387	10387
DELISLE	56124	56124	56124	56124	56124	56124	56124	56124	65324
DELMAS	19863	19863	19863	19863	19863	19863	19863	19863	19863
DENHOLM	6052	6052	6052	6052	6052	6052	6052	6052	6052
DINSMORE	75234	114107	75234	114107	165827	165827	0	0	0
DODSLAND	35811	0	35811	0	35811	35811	35811	35811	35811
DUNBLANE	7860	7860	7860	7860	0	0	0	7860	0
EATONIA	20557	20557	20557	20557	20557	0	0	0	0
ELROSE	56052	56052	108686	56052	111480	111480	0	0	0
ESTON	72246	72246	72246	72246	72246	72246	0	0	0
FISKE	27866	84613	27866	84613	27866	27866	27866	27866	27866
FLAXCOMBE	19297	34028	19297	34028	19297	44791	44791	44791	44791
HARRIS	42172	42172	42172	42172	42172	42172	42172	42172	42172
HERSCHEL	84685	0	84685	0	84685	84685	84685	84685	84685
HUGHTON	20261	20261	20261	20261	20261	20261	0	0	0
KERROBERT	54789	131513	54789	131513	54789	54789	54789	54789	54789
KINDERSLEY	92978	99853	92978	99853	92978	147053	186674	179378	186674
KINLEY	21217	21217	21217	21217	21217	21217	21217	21217	21217
KYLE	69448	69448	0	69448	0	0	0	0	0
LACADENA	24009	24009	0	24009	0	0	0	0	0
LANDIS	103729	107359	103729	107359	103729	103729	103729	103729	103729
LANGHAM	17045	17045	17045	17045	17045	17045	17045	17045	17045
LAPORTE	48771	48771	52984	48771	52984	0	0	0	0
LASHBURN	103521	103521	103521	103521	103521	103521	103521	103521	103521
LAURA	17778	17778	17778	17778	17778	17778	17778	17778	17778
LENEY	19379	19379	19379	19379	19379	19379	19379	19379	19379

LLOYDMINSTER	86830	86830	86830	86830	86830	86830	86830	86830	86830
LUCKY LAKE	60139	60139	61471	60139	0	0	0	64370	0
LUSELAND	150470	150470	150470	156308	150470	150470	150470	150470	150470
MACKLIN	54329	54329	54329	59957	54329	54329	54329	54329	54329
MACRORIE	23333	23333	23333	23333	62513	62513	134422	40220	0
MADISON	30101	30101	30101	30101	30101	30101	0	0	0
MAIDSTONE	67126	67126	67126	67126	67126	67126	67126	67126	67126
MAJOR	23494	23494	23494	33524	23494	23494	23494	23494	23494
MANTARIO	17629	17629	17629	17629	17629	0	0	0	0
MARENGO	60165	60165	60165	60165	60165	71766	71766	71766	71766
MARSDEN	54310	54310	54310	54310	54310	54310	54310	54310	54310
MARSHALL	49353	49353	49353	49353	49353	49353	49353	49353	49353
MAYMONT	57072	57072	57072	57072	57072	57072	57072	57072	57072
MILDEN	39009	0	39009	0	39009	39009	150936	101845	302182
NEILBURG	30594	30594	30594	30594	30594	30594	30594	30594	30594
NETHERHILL	7634	7634	7634	7634	7634	7634	7634	7634	7634
NORTH BATTLEFORD	3186	3186	3186	3186	3186	3186	3186	3186	3186
PAYNTON	16043	16043	16043	16043	16043	16043	16043	16043	16043
PERDUE	58852	58852	58852	58852	58852	58852	58852	58852	58852
PINKHAM	10716	10716	10716	10716	10716	10716	10716	10716	10716
PLATO	18596	18596	75825	18596	75825	75825	0	0	0
PLENTY	51416	0	51416	0	51416	51416	51416	51416	51416
PRIMATE	15137	15137	15137	15137	15137	15137	15137	15137	15137
RADISSON	32654	32654	32654	32654	32654	32654	32654	32654	32654
REFORD	15015	15015	15015	15015	15015	15015	15015	15015	15015
RICHLEA	40996	40996	40996	40996	40996	40996	0	0	0
ROCKHAVEN	83571	83571	83571	83571	83571	83571	83571	83571	83571
ROSETOWN	60037	87112	60037	87112	60037	60037	106700	106700	106700
SALVADOR	15007	15007	15007	15007	15007	15007	15007	15007	15007
SANCTUARY	10669	10669	0	10669	0	0	0	0	0
SASKATOON	58566	58566	58566	58566	58566	58566	58566	58566	58566
SCOTT	32350	32350	32350	32350	32350	32350	32350	32350	32350
SENLAC	12096	12096	12096	12096	12096	12096	12096	12096	12096
SMILEY	14781	0	14781	0	14781	14781	14781	14781	14781
SOVEREIGN	9037	0	9037	0	9037	9037	24688	24688	24688
SUPERB	17932	17932	17932	17932	17932	17932	17932	17932	17932
TESSIER	15119	15119	15119	15119	15119	15119	15119	15119	15119
THACKERAY	7596	7596	7596	7596	7596	7596	7596	7596	7596
TRAMPING LAKE	36911	36911	36911	36911	36911	36911	36911	36911	36911
TYNER	14047	14047	0	14047	0	0	0	0	0
UNITY	25718	25718	25718	25718	25718	25718	25718	25718	25718
WILBERT	17212	17212	17212	17212	17212	17212	17212	17212	17212
WILKIE	85058	85058	85058	85058	85058	85058	85058	85058	85058
WISETON	26428	26428	26428	26428	26428	26428	0	0	0
ZEALANDIA	11898	11898	11898	11898	11898	11898	11898	11898	11898
TOTAL EXPORT	3189821	3188808	3188546	3188802	3186974	3186973	3181783	3184297	3180302
EXPORT DECREASE		-1013	-1275	-1019	-2847	-2848	-8038	-5524	-9519

Table 5.5 (Continued...). Supply Response to the Branch Line Abandonment and Grain Distribution.

Delivery Points	Abandoned Branch Lines							
	Current Situation	Smiley& Kerrobert &Bodo& Major	Smiley& Kerrobert &Bodo& Major& Reford	Smiley& Kerrobert &Bodo& Major& Reford& Maclin	Smiley& Kerrobert &Bodo&Major; Reford& Maclin& Lloydminster	All Branch Lines Abandoned	All Branch Line Abandoned Except Kerrobert& Maclin& Rosetown	W.Bear& Matador; Conquest; Mantario; Smily& Major& Reford& Bodo
ALSASK	7061	7061	7061	7061	7061	0	7061	7061
ASQUITH	22062	22062	22062	22062	22062	30795	22062	22062
BALDWINTON	36771	36771	36771	36771	0	0	0	36771
BATTLEFORD	68269	68269	68269	68269	84596	84596	84596	68269
BEADLE	13889	13889	13889	13889	13889	0	21429	13889
BEECHY	46910	46910	46910	46910	46910	0	0	0
BIGGAR	33173	33173	33173	33173	33173	228232	33173	33173
BIRSAY	16408	16408	16408	16408	16408	0	0	0
BROCK	49188	77038	77038	102502	102502	0	289160	49188
CACTUS LAKE	21502	0	0	0	0	0	0	0
COLEVILLE	18781	0	0	0	0	0	0	0
CONQUEST	22817	22817	22817	22817	22817	0	0	22817
CUTKNIFE	31940	31940	31940	31940	0	0	0	31940
DALMENY	45687	45687	45687	45687	45687	45687	45687	45687
D'ARCY	10387	10387	10387	10387	10387	0	10387	10387
DELISLE	56124	56124	56124	56124	56124	0	65324	56124
DELMAS	19863	19863	19863	19863	19863	19863	19863	19863
DENHOLM	6052	6052	6052	6052	6052	6052	6052	6052
DINSMORE	75234	114107	114107	114107	114107	0	0	165827
DODSLAND	35811	0	0	0	0	0	35811	35811
DUNBLANE	7860	7860	7860	7860	7860	0	0	0
EATONIA	20557	20557	20557	20557	20557	0	0	0
ELROSE	56052	56052	56052	56052	56052	0	0	111480
ESTON	72246	72246	72246	72246	72246	0	0	72246
FISKE	27866	84613	84613	84613	84613	0	27866	27866
FLAXCOMBE	19297	34028	34028	47653	47653	0	59522	59522
HARRIS	42172	42172	42172	42172	42172	0	42172	42172
HERSCHEL	84685	0	0	0	0	0	84685	84685
HUGHTON	20261	20261	20261	20261	20261	0	0	20261
KERROBERT	54789	131513	131513	0	0	0	73514	73514
KINDERSLEY	92978	99853	99853	178924	178924	0	186674	147053
KINLEY	21217	21217	21217	21217	21217	21217	21217	21217
KYLE	69448	69448	69448	69448	69448	0	0	0
LACADENA	24009	24009	24009	24009	24009	0	0	0
LANDIS	103729	107359	107359	132424	132424	310309	103729	103729
LANGHAM	17045	17045	17045	17045	17045	17045	17045	17045
LAPORTE	48771	48771	48771	48771	48771	0	0	0
LASHBURN	103521	103521	103521	103521	227012	227012	227012	103521
LAURA	17778	17778	17778	17778	17778	0	17778	17778

