AN ECONOMIC ANALYSIS OF THE CHARACTERISTICS RELEVANT TO PRIMARY ELEVATOR CONSTRUCTION AND CLOSURE DECISIONS

by
Lorraine Hope

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Submitted to the Faculty of Graduate Studies
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for the Degree of

DOCTOR OF PHILOSOPHY

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AN ECONOMIC ANALYSIS OF THE CHARACTERISTICS RELEVANT TO PRIMARY ELEVATOR CONSTRUCTION AND CLOSURE DECISIONS

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A Thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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Abstract

Grain elevator companies ultimately determine where elevators will close and where new ones will be constructed. Analysis of the characteristics elevator company managements consider in their decision making process is useful to all participants in the grain handling and transportation system.

The study identifies market, point and elevator characteristics that Western Canadian grain elevator companies consider in their investment and rationalization decisions to build and close elevators at prairie delivery points. Data pertaining to elevators constructed in Manitoba and Saskatchewan and closed in Alberta and Saskatchewan between 1980/81 and 1989/90 were summarized and investment and closure patterns identified. A few of the patterns included: 1) elevator companies tend to build replacement elevators, elevators built at a point at which the company is already located, as opposed to expansion elevators, elevators constructed at a point where a company has no experience, 2) replacement elevators tended to be larger than expansion elevators, 3) Saskatchewan elevator companies tend to build elevators at multicompany points, 4) elevators constructed in Saskatchewan were smaller than in Manitoba, 5) in Manitoba slightly more elevators were constructed on mainlines than branchlines, but in Saskatchewan the opposite was observed, 6) a greater proportion of elevators were closed at single company points than multicompany points, and 7) elevators closed in Saskatchewan were smaller than in Alberta.

Multiple regression analysis was also used to develop models which would predict the probability of elevator construction and elevator closures. Separate logit models were identified for those elevators which were constructed and those which were closed as the decisions to construct and to close were viewed as separate decisions and not alternatives. Four logit models, a Manitoba open model, A Saskatchewan open model, an Alberta closure model and a Saskatchewan closure model were estimated, generating 81, 82, 94 and 82 percent correct predictions, respectively.

Variables significant in predicting elevator construction included, total elevator capacity and average elevator turnover for the surrounding market area, existing delivery point capacity, expected point company volumes, the presence of other new competitive elevators and the age of alternative company elevators in the market area. Variables significant in predicting elevator closure were company elevator capacity at the point of closure, company point deliveries, average point turnover and company representation in the market area. Road quality access, which is a measure of the number of roads and quality of roads at a point, was significant in each of the closure and open logit model.

Sensitivity analyses were conducted on each model to assess the impact of changes in the values of the explanatory variables on the predicted probabilities. Elevator capacity in the surrounding market area and age of alternative company elevators in the market area had a greater impact on the probability of elevator construction at a site than other variables. The capacity of the elevator to be closed had the greatest impact on the probability of closure in both the Alberta and Saskatchewan models, followed by company delivery volumes and average turnover rate.

The models were verified employing *ex post* forecasts and *ex ante* forecasts conducted of selected delivery points. Each model was assessed regarding its ability to forecast elevator construction or closure in the 1990s. Evidence of structural change was indicated in the Saskatchewan models and the Saskatchewan closure model reestimated. Too few observations in the 1990s prohibited reestimation of the Saskatchewan open logit model.

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CHAPTER 1 INTRODUCTION

Construction of the first Canadian transcontinental railway in the 1880s, by Canadian Pacific Railway (CPR), facilitated extensive Prairie settlement and was a key factor in promoting growth in the agricultural sector. The railway enabled development of a gathering and distribution network for grain, a prerequisite for exploiting potential grain export markets. To enable Canadian grain exports to expand, handling and storage structures were required. The building of these structures was the forerunner to the present Canadian primary elevator system (PES).

The horse and wagon greatly influenced the pattern of the PES that emerged. Movement of grain from the farm to the elevator by horse and wagon limited hauling distance. Therefore there was pressure to provide an extensive grain handling and railway network. At its peak elevators were spaced every six to ten miles along rail lines. The number of country elevators built increased rapidly to reach 5757 in 1933, with a combined storage capacity of 192.8 million bushels[1]. However, from 1933 to 1973 the number of primary elevators declined by 23.9 percent to 4165 while storage capacity increased[2]. Actions such as the Canadian Wheat Board's strategy of producer income protection and the Temporary Wheat Reserves Act (1956) along with increased production between 1935 and 1960 raised elevator storage revenues thereby encouraging construction of additional storage facilities. Total storage

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[1] Dennis Waithe, Evolution of the Primary Elevator System in Western Canada. Working Paper 14/84,(Ottawa: Ontario, Marketing and Economics Branch, Food Markets Analysis Division, Agriculture Canada, October 1984), p. 14.

[2] ibid

capacity increased by approximately 90 percent during this period. This was followed by a modest eight percent growth between 1960 and 1975 raising total storage capacity to 412.2 million bushels.

Between 1973 and 1990, both total elevator storage capacity and elevator numbers were rationalized. The number of operating units fell to 1,578 these having a total licensed capacity of 266.8 million bushels. While elevator numbers and total storage capacity declined, the average elevator storage capacity has continued to increase[3].

The rationalization of the primary elevator system has been attributed to a number of factors. One factor of particular importance was the changing functional orientation of the elevator from a storage to handling facility. The termination of the Temporary Wheat Reserves Act, and the introduction of a modified quota system emphasizing on-farm storage reduced the need for elevator storage. Consequently storage earnings were reduced. This placed increased emphasis on grain throughput and handling revenues. Firms needed access to larger market areas and to increase throughput as existing revenues from elevator operations often no longer covered labour, maintenance and repair costs. Faced with rising operating costs, elevator companies experienced losses[4]. Companies were forced to close inefficient elevators

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[3] The reduction in small capacity elevators combined with rebuilding and upgrading of existing elevators to larger more operationally efficient facilities contributed to the increase in average storage space per elevator while total elevator numbers decreased.

[4] Canada Grains Council, Grain Handling and Transportation: Definition of the Problem (Winnipeg: Manitoba, Canada Grains Council, 1975), p. 13.

and cross subsidize their primary elevator operations with revenue earned from terminal operations and the sale of farm equipment and supplies.

Another factor contributing to the on-going rationalization of the PES was the closure of elevators due to age and obsolescence. Over fifty years have passed since primary elevator numbers peaked. Many of the elevators have reached or will soon reach the end of their economic lives. Although the volume of grain handled at many of these elevators may have been adequate to cover costs given either a fully depreciated or low book value of the elevator, grain deliveries at many of these points were insufficient to warrant rebuilding. Car spots at many points were also limited.

Other important factors which contributed to rationalization of the PES include 1) closure of light density rail lines which service the elevators, 2) an improved highway network which facilitates longer hauls by truck thereby allowing expansion of market areas to support larger elevator facilities and increased price competition and 3) larger and more efficient trucks.

1.1. Problem

No primary elevator system configuration can simultaneously minimize 1) elevator operating and rail transportation costs, and 2) producer transportation costs. These two goals are mutually exclusive as the configuration which would minimize producer costs would not reduce aggregate transportation or handling costs. Consequently, the parties involved hold diverging views as to what configuration is desirable.

As previously mentioned, rising operating costs have contributed to rationalization of both the PES and rail lines. It is argued that rationalization will reduce elevator costs through both economies of size and increased capacity utilization. Similarly, rationalization has lowered railway operating costs, thereby reducing losses incurred by the railways while improving their ability to maintain an efficient grain transportation system. Proponents of grain handling and transportation rationalization point out that potential elevator operating and rail transport cost savings can be passed on to producers in the form of lower rates.

For many farmers who patronize local elevators, rationalization increases the cost of marketing their grain as they are required to deliver to alternative elevator facilities which frequently necessitates hauling longer distances. In addition, rationalization may result in 1) higher on-farm storage costs, 2) an increase in taxes due to higher road costs associated with increased traffic and 3) a lower tax base arising from the loss of assessments on elevator and rail facilities. Elevator closures may also create spatial monopolies thereby enabling elevator companies to retain any cost savings for themselves[5].

To a large extent, concern over rationalization of the grain handling and transportation system (GHTS) has been focused on rail line abandonment and the cost implications of closing elevators to the farmer. For instance both Tyrchniewicz[6]

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[5] Grains Group. Grain Handling and Transportation Costs in Canada. Toronto, August, 1971.

[6] Edward W. Tyrchniewicz, and Robert J. Tosterud, " A Model for Rationalizing the Canadian Grain Transportation and Handling System on a Regional Basis".

and Martin[7] have analyzed and estimated 1) the cost of grain handling and transportation rationalization to the farmer and 2) regional optimum primary elevator configurations which minimize system costs.[8] However, research concerning the process of elevator rationalization has been minimal. This is possibly due to the enormity of the task and the tendency to focus on issues of current concern.

Given the extensive network of rail lines crossing the Canadian Prairies and abandonment of light density rail lines, it is assumed that the current rail network[9] must define the outside limit of the feasible solution space within which the primary elevator system will evolve. In other words, construction of 'new' rail lines - to be distinguished from branch line rehabilitation- would be the exception rather than the norm.

Farmers, rural communities, governments, elevator companies and the railway companies participate in the process of rail line abandonment hearings held under the auspices of the National Transportation Agency. These participants, therefore, are jointly party to the process that determine the boundary of the feasible solution

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Proceedings of American Agricultural Economics Association. 1973. p. 805-813.

[7] Larry F. Martin, Grant D. Devine, and Surendra A.Kulshreshtha, " Centralized Prairie Grain Collection: Savings Related to Market Efficiency." Canadian Journal of Agricultural Economics. 26 (2) 1978, pp. 18-34.

[8] System costs are defined to include 1) trucking costs associated with grain assembly from the farm to the country elevator, 2) elevator handling costs, which include receiving, weighing, elevation and loading 3) rail transport costs from the elevator to the port and 4) frequently, road and on-farm storage costs.

[9]Current is defined to include lines slated for abandonment in 1990s.

set. The branch line system was 'frozen' by Order in Council to the year 2,000[10].

For those light density branch lines to be abandoned, the elevator companies have two choices, 1) to close the elevator or 2) to operate the elevator as a satellite elevator where farmers deliver to the elevator, but grain is forwarded by truck to another track side elevator for shipment to port. Studies by Fleming and Yansouni [11] have shown that the costs associated with double handling far outweigh the cost of farmers trucking the grain the extra distance to the next closest elevator. This system is cost inefficient from an overall standpoint and more costly to the farmer if he pays the cost of double handling. Consequently, these abandoned branch lines are assumed to be outside the feasible solution space.

If the current rail system defines the feasible solution space, the question then remains " Who will determine the location of the country elevator, and what criteria are considered in this decision making process"? Assuming that all delivery points must be located on rail lines, it seems that, within this constraint, it is the elevator company management who ultimately determines at which delivery points elevators will continue to operate and where new elevators will be constructed. This does not mean farmers have no input into the decisions made concerning elevator rationalization. However, either Board members of farmer cooperative elevator companies or the management of private companies ultimately make the final

[10]The prohibition against further branchline abandonment was removed in 1995.

[11] M.S. Fleming and P.A. Yansouni, Economic Feasibility of Off-Track Elevators, Canadian Transport Commission, August 1980.

decision.

As elevator companies make the final decisions concerning the location of country elevators, the point, elevator and market characteristics considered in their decision to close or construct and elevator could be useful. This information would be helpful to the federal government when developing policies with respect to 1) the direction of GHTS rationalization, and 2) compensation issues. It would also aid the railways, provincial and municipal governments, and custom truckers in their planning processes.

1.2 Objectives

The overall goal is to provide information concerning delivery point and elevator characteristics which grain elevator companies consider in their investment and rationalization decisions. To achieve this goal, the following objectives are proposed.

1. To summarize grain elevator closure and construction statistics to ascertain if patterns can be observed.

2. To develop a model that predicts the probability of elevator construction based on delivery point characteristics which grain companies consider in their decision to construct an elevator. Separate models will be developed for each Saskatchewan and Manitoba.

3. To develop a model that predicts the probability of elevator closure based on elevator and point characteristics which grain companies consider in electing to close an elevator. Separate models will be developed for each Saskatchewan and

Alberta.

4. Using the models developed, to forecast the probability of elevator closure and construction at selected delivery points in the prairies.

5. To determine if elevator companies view the market area an elevator serves from a linear or areal perspective; and to determine if the development of Thiessen polygons is a suitable technique to identify elevator market area.

1.3 Scope

The thrust of this study is to put together an information and analytical package which outlines those delivery point and elevator characteristics which are considered in the course of primary elevator rationalization and investment decisions.

It is not the intent of the study to forecast what handling system might evolve. The announced repeal of the Western Grain Transportation Act (1983) and changes to Canadian Wheat Board freight pooling points will alter prairie production patterns. Increased crop diversity and livestock feeding, and growth in value added sectors of the agriculture industry are expected to reduce grain handling at the primary elevators. These factors not only will change the configuration of the prairie elevator system but will expedite current elevator rationalization. How severe the change will be, and how quickly it will occur will emerge over the next few years.

1.4 Study Outline

This discussion proceeds with a review of the theory of location choice in Chapter 2 followed by a description of the Canadian primary grain handling system in Chapter 3. Chapter 4 reviews the literature pertaining to related studies. Chapter

5 outlines the various samples, sources of data and methods used to determine the characteristics of elevator delivery points and elevators where elevators were closed and those at which elevators were constructed. Chapter 6 presents the Manitoba and Saskatchewan open logit models and sensitivity analyses are performed to determine the effect of point characteristic values on the probability of elevator construction. The Alberta and Saskatchewan closure logit models are presented in Chapter 7 and sensitivity analyses are also undertaken to determine the effect of elevator and point characteristic values on the probability of closure. In Chapter 8, out-of-sample and *ex post* forecasts are used to verify the four models developed. Forecasts of the probability of future elevator construction in Saskatchewan and Manitoba and elevator closure at various points in Alberta and Saskatchewan are also covered in this chapter. Conclusions of the study are presented in Chapter 9.

CHAPTER 2. THEORETICAL BACKGROUND

The chapter begins with a general discussion of the goals of firms, the conflicts that arise and the investment decision process. Following this the theoretical aspects of spatial market theory and location choice are presented. These subject areas are discussed as they are pertinent to the development of the prairie elevator system and the techniques and approach which will be adopted in the research.

2.1. Goals of Firms

It is often assumed that firms have a set of goals which provide the basic framework or guidelines for development of their marketing, investment and divesture strategies. However, Scherer[1] indicates that it is not certain that firms have " well defined unambiguous goals". Two theories have been proposed which attempt to explain the apparent lack of clearly defined goals.

The first theory states that management "satisfices" a set of objectives. That is, they aspire to attain some minimum level of achievement rather than to maximize achievement. It is suggested that when owners and management are separate entities, management may not pursue goals consistent with those of the owners. Several hypotheses have been suggested to account for this possible dichotomy of objectives. Management attitudes toward risk of failure versus the unequitable rewards of success is one explanation. Another is that management is often evaluated on the basis of some benchmark which does not necessarily ensure profit

[1]F. M. Scherer, Industrial Market Structure and Economic Performance. 2nd ed. Dallas: Houghton Mifflin Company, 1980, p. 34.

maximization. For example, the case of where management is evaluated on the basis of total revenues rather than on after tax profits is an often quoted example.

While separation of management and ownership may result in conflicting goals, so may individual owner's objectives versus aggregate ownership objectives give rise to conflict. The goals of a single stockholder may not coincide with the Board of Directors representing a company. Consequently, members or stockholders often argue that the firm is not operating in their best interest.

The second theory suggests that management has a set of goals which are priorized. As many of the goals are conflicting, management attempts to satisfy the primary goal and sequentially attempts to achieve secondary goals. This theory is basic to the foundations of goal programming.

In economic theory it is generally assumed that the primary goal of firms, whether they be monopolistic, oligopolistic or competitive, is to maximize profit. In some instances this may not be true. The primary goals of cooperatives may be to reduce the price of inputs or to increase the product price received by members or to increase service. For some firms, some desired level of market share may be the primary goal. While these goals often have profit making motivations underlying them, a firm's conduct may vary with the type of goals advanced.

2.2. **Investment Decision Process**

While the goals held by firms may vary, the ability of firms to remain competitive, or to grow depends on their investment decisions involving fixed assets. The investment decision process, alternatively referred to as capital budgeting, involves many stages. The stages can be generally described as follows:

1) Assessment of the firm's investment needs and capabilities.

2) Identification of possible projects.

3) Prediction of cash inflows and outflows.

4) Assessment of capital requirements.

5) Sources of capital and the relative cost of capital.

6) Project Evaluation- Risk Assessment

This study is particularly interested in stage two, the identification of grain delivery points which enter in elevator firms' divesture and investment decisions.

2.2.1. Assessment of Firm Investment Needs.

Firm investment needs can be categorized into five classifications.

1.Replacement: Maintenance of Business - This involves replacement of obsolete or worn out assets so as to maintain the business.

2.Replacement: Cost Reduction - Expenditures to reduce costs. This can include capital deepening investment, that is investment in capital replacing labour and other variable inputs. Replacement of old and obsolete assets may also reduce costs due to technological advances inherent in new capital and reduced maintenance requirements. The economies of size associated with fixed plant may also reduce per unit fixed costs.

3.Expansion of Existing Markets - This includes expenditures to expand output or increase size of market serviced.

4.New Market Development - Expenditures necessary to expand markets either through production of a new product, market integration or diversification into other sectors.

5. Other - This category is a catch all, including for example investment in safety and environment projects.

2.2.2 Identification of Possible Projects

Projects to fulfil a firm's investment needs must be identified. Sometimes ideas for these projects come from sources within the firm. For example, ideas may be advanced by management and the company's board, by research and development and by planning or marketing departments.

Critical to the ideas advanced, is the demand for the goods and services provided by firms in the industry. Firms must assess the market demand for their own and competitors' goods and services. Factors such as own price elasticity, cross elasticity of demand, size of the target population, tastes, income, and projected growth must be considered in assessing demand. Firms must also assess the cost implications of location, economies of scale and size.

2.2.3. Prediction of Cash Inflow and Outflow

The first step in determining project cash flows is to estimate the project's planning horizon. The planning horizon is dependent on the economic life of the project and management's risk preferences. The economic life of a project will depend on the relative costs and price of goods and services. Generally profit earning ability determines a project's economic life which may be shorter or longer than its anticipated physical life given ordinary repair projections. Also uncertainty concerning cash flows increases over time, therefore, managers may limit project planning horizons to some period of time which they are willing to risk estimates of cash flows. Consequently, the length of the planning horizon is variable and will affect net cash flow.

To determine cash inflow, the price and sales volume of each product or service must be predicted over time. Similarly, operating costs, variable and fixed, must also be forecasted over time, along with the expected tax rate to determine net profits after tax.

This procedure of projecting future revenues and costs is difficult as many factors can interact to affect product price, sales, input costs and relative usage. General inflationary or deflationary trends, government programs and interventions, technological developments, competitor actions, and input characteristics can affect both product and input prices. Aside from the direct effect of price on sales volumes, changing tastes, income levels, competitors' strategies and product development also affect such volumes.

Due to uncertainty, firms will often assume static relative prices and straight line growth trends unless they believe that the price of a good or the growth trend will change in a given direction. As a check on the variable levels chosen, sensitivity analysis may be undertaken to determine how critical the forecasted prices, sales, costs and input rates are to cash inflows and outflows.

Generally assessment of cash inflow and outflow is easier for replacement rather than for new investment projects since there is less uncertainty. The current market is known; if the project involves replacing worn assets with identical new assets, the costs are also known. Uncertainty is normally greater for investment projects aimed at developing new products and markets.

2.2.4 Assessment of Capital Requirements

The initial capital investment and any infusion of capital required during the project's lifetime must be assessed. The usual capital investments include land, land improvements, buildings, office, processing and transportation equipment and, other capital investments such as patents and rights. The size of capital investment is not only critical to the profitability of the project but also determines project feasibility in light of the supply of funds available to the firm, and its effect on future investment opportunities.

2.2.5 Sources of Capital and Relative Cost of Capital

Funds for investment projects are obtained from internal firm sources or from sources external to the firm. Retained earnings and depreciation allowances are sources of investment funds available to the firm. Often firms choose to finance investment projects using internal funds as they are reluctant to increase their debt load. Conversely, a firm's ability to borrow funds may be restricted by its current financial position forcing it to utilize any internal funds available.

External sources of credit open to firms include borrowed funds from parent companies, short term and long term debt from arms length credit organizations, bonds and the sale of preferred and common stocks. The choice of credit source will depend on the time period over which the investment project extends, the interest charges on borrowed capital, the repayment period and contractual commitments, mortgage provisions and the amount of money which can be raised from the source. The greater the project risk and the more insecure the firm's financial status, the higher the interest charges.

2.2.6 Project Evaluation- Risk Assessment

Once projects have been identified and financial potential estimated, projects must be evaluated with profit maximization generally assumed to be the primary goal of the firm. Certainty and perfect knowledge are the initial assumptions made in the profit maximization calculations.

Despite the profitability of a project and the availability of investment capital, firms may choose not to proceed with a project for a number of other reasons. Risk adverse firms may reject projects having potential for large gains or losses in favour of projects with narrower profit or loss probabilities. Competitors' marketing strategies may also alter the profitability of projects. If competing firms choose to expand when there is limited growth in demand, under-utilization of resources may occur. Unforeseen world events may change the predicted trend in interest rates, altering the time value of money. Similarly, events in industrial sectors which supply inputs may affect cost predictions.

Projects may also be shelved due to management and personnel limitations. If the firm expands rapidly and does not possess sufficient and appropriate management and personnel skills, organizational and administrative problems may be experienced. Firms may not borrow from external sources if they are concerned over their debt loads or speculate that their timing may be faulty.

2.3. **Location Theory**

The focus of this study is the Canadian primary grain elevator system and the object of the study is to determine the characteristics of grain delivery points at which an elevator company choose to close an existing elevator or construct a new elevator. Project identification and evaluation are therefore interpreted to mean identification and evaluation of specific grain delivery locations. The following discussion reviews the literature pertaining to location theory including the theory of location choice and the determination of market areas around plant locations.

2.3.1. Least Cost Models

The birth of industrial location theory is generally associated with German economists Launhardt (1885) and Weber (1909)[2]. Launhardt attempted to determine the optimum location of a plant given the simple situation of one market and two input locations. These three points comprise the corners of a triangle which have become known as a location triangle. Based on Launhardt's locational triangle, Weber determined a least transport cost location. Weber believed three factors affect industrial location, a) transport costs, b) labour costs and c) agglomerative or deglomerative forces. Transport costs were the primary factor in determining market location, hence the least transport cost location was determined.

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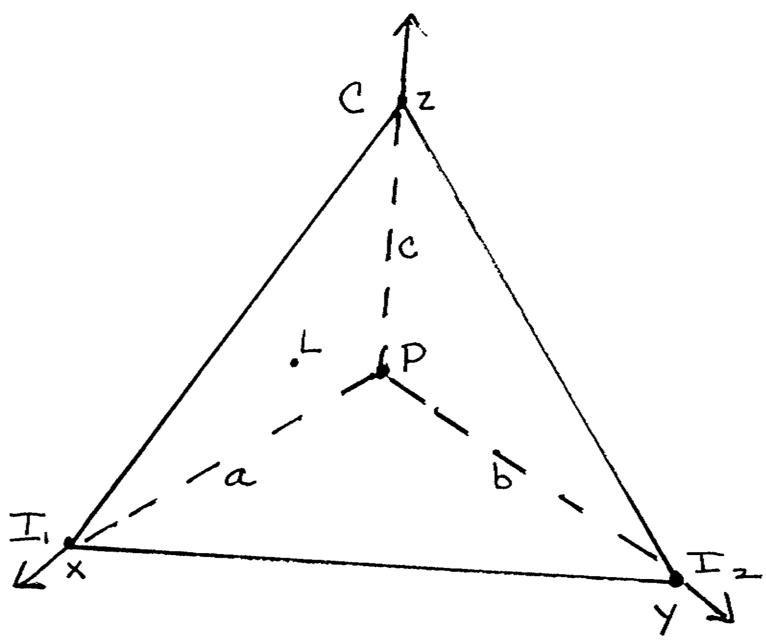
[2] David M. Smith, Industrial Location: An Economic Geographical Analysis. John Wiley and Sons : New York, 1971.

Figure 2.1 illustrates a locational triangle formed by joining the market (C) and two input locations I_1 and I_2. Weber defined the least transport cost point (P) as the point where total ton-miles per unit of production is minimized- total ton-miles to include the ton-miles of materials transported to place of production and the ton-miles of product moved to market. With respect to Figure 2.1 this is calculated by deriving the number of tons of material x and y moved a distance of a and b from I_1 and I_2 respectively, and the number of tons of product z moved a distance of c. Alternative plant locations within the triangle can be evaluated on the basis of least transport cost location. The optimal least cost transport location within the triangle can be identified using computer algorithms but may be of limited practical value given other locational factor considerations.

Weber's determination of the least cost transport location was based initially on the assumption that uniform transportation costs per ton-mile prevail which ignore the mass, perishability or other characteristics of the materials or product transported. Weber later relaxed this assumption and determined least cost points on the basis of costs per unit of distance transported. He further broadened his analysis by considering the cost of labour. Based on the least cost transport location (P), the labour cost savings at alternative labour saving locations (L) are identified and the increased transport costs to that point identified. The location of the plant would be diverted if the labour savings outweighed the increased transportation savings. The same approach was used to determine least cost points when

Figure 2.1 Locational Triangle



agglomeration of industry yielded production savings.

E. M. Rawston (1958) suggests that location choice may be narrowed by a series of location factors which restrict the choice of sites[3]. He proposed three types of restrictions which affect location, 1) physical restrictions, 2) technical restrictions and 3) economic restrictions[4]. His contention is physical restrictions narrow the choice of locations by ruling out where plants cannot locate. For example, grain elevator firms cannot locate at points which do not have large tracts of land available to construct an elevator and rail trackage.

Taken in a broader sense, it is possible that a location's physical characteristics are one of a series of locational factors that are useful in evaluating sites not just restricting choice of sites. For example, road access to an elevator site, while not directly measurable in economic terms, could affect elevator viability.

Technical restrictions refer to the effect of technological progress in the production process on location choice. If it is anticipated that technological improvements in production may become less or more frequent, locational economies associated with other input factors may play a greater or lesser role in location choice. For example, technological innovations in trucking have allowed grain to be economically transported over longer distances. Thus, emphasis on the length of haul has been reduced, shifting emphasis to other factors important to elevator and company profitability.

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[3] ibid.

[4] Both the physical and technical restrictions have economic implications.

Rawston points out that where a plant could ultimately locate and its level of economic activity are determined by economic restrictions. Each component of a firm's cost structure such as labour, materials, land and other capital inputs has a different cost associated with the location. The total difference in the costs at each location due to location is termed locational cost. These different locational costs give rise to spatial margins to profitability. A comparison of the locational costs at potential locations narrows the number of feasible location sites. The advantage of Rawston's approach is successive restrictions narrowed down the choice of location sites yet enabled him to avoid using the concept of profit maximization as a determinant of location site. This is particularly useful if actual cost data are unavailable but the price of inputs and the relative importance of each input to total cost are known.

2.3.2. Allocation of Market Area

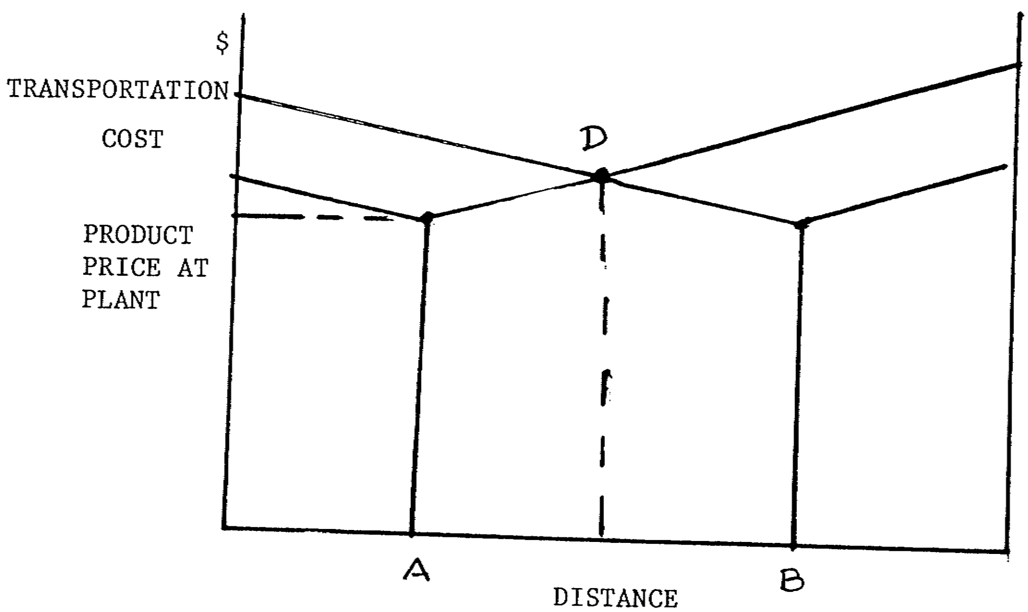
In the least cost models presented thus far demand for a firm's product is not considered in the choice of site location, only aspects which affect delivered cost. Demand was constant and there was no locational interdependence between firms. It was assumed that perfect competition exists and no firm has a market advantage over another due to its location site.

The theory of market area allocation seeks to discover demand for a firm's product by attempting to determine how market areas are allocated among firms. The weakness of this approach, however, is that location site is assumed a "given" and the costs associated with the selection are not addressed.

Given a firm's location, Tord Palander[5] (1935) sought to discover how product price determined the market size and boundaries a firm served. Assuming a linear market, two firms producing the same product and a rational economic buyer, he derived plant market boundaries based on buyer procurement prices.

The net procurement price at any point along a linear market is illustrated in Figure 2.2 as the combined purchased plant price and transportation cost[6]. Transportation costs are generally assumed to be directly related to the distance

Figure 2.2 Market Boundary, Identical Production Costs.



hauled, hence as the distance from the firm's point of production increases, the procurement price increases. The boundary between two plants A and B is at point

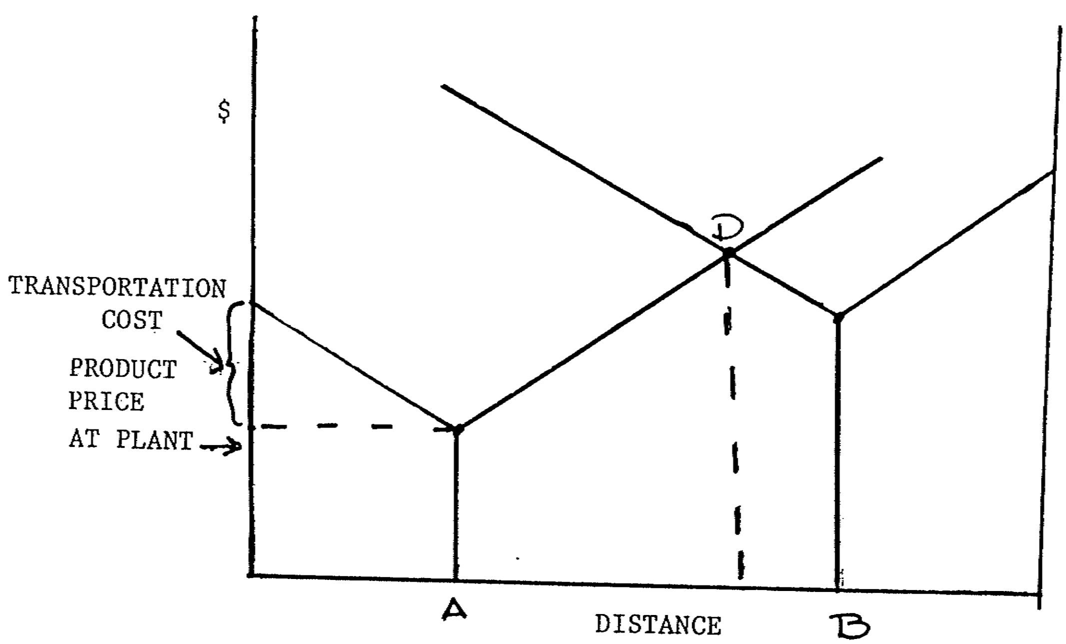
[5] David Smith, op cit.

[6]Transportation costs are assumed equal and constant over distance.

D where the procurement price from either plant is identical. Assuming identical costs of production and uniform transportation costs, the boundary will be equidistant from each plant.

Alternatively, if plant A produced a product at lower cost and transportation costs remained uniform, Plant A's market would be larger than Plant B as buyers would buy from the firm with the lowest procurement price, as demonstrated in Figure 2.3.

Figure 2.3. Market Boundary, Unequal Production Costs.



This example is typical of extractive, manufacturing, or processing based industries where the product is distributed to buyers. However, in many agriculture situations, production is areal based and not produced at one location. Consequently, the product must be assembled. Following Palander's assumptions, that agricultural producers are located along a linear market, produce homogenous products, are rational and deliver to a single buyer (firm). The approach used for extractive and manufacturing based firms can also be applied to agriculture assembly plants, where the boundary between two plants A and B is at point D where the procurement price from either plant is identical. However, the procurement price or farm gate price is the delivered plant price less the cost of transporting the product to the plant as illustrated in Figure 2.4.

The approach used to determine market boundaries in the linear model can be extended to areal spatial markets. Assuming 1) a uniform standardized commodity and 2) that producers are rational, profit maximizers, spatial market theory demonstrates that given free choice producers will deliver to the market that gives them the highest site price, $P_a - T_a$. Presented in plane view, Figure 2.5 shows isocost contours or isotims that indicate locations with identical site prices relative to plant M.