LENEY	19379	19379	19379	19379	19379	420289	19379	19379
LLOYDMINSTER	86830	86830	86830	86830	90361	90361	90361	86830
LUCKY LAKE	60139	60139	60139	60139	60139	0	0	0
LUSELAND	150470	193713	207821	0	0	0	207821	207821
MACKLIN	54329	64614	64614	202403	207853	580941	70064	64614
MACRORIE	23333	23333	23333	23333	23333	0	0	62513
MADISON	30101	30101	30101	30101	30101	0	0	30101
MAIDSTONE	67126	67126	67126	67126	67126	67126	67126	67126
MAJOR	23494	0	0	0	0	0	0	0
MANTARIO	17629	17629	17629	17629	17629	0	0	0
MARENGO	60165	69343	69343	79206	79206	0	80944	80944
MARSDEN	54310	54310	54310	54310	0	0	0	54310
MARSHALL	49353	49353	49353	49353	49353	49353	49353	49353
MAYMONT	57072	57072	57072	57072	57072	57072	57072	57072
MILDEN	39009	0	0	0	0	0	302182	39009
NEILBURG	30594	30594	30594	30594	0	0	0	30594
NETHERHILL	7634	7634	7634	7634	7634	0	7634	7634
NORTH BATTLEFORD	3186	3186	3186	3186	3186	3186	3186	3186
PAYNTON	16043	16043	16043	16043	25596	25596	25596	16043
PERDUE	58852	58852	58852	58852	58852	58852	58852	58852
PINKHAM	10716	10716	10716	10716	10716	0	10716	10716
PLATO	18596	18596	18596	18596	18596	0	0	75825
PLENTY	51416	0	0	0	0	0	51416	51416
PRIMATE	15137	15137	15137	0	0	0	15137	15137
RADISSON	32654	32654	32654	32654	32654	32654	32654	32654
REFORD	15015	15015	28877	41293	41293	256198	28877	28877
RICHLEA	40996	40996	40996	40996	40996	0	0	40996
ROCKHAVEN	83571	83571	83571	83571	0	0	0	83571
ROSETOWN	60037	87112	87112	87112	87112	0	106700	60037
SALVADOR	15007	15007	15007	0	0	0	15007	15007
SANCTUARY	10669	10669	10669	10669	10669	0	0	0
SASKATOON	58566	58566	58566	58566	58566	156106	58566	58566
SCOTT	32350	32350	41241	83616	114700	128707	72325	41241
SENLAC	12096	12096	12096	13716	19139	19139	17520	12096
SMILEY	14781	0	0	0	0	0	0	0
SOVEREIGN	9037	0	0	0	0	0	24688	9037
SUPERB	17932	0	0	0	0	0	0	0
TESSIER	15119	15119	15119	15119	15119	0	15119	15119
THACKERAY	7596	7596	7596	7596	0	0	0	7596
TRAMPING LAKE	36911	36911	0	0	0	0	0	0
TYNER	14047	14047	14047	14047	14047	0	0	0
UNITY	25718	25718	25718	44506	82593	82593	63806	25718
WILBERT	17212	17212	17212	17212	0	0	0	17212
WILKIE	85058	85058	85058	85058	112165	112165	112165	85058
WISETON	26428	26428	26428	26428	26428	0	0	26428
ZEALANDIA	11898	11898	11898	11898	11898	0	11898	11898
TOTAL EXPORT	3189821	3188585	3188536	3185134	3183191	3131146	3177983	3186596
EXPORT DECREASE		-1236	-1285	-4687	-6630	-58675	-11839	-3225

Table 5.6. (Summarized Table). Supply Response to the Branch Line Abandonment (Tonne).

Scenarios (Line Abandonment)	Farmers' Total Export	Export Change
Current Situation	3189821	
Bodo	3189815	-6
Smiley	3189717	-105
White Bear	3189725	-96
Matador	3189204	-617
Major	3189628	-193
Reford	3189771	-50
Lloydminster	3187878	-1943
Conquest	3188631	-1190
Mantario	3189820	-1
Smiley&Kerrobert	3188808	-1013
W.Bear&Matador	3188546	-1275
Smiley&Kerrobert&Bodo	3188802	-1019
W.Bear&Matador&Conquest	3186974	-2847
W.Bear&Matador&Conquest&Mantario	3186973	-2848
W.Bear&Matador&Conquest&Mantario&Elrose	3181783	-8038
W.Bear&Matador&Mantario&Elrose	3184297	-5524
W.B&Matador&Mantario&Elrose Both Conquest	3180302	-9519
Smiley&Kerrobert&Bodo&Major	3188585	-1236
Smiley&Kerrobert&Bodo&Major&Reford	3188536	-1285
Smiley&Kerrobert&Bodo& Major&Reford&Maclin	3185134	-4687
Smiley&Kerrobert&Bodo&Major; Reford&Maclin&Lloydminster	3183191	-6630
All Branch Lines Abandoned	3131146	-58675
All Branch Line Abandoned Except Kerrobert&Maclin&Rosetown	3177983	-11839
W.Bear&Matador&Conquest&Mantario& Smily&Major&Reford&Bodo	3186596	-3225

If the grain volume in the branch line increases, the average cost will decline for that line because of the high fixed costs associated with maintenance i.e. line-related costs. Table 5.7 shows the change in average cost per tonne kilometer for various branch lines as the other lines were abandoned. In the left margin of the table the branch lines in the study region are listed. The abandoned branch are shown along the top. A comparison of abandonment with the current situation can be easily made by comparing the respective column with the first column of the table (current situation). For example, under the current situation the average cost per tonne kilometer for the subdivision *Bodo* is 45.611 cents. When this subdivision was abandoned, the average cost per tonne-kilometer is reported as zero for the *Bodo* subdivision. However, since the farmers now deliver their grain to the delivery point in *Coronation* subdivision, the cost per tonne kilometer in *Coronation* declines from 27.9 cents to 22.22 cents. The same comparison can be made with the other subdivisions. The reason is because as branch lines are abandoned the grain volume is spread over a declining fixed cost base.

Table 5.7. Change in Average Cost Per Tonne-Kilometer as a Result of Branch Line Abandonment.

Subdivision	Average Cost Per Tonne-Kilometer as a Result of Branch Line Abandonment									
	Current Situation	Bodo	Smiley	White Bear	Matador	Major	Reford	Lloyd-Minister	Conquest	Mantario
LLOYDMINSTER	0.07993	0.07993	0.07993	0.07993	0.07993	0.07993	0.07993	0.00000	0.07993	0.07993
BODO	0.45611	0.00000	0.45611	0.45611	0.45611	0.45611	0.45611	0.45611	0.45611	0.45611
MAJOR (Coronation)	0.27900	0.22224	0.27900	0.27900	0.27900	0.00000	0.27900	0.27900	0.27900	0.27900
REFORD	0.27322	0.27322	0.27322	0.27322	0.27322	0.27322	0.00000	0.27322	0.27322	0.27322
SMILEY(Dodsland)	0.37235	0.37235	0.00000	0.37235	0.37235	0.29752	0.37235	0.37235	0.37235	0.37235
CONQUEST (Top)	0.03301	0.03301	0.03301	0.03302	0.03313	0.03301	0.03301	0.03301	0.03304	0.03301
MATADOR	0.14276	0.14276	0.14276	0.12470	0.00000	0.14276	0.14276	0.14276	0.09010	0.14276
W.BEAR	0.28820	0.28820	0.28820	0.00000	0.10977	0.28820	0.28820	0.28820	0.28820	0.28820
MANTARIO	0.14324	0.14324	0.14324	0.14324	0.13729	0.14324	0.14324	0.14324	0.14324	0.00000
ELROSE	0.05269	0.05269	0.05269	0.05356	0.05112	0.05269	0.05269	0.05269	0.04812	0.05269
MACKLIN	0.03729	0.03676	0.03790	0.03729	0.03729	0.03794	0.03693	0.03729	0.03729	0.03729
KERROBERT	0.08492	0.08492	0.08824	0.08492	0.08492	0.08426	0.08492	0.08492	0.08492	0.08492
ROSETOWN	0.03996	0.03996	0.03932	0.03996	0.03978	0.03967	0.03996	0.03996	0.03997	0.04089
CONQUEST	0.11412	0.11412	0.11412	0.11412	0.11218	0.11412	0.11412	0.11412	0.00000	0.11412

Table 5.7 (Continued…). Change in Average Cost Per Tonne-Kilometer as a Result of Branch Line Abandonment.

Subdivision	Average Cost Per Tonne Kilometer as a Result of Branch Line Abandonment							
	Current Situation	Smiley& Kerrobert	W.Bear; Matator	Smiley& Kerrobert &Bodo	W.Bear; Matador; Conquest	W.Bear& Matador; Conquest ; Mantario	W.Bear& Matador; Conquest ;Mantari o&Elrose	W.Bear& Matador; Mantario &Elrose	W.Bear& Matador; Mantario &Elrose &Both Conquest
LLOYDMINSTER	0.07993	0.07993	0.07993	0.07993	0.07993	0.07993	0.07993	0.07993	0.07993
BODO	0.45611	0.45611	0.45611	0.00000	0.45611	0.45611	0.45611	0.45611	0.45611
MAJOR(Coronation)	0.27900	0.27900	0.27900	0.22224	0.27900	0.27900	0.27900	0.27900	0.27900
REFORD	0.27322	0.27322	0.27322	0.27322	0.27322	0.27322	0.27322	0.27322	0.27322
SMILEY(Dodsland)	0.37235	0.00000	0.37235	0.00000	0.37235	0.37235	0.37235	0.37235	0.37235
CONQUEST (Top)	0.03301	0.03214	0.03315	0.03214	0.03319	0.03319	0.07959	0.05712	0.00000
MATADOR	0.14276	0.14276	0.00000	0.14276	0.00000	0.00000	0.00000	0.00000	0.00000
W.BEAR	0.28820	0.28820	0.00000	0.28820	0.00000	0.00000	0.00000	0.00000	0.00000
MANTARIO	0.14324	0.14324	0.13729	0.14324	0.13729	0.00000	0.00000	0.00000	0.00000
ELROSE	0.05269	0.05151	0.05411	0.05151	0.05109	0.05109	0.00000	0.00000	0.00000
MACKLIN	0.03729	0.05147	0.03729	0.04990	0.03729	0.03729	0.03274	0.03396	0.02992
KERROBERT	0.08492	0.00000	0.08492	0.00000	0.08492	0.08492	0.05125	0.05821	0.03968
ROSETOWN	0.03996	0.03604	0.03978	0.03604	0.03979	0.04077	0.03529	0.03567	0.03591
CONQUEST	0.11412	0.11412	0.11182	0.11412	0.00000	0.00000	0.00000	0.08191	0.00000

Table 5.7 (Continued...). Change in Average Cost Per Tonne-Kilometer as a Result of Branch Line Abandonment.

Subdivision	Average Cost Per Tonne Kilometer as a Result of Branch Line Abandonment							
	Current Situation	Smiley& Kerrobert &Bodo& Major	Smiley& Kerrobert &Bodo& Major& Reford	Smiley& Kerrobert &Bodo& Major& Reford& Maclin	Smiley& Kerrobert &Bodo&Major; Reford&Maclin ; Lloydminster	All Branch Lines Abandoned	All Branch Line Abandoned Except Kerrobert& Maclin& Rosetown	W.Bear& Matador; Conquest; Mantario; Smily& Major& Reford& Bodo
LLOYDMINSTER	0.07993	0.07993	0.07993	0.07993	0.00000	0.00000	0.00000	0.07993
BODO	0.45611	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
MAJOR(Coronation)	0.27900	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
REFORD	0.27322	0.27322	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SMILEY (Dodsland)	0.37235	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
CONQUEST (Top)	0.03301	0.03214	0.03214	0.03214	0.03214	0.00000	0.00000	0.03319
MATADOR	0.14276	0.14276	0.14276	0.14276	0.14276	0.00000	0.00000	0.00000
W.BEAR	0.28820	0.28820	0.28820	0.28820	0.28820	0.00000	0.00000	0.00000
MANTARIO	0.14324	0.14324	0.14324	0.14324	0.14324	0.00000	0.00000	0.00000
ELROSE	0.05269	0.05151	0.05151	0.05151	0.05151	0.00000	0.00000	0.05109
MACKLIN	0.03729	0.05309	0.05192	0.00000	0.00000	0.00000	0.03020	0.03806
KERROBERT	0.08492	0.00000	0.00000	0.00000	0.00000	0.00000	0.04001	0.08824
ROSETOWN	0.03996	0.03575	0.03575	0.03306	0.03306	0.00000	0.03521	0.03965
CONQUEST	0.11412	0.11412	0.11412	0.11412	0.11412	0.00000	0.00000	0.00000

Table 5.8 and 5.9 and Figure 5.6 describe the cost analysis for the four main components of the grain handling and transportation system: farmers, railways, elevators, and roads. For this table, the various scenarios are arranged in the left margin of the table and component costs are listed along the top. In accordance with prior expectation, in all cases, farmers' cost and road costs increase as more and more lines are abandoned. However, the important question is whether the magnitude of these costs are so significant that they overcome the cost savings generated in the whole system.

A large portion of the increase in transportation costs is incurred by the producers, because they are captive to the rail system to move their grain to the export destination.

Another significant portion of the increase in transportation cost is paid by the public due to an increase in road costs. Road costs increase with branch line abandonment because farmers are forced to use trucks for longer road distances. Railways benefit most by moving from the current situation to the case where the branch lines are abandoned. The railways are able to extract the highest rent when all the branch lines are abandoned.

Of all cases simulated with the model, two particular scenarios are important to consider: 1) the situation where all the branch lines are abandoned, and 2) a more realistic scenario where all the branch lines except *Kerrobert* subdivision, *Maclin* subdivision, and *Rosetown* subdivision are abandoned. In the second scenario, two branch lines in the form of CN's *Rosetown* and CP's *Kerrobert* and *Maclin*, other than the main line on the top, cross the study region like a multiplication sign (this can be viewed by looking in the Map 4.3 in Chapter 4).

In the first scenario where all branch lines are abandoned by both railroads, farmers' total transportation and handling costs increase by 6.67%. Road costs increase by 253.9%, and railways' costs decrease by 24.389%. The overall cost saving in this case is $2,267,548. In the second scenario, farmers' total transportation and handling costs increase by 1.377%. Road costs increase only by 70.76% and railways' costs decrease by 11.187%. The overall cost saving in the second scenario is $5,239,950. Even though the railways gained the greatest saving in first scenario, it appears that a socially optimal situation, as defined in Sub-Section 3.2.6, obtains where the *Rosetown* branch line of the CN and *Kerrobert* and *Macklin* branch lines of the CP stay open. The grain handling and transportation system is least cost when the sum of the cost to farmers, elevators, railways, and the roads are minimized. Clearly, the cost saving under the two scenarios is small, but from a social welfare perspective the second scenario is a Pareto improvement. Comparison of the other cases with the current scenario can be made by the readers.

Table 5.8. Cost Analysis in the Grain Handling and Transportation System When Branch Line Abandonment Takes Place with No Penalty (Dollars).

Scenarios (Line Abandonment)	Farmers Total Cost	Road Cost	Railways Cost	Elevator Cost	Total Cost	Total Cost Saving
Current Situation	140444955	1687083	80050246	33170128	255352412	
Bodo	140446012	1698248	79433351	33151808	254729418	622994
Smiley	140462726	1699875	79661186	33153429	254977215	375197
White Bear	140461120	1700015	79648761	33287630	255097525	254887
Matador	140545993	1723826	79643062	32945022	254857902	494510
Major	140477827	1710656	79729272	33149120	255066875	285538
Reford	140453268	1704214	79703574	33156425	255017481	334932
Lloydminster	140769557	1888928	78514270	33458388	254631142	721270
Conquest	140638643	1840653	79328465	33182039	254989800	362612
Mantario	140445107	1787358	79392481	32989868	254614813	737599
Smiley&Kerrobert	140614224	1819997	78809115	32887725	254131061	1221351
W.Bear&Matador	140653580	1769605	79118460	33333192	254874836	477576
Smiley&Kerrobert&Bodo	140615281	1831161	78192220	32869405	253508067	1844345
W.Bear&Matador&Conquest	140908218	1927824	78284070	33390067	254510179	842234
W.Bear&Matador&Conquest&Mantario	140908370	2034038	77617402	33198181	253757991	1594421
W.Bear&Matador&Conquest&Mantario& Elrose	141756155	2464114	75129901	33479832	252830002	2522410
W.Bear&Matador&Mantario&Elrose	141354106	2223146	76125969	33318413	253021634	2330778
W.B&Matador&Mantario&Elrose&Both Conquest	141990710	2606355	74287049	33546147	252430260	2922152
Smiley&Kerrobert&Bodo&Major	140652138	1862818	77862358	32842011	253219325	2133088
Smiley&Kerrobert&Bodo&Major&Reford	140660451	1879949	77515687	32828307	252884393	2468019
Smiley&Kerrobert&Bodo& Major&Reford&Maclin	141232768	2075466	77229920	32851338	253389492	1962920
Smiley&Kerrobert&Bodo&Major; Reford&Maclin&Lloydminster	141557370	2277311	75693944	33139597	252668222	2684191
All Branch Lines Abandoned	149820677	5970277	60654034	36770060	253215048	2137364
All Branch Line Abandoned Except Kerrobert&Maclin&Rosetown	142379309	2880943	71068774	33758289	250087315	5265097
W.Bear&Matador&Conquest&Mantario& Smily&Major&Reford&Bodo	140972367	2106782	75934755	33122064	252135967	3216445

Table 5.9 (Summarized Table). Cost Analysis in the Grain Handling and Transportation System When Branch Line Abandonment Takes Place with No Penalty (Dollars).

Scenarios (Line Abandonment)	Farmers Total Cost	Road Cost	Railways Cost	Elevator Cost	Total Cost	Total Cost Saving
Current Situation	140.4	1.7	80.0	33.2	255.3	
Percentage	55.00	0.66	31.34	12.98	100	
All Branch Lines Abandoned	149.8	6.0	60.6	36.8	253.2	2.1
Percentage	59.16	2.35	23.95	14.52	100	
All Branch Line Abandoned Except Kerrobert&Maclin&Rosetown	142.4	2.9	71.1	33.7	250.1	5.2
Percentage	56.93	1.16	28.41	13.49	100	