The free choice principle gives rise to the law of market areas which says that the boundary between two market areas is the locus of points where the site price between competing markets is equal.

Boundary site price $= P_a - T_a = P_b - T_b$

Figure 2.4 Market Boundary in Agricultural Situation Where the Product Must be Assembled.

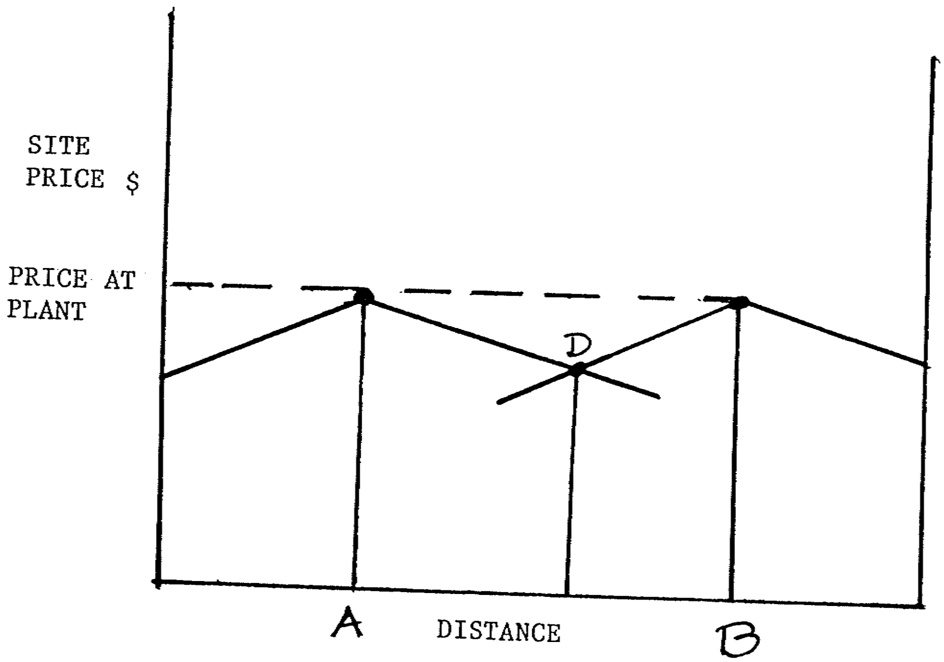
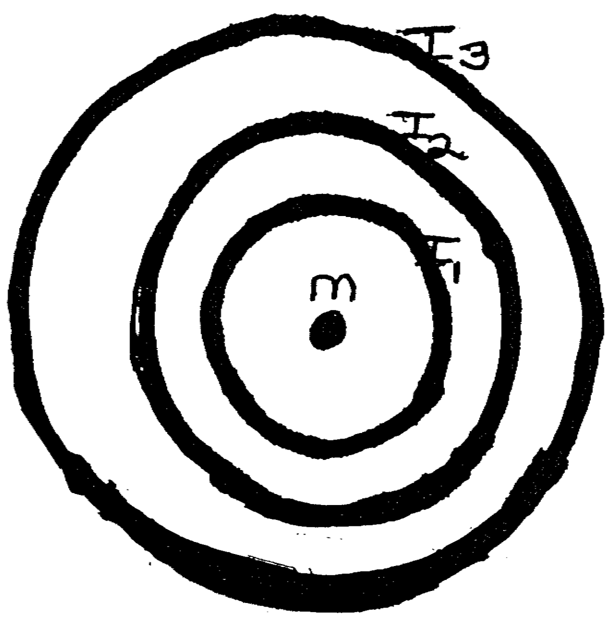
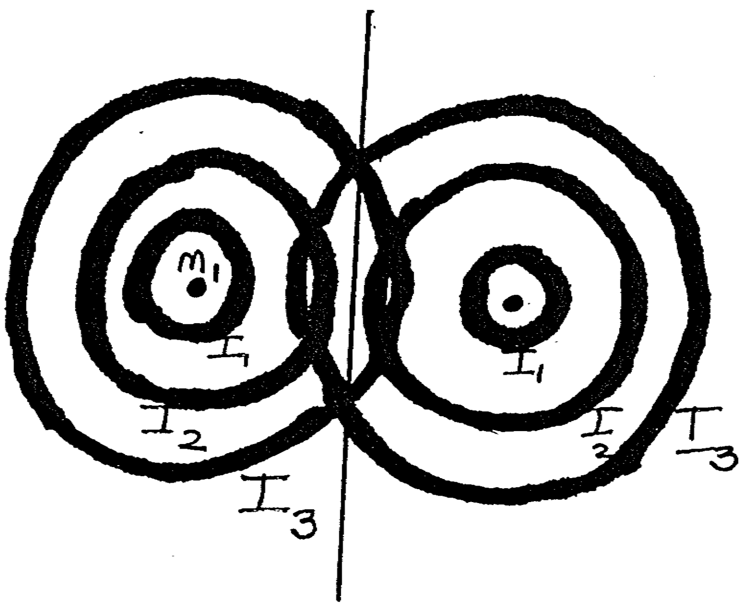


Figure 2.5 Location of Identical Site Prices



If the transportation rate is constant per unit and the market prices offered by the two plants are identical, the boundary will be a straight line equidistant from each market, Figure 2.6. If the market price in one market exceeds the price in the other, the boundary will be curved toward the market with the higher price as depicted in Figure 2.7.

Figure 2.6 Market Boundary Between Markets With Equal Price.



However, transportation is restricted to existing transport networks, so that isocost contours are unlikely to be perfectly round. Frequently, isocost locations are depicted using road network grids. In this case, the isocost contours are square and lie at a 45 degree angle to the x and y axis as illustrated in Figure 2.8.

Figure 2.7 Market Boundary Between Markets with Unequal Selling Price

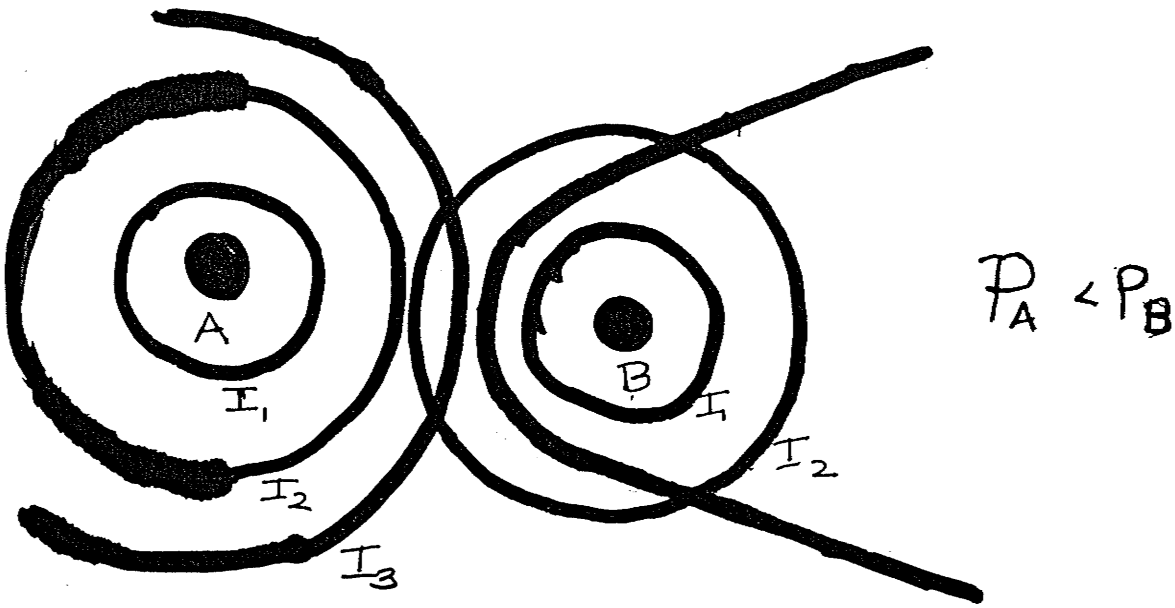
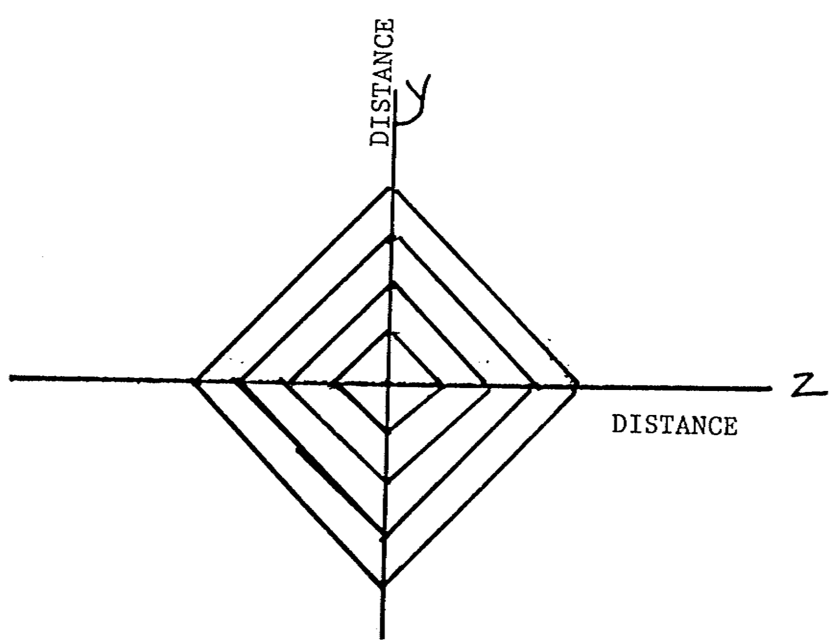


Figure 2.8 Shape of Isocost Contours Based on Grid Like Road Network.



2.3.3. Locational Interdependence

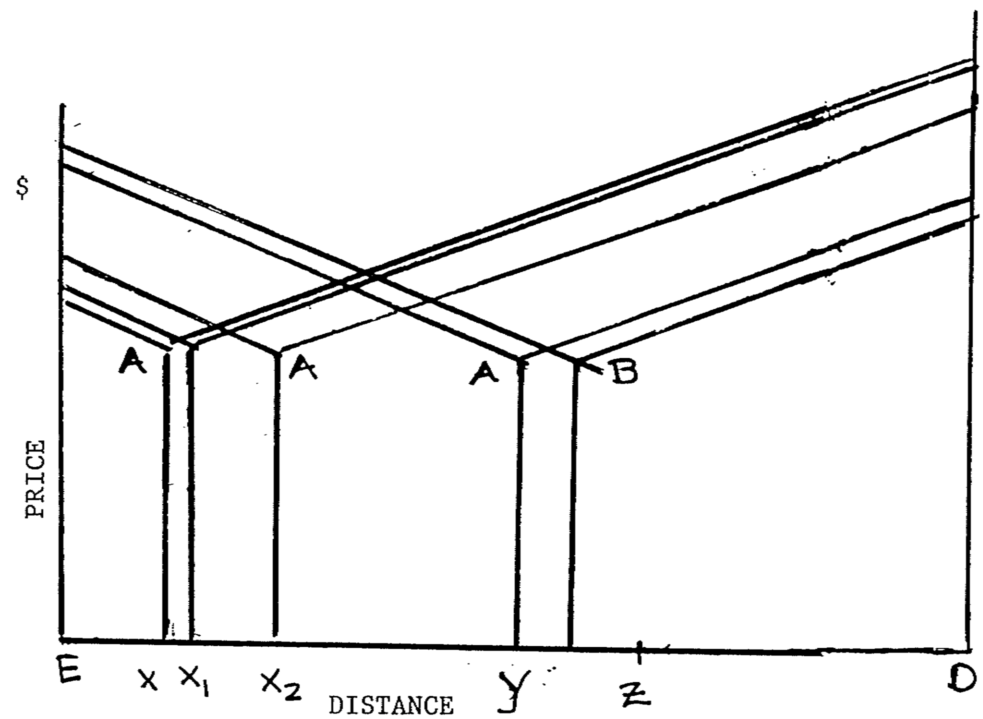
Several locational interdependence models were developed based on the theory of market allocation. However, they go further than allocation of market area theory by introducing interdependence between firms in choice of location site.

The model developed by Hotelling[7] in 1929, frequently referred to as the Beach model as his model described two sellers competing to sell ice cream to buyers evenly distributed along a beach, illustrated where a firm would locate given the location of other firms. He hypothesized that a firm, B, contesting a market serviced by a competitor, A, will strategically locate its new plant beside the rival plant so as to capture a portion of its competitor's market. These results are based on the assumptions that 1) firm A's investment is mobile, 2) customers are uniformly distributed, 3) demand for the product or service is inelastic, 4) customer preferences are solely dependent on site price, 5) production costs are the same and 6) transportation rates the same per unit of distance.

He also hypothesized that both firms would locate at point Y, the centre of the market area, Figure 2.9. At any other point, a second firm could locate immediately beside the first firm and capture a greater share of the market. For example, if firm A were located at point X, firm B could locate at point X_1 thus serving X_1D while A served EX. As the firms are assumed mobile, firm A would skip to point X_2. This situation is unstable and the two firms would continue to

[7] H. Hotelling, " Stability in Competition", The Economic Journal. 1929. pp. 41-57.

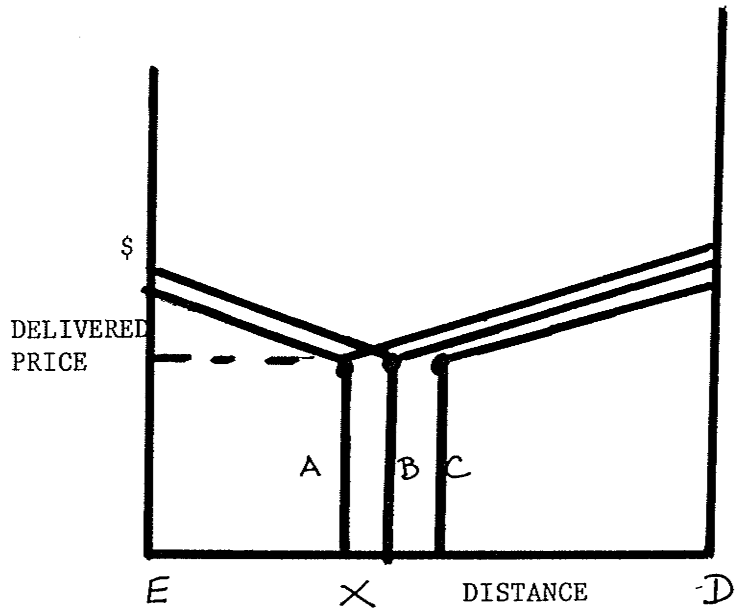
Figure 2.9 Location Site of Mobile Competing Firms in Linear Market



move until equilibrium was reached at point Y, the centre of the market. While this position is clearly inefficient as customers must travel twice the distance than if each plant were located at quartile positions, X and Z, Hotelling hypothesized that it is the agglomeration in the middle that results in competitive stability.

Dropping the assumption that firms are mobile, does not alter Hotelling's hypothesis that firms tend to cluster. Figure 2.10 shows that if firm A were located at point X, it would be advantageous for firm B to locate beside point X thereby

Figure 2.10. Choice of Market Site by Competing Firm in Linear Market Under the Assumption of Firm Immobility.



capturing market XD leaving firm A to service market EX. As firms are assumed immobile there would be no jostling for location therefore agglomeration would not necessarily occur at the centre of the market[8].

Chamberlain (1936) argues that based on Hotelling's assumptions duopolists need not cluster at one location. Rather they are able to situate themselves at quartile positions and maintain the same market share more efficiently. However, this implies tacit collusion. He points out that even if two firms were located at the same location, a third firm would locate itself so as to create its own spatial

[8] This assumes a firm would not anticipate competitor's behaviour and choose its location site accordingly.

monopoly. Otherwise, to locate beside the first two firms would create a situation of "pig in the middle" where one firm has no sales.

Chamberlain also argues that if three firms were involved, the firms would disperse[9]. He suggests that two firms would locate at quartile positions, and a third firm would locate in between. As more firms entered the market, firms would continue to disperse themselves throughout the market.

The Hotelling and Chamberlain results are dependent on the assumption that a firm's pricing policy is independent of the actions of competitors. Palander (1935) expands on the Hotelling and Chamberlain assumptions allowing for various pricing policies. He generalizes that 1) if firms price autonomously, either a new firm a) will locate beside an existing firm and undercut prices forcing the existing firm out of the market, or b) will raise its price and locate as far away as the midpoint of the longest market stretch confining its sales to its own hinterland thereby exercising monopoly control over the market area, or 2) if firms believe that competitors will react to their choice of location and price, they will locate away from each other garnering their own spatial monopolies.

In the industrial least cost models and the market area and locational interdependence models, demand is either implicitly and explicitly assumed to be inelastic and customers evenly distributed. When demand factors are introduced and the assumptions relaxed, the choice of location indicated in the above models is likely

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[9] W. Isard, Location and Space Economy. M.I.T. Press: Cambridge Mass., 1956. pp. 160-171._

not a profit maximizing point. The industrial least cost model does not consider sales potential associated with market size and elastic demand which affect revenue. The market or locational interdependence models do not consider cost of production in choice of location site[10].

Greenhut (1956) integrated the least cost and locational interdependence approaches in his industrial location theory by taking profit maximization as the criterion for optimum location. To determine profit maximizing locations, cost factors, demand factors, cost reducing and revenue increasing factors were considered. He particularly urged that more attention should be given to demand factors. While locational choice will determine the demand a firm faces, demand also influences location. Demand may even be more variable with location than cost hence may have a greater effect on profit.

Greenhut further distinguishes two types of demand factors, 1) area determining and 2) site determining. Demand as an area determining factor refers to selecting areas on the basis of market size whereas the site determining demand factor relates to choice based on location of competitors. The site determining demand factor involves many behavioral (conduct) issues such as tacit collusion and pricing strategies which are difficult to measure and model.

2.3.4. Optimum Plant Organization Within Producing Regions

The spatial market theory principles which allocate producing territories (ie.

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[10]Costs of production is introduced in locational interdependence models insofar as it affects the site price hence each plant's market size. It is not introduced as a factor which affects choice but is treated as a given.

farms) to specific markets, can also be used to determine the efficient organization of plants within a producing regions. The efficient organization of plants within a producing regions presumes the number, size and location of plants are variable and incorporates assembling, production and distribution costs in the assessment. In contrast, the theory of market allocation presumed plant numbers and location were fixed.

Efficient organization of markets is concerned with minimizing combined assembly, processing and distribution costs through an optimum plant number, size and location configuration. However due to economies of size, processing costs are a function of volume and can be reduced at the expense of assembly and/ or distribution costs.

In the long run, firms can almost build any size of plant they wish as all resources are variable. Factors such as division and specialization of labour and technological factors increase the possibility of lowering processing costs as the size of plant is increased. Aside from increased production in areas currently delivering to a plant, the volume required to justify construction of a larger plant can only be achieved by expanding the market area. Market boundaries can be extended by raising market price or reducing service charges which in turn raise producer site price.

While this strategy increases the volume necessary to increase plant capacity, it also raises total assembly costs by extending market boundaries. Consequently, optimum plant location requires balancing plant costs which decrease with increased plant size against assembly and distribution costs which increase with the size of the market area and reduction in plant numbers. If economies of size were nonexistent the most efficient configuration would be a plant at each producing location.

Figure 2.11 shows the processing and combined processing and assembly cost minimizing volume. Plants would minimize costs at point *a* where the marginal cost of processing one more unit is equal to the average cost of producing the unit. However, when processing and assembling costs are combined, costs are minimized at point b. This figure illustrates why the optimal plant size may deviate when the firm is not responsible for assembly or distribution costs.

2.3.5. Monopolistic Behaviour in Spatial Markets

Within organized spatial markets, the potential for pricing and operational efficiency conflicts arise. Operational efficiency or technical efficiency is attained if

> production function yields the greatest output for any set of inputs, given its location and environment".[11]

Exchange or pricing efficiency " refers primarily to price; the effectiveness with which price reflects costs depends upon the market structures and the applicable competitive strategies".[12] Frequently, the market structure under which operational efficiency could be attained, may also give rise to pricing inefficiencies;

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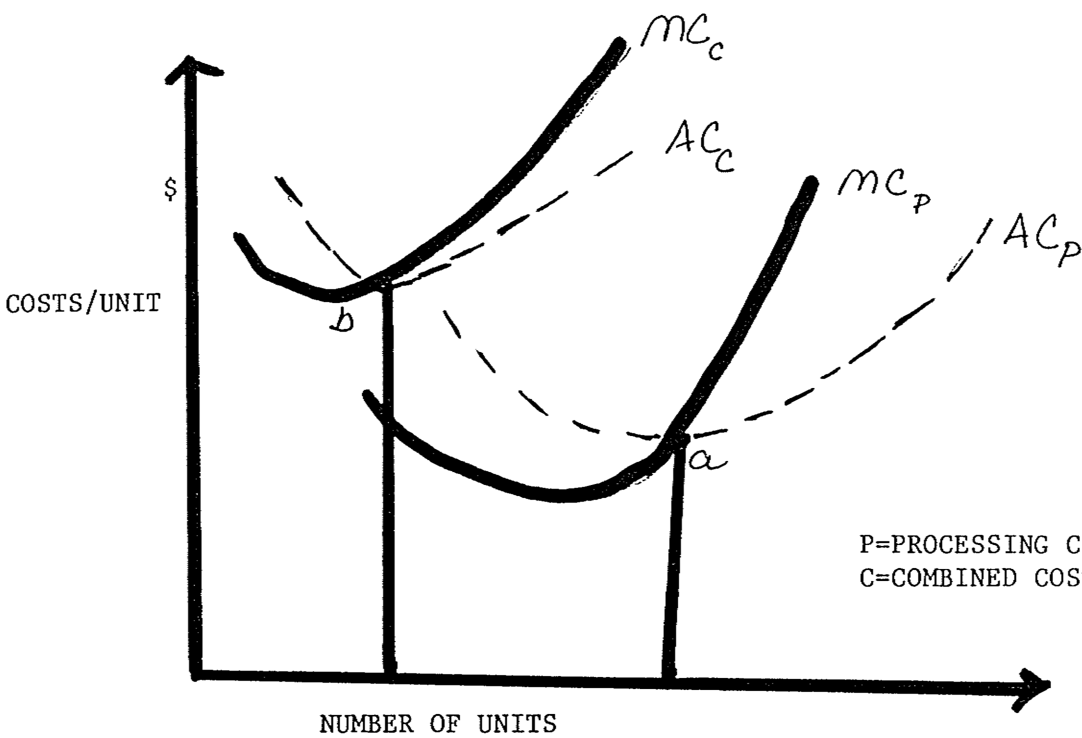
[11] Ben C. French, " The Analysis of Productive Efficiency in Agricultural Marketing: Model, Methods and Progress", Volume I, A Survey of Agricultural Economics Literature. St. Paul, Minnesota: University of Minnesota Press, 1977, p. 94.

[12] A.A. Warrack, " A Conceptual Framework for Analysis of Marketing Efficiency" Canadian Journal of Agricultural Economics, Vol 20(3), 1972, p. 9.

Figure 2.11 Plant Operating Costs and Combined Plant Operating and Assembly Costs.



Source: Raymond G. Bressler and Richard King. Markets,Prices and Interregional Trade. John Wiley and Sons Inc. New York: 1970, p. 143.

monopolistic and oligopolistic market structures often cited as examples.

The allocation of exclusive producing territories to a specific market or plant provides an environment for monopolistic exploitation[13]. Plants may price discriminate, offering higher product prices to producers near and outside their borders than those within their boundary to maintain and expand product deliveries. Alternatively, plants may offer flat assembling fees, thus effectively raising site prices

[13]Bressler, Raymond and King, Richard. Markets, Prices and Interregional Trade. John Wiley and sons, Inc.: New York, 1970.

to territories on the boundaries.

Due to the spatial aspects associated with its market, each firm has some market power where, within limits, it can set its own price. If monopolistic pricing occurs where $P > AC > MC = MR$, excess profits are earned and could attract new entrants. However, new entrants reduce the product available to each plant thereby increasing per unit production costs and reducing the volume available for sale. Eventually new entrants would reduce monopoly profits to zero where $P=AC$. The evolving plant organization, however, would continue to be price inefficient if $P > MC$, as well as operationally inefficient. Operational efficiency could be improved if excess capacity within each operation were reduced and quantity produced expanded.

The extent to which monopolistic profits can be earned without attracting new entrants, however, is dependent on barriers to entry. Sunk costs, distinguished from fixed costs can be a barrier to entry. Capital that is immobile and has limited alternative use, therefore not easily rented or sold, can be considered a sunk cost. Institutional constraints such as government regulations may also impede entry. These impediments to entry reduce the probability of "hit and run" entry, as entrants must 1) stay in the industry to recoup returns on investment which the market may not be able to sustain unless some incumbents were to leave, or 2) lose their investment if they were to pull out as the salvage value of immobile capital would likely be below net depreciated value.

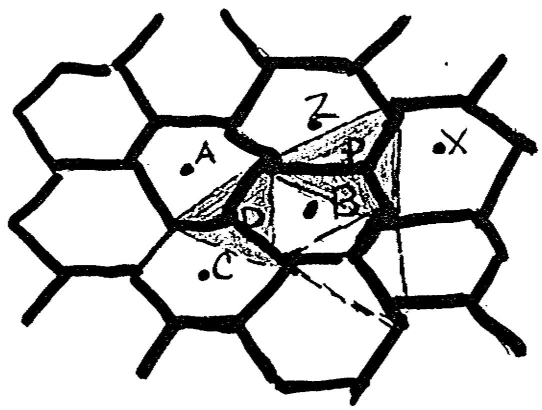
2.3.6. Degeneration of Efficient Plant Organization

Just as spatial market theory provides a framework to determine the efficient organization of plants within a producing region, it also explains how spatial competition can lead to inefficient plant organization.

Assuming new entrants would locate away from existing firms creating their own spatial monopoly, new firms would locate where farm site prices were lowest, on the boundaries of other firms' markets. At this point, the new entrant could offer lower product prices without reducing farm site price as transportation costs are lower due to shorter distances between the producing territories and the new plant. The boundaries surrounding the new entrant would be where the site price to the new entrant's plant equals that to his competitor's plant.

New entrants reduce the market volume available to the other firms it shares its boundaries causing them to become less efficient. The new entrants themselves may have higher operating costs but survive due to lower product prices. This market degeneration process could continue as long as lower product prices can compensate for other higher operating costs. This degeneration of efficient plant organization is sometimes referred to as "law of mediocracy" because it results in high costs for all firms rather than low costs for firms in an efficient organization. Figure 2.12 illustrates the degeneration of hexagonal market areas based on the assumption that firms will locate away from existing firms creating their own spatial monopoly. A firm may locate at point D, on the boundary to market A, B, and C. This process leads to smaller triangular market areas.

Figure 2.12 The Degeneration of Efficient Plant Organization.



Source: Raymond G. Bressler and Richard King. Markets,Prices and Interregional Trade. John Wiley and Sons Inc. New York: 1970, p. 143.

2.3.7. Corporate Limitations and Personal Considerations Affecting Locational Choice and Market Area

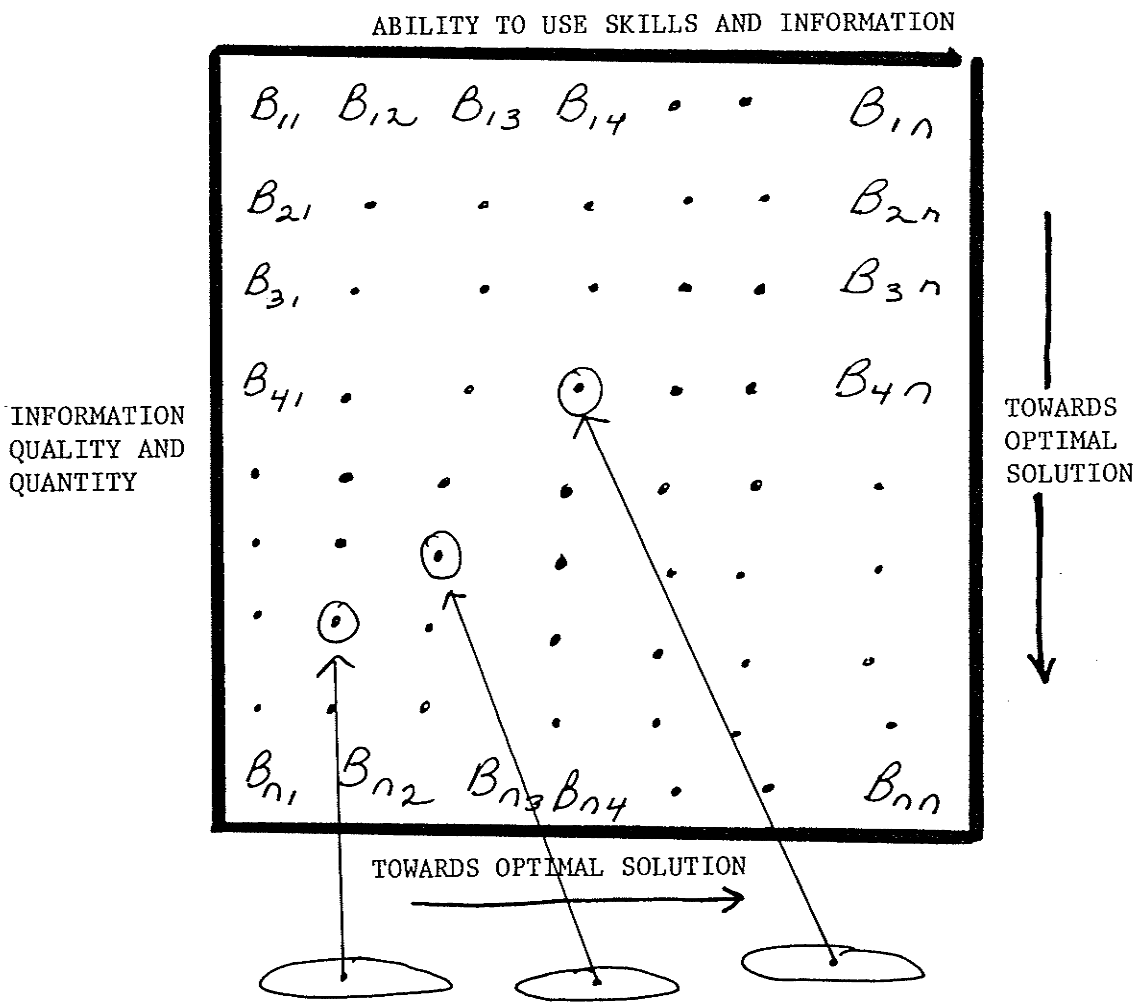
The models presented so far implied firms wished to maximize profits and had perfect knowledge. In reality, firms have limited knowledge and limited power to use any knowledge acquired. Furthermore firms may have goals other than profit maximization. As a consequence, less than optimum locations may be chosen by firms.

Allen Pred (1967) developed a behaviourial matrix to illustrate the effect of limited power and imperfect knowledge on location choice[14]. While the

[14]David Smith, op cit.

behaviourial matrix illustrated in Figure 2.13 has limited application, it is useful in conceptualizing how limited skills and the quality and quantity of information can affect decisions regarding the choice of location. How close a firm gets to choosing an optimal location may be dependent on the financial status and size of the firm. Larger firms may be better able to buy information or form departments specializing in data collection and capital investment analysis.

Figure 2.13 Behaviourial Matrix



Source: David Smith, Industrial Location Theory: An Economic Geographical Analysis. John Wiley and Sons Inc. New York: 1971, p.108.

Greenhut suggested that personal considerations of rational individuals may help explain why firms choose suboptimal locations. Rather than maximizing profits, managers or owners may wish to maximize personal satisfaction which has both a monetary and a psychic component. The psychic component could include utility associated with minimizing the risk of failure or with environmental concerns, both which are difficult to measure and model.

Not only are locational choices affected by personal considerations but so is the market area surrounding these locations. Devletoglou (1965) argues that it is unrealistic to think of markets having rigid boundaries, that in reality there is a doubtful area[15]. Within the doubtful area, consumers may be subject to a "fashion effect" and purchase from another firm. In an agricultural context, producers may patronize one particular firm for a variety of reasons such as tradition thus crossing "so called" market boundaries.

2.4. Relevance of Theory to Prairie Primary Elevator System.

The allocation of market area theory illustrates the development of the prairie elevator system and its spatial aspects. It also provides reasons for the ultimate degeneration of the current primary elevator system manifested in the pervasiveness of small inefficient elevators throughout the prairies. This in conjunction with an aging elevator system, changes in market function which reduced revenue sources, and higher input prices which raised operating costs, have forced grain elevator firms

[15] N.E. Devletoglou, "A Dissenting View of Duopoly and Spatial Competition". Economica, Vol 32, p. 158.

to rationalize their elevator systems. The spatial aspects of the market suggest that grain elevator firms must carefully scrutinize which elevators to close, if firms are to simultaneously minimize grain delivery and other sales losses, yet reduce operating costs.

Contestable market theory indicates that the size of investment is not an impediment to market entry. However, the theory does indicate that if the investment is sunk in nature, the opportunity for "hit and run entry" is diminished. The size of investment in elevator construction is not only sizeable but sunk in nature due to elevator immobility and few alternative uses. Consequently, it may be concluded that choice of location is also critical to elevator firms' decisions where to construct an elevator due to the long run economic implications of the decision.

The locational theory models presented assumed the primary goal of the firm was profit maximization. The discussion regarding the separation of management and ownership explains why profit maximization may not be a primary goal. Consequently, choice of elevator construction or closure points may be based on other goals such as 1) maximizing deliveries handled, 2) ensuring market coverage, 3) a show of market presence or 4) minimizing costs.

In the case of primary elevator firms, this separation may even be wider since United Grain Growers and Saskatchewan Wheat Pool went public selling shares to raise capital. Not only is there a separation of ownership and management but the composition of owners has been altered. The owners comprise grain producers and investors who possibly have conflicting objectives, such as maximizing producer prices versus maximizing investor dividends.

Other factors affect a firms decision where to locate. Interdependence locational choice models developed by Hotelling and Chamberlain imply sellers will choose locations that will give them the largest possible market area given the relative location of other firms. Hotelling's model suggests firms will cluster whereas Chamberlain's model suggests they will disperse. Analysis of the prairie elevator system indicates that both locational patterns exist. Consequently, firms that locate where other firms are located (cluster), would seem to perceive the market differently than those firms which disperse.

The tendency or behaviour to cluster or disperse may reflect a firm's marketing strategies. For example, a firm with an aggressive price marketing strategy may decide to locate at location sites occupied by competitors, hence clustering occurs. If the firm is aggressive, they may believe they can capture more of the market than if they passively shared the market. This could be accomplished by offering higher offboard grain prices, or higher Board prices through blending. The more grain delivered, the easier it is to mix grades and loads of varying dockage levels. In addition, per tonne elevator processing costs are reduced as grain volumes delivered increase. The advantage of the new entrant is that they can anticipate the capital requirements which would facilitate this strategy such as elevator size and number of car spots. The existing firm has sunk costs and cannot easily change in the short or medium run.

Alternatively, a firm may exhibit isolationist tendencies and wish to locate away from other firms and avoid direct competition. Chamberlain's model illustrating that firms would tend to locate away from one another may illustrate the behaviour of less aggressive grain companies that wish to avoid conflict. By spacing themselves, they are creating their own spatial monopoly over which they have some market power.

In the prairie elevator system, elevators at a delivery point are often located side by side. The cost to the producer of hauling the extra distance is negligible hence realistically a second firm can hope to capture a share of the market surrounding the delivery point. The same applies to the entry of a third firm. Because distances between elevators at one delivery point are small, transportation cost differences are negligible. Chamberlain's example of " pig in the middle" where one firm has no market would not occur as evidenced by grain data at points where three or more elevator companies compete.

The choice of location site may also be indicative of how a firm views its primary function. For example, some firms in the primary grain elevator industry may view themselves as primarily facilitators of grain movements whose activities include handling, elevation, cleaning and storage. These firms may be more inclined to locate away from other firms and locate at single elevator delivery points, as their earnings would be dependent on deliveries hence market size. Conversely, firms that perceive themselves as grain merchandisers may exhibit more aggressive behaviour and locate at multicompany points so as to directly compete with competitors. In the course of the study analysis, assessment of the class of point, single or multicompany points, companies construct elevators or close elevators may be indicative of various company strategies.

CHAPTER 3. RELATED STUDIES

Very few studies directly address the characteristics of delivery points where grain elevators or other agricultural collection industries choose to locate. Most of the literature pertained to agricultural processing industries and cost minimization as the principal criterion in determining market and site location. However, several studies pertaining to the grain handling industry are reviewed in this chapter as delivery point and market characteristics that may be considered in a grain elevator company's decision making process may be either inferred or deduced.

3.1. Rationalization and Investment in Agricultural Industries

Tangri et al. discuss the implication of elevator closures on the grain elevator companies[1]. In the late 1960s, the average distance between the farm and the country elevator was 5.5 miles in Manitoba illustrating the close proximity between elevators and the relatively small collection areas. As the functional role of the elevator changed from that of a storage/handling facility to predominantly a handling facility, the revenue generated from these small market areas was insufficient to cover costs. Concurrent inflation added to the cost burden. To reduce costs elevator companies traded elevators, each taking over the other's elevator and combining it with their own to run as one operating unit. This released labour and reduced taxes and administrative charges. Assuming that client patronage was not lost as a result of the trade, increased handlings also contributed to lower average costs. This

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[1]Tangri, D. Zasada and E.W. Tyrchniewicz. Country Grain Elevator Closures: Implications for Grain Elevator Companies. Res. Rep. No. 10, Centre for Transportation Studies, University of Manitoba, Winnipeg, Manitoba, January 1973

method of cost reduction was preferred to elevator closure as elevator capacity was not reduced and handling and storage revenues maintained.

The extent to which elevator system costs could be reduced through trades was limited. Tangri et al also determined that the operating cost of elevators were largely fixed and insensitive to the volume of grain handled. They estimated that salaries comprised 60 percent and taxes and insurance 20 percent of operating costs, and these costs did not vary with volume. Elevator closure did not appear to be the answer either as they estimated at that time that the elevator companies lost more in storage revenue than they would save on elevator costs if the elevator were closed. With the changing functional role of elevators, they suggest the solution appeared to lie in increasing elevator handling revenue. While closure of old elevators, rail line abandonment and trades contributed to larger market areas, it was apparent that further elevator closures were necessary.

Evidence of further elevator closure in the 1970s was provided by Alberta Wheat Pool (AWP) in a submission to the Canadian Grain Commission on primary and terminal elevator costs and charges. AWP reported they closed 189 operating units between 1974/75 and 1982/83. This resulted in significant cost savings to the Pool but they stressed that further consolidation would not generate savings of the same magnitude. They indicated that it is difficult to reduce costs at individual elevators as 90 percent of operating costs were fixed in the short term. On the revenue side, they indicated that storage revenues had declined to 10 percent of total grain revenues. This placed more emphasis on handling revenues and illustrated the importance of high throughput.

AWP stressed the importance of throughput to revenue indicating that their new country elevators were designed for high throughput, large storage capacities, larger car spots and higher capacity equipment. Also an increasing number of the their new elevators were constructed on private sites and private sidings built to accommodate 15 cars as existing rail sidings were usually not long enough to spot more than a few cars. They believed that expansion and installation of rail siding trackage will also be a major investment factor in the future.

Excessive plant capacity and the need for rationalization are not unique to the Canadian grain handling system. Casavant and Griffin describe the influences governing the development of the North Dakota grain elevator industry and its current rationalization. Like the Canadian grain handling system, the distance a horse and wagon could travel in a day influenced the pattern of North Dakota grain elevator and rail line development. The economic and technological forces that influenced development have changed and other economic and technological forces such as branch line abandonment, unit trains, improved roads and design and size of trucks have contributed to rationalization.

Casavant and Griffin indicate that

> rural grain elevators, whether cooperative or private, are concerned about the need for mergers or consolidation of both physical and business entities[2].

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[2] Ken Casavant and Gene Griffin. Structure and Operating Characteristics of the North Dakota Grain Elevator Industry. Upper Great Plains Transportation Institute Report No. 47. Agricultural Economics Report No. 166: Fargo, North Dakota, p.1. December 1983.

They also indicate that the trend is to construct larger elevators and that more of the new elevators are being built on main lines.

Chern and Polopolus indicate that excess capacity also exists in the orange processing industry. Despite excess capacity they point out that firms will continue to commit resources to construct new facilities:

> ...the current plant locations and plant numbers are excessive in relation to a long-run plan for industry efficiency in assembling and processing oranges in Florida. ... merger, consolidation and possible abandonment of some old plants will be necessary in the future. On the other hand establishment of new plants in some new locations is also appropriate[3].

3.2. Factors Affecting Grain Elevator Revenue and Costs

Elevator grain revenue is largely determined by the volume of grain producers deliver and store. Therefore, those factors which induce a producer to deliver to a point are critical to the economic survival of an elevator. A survey of Prairie grain producers by Deloitte, Haskins and Sells[4] indicated that there were two key determinants producers considered when selecting a grain company at which to deliver, 1) grain grading and dockage policy and 2) attitude and capability of elevator manager.

Grading and dockage policies are contingent on the projected volume of grain to be delivered to the proposed new elevator site. The more grain delivered, the

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[3]Chern, Wen-Fhyong and Leo Polopolus. "Discontinuous Plant Cost Functions: Modifications of the Stollsteimer Location Model" American Journal of Agricultural Economics. Vol 52, Nov. 1970. p. 585.

[4]Deloitte, Haskins and Sells. "Determination Of Features Considered By Farmers When Selecting A Grain Company". Winnipeg, January, 1984.

larger the pool of grain available to mix hence the greater the chance of realizing a flexible grading and dockage strategy. In a producer survey, Devine and Kulshreshtha report that producers indicated they would be willing to haul 5.5 miles further to get better grades and 4.8 miles further for better dockage[5].

Other determinants included competitiveness for nonboard grains[6], the speed with which grain is unloaded, availability of elevator space and accuracy of weighing facilities. The study reported that competitiveness for nonboard grains was becoming an increasingly important factor among younger producers when choosing the elevator point to deliver their grain. Since information concerning nonboard grain sales and revenues is largely confidential, it is unclear to what degree market power is exercised when setting nonboard grain prices.

Some producers indicated they would bypass the local elevator if the facility was slow to unload as distance was not as important as the waiting time. Weighing and unloading facilities to be installed and the size of elevator are also contingent on the projected volume of grain to be delivered. The relationship is circular. The size of elevator and scale are dependent on the delivery volume expected, but deliveries are affected by company pricing policies and facility capacity. Given that producers

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[5]D. Grant Devine and S.N. Kulshreshtha. Performance of Grain Elevators in Saskatchewan. Department of Agricultural Economics, University of Saskatchewan, Saskatoon, Saskatchewan, June 1979, p. 49.

[6]Nonboard grains include all grains other than wheat, durum and barley for export or domestic human consumption. Wheat and barley used in feed or an offboard grain.

have identified these features as important to their decision where to deliver their grain, it is assumed that volume, which inevitably dictates the success and the drawing features of an elevator, would be an important factor determining choice of building location.

According to the survey elevator proximity to other types of agricultural businesses was not important and producers were less sensitive to the proximity of local elevators given increased utilization of large trucks. In regard to this last point

> ..they could and would consider a range of delivery options based on anticipated grading and dockage policy, manager attitude, unloading facilities and competitiveness. Nevertheless farmers were cognizant of, and sensitive to, the time, distance and investment involved in longer delivery distances[7].

Assuming grain elevator companies are cognizant of these views, it would seem less emphasis would be put on building in towns and that adjacent grain companies must be viewed as direct competitors.

Elevator operating costs at a delivery point are important to the long term economic survival of a grain elevator. Consequently, it is critical to understand what factors affect costs as they in turn affect which elevators will be closed or where they will be constructed. Although traditional location factors such as availability and cost of inputs are considered in the decision where to locate a plant or elevator, these considerations are likely to be of lessor importance than the effect of capacity utilization and economies of size on elevator costs. Because large volumes of grain are shipped, capacity utilization (turnover rate) and economies of size can

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[7]Deloitte, Haskins and Sells. "Determination Of Features Considered By Farmers When Selecting A Grain Company". Winnipeg, January, 1984, p.ii.

significantly affect costs.

Russell Jeffrey estimated primary elevator average total costs as a means to assess the primary elevator system's economic performance. He regressed average total costs against the grain volume delivered, the turnover ratio, five dummy capacity variables, two dummy provincial variables and one dummy time variable. A log linear regression equation was derived[8] consequently, the coefficients are elasticity measures. The coefficients derived are as follows:

Intercept	5.4127
Volume	-.3523
Turn rate	-.2774
Log Year	-.0241
Elevator capacity	
6501-13000	-.1877
5001-6500	-.1766
4001-5000	-.1705
3001-4000	-.1452
2001-3000	-.1014
Province	
Saskatchewan	-.1397
Alberta	-.0333

If the volume or turn rate values were increased 1 percent, the average total costs would decrease .35 and .28 percent, respectively. The coefficients associated with each size of elevator indicate the cost savings of operating an elevator of that capacity relative to that of a 700-2000 tonne capacity elevator[9]. For example, an

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[8] J. Russell Jeffrey. " Economic Performance in the Western Canadian Primary Elevator Industry". Unpublished M.Sc. Thesis, University of Manitoba, 1985, p. 64.

[9] If all the dummy variables associated with elevator size assume a value of zero, the estimating equation represents the ATC for a 700 to 2000 tonne elevator. If the provincial dummy variables assume a value of zero, the ATC estimated are basis Manitoba elevators.

elevator of 2001-3000 tonnes is 10.1 percent less expensive to operate given the same turn rate. An elevator 3001-4000 tonnes is 14.5 percent cheaper to operate than a 700-2000 tonne elevator.

Based on these results, the volume of grain delivered appears to be the most important factor affecting elevator operating cost. Consequently, it is reasonable to assume that elevator companies look at total actual or expected deliveries in a market area in their decisions to close or construct an elevator.

The turn rate was the second most important factor in the model affecting average total costs. Obviously at an existing elevator, the turn rate is dependent on the size of the elevator and the volume delivered. At a proposed elevator site, the expected average turn rate would be based on assumptions concerning market share and the size of elevator to construct. Given elevator operating costs vary with the size of elevator, firms can choose the size of elevator that minimizes total costs. For example given the same turn rate, a 4000 to 5000 tonne elevator is 2.5 percent less costly to operate than a 3000 to 4000 tonne elevator. However, given a 1 percent increase in the turn rate yields a .28 percent decrease in ATC, a 10 percent increase in the turn rate would compensate for higher costs associated with building a smaller 3000 to 4000 tonne elevator.

3.3. The Effect of Transportation Costs on Location Choice.

Transportation costs are another major factor determining the size and location of plants. In location theory modelling, these transportation costs are usually divided into two categories, assembly and distributive costs. Assembly costs include the cost of loading and transporting the product to a plant which performs some type of processing function. Distributive costs are the cost of loading and forwarding the product either to points of consumption or additional processing.

Many raw agricultural materials are characterized as high volume/low value and perishable. As a consequence they are expensive to assemble. On the other hand, processed products are frequently low volume/high value and less perishable resulting in lower transportation costs per product unit value. As a result many agricultural processing plants will often locate near the area of production to reduce transportation costs. The dairy industry is one example of processing plants locating near points of production due to large assembly costs.

Based on the assumption that the milk plants paid the assembly costs, Olson developed a milk processing plant model to determine the number and size of milk processing plants as well as the distance between plants given a fixed milk supply and uniform transportation costs per hundredweight of milk[10, 11]. He found assembly and processing costs diverged. As the number of plants increased, the size of the collection area or market for each plant decreased, therefore assembly costs decreased. Processing costs increased as there were diseconomies of size associated with smaller plants. Consequently, the optimum number, size and location of plants were jointly dependent on assembly and processing costs.

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[10]Fred L. Olson. "Locational Theory as Applied to Milk Processing Plants". Journal of Farm Economics. December, 1959. pp. 1546-1555.

[11]The prices of the finished products at numerous market locations were assumed to be equal with zero transportation costs.

While assembly costs are important economic variables in analyzing of system efficiency, it is important in location site choice to determine 'who pays the assembly costs'. Ahmed A. Araji and Richard G. Walsh [12] indicate that previous studies determining the least cost grain elevator size did not include assembly costs. This is because grains are priced f.o.b. the elevator and assembly costs are incurred by producers and not elevator companies. Consequently, the authors of these previous studies assumed assembly costs do not enter grain companies' decisions in choice of location or even size of the elevators.

While grain elevator companies may not consider assembly costs in their cost profile, it cannot be presumed that grain companies do not consider assembly costs in their decision where to locate. Assuming hauling distance and assembly costs are correlated, there is some point at which producers' assembly costs would prohibit delivery to an elevator consequently defining market boundaries. This is supported by the Deloitte survey which indicates that farmers are sensitive to the time, distance and costs involved in hauling grain longer distances.

3.4. **Investment Strategies**

Many types of investment strategies have been examined to determine the linkage between investment and market structure and performance. Gilbert and

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[12] Ahmed A. Araji, and Richard G. Walsh, " Effect of Assembly Costs on Optimum Grain Elevator Size and Location". Canadian Journal of Agricultural Economics. Vol 17. 1969: pp. 36-45.

Liberman[13] and Deily[14] used investment behaviour to predict the probability of various events occurring.

Gilbert and Lieberman examine investment by firms in the chemical products industries to determine whether firms invest preemptively to increase market share or whether they invest to maintain market share. Preemptive investment presumes that a firm's investment acts to delay or deter investment by rival firms. By investing first either in a product market or spatial market, the first firm is signalling other firms that they may sustain losses if they contest the market. If preemptive investment is successful, the investing firm will increase their market share but their investment will not stimulate investment by other firms which could lead to excess capacity. A logit model was developed to determine if these investment behaviours could be identified in the chemical products industries.

They concluded that preemptive investment delayed rival investment but the effect was not persistent. Preemptive investment behaviour also enabled a firm to increase their market share but this strategy could not be used as an on-going basis to increase market share. Larger firms tended to invest when market share began to drop in order to maintain market share. On the other hand, smaller firms tended to follow the investment activity of other firms, which Gilbert and Lieberman call "jumping on the band wagon".

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[13]Richard J. Gilbert and Marvin Lieberman. "Investment and Coordination of Oligopolistic Industries" Rand Journal of Economics. Vol 18, No 1, Spring 1987.

[14]Mary E. Diely. "Exit Strategies and Plant-Closing Decisions: The Case of Steel", Rand Journal of Economics. Vol 22(2), 1991, pp 250-263.

An investment strategy similar to preemptive investment, mimicry, is discussed by Eaton and Lipsey. Also called positioning, an incumbent firm in a market area can deter entry of other firms by building a new plant before the old one is expected to be replaced. The premise behind the positioning strategy is that the market cannot economically support two plants, particularly in a contracting industry.

3.4. Summary

In summary, these studies have pointed out several delivery point and market characteristics elevator companies may consider in their decisions to close or construct an elevator. The single most important characteristic was volume of deliveries as it affects both revenue and costs. Elevator capacity was also identified as important to cost determination and the revenue earning potential of an elevator. In terms of elevator closure, the volume received at a delivery point in conjunction with the size of elevator and resulting turn rates would be assessed. At proposed construction sites the size of elevator and turn rate which would minimize ATC given expected market volume are not, of course, already pre-determined and also enter into the analysis.

Other factors such as dockage and grading policy and price competition for nonboard grains have become increasingly important to the choice of elevator to deliver. On the other hand, the proximity to the nearest elevator has become less important, particularly as the size of farm trucks increases. It follows that road quality and access would be important to elevator deliveries and therefore on the decision of where to construct a new elevator.

The fact that producers are showing an increased willingness to drive beyond the nearest elevator would imply the area of competition is widening. Competing elevators are not limited to those at the same point but must be expanded to include those in the surrounding market area. Cognizant of their competitors, various marketing strategies may also be employed in the decision where to construct an elevator, as incumbent firms attempt to maintain market share and other firms attempt to increase market share by preempting incumbent plans for future construction.

Due to the bulky nature of grain and distance to ocean ports, rail transport remains the most economical mode of transport. Given the uncertainty concerning rail line abandonment, companies may be more inclined to build elevators on main lines or branch lines they feel confident will not be abandoned.

CHAPTER 4. HISTORICAL DESCRIPTION AND APPLICATION OF MARKET THEORY TO THE WESTERN CANADIAN PRIMARY GRAIN ELEVATOR SYSTEM

4.1 Structure of Primary Grain Handling System

The Canadian prairie primary elevator handling system (PES) is spread over an extensive area so as to accommodate approximately 130,000 farmers who as of 1994 delivered to over 1400 licence elevators. While agriculture is frequently portrayed in a perfectly competitive framework, the primary elevator system is oligopolistic as there are few firms with strategic interdependence between them.

4.1.1. Market Concentration

The number of firms owning primary elevators declined from 66 in 1912 to 19 in 1994. However, eight companies, AWP, SWP, MPE, UGG, Cargill, Pioneer, Paterson and Sons, and Parrish and Heimbecker Ltd own 98.6 percent of the total primary elevators in the prairies. Three of these companies do not compete with each other as they operate strictly in the province which their name designates. Consequently, six elevator companies own most of the elevators within each prairie province. The first four companies, producer cooperatives[1], operate over 70 percent of the PES elevators located in Manitoba, Saskatchewan, Alberta and the Peace River region of British Columbia.

Table 4.1 lists the number of elevators each company operated within each

[1] SWP and UGG are now public companies.

Table 4.1 Number of Elevators by Company by Province, August 1994.			
Company	Manitoba	Saskatchewan	Alberta
Alberta Wheat Pool	--	--	256
Cargill	17	38	28
Manitoba Pool Elevators	137	--	--
Parrish and Heimbecker	1	12	15
Paterson and Sons	24	21	1
Pioneer	7	130	38
Saskatchewan Wheat Pool	--	423	--
United Grain Growers	56	96	89
Other Companies	9	7	4
Total	251	727	431

Source: Canadian Grain Commission. Grain Elevators in Canada. 1994/95 Minister of Supply and Services Canada, Winnipeg: 1994.

province. In terms of the number of elevators operated, SWP is the largest grain company on the prairies followed by UGG, AWP, Pioneer, MPE, Cargill, Paterson and Sons and Parrish and Heimbecker. Within the prairie provinces, the three Pools are the largest local grain elevator companies.

In 1971/72 there were 765 single company points and 1070 multicompany points, 42 and 58 percent of the total points, respectively. However, the sale of Federal Grain to the three Pools reduced the number of multicompany points. Pool elevators were combined with Federal Grain elevators and functioned as one operating unit. As a result of the sale transaction, there were 1040 single and 788 multicompany points in 1971/72[2], single company points comprising 57 percent of the total delivery points.

By 1989/90 due to railway and elevator rationalization, the total number of delivery points declined to 1005, 557 single company points and 448 multicompany points. The proportion of single company points had dropped slightly to 55 percent of the total number of delivery points. As many of the multicompany points became single points, this indicates that more single company points were closed than multicompany points[3].

During the 1989/90 crop year approximately 1567 elevators were located at 1005 primary elevator grain delivery points or stations. Table 4.2 lists the number of single, double and triple + company delivery stations located in each province. Proportionally, Manitoba has more single company points than Alberta and Saskatchewan. The distribution of each company's elevators between single and multi-company points by province is shown in Table 4.3. With the exception of Alberta Pool Elevators and Manitoba Pool Elevators, each company has more elevators at multi-company points than single company points. The average number

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[2]O.P. Tangri, D. Zasada and E.W. Tyrchniewicz. Country Grain Elevator Closures: Implications for Grain Elevator Companies. Res. Rep. No. 10, Center for Transportation Studies, University of Manitoba, Winnipeg, Manitoba, January 1973, p.8.

[3] Between 1971/72 and 1989/90, 823 delivery points were closed, the number of single points declined by 490 and the number of multicompany points by 333.

Table 4.2 Number of Single, Double and Triple Delivery Points, by Province, Crop Year 1989/90.					
Province	Single	Double	Three and More	Total	Single Pt as a Percent of Total
Manitoba	116	54	13	183	63.4
Saskatchewan	263	213	47	523	50.3
Alberta	171	92	36	299	57.2
Total	550	359	96	1005	54.7

Source: Data acquired from Canadian Grain Commission. Grain Elevators in Canada. 1990/91 Minister of Supply and Services Canada, Winnipeg: 1990.

Table 4.3 Location of Grain Companies at Single and Multi Company Elevator Points, By Province, Crop Year 1989/90.						
Company	Manitoba		Saskatchewan		Alberta	
	Single	Multi	Single	Multi	Single	Multi
Alberta Wheat Pool	-	-	-	-	135	125
Cargill	2	15	23	32	5	23
Man. Pool Elevators	75	59	-	-	-	-
P. and H.	0	2	0	13	2	15
Paterson and Sons	10	15	2	24	--	1
Pioneer	4	4	23	126	10	33
Sask. Wheat Pool	-	-	216	256	-	-
U.G.G.	22	44	16	99	15	87
Other Companies	3	5	0	4	1	10

Source: Data acquired from Canadian Grain Commission. Grain Elevators in Canada. 1990/91 Minister of Supply and Services Canada, Winnipeg: 1990.

of elevators at multi-company points is 2.1, 2.1 and 2.3, respectively, for Manitoba, Saskatchewan and Alberta. The number of single company points as a percent of total delivery points for each company is represented is presented in Table 4.4.

The proportion of each company's elevators located at single and multi-company points may signify each company's competitive strategy which may differ by province depending upon their competitor. For example, Cargill has 88 and 82 percent of their elevators located at multi-company points in Manitoba and Alberta, respectively, whereas in Saskatchewan they have only 58 percent of their elevators located at multi-company points. Depending on who was at the point first, it may be that Cargill is more leery of competing with SWP head on than it is with AWP or MPE. Alternatively, this pattern may be indicative of the location of National Grain elevators as Cargill purchased National Grain's elevator system in 1972. United Grain Growers has a high percentage of elevators at multi-company points in Alberta and Saskatchewan, 85 and 86 percent respectively, and a lower percent in Manitoba, 67 percent.

Within each province, the three provincial cooperatives have the most extensive elevator network. In terms of percentage of total elevator points covered in each province, Table 4.5 showed MPE is present at 73 percent of the delivery points, AWP 87 percent and SWP 90 percent. Given the extensive coverage of the three cooperatives, it may be difficult for the other companies to find suitable unique points at which only they would be located. MPE's low market coverage may explain why UGG is able to locate at more single company points in Manitoba than in

Table 4.4 Multi Company Points as a Percent of Total Company Delivery Points, Crop Year 1989/90, by Company.			
Company	Manitoba %	Saskatchewan %	Alberta %
Alberta Wheat Pool	--	--	48
Cargill	88	58	82
Man. Pool Elevators	44	--	--
P and H	100	100	94
Paterson and Sons	60	92	100
Pioneer	50	85	77
Sask. Wheat Pool	--	54	--
U.G.G.	67	86	85
Other Companies	62	100	91

Source: Data acquired from Canadian Grain Commission. Grain Elevators in Canada. 1990/91 Minister of Supply and Services Canada, Winnipeg: 1990.

Table 4.5 Primary Elevator Market Coverage of Provincial Grain Cooperatives, Crop Year, 1989/90.					
Provincial Cooperative	Number of Pool Coop Elevators A	Number of Total Elevators B	Number of Delivery Points C	Percent Pool Elevators A/B	Percent Pool Coverage A/C
Manitoba	134	260	183	52	73
Saskatchewan	472	836	523	56	90
Alberta	260	462	299	56	87

Alberta or Saskatchewan. The market coverage for the three provincial grain cooperatives are shown in Table 4.5.

4.1.2. Vertical Integration and Barriers to Entry

The grain companies are also forward vertically integrated. The grain collected on the prairies is funnelled to port terminals in Vancouver, Thunder Bay, Churchill and Prince Rupert where the grain is cleaned and graded to export standard prior to shipping. Seven of the eight major primary grain elevator companies own and are licensed to operate terminal elevators at these locations. Table 4.6 lists the companies licensed to operate at the various port locations. AWP, SWP, MPE, UGG, Cargill and Pioneer also have a joint venture in the Prince Rupert Consortium and the three Pools in Pacific Elevators Limited in Vancouver. The Pools have also formed cooperative ventures in other areas such as 1) processing- XCAN an export company and CSP Foods, a canola crushing plant, 2) producer inputs- Western Cooperative Fertilizers Limited and 3) policy development and promotion- Prairie Pools Incorporated.

Due to extensive horizontal and vertical integration, it is difficult for new entrants to contest either the primary grain handling or terminal handling markets unless they provide very specialized services[4]. The potential entrant would have to purchase or build a network of primary elevators, otherwise they could not acquire enough grain to operate terminal facilities, given other companies own their own

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[4] Stow Seed Processors Ltd, Johnson Seeds Ltd, and Canbra Foods Ltd are examples of companies serving a specialized market.

terminal facilities. In addition, they could not economically operate a primary elevator network without terminals as terminal earnings have long subsidized primary

Table 4.6. Grain Elevator Companies Licensed to Operate at Port Terminal Locations.	
Location	Licensee
Thunder Bay	Cargill Limited Manitoba Pool Elevators No. 1 Manitoba Pool Elevators No. 3 Parrish and Heimbecker Limited Richardson Terminals Limited Saskatchewan Wheat Pool No. 4 Saskatchewan Wheat Pool No. 7 United Grain Growers Limited A United Grain Growers Limited M
North Vancouver	Pioneer Grain Terminal Limited Saskatchewan Wheat Pool
Vancouver	Alberta Wheat Pool Pacific Elevators Limited United Grain Growers Limited
Prince Rupert	Prince Rupert Grain Ltd

Source: Canadian Grain Commission. Grain Elevators in Canada:Crop Year 1994/95. Minister of Supply and Services: Ottawa: 1994

elevator losses. The large capital investment required to invest in such a venture coupled with the sunk cost of the assets, discourages new entrants.

Other factors such as locational and institutional constraints also restrain entry. The north shore of the port of Vancouver[5] is crowded and has little room for additional terminal elevators or even space required to marshal rail cars. Institutional restrictions such as bonding insurance may also restrict business. The Canadian

[5] CN Lynn Creek yard.

Grain Commission does not require the larger grain companies with financial depth to be bonded to the full extent of their outstanding business activities giving them an advantage.

Consequently, the primary grain handling industry has only been contested by participants already in the PES. These participants have established terminal operations or arrangements whereby grain acquired on the prairies can be forwarded to the port. Bonds and licences are also in place as is the administrative network. Existing participants in the PES also have an immediate advantage in terms of better knowledge and know how.

4.1.3. Excess Capacity and Economies of Size

Congestion of the elevator system in the late forties and early fifties and earnings from grain storage spurred elevator and annex construction. Building continued through the sixties and peaked in 1970 at a capacity of 11.17 million tonnes. However, the termination of the Temporary Wheat Reserves Act and the introduction of a modified quota system, emphasizing on-farm storage reduced the need for elevator storage. As a result there was excess elevator capacity in the system.

Evidence of excess capacity in the PES is indicated in Table 4.7. Over the eleven year period 1978/79 to 1989/90 total elevator capacity fell from 9.06 million tonnes in 1978/79 to 7.13 million tonnes in 1989/90, a decrease of 21 percent yet elevator companies were able to handle 29.25 million tonnes in the 1989/90 crop year, a 38 percent increase in volume over the period.

Table 4.7 Elevator Turnover Rates, by Province.						
Year	Province	Elevator Numbers A	Total Capacity (000,000) B	Average Capacity B/C	Avg 10 Yr Deliveries 1978/79-1988/89 (000,000) D	Turnover D/B
1978/79	Manitoba	417	1.19	2825	3.13	2.66
	Sask.	1915	4.68	2443	12.16	2.60
	Alberta	1174	3.11	2647	5.70	1.83
	B.C.	22	.10	4373	.21	2.15
	Prairies	3528	9.06	2568	21.19	2.34
1989/90	Manitoba	272	1.07	3943	4.76	4.44
	Sask.	857	3.46	4040	15.42	4.45
	Alberta	478	2.52	5282	8.82	3.49
	B.C.	12	.07	5733	.25	3.63
	Prairies	1619	7.13	4403	29.25	4.10

Source: Data derived from Canada Grain Commission, Grain Deliveries at prairie Points Crop Year 1978/79 and 1988/89.

As the elevators' function changed from being a storage/handling facility to a handling/storage facility, spatial market expansion became critical as companies needed additional volume, to increase handling revenues. Elevator unit costs also needed to be reduced as handling revenues and nonboard grain sales in many locations were inadequate to cover costs. As a consequence, the overdeveloped primary elevator system was rationalized during the seventies and eighties thereby increasing average elevator market area. Older elevators which reached the end of their economic life and other obsolescent elevators having inefficient scales and inadequate car spotting capacity were rationalized. Smaller elevators were also closed as they used labour, investment capital and utilities less efficiently. Older, obsolescent, smaller elevators were often one and the same as age and technical and economic obsolescence are highly correlated as are age and size of elevator. Evidence that the grain companies closed smaller elevators is shown in Table 4.8. Despite a decrease in total elevator capacity, average elevator capacity increased substantially between 1978 and 1990.

Table 4.8. Elevator Size and Capacity, By Province.

	Prairies	Man.	Sask.	Alta	B.C.
1978 Average Capacity Tonnes	2477	2641	2363	2569	4373
1978 Number Elevators	3658	446	1980	1210	22
1990 Average Capacity Tonnes	4403	3943	4040	5282	5733
1990 Number Elevators	1619	272	857	478	1
Percent Change Average Capacity	+78	+49	+71	+106	+31
Percent Change Elevators	-56	-39	-57	-61	-46

Source: Data derived from Canadian Grain Commission, Grain Elevators in Canada. Crop Year 1978/79 and 1990/91.

Since the number of new elevators built was insignificant relative to the number of closures, average capacity could only increase if smaller elevators were closed.

Alberta had the lowest average deliveries per elevator of the three prairie Provinces. In 1978/79, average deliveries per elevator, based on ten year average deliveries were 4850, 6350 and 7500 tonnes for Alberta, Saskatchewan and Manitoba, respectively. Alberta's lower average elevator deliveries were partially due to intensive livestock feeding. But by 1988/89, Alberta's average deliveries per elevator were slightly higher than for the other to provinces as Alberta closed proportionally more elevators than the other two provinces. The average deliveries per elevator for Alberta, Saskatchewan and Manitoba were 18,450, 18,000 and 17,500 tonnes, respectively, Table 4.9.

Inspection of the 1988/89 statistics in Table 4.7 indicates that the turnover rate improved in all three prairie provinces as elevators were rationalized and production increased. Table 4.9 highlights the changes that took place over the ten year period. Saskatchewan had the highest turnover rate and largest improvement in turnover rate followed by Manitoba and Alberta. Approximately .91 of Saskatchewan's 1.85 improvement in turnover rate can be attributed to elevator and annex closure[6] as Saskatchewan removed 26 percent of its total elevator capacity. In comparison, Alberta and Manitoba reduced 19 and 9 percent of their elevator capacity, thus raising their turnover rate .43 and .26, respectively. Approximately .94, 1.23 and 1.52 of Saskatchewan's, Alberta's and Manitoba's turnover rate can be attributed to increased total deliveries. Although Alberta's average elevator deliveries increased tremendously, their elevators were large thereby reducing their overall turnover rate.