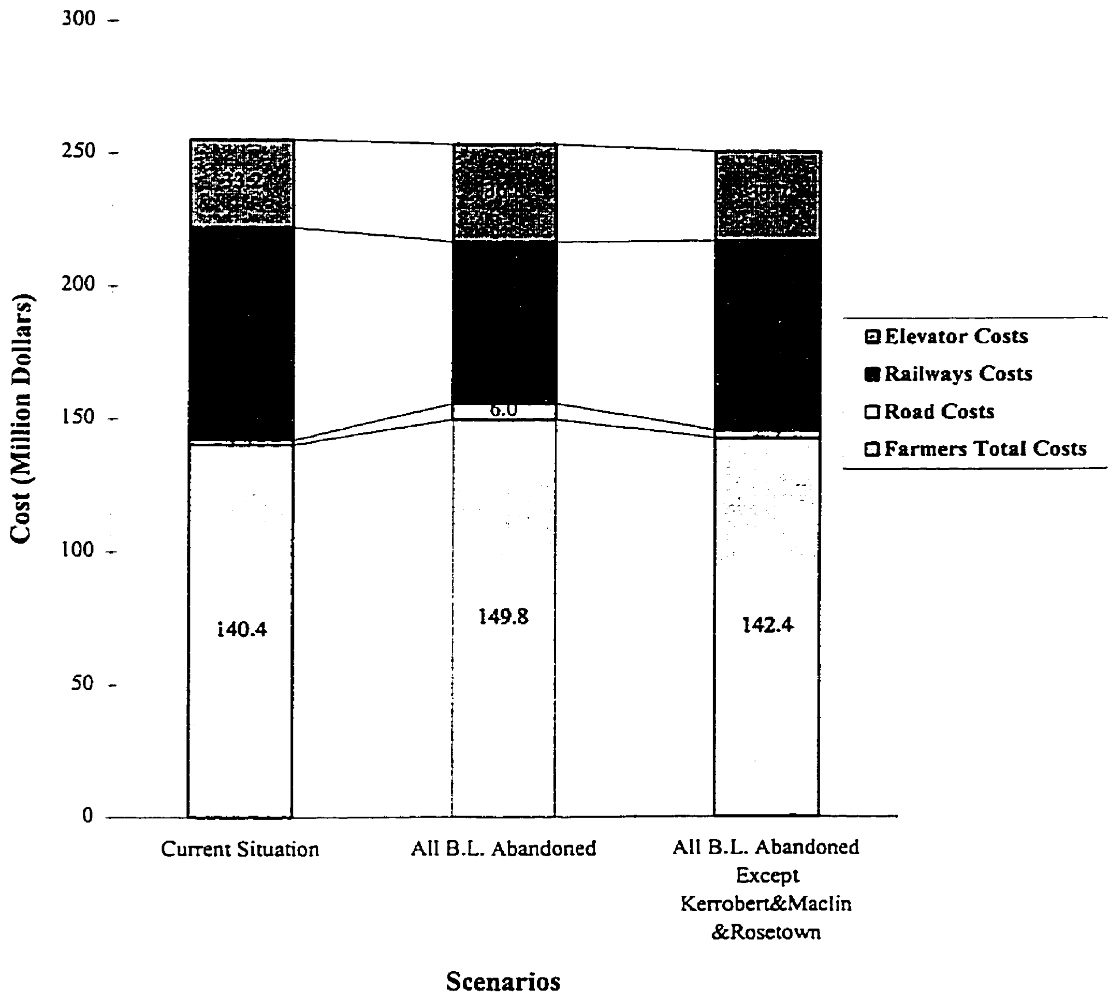

Figure 5.6. Cost Analysis of Branch Line Abandonment.

Elevator costs increase in some branch line abandonment scenarios (Table 5.8, Table 5.9, and Figure 5.6) though logic suggests it should be the other way around. In calibrating the catchment areas, elevation charges were adjusted in the model to minimize the differences between the actual and predicted grain volume in the region. This adjustment caused elevator charges to increase for some of the elevators. The adjusted rates were kept fixed even with branch line abandonment. In reality when a branch line is abandoned, the grain volume moved to remaining elevators should create some economies of size and more intense competition among grain handlers. If in the calibrating process, the elevation charges of elevators in new lines have increased, this overall generates higher elevation costs. This is contrary to what is likely to happen. If elevator consolidation occurs at the same time of branch line closure, elevation costs would be expected to decline rather than to increase, with additional cost saving to the system. This study of optimal branch line configuration is compromised by assuming the costs of the existing elevator system with branch line abandonment, but the general direction of the results are approximately right.

The last thing left to explain is to see how the two railways might abandon the branch lines in the region. In effect, this is the question of market arrangement. Table 5.10 and 5.11 and Figure 5.7 provide some answers to this question. Under the current scenario, CP earns $5,587,564 in profits and CN earns $3,843,249 profits from the branch lines in the region. They also extract $8,854,393 and $13,871,299 profits on both the main and branch lines respectively.

On the part of the railways, two outcomes are possible when branch line abandonment takes place:

Non-cooperative Case: One rail company abandons its own branch lines, allowing the profits of the other rail company to increase or remain the same. There are a few scenarios representing this case - for instance, when the *Bodo* subdivision of CN was abandoned, or when the *Smiley* subdivision of CP was abandoned (more of this situation can be viewed from the Table 5.10). The extreme example of this could occur if CN decided to abandon the subdivision of *Bodo* and CP decided to abandon the subdivisions of *Smiley*, *Kerrobert*, *Major*, *Reford*, *Maclin* and *Lloydminster*. This leads to another important issue: why would one rail company let the other company benefit more from its decision toward abandonment? If there is no collusion between the CP and CN rail lines and if each rail company solely cares about itself, the scenario where all the branch lines are abandoned generates highest benefits to the railways in total though the CP rail line does not gain much and lets CN gain all the benefits compare to other option in Figure 5.7 (unlikely scenario).

Cooperative Case: The two companies, CP and CN, act together to maximize profits. The most obvious example of this situation is where both firms decide to abandon all the branch lines in the region. It can be concluded that for some areas in the study region, one rail company can increase its own profits or its rival's profits by abandoning its own branch lines. However, the profits of each railway are maximized when all the branch lines in the region are abandoned.

Table 5.10. Distribution of the Branch Line Profits as a Result of Abandonment with No Penalty (Dollars).

	Railways Profit as a Result of Branch Line Abandonment									
Subdivision	Current Situation	Bodo	Smiley	White Bear	Matador	Major	Reford	Lloyd-Minister	Conquest	Mantario
LLOYDMINSTER	1968818	1968818	1968818	1968818	1968818	1968818	1968818	0	1968818	1968818
BODO	-365201	0	-365201	-365201	-365201	-365201	-365201	-365201	-365201	-365201
MAJOR (Coronation)	70287	167231	68428	70287	70287	0	71393	70287	70287	70287
REFORD	99913	99913	99913	99913	99913	99913	0	99913	99913	99913
SMILEY(Dodsland)	-164105	-162777	0	-164105	-164105	-110610	-163209	-164105	-164105	-164105
CONQUEST (Top)	433149	433149	434146	433142	433111	433597	433149	433149	757487	431699
MATADOR	-195851	-195851	-194120	-166123	0	-195074	-195851	-195851	27081	-198369
W.BEAR	-196684	-196684	-195861	0	122150	-196315	-196684	-196684	-171998	-197880
MANTARIO	-372387	-372387	-357728	-372402	-361737	-365809	-372387	-372387	-372567	0
ELROSE	1288010	1288010	1295354	1327353	1362222	1291306	1288010	1288010	1740834	1277325
MACKLIN	2455937	2523452	2636575	2455937	2455937	2739591	2607721	2455937	2455937	2455937
KERROBERT	1156714	1165416	1099080	1156714	1156714	1155674	1162587	1156714	1156714	1156714
ROSETOWN	2722196	2722196	2808165	2722153	2734770	2754959	2722196	2722196	2721658	2941337
CONQUEST	530017	530017	532855	529992	553130	531291	530017	530017	0 .	525890
Branch Lines CP Profit	5587564	5762052	5872813	5587564	5587564	5853385	5647310	3618746	5587564	5587564
Branch Lines CN Profit	3843249	4208450	3957610	4108913	4478445	3888753	3843249	3843249	4337294	4414800
Main and Branch Lines CN Profit	13871299	14236500	13986191	14136963	14506647	13917041	14133756	16222010	14365337	14442077
Main and Branch Lines CP Profit	8854393	9095693	9128919	8854393	8854393	9120644	8914941	7537749	8854393	8854393
Total Main and Branch Lines Profit	22725692	23332193	23115110	22991356	23361040	23037685	23048698	23759759	23219731	23296470

Table 5.10 (Continued...). Distribution of the Branch Line Profits as a Result of Abandonment with No Penalty (Dollars).

Subdivision	Railways Profit as a Result of Branch Line Abandonment								
	Current Situation	Smiley&Kerrobert	W.Bear; Matator	Smiley& Kerrobert &Bodo	W.Bear; Matador; Conquest	W.Bear& Matador; Conquest; Mantario	W.Bear& Matador; Conquest; Mantario &Elrose	W.Bear& Matador; Mantario &Elrose	W.Bear& Matador; Mantario &Elrose& Both Conquest
LLOYDMINSTER	1968818	1968818	1968818	1968818	1968818	1968818	1968818	1968818	1968818
BODO	-365201	-365201	-365201	0	-365201	-365201	-365201	-365201	-365201
MAJOR(Coronation)	70287	26684	70287	117039	70287	70287	84297	80526	92971
REFORD	99913	99913	99913	99913	99913	99913	99913	99913	99913
SMILEY(Dodsland)	-164105	0	-164105	0	-164105	-164105	-124004	-133007	-107098
CONQUEST (Top)	433149	441714	433060	441714	807940	805122	1056967	556309	0
MATADOR	-195851	-170763	0	-170763	0	0	0	0	0
W.BEAR	-196684	-182765	0	-182765	0	0	0	0	0
MANTARIO	-372387	-282292	-361839	-282292	-362084	0	0	0	0
ELROSE	1288010	1679336	1603343	1679336	2396200	2378259	0	0	0
MACKLIN	2455937	2976926	2455937	3062247	2455937	2455937	2511160	2496296	2545349
KERROBERT	1156714	0	1156714	0	1156714	1156714	2437796	1965966	3970329
ROSETOWN	2722196	4073343	2734477	4073343	2733778	2968734	5343257	5076991	5370985
CONQUEST	530017	555870	556550	555870	0	0	0	712425	0
Branch Lines CP Profit	5587564	5072341	5587564	5248017	5587564	5587564	6977980	6478512	8570281
Branch Lines CN Profit	3843249	5749241	4600390	6114442	5210632	5786913	6035023	5980523	5005783
Main and Branch Lines CN Profit	13871299	15823462	14628589	16188663	15238823	15814291	16066967	16012145	15037208
Main and Branch Lines CP Profit	8854393	8240597	8854393	8481897	8854393	8854393	10508484	9969191	12170026
Total Main and Branch Lines Profit	22725692	24064059	23482982	24670560	24093216	24668685	26575450	25981336	27207234

Table 5.10 (Continued...). Distribution of the Branch Line Profits as a Result of Abandonment with No Penalty (Dollars).