[6] The portion of the turnover rate attributed to rationalization of elevator space was calculated by dividing 1978/79 total deliveries by 1988/89 elevator capacity.

4.2. Market Conduct and Limitations on Primary Grain Handling Companies Decision Variables

The presence of only 9 firms theoretically accords each firm some degree of market power in determining price and the level of output which maximizes profit.

Table 4.9 Changes in Turnover, Average Deliveries and Capacity, by Province over the Period 1978/79 and 1988/89.

	Alberta	Sask.	Manitoba
Percent Change in Elevator Numbers	-59.3	-55.2	-34.8
Percent Change in Total Capacity	-18.8	-26.0	-9.0
Percent Change in Total Deliveries	+54.8	+26.8	+52.1
Average Turnover 1988/89	3.49	4.45	4.44
Improvement in Turnover	1.66	1.85	1.78
Average Deliveries per Elevator 1988/89 (tonnes)	18450	18000	17500

Source: Derived from Table 4.7.

Theoretically, the spatial aspects of the PES should also provide some degree of spatial monopoly hence market power. In terms of the PES, handling and storage rates and nonboard grain prices could generally be regarded as the elevator companies price decision variables. However, the extent to which they can exercise pricing power to increase their financial returns is limited by their functional role, institutional constraints and competition.

The principal activity of most grain elevators is grain handling and storage. Although most elevator companies do purchase nonboard grains on their own behalf, the revenues earned from this activity are only a small percentage of total revenues.

Mike Wakefield, Chief Commissioner for the Canadian Grain Commission compared the functional role of Canadian country elevators with those in the United States[7]. He indicated that Canadian grain elevator companies receive most of their revenue from handling tariffs whereas grain merchandising was the principal revenue source of their U.S. counterparts.

Insofar as institutional constraints are concerned, the Canadian Grain Commission (CGC) sets the maximum tariffs elevators are able to charge. Elevator companies must file with the CGC the tariffs they will charge at each elevator point. The tariff charged at any point can differ from that at other operating points. However, once the tariff for each point has been established, the elevator cannot discriminate between producers as to the rate charged at that point. Companies are, therefore, unable to charge lower rates to producers at the periphery of their market area in order to encourage delivery to the elevator. While discriminatory tariffs are not allowed, the constraint it imposes is a mute point as the companies offer the same tariff for services province wide.

Generally firms' decisions to lower prices are partially influenced by the elasticity of demand for their services and the firms' cost functions. For instance, total revenue will only be increased if the increase in expected deliveries from a price decrease exceeds the drop in price. Therefore, the firm must determine if a drop in price can increase revenue while simultaneously reducing per unit costs through

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[7] Mike Wakefield. "Primary and Terminal Elevators". Conference on Keeping Canada Competitive: Winnipeg, Manitoba, Date Unknown (approximately 1990).

increased throughput.

The assumption that price changes will not be matched by competitors is unrealistic as it does not recognize the strategic interdependence of each firm's pricing policy. If one firm's downward price adjustment reduces the volume of grain delivered to the surrounding elevators, the competitors will experience a decrease in revenue earnings as well as an increase in their per unit costs. Consequently, one firm's downward price adjustment would usually force other firms to similarly adjust their price downward in order to maintain their market share.

The theory behind the allocation of market areas discussed previously in Chapter 2 explains why competing firms with homogenous products and services must adjust their prices according to competitor price adjustment if they are to maintain their market[8]. In the case of the PES, each elevator's market is the producing territories delivering to that elevator. The theory assumes that sellers (producers) are rational, profit maximizers and that given free choice, sellers will deliver to the market that gives them the highest site price[9]. Based on the principle of free choice, the boundary between two market areas is the locus of points where the site price

[8] The assumption of homogeneous products or services means the consumer will derive the same utility from the product regardless of the seller from whom the product is purchased. However, if the consumer must expend cost or effort in taking possession of the homogeneous product(aside from the price of the product), the firms' products become differentiated in location.

[9] The site price is defined as the base market price less any transfer costs required in getting the product to market. In the case of grain delivered to elevators, the site price is the quoted port price less rail, handling and elevation charges and trucking costs from the farm to the elevator.

between competing markets is equal. Producers located at this point are indifferent as to which market they deliver. Hence any change in tariffs or prices will alter the market boundaries stressing the strategic interdependence between firms.

This behaviour of firms adjusting rates to competitors' rate levels is discussed by Jeffrey[10]. A review of tariff filings with the CGC indicated that 1) firms tend to file similar tariffs and 2) in situations where firms' tariffs deviated from the industry level, the firms refiled, adjusting their tariffs to conform to the industry level. Analysis of the firms who refiled their handling tariffs indicates that none of the three prairie cooperatives had ever adjusted their tariffs through the crop year. Jeffrey concluded that SWP appeared to be the price leader across the prairies. The other two cooperatives, AWP and MPE would in turn file their tariffs which generally guide those rates charged by the remaining companies.

Generally, terms such as price leadership, conjure up suspicions of tacit price collusion and excess profits. Shephard[11] submits that tacit collusion is more likely to arise when industry concentration is high, costs and demand stable, the product homogeneous and there exists a long industry experience. With the exception of stable costs and demand for services, the conditions Shephard outlines describe the PES. While, price leadership may exist in the PES one cannot conclude that excess

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[10] J. Russell Jeffrey. Economic Performance in the Western Canadian Primary Elevator Industry. Unpublished M.Sc. Thesis, University of Manitoba, Winnipeg: 1985.

[11] William Shephard. The Economics of Industrial Organization. Prentice-Hall: New Jersey, 1979, p.286.

profits are incurred. The elevator companies claim that competitive handling tariffs result in losses at many elevator points as the tariffs are less than the cost/tonne of running the elevator. In many instances, this has been a contributing factor to the rationalization of the elevator system as elevators experiencing losses over time are closed. Some elevators continue to operate as long as the handling revenues cover some portion of fixed costs since the grain received contributes to terminal earnings. The extent to which the elevator companies are able to support elevators operating at a loss depends on the ability of the remaining primary elevators and terminal earnings to cross subsidize them.

In the early oligopoly models developed [Cournot, Stackelberg], the quantity of output produced by the firm was a decision variable. However, the quantity of output or the volume delivered to an elevator company (V) is not solely a firm decision variable[12]. Rather the quantity delivered, V, is dependent on the sum of individual producer deliveries, v_i, who individually choose where to deliver.

$$V = f(v_i) \qquad (1)$$

where i = 1,2....n, i is the individual producer's delivery volume.

If elevators do not directly determine their quantity of output, and are restricted over a crop year as to the "price level" they set for their services, one may ask how do the elevator companies gain financial control? In the past, they have

[12] The volume of grain handled is a target variable. Companies can set goals regarding the volume of grain they wish to receive and take steps to achieve those goals. Discretionary price techniques and premiums are examples of ways which firms can entice farmers to deliver.

tried to influence other pecuniary and nonpecuniary factors that affect farmers choice of elevator. Factors affecting farmers' choices aside from handling rates include price offered on nonboard grains, flexible grading and dockage, patronage dividends, ancillary services such as farm supplies sold and elevator space.

Offering cooperative patronage dividends as a means of enticing farmers to deliver to cooperative elevator points appears to have mixed results. Deloitte, Haskins and Sell in their study for UGG indicated

> Dividends were a sore point with farmers, particularly younger farmers. The promise of "jam tomorrow" was an empty promise for the younger producer and the producer with a tight cash flow. Having to pay tax immediately on the imaginary benefit only rubbed salt into the wound.
>
> Older producers had a more sage attitude towards dividends. All other things being equal " they would deliver for the dividend".

The elevator companies have also tried to increase their output by distinguishing the ancillary services provided. Provision of farm supplies, particularly herbicides and fertilizers is one example. However prices must be competitive as farmers interviewed by Deloitte, Haskins and Sells[13] indicated that their decision where to purchase farm inputs was not necessarily predicated by where they delivered their grain but by who offered the best price.

Depending on a firm's grading and dockage policy, firms can frequently offer enhanced prices to entice current and future deliveries and loyalty. Elevator managers can blend 1) damp grain with dry grain yielding a mixture whose average

[13] Deloitte, Haskins and Sells. "Determination Of Features Considered By Farmers When Selecting A Grain Company". Winnipeg, January, 1984, p. i.

level of moisture is within acceptable export standards, and 2) different grades to achieve a grade which commands higher price. Grains with different levels of dockage can also be mixed to arrive at average dockage levels which are within the tolerance for the grade. This blending of grain allows companies to offer better prices on some grains.

To circumvent the CGC regulations of nondiscriminatory handling rates, some firms have offered trucking premiums to encourage producers on the fringes of their market area to deliver grain. The grain companies have also tried with limited success to organize multiple car shipments to obtain freight rate savings[14].

The extent to which discretionary pricing, farm input sales, trucking premiums and variable freight rate breaks distinguish one elevator company from another is not known. However, the practices are widespread amongst all the companies. It is possible that attempts by each firm to differentiate its services in order to increase market share have been thwarted by the actions of competitors.

Cost minimization is also a goal of many firms as they can improve their financial position through cost control measures. Due to market and institutional restraints which restrict grain elevator companies' abilities to control earnings through price and output, cost cutting measures play an important part in their financial survival. As indicated previously, one method of reducing costs is to close old small

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[14] CN and CP Rail offered " variable rates" or "incentive rates" to elevator companies, if elevators guarantee that at a single delivery point they could load within 8 to 24 hours, a specified number of cars or tonnes with a single destination. For example in 1994/95, CP offered reductions of $1.00 to $1.50/tonne on shipments over 45,000 tonnes.

elevators. However, the extent firms are able to incorporate other cost control measures depends on a number of factors.

Fixed costs accrued by an elevator include asset depreciation, interest on investment, taxes, building insurance and overhead expenses (administration). The greater the proportion of fixed costs to total costs, the more difficult it is for firms to minimize total costs in the short run.

In addition to fixed costs, elevators incur quasi-fixed costs that are difficult to reduce. For instance, elevator labour although often categorized as a variable cost is really a quasi-fixed cost in that an operator is required regardless of whether the elevator accepts one tonne of grain or thousands of tonnes. Elevator firms, however, have had some success in reducing the cost of manager salaries by trading elevators at two or more operating points so that one manager can manage more than one elevator at each point.

In terms of reducing network costs closing an elevator is sometimes not a viable option. Only taxes, licensing, building insurance and administrative cost would be saved. The decision depends on which alternative minimizes costs in the long run either operating or closing a point.

In those situations where network losses could be reduced by closing elevators, divesture options are limited due to the nature of the capital asset. Elevators are examples of durable capital that are relatively infungible as the demand for these durable, largely immobile and inflexible assets is limited. The sunk nature of these assets also constitutes another barrier to entry. The following anecdote expresses the problem faced by elevator firms and prospective new entrants with respect to investment and divestment decisions.

> An old timer tells about coming to a long stretch of unimproved country road with his new Model T in early spring. At the side of the road was a sign which obviously had been placed there by someone coming in the opposite direction. It read ' Choose your ruts carefully you'll be in them for the next thirty miles.

4.3. Rail and Road Network Affecting Elevator Location and Market Area

The railway system comprises a network of main, secondary and branch lines. The Canadian National and Canadian Pacific main lines followed a direct route between major developing centres. Secondary and branch lines were also built to service smaller rural agriculture and other primary resource based communities throughout the prairies. In addition, railways also facilitated the growth of communities alongside the tracks as rail was the only major means of transportation besides the horse and buggy. These rail lines do not follow any pattern and transect the prairies from all angles. As most grain is moved to export position via the railway, the primary elevator system developed along the railway. As of 1985, there was 18,700 miles of prairie railway track.

The development of the prairie road network has its origin in the method which land was surveyed. Land is identified according to sections of 640 acres and townships of 36 sections. The lines dividing the townships and sections have a north-south and east-west orientation parallel to the longitude and latitude measures. Each township consists of six sections stretching north-south and six stretching east-west resulting in a square configuration. The sections were similarly divided, each comprising four quarter sections of 160 acres. As a consequence of the rectangular land parcels, a rectilinear roadway network was developed with roadways every two miles or less to access each section.

The provincial highway system in each of the three prairie provinces follows the major rail lines, hence they are found to obliquely traverse the provinces. While the municipal road system is rectilinear and conducive to a square shaped market area, the oblique orientation of the rail lines and the highway network alter market boundaries which deviate from the uniform shaped market areas that might be expected. In total, provincial and municipal roads comprise a network of approximately 250,000 miles

The subsidized rates charged until August 1, 1995 for movement of statutory grains to export position also affected the size and shape of market areas. The rail rates charged did not reflect the cost of transportation after 1960, hence on-farm grain prices exceeded their real value. This distorted the comparative advantage of livestock feeding and oilseed processing and increased the amount of export grain available in each primary elevator's market catchment area.

4.4 Summary

A review of the PES indicates that the monopolistic power often associated with spatial monopolies is waning in the prairie elevator system. This is partially due to a trend towards larger farm trucks and an improved road system which permit producers to bypass the nearest elevator; this will be strengthened by the end of the subsidy on rail transport effective August 1, 1995.

The change in elevator and elevator company function, from a storage and handling facility which charged tariffs regulated by the CGC, to a handling facility whereby the companies have also become increasingly active in purchasing and processing nonboard grains on their own behalf, has also contributed to increased competition. To attract a larger share of grain from the market, companies attempt to implement flexible grading and dockage policies and offer competitive nonboard grain prices. Producers can often obtain higher prices which outweigh the additional cost of transporting grain to more distant elevators, if they spend the time and expense involved in the search. As a result, the number of competing elevators and the capacity of the elevators in a market area are important to the economic viability of an existing elevator and to the location of new elevators.

The most important underlying market characteristic to the economic viability of an elevator or points at which elevators will be located is the volume of grain that can be delivered for export. It is volume which affects revenues and average costs per tonne, as well as the volume which affects each company's ability to implement a flexible grading and dockage policy.

The statistics indicate that more single points have been closed in the seventies and eighties than multicompany points and the trend has been to close smaller elevators. The data also indicates that elevator construction by non-Pool elevator companies is more likely to occur at multicompany points, particularly in Saskatchewan and Alberta.

Due to extensive horizontal and vertical integration in the grain handling industry, it would be difficult for new entrants to successfully compete with current grain handling companies. Consequently, current and future competition can be assessed in context of existing grain elevator companies.

Finally, due to the immobile, durable and infungible nature of elevators, companies may not close elevators operating at a loss if fixed costs are partly covered, particularly if the elevators are newer and larger and have not been fully depreciated.

CHAPTER 5 METHODS OF ANALYSIS

5.1 Definition of Market Area and Fringe Competitors

It is necessary to discern the relevant market area and competing delivery points surrounding each sample point in order to analyze the characteristics which affect an elevator company's decisions to construct and to close elevators at specific points. A producer survey by Deloitte, Haskins and Sells indicated that producers were less sensitive to proximity of their local elevators with increased utilization of large trucks. In regard to this last point

> ..they could and would consider a range of delivery options based on anticipated grading and dockage policy, manager attitude, unloading facilities and competitiveness. Nevertheless farmers were cognizant of, and sensitive to, the time, distance and investment involved in longer delivery distances.

With unknown economic opportunity at alternative delivery points, the size and shape of each market area is uncertain and cannot be based on posted tariffs and transportation costs. In fact, the market area would be continuously changing as prices, marketing and investment strategies changed. The changing nature of the market areas might be likened to that of an amoeba moving about on a microscope slide.

It is assumed that elevator companies are cognizant of producer attitudes and would analyze deliveries to competing delivery points before any investment or divesture decision was made. To identify potential competitors, a procedure called Thessein tessellation[1] was used. This procedure divides space so each geographic

[1] Also known as Voronoi tessellation.

location is allocated to the nearest centre point. Assuming transportation costs are constant per unit of distance and prices at delivery points identical, the space allocated to each delivery point is the market area associated with a spatial monopoly. This procedure of allocating geographic space to a point was accomplished by computer.

To derive the market area associated with each sample point, all existing elevator points in 1980/81 were listed for each province and a data entry number assigned to each elevator point. In total 235, 690 and 334 elevator delivery points were recorded in Manitoba, Saskatchewan and Alberta, respectively during the 1980/81 crop year.

Each elevator point within a province was then electronically entered in numerical order into the computer using a digitizing process. Maps of 1:500,000, 1:750,000 and 1:1,000,000 scale were used for Manitoba, Alberta and Saskatchewan, respectively. Each map was placed on a digitizing table[2]and with the aid of a computer software package, Tydig, the x and y coordinate of each delivery point was entered in the computer.[3]

It was critical to the analysis, that the data entry number (n) assigned each delivery point correspond to the nth data observation the computer was about to digitize as the computer did not recognize point names but assigned digitized delivery

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[2]A digitizing table is an electronic surface connected to a computer.

[3]When a point is digitized, its coordinates are sent to the computer. Preliminary calibration of map corners and several random points allow table coordinates to be georeferenced to longitude and latitude coordinates.

points a number on the basis of the order of entry. Consequently, to correctly identify a delivery point the digitization number had to match the data entry number.

As the spatial distribution of elevators in the prairie grain elevator system is dynamic, a new list of existing elevators was required each year and new data entry numbers assigned each delivery point. Generally the number of points digitized within each province declined each year. Each province was digitized ten times, once for every year 1980/81 through 1989/90 to capture the changes brought about by elevator rationalization and investment. In total 30 Tydig computer files were created.

Each Tydig file was then exported as a vector file in Ascii format[4] which identified each reference point by number and coordinates. Idrisi, a grid based geographic analysis system developed at Clark University, Massachussettes was then incorporated to construct Thiessen polygons around each and every existing delivery point in the grain handling system for each crop year.

Based on the coordinates of each delivery point, the computer process entails drawing straight lines between neighbouring points. Perpendicular lines are then drawn at the point bisecting each of the lines connecting neighbouring points. The catchment area for any delivery point is then defined as the area within the boundary of where perpendicular lines intersect. Figure 5.1 illustrates this procedure. Given elevator points, A, B, C, and D, lines AC, CB, AD, BD and CD are drawn connecting the points. Assuming point C is the elevator point of interest,

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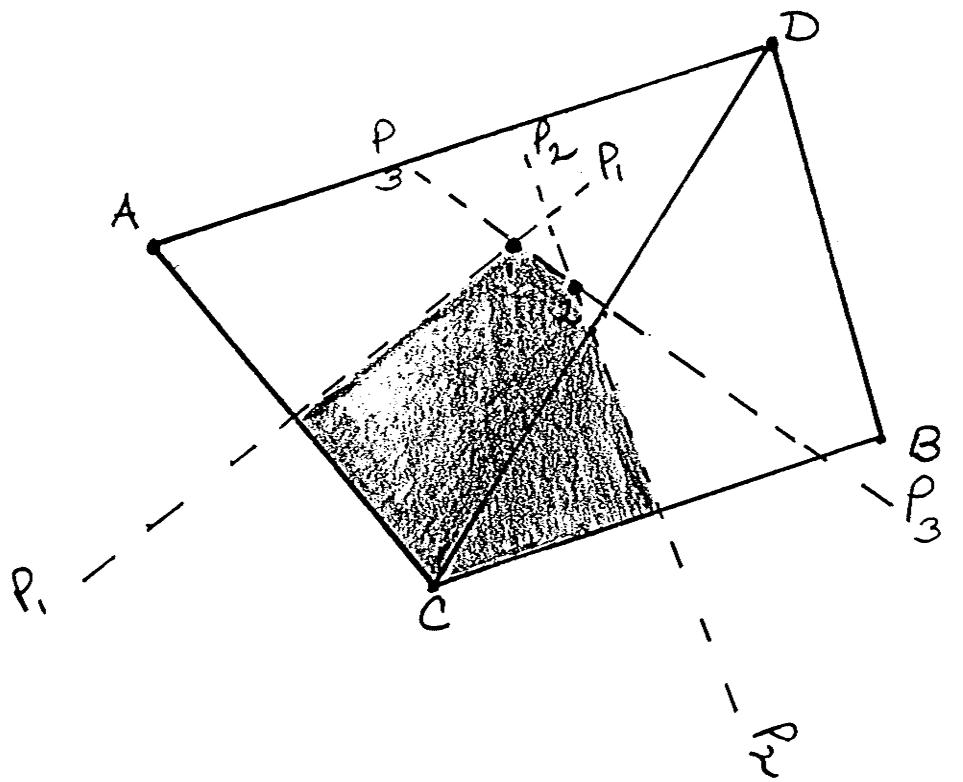
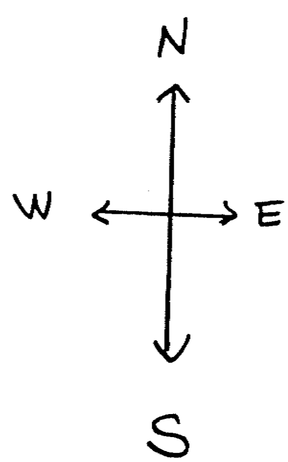
[4] Ascii format facilitated editing in Quattro Pro.

Figure 5.1 Voloni Tessellation Method of Deriving Polygons about Central Points.





perpendicular lines P_1, P_2 and P_3 can be drawn through lines AC, CB and CD. Lines P_1 and P_3 intersect at point 1 and lines P_2 and P_3 intersect at point 2. The shaded area underneath the line connecting 1 and 2 is the northern portion of the Thiessen polygon representing the catchment area for delivery point C.

Once the Thiessen polygons had been constructed, each polygon was assigned a typed character[5]. The area within each polygon was identified by the typed character. The process of identifying elevator points and their surrounding market area was complicated by the fact that the Idrisi program was limited to 90 typed characters. For example, lower case letters a through z and upper case letters A through Z represent 52 typed characters. Given there were 235, 690 and 334 points in Manitoba, Saskatchewan and Alberta, respectively in 1980/81, the range of characters were repeated 2.6, 3.7 and 7.7 times in Manitoba, Saskatchewan and Alberta, respectively. Often geographical distance between delivery points made identification obvious, particularly in Manitoba and Alberta. However, in Saskatchewan the boundaries of many market areas assigned the same type character touched making identification very arduous. Generally the Idrisi program is more suitable for smaller scale projects.

Due to the large number of delivery points within each province, large maps were printed in order to identify market areas. Portions of maps approximately 3 x 4 feet were printed on standard 8.5 x 11 inch paper and pieced together. To determine delivery points which potentially competed with sample delivery points, the

[5]The type characters were those found on most keyboards.

sample delivery point was first located on the map according to the typed character which matched its data entry number. The surrounding points whose boundaries it shared were also recorded. A portion of the Manitoba map illustrating the area allocated to each delivery point is shown in Figure 5.2.

One disadvantage of this technique is that the provincial borders determine the outside boundary of the periphery polygons. However, the Thiessen polygon tessellation procedure does ensure that the area assigned to each delivery point is mutually exclusive and that all areas are collectively exhausted. If it is assumed that 1) prices offered for grain and charges for handling and elevation are identical[6] between delivery points within the region, 2) producers are profit maximizers and they will deliver their grain to the point that maximizes the farm gate price, 3) road infrastructure does not dictate a single route over which grain must be transported and 4) the marginal cost per mile of transporting in all directions is identical. Under these conditions, the polygon would be a good indicator of the market area or spatial monopoly associated with a particular delivery point. Each producer within the polygon or catchment area would consequently deliver to the delivery point within his catchment area as the transfer costs would be minimized, hence the farm gate price maximized.

The above identified assumptions do not hold in reality. First, the road

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[6] This is not totally unrealistic as the price offered for Board grain of same grade and quality is the initial payment set by the Canadian Wheat Board. Elevator charges for the various services are also set annually by each company and apply to all delivery points within each company's network.

Figure 5.2 Portion of Manitoba Map of Area of Land Allocated to Each Primary Elevator Delivery Point.

infrastructure which is predominately a grid network is broken by geographical topography such as lakes, rivers, reserves, parks and hills. Also the elevators are located along rail lines that obliquely transect the Prairies. Consequently, while a farm may fall within one polygon, the shortest travelling distance may be to another elevator in another polygon. Second, discretionary grading and dockage allowances can alter grain prices. Third, producers often will deliver to an alternative elevator on the basis of tradition or patronage royalties which have a personal or financial value.

However, the primary purpose of using the Thiessen tessellation procedure is to identify objectively neighbouring delivery points. These neighbouring points are assumed to be competing points. Other criteria such as rectangular or linear market areas are much less realistic in view of topography, a linear rail system and grid like road network. To compensate for the fact that some neighbouring Thiessen points are not competing points due to geographical terrain such as rivers, lakes, hills, parks and reserves which interrupted the production areas, these points are omitted from the list of competing points associated with any particular delivery point.

5.2. Choice of Analytical Technique

Multiple regression analysis is used to determine the models which will explain the probability of elevator construction and elevator closure at delivery points. Because the dependent variable is a binary discrete variable, taking on values of only zero or one, a binary regression model approach was utilized. Specifically, the logit model technique was chosen to estimate the model. Other regression and programming techniques though available, were unsuitable for a variety of reasons. The advantages and disadvantage of various techniques are discussed briefly below followed by a review of the logit model.

5.2.1. Linear Probability Models

5.2.1.1. Binary Dependent Variable Linear Probability Model

The regression model does not restrict the values of the independent variables, the coefficients or the disturbance term. Consequently, the estimated value of the dependent variable must be free to assume any value. However, in event analysis when a qualitative dependent variable is used, the values the dependent variables can assume are restricted. In the case of a binary dependent variable, the value of the dependent variables is restricted to zero or one. Given this restriction, the expected value of Y_i is equal to the probability of the event occurring, $Y_i = 1$.

$$E(Y_i) = (1)\ P(Y_i{=}1) + (0)\ P(Y_i{=}0) = P(Y_i{=}1)$$

Given the Gauss-Markov assumption that the mean of the disturbance terms is equal to zero, the linear regression equation can then be interpreted as a probability.

$$E(Y_i) = (Y_i{=}1) = b_k X_{ik}$$

where b_k = estimated population parameters

X_{ik} = explanatory variables, 1 through k, for observation i.

This technique, however, violates the Gauss-Markov assumption that the variance of the disturbance term is constant across all observations therefore, the disturbances are homoscedastic. If the dependent variable Y_i must take on values of zero or one, and the coefficient and independent variables can take on any values, the disturbance term u_i can take on only two values. It is therefore not homoscedastic[7]. If a linear ordinary least squares technique were used in this situation, the estimates would not be efficient and the sampling variances incorrect, consequently no inferences can be made concerning the effects of the explanatory variables.

5.2.1.2. Weighted Least Squares Linear Probability Model

The weighted least squares (WLS) technique is a two stage technique correcting for the systematic variation in the disturbance term with the explanatory variables. The first step involves estimating linear OLS coefficients. As the coefficients are unbiased they are used to estimate the standard error of the disturbance term associated with each set of observations, which in turn are used to construct a set of weights, one for each observation. By multiplying the dependent and explanatory values by the appropriate weight, the property of homoscedasticity is restored. A second linear OLS regression is run on the adjusted observation values yielding correct sampling variances[8].

A problem common to both the OLS and WLS techniques is that the values of Y can frequently lie outside the (0,1) interval. While the values may be truncated at zero or one, the reasonableness of the model may be questioned if too many

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[7] Aldrich, John H. and Forrest D. Nelson. Linear Probability, Logit and Probit Models. Series: Quantitative Applications in the Social Sciences, Sage University: Beverly Hills, California, 1984, p 13.

[8] The second set of coefficients are approximately normally distributed in large samples, so that hypothesis testing and confidence intervals can be used.

estimates fall outside the probability interval, particularly if the values of the independent variables are within feasible ranges for analysis. In the case of a single independent variable, X_1, if X values were extended beyond the initial low and high end range which yielded Y values between zero and one, the estimated coefficient must be lower if the probability estimates were to lie within the (0,1) probability interval. Figure 5.3 illustrates that a flatter linear approximation is required to maintain values of Y in the appropriate probability interval.

A second problem associated with linear models is that the marginal effect of each independent variable on Y is constant. In other words, equal increments of X_k yield equal incremental changes in probability. In reality, the probability of an event occurring may decrease and increase at a decreasing rate when the values of X_k get very small or large. This is also illustrated in Figure 5.3 by the curved line. The flatter the slope, the proportionally smaller change in probability is expected to occur for each increment of X.

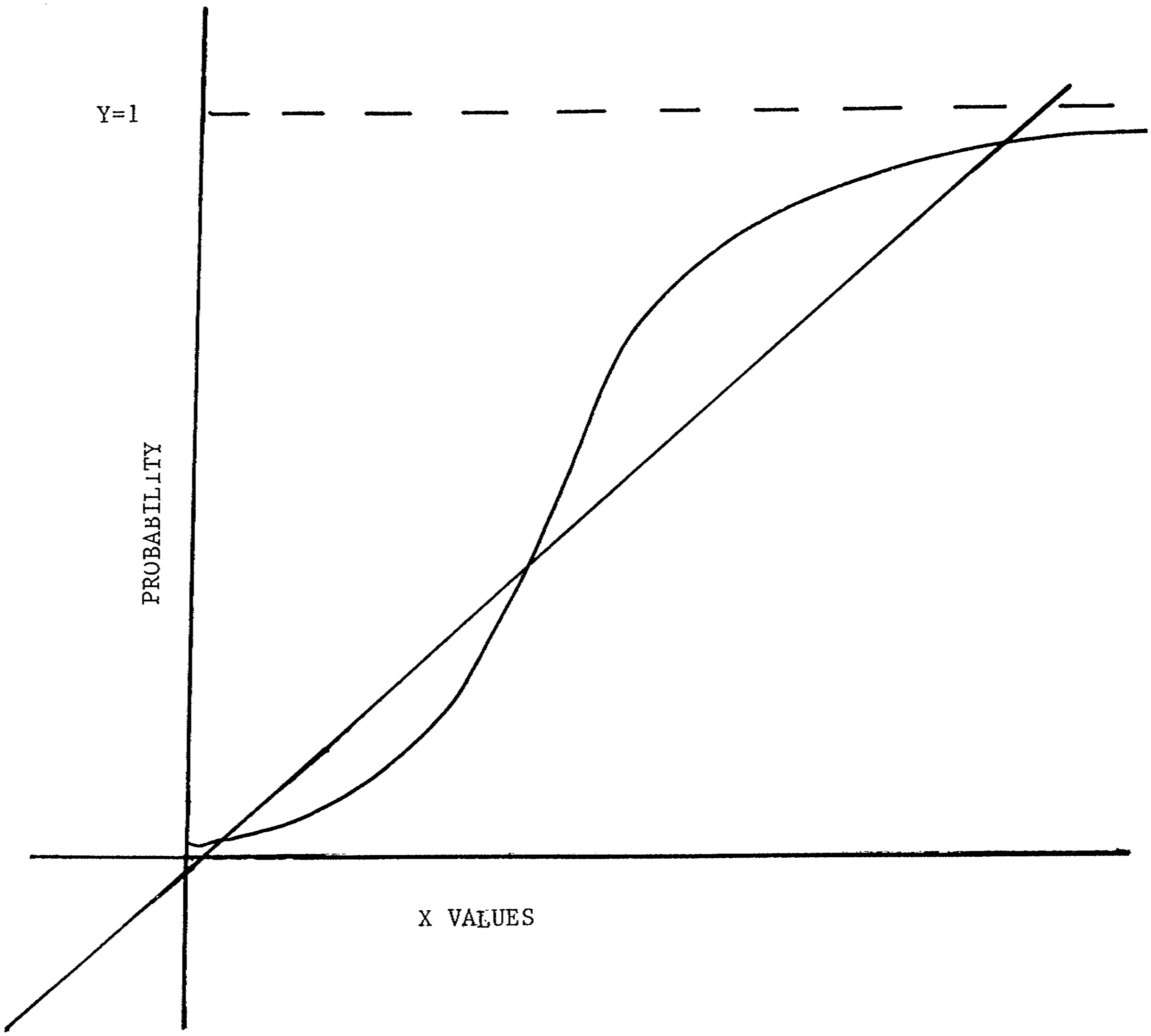
5.2.1.3. Constrained Programming Model

Mathematical programming techniques may be used that constrain the coefficients so that the probability of an event occurring are restricted to $0 \leq Y \leq 1$. The problem with this technique is that the procedure can be very expensive to run and there is no guarantee the estimates are not biased.

5.2.2. Nonlinear Probability Models

One of the difficulties with linear probability models arises from the fact that the right hand side (RHS) of the equation, b_kX_{ik} is not constrained but the

Figure 5.3. Linear Estimation of Binary Discrete Model



probability of Y is constrained to between zero and one. To bypass this problem, the original model is transformed so that 1) all the predictions fall within the (0,1) interval, 2) the values of X lie over the range of real numbers and 3) the monotonicity of the original function is maintained in the transformed function.

Several alternative transformation specifications are available which fulfil the above three criteria. The Probit and Logit models use a normal and logistic cumulative probability function, respectively. Because the transformations are nonlinear, the marginal effect of independent variables on probability is no longer constant.