Subdivision	Railways Profit as a Result of Branch Line Abandonment							
	Current Situation	Smiley& Kerrobert &Bodo& Major	Smiley& Kerrobert &Bodo& Major& Reford	Smiley& Kerrobert &Bodo& Major&Ref-ord&Maclin	Smiley& Kerrobert &Bodo&Major; Reford&Maclin; Lloydminster	All Branch Lines Abandoned	All Branch Line Abandoned Except Kerrobert& Maclin& Rosetown	W.Bear& Matador; Conquest; Mantario; Smily& Major& Reford& Bodo
LLOYDMINSTER	1968818	1968818	1968818	1968818	0	0	0	1968818
BODO	-365201	0	0	0	0	0	0	0
MAJOR(Coronation)	70287	0	0	0	0	0	0	0
REFORD	99913	99913	0	0	0	0	0	0
SMILEY(Dodsland)	-164105	0	0	0	0	0	0	0
CONQUEST (Top)	433149	442168	442168	446375	446375	0	0	808355
MATADOR	-195851	-169975	-169975	-162671	-162671	0	0	0
W. BEAR	-196684	-182391	-182391	-178921	-178921	0	0	0
MANTARIO	-372387	-275615	-275615	-213770	-213770	0	0	0
ELROSE	1288010	1683064	1683064	1717595	1717595	0	0	2398839
MACKLIN	2455937	3365800	3526261	0	0	0	3358654	3230584
KERROBERT	1156714	0	0	0	0	0	3942899	1096501
ROSETOWN	2722196	4128661	4128661	5078713	5078713	0	5553979	3127916
CONQUEST	530017	557162	557162	569133	569133	0	0	0
Branch Lines CP Profit	5587564	5434531	5495078	1968818	0	0	7301553	6295903
Branch Lines CN Profit	3843249	6183076	6183076	7256453	7256453	0	5553979	6335109
Main and Branch Lines CN Profit	13871299	16257538	16519996	18630554	20981265	24734623	18199156	16625876
Main and Branch Lines CP Profit	8854393	8722717	8783265	6986380	5669735	11741220	11670575	9671587
Total Main and Branch Lines Profit	22725692	24980256	25303261	25616934	26651001	36475844	29869731	26297463

Table 5.11 (Summarized Table). Distribution of the Branch Line Profits as a Result of Abandonment with No Penalty (Dollars).

No Penalty Subdivision	Railways Profit as a Result of Branch Line Abandonment					
	Current Situation		All Branch Lines Abandoned		All Branch Line Abandoned Except Kerrobert&Maclin& Rosetown	
	Dollars	%	Dollars	%	Dollars	%
Main and Branch Lines CN Profit	13.9	61.03	24.7	67.81	18.2	60.92
Main and Branch Lines CP Profit	8.85	38.96	11.74	32.18	11.67	39.07
Total Main and Branch Lines Profit	22.7	100	36.4	100	29.9	100

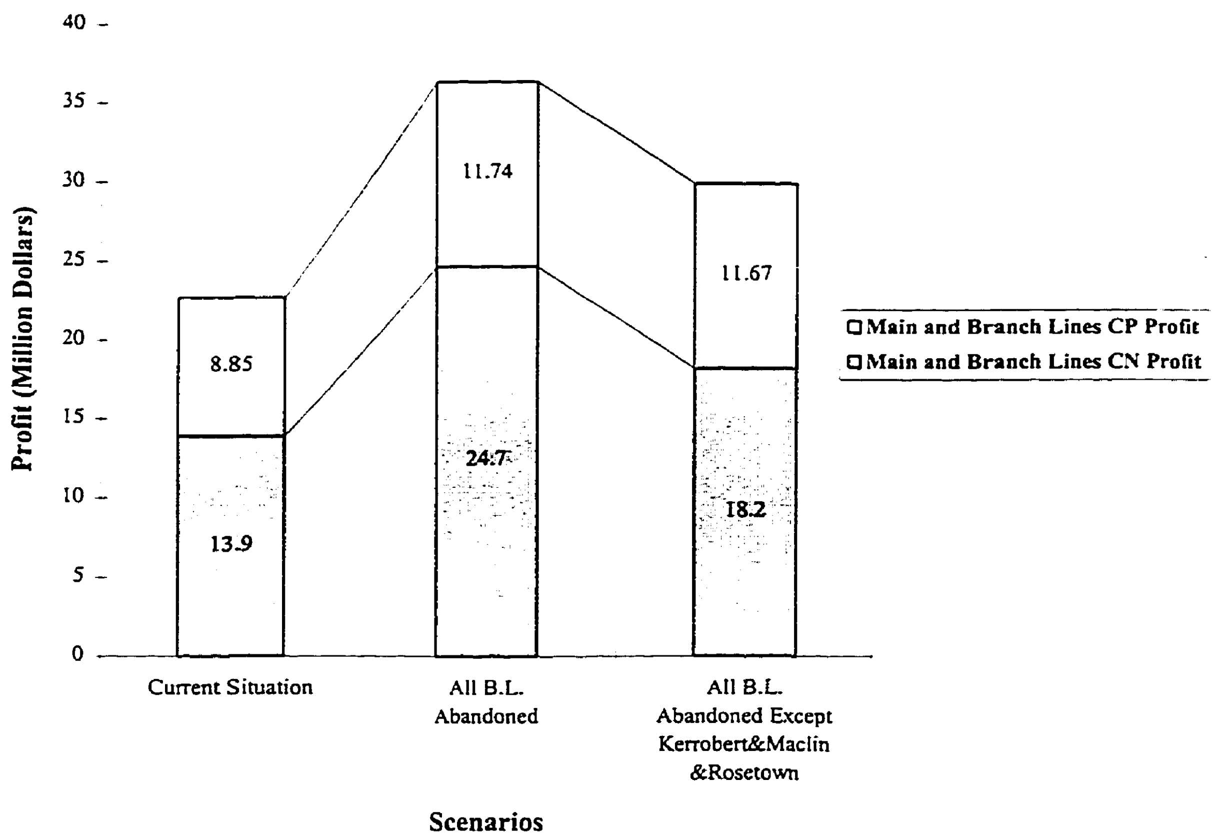

Figure 5.7. Distribution of Branch Line Profits with No Penalty.

5.4 Branch Line Abandonment (Bill C-101 with Penalty)

Table 5.12 and 5.13 and Figure 5.8 illustrate branch line profits in the case where the railway is given the power to abandon the lines with a penalty. It is assumed the railway has to pays a fee of $6000 per kilometer of line abandoned (an amount close to that originally suggested by CP).

The general conclusions made in Section 5.3 can be extended to this case. In the scenario where the railways separately maximize profits, all the branch lines except

Kerrobert subdivision, *Maclin* subdivision, and *Rosetown* subdivision were abandoned. However, if the two railways cooperate to maximize their joint profits, all branch lines will be abandoned. If the two railways do not collude, the CP can be better off and make its competitor worse off (dominant strategy)[4].

Table 5.14 describes the cost analysis under the Bill C-101 with the penalty on railway abandonment. Total costs of the system are minimized from society's point of view when all the branch lines except *Kerrobert* subdivision, *Maclin* subdivision, and *Rosetown* subdivision are abandoned. Thus, when the railways do not act together, imposition of the penalty on abandonment results in the least cost (socially optimal) branch line configuration. However, if the railways collude to maximize their joint profits, then complete (and excessive) abandonment takes place. Given this result, it is somewhat unclear as to whether or not the proposed penalties through Bill C-101 could result in maximization of social welfare. As might be expected, this depends on the strategic behavior of the railways regarding their abandonment policy.

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[4] The CP might search for a shortline partner that would enable them to shed the costs of the branch line, but prevent the grain from flowing to a CN owned mainline.

Table 5.12. Distribution of Profits as a Result of Branch Line Abandonment with Penalty (Dollars).

	Railways' Profit as a Result of Branch Line Abandonment									
	Current Situation	Bodo	Smiley	White Bear	Matador	Major	Reford	Lloyd-Minister	Conquest	Mantario
Branch Lines CP Profit	5587564	5762052	5600173	5587564	5587564	5646385	5450750	2981786	5587564	5587564
Branch Lines CN Profit	3843249	3820610	3957610	3876593	4200765	3888753	3843249	3843249	3870734	4094160
Main and Branch Lines CN Profit	13871299	13848660	13986191	13904643	14228967	13917041	14133756	16222010	13898777	14121437
Main and Branch Lines CP Profit	8854393	9095693	8856279	8854393	8854393	8913644	8718381	6900789	8854393	8854393
Total Main and Branch Lines Profit	22725692	22944353	22842470	22759036	23083360	22830685	22852138	23122799	22753171	22975830

Table 5.12. (Continued...). Distribution of Profits as a Result of Branch Line Abandonment with Penalty (Dollars).

	Railways' Profit as a Result of Branch Line Abandonment								
	Current Situation	Smiley& Kerrobert	W.Bear; Matator	Smiley& Kerrobert &Bodo	W.Bear; Matador; Conquest	W.Bear& Matador; Conquest; Mantario	W.Bear& Matador; Conquest; Mantario &Elrose	W.Bear& Matador; Mantario &Elrose	W.Bear& Matador; Mantario &Elrose& Both Conquest
Branch Lines CP Profit	5587564	4029781	5587564	4205457	5587564	5587564	6977980	6478512	8570281
Branch Lines CN Profit	3843249	5749241	4090390	5726602	4234072	4489713	3693343	4105403	2225263
Main and Branch Lines CN Profit	13871299	15823462	14118589	15800823	14262263	14517091	13725287	14137025	12256688
Main and Branch Lines CP Profit	8854393	7198037	8854393	7439337	8854393	8854393	10508484	9969191	12170026
Total Main and Branch Lines Profit	22725692	23021499	22972982	23240160	23116656	23371485	24233770	24106216	24426714

Table 5.12. (Continued...). Distribution of the Branch Line Profits as a Result of Abandonment with Penalty (Dollars).

	Railways' Profit as a Result of Branch Line Abandonment							
	Current Situation	Smiley& Kerrobert &Bodo& Major	Smiley& Kerrobert &Bodo& Major& Reford	Smiley& Kerrobert &Bodo& Major&Reford &Maclin	Smiley& Kerrobert &Bodo&Major; Reford&Maclin; Lloydminster	All Branch Lines Abandoned	All Branch Line Abandoned Except Kerrobert& Maclin& Rosetown	W.Bear& Matador; Conquest; Mantario; Smily& Major& Reford& Bodo
Branch Lines CP Profit	5587564	4184971	4048958	77258	-2528520	-2528520	5988393	5619703
Branch Lines CN Profit	3843249	5795236	5795236	6868613	6868613	-4755240	2385619	4650069
Main and Branch Lines CN Profit	13871299	15869698	16132156	18242714	20593425	19979383	15030796	14940836
Main and Branch Lines CP Profit	8854393	7473157	7337145	5094820	3141215	9212700	10357415	8995387
Total Main and Branch Lines Profi	22725692	23342856	23469301	23337534	23734641	29192084	25388211	23936223

Table 5.13 (Summarized Table). Distribution of the Branch Line Profits as a Result of Abandonment with Penalty (Dollars).

With Penalty	Railways' Profit as a Result of Branch Line Abandonment					
Subdivision	Current Situation		All Branch Lines Abandoned		All Branch Line Abandoned Except Kerrobert&Maclin& Rosetown	
	Dollars	%	Dollars	%	Dollars	%
Main and Branch Lines CN Profit	13.9	61.03	20.0	68.44	15.0	59.20
Main and Branch Lines CP Profit	8.8	38.96	9.2	31.55	10.4	40.79
Total Main and Branch Lines Profit	22.7	100	29.2	100	25.4	100

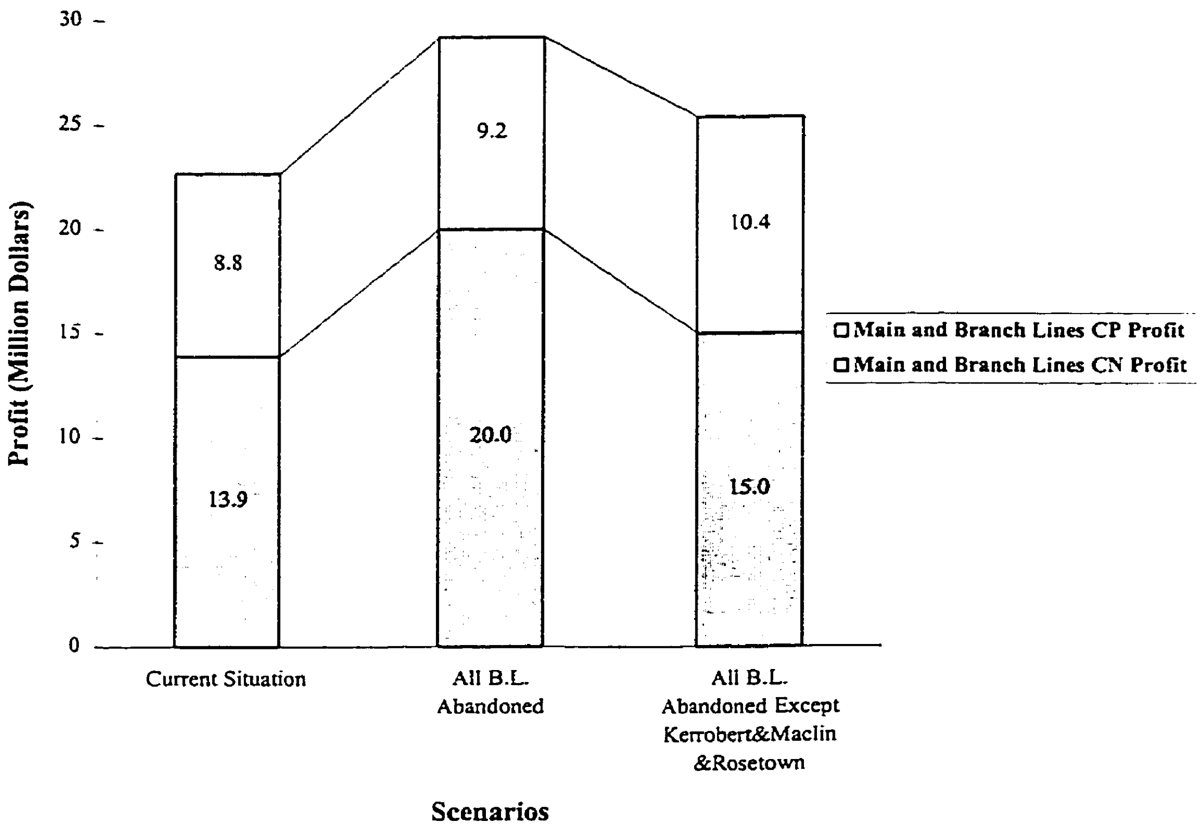

Figure 5.8. Distribution of Branch Line Profits with Penalty.

Table 5.14. Cost Analysis in the Grain Handling and Transportation System When Branch Line Abandonment Takes Place with Penalty (Dollars).

Scenarios (Line Abandonment)	Farmers' Total Cost	Road Cost	Railways Cost	Elevator Cost	Penalty To Railways	Total Cost	Total C Saving
Current Situation	140444955	1687083	80050246	33170128		255352412	
Bodo	140446012	1698248	79433351	33151808	387840	254729418	622994
Smiley	140462726	1699875	79661186	33153429	272640	254977215	375197
White Bear	140461120	1700015	79648761	33287630	232320	255097525	254887
Matador	140545993	1723826	79643062	32945022	277680	254857902	494510
Major	140477827	1710656	79729272	33149120	207000	255066875	285538
Reford	140453268	1704214	79703574	33156425	196560	255017481	334932
Lloydminster	140769557	1888928	78514270	33458388	636960	254631142	721270
Conquest	140638643	1840653	79328465	33182039	466560	254989800	362612
Mantario	140445107	1787358	79392481	32989868	320640	254614813	737599
Smiley&Kerrobert	140614224	1819997	78809115	32887725	1042560	254131061	1221351
W.Bear&Matador	140653580	1769605	79118460	33333192	510000	254874836	477576
Smiley&Kerrobert&Bodo	140615281	1831161	78192220	32869405	1430400	253508067	1844345
W.Bear&Matador&Conquest	140908218	1927824	78284070	33390067	976560	254510179	842234
W.Bear&Matador&Conquest&Mantario	140908370	2034038	77617402	33198181	1297200	253757991	1594421
W.Bear&Matador&Conquest&Mantario& Elrose	141756155	2464114	75129901	33479832	2341680	252830002	2522410
W.Bear&Matador&Mantario&Elrose	141354106	2223146	76125969	33318413	1875120	253021634	2330778
W.B&Matador&Mantario&Elrose&Both Conquest	141990710	2606355	74287049	33546147	2780520	252430260	2922152
Smiley&Kerrobert&Bodo&Major	140652138	1862818	77862358	32842011	1637400	253219325	2133088
Smiley&Kerrobert&Bodo&Major&Reford	140660451	1879949	77515687	32828307	1833960	252884393	2468019
Smiley&Kerrobert&Bodo& Major&Reford&Maclin	141232768	2075466	77229920	32851338	2279400	253389492	1962920
Smiley&Kerrobert&Bodo&Major; Reford&Maclin&Lloydminster	141557370	2277311	75693944	33139597	2916360	252668222	2684191
All Branch Lines Abandoned	149820677	5970277	60654034	36770060	7283760	253215048	2137364
All Branch Line Abandoned Except Kerrobert&Maclin&Rosetown	142379309	2880943	71068774	33758289	4481520	250087315	5265097
W.Bear&Matador;Conquest;Mantario; Smily&Major&Reford&Bodo	140972367	2106782	75934755	33122064	2361240	252135967	3216445

5.5 Sensitivity Analysis

Two critical variables of the model were chosen for sensitivity analysis. These variables are trucking cost and railway volume-related cost. The latter was chosen because foreseeable technological improvement in the railway industry will be reflected in a lowering of the volume-related cost, line-related costs are very unlikely to be affected in near future. The results are discussed below.

5.5.1 Change in the Trucking Costs

Recall from the linear trucking cost function that trucking cost was assumed to be eight cents per tonne/kilometer on average. We now examine the overall impact on the grain handling and transportation system of lowering the trucking cost from eight cents to six cents. Table 5.15 compares the actual received volume of 1994-95 and estimated received volume as a change in the trucking cost. The results of Table 5.15 suggest that a reduction in the trucking cost generates more grain production and more export, though not significantly. It also suggests that, as a result of reductions in trucking cost, the change in the distribution of delivered grain is quite significant.

As trucking costs decrease, the average cost of branch lines receiving more grain will decrease. Table 5.16 indicates that lowering trucking cost from eight cents to six cents causes abandonment of higher cost branch lines and creates more traffic on lower cost branch lines. These figures also indicate that a reduction in trucking cost reduces the socially optimal number of branch lines and facilitates more elevator consolidation.

Table 5.15. Actual (1994-1995) and Predicted Received Volumes at Each Delivery Point as a Result of Lowering the Trucking Cost (Tonne).