5.2.2.1. Probit Model

The Probit model utilizes a normal cumulative probability function.

$$P_i = F(b_k X_{ik}) = F(Z) \text{ where } Z = b_k X_{ik}$$

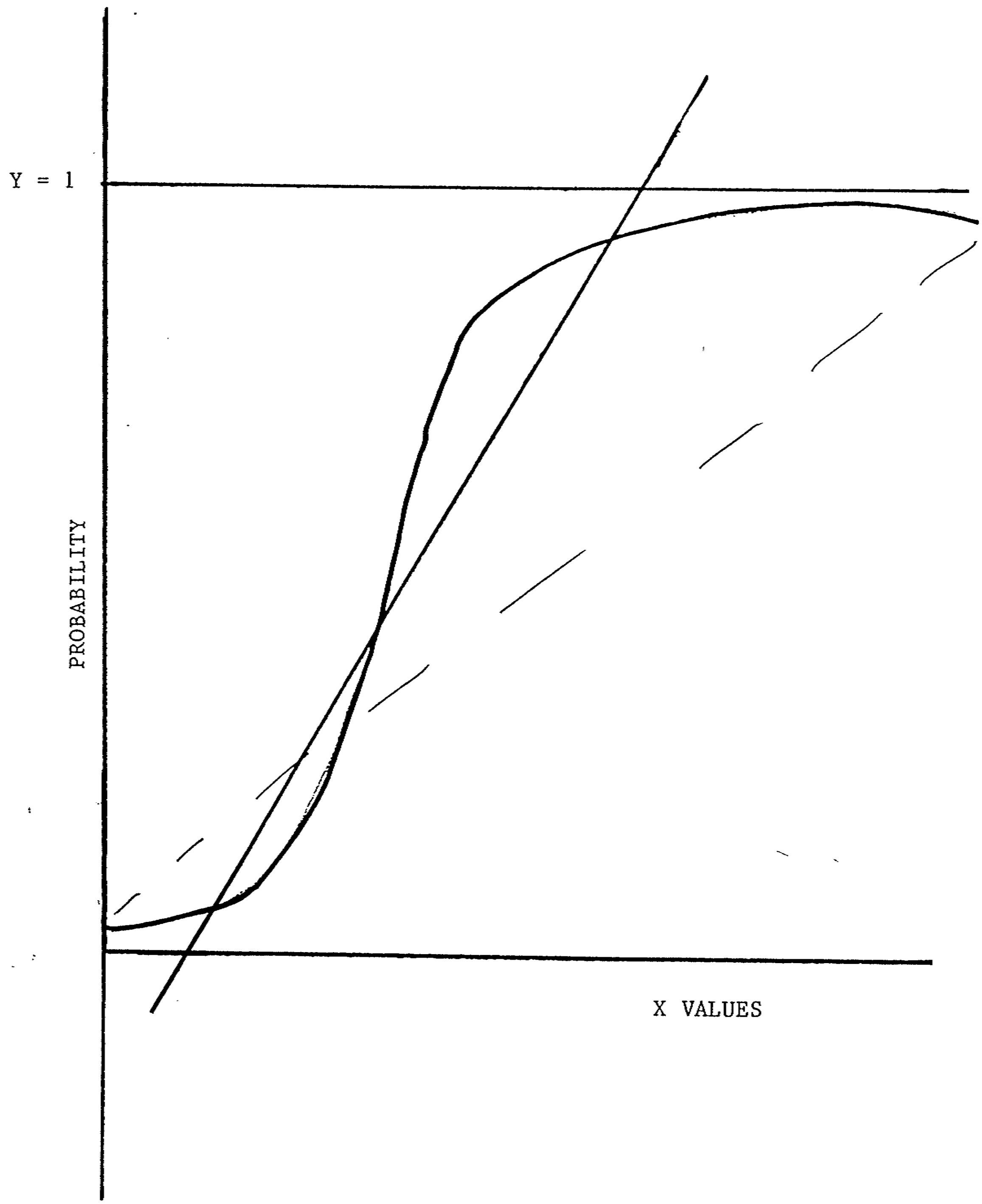
$$P_i = F(Z) = 1/\,2\sqrt{\pi} \qquad e^{-Z/2}\,dz$$

In this model, Z a type of index, is linear with respect to the independent variables, therefore equal increments in X will yield constant marginal changes in Z. However, Z is nonlinear with respect to probability, therefore equal increments in X do not yield constant marginal changes in probability.

The normal cumulative probability curve is positively sloped so that the probability that an event will occur increases with Z, and changes in independent variables have their greatest impact on the probability of an event occurring at Z=0 or P=.5, Figure 5.4.

The disadvantage of this technique is computational cost of calculation hence

Figure 5.4. Cumulative Probability Curve, Probit and Logit Model



a logit model was used.

5.2.2.2. Logit Model

The logit model is based on the logistic cumulative probability function.

$$P_i = F(b_kX_{ik}) = F(Z) \text{ where } Z= b_kX_{ik}$$

$$P_i = F(Z) = 1/1+e^{-Zi}$$

Algebraic manipulation of the logit model yields values of Z equal to the log of the odds ratio.

$$P_i = 1/1+e^{-Zi}$$

$$P_i(1+e^{-Zi}) = 1$$

$$(1+e^{-Zi}) = 1/P_i$$

$$e^{-Zi} =(1/P_i) - 1$$

$$e^{-Zi} =(1-P_i) / P_i$$

$$e^{Zi} =P_i /(1-P_i)$$

$$\log(e^{Zi})= Z = \log [P_i /(1-P_i)]$$

The upper probability restriction $P_i=1$ of the linear model is removed by taking the odds ratio, $P_i/(1-P_i)$. While P_i continues to be less than one and greater than zero, the odds ratio is positive and has no upper bound. The lower bound of zero is eliminated by taking the logarithm of the odds ratio yielding any negative or positive number.

The logit curve is similar to the probit model, Z is linear with respect to the independent variables but probability is not linear with respect to Z. The logit curve, however, is a bit flatter at low and high values of Z resulting in smaller changes in probability for same incremental changes in Z. The difference in the probit and logit model only become critical if there are many observations at both the extreme scale of Z values.

The logit estimates are derived using the maximum likelihood technique. This technique seeks estimates of the population parameters, B_k which maximize the likelihood that the sample data came from that population rather than from another population with different parameter values. These estimates are unbiased and asymptotically efficient and normal in small samples.

The logit model is chosen for the purpose of analysis as:

1) it avoids values of P exceeding 1 or less than zero.
2) it does not assume the changes in probability to be constant for each unit change in an explanatory variable.
3) it is easy to calculate as exponentials are computed rather than the integrals as in the probit model.

5.2.3. Interpretation of the Logit Model Results

The estimated coefficients, b_k measure the marginal effect of a unit change in variable X_k on Z. Regardless of the level of X_k, the change in Z per unit of X_k is constant due to the linear relationship. The larger the coefficient, the greater the marginal change in Z. The sign and size of the coefficients and the magnitude of the X values together determine the Z value.

For each Z value calculated, a unique probability value is calculated. The probability of an event occurring, P(Y=1) is always .5 at Z=0. Due to the symmetrical nature of the logistic curve around Z=0, for every negative Z value, the same positive Z value will have a probability $1-P_{-Z}$. For example, if Z = -3.0 yielded a P(Y=1)=.045, then Z = 3.0 would have a probability P(Y=1)=.955. While the probabilities are symmetrical about Z=0, unit changes in Z do not yield constant changes in probabilities. The rate of change in $P(Y=1)$ is small when Z is large and negative, increases when Z approaches zero and again is small when Z is large and positive. Because the level of a X_k variable affects the Z value, incremental changes in X_k will have varying affects on $P(Y=1)$, hence the level of the independent variable value is important to the probability of an event occurring.

5.2.4. Statistical Tests

The statistical significance of each b_k coefficient is tested by calculating the t statistic from the coefficient estimate and standard error of the estimate. Each t statistic is then compared to critical t values at various levels of significance. The signs of the coefficients are also analyzed to determine if the expected signs are derived.

A goodness of fit test of the regression equation can be undertaken by testing the joint hypothesis that all but the intercept coefficients are equal to zero. A chi-square statistic is produced based on the likelihood ratios of two models; the first model being the estimated logit model and the second model that which includes only the intercept. The computed chi square statistic is compared to the critical chi square statistic to assess statistical significance of the model. The goodness of fit test can also test the significance of subsets of coefficients against the estimated model.

Another measure of goodness of fit is the percent correct predictions. Events are predicted to occur when the probability associated with an observation is greater than .5 and are predicted not to occur when probability is less than .5. Predictions are compared to actual results to derive percent correct predictions.

Aldrich and Nelson proposed a pseudo R^2, defined as $R^2 = c/(N+c)$ where c is the chi-square statistic and N the total sample size. Values of R^2 lie between (0,1) interval and the fit diminishes as R^2 approaches zero.

5.3. Model Specification

The objective of determining the characteristics of delivery points and market areas where elevators were closed and those where elevators were constructed required separate model specifications for closure and construction. First, while the decision to close or construct an elevator may have market considerations common to each, other characteristics or market considerations are specific to the decision to divest or invest. For example, elevator capacity is probably considered in the decision to close an elevator as it affects average costs. However, the size of elevator is not a factor in determining where to locate. Once a location is identified, management then enters the next planning stage determining which size of elevator to build that minimizes average costs given the volume delivered[9].

Second, the dependent variable has only two alternative choices. It is obviously incorrect to assume the choice is to construct or close an elevator at a point. Rather the alternative to the decision to construct an elevator is to not build, just as the alternative to closing an elevator is not to close. For example, volume of deliveries is likely considered in both a firm's decision to close or construct an elevator. However, it is unlikely that the level of deliveries yielding a probability of .5 of an elevator being constructed is identical to the critical level of deliveries where

[9] Management may have a minimum size elevator in mind when they select delivery points to build an elevator which implies a minimum expected volume of deliveries.

the probability of closing an elevator is .5. Due to the sunk nature of capital invested in a primary grain elevator, greater returns are required to cover full cost depreciation and interest charges on a new structure than an older facility that is fully depreciated and has no alternative use[10]. As a consequence of the differences involved in these two investment decisions, separate models were estimated.

5.3.1 Open Model Specification

This sub-section addresses model specification relating to construction of new elevators in Saskatchewan and Manitoba. Discussions with the grain companies and information inferred from relevant studies provide a list of specific characteristics which decision makers likely utilize when making their decision where to construct an elevator. Point and market characteristics and company strategies hypothesized to affect the location grain companies choose to build an elevator were grouped into four categories, 1) market productivity, 2) competition, 3) investment strategies and goals and 4) road and rail facilities. Several variables are proposed for each category which on a priori grounds are expected to affect the decision to construct an elevator at a given delivery point. In many instances several measures for a variable were proposed and tested as there are different data sources available for different time periods, one of which may be a more suitable measure of the variable being tested.

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[10] P.W. Lytle and L. D. Hill. " The Optimum Combination of Resources Within and Among Country Elevators". American Journal of Agricultural Economics. May 1973. p. 202-208.

5.3.1.1. Productivity Measures

Crop productivity within an elevator's catchment area is important to the revenue generating ability of an elevator point. The types of crops produced and the utilization of those crops are equally important as output may be fed to livestock and not delivered to an elevator. To measure the productivity of an area, yet capture the effect of crop utilization as it affects the elevator, data on the volume of grain delivered was collected.

Moore indicated the importance of elevator deliveries to choice of location.

> There will be virtually no elevators built at locations which do not posses the type of permanency associated with handling upwards of 40 thousand tonnes annually... as companies seek economies of scale and carve out catchment territories sufficient in size to cover the high capital investment required.[11]

It may also be assumed that other earnings such as drying and returns on dockage will increase with volume of grain delivered as may nonboard grain and farm input sales. Volume of grain delivered would appear to be an appropriate measure of grain market area potential.

Two measures of volume are tested, linear market volume and fringe or Thiessen market volume. It is uncertain how grain companies effectively perceive their market or competitors, in linear or areal space. Therefore which measure is more suitable for developing a model predicting the probability of elevator construction or closure is also uncertain. For the

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[11] Gerry Moore. Development in Canada Grain Transportation Policy Proceedings to Development in Canada Grain Transportation Policy, Transport Institute, University of Manitoba: Winnipeg, Manitoba. June 1988, p10.

purpose of this study the linear market is defined as the sample point and delivery points immediately adjacent the sample point on the rail line. Fringe market volume is defined as the sum of deliveries received at each delivery point making up the sample point fringe. In either case, both measures are objective.

Annual as well as three and ten year average data were collected for each sample point as well as those delivery points immediately adjacent the sample point and those on its market fringe. This entailed collecting delivery data for 359 Saskatchewan points and 403 Manitoba points[12].

Three year average delivery was utilized as annual data was believed to be a poor measure of market productivity. In any one crop year, delivery points may experience below or above average deliveries depending on weather conditions and biological infestations. Due to rail line abandonments, elevator rationalization and changes in crop productivity, ten year averages also may not be an appropriate measure of current productivity and competition in an area. The ten year average would have assimilated past conditions in its figure. Consequently, three year average deliveries was also formulated as an alternative to the annual and ten year data. With all three measures, a positive coefficient is expected, as the probability of constructing

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[12] Not only were annual, three preceding years and ten year average delivery data collected for all these points, but elevator capacity and number of elevators and companies at each point. This was necessary to derive turnover ratios as well as competition indicators associated with capacity and number of elevator companies.

an elevator is expected to increase as grain deliveries increases.

Although Canadian Grain Commission computer files "Grain Deliveries at Prairie Points" are organized in alphabetic order, this did not expedite data collection in the study. The data associated with particular points in each crop year were marked and transferred from the CGC file to another computer spreadsheet listing delivery points. The delivery points were then reordered so that the fringe points were paired with the appropriate sample point. This process was repeated three times for each delivery point to obtain the three years of delivery data required to formulate a three year average statistic.

A second measure derived to measure market productivity was a turnover index. Market turnover was determined by dividing the sum of linear or areal three year average market volumes by the sum of linear or areal elevator capacities. The turnovers calculated were then indexed against an estimate of the turnover for each province[13]. A high turnover index may be indicative of an area which has high yielding acreage devoted to export crop sales or of an area which is not overdeveloped in terms of primary elevator capacity. A positive sign is expected as the probability of constructing an elevator is expected to be higher in areas with a greater turnover index[14].

Linear and fringe market turnover estimates were also tested as an

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[13] A running three year average of provincial turnovers was used as the basis for setting turnover indices.

[14] Variables associated with productivity ratio are LRATIO and FRATIO.

alternative measure to provincial turnover indices.

5.3.1.2. Competition Measures

The number of companies in a market area or the number of companies at the central delivery point may affect a company's decision to build at a point[15]. However, the expected sign of number of companies is unknown as the sign hinges on companies' marketing strategy. As the number of companies in a market area increases, the probability of building an elevator at the central delivery point may decrease due to increased competition and potential for reduced market share. These same firms may seek points where few or no companies exist, hence a negative sign may occur. In contrast, companies may wish to open at points where other companies are located, thus a positive sign would be expected. Because these alternative strategies are possible given the number of companies involved, the variable may offer little explanatory power as to where elevator companies choose to build.

Point and market capacity are other measures of market competition[16]. For example, the ability to obtain lower rail rates[17], and to

[15] Variables are designated PTNO= number of companies at point, NF= number of companies at delivery points on the market fringe and NL=number of companies at adjacent rail points.

[16] Variables designating capacity are PTCAP=capacity at delivery centre point, CF=total capacity at delivery points on market fringe, and CL=total capacity at adjacent linear points.

[17] Larger capacity elevator can collect larger volumes of same grade grain and

earn storage revenues when transportation bottlenecks occur are dependent on elevator capacity. Again, the expected sign is unknown. A negative sign could occur if companies wish to avoid competition. Alternatively, a positive sign may arise if capacity is a measure of market power, and market representation is sought.

Market capacity increases with the number of elevators in a market. Consequently, it is not surprising that there is a high degree of multicollinearity between the two variables[18]. Although the presence of two collinear independent variables in a regression model will yield unbiased estimates, the standard errors may be large resulting a misinterpretation of the significance of the explanatory variable to the explanation of the dependent variable.

5.3.1.3. Investment Strategies and Goals

Three investment strategies are tested, market presence, market preemption and market positioning as well as a possible firm goal, market coverage.

Market Presence

It is hypothesized that elevator companies may decide to locate a new elevator in areas competitors have located a new facility, as a show of market

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perhaps put together larger car blocks.

[18] The correlation coefficient between number of companies and elevator capacity for linear and Thiessen markets was .65 and .68, respectively.

presence and strength in addition to a manifestation of competitive spirit. To test this hypothesis, a dummy variable was used[19]. A value of one was designated at a point an elevator was built if a competitor had also constructed a new elevator[20] at the same point or an adjacent rail line point within the last three years. A value of zero was assigned otherwise.

The choice of a three year time frame was subjective. A longer time frame would increase the chances of one company building at the same or adjacent rail line points for other reasons, particularly with continued rail rationalization and elevator obsolescence. Conversely, a lesser time period would be too short to permit completion of the decision making and construction process.

Market Preemption

In their investment decisions, elevator companies may anticipate imminent closure of competitor elevators in the market fringe either due to age of elevator or anticipated rail line abandonment. Consequently, they may attempt to preempt their competitor from the market by building before their competitor rebuilds. The preemptive move is meant to encourage other elevator companies that wish to avoid confrontation to seek locations elsewhere.

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[19]Dummy variable PRES.

[20] In situations where competitors built new annexes larger than their existing primary house, a value of 1 was also assigned the dummy variable.

To measure the possibility of preemptive moves, the age of elevators at each sample delivery point and their adjacent rail points was measured. Age was based on the construction date of the primary house and annexes and weighted according to the capacity of the various storage facilities. The age of the oldest competing facility at either the sample delivery point or the adjacent rail point was selected.[21] [22] It is assumed that the older the facility, the increased likelihood of preemption by another company.

Market Positioning

Market positioning is similar to market preemption except that an elevator company anticipates closure of its own elevator at either the sample delivery point or adjacent rail line points. By constructing a new elevator or rebuilding a replacement elevator at the sample delivery point, companies may be signalling competitors its intention to stay in the market area and possibly preempt competitor construction.

The age of the newest elevator among a company's own elevators at either the sample point or adjacent rail line was used to measure a market

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[21] Variable PREM.

[22] Some company representatives indicated that when attempting to preempt competitors, their focus is often directed at a particular competitor. As this information is unavailable, the oldest elevator was taken as the logical alternative representing who was preempted. It is believed to be a better measure of the opportunity offered to preempt an old competitor facility.

positioning strategy[23]. For example, assume three delivery points, A the sample delivery point and B and C delivery points located on the rail line on either side of point A. A company may not build an elevator at point A, when it has a fifty year old elevator at point B because it has an twenty year old elevator at point C. By taking the newest aged elevator at the sample or adjacent rail points, it is assumed a) a company might not choose to construct another elevator if there were an alternative elevator in the immediate vicinity that would likely remain in operation over the near future, and b) construction might occur if the newest elevator were old and approaching the end of its economic life. A positive sign is expected as the probability of constructing a new elevator is likely to increase as the age of the newest elevator at either the sample or adjacent rail points increases.

Market Coverage

Market coverage through a region may be a goal of elevator companies. They may achieve this by replacing elevators at existing points and expanding into new areas. A variable COV was developed to incorporate these two aspects of market coverage, market maintenance and market expansion.

As with the market positioning variable POST which signifies a company's intention to maintain their market, it is presumed that the probability of constructing a new elevator will increase the older is the newest

[23] Variable POST.

company elevator at either the sample or adjacent rail points. Companies that did not have an elevator at either the sample delivery point or adjacent rail points were assigned a value of zero. It is hypothesized that the probability of construction of an elevator at the sample point is thus greater than if the company had an existing elevator at either the sample or adjacent rail points. This situation signified areas a company might want to expand its coverage.

In order that these two aspects of market coverage be consistent, the age of the newest elevator was divided into one obtaining its inverse. In doing so, a negative correlation is expected between COV and the probability of elevator construction. This was done so that the relationship between the values assigned companies with elevators in the immediate areas was consistent with the zero values assigned sample points which have no elevator at either the sample or adjacent rail points.

5.3.1.4. Road and Rail Facilities

Road Access Index

The road access index takes into account two factors which affect a producer's decision to deliver to a given delivery point, 1) road access and 2) road quality. Based on provincial maps, three road qualities were identified, paved highway, other highway and gravel roads. The numbers of each of these types of roads leading into a delivery point were identified. Each of the type of roads was indexed. Paved highways were given a designation of three, other paved provincial roads a designation of two and gravel roads a value of one. The total value of each type of roadway was calculated and the value of each type of road summed to derive a road access index.

Example:

Highway 16, Highway 250 and Route 473 converge at Newdale. Newdale can be approached from either the east or west on Highway 16. The southern approach of Highway 250 is a paved provincial road but the northern approach is gravel. Route 473 is a gravel road and approaches Newdale only from the east. The road access index assessment for Newdale is 10.

Type of Roadway	Number of Roads	Value/ Road	Type Value
Paved Highway (#16)	2	3	6
Paved Prov Road	1	2	2
Gravel	2	1	2
Road Access Index	5		10

A positive sign is expected as the probability of opening an elevator is likely to increase with improved road quality and access.

Rail Line Status

Status of rail line is used as a measure of longevity and condition of the rail line. During the study period, most branch lines were protected against abandonment to the year 2000[24]. Moore states that security of the rail line

[24] Removal of the prohibition against branch line abandonment in Western Canada was announced in the February 27, 1995 federal government budget, to be effective January 1, 1996.

is critical to elevator investment.

> Lines protected to the year 2000 don't mean a thing when it comes to capital investment. At a cost of $1.5 to $2.0 million per copy, the selection of a location to build a new elevator will be critical. Again, mainline areas will be high priority[25].

Two alternative means of measuring rail line status are available:

1) Grain Dependent Line- The Grain Transportation Agency (GTA) publishes a report Branch Line Profiles, that indicates whether or not a line is grain dependent. Using a dummy variable, GRDEP, grain dependent lines were designated a value of zero and main and secondary rail lines a value of one. A positive sign is expected as an elevator's future may be more secure if it is not on a grain dependent line.

2) Average Tonnes/Mile - The GTA also publishes in Branch Line Profiles the miles of track and average 10 year deliveries in tonnes for each train run. Average tonne miles for each train run were calculated and that value assigned to each delivery point as the average tonnes/mile shipped on the line. A positive sign for this variable is expected as the security of an elevator is likely to increase with increased shipments along a line.

5.3.1.5. Other Variables Not Included in Study Analysis

Several factors which affect a grain company's decision to locate an elevator have not been included in the analysis due to the unavailability of

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[25] Gerry Moore. Development in Canada Grain Transportation Policy Proceedings to Development in Canada Grain Transportation Policy, Transport Institute, University of Manitoba: Winnipeg, Manitoba. June 1988, p.10

data. They are as follows:

Mill rate/Assessment Values- The mill rate in combination with the assessed land and building values may result in high taxes thus raising fixed costs.

Availability of suitable land for rail tracks- Some grain companies indicated that often the land available was to small to accommodate the tracks required to marshall 25 or more railcars. Also town roads frequently traversed available land thus interfering with marshalling of rail cars.

5.3.2. Closure Model Specification

This section addresses model specification relating to elevator closures in Alberta and Saskatchewan. The same productivity, competitive, and road and rail point and market area characteristics hypothesized to affect a grain company's decision to construct an elevator could also affect a company's decision to close an elevator. Investment strategies hypothesized to affect elevator construction such as market presence, preemption and positioning as described in Section 5.3.1., however, are inappropriate.

Other factors which may affect an elevator company's decision to close an elevator include elevator age and capacity. Assuming elevator age is positively correlated with maintenance and repairs and technological obsolescence, older elevators may be stronger candidates for closure. Smaller elevators are also likely to be closed as capacity directly affect elevator costs per unit and economic viability.

Unfortunately, data concerning age of elevators that were closed were not available. The Canadian Grain Commission does record the date of elevator and annex construction in its " Application for Renewal of Primary Elevators Licence" file, but that information is only available for existing elevators. Once an elevator is closed, its record is erased from the file.

As an alternative to elevator age, elevator capacity was tabulated. Perusal of the Canadian Grain Commission's " Application for Renewal of Primary Elevators Licence" file indicates that elevator age and elevator capacity are negatively correlated. Generally elevators over fifty years of age are of less than 2,000 tonnes capacity, many being less than 1,000 tonnes. Information concerning the capacity of elevators closed was obtained from historic issues of the Canadian Grain Commission's Grain Elevators in Canada which indicate elevator capacity at each delivery point by company. Based on the assumption that smaller elevators are more likely to be technologically obsolete and cost inefficient, a negative relationship is expected between elevator capacity and the probability of closure; as elevator capacity increases, the probability of closure diminishes.

Delivery point and market fringe turnover indicators incorporated in the elevator construction model may be of less importance to the decision to close an elevator. Firms are more likely concerned with their own elevator turnover at the point closure is contemplated. This information is available in the public domain for single company delivery points but not for multicompany delivery points in order to preserve company confidentiality. Consequently, elevator turnover for a specific company was estimated at multicompany points. The total volume of grain handled at the point was divided between the companies according to the percentage of each elevator capacity as a proportion of total point capacity. The estimated company volume was then divided by elevator capacity to obtain estimated turnover. This procedure may not be logically perfect, as candidates for closure probably had lower than average turnover rates, but the data do not allow any more sophisticated measure.

Grain elevator firms may also consider their market coverage in the market area which elevator closure is contemplated. If a company is well represented in an area, and they hope a good proportion their customers will alternately ship to that same company's elevators at other delivery points, a firm may be more inclined to close an elevator. The variable REPRATIO is used as an indicator of a company's market coverage. REPRATIO is determined by dividing the number of elevators a company has at all competitive points on the fringe by the total number of elevators operated by all grain elevator companies at the same points. For example, for UGG at the elevator point Bawlf:

Bawlf	UGG
Daysland	AWP
Holden	UGG, Cargill, AWP
Kelsey	AWP
Ohaton	AWP
Rosiland	UGG, AWP
Ryley	AWP

REPRATIO= 3/10=.30

5.4. Sources of Data

Data pertaining to elevator closure and construction were obtained from the following sources. Information concerning number of companies, elevator capacity by company, point elevator capacity, total crop year deliveries for each delivery point were obtained from the Canadian Grain Commission's Grain Deliveries at Prairie Points, Crop Years 1977-78 to 1989/90. Linear and market fringe estimates of three year average deliveries, used in the open model specification, were derived by summing average grain deliveries over the three crop years preceding elevator construction at the appropriate points. For example if an elevator was constructed in 1981, 1977/78, 1978/79 and 1979/80 deliveries were used. Crop year data for 1979/80 would be the most recent information grain companies would have concerning deliveries at competing points prior to building in 1981[26]. Turnover ratios and indices used in both open and closure model

[26]1980/81 grain deliveries at prairie points would have been released November 1981.

specifications were calculated from delivery and capacity information. The companies operating at each delivery point and the size of the elevator were identified in the CGC Grain Elevators in Canada, Crop Year 1979/80 to 1990/91.

The above data were not only collected for the delivery points at which elevators were closed and constructed but all the delivery points on the market fringe. As indicated previously, it is uncertain whether elevator companies view the market in linear or areal terms. This involved data collection for 654 Saskatchewan and 357 Alberta points in the closure models. Similarly in the open models, data was collected for a total of 339 Manitoba and 354 Saskatchewan delivery points.

Information concerning the age of existing elevators, used in the positioning and market coverage investment strategy variables tested in the open models, was derived from the CGC's computer file of Application for Renewal of Primary Elevator Licence. The file contained information by company on the capacity and year of construction of each existing primary elevator house and its annexes. This was used to calculate weighted average ages of the elevator facilities at sample and fringe delivery points to determine positioning and preemption strategies.

Information concerning the miles of track, average delivery volumes and grain dependent status for each train run were obtained from the GTA. Branch Line Profiles, September 1989.

The number of roads and the road type leading to delivery points were obtained from provincial road maps. The main line/branch line status of train runs was obtained from CP Rail Prairie Line Network, Canadian Wheat Board Train Runs in Western Canada and the Canadian Freight Association Western Lines maps. Information concerning roads and rail status were collected only for the delivery points at which elevators were closed and those at which elevators were constructed.

5.5. Sample Selection

SWP, AWP, MPE, UGG, Cargill, Pioneer, Paterson and Parrish & Heimbecker in Manitoba, Saskatchewan and Alberta were contacted to ascertain where they had built new elevators and those they had closed between 1980/81 and 1989/90. Due to time constraints and the size of the project, closure logit models were developed for Saskatchewan and Alberta only and open logit models for Saskatchewan and Manitoba. The elevator and delivery points selected for the study samples are indicated in the following sections.

5.5.1. Sample Selection: Construction of Grain Elevators, Manitoba and Saskatchewan

The principal grain companies in Manitoba and Saskatchewan were contacted to determine where new elevators were constructed between 1980/81 and 1989/90. A total of 36 primary elevator houses were built both at existing and newly created points in Manitoba and 50 in Saskatchewan. All 36 delivery points in Manitoba and 41 delivery points in Saskatchewan were selected for the sample[27]. Time constraints limited the number of Saskatchewan points that were analyzed.

The Saskatchewan data were then ordered in time and by company and the percent of observations within each category calculated. The sample observations were chosen so that the time and company patterns were replicated in the sample. The dependent variable (Y) associated with the points selected for the sample was assigned a value of 1. Construction of elevators at Manitoba and Saskatchewan points were verified using the Canadian Grain Commission " Application for Renewal of Primary Elevators Licence" file.

To derive that part of the sample representing delivery points where elevators were not constructed, Y=0, herein referred to as alternative points, was more difficult. It is not obvious how the points in the set - geographic spaces along rail lines in the province of Manitoba and Saskatchewan - should be identified. For example, are towns, villages and hamlets feasible points of analysis as to why an elevator was not constructed at that point? Alternatively, perhaps the geographic space one, two, three, and four miles down the road is a more appropriate sample choice. In choosing this part of the sample, one basic assumption was made. Existing elevator points would constitute the set from which alternative delivery points would be chosen.

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[27]The Saskatchewan points not incorporated in the study sample were used in the out-of-sample forecasts used to verify the estimated open Saskatchewan model.

This decision was made as 78 and 98 percent of elevators constructed in Manitoba and Saskatchewan, respectively, were built at existing delivery points suggesting that the existing system is the principal set elevator companies examine in their location choice.

In choosing the alternative points required for the Manitoba and Saskatchewan sample, delivery points in each province, listed in alphabetical order in the Canadian Grain Commission's Grain Deliveries at Prairie Points annual publication, were assigned a number. Random numbers were then generated using Quattro Pro and the point with that assigned number chosen.

Each alternative point chosen was also assigned a year in which construction did not take place. The sampling fraction of alternative points chosen each year followed the distribution of elevators constructed each year between 1980/81 and 1989/90. This was done to reflect the dynamic aspect of the primary elevator system. Thirty-four Manitoba and 20 Saskatchewan alternative points were chosen[28] yielding a total of 70 and 61 observations in the Manitoba and Saskatchewan open model samples, respectively.

5.5.2 Sample Selection: Grain Elevator Closure, Saskatchewan and Alberta

In obtaining information on elevator closures, elevator companies were asked to exclude points where elevators were closed due to rail line

[28] Thirty-four alternative points were chosen for the Manitoba sample so that there would be equal representation between points at which elevators were constructed and those at which elevators were not constructed. However, as the study progressed time became a constraint and the number of alternative points incorporated in the Saskatchewan open model sample was reduced to 20.

abandonment or points where trades occurred[29]. The data were then ordered in time and by company and the percent of observations within each category calculated. The sample observations were chosen so that the time and company patterns were replicated in the sample. A total of 58 Alberta and 126 Saskatchewan elevators were closed. Of these, 41 Alberta elevators and 73 Saskatchewan elevators were selected for the closure model samples and the dependent variable Y assigned a value of 1 indicating closure had occurred.

To obtain that part of the sample representing delivery points at which elevators were not closed, Y=0, random numbers were generated using Quattro Pro and delivery points were chosen from the Canadian Grain Commission's Grain Deliveries at Prairie Points annual publication documenting deliveries to delivery points. The number of alternative points chosen each year followed the distribution of elevators closed between 1980/81 and 1989/90. In total, 28 and 53 alternative points were chosen for Alberta and Saskatchewan closure samples, respectively, yielding a total sample size of 69 and 126 observations for Alberta and Saskatchewan.

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[29]It was assumed that points at which a company discontinued operations was less desirable. However, the points at which companies trade elevators are not necessarily undesirable. In making the trades, companies are endeavouring to reduce costs by consolidating elevators at a point. Given this assumption, modelling difficulties would likely be encountered as the volumes, road quality, elevator turnovers and elevator capacities may not be as low or poor as might be expected at points elevators were closed, but may be more in line with existing elevator values which would comprise the alternative part of the sample.

5.5.3. Sampling Summary

Table 5.1 summarizes the number of observations selected for each of the closure and open model samples. The number of observations Y=0 within each sample is between 30 and 50 percent which provides adequate representation for modelling purposes. In Appendix A, the distribution of sample observations between Y=0 and Y=1 in other logit studies are presented illustrating the variation in the distribution of the observations.

Table 5.1. Number of Observations Within Each Sample.

Open Models	Y=0 No Construction	Y=1 Elevator Construction	Percent Y=0 of Total N	Total N
Saskatchewan	20	41	33	61
Manitoba	34	36	49	70
Closed Models	**Y=0 No Closure**	**Y=1 Closure**	**Percent Y=0**	**Total N**
Saskatchewan	53	73	42	126
Alberta	28	41	41	69

CHAPTER 6. DELIVERY POINT CHARACTERISTICS AFFECTING THE PROBABILITY OF ELEVATOR CONSTRUCTION IN MANITOBA AND SASKATCHEWAN

This chapter begins by identifying and summarizing the point characteristics at which elevators were constructed by companies. In many cases inferences are drawn concerning the investment strategies of the individual firms. Following this, the Manitoba logit model, to determine the probability of elevator construction at a point, is introduced and statistical tests on the model performed. Various sensitivity analyses indicating the probability of construction when explanatory variable value levels changed are conducted. The chapter continues with the presentation of the Saskatchewan open logit model and the sensitivity analyses performed. Data from both the Manitoba and Saskatchewan data bases were combined to determine if a Saskatchewan-Manitoba logit model would have superior forecasting ability.

6.1 Manitoba and Saskatchewan Elevator Construction Summary Statistics

Tables 6.1 and 6.2 show the distribution of elevators constructed by year over the 1980s. The distribution appears bimodal with the peaks occurring in 1981-82 and 1985-86 in Manitoba and in 1983 and 1985-86 in Saskatchewan. The timing of the peaks may be related to the passage of the <u>Western Grain Transportation Act</u> (1983). With strong expectations and subsequent passage of the <u>Act</u>, there was less uncertainty concerning the method of payment hence less uncertainty concerning the future of grain elevator companies. The first peak in Saskatchewan in 1983 may be indicative of plans to build elevators that were put on hold until the conclusion of the

Table 6.1. Time Distribution of Manitoba Elevators Constructed.		
Year	Number of Elevators Constructed	Percent of Elevators Constructed
1980	3	8.3
1981	4	11.1
1982	5	13.9
1983	3	8.3
1984	3	8.3
1985	4	11.1
1986	6	16.7
1987	3	8.3
1988	3	8.3
1989	2	5.6
Total	36	100.0

Table 6.2. Time Distribution of Saskatchewan Elevators Constructed		
Year	Number of Elevators Constructed	Percent of Elevators Constructed
1980	0	0.0
1981	2	4.0
1982	4	8.0
1983	14	28.0
1984	4	8.0
1985	13	26.0
1986	7	14.0
1987	1	2.0
1988	4	8.0
1989	1	2.0
Total	50	100.0

Table 6.3 Number of Operating Units Licensed by Company in Manitoba, 1979/80 to 1989/90.

Company	Number of Operating Units 1979/80	Number of Operating Units 1989/90	Percent Share of Operating Units 1979/80	Percent Share of Operating Units 1989/90
Manitoba Pool	201	141	56.8	52.6
United Grain Growers	83	66	23.4	24.6
Cargill	23	18	6.5	6.7
Paterson	33	25	9.3	9.3
Pioneer	8	8	2.3	3.1
Other	6	10	1.7	3.7
Total	354	268	100.0	100.0

Table 6.4. Primary Elevator Construction by Company, in Manitoba, 1980/81 to 1989/90.

Company	Number of Elevators Constructed	Percent of Elevators Constructed
Manitoba Pool	17	47.0
United Grain Growers	7	19.5
Cargill	7	19.5
Paterson	1	3.0
Pioneer	4	11.0
Other[1]	0	0.0
Total	36	100.0

1. The increase in other licensed elevators in Table 6.3 is due to 1) purchase of an elevator from either UGG or Paterson and 2) construction of 2 seed plants.

Gilson talks and the passage of the Act. Considering the time lag between the beginning of the decision making process and commencement to build, elevator construction in 1985/86 may also reflect this confidence.

Table 6.3 lists the number of operating units licensed by each company[1] in Manitoba between crop years 1979/80 and 1989/90 and each company's share of the elevator facilities. Table 6.4 lists the number of elevators constructed in Manitoba by each company during the 1980s. Comparison of the two tables indicates that within Manitoba, Manitoba Pool Elevators, United Grain Growers and Paterson built proportionally less elevators in terms of their share of licensed operating units. Conversely, Cargill and Pioneer constructed proportionally more elevators when measured in terms of licensed operating units.

Table 6.5 and 6.6. list the number of operating units licensed by the various grain companies in Saskatchewan. Like Manitoba Pool Elevators, Saskatchewan Wheat Pool constructed proportionately fewer new elevators relative to its share of total elevators. The three other major grain elevator companies, UGG, Cargill and Pioneer built proportionally more new facilities relative to their total operating units. Only Cargill and Pioneer increased their share of licensed elevators in both Saskatchewan and Manitoba.

[1] The number of operating units was used rather than the number of elevators as many companies had more than one elevator at a delivery point.

Table 6.5 Number of Operating Units Licensed by Company, in Saskatchewan, 1979/80 to 1989/90.

Company	Number of Operating Units 1979/80	Number of Operating Units 1989/90	Percent Share of Operating Units 1979/80	Percent Share of Operating Units 1989/90
Sask Wheat Pool	728	481	57.2	57.3
United Grain Growers	170	111	13.4	13.2
Cargill	98	55	7.7	6.6
Pioneer	213	149	16.7	17.8
Other	63	43	5.0	5.1
Total	1272	839	100.0	100.0

Table 6.6. Primary Elevator Construction by Company, Saskatchewan, 1980/81 to 1989/90.

Company	Number of Operating Units	Percent Share of Elevators Constructed
Saskatchewan Wheat Pool	22	44.0
United Grain Growers	10	20.0
Cargill	6	12.0
Pioneer	11	22.0
Other	1	2.0
Total	50	100.0

Tables 6.7 and 6.8 list the number of replacement and expansion elevators built within each province in the 1980s. One third of the elevators constructed in Manitoba were expansion market elevators, ie. companies seeking to operate at points where they previously did not operate. In Saskatchewan only eight percent

were expansion market elevators. In Manitoba, 8 of the 12 expansion elevators were built at newly created points. It may be hypothesized that elevator representation in Saskatchewan is so extensive that it is difficult to find suitable new locations. Nevertheless, there may be a particular reluctance on the part of grain companies operating in Saskatchewan to build an elevator at a point where they have no experience as the risks are greater than when building a replacement elevator at a

Table 6.7 Number of Elevators Constructed by Type, Manitoba, 1980/81 to 1989/90.

Type of Elevator	Number of Points	Percent
Replacement	24	66.6
Expansion	12	33.3
Total	36	100.0

Table 6.8 Number of Elevators Constructed by Type, Saskatchewan, 1980/81 to 1989/90.

Type of Elevator	Number of Points	Percent
Replacement	46	92.0
Expansion	4	8.0
Total	50	100.0

point where producer delivery patterns and competitor behaviour are known[2].

Tables 6.9 and 6.10 list the type of elevator built by company. In Manitoba, Cargill and Pioneer built a proportionately higher percentage of expansion elevators

[2] Total construction costs are also less at replacement sites. Industry representatives indicated the cost of building a 3500 tonne elevator in the 1980s was approximately 1 million dollars. The cost of building in a new market can increase to 1.75 million dollars as companies need to purchase land, and trackage.

Table 6.9 Number of Elevators Constructed by Elevator Type and Company, Manitoba, 1980/81 to 1989/90.

Company	Replacement	Expansion	Total
Manitoba Pool	12	5	17
United Grain Growers	5	2	7
Cargill	4	3	7
Pioneer	2	2	4
Paterson	1	0	1
Total	24	12	36

Table 6.10. Number of Elevators Constructed by Elevator Type and Company, Saskatchewan, 1980/81 to 1989/90.

Company	Replacement	Expansion	Total
Saskatchewan Pool	22	0	22
United Grain Growers	8	2	10
Cargill	4	2	6
Pioneer	11	0	11
Other	1	0	1
Total	46	4	50

than did the cooperatives. In Saskatchewan, only four expansion elevators were constructed while all SWP and Pioneer elevators constructed replaced existing facilities.

Tables 6.11 and 6.12 indicate the type of point at which elevators were constructed. Overall there was a tendency for companies to build at multicompany

Table 6.11 Number of Elevators Constructed by Type of Point, Manitoba, 1980/81 to 1989/90.

Type of Point	Number of Points	Percent
Multicompany	21	58.3
Single company	15	41.7
Total	36	100.0

Table 6.12 Number of Elevators Constructed by Type of Point, Saskatchewan, 1980/81 to 1989/90.

Type of Point	Number of Points	Percent
Multicompany	42	84.0
Single company	8	16.0
Total	50	100.0

delivery points. Fifteen elevators, 42 percent, were constructed in Manitoba at single company points where there were no competitors. In comparison, only 8 elevators, 16 percent of the elevators constructed, were built at single company points in Saskatchewan.

Tables 6.13 and 6.14 list the number of elevators built by company within Manitoba and Saskatchewan by type of point. In Table 6.13 two types of investment strategies became apparent in Manitoba, clustering and spatial monopoly. Cargill built exclusively at competing points which is more indicative of clustering. UGG was next aggressive, building 5 of their 7 elevators at multicompany points. Manitoba Pool Elevators built ten of their 17 elevators at single points where there were no competitors. This is indicative of a spatial monopolist.

Table 6.13. Number of Elevators Constructed by Type of Point and Company, Manitoba, 1980/81 to 1989/90.			
Company	Multicompany	Single Company	Total
Manitoba Pool	7	10	17
United Grain Growers	5	2	7
Cargill	7	0	7
Pioneer	2	2	4
Paterson	0	1	1
Total	21	15	36

Table 6.14. Number of Elevators Constructed by Type of Point and Company, Saskatchewan, 1980/81 to 1989/90.			
Company	Multicompany	Single Company	Total
Saskatchewan Pool	15	7	22
United Grain Growers	10	0	10
Cargill	5	1	6
Pioneer	11	0	11
Other	1	0	1
Total	42	8	50

With the exception of SWP, the grain companies in Saskatchewan tended to build at multicompany points. The seven elevators built by SWP at single company points were replacement elevators, indicating that the company was seeking to maintain its market coverage. The only Cargill elevator built at a single point was an expansion market elevator as the company had not previously been located at that point.

Tables 6.15 and 6.16 itemize the number of elevators built at existing and newly created points. MPE built at 5 of the 8 newly created delivery points. United Grain Growers located at one new point, and Pioneer at two points. Manitoba Pool's strategy of building at new points may also be indicative of a reluctance to compete with other elevator companies at the same point. While the creation of new delivery points may also be indicative of MPE desire to expand market coverage, increased coverage could also be achieved at existing single and multicompany delivery points. The single point at which Cargill built an elevator in Saskatchewan was the only newly created delivery point in that province. The remaining points in Saskatchewan at which elevators were built were existing delivery points.

Table 6.15. Status of Delivery Points at which Elevators Were Constructed, Manitoba, 1980/81 to 1989/90.

Status	Number of Elevators	Percent
Created Point	8	22.2
Existing Point	28	77.8
Total	36	100.0

Table 6.16. Status of Delivery Points at which Elevators Were Constructed, Saskatchewan, 1980/81 to 1989/90.

Status	Number of Elevators	Percent
Created Point	1	2.0
Existing Point	49	98.0
Total	50	100.0

Tables 6.17 and 6.18 list the range and average capacity of elevators constructed in Manitoba and Saskatchewan, respectively. The average size of existing grain elevators in Manitoba in 1979/80 was 2,823 tonnes and this had increased to 3,941 tonnes by 1989/90. This increase was partially due to larger elevators built during that period but primarily due to the closure of smaller elevators. Within Manitoba, Cargill built the largest elevators, with the hierarchy of size constructed by other companies being MPE, Pioneer, Paterson and United Grain Growers. The capacity of the new elevators constructed within Manitoba averaged 5,137 tonnes.

Table 6.17. Capacity of Elevators Constructed by Company, Manitoba, 1980/81 to 1989/90.

Company	Low (tonnes)	High (tonnes)	Average Capacity
Manitoba Pool	2610	13140	5475
United Grain Growers	2240	6020	4149
Cargill	3360	10650	5616
Pioneer	3800	5600	4737
Paterson	4550	4550	4550
All Companies			5137

Within Saskatchewan, the average size of existing grain elevators in 1979/80 was 2,441 tonnes and this had increased to 4,037 tonnes by 1989/90. Over the decade, the average size of elevator constructed in Saskatchewan was 4,208 tonnes, almost 20 percent smaller than were elevators constructed in Manitoba. This was partially due to SWP building slightly smaller elevators than Manitoba Pool. However, the major explanation is that UGG, Cargill and Pioneer built smaller

Table 6.18 Capacity of Elevators Constructed by Company, Saskatchewan, 1980/81 to 1989/90.			
Company	Low (tonnes)	High (tonnes)	Average Capacity
Saskatchewan Wheat Pool	1490	10200	4985
United Grain Growers	2730	4620	3463
Cargill	2990	5040	3922
Pioneer	1540	4500	3121
Other	8250	8250	8250
All Companies			4208

elevators in Saskatchewan than in Manitoba. The larger elevators constructed in Manitoba may be indicative of "a keep up with the Jones" approach. Only in 1987 did SWP begin building their 10,200 tonne concrete elevators.

Table 6.19 shows that all the grain elevator companies in Manitoba built larger replacement elevators than expansion elevators. It could be argued this occurred because firms have better information in known as compared to unknown markets, thus there is less risk. However, the opposite relationship was found true in Saskatchewan as Table 6.20 indicates that expansion elevators were larger than replacement elevators. This result could be biased by the small number of expansion elevators observations relative to replacement elevators.

Table 6.19 shows that Cargill tends to construct elevators in Manitoba on rail mainlines. The other grain elevator companies do not appear to differentiate between mainlines and branch lines. Cargill is the most aggressive grain elevator company in Manitoba from the standpoint of always building at multicompany points, while also ensuring that their elevators are built on secure rail lines. They also build smaller elevators in markets where they have no experience. Of the total 36 elevators constructed in Manitoba, 20 were on mainlines.

Table 6.20 shows Saskatchewan grain elevator companies have a greater tendency to build on branch lines. Only 13 of 50 elevators constructed, 26 percent, were located on mainlines as compared to 56 percent in Manitoba. The fact that a high proportion, 74 percent, of Saskatchewan elevators were built on branch lines may also partially explain why smaller elevators, on average, were built in Saskatchewan.

Table 6.19 Mainline/Branchline Placement and Average Capacity of Expansion and Replacement Elevators Constructed, Manitoba, 1980/81 to 1989/90.

	Expansion Elevator ML/BL number	Replacement Elevator ML/BL number	Expansion Elevator Avg Size tonnes	Replacement Elevator Avg Size tonnes
Manitoba Pool	3/2	5/7	5216	5582
United Grain Growers	1/1	3/2	3080	4576
Cargill	3/0	3/1	3573	7147
Pioneer	1/1	1/1	4700	4775
Paterson	0/0	0/1	-	4550
Total	8/4	12/12	4363	5523

Table 6.20 Mainline/Branchline Placement and Average Capacity of Expansion and Replacement Elevators Constructed, Saskatchewan, 1980/81 to 1989/90.				
	Expansion Elevator ML/BL number	Replacement Elevator ML/BL number	Expansion Elevator Avg Size tonnes	Replacement Elevator Avg Size tonnes
Saskatchewan Pool	0/0	8/14	-	4985
United Grain Growers	0/1	2/7	4620	3334
Cargill	1/1	1/3	4340	3712
Pioneer	0/0	1/10	-	3121
Other	0/1	0/0	-	8250
Total/Average	1/3	12/34	4480	4105

Support for the conclusion that Cargill is more aggressive in its investment approach was found in a survey undertaken by Deloitte, Haskins and Sells[3] for UGG. These consultants indicated that Cargill was the most competitive with respect to fertilizer, herbicide and non-board grain services. This perhaps explains Cargill's willingness to compete with other grain companies at the same points. When given key word choices to describe major companies, the percentages of the respondents describing the individual grain companies as competitive were as follows:

[3] Deloitte, Haskins and Sells. "Determination Of Features Considered By Farmers When Selecting A Grain Company". Winnipeg, January, 1984.

Cargill	85
UGG	64
Pioneer	60
MPE	44
SWP	40
AWP	31

The principal key words describing each of the companies is also enlightening:

MPE	Friendly,Reliable and Honest (each 55 percent)
SWP	Big (50 percent)
AWP	Businesslike (56),Big(50) and Complacent (44)
Pioneer	Well Managed(80),Honest and Friendly (70)
Cargill	Aggressive (60), Businesslike(55)
UGG	Well Managed(44), Businesslike(39)

In summary for Manitoba, Manitoba Pool Elevators and Pioneer are more likely to build new elevators at single points and more willing to build replacement elevators at multicompany points. Deliveries and patronage expectations are more certain and less risky in existing markets than in new markets, therefore the replacement elevators constructed are larger than expansion elevators. Conversely, Cargill continues to build new elevators at multicompany points whether or not they have previous experience in that market.

It is more difficult to come to any conclusion regarding investment strategies in Saskatchewan as so few expansion elevators were constructed. Of the few built, three of the four were built at multicompany points. This is completely opposite to that found in Manitoba where two thirds of expansion elevators were built at single points. However, two conclusions may be drawn. First, the Saskatchewan elevator system is more extensive than that in Manitoba. Consequently there are fewer opportunities and less need to create new delivery points. Second, it appears that grain elevator companies in Saskatchewan " set the stage" for a competitive environment by indicating their willingness to compete with each other at the same points.

6.2. Comment on Explanatory Variables in Selected Manitoba and Saskatchewan Open Logit Models.

In Chapter 5, point and market characteristics and company strategies were hypothesized to affect the location grain companies choose to build an elevator. These were grouped into four categories, 1) market productivity, 2) market competition, 3) investment strategies and 4) rail and road facilities. Several variables were proposed for each category on a priori grounds. In many instances, several measures were proposed: as 1) there were different data sources available for different time periods, 2) it was not clear whether point, linear or areal data would best measure productivity and competitive point characteristics, and 3) multicollineary between many of the variables would result in large standard errors therefore possibly understating the significance of a particular independent variable in explaining the variations in the dependent variable.

The relationships between some of the variables analyzed in the Manitoba and Saskatchewan open logit model are discussed in order to illustrate why some of these variables were not incorporated in the model and why others were chosen.

6.2.1. Manitoba Open Logit Model

The explanatory variables used in the Manitoba open logit model to predict the probability of elevator construction at delivery points were RQI, VOLCO3, CF, COV and PRES.

RQI	= Road quality index.
VOLCO3	= Three year average annual volume per company measured at adjacent rail points and the sample point. Data measured in thousands of tonnes.
CF	= Total elevator capacity of all points on the polygon fringe, including the sample point, measured in thousands of tonnes.
COV	= Market coverage. This is a measure of market maintenance and expansion strategies, measured in terms of the age of a company's own newest elevator at either the sample point or adjacent rail elevator points. The values are the inverse of elevator age. Therefore the COV values range from 0 to 1. For example, a value of 1 represents an elevator 1 year old and a value of .02 represents a 50 year old elevator.
PRES	= A dummy variable representing the presence of a competitor in the local market. A value of 1 is assigned if a competing elevator firm has constructed a new elevator at either the sample point or adjacent points within the past three years.

The variable VOLCO3 is both a market productivity and competition measure as it is derived by dividing the average three year deliveries in the linear market, LVOL3 which represents those at the sample point and the adjacent points, by the number of companies at these same points, NL. The correlation between LVOL3 and NL was .72 suggesting collinearity between the two variables. The derived variable volume per company, VOLCO3, thus avoided the multicollinearity problems experienced between volume LVOL3 and number of companies, NL.

The three year average linear volume, LVOL3, was also highly correlated with fringe capacity, CF, the correlation being .71. The variable VOLCO3 avoids the multicollinear problem as the correlation coefficient between VOLCO3 and CF observations was only .16.

Other pairs of variables were not included in the model as they resulted in fewer correct predictions and coefficients which were not significant. Some of this may be due to collinearity between the variables. Not surprisingly, the following pairs of variables[4] had high collinear coefficients.

PTCAP	PTNO	.68
CF	NF	.68
CL	NL	.65
FVOL3	NF	.70

In other instances, variables were excluded as they were not the best measure of either productivity or competition.

None of the variables PRES, PREM, POST and COV, representing different investment strategies were highly correlated with the dependent variable. The correlation coefficients ranged between .08 and .29. The variable PREM was not significant in the analysis indicating there was no preemptive behaviour. However,

[4]PTCAP=Point Capacity; PTNO= number of elevator companies at the point; CF = total elevator capacity among delivery points on market fringe; NF = number of elevator companies at delivery points on the market fringe; CL = total elevator capacity among delivery points in linear market; NL = number of elevator companies at delivery points in the linear market; FVOL3 = three year average deliveries to fringe delivery points.

the PRES and COV variables[5] indicate that the presence of a new competitive elevator and the age of an alternative company elevator affect the decision where to build an elevator.

The two measures of type of rail facilities 1) grain dependent status and 2) grain tonne miles did not add to the explanatory power of the model. Neither of these two variables independently or jointly as an interactive variable were able to capture the numerous aspects of grain movements that might be important to the location of elevator construction. For example, a branch line may be grain dependent and have a high volume of grain hauled per mile of track. No suitable quantitative variable was found nor any combination of dummy variables which could act adequately as proxies for the variables.

The variable VOLCO3 which represented the three year mean volume of grain delivered within a linear market was expected to give better results than either 10 year or annual data. It was not expected that the 10 year average would be representative of current grain deliveries to elevator points as elevator rationalization and rail line abandonment continually force grain deliveries to be redirected to the remaining elevators. Consequently, it would tend to understate deliveries to a point. Annual data was also not expected to be representative of deliveries as bumper crops or drought conditions do not reflect average delivery levels.

The variable CF measures market fringe whereas VOLCO3 is a linear market

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[5]The variable POST is a subset of COV as COV includes not only market maintenance but market expansion in a region as well.

measure. If fringe market capacity is a reasonable measure of competition, it makes sense that an elevator company would take this factor into account at the sample point, as farmers are not restricted as to where they can deliver their grain. The linear aspect of the variable VOLCO3 is not surprising given there was a 72 percent correlation between the fringe and linear market estimate of expected company volume. Also the linear measure may be a better measure if it provides information as to how the distribution of rail cars along a train run[6] may be affected.

6.2.2. *Saskatchewan Open Logit Model*

The explanatory variables in the selected Saskatchewan model include RQI, PTCAP, FTOVERA and POST.

RQI	= Road quality index.
PTCAP	= Total elevator capacity at sample point measured in thousands of tonnes.
FTOVERA	= Turnover rate of market fringe based on annual deliveries and elevator capacity.
POST	= The age of newest own company elevator at the sample point or adjacent points.

The correlation coefficient between annual volume, FVOLA, and fringe capacity, CF, was .83 indicating a high degree of multicollinearity. Another explanatory variable PTCAP was also highly collinear with CF and FVOLA, as the

[6]The number of rail cars allocated to a company by the GTA was based on the volume of board grain and offboard grains handled. The cars were then allocated to train runs, on which both the sample point and adjacent points would be located. This procedure has since been revised. Companies can redirect cars allocated to them anywhere within a shipping block or even between blocks.

correlation coefficients were .59 and .65, respectively. Consequently using FTOVERA reduced the problems associated with collinearity as the correlation coefficient between PTCAP and FTOVERA was only .10 reducing the likelihood of large standard errors due to collinearity.

Surprisingly FTOVERA was a better measure than FTOVER3. However, inspection of the correlation coefficients between these two variables indicates a correlation coefficient of .83. The correlation between the linear market measure of the same derived variables, LTOVERA and LTOVER3 was .85. Also the correlation between the linear three year and annual data, LVOLA and LVOL3 was .94 and, .92 between fringe three year and annual volume measures, FVOL3 and FVOLA.

These results indicate that the three year and annual data are highly correlated. This is possible considering the time frame and the manner in which the data was collected. Data pertaining to annual volumes was collected for two crop year preceding the year which an elevator was constructed. Three year average data was collected the second, third and fourth crop year preceding the year the elevator was built. Therefore, both annual and three year volume data were collected every year between 1976/77 to 1987/88. It is therefore likely that on average, annual data was just as representative of actual delivery levels as three year average volumes as in those annual volume observations which deliveries may have been underestimated due to drought or infestation were offset by annual volumes observations in other years which overestimated typical delivery levels as a result of bumper crops.

6.3 Manitoba Open Model Results

6.3.1. Statistical Inference of Manitoba Open Model

The model estimating elevator construction in Manitoba was chosen on the basis of correct sign, significance of the coefficients, percent correct predictions and the log likelihood function. The following logit model predicting the probability of opening an elevator in Manitoba was chosen.

$$Z= -1.1788 +.22960\ RQI +.11848\ VOLCO3 -.075394\ CF -12.306\ COV + 1.3465\ PRES$$

where

Z	< .50 predicts construction will not take place.
Z	≥ .50 predicts elevator construction will take place.
RQI	= Road quality index.
VOLCO3	= Three year average annual volume per company measured at adjacent rail points and the sample point. Data measured in thousands of tonnes.
CF	= Total elevator capacity of all points on the polygon fringe, including the sample point, measured in thousands of tonnes.
COV	= Market coverage. This is a measure of market maintenance and expansion strategies, measured in terms of the age of a company's own newest elevator at either the sample point or adjacent rail elevator points. The values are the inverse of elevator age. Therefore the COV values range from 0 to 1. For example, a value of 1 represents an elevator 1 year old and a value of .02 represents a 50 year old elevator.

PRES = A dummy variable representing the presence of a competitor in the local market. A value of 1 is assigned if a competing elevator firm has constructed a new elevator at either the sample point or adjacent points within the past three years.

Details on the statistical analysis including the number of observations, the log likelihood function, the estimated coefficients, the standard error, t statistics and the percent correct predictions are presented in Appendix B.

6.3.1.1. Signs and Significance of Coefficients in Manitoba Open Model

Variables RQI, VOLCO3 and PRES all had positive signs as expected indicating that as the values associated with these variables increased, the probability of constructing an elevator increased. Conversely, CF and COV had the expected negative signs indicating the probability of construction would increase as the variable values decreased.

Since the direction of the effect of variables RQI, VOLCO3, CF, PRES and COV was anticipated, the significance of the coefficients is determined by a one-tailed t-test. The null hypotheses that each slope coefficient equals zero is rejected for all the variables as the coefficients are all statistically significant at the following levels.

	T statistics	Significance Level
RQI	2.5042	.025
VOLCO3	2.2696	.025
CF	2.3984	.025
COV	2.0320	.025
PRES	2.0784	.025

6.3.1.2 .Goodness of Fit of Manitoba Open Model

One goodness of fit test examines the joint hypothesis that all the coefficients, except the intercept, are zero, H^0 : RQI = VOLCO3 = CF COV = PRES = 0. A c statistic is calculated from the maximum value (L^0) of the constrained log likelihood function (LLC) where all coefficients are set equal to zero, and the log likelihood (L^2) of the unconstrained equation (LLUC).

c= -2 (LLC - LLUC) = -48.52 - -35.75 = 25.54

Based on five degrees of freedom and a 99.5 significance level, the null hypothesis that the coefficients equal zero is rejected as the c statistic of 25.54 is greater than the critical square statistic of 16.75.

The percent correct predictions also measures the model's explanatory power. Based on the estimated probability levels, outcomes Y=0 or Y=1 can be predicted. Assuming a P(Y=1) greater than fifty percent evokes an outcome of 1, elevator construction and a P(Y=1) less than fifty percent evokes an outcome of 0, no construction, the predicted outcomes can be compared to the actual outcomes. The correct outcome was predicted for 57 of the 70 observations or 81 percent of the points. A major problem with this measure is it does not measure the degree of error. For example, probabilities of 51 and 99 percent would both yield a predicted outcome of 1. However, if both elevators were not constructed, the prediction error may be more serious in the second case.

The percent correct predictions within each subsample is also a measure of the model's overall goodness of fit. Table 6.21 presents the number of correct predictions for each subsample, Y=0 and Y=1. The model correctly predicted 26 or 76 percent of the 34 actual points where elevator construction would not take place, Y=0. Fewer prediction errors occurred in subsample Y=1 as the correct outcome was predicted at 31 or 86 percent of the 36 points.

Table 6.21. Correct Predictions for Each Subsample of Manitoba Open Model.

Actual	Predicted		Total
	0	1	
0	26	8	34
1	5	31	36
			70

Assuming the true probabilities of construction were 0 at points where construction did not occur, and 100 percent at points elevators were constructed, the forecast error and forecast error variance were calculated of the correct predictions. The average forecast errors for subsamples n1 (Y=0) and n2 (Y=1) were 34.4 and 32.5 percent, respectively. The forecast error variances for subsamples n1 and n2 were 16.6 and 16.1, respectively. These results indicate the variation in the predicted probabilities about the true probability are not significantly different within each subsample.

The average forecast error about the incorrect predictions in subsample n1, Y=0, was 66 percent indicating that the incorrect probability of construction predictions averaged 66 percent rather than 0. The average forecast error associated with subsample n2, Y=1, was 82 percent indicating that the incorrect probability of construction predictions averaged 18 percent rather than 100 percent. In both cases, the prediction errors were large and did not fall near the 50 percent probability level as might be expected. As the errors associated with incorrect predictions were so large, defining a range of indecision, ie 35 - 65 percent about the 50 percent probability level would be unproductive as it would not capture the errors.

6.3.2. Sensitivity Analyses: The Effect of Elevator Characteristic Levels on the Probability of Elevator Construction in Manitoba.

In linear regression analysis, the coefficients indicate the direction of change and the magnitude of the effect of a change in an explanatory variable (x_i) on the dependent variable (y). Because the relationship is linear, changes of equal size in an independent variable (Δx) will yield changes in the dependent variable (Δy) which are also equal in size. In the logit model used, equal changes in an explanatory variable will yield equal changes in the estimated Z values as the relationship between the estimated coefficients and their corresponding explanatory variables is linear. However, the relationship between the Z value and the probability of construction is nonlinear, hence changes in an independent variable cannot be assumed to yield equal changes in probability.

Since the relationship between an explanatory variable and the predicted probability is nonlinear, a description of the effect of explanatory values on the predicted probability is complex. When there is more than one explanatory variable involved, explanation of the probability changes becomes even more complex as the predicted probability depends not only on the value of the explanatory variable under analysis, but also on the values of the remaining explanatory variables.

To analyze the effect of changing explanatory values upon the predicted probabilities, tables are utilized incorporating relevant values of the explanatory variables. The range and mean values of the explanatory variables are useful in determining interesting and pertinent values of the explanatory variables to assess. Tables 6.22 and 6.23 list the mean values and the range of the explanatory variables for the total Manitoba sample (N), and the subsamples n1, points at which construction did not occur (Y=0) and n2 points where construction occurred (Y=1).

Table 6.22 Variable Mean Values within Manitoba Open Model, Sample and Subsamples.

Sample	RQI	VOLCO3	CF	COV	PRES
n1 (Y=0)	7.8	15.8	36.3	.129	.38
n2 (Y=1)	9.6	18.3	32.3	.043	.47
N (Y=1,Y=0)	8.8	17.1	34.2	.085	.43

Table 6.23 Range of Variable Values within Manitoba Open Model, Sample and Subsamples.

Sample	RQI	VOLCO3	CF	COV	PRES
n1 (Y=0)	2-12	8.2 - 33.5	19.7 - 69.7	0 - 1	0 - 1
n2(Y=1)	2-16	8.6 - 32.4	14.5 - 51.7	0 - .37	0 - 1
N (Y=1,Y=0)	2-16	8.2 - 33.5	14.5 - 69.7	0 - 1	0 - 1

An analyses of the mean values alone do not provide very much information. Consequently, a range of values for each explanatory variable is assessed, the range being guided by the spread of values existing throughout the sample observations. In order to assess systematically the impact of adjusting the magnitude of an explanatory variable, only one variable was considered at a time. For example, in the Manitoba open model, each explanatory variable RQI, VOLCO3, CF and COV is individually assessed in scenarios 1 through 4, respectively. For identification purposes, the variable adjusted in each scenario is referred to as the principal variable. As any changes in the value of the principal explanatory variables are dependent on the values of the remaining explanatory variables, three sets of remaining variable values are assessed. The three sets of values assessed are the N sample and the n1 and n2 subsample means, each presented in a different frame. The N sample mean values are presented in the base frame. Subsample n1 and n2 mean values are presented in frames D1 and D2, respectively[7]. Throughout each frame, the remaining variables are held constant at their mean values to test the effect of incremental increases in the principal variable. For example, to determine the effect of road quality on the probability of elevator construction, road quality index values of 2, 4, 6, 8, 10 and 12, were analyzed in Scenario 1, Table 6.24. The remaining explanatory variables, VOLCO3, CF and COV were held constant at their sample (N) mean values, 17.1, 34.2 and .07, respectively, in the base frame. In frames D1 and D2, the remaining variables assumed n1 and n2 sample values, respectively.

The frames can be ranked with respect to the desirability of the point characteristic values. Those values in frame D2 represent points with more desirable

[7]The probabilities arising when only one of the remaining variable values is changed to n1 or n2, mean values while the remaining two variables continue to assume N mean values are presented in frames A1, A2, B1, B2, C1 and C2 in Appendix C.

characteristics. The values in the base frame represent points having moderately desirable characteristics and the values in frame D1 reflect points with less desirable point characteristics.

As mentioned previously, there are 3 frames within each scenario in which the remaining variables assume either N, n1 or n2 mean sample values. However, as the variable PRES is a dummy variable assuming values of 0 or 1, an average value is misleading. To show the effect of PRES on the probability of construction, two sets of predicted probabilities have been estimated for each frame. Array 1 displays the predicted probabilities when PRES assumes a zero value and Array 2 when PRES assumes a value of one.

In summary, each scenario table lists the values assumed by the principal variable, the values assumed by each remaining variable, the corresponding Z values for each array, the predicted probability associated with each array and the difference in probability between array 1 and 2.

6.3.2.1. Road Quality Index: Scenario 1

In scenario 1, Table 6.24, road quality index values of 2,4,6,8,10 and 12 were analyzed. As the RQI index increased so did the probability of elevator construction in each frame across both arrays. The change in the probability associated with an increase in the RQI from 2 to 12 ranged from 38 to 51 percent. With the exception of frame D1/array 1, raising the road quality index changed the predicted outcome. In frame D1/array 1, it appears the drawbacks associated with the other variable values outweighed the benefits associated with improved road access.