Delivery Points	Actual Received Volume (1994-95)	Estimated Received Volume	Percentage Difference
ALSASK	7400	7080	4.3
ASQUITH	21600	12272	43.2
BALDWINTON	33800	21091	37.6
BATTLEFORD	55200	39017	29.3
BEADLE	15400	7188	53.3
BEECHY	54200	60430	(11.5)
BIGGAR	28700	21041	26.7
BIRSAY	16700	14075	15.7
BROCK	56400	71743	(27.2)
CACTUS LAKE	20600	0	100.0
COLEVILLE	25500	18805	26.3
CONQUEST	21400	15964	25.4
CUTKNIFE	35200	37897	(7.7)
DALMENY	43700	45744	(4.7)
D'ARCY	10000	0	100.0
DELISLE	48900	67944	(38.9)
DELMAS	16700	7514	55.0
DENHOLM	8279	103573	(1151.0)
DINSMORE	77500	123564	(59.4)
DODSLAND	39200	62216	(58.7)
DUNBLANE	7400	1380	81.4
EATONIA	41900	0	100.0
ELROSE	63000	57448	8.8
ESTON	81100	116399	(43.5)
FISKE	30600	32433	(6.0)
FLAXCOMBE	21200	6981	67.1
HARRIS	40700	36120	11.3
HERSCHEL	82100	101283	(23.4)
HUGHTON	22800	13779	39.6
KERROBERT	60000	71464	(19.1)
KINDERSLEY	114400	193473	(69.1)
KINLEY	20700	6319	69.5
KYLE	72800	79363	(9.0)
LACADENA	26400	12516	52.6
LANDIS	98500	83503	15.2
LANGHAM	17200	23406	(36.1)
LAPORTE	50900	0	100.0
LASHBURN	69200	203880	(194.6)
LAURA	14200	6034	57.5
LENEY	17200	52402	(204.7)
LLOYDMINSTER	81100	92322	(13.8)
LUCKY LAKE	61000	40448	33.7
LUSELAND	127900	220187	(72.2)
MACKLIN	51500	66565	(29.3)

MACRORIE	24700	23295	5.7
MADISON	33100	12759	61.5
MAIDSTONE	60900	0	100.0
MAJOR	25900	21640	16.4
MANTARIO	26900	0	100.0
MARENGO	67700	111756	(65.1)
MARSDEN	47300	30660	35.2
MARSHALL	47700	21114	55.7
MAYMONT	35000	0	100.0
MILDEN	42600	52626	(23.5)
NEILBURG	34200	49749	(45.5)
NETHERHILL	9600	0	100.0
NORTH BATTLEFORD	5810	23200	(299.3)
PAYNTON	11400	0	100.0
PERDUE	38300	20925	45.4
PINKHAM	8800	0	100.0
PLATO	28100	0	100.0
PLENTY	46600	0	100.0
PRIMATE	16600	15145	8.8
RADISSON	27400	43651	(59.3)
REFORD	18200	36819	(102.3)
RICHLEA	38900	32803	100.0
ROCKHAVEN	69200	114089	(64.9)
ROSETOWN	56400	40477	28.2
SALVADOR	17400	0	100.0
SANCTUARY	18600	10677	42.6
SASKATOON	51200	52348	(2.2)
SCOTT	26700	34334	(28.6)
SENLAC	16200	0	100.0
SMILEY	15300	11556	24.5
SOVEREIGN	10700	0	100.0
SUPERB	18700	21061	(12.6)
TESSIER	14100	6718	52.4
THACKERAY	9500	32527	(242.4)
TRAMPING LAKE	34000	15735	53.7
TYNER	15600	6753	56.7
UNITY	23900	0	100.0
WILBERT	18000	0	100.0
WILKIE	75600	92314	(22.1)
WISETON	22800	0	100.0
ZEALANDIA	10600	6838	35.5
TOTAL	3189823	3196434	

Table 5.16. Branch Lines Estimated Costs per Tonne-Kilometer When Trucking Cost Changes from 8 Cents to 6 Cents per Tonne/Kilometer.

Subdivision	From - To	Kilometer	Branch Line Estimated Cost Cents Per Tonne/ Kilometer with 8 Cents Trucking Costs	Branch Line Estimated Cost Cents Per Tonne/ Kilometer with 6 Cents Trucking Costs
Lloydminster	Lloydminster - Wilkie	106.16	7.99	8.44
Bodo (CN)	Cactus Lake - Unity	64.64	45.61	-
Reford (CP)	Kerrobert-Wilkie	32.76	27.32	61.67
Smiley (Dodsland)(CP)	Smiley - Dodsland	45.44	37.24	42.10
Conquest (Top) (CN)	Macrorie - Delisle	73.14	3.30	3.33
Conquest (CN)	Beechy - Macrorie	77.76	11.41	11.71
Matador (CN)	Kyle - Wartime	46.28	14.28	12.83
White Bear (CN)	Lacadena - Eston	38.72	28.82	54.92
Mantario (CN)	Eatonia - Alsask	53.44	14.32	-
Macklin (CP)	Kerrobert - Macklin	74.24	3.86	3.66
Rosetown (CN)	Alsask - Saskatoon	264.48	3.94	3.92
Major (CP) (Coronation)	Major - Kerrobert	34.50	27.90	27.65
Kerrobert (CP)	Conquest-Kerrobert	128.32	9.73	9.51
Elrose (CN)	Glidden - Macrorie	174.08	5.27	5.37

Source: Saskatchewan Highways and Transportation, and author's calculations.

Formally, our computations show that a reduction of two cents per tonne/kilometer in trucking cost reduces farmers' costs from $140.4 million to $139.3 million, reduces railway costs from $80 million to $78.8 million, and reduces elevation costs from $33.2 million to $32.1 million. Road costs increase from $1.7 million to $2.3 million. These results are obtained under the assumption that road costs remain the same at three cents per tonne/kilometer and that road use increases (Table 5.17). It is interesting to note that a switch to more efficient trucking would lead to a system cost saving of $2.8 million. Taxpayers are the most affected with $0.6 million more road costs, but also the lost of property taxes on the abandoned rail lines.

Table 5.17. Cost Analysis in the Grain Handling and Transportation System When Trucking Cost Decreases from 8 Cents to 6 Cents per Tonne-Kilometer (M$).

Scenarios	Farmers Total Cost	Road Cost	Railways Cost	Elevator Cost	Total Cost	Total Cost Saving
Current Situation (8 Cents Trucking Cost)	140.4	1.7	80.0	33.2	255.3	
New Situation (6 Cents Trucking Cost)	139.3	2.3	78.8	32.1	252.5	2.8
Change	1.1	-0.6	1.2	1.1	2.8	

As trucking cost falls, it causes the distribution of profit on branch lines to change for both railways. Table 5.18 compares the distribution of benefits of the current situation (eight cents trucking cost) with the new situation (six cents trucking cost).

Table 5.18. Distribution of the Branch Line Profits as a Result of Change in the Trucking Cost (Dollars).

Subdivision	Current Situation (8 Cents Trucking Cost)	New Situation (6 Cents Trucking Cost)
LLOYDMINSTER	1968818	2274296
BODO	-365201	0
MAJOR(Coronation)	70287	85270
REFORD	99913	-134451
SMILEY(Dodsland)	-164105	-194943
CONQUEST (Top)	433149	370108
MATADOR	-195851	-175280
W.BEAR	-196684	-282450
MANTARIO	-372387	0
ELROSE	1288010	1412039
MACKLIN	2455937	3199725
KERROBERT	1156714	927074
ROSETOWN	2722196	3288682
CONQUEST	530017	378441
Branch Lines CP Profit	5587564	6156972
Branch Lines CN Profit	3843249	4991539
Main and Branch Lines CN Profit	13871299	15198233
Main and Branch Lines CP Profit	8854393	8709060
Total Main and Branch Lines Profit	22725692	23907293

5.5.2 Change in Elevation Charges and Trucking Costs

In this scenario, the trucking cost is lowered from 8 cents to 6 cent per tonne/kilometer and was combined with a ten percent reduction in the elevation rates. The results indicate that the total volume of exports increases to 3,211,621 tonnes compared to 3,189,823 tonnes in the current situation, a change of 21,798 tonnes. The branch line configuration is similar to the case where just the trucking cost is lowered from 8 cents to 6 cents; but the distribution of received volume changes slightly among the delivery points. Table 5.19 illustrates the branch line average cost under this scenario. The branch line average costs decline for the lines that receive more grain.

Table 5.19. Branch Lines Estimated Costs per Tonne-Kilometer.

Subdivision	Kilometer	Branch Line Estimated Cost Cents Per Tonne/ Kilometer with 8 Cents Trucking Costs	Branch Line Estimated Cost Cents Per Tonne/ Kilometer with 6 Cents Trucking Costs	Branch Line Estimated Cost Cents Per Tonne/ Kilometer with 6 Cents Trucking Costs and 10% Reduction in Elevation Costs
Lloydminster	106.16	7.99	8.44	8.09
Bodo (CN)	64.64	45.61	-	-
Reford (CP)	32.76	27.32	61.67	61.35
Smiley (CP)	45.44	37.24	42.10	37.04
Conquest (Top) (CN)	73.14	3.30	3.33	3.39
Conquest (CN)	77.76	11.41	11.71	11.66
Matador (CN)	46.28	14.28	12.83	12.07
White Bear (CN)	38.72	28.82	54.92	81.44
Mantario (CN)	53.44	14.32	-	-
Macklin (CP)	74.24	3.86	3.66	3.58
Rosetown (CN)	264.48	3.94	3.92	3.96
Major (CP) (Coronation)	34.50	27.90	27.65	26.26
Kerrobert (CP)	128.32	9.73	9.51	8.59
Elrose (CN)	174.08	5.27	5.37	5.50

The results in Table 5.20 indicate that there is a $4.7 million cost saving under this scenario compared to the current situation. Farmers, railways, and elevators all benefit as a result of this change. The only "losers" are taxpayers, but this is not quantified.