Table 6.24 RQI Sensitivity Analysis , Manitoba Open Logit Model

Frame	RQI	VOLCO3	CF	COV	Z1	Z2	PROB 1	PROB 2	DIFF
					Array 1	Array 2	Array 1	Array 2	
Base	2	17.1	34.2	0.0	-2.010	-0.4	0.11	0.34	0.222
	4	17.1	34.2	0.0	-1.551	-0.205	0.17	0.44	0.274
		17.1	34.2	0.0	-1.092	0.254	0.25	0.53	0.312
	8	17.1	34.2	0.0	-0.33	0.714	0.34	0.71	0.324
	10	17.1	34.2	0.0	-0.174	1.173	0.45	0.74	0.307
	12	17.1	34.2	0.0	0.28	1.32	0.57	0.83	0.200
	Total						0.45	0.49	0.284
D1	2	15.8	3.3	0.07	-2.44	-1.099	0.08	0.25	0.170
	4	15.8	3.3	0.07	-1.987	-0.40	0.12	0.34	0.225
	6	15.8	3.3	0.07	-1.527	-0.181	0.17	0.45	0.277
	8	15.8	3.3	0.07	-1.08	0.278	0.25	0.59	0.313
	10	15.8	3.3	0.07	-0.09	0.737	0.35	0.70	0.324
	12	15.8	3.3	0.07	-0.150	1.197	0.43	0.78	0.305
	Total						0.38	0.52	0.290
D2	2	18.3	32.3	0.04	-1.479	-0.132	0.18	0.47	0.281
	4	18.3	32.3	0.04	-1.020	0.327	0.25	0.58	0.310
	6	18.3	32.3	0.04	-0.50	0.78	0.33	0.87	0.324
	8	18.3	32.3	0.04	-0.101	1.245	0.47	0.77	0.302
	10	18.3	32.3	0.04	0.358	1.704	0.59	0.84	0.258
	12	18.3	32.3	0.04	0.817	2.14	0.94	0.90	0.203
	Total						0.52	0.43	0.281

A comparison of the predicted probabilities of construction in arrays 1 and 2 indicates that the presence of a new competitive elevator at the sample point or adjacent points, increases the probability of construction by 28 percent, on average. This increase in probability points to a "keep up with the Jones" approach in their investment decisions. Of the 36 sample delivery points at which elevators were built, 17 had new competitive elevators at the sample point or at adjacent rail points.

At points with low to moderate elevator characteristic values, such as those represented in the base frame and frame D1, the quality of road can affect the decision to construct an elevator. At the better quality points, an increase in the RQI only becomes a decision variable if a competitive elevator is not present such as in D2/array 1. Whereas at better points if a new competitive elevator is present, D2/array 2, the model predicts an elevator would be constructed even with an RQI of 2. Consequently any increase in road quality access may only validate the decision to construct rather than being instrumental in the decision.

6.3.2.2. Average Company Volume: Scenario 2

In scenario 2, expected elevator deliveries of 12, 15, 18, 21, 24 and 27 thousand tonnes were analyzed. In all the frames in Table 6.25, the probability of elevator construction increased between 23 and 41 percent as elevator delivery volumes increased.

An increase in elevator volume changed the predicted outcome in every frame of array 1. In frame D1, the outcome changed between 24,000 and 27,000 tonnes (i.e. probability moved from <.5 to >.5), between 18,000 and 21,000 tonnes in the

Table 6.25 VOLCO3 Sensitivity Analysis, Manitoba Open Logit Model .

Frame	VOLCO3	RQI	CF	COV	Z1	Z2	PROB 1	PROB 2	DIFF
					Array 1	Array 2	Array 1	Array 2	
Base	12	8.8	34.2	0.06	-1.053	0.293	0.259	0.573	0.314
	15	8.8	34.2	0.06	-0.698	0.649	0.332	0.657	0.324
	18	8.8	34.2	0.06	-0.343	1.004	0.415	0.732	0.317
	21	8.8	34.2	0.06	0.013	1.359	0.503	0.796	0.292
	24	8.8	34.2	0.06	0.368	1.715	0.591	0.847	0.256
	27	8.8	34.2	0.06	0.724	2.070	0.673	0.888	0.215
	Total/Avg						0.415	0.315	0.286
D1	12	7.8	36.3	0.07	-1.564	-0.218	0.173	0.446	0.273
	15	7.8	36.3	0.07	-1.209	0.138	0.230	0.534	0.304
	18	7.8	36.3	0.07	-0.854	0.493	0.299	0.621	0.322
	21	7.8	36.3	0.07	-0.498	0.848	0.378	0.700	0.305
	24	7.8	36.3	0.07	-0.143	1.204	0.464	0.769	0.273
	27	7.8	36.3	0.07	0.213	1.559	0.553	0.826	0.300
	Total/Avg						0.380	0.381	0.300
D2	12	9.6	32.3	0.04	-0.480	0.866	0.382	0.704	0.322
	15	9.6	32.3	0.04	-0.125	1.222	0.469	0.772	0.304
	18	9.6	32.3	0.04	0.231	1.577	0.557	0.829	0.271
	21	9.6	32.3	0.04	0.586	1.932	0.642	0.874	0.231
	24	9.6	32.3	0.04	0.941	2.288	0.719	0.908	0.188
	27	9.6	32.3	.04	1.297	2.643	0.785	0.934	0.148
							0.403	0.230	0.244

base frame and between 15,000 and 18,000 tonnes in frame D2. This indicates that at points with other less desirable characteristics, expectations of higher elevator volumes are required to induce construction, as market risks may be considered greater and market coverage already sufficient. Conversely, points exhibiting other more desirable characteristics may not require as high elevator volumes to induce companies to construct an elevator as the competition may be less and the need to construct an elevator more compelling.

A comparison of the three frames in array 2 shows that the total change in the probability of construction attributed to an increase in the volume delivered, declines as points assume more desirable characteristics. Also an increase in elevator deliveries did not change the outcome in the base frame or frame D2 of array 2 as the probability of construction at the lowest elevator volume tested, 12,000 tonnes, was already over 50 percent. Consequently, any increase in volume only validates the probability of construction.

The probability of construction increased, on average, 28 percent in array 2 if a competitor had built a new elevator at either the sample point or adjacent points within the last three years. However, the effect of incremental increases in company volumes on the probability of construction were not augmented by the presence of a new competitive elevator. Rather the reverse occurred. At volumes between 12,000 and 15,000, the probability of construction exceeded 50 percent in array 2 due to the presence of a new competitive elevator. Once the probability of construction exceeds 50 percent, increases in company volumes cause the probability to increase but at a decreasing rate. Consequently, raising company volumes from 12,000 to 27,000 yields lesser changes in the probabilities in array 2 as compared to array 1.

6.3.2.3. Fringe Capacity: Scenario 3

Fringe capacity values of 20, 30, 40, 50, 60 and 70 thousand tonnes were analyzed in scenario 3. As shown in Table 6.26, raising the fringe elevator capacity between 20,000 and 70,000 tonnes reduced the probability of construction between 50 and 74 percent in all frames. Not only did the probability of elevator construction decline as fringe capacity increased, but the predicted outcome also changed in every frame over the range of fringe capacities analyzed.

It would appear that Manitoba grain elevator companies consider increased elevator capacity to be synonymous with increased competition. Increased elevator capacity in an area signifies greater competition in two ways. Higher elevator capacity in an area may be indicative of larger elevators in the region. If so, these competitors may have greater ability to store incoming deliveries and able to offer transportation incentives. Increased elevator capacity in an area may also indicate there are many competitors thus dividing up the volume of deliveries.

The model indicates that in all probability, an elevator company would not construct an elevator at a delivery point, if elevator capacity in the surrounding fringe is high. In the base frame and frame D1 of array 1, the predicted outcome changed at fringe capacities between 20,000 and 30,000 tonnes. At points that exhibited desirable characteristics such as those in frame D2/array 1, the fringe capacity increased to 30,000 to 40,000 tonnes before the outcome changed.

Table 6.26 Sensititivity Analysis, CF, Manitoba Open Logit Model									
Frame	CF	RQI	VOLC	COV	Z1	Z2	Prob 1	Prob 2	Diff
					Array 1	Array 2	Array 1	Array 2	
Base	20	8.8	17.1	0.06	0.621	1.968	0.651	0.877	0.227
	30	8.8	17.1	0.06	-0.132	1.214	0.467	0.771	0.304
	40	8.8	17.1	0.06	-0.886	0.460	0.292	0.613	0.321
	50	8.8	17.1	0.06	-1.640	-0.294	0.162	0.427	0.265
	60	8.8	17.1	0.06	-2.394	-1.048	0.084	0.260	0.176
	70	8.8	17.1	0.06	-3.148	-1.802	0.041	0.142	0.100
	Total/Avg						0.609	0.736	0.232
D1	20	7.8	15.8	0.07	0.115	1.461	0.529	0.812	0.283
	30	7.8	15.8	0.07	-0.639	0.707	0.345	0.670	0.324
	40	7.8	15.8	0.07	-1.393	-0.047	0.199	0.488	0.289
	50	7.8	15.8	0.07	-2.147	-0.801	0.105	0.310	0.205
	60	7.8	15.8	0.07	-2.901	-1.554	0.052	0.174	0.122
	70	7.8	15.8	0.07	-3.655	-2.308	0.025	0.090	0.065
	Total/Avg						0.503	0.721	0.215
D2	20	9.6	18.3	0.04	1.193	2.540	0.767	0.927	0.160
	30	9.6	18.3	0.04	0.439	1.786	0.608	0.856	0.248
	40	9.6	18.3	0.04	-0.314	1.032	0.422	0.737	0.315
	50	9.6	18.3	0.04	-1.068	0.278	0.256	0.569	0.313
	60	9.6	18.3	0.04	-1.822	-0.476	0.139	0.383	0.244
	70	9.6	18.3	0.04	-2.576	-1.230	0.071	0.226	0.156
	Total/Avg						0.697	0.701	0.239

The predicted outcomes in array 2 changed between 30,000 and 40,000 tonnes in frame D1, 40,000 and 50,000 tonnes in the base frame and between 50,000 to 60,000 tonnes in D2. Because of the influence of a new competitive elevator, the fringe capacity at which the outcome changed in array 2 increased 10,000 tonnes in frame D1 and 20,000 tonnes in both the base frame and frame D2.

Inspection of Table 6.26 also shows that the change in fringe capacity, CF, was augmented by the presence of a competitor elevator, particularly at points having less desirable characteristics. The probability of construction declined between 50 and 70 percent in array 1 and 70 and 74 percent in array 2.

6.3.2.4. Market Coverage: Scenario 4

Coverage values between .02 and .12 were analyzed in Table 6.27. Due to the definition of coverage values as the reciprocal of elevator age, these values represent elevators from 50 to 8 years of age, respectively. The aggregate increase in the coverage value from .02 to .12 reduced the probability of construction between 23 to 30 percent in array 1 and 21 to 29 percent in array 2.

In array 1, raising the coverage value changed the predicted outcome between values .02-.04 in the base frame and between .06 and .08 in frame D2. In frame D1, the probability of construction never exceeded 50 percent even at the lowest coverage value analyzed .02. These results suggest that at points with poor characteristic values, 1) companies probably would not build an elevator to replace their own old existing elevators, and 2) companies would probably not build at such a point even when they do not have alternative elevators at the adjacent rail points, (COV=0).

Table 6.27 COV Sensitivity Analysis, Manitoba Open Logit Model.

Frame	COV	RQI	VOLC0	CF	Z1 Value Array 1	Z2 Value Array 2	Prob 1 Array 1	Prob 2 Array 2	Diff A-B
Base	0.02	8.8	17.1	34.20	0.043	1.390	0.511	0.801	0.290
	0.04	8.8	17.1	34.20	-0.203	1.143	0.449	0.758	0.309
	0.06	8.8	17.1	34.20	-0.449	0.897	0.390	0.710	0.321
	0.08	8.8	17.1	34.20	-0.695	0.651	0.333	0.657	0.324
	0.10	8.8	17.1	34.20	-0.941	0.405	0.281	0.600	0.319
	0.12	8.8	17.1	34.20	-1.188	0.159	0.234	0.540	0.306
	Total/Avg						0.277	0.261	0.312
D1	0.02	7.8	15.8	36.30	-0.499	0.848	0.378	0.700	0.322
	0.04	7.8	15.8	36.30	-0.745	0.602	0.322	0.646	0.324
	0.06	7.8	15.8	36.30	-0.991	0.355	0.271	0.588	0.317
	0.08	7.8	15.8	36.30	-1.237	0.109	0.225	0.527	0.302
	0.10	7.8	15.8	36.30	-1.483	-0.137	0.185	0.466	0.281
	0.12	7.8	15.8	36.30	-1.729	-0.383	0.151	0.405	0.255
	Total/Avg						0.227	0.295	0.300
D2	0.02	9.6	18.3	32.30	0.512	1.859	0.625	0.865	0.240
	0.04	9.6	18.3	32.30	0.266	1.613	0.566	0.834	0.268
	0.06	9.6	18.3	32.30	0.020	1.366	0.505	0.797	0.292
	0.08	9.6	18.3	32.30	-0.226	1.120	0.444	0.754	0.310
	0.10	9.6	18.3	32.30	-0.472	0.874	0.384	0.706	0.322
	0.12	9.6	18.3	32.30	-0.718	0.628	0.328	0.652	0.324
	Total/Avg						0.298	0.213	0.293

The data also suggest that there is a greater likelihood that a company may construct an elevator at points with more desirable characteristics even when they have an elevator only 12 to 16 years old in the immediate vicinity.

The probability of construction never fell below 50 percent over the range of coverage values in both the base frame and frame D2 in array 2. It appears that when there is the influence of a new competitive elevator, the presence of an existing viable own company elevator is largely irrelevant to the decision to construct an elevator, particularly at points having desirable characteristics.

The coverage value was not augmented by the presence of a new competitor elevator in the base frame or frame D2 of array 2 but rather declined. The presence of a competitive elevator partially offset the negative influence imposed by the presence of a viable company elevator on the probability of construction. The net effect was to reduce the total decline in the probability of construction associated with increasing coverage values. Conversely, in frame D1/array 2 incremental increases in the coverage values were augmented by the presence of a new competitive elevator. This is probably because companies would become increasingly reluctant to construct a new elevator at a point with poor point attributes, particulary the newer their own elevator in that area.

6.3.2.5. Summary

Table 6.28 summarizes the base frame results in each scenario and indicates the probability of construction at the means. In array 1, the predicted probabilities were less than 50 percent, consequently an elevator company would not be expected to build an elevator at a point exhibiting these attribute values.

Table 6.28 Predicted Probability of Construction at Points Exhibiting Variables with N Sample Mean Values, Manitoba.

Variable	Remaining Variable N Mean Values	Array 1 (percent)	Array 2 (percent)
RQI 8 - 10[1]	VOLCO3 = 17.1 CF = 34.2 COV = 0.06	35 - 45	67 - 76
VOLCO3 15,000 - 18,000[1] tonnes	RQI = 8.8 CF = 34.2 COV = 0.06	33 - 41	66 - 73
CF 30,000 - 40,000[1] tonnes	RQI = 8.8 VOLCO3 = 17.1 COV = 0.06	29 - 47	61 - 77
COV .06	RQI = 8.8 VOLCO3 = 17.1 CF = 34.2	39	71

[1] The mean value for this variable lies within this range.

Alternatively, the predicted probabilities for array 2 exceeded 50 percent therefore, an elevator might be constructed at points exhibiting these characteristics. This comparison highlights the importance of the presence of a new competitive elevator in the decision of a grain elevator company as to construct an elevator in Manitoba.

For comparison purposes Table 6.29 shows the variable values required in each base frame of the four scenarios to change the predicted outcome to Y=1 in array 2, indicating the presence of a new competitor elevator. The corresponding probability of construction in array 1, where no competitor elevator is present at these variable values is also indicated.

Table 6.29 Principal Variable Values Required to Raise the Probabilities of Construction in the Base Frames, Array 2, over 50 percent, Manitoba Model.		
Primary Variable	Array 1 (percent)	Array 2 (percent)
RQI (6)	25.1	56.3
VOLCO3 (12,000 Tonnes)	25.9	57.3
CF (40,000 tonnes)	29.2	61.3
COV (.10)	28.1	60.0

For example, at delivery points with an RQI of 6, the probability of elevator construction in array 2 was 56.3 percent[8]. However given the same RQI, companies would not be predicted to construct an elevator as the model predicted a 25.9 percent probability of construction for array 1. Similarly, the outcomes were reversed in array 2 at the lowest level VOLCO3 analyzed, 12,000 tonnes, when fringe capacity increased to 40,000 tonnes and the representative value reached .10. These results emphasize that maintaining company image, through a 'keeping up with the Jones' is an important factor in the decision as to where to construct a new grain elevator.

It is apparent from the previous sensitivity analyses in scenarios one through four, that it cannot be said unequivocally that an increase or decrease in this point characteristic will result in the decision to invest or not to invest in elevator construction. The signs of the model coefficient only reveal the direction of the change in probability. However, the results of the scenario analyses permit some generalizations to be made.

[8]All the remaining variables have assumed N sample mean values.

First, elevator companies are more likely to construct an elevator in an area where a competitor has recently built. Moreover, if the delivery point of interest exhibits desirable characteristics, the presence of an existing viable company elevator does not appear to deter the same company from constructing another elevator if a new competitive elevator has been recently built. However, if a point exhibits poor characteristics and the company has a reasonably viable elevator in the vicinity, the presence of a new competitive elevator is not likely to entice management to build at that locale.

Second, Manitoba elevator companies are not likely to construct an elevator at a point where the market fringe capacity exceeds 40,000 tonnes. But if a new competitive elevator is present a higher fringe capacity of 60,000 tonnes would be tolerated at more desirable elevator points.

Third, at points with moderate to desirable characteristics, the model predicts a company may build an elevator at a point expected to receive only 12,000 tonnes per year if there is a new competitive elevator. If a new competitor elevator were not present, the volume would need to climb to between 15,000 and 21,000 tonnes annually depending on the point characteristic values. Given the presence of a new competitive elevator at an adjacent point having less desirable characteristics, a volume of 15,000 tonnes is required before the probability of construction exceeded 50 percent. If a company elevator were not present, a volume between 24,000 and 27,000 tonnes is required.

Tables 6.30 and 6.31 summarize these results indicating the variable values at which the probability of construction exceeds 50 percent.

Table 6.30 Turning Point Value of Explanatory Variable where Predicted Outcome, Becomes Y= 1, Manitoba, Array 1.			
Sample	n1 means	N means	n2 means
Variable	RQI = 7.8 VOLCO3 = 15.8 CF = 36.3 COV = 0.07	RQI = 8.8 VOLCO3 = 17.1 CF = 34.2 COV = 0.06	RQI = 9.6 VOLCO3 = 18.3 CF = 32.3 COV = 0.04
	Variable Turning Point Values		
RQI	Exceeds 12. Not in range of analysis	10 -12	8 - 10
VOLCO3	24,000 - 27,000 tonnes	18,000 - 21,000 tonnes	15,000 - 18,000 tonnes
CF	20,000 - 30,000 tonnes	20,000 - 30,000 tonnes	30,000 - 40,000 tonnes
COV	Less than .02. Not in range of analysis	.02 - .04	.06 - .08

Table 6.31. Turning Point Values of Explanatory Variable where Predicted Outcome Becomes Y= 1, Manitoba, Array 2.			
Sample	n1	N	n2
Variable	RQI = 7.8 VOLCO3 = 15.8 CF = 36.3 COV = 0.07	RQI = 8.8 VOLCO3 = 17.1 CF = 34.2 COV = 0.06	RQI = 9.6 VOLCO3 = 18.3 CF = 32.3 COV = 0.04
	Variable Turning Point Values		
RQI	6 - 8	4 -6	2 - 4
VOLCO3	12,000 - 15,000 tonnes	Less than 12,000 tonnes. Not in range of analysis	Less than 12,000 tonnes. Not in range of analysis
CF	30,000 - 40,000 tonnes	40,000 - 50,000 tonnes	50,000 - 60,000 tonnes
COV	.08 - .10	Exceeds .10. Not in range of analysis	Exceeds .10. Not in range of analysis

6.4. Analysis of Saskatchewan Open Model

6.4.1. Statistical Inference of Saskatchewan Open Logit Model

The model estimating elevator construction in Saskatchewan was also chosen on the basis of correct sign, significance of the coefficients, percent correct predictions and the log likelihood function. The following logit model predicting the probability of constructing an elevator in Saskatchewan was chosen.

$$Z = -9.5020 + .34827\ RQI + 0.21744\ PTCAP + 0.72619\ FTOVERA + .094339\ POST$$

where

Z	< .50 predicts construction will not occur.
Z	≥ .50 predicts elevator construction will occur.
RQI	= Road quality index.
PTCAP	= Total elevator capacity at sample point measured in thousands of tonnes.
FTOVERA	= Turnover rate of market fringe based on annual deliveries and elevator capacity.
POST	= The age of newest own company elevator at the sample point or adjacent points.

The results regarding the number of observations, log likelihood function, standard error of the estimates and percent correct predictions are presented in Appendix B.

6.4.1.1. Signs and Significance of Coefficient Estimates in Saskatchewan Open Logit Model

The variables RQI, FTOVERA AND POST had positive signs as expected indicating that as the values associated with these variables increased, the probability of opening an elevator increased. There was no 'a priori' knowledge concerning the PTCAP sign, as the direction of the effect would depend on the behaviour of grain companies. The positive sign obtained for point capacity indicates there is a tendency for Saskatchewan companies to build at larger delivery points.

Since the direction of the effect of variables RQI, FTOVERA and POST was anticipated, the significance of the coefficients is determined by a one-tailed t-test. A two tailed t-test statistic is required for PTCAP. The following t statistics and significance levels were estimated for the model coefficients.

	T statistics	Significance Level
RQI	2.3221	.005
PTCAP	1.8917	.100
FTOVERA	1.8321	.050
POST	2.6881	.005

6.4.1.2. Goodness of Fit

The percent correct predictions is one measure of the model's explanatory power. Assuming a P(Y=1) greater than fifty percent evokes an outcome of 1, elevator construction and P(Y=1) less than fifty percent evokes an outcome of 0, no construction, the predicted outcomes can be compared to actual outcomes. Of the 61 observations, the correct outcome was predicted 82 percent of the time.

Table 6.32 presents the number of correct predictions for each subsample, Y=0 and Y=1. The model correctly predicted 15 or 75 percent of the 20 points where elevator construction would not take place, Y=0. Like the Manitoba model, fewer prediction errors occurred in subsample Y=1, as the correct outcome was predicted at 35 of the 41 or 85 percent of the Saskatchewan points.

Assuming the true probabilities of construction were 0 at points where construction did not occur, and 1 at points elevators were constructed, the forecast error and forecast error variance about the correct predictions were calculated. The average forecast error for subsamples n1 (Y=0) and n2 (Y=1) were 37.4 and 18.3 percent, respectively. The forecast error variances for subsamples n1 (Y=0) and n2 (Y=1) were 19.3 and 8.9, respectively. These results indicate there was less variation in the probabilities at points at which construction occurred.

Table 6.32 Correct Predictions for Each Subsample, Saskatchewan Open Model.

Actual	Predicted		Total
	0	1	
0	15	5	20
1	6	35	41
			61

The average forecast error about the incorrect predictions in subsample n1 Y= 0 was 71.6 percent indicating that the incorrect probability of construction predictions averaged 71.6 percent rather than 0. The average forecast error associated with subsample n2, Y=1, was 69.3 percent indicating that the incorrect probability of construction predictions averaged 30.7 percent rather than 100 percent. As in the Manitoba model, the prediction errors were large and did not fall near the 50 percent probability level as might be expected. As the errors associated with incorrect predictions were so large, defining a range of indecision, ie 35 - 65 percent about the 50 percent probability level would be unproductive as it would not capture the errors.

Another goodness of fit test examines the joint hypothesis that all the coefficients except the intercept are zero, H^0 : RQI = PTNO = VFCO3 = POST = 0. A c statistic is calculated from the maximum value (L^0) of the constrained log likelihood function (LLC) and the log likelihood (L^2) of the now unconstrained equation (LLUC).

c= -2 (LLC - LLCR) = 38.45

Based on four degrees of freedom and a 99.5 significance level, the null hypothesis that the coefficients equal zero is rejected as the c statistic of 38.45 is greater than the critical square statistic of 14.86.

6.4.2. Sensitivity Analyses: The Effect of Elevator Characteristic Levels on the Probability of Saskatchewan Elevator Construction

In this section four scenarios are presented, one for each explanatory variable RQI, PTCAP, FTOVERA and POST. The effect of incremental increases in one of these variables on the probability of construction is tested within each scenario. The incremental increases in the variable being tested cover the range of sample observation values.

Within each scenario, the remaining variables in the base frame assume N sample mean values. In frames D1 and D2, the variables assume n1 and n2 subsample mean values, respectively. The mean values in subsample n1 are the means of sample elevators where construction did not occur whereas n2 represents the average variable values of those elevator points where construction occurred. The three sets of mean values are listed in Table 6.33 and the ranges in Table 6.34.

Table 6.33 Variable Mean Values within Saskatchewan Open Model, Sample and Subsample.				
Sample	RQI	PTCAP	FTOVERA	POST
n1 (Y=0)	7.0	6.7	3.8	24.2
n2 (Y=1)	10.6	11.5	4.1	35.3
N (Y=1,Y=0)	9.4	9.9	4.0	31.7

Table 6.34 Range of Variable Values within Saskatchewan Open Model, Sample and Subsample.				
Sample	RQI	PTCAP	FTOVERA	POST
n1 (Y=0)	2-14	1.9 - 14.3	2.6 - 6.2	11.8 - 42
n2(Y=1)	4-18	0 - 52.9*	1.6 - 5.7	0 - 74
N (Y=1,Y=0)	2-18	0 - 52.9*	1.6 - 6.2	0 - 74

For discussion purposes, the frames can be ranked with respect to the desirability of the point characteristic values. These values in frame D2 represent points with more desirable point characteristics, the values in the base frame reflect points with moderately desirable characteristics and the values in frame D1 represent elevators with less desirable point characteristics[9].

6.4.2.1. Road Quality Index: Scenario 1

In scenario 1, Table 6.35, road quality index values of 2, 4, 6, 8, 10, and 12 were analyzed. In each frame as the road quality index increased so did the

[9] The probabilities arising when only one of the remaining variable values is changed to n1 or n2 mean values while the remaining two variables continue to assume N mean values are presented in frames A1, A2, B1, B2, C1 and C2 in Appendix C.

Table 6.35 RQI Sensitivity Analyses, Saskatchewan Open Logit Model

	RQI	PTCAP	FTOVERA	POST	Z Value	Prob	CH Prob
Base	2	9.9	4	31.7	-0.757	0.319	
	4	9.9	4	31.7	-0.061	0.485	0.166
	6	9.9	4	31.7	0.636	0.654	0.169
	8	9.9	4	31.7	1.332	0.791	0.137
	10	9.9	4	31.7	2.029	0.884	0.093
	12	9.9	4	31.7	2.725	0.938	0.055
							0.619
D1	2	6.7	3.8	24.2	-2.306	0.091	
	4	6.7	3.8	24.2	-1.610	0.167	0.076
	6	6.7	3.8	24.2	-0.913	0.286	0.120
	8	6.7	3.8	24.2	-0.216	0.446	0.160
	10	6.7	3.8	24.2	0.480	0.618	0.172
	12	6.7	3.8	24.2	1.177	0.764	0.147
							0.674
D2	2	11.5	4.1	35.3	0.003	0.501	
	4	11.5	4.1	35.3	0.699	0.668	0.167
	6	11.5	4.1	35.3	1.396	0.802	0.133
	8	11.5	4.1	35.3	2.092	0.890	0.089
	10	11.5	4.1	35.3	2.789	0.942	0.052
	12	11.5	4.1	35.3	3.485	0.970	0.028
							0.470

probability of elevator construction. The total change in the probability of construction, resulting from an increase in the RQI from 2 to 12, ranged from 47 to 67 percent. In the base frame and frame D1, the predicted outcomes subsequently changed.

Overall road quality access was predicted to have a greater impact on the probability of construction at delivery points with less desirable characteristic values, such as those depicted in frame D1. Also due to lower characteristic values, an RQI between 8 and 10 was required to raise the probability of construction beyond 50 percent in frame D1. The outcome changed in the base frame between an RQI of 4 to 6. In frame D2, a probability of 50 percent was predicted at an RQI of 2 on the basis of the higher n2 mean values for the remaining variables. Any increase in RQI only solidified the predicted outcome in frame D2.

6.4.2.2. Point Capacity: Scenario 2

In scenario 2, Table 6.36, the probabilities of construction associated with 2.0 thousand tonne increments in point capacity at an elevator station are listed. Due to the positive relationship between point capacity and probability of construction, the probability of construction increased as point capacity was raised. Over the 3 to 13 thousand tonne range analyzed, the probability of construction increased between 21 and 49 percent.

Given that point capacity and the probability of construction are positively correlated, and that point capacity and the number of competitors at a point are also positively correlated, the probability of construction increases if many competitors

Table 6.36 PTCAP Sensitivity Analysis, Saskatchewan Logit Model.

Frame	PTCAP	RQI	FROVER	POST	Z VALUE	PROB	CH PROB
Base	3	9.4	4	31.7	0.319	0.579	
	5	9.4	4	31.7	0.754	0.680	0.101
	7	9.4	4	31.7	1.189	0.767	0.086
	9	9.4	4	31.7	1.624	0.835	0.069
	11	9.4	4	31.7	2.059	0.887	0.051
	13	9.4	4	31.7	2.494	0.924	0.037
	Total						0.345
D1	3	7	3.8	24.2	-1.369	0.203	
	5	7	3.8	24.2	-0.934	0.282	0.079
	7	7	3.8	24.2	-0.500	0.378	0.096
	9	7	3.8	24.2	-0.065	0.484	0.106
	11	7	3.8	24.2	0.370	0.592	0.108
	13	7	3.8	24.2	0.805	0.691	0.100
	Total						0.488
D2	3	10.6	4.1	35.3	1.150	0.759	
	5	10.6	4.1	35.3	1.584	0.830	0.070
	7	10.6	4.1	35.3	2.019	0.883	0.053
	9	10.6	4.1	35.3	2.454	0.921	0.038
	11	10.6	4.1	35.3	2.889	0.947	0.026
	13	10.6	4.1	35.3	3.324	0.965	0.018
	Total						0.206

exist at a point. This may be a market presence response. Large centres where all or most of the major companies are represented may be viewed by the farmer as a desirable feature[10]. If large multicompany points are able to attract producers who might otherwise deliver to smaller centres, there may be more incentive to locate at such points. Once a producer has been attracted to these points, it is up to each company to acquire the patronage of that producer. Responses from a producer survey conducted by Devine and Kulshreshtha confirm this result. They report that as the number of competing agents or companies at a point increases, the distance farmers travel jumps dramatically[11].

In the base frame and frame D2, the predicted probabilities were over 50 percent at the lowest point capacity tested , 3.0 thousand tonnes. This indicates that construction will still proceed at a low capacity delivery point so long as the other elevator point characteristics are of the magnitude represented in these frames. A station with 3.0 thousand tonnes capacity is likely a single company point. Therefore, it appears that single company delivery points were not excluded as viable points as long as the levels of the other explanatory variable values were satisfactory.

Raising point capacity changed the predicted outcome in frame D1 between

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[10] Marketing information such as price and grade offered by each company is less costly to attain and trucking costs from the farm-gate to the elevator are essentially identical.

[11] Devine, Grant and S. N. Kulshreshtha. Performance of Grain Elevators in Saskatchewan: A Summary of Farmers Responses Under Alternative Competitive Environments. Department of Agricultural Economics, University of Saskatchewan: Saskatoon, Saskatchewan, June 1979, p.49.

point capacities of 9 to 11 thousand tonnes. As the values of the remaining explanatory variables are generally less desirable within this frame, construction would proceed at the point only if it was perceived as being competitive.

6.4.2.3. Fringe Turnover: Scenario 3

Fringe turnover was used as a measure of market area performance, taking into consideration the volume of deliveries and capacity. In the previous scenarios, n1 and n2 mean fringe turnover values of 3.8 and 4.1 were analyzed. The deviation between these two means was small and resulted in limited changes in probability[12].

In this scenario, the range of turnover values tested was greater, being between 3.0 - 5.5. Compared to the range of the other variable values tested, the turnover range is still narrow when measured as a percent of the total sample mean[13]. However, only values for 7 points representing 11 percent of the fringe turnover observation values were not captured within the selected fringe turnover range of 3.0 and 5.5. The fringe turnover at these 7 points exceeded 5.5. A review of the probabilities estimated at a fringe turnover of 5.5 in this scenario indicates there is little information to be gained by testing higher fringe turnover values, as the probability of construction remained over 90 percent.

Table 6.37 lists the probability of construction associated with changes in fringe

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[12] See frames B1 and B2 in scenarios 1, 2 and 4 in Appendix C7.

[13] Fringe turnover values between 3.0 and 5.5 are analyzed. The range of 2.5 is 62.5 percent of N sample mean, 4.0. In the other scenarios, the variation in primary explanatory values as a percent of total sample means N was RQI:106.4, PTCAP: 101.0 and MAIN: 130.2 percent.

turnover. In all the frames in Table 6.37, the probability of elevator construction increased between 8 and 42 percent as the fringe turnover increased. The fringe turnover level, however, did not significantly affect the outcome. With the exception of frame D1, the probabilities in the base frame and frame D2 exceeded 50 percent at the lowest fringe turnover level tested, 3.0. All other things remaining equal, an increase in fringe turnover only boosted confidence in the prediction. At a turnover of 5.5, the probability of construction in these two frames exceeded 94 percent.

In frame D1, when the remaining explanatory values were reduced to n1 mean values, the probability of construction was 24.1 percent at a turnover of 3.0. Only when fringe turnover was increased between 4.5 and 5.0 did the probability of construction exceed 50 percent.