Table 5.20. Cost Analysis in the Grain Handling and Transportation System (M$).

Scenarios	Farmers Total Cost	Road Cost	Railways Cost	Elevator Cost	Total Cost	Total Cost Saving
Current Situation (8 Cents Trucking Cost)	140.4	1.7	80.0	33.2	255.3	
Tow Cents Reduction in Trucking Cost and a 10% Reduction in Elevation Rates	136.8	2.2	79.1	32.5	250.6	4.7
Change	-3.6	+0.5	-0.9	-0.7	-4.7	

5.5.3 Change in the Railway Volume-Related Cost

During the WGTA era, some authors argued that the railways received about half of their cost savings from technological advancements and productivity gains in grain transportation (Vercammen, 1996). On the other hand, with the elimination of the WGTA, the railways now capture a much larger share of the productivity benefits (Vercammen, 1996). In the present policy environment, the railways are far more likely to aggressively seek out cost-efficient technologies.

This thesis represents technological gain by a lower railway volume-related cost. For the scenarios studied here, the railways' volume-related cost was assumed to be 1.2 cents and 1.8 cents per tonne-kilometer for the main and branch lines respectively. These costs were lowered to 1.0 cent for the main line and 1.5 cents for the branch lines in the productivity analysis. The other variables were assumed to be the same in the model.

Under the new *Canadian Transportation Act* (CTA), the railways will receive close to one half of the annual productivity benefits, both in the short run and in the long run (Vercammen, 1996). If this is true, then the results of this study indicate that the railways gain $6.11 million annually as a productivity benefit in the study region. Such a substantial benefit gives strong incentives to the railways to seek out more cost-efficient technologies and improve the overall performance of their grain transportation system.

Vercammen states that one major consequence of the redistribution of productivity benefits is comparatively higher freight rates for producers than of present. This is true only if the rates are allowed to rise above the rate cap. However, with technological improvement, reflected in lower railway volume-related cost and consequently lower average and marginal costs for the branch lines and main lines, railways can offer lower freight rates to producers. If farmers face higher freight rates even with technological improvement, then this is because railways are exploring market power and is not a result of the productivity gains. With the assumption that the rate cap is still in place, the results of this study indicate that lowering the volume-related cost leads to substantial benefits to the railways.

5.6 Conclusion

This chapter examined the impacts of branch line abandonment in Western Canada on supply response and costs for railways, farmers, elevators, and roads. The increase in transport costs as a result of line abandonment caused a relatively small decrease in grain production. The overall impact of abandonment is a loss to social welfare, more road costs, and large gain to the railways.

Specifically, this study found that the least-cost rail configuration occurs when the *Rosetown* branch line of the CN rail and the *Kerrobert* and *Macklin* subdivisions of the CP rail stay open. As expected, the socially optimal configuration was different from the scenarios representing the railways' best interests. Railway profits are maximized through a complete abandonment of branch lines though CN rail gained almost all the benefits while CP rail did not gain much. Given the assumption that the railways are unlikely to collude, and that CP is unlikely to abandon its track to help CN make more profit, the socially optimal outcome is the most likely outcome given the market dynamics that are in place. However, the difference in efficiency gains between a complete abandonment as compared to a partial abandonment (socially optimal outcome) is relatively small. Furthermore, a $6,000/km abandonment penalty does reduce the railways' incentive for abandonment. The study found that if railways do not act together in abandoning lines, this penalty would result in the socially optimal level of abandonment. If the railways were to collude and maximize joint profits, it would be in their interest to abandon all branch lines, even with the penalty in place.

In sum, the model shows that moderate changes in trucking and rail costs yield a range of results. The results indicated that using larger trucks leads to significant redistribution of benefits among the parties involved in the grain industry. Finally, lowering of railways volume-related cost leads to significant benefits to all parties if railway freight rates decrease. As expected, railways will benefit most from technological improvements in the rail industry.

CHAPTER VI

SUMMARY AND CONCLUSION

6.1 Summary

Branch line abandonment and the optimal length of branch lines are major concerns in the new deregulated grain handling and transportation environment. The length of branch lines as well as the number and location of delivery points are important for an efficient transportation system. Production quantity, farmers costs, railway costs, elevator costs and road costs (taxpayers) all can be affected if a rail way decides to abandon a branch line.

The aim of this research was to analyze the costs of alternative branch line configurations under a regulatory framework (Bill C-101). Specifically, this study was designed to provide the comparative efficiency of alternative branch line configurations if the maximum cap rates were in place. The objective of this thesis was first to use simulation techniques to explore the optimal configuration of a railway branch line system under the existing elevator system and consequent impacts on railways, farmers, grain companies and roads in a chosen region, and then to comment briefly on the major changes in regulatory rules pertaining to railroads.

In Chapter 2, an overview of railway regulation was provided. It was noted that the history of regulation, despite its limits, provides a perspective on the plurality of strategies that have been adopted to allocate scarce resources in our society.

The theoretical background of grain handling and transportation system was presented in Chapter 3. The study utilized a spatial equilibrium model of a particular region in the Western Canadian grain market. The spatial model incorporated cost behavior of various industry components of the grain transportation industry. The discussion of production costs, trucking costs, elevator costs, railway costs, and road costs were also provided in this chapter. In the model the interaction of the cost relationships determined the behavior of farmers and the railway. With a given export price, changes in the branch line configuration may affect the returns received by farmers and the railways.

Chapter 4 provided a description of the region, the data and the specification of the empirical model. In particular, it discussed the development of the empirical model that was used to search for the welfare analysis of various branch line configuration in the grain handling and transportation industry.

In Chapter 5, various configuration of branch lines were simulated. These configurations were developed to determine: 1) with branch line abandonment what was the distribution of losses and surpluses; and 2) what configuration of branch lines was socially optimal. In each scenario, a different length of branch line was abandoned and a comparison was made to answer the above questions.

6.2 Conclusions and Implications of the Study

The attempt was made in this study to examine the impacts of branch line abandonment on supply response and costs for railways, farmers, elevators, and the roads (taxpayers). The increase in transportation costs as a result of line abandonment caused a relatively small decrease in grain produced, and a movement away from the higher volume commodities toward the lower volume commodities. Increased transport distances to elevators also led to more use of trucks and more damage to the roads in the study region. The overall impact is that there was a loss to producer's welfare, more costs for roads, and a large gain to the railways. The size of trucks and their costs were fixed however, and no allowance was made for expected decrease in elevation costs.

The least-cost rail configuration is where the *Rosetown* branch line of CN rail and *Kerrobert* and *Macklin* subdivisions of CP rail stayed open in the region. Thus, current costs suggest that fairly widespread abandonment is cost-reducing from a social perspective. Any reduction in the cost of the operation of branch lines, such as a short-line operation, would increase the optimal number of branch lines. Similarly, any reduction in trucking costs would reduce the optimal number of branch lines.

This socially optimal configuration differed from the railways' interests with Bill C-101, where profits are maximized with a complete abandonment of the branch lines. Thus, it is in the interests of the railways to have more widespread abandonment than what is the least cost from a social perspective though CN rail gains almost all the benefits while CP rail do not gain much. Given the assumption that the railways are unlikely to collude, and that CP is unlikely to abandon its track to help CN make more profit, the socially optimal outcome is the most likely outcome given the market dynamics that are in place. However, the difference in efficiency gains between a complete abandonment as compared to a partial abandonment was relatively small especially if one allows for competition between the railways. In a "competitive scenario" the result is essentially the same as the socially optimal configuration.

A $6,000/km penalty for abandonment reduces the railways' incentive for abandonment. If they do not collude, this penalty would result in the socially optimal level of abandonment. If the railways were to collude, it would be in CN's interest to abandon all branch lines, even with the penalty in place, but not in CP's interest.

The results indicated that using larger trucks leads to significant redistribution of benefits among the parties involved in the grain industry. The results illustrated that lowering the railway's volume-related cost leads to significant benefits to the railways. Other parties involved in the grain industry can benefit only if railway freight rates decrease – the only "losers" are taxpayers.

6.3 Limitations and Suggestions for Further Study

The reliability of the results of this thesis depends on the validity of the various assumptions and the accuracy of data inputs. However, the results provide a perspective about what the optimum grain handling and transportation system on the Prairies should look like.

In developing the model, the study made a trade off between simplicity and complexity. For example, trucking costs used in the study was of a linear type. This may slightly underestimate or overestimate the overall trucking costs of the model. It would be more precise if a better trucking costs such as Trimac trucking costs were incorporated in the model. Assuming no change in trucking size with increase in distance however, can only overestimate truck costs.

At the beginning of this report it was stated that in recent years consolidation has been occurring in two processes: a) the abandonment of lower volume railway branch line, b) the closure of lower volume primary elevators and opening new large facilities. This thesis considered only the last part. Undertaking both (a) and (b) at the same time would bring more cost savings to the system, though the general direction of the results are approximately right.

The research has examined some possible outcomes of deregulation, but it is not possible to predict the actual outcome of deregulation of the industry. This would only be possible if railways were given the power to freely set rates. In fact, one suggested further study would be to investigate the outcome of free rate-setting by the railways. Another further work would be to examine the viability of the branch lines abandoned by the railways if a short-line railway decided to operate on these lines. With the hold-up problem addressed by Fulton and Gray (1997), another important area that requires further study is the possibility of regulating entry rather than regulation of behavior in the railway industry. Regulating entry, as stressed by Fulton and Gray, would use competitive forces to develop a more efficient system.

The study does not consider the impact on taxpayers if rail branch line abandonment leads to a loss in property taxes. Presently part of the railway "savings" on abandonment is an end of this transfer to local governments. Finally, if trucks go further – and burn more fuel, increase in collected taxes helps to offset some of the road costs.

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