6.4.2.4. Market Positioning: Scenario 4

Table 6.38 lists the probability of construction when elevator age is increased from 10 to 50 years in increments of ten. This variable was intended as a measure of market maintenance behaviour. The age of a company's newest elevator at either the sample point or adjacent rail points was recorded. It is hypothesized that if a company is going to maintain market coverage in the area, the probability of construction increases as the age of a company's most recently built elevator within the linear market increases.

Table 6.38 shows that the probability of construction increased as elevator age

Table 6.37 Sensitivity Analysis, FTOVERA, Saskatchewan Open Logit Model.							
Frame	FTOVERA	RQI	PTCAP	POST	Z VALUE	PROB	CH PROB
Base	3.0	9.4	9.9	31.7	1.094	0.749	
	3.5	9.4	9.9	31.7	1.457	0.811	0.062
	4.0	9.4	9.9	31.7	1.820	0.861	0.050
	4.5	9.4	9.9	31.7	2.183	0.899	0.038
	5.0	9.4	9.9	31.7	2.546	0.927	0.029
	5.5	9.4	9.9	31.7	2.909	0.948	0.021
	Total						0.199
D1	3.0	7	6.7	24.2	-1.146	0.241	
	3.5	7	6.7	24.2	-0.783	0.314	0.072
	4.0	7	6.7	24.2	-0.419	0.397	0.083
	4.5	7	6.7	24.2	-0.056	0.486	0.089
	5.0	7	6.7	24.2	0.307	0.576	0.090
	5.5	7	6.7	24.1	0.670	0.661	0.085
	Total						0.420
D2	3.0	10.6	11.5	35.3	2.199	0.900	
	3.5	10.6	11.5	35.3	2.562	0.928	0.028
	4.0	10.6	11.5	35.3	2.925	0.949	0.021
	4.5	10.6	11.5	35.3	3.288	0.964	0.015
	5.0	10.6	11.5	35.3	3.651	0.975	0.011
	5.5	10.6	11.5	35.3	4.014	0.982	0.008
	Total						0.082

Table 6.38 Sensitivity Analysis, POST, Saskatchwan Open Logit Model.							
Frame	POST	RQI	PTCAP	FTOVERA	Z VALUE	PROB	CH PROB
Base	10	9.4	9.9	4	-0.227	0.443	
	20	9.4	9.9	4	0.716	0.672	0.228
	30	9.4	9.9	4	1.659	0.840	0.168
	40	9.4	9.9	4	2.603	0.931	0.091
	50	9.4	9.9	4	3.546	0.972	0.041
	Total						0.529
D1	10	7	6.7	3.8	-1.904	0.130	
	20	7	6.7	3.8	-0.961	0.277	0.147
	30	7	6.7	3.8	-0.018	0.496	0.219
	40	7	6.7	3.8	0.926	0.716	0.221
	50	7	6.7	3.8	1.869	0.866	0.150
	Total						0.737
D2	10	10.6	11.5	4.1	0.611	0.648	
	20	10.6	11.5	4.1	1.554	0.826	0.177
	30	10.6	11.5	4.1	2.498	0.924	0.098
	40	10.6	11.5	4.1	3.441	0.969	0.045
	50	10.6	11.5	4.1	4.385	0.988	0.019
	Total						0.340

increased. The change in probability when elevator age was increased from 10 to 50 years varied between 34 and 74 percent.

In frame D1, representative of less desirable points, elevator companies would be reluctant to construct an elevator particularly if they have a viable alternative elevator in the market area. According to the model predictions, only when the age of an alternative elevator increased to between 30 and 40 years was construction at the sample point considered. In the base frame, the predicted outcome changed between 10 and 20 years and in frame D2, the probability of construction was already beyond 50 percent at the 10 year level.

While elevators less than 30 years of age are generally still functional, the model predicts in the base frame and in frame D2 that a company would construct an elevator at the sample point despite the presence of a viable alternative elevator at an adjacent point. This requires some explanation and three examples are given to clarify this point. First, while a company may have a functional elevator at one of the adjacent points, it does not preclude the possibility that the grain company may wish to expand their market and construct an elevator at the sample point. Second, a company may have a very old elevator that needs to be replaced at the sample point, if they wish to maintain this market, despite the presence of one of their own elevators at an adjacent point. Third, a company may wish to rebuild at a point despite the existence of an alternative elevator at an adjacent point as they plan on closing the elevator at the adjacent point in the near future. Hence, the model should not be interpreted to mean necessarily that they are building a new elevator to replace an elevator of that given age. Rather, the model indicates there is more of a tendency to build at a sample point where the elevators in the linear market are older.

6.4.2.6 Summary

The results of the scenario analyses permit several generalizations to be made. First, at more desirable elevator points such as those characterized in frame D2, an increase in road quality access is not likely to change the outcome as the decision to invest had been made on the basis of other point characteristics values. But at lesser to moderately desirable elevator points such as those represented in frame D1 and the base frame, respectively, an improvement in RQI may improve the point's advantage resulting in elevator construction.

Second, there is a greater probability of construction at points having high point capacity. Assuming point capacity and the number of competitors are highly correlated, it would appear that Saskatchewan grain companies have a tendency to construct elevators at multicompany points. This does not rule out construction at single company points. The model indicates that construction would proceed at low capacity points only if the other point characteristics were desirable.

Third, fringe turnover will increase the probability of construction but is less significant than the other variables in determining the locations at which construction will occur. However, the model predicted that at less desirable points an increase in fringe turnover to between 4.5 and 5.0 would change the outcome.

Fourth, at less desirable points, elevator companies would be reluctant to construct an elevator, particularly if they have a viable alternative elevator in the linear market area. Only when the alternative elevator became either technically or economically obsolete would construction be considered.

Table 6.39 summarizes these results and indicates the variable values at which the probability of construction exceeds 50 percent.

Table 6.39 Turning Point Values of Explanatory Variable where Predicted Outcome Becomes Y= 1, Saskatchewan.

Sample	n1	N	n2
Variable	RQI = 7.0 PTCAP = 6.7 FTOVERA = 3.8 POST = 24.2	RQI = 9.4 PTCAP =9.9 FTOVERA = 4.0 POST = 31.7	RQI = 10.6 PTCAP = 11.5 FTOVERA = 4.1 POST = 35.3
	Variable Turning Point Values		
RQI	8 - 10	4 -6	2 - 4
PTCAP	9,000 - 11,000 tonnes	Less than 3,000 tonnes. Not in range of analysis	Less than 3,000 tonnes. Not in range of analysis
FTOVERA	4.5 - 5.5	Less than 3.0. Not in range of analysis	Less than 3.0 Not in range of analysis
POST	30 - 40 years	10 - 20 years	Less than 10 years. Not in range of analysis

From the sensitivity analyses, it is apparent that it is difficult to rank the explanatory variables according to their effect on the probability of construction. In the following tables, the magnitudes of the explanatory variable values are changed to show the variability of the impact of the explanatory variables on the Z values, hence the probability of construction. A comparison of the tables allows some generalizations to be made concerning the ranking of the variables.

Table 6.40 lists the explanatory variables and the expected change in Z values when the variable is increased by the incremental values indicated in scenarios 1 through 4. Ranking the variables according to the change in Z values indicates that

Table 6.40 Change in Z Values Arising from Scenario Incremental Increases in Explanatory Variables, Saskatchewan Open Logit Model.

Variable	Coefficient	Incremental Increase	Change in Z Values	Rank
RQI	.34827	2.0	.6965	2
PTCAP	.21744	2.0	.4349	3
FTOVERA	.72619	.5	.3631	4
POST	.09434	10	.9434	1

incremental increases in POST have the greatest impact on the probability of construction, followed by RQI, PTCAP and FTOVERA, respectively.

An alternative means of comparing the impact of the variables on the probability of construction is to compare the contribution of each to the total Z value using N, n1 and n2 mean values. The contribution of each variable at the different mean levels to the Z value is shown in Table 6.41, 6.42 and 6.43. When n1 subsample means are used, FTOVERA is responsible for the largest contribution to the derived Z value, followed by RQI, POST and PTCAP. Alternatively when N sample mean values are assumed, RQI has a greater impact on the decision where to invest than does POST, FTOVER and PTCAP, respectively. When n2 subsample mean values are assumed, the RQI value yields the largest contribution to the Z value followed by POST, FTOVERA and PTCAP.

Table 6.41 Contribution of Explanatory Variables to Z Value Based on N Sample Means, Saskatchewan Open Logit Model

Variable	Coefficient	N Mean Values	Change in Z Values	Rank
RQI	.34827	9.4	3.27	1
PTCAP	.21744	9.9	2.15	4
FTOVER	.72619	4.0	2.90	3
POST	.09434	31.7	2.99	2

Table 6.42 Contribution of Explanatory Variables to Z Value Based on n1 Subsample Means, Saskatchewan Open Logit Model

Variable	Coefficient	n1 Mean Values	Contribution to Z Value	Rank
RQI	.34827	7	2.44	2
PTCAP	.21744	6.7	1.46	4
FTOVERA	.72619	3.8	2.76	1
POST	.09434	24.2	2.28	3

Table 6.43 Contribution of Explanatory Variables to Z Value Based on n2 Subsample Means, Saskatchewan Open Logit Model

Variable	Coefficient	n2 Mean Values	Contribution to Z Value	Rank
RQI	.34827	10.6	3.69	1
PTCAP	.21744	11.5	2.50	4
FTOVERA	.72619	4.1	2.98	3
POST	.09434	35.3	3.33	2

The standard deviations about sample N means were calculated and are as follows.

Variable	Sample N Mean Values	1 St. Dev	St. Dev as a Percent of N
RQI	9.4	± 3.4	36.2
PTCAP	9.9	± 4.4	44.4
FTOVERA	4.0	± 1.0	25.0
POST	31.7	±13.9	43.8

Approximately 68 percent of the observations associated with each explanatory variable lay within one standard deviation of the sample N means. The total possible changes in Z value that could occur within one standard deviation from the means of each explanatory variables are listed in Table 6.44. Assuming the sample observations are representative of the population of prairie delivery points, a company's elevator age may have the largest effect on the change in Z values and the probability of construction at various points.

Table 6.44 Possible Change in Z Values Arising from Change in One Standard Deviation of Explanatory Variables Values, Saskatchewan Open Logit Model.

Variable	Coefficient	Range ± 1 Standard Deviation about N Means	Change in Z Values over One St. Dev	Rank
RQI	.34827	6.8	2.37	2
PTCAP	.21744	8.8	1.91	3
FTOVERA	.72619	2.0	1.45	4
POST	.09434	27.8	2.62	1

The variable rankings in Tables 6.40 through 6.44 are summarized in Table 6.45. Based on these rankings several generalizations may be made. RQI followed closely by the age of an alternative company elevator in the linear market, POST, generally have a greater impact on the probability of construction at a site than do the other point characteristics. FTOVERA appeared to have more of an impact on the estimated probability of construction than PTCAP. In summary, differences in the probability of construction between delivery points appears to be determined primarily by differences in elevator age and road quality access.

Table 6.45 Rank of Model Explanatory Variables based on Changes to Z Values.

Variable	Scenario Incremental Changes	Sample N means	Subsample n1 Means	Subsample n2 Means	Range ± 1 Standard Deviation about N Means
RQI	2	1	2	1	2
PTCAP	3	4	4	4	3
FTOVERA	4	3	1	3	4
POST	1	2	3	2	1

6.5. Saskatchewan and Manitoba Open Model Results

6.5.1. Statistical Inference of Saskatchewan-Manitoba Open Model

Data from the Saskatchewan and Manitoba data base were combined to determine if an increased number of observation resulted in a better model with improved forecasting ability. Based on the combined data set of 131 observations and the same explanatory variables, the Saskatchewan and Manitoba models were each reestimated. The results are shown in Appendix B. Combining the data sets did not improve the percent correct predictions. Rather, the percent correct predictions dropped from 82 percent in the original Saskatchewan open logit model to 73 percent, and from 81 percent in the original Manitoba open model to 74 percent. It may be concluded the poorer predictive ability of the models when data was combined is a result of the different company investment strategies exhibited primarily by Saskatchewan Wheat Pool and Manitoba Pool Elevators.

Based on the 131 sample observations, an attempt was made to derive a Saskatchewan-Manitoba model with improved predictability. The effort was unsuccessful as only 76 percent of the observations were correctly predicted in the new joint provincial model and one of the variables was insignificant. The model is as follows:

$$Z = -2.3591 + .28515\ RQI - .037267\ PTCAP + .073576\ VOLCO3 - 14.959\ COV$$

where

Z	< .50 predicts construction will not occur.
Z	≥ .50 predicts construction will occur.
RQI	= Road quality index
PTCAP	= Total elevator capacity at sample point measured in thousands of tonnes.
VOLCO3	= Three year average annual volume per company at adjacent rail points and the sample point. Measured in thousands of tonnes.
COV	= Market coverage. Includes market maintenance and expansion. Values range from 0 to 1.

The results indicating the number of observations, log likelihood function, coefficient estimates, standard error, t statistics and percent correct predictions are presented in Appendix B. Based on these results, the individual provincial models are more suitable for forecasting locations where companies may construct an elevator.

CHAPTER 7 DELIVERY POINT CHARACTERISTICS AFFECTING THE PROBABILITY OF ELEVATOR CLOSURE IN ALBERTA AND SASKATCHEWAN

This chapter begins by identifying and summarizing the characteristics of points where elevators were closed. In many cases, inferences are drawn concerning the investment strategies of the individual firms. Following this, the explanatory variables in the selected Alberta and Saskatchewan closure logit model and alternative variable measures are discussed. In the next section, the Alberta logit model is used to determine the probability of elevator closure at a point and statistical tests performed. Numerous sensitivity analyses are also undertaken to indicate the probability of closure when the explanatory variables are adjusted. The chapter proceeds with the presentation of the Saskatchewan closure model, an assessment of the model's goodness of fit and also a series of sensitivity analyses. Finally, data from both provincial data bases are combined and the resulting joint provincial model estimated and assessed.

7.1 Characteristics of Alberta and Saskatchewan Points Where Elevators Closed.

Tables 7.1 and 7.2 show the distribution of grain elevators closed between 1980 and 1989 in Alberta and Saskatchewan[1]. The distribution of elevators closed in Saskatchewan appears bimodal with peaks occurring in 1983/84 and 1986. In Alberta, the number of elevators closed in the eighties also peaked in 1983/84 but

[1]Elevators closed due to rail line abandonment, elevators closed as a result of trades between companies, a company elevator closed at a point where another same company elevator remained and elevators which were replaced are not included in the data.

Table 7.1. Time Distribution of Alberta Elevators Closed, 1980/81 to 1989/90.

Year	Number of Elevators Closed	Percent of Elevators Closed
1981	9	15.5
1982	9	15.5
1983	10	17.2
1984	12	20.7
1985	8	13.8
1986	3	5.2
1987	2	3.4
1988	2	3.4
1989	3	5.2
Total	58	100.0

Table 7.2. Time Distribution of Saskatchewan Elevators Closed, 1980/81 and 1989/90.

Year	Number of Elevators Closed	Percent of Elevators Closed
1980	0	0.0
1981	5	4.0
1982	13	10.3
1983	18	14.3
1984	21	16.7
1985	10	7.9
1986	28	22.2
1987	14	11.1
1988	13	10.3
1989	4	3.2
Total	126	100.0

levelled off to two to three elevators per year from 1986 forward.

Table 7.3 lists the number of operating units licensed by each company in Alberta between 1979/80 and 1989/90 and each company's share of elevator facilities. Table 7.4 illustrates the number of elevators closed in Alberta by each grain company over that ten year period. A comparison of the two tables indicates that Pioneer and Cargill closed proportionally more elevators in terms of their relative share of licensed operating units while Alberta Wheat Pool closed a proportionally smaller share.

Table 7.5 and 7.6 list the number of operating units licensed in Saskatchewan and the number of elevators closed. Unlike Alberta Wheat Pool, Saskatchewan Wheat Pool closed proportionally more elevators than did Cargill. On the other hand, the proportion closed by UGG was negligible while Pioneer closed slightly less than its share as measured in terms of licensed operating units. In both provinces, Cargill closed proportionally more elevators than the other non-Pool grain elevator companies.

Tables 7.7 and 7.8 indicate the type of point at which elevators were closed. In both provinces, 63 percent of the elevators closed were at single company points. As a result grain collection ceased at that point. Tables 7.9 and 7.10 provide the number of elevators closed by type of point and company. Of the elevators closed by AWP, 23 or 92 percent were at single company points. On the other hand, 9 or 82 percent of the elevators closed by UGG in Alberta were located at multicompany points. There were too few Cargill and Pioneer observations in the Alberta sample

Table 7.3 Number of Operating Units Licensed by Each Company in the 1980s in Alberta.

Company	Number of Operating Units 1980/81	Number of Operating Units 1989/90	Percent Share of Operating Units 1980/81	Percent Share of Operating Units 1989/90
AWP	366	271	55.5	57.2
UGG	149	102	22.6	21.5
Cargill	43	28	6.5	5.9
Paterson	1	1	0.1	0.2
Pioneer	68	43	10.3	9.1
Other	33	29	5.0	6.1
Total	660	474	100.0	100.0

Table 7.4. Primary Elevator Closures in Alberta, by Company, 1980/81 to 1989/90.

Company	Number of Elevators Closed	Percent of Elevators Closed
AWP	25	43.1
UGG	12	20.7
Cargill	9	15.5
Paterson	0	0.0
Pioneer	12	20.7
Total	58[2]	100.0

[2] The discrepancy between Table 7.3 and the number of elevators closed in Table 7.4 is due to requirements imposed on the study sample. For example, AWP indicated they closed 151 elevators between 1980/81 and 1989/90. AWP frequently had three and four elevators at a point of which they closed two or three elevators. In total, AWP closed elevators at 104 delivery points. At 59 of these points AWP either continued to maintain or replaced an elevator. Therefore, AWP actually withdrew from only 45 points. Of these 45 points, 14 points were closed to rail line abandonment leaving 31 elevators. Five of the elevators were physically closed before 1980 as they did not receive deliveries although they continued to be licensed with the CGC. One elevator closed was in B.C., leaving 25 points at which AWP made the decision to close an elevator therefore withdrawing from the market.

Table 7.5 Number of Operating Units Licensed by Each Company, in Saskatchewan, 1980/81 to 1989/90.

Company	Number of Operating Units 1980/81	Number of Operating Units 1989/90	Percent Share of Operating Units 1980/81	Percent Share of Operating Units 1989/90
Saskatchewan Wheat Pool	667	481	57.2	57.3
United Grain Growers	151	111	13.0	13.2
Cargill	88	55	7.6	6.6
Pioneer	201	149	17.2	17.8
Other	58	43	5.0	5.1
Total	1165	839	100.0	100.0

Table 7.6. Primary Elevator Closure[1] in Saskatchewan, by Company, 1980/81 to 1989/90.

Company	Number of Operating Units	Percent Share of Elevators Closed
Saskatchewan Wheat Pool	81	64.3
United Grain Growers[1]	4	3.2
Cargill	21	16.7
Pioneer	20	15.9
Total	126	100.0

1. UGG closed many elevators at points where they had two to three elevators and also at points on abandoned rail lines. These points were not included in the study sample since in the latter case the decision to close fell outside the company's jurisdiction, and in the former case they had not withdrawn from that local market since they continued to be represented at the point.

Table 7.7 Number of Elevators Closed by Class of Point, Alberta Sample, 1980/81-1989/90.		
Type of Point	Number of Points	Percent
Multicompany	15	36.6
Single company	26	63.4
Total	41	100.0

Table 7.8 Number of Elevators Closed by Class of Point, Saskatchewan Sample, 1980/81-1989/90.		
Type of Point	Number of Points	Percent
Multicompany	27	37.0
Single company	46	63.0
Total	73	100.0

Table 7.9 Number of Elevators Closed at Different Class of Point, Alberta Sample,by Company.			
Company	Multicompany	Single Company	Total
Alberta Wheat	2	23	25
United Grain	9	2	11
Cargill	1	1	2
Pioneer	3	0	3
Total	15	26	41

Table 7.10 Number of Elevators Closed by Class of Point and Company, Saskatchewan Sample, 1980/81 - 1989/90.			
Company	Multicompany	Single Company	Total
Saskatchewan Pool	10	38	48
United Grain	3	1	4
Cargill	8	1	9
Pioneer	6	6	12
Total	27	46	73

to determine if any pattern existed. Thirty eight, almost 80 percent of the elevators closed by SWP were also at single company points. On the other hand, 8 of the 9 elevators closed by Cargill were at multicompany points. This is not surprising , however, as most of Cargill's elevators are located at multicompany points leaving little alternative. Pioneer closed an equal number of elevators at both multicompany and single company points in Saskatchewan.

Tables 7.11 and 7.12 indicate the range in capacity of elevators closed in Alberta and Saskatchewan, respectively. The average capacity of elevators closed in Alberta was similar between companies, ranging between 2,600 and 2,800 tonnes. In Saskatchewan, the average capacity of elevators closed by company showed greater variation and on average was lower than that of the elevators closed in Alberta. Elevators closed by SWP had approximately 600 tonnes less capacity than those closed by AWP. The average capacity of both Pioneer and Cargill elevators closed in Saskatchewan was also lower their Alberta counterparts being approximately 650 and 1,100 tonnes less, respectively. It may be that the elevators rationalized in Alberta were not as aged as in Saskatchewan, therefore they also tended to be of greater capacity since progressively larger facilities have been built through the last 40 years[3].

Table 7.13 provides data on elevator closures by company and type of rail line. In both provinces, more elevators on branch lines were closed, 61 percent in Alberta

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[3]The Pioneer and Cargill samples were small therefore the results may be biased if the Alberta samples were particularly large elevators.

Table 7.11 Range in Capacity of Elevators Closed by Company, Alberta Sample, 1980/81-1989/90.

Company	Low (tonnes)	High (tonnes)	Average Capacity (tonnes)
Alberta Wheat Pool	780	4930	2755
United Grain Growers	1710	3540	2615
Cargill	2840	2870	2855
Pioneer	2380	2970	2660
Province	780	4930	2715

Table 7.12 Range in Capacity of Elevators Closed by Company, Saskatchewan Sample, 1980/81-1989/90.

Company	Low (tonnes)	High (tonnes)	Average Capacity (tonnes)
Sask Wheat Pool	840	4420	2182
United Grain Growers	1850	3810	2500
Cargill	1290	2330	1764
Pioneer	1230	2830	2017
Province	840	4420	2195

Table 7.13 Elevators Closure by Type of Rail line, Alberta and Saskatchewan Sample, 1980/81-1989/90.

	Alberta Mainline	Alberta Branchline	Saskatchewan Mainline	Saskatchewan Branchline
Alta Wheat Pool	7	18	-	-
Sask Wheat Pool	-	-	10	38
United Grain	6	5	1	3
Cargill	1	1	3	6
Pioneer	2	1	1	11
Total	16	25	15	58

and 79 percent in Saskatchewan. This is not unexpected as the future of some branch lines is uncertain, and on many of these branchlines there are hauling delays and often no opportunity for assembling multicar shipments. Two thirds of the elevators closed in Saskatchewan by Cargill were located on branchlines, 79 percent of elevators closed by SWP were similarly located as were 92 percent of the elevators closed by Pioneer. Eighteen, or 72 percent of the elevators closed by AWP were located on branch lines, while equal numbers of Alberta elevators closed by UGG were located on main and branch lines.

7.2. Comment on Explanatory Variables in Selected Alberta and Saskatchewan Closure Logit Models.

The relationship between some of the variables explored in the development of the Alberta and Saskatchewan closure logit models are discussed below to illustrate why the explanatory variables incorporated in the models were chosen.

7.2.1. Alberta Closure Logit Model

The explanatory variables in the Alberta closure logit model predicting the probability of elevator closure at grain delivery points were RQI, ELEVCAP and COMPVOLA.

RQI	= road quality index.
ELEVCAP	= sample elevator capacity in tonnes.
COMPVOLA	= the average company volume at the point. Measured in thousands of tonnes.

The variable COMPVOLA, an estimation of annual volume handled per company, is derived by dividing total annual crop year deliveries to a point, AVOL, by the number of companies at the point, PTNO. As 63 percent of the points at which elevators were closed were single company points, it is not surprising that the estimate COMPVOLA is a reasonable measure of the volume handled per company.

None of the model variables are fringe market measures, consequently the Voloni tessellation procedure used to derive Thiessen polygons was unnecessary. The variables RQI, AVOL, and PTNO, are point specific characteristics whereas elevator capacity, ELEVCAP, is specific to the elevator. At single company points, the volume, COMPVOLA, would also be elevator specific.

Two estimates of company crop year deliveries were derived, COMPVOLA and COMPVOL3, each based on annual and three year data, respectively. It was anticipated that COMPVOL3 would be a more representative measure as the effects of drought or bumper crop deliveries would be averaged. However, COMPVOLA had greater explanatory power. This unexpected result had be attributed to two factors. First, the correlation coefficient between the two variables, .88 indicates a strong correlation between COMPVOLA and COMVOL3. Second, annual data was taken in the year preceding elevator closure. For example, if an elevator was closed in 1981/82, annual delivery volumes were collected for 1980/81 rather than 1981/82, to avoid underestimating deliveries at elevators that may have closed before the end of the crop year. However, if it was common knowledge that the elevator was going to close, deliveries in the preceding year may also have been low relative to normal delivery volumes. If this were the case, the negative correlation between delivery volumes represented by COMPVOLA and the probability of closure would be greater than COMPVOL3.

As indicated previously, the variable, COMPVOLA is derived from AVOL and PTNO. When these two variables were included in the model, the percent correct predictions were lower and the estimated coefficient were not significantly significant. Similarly, when other competition and market productivity measures were included together poor results were obtained due to multicollinearity between thee variables. The following correlation coefficients give an indication of the collinearity existing between pairs of variables.

PTNO	PTCAP	.74
PTCAP	AVOL	.88
PTCAP	VOL3	.84
PTNO	AVOL	.68
PTNO	VOL3	.67

Ratios of the above variables also reduced collinearity problems between other explanatory variables. For example, the correlations coefficients between RQI and PTNO, PTCAP, AVOL and VOL3 were in the .50 to .60 range but fell to .40 with COMPVOLA.

It was hypothesized that the rail line on which an elevator was located may be a factor in the decision to close. While this may be true, the two measures of rail line status; 1) grain dependency and 2) tonne miles of traffic were not significant in determining the probability of elevator closure. The following correlation coefficients between the dependent variable and the data for each of the three rail line measures were calculated:

Grain dependence, GRDEP	-.19
Tonne Miles moved	-.02

The correlation coefficients indicate the relationship between these rail facility measures and the dependent variable are low.

7.2.2. Saskatchewan Closure Logit Model

The independent variables used in the Saskatchewan closure logit model to predict the probability of elevator closure were RQI, ELEVCAP, AAVGTURN and REPRATIO.

RQI	= road quality index.
ELEVCAP	= sample elevator capacity in tonnes.
AAVGTURN	= average turnover rate at the sample point.
REPRATIO	= representation ratio of the grain company in terms of number of elevators on the market fringe.

The variable AAVGTURN, an estimation of the average turnover at a point, is derived by dividing annual volume handled at a point, AVOL, by the point capacity, PTCAP. As 63 percent of the points at which elevators were closed in Saskatchewan were also single company points, AAVGTURN, is a reasonable measure of average turnover per company.

Incorporating AAVGTURN eliminated collinearity problems that would arise if AVOL or PTCAP were both introduced, as the correlation coefficient between these two variables was .75. Using AAVGTURN also eliminated collinearity problems between ELEVCAP and other competition and market productivity factors, as the correlation coefficient between ELEVCAP and AAVGTURN was only .05.

The following correlation coefficients were calculated between ELEVCAP and other measures of competition and productivity:

ELEVCAP	PTCAP	.56
ELEVCAP	AVOL	.62
ELEVCAP	VOL3	.65
ELEVCAP	COMPVOLA	.64
ELEVCAP	COMPVOL3	.66

It was expected that AVGTURN3 would be a better measure than AAVGTURN. Correlation coefficients between AVOL and VOL3 of .91, and between COMPVOLA and COMPVOL3 of .79, however, indicate that the measures have comparable explanatory power.

Variables RQI and ELEVCAP were in both the Alberta and Saskatchewan logit models. The variable COMPVOLA in the Alberta model and AAVGTURN in the Saskatchewan model are both measures of profitability, albeit COMPVOLA is an indirect measure - revenue increases and costs decline per tonne as volume increases. The Saskatchewan closure *ex post* forecasts presented in Chapter 8 indicate that the variable REPRATIO was indicative of SWP rationalization policy. The representation ratio, REPRATIO, an investment strategy measuring company representation or coverage in the market fringe, was not found to be significant in the Alberta model.

7.3. **Alberta Closure Model Results**

7.3.1. Statistical Inference of Alberta Closure Logit Model

The following model was derived and used to determine the effect magnitude of the explanatory variables on the probability of elevator closure in Alberta.

$$Z = 12.283 - .26373\ RQI - .0017474\ ELEVCAP - .30926\ COMPVOLA$$

where

Z	< .50 elevators would not be predicted to close.
Z	≥ .50 elevators would be predicted to close.
RQI	= road quality index.
ELEVCAP	= sample elevator capacity in tonnes.
COMPVOLA	= the average company volume at the point. Measured in thousands of tonnes.

7.3.1.1. Signs and Significance of Variable Coefficients

Variables road quality access, elevator capacity and company volume all had negative signs as expected indicating that as the values associated with these variables increased, the probability of closure would decrease. As the direction of the effect of variables RQI, ELEVCAP, and COMPVOLA, was anticipated the significance of the coefficients is based on a one-tailed t-test. The coefficients are all significant at the following significance levels:

	T statistics	Significance Level
RQI	1.7302	.05
ELEVCAP	2.6738	.005
COMPVOLA	2.7284	.005

7.3.1.2. Goodness of Fit of Model

Of the 69 observations, the outcome was correctly predicted 94 percent of the time. Table 7.14 presents the percent predicted for each subsample, Y=0, not closed and Y=1, closed. The model correctly predicted 25 of the 28 elevators that did not close. There were fewer errors in predicting which elevators would close, as 40 of the 41 elevators closed were predicted to close.

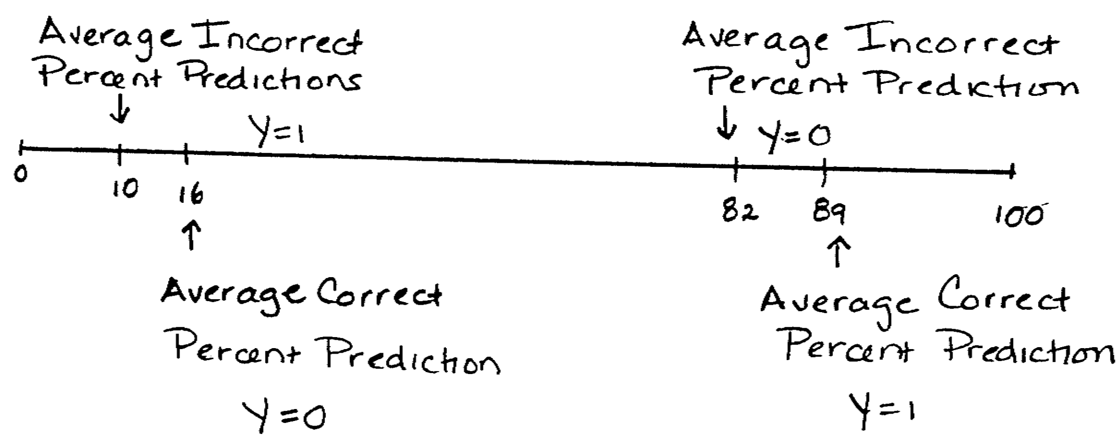
Table 7.14 Predictions for Each Subsample of Alberta Closed Logit Model.			
Actual	Predictions		Total
	0	1	
0	25	3	28
1	1	40	41
			69

The average forecast errors about the correct predictions, subsamples n2 (Y=0) and n1 (Y=1) were .16 and .11, respectively. Given the true probability of elevator closure was 1 at points where elevators were closed, and 0 at points elevators were not closed, the errors can be interpreted as the average predicted probability of closure. At points elevators were not closed, the average probability of closure was .16 and the average probability of closure at points elevators where closed was .89 (1-.11).

The average forecast error about the incorrect predictions in subsample n2, Y=0, was .82 indicating that the average predicted probability of elevator closure was 82 percent rather than zero. The average forecast error associated with subsample n1, Y=1, was .10, indicating that the incorrect probability of closure averaged 90 percent rather than 100 percent.

Given the range of predicted probabilities is 0 - 1, the incorrect prediction errors in both subsamples were large. The probability of the incorrect predictions did not fall near the 50 percent probability level, but each at the opposite end of the range of the actual outcome. Both the placement of the average incorrect predicted probabilities and the correct predicted probabilities are presented in Figure 7.1. If a range of indecision was set between .10 and .82, the average incorrect predicted probabilities, thereby disregarding all observations that fell within these boundaries, the total percent correct predictions would fall to 77 percent from 94 percent. Consequently, defining a range of indecision about the 50 percent probability level would be unproductive.

Figure 7.1 Average Correct and Incorrect Predicted Probabilities of Closure for Subsamples, Y=0 and Y=1.



A second goodness of fit test, examines the joint hypothesis that all the coefficients except the intercept are zero, H^0 : RQI = ELEVCAP = COMPVOLA = 0. A c statistic is calculated from the maximum value (L^0) of the constrained log likelihood function (LLC) and the log likelihood (L^2) of the now unconstrained equation (LLUC).

c= -2 (LLC - LLUC) = 65.75

Based on three degrees of freedom and a 99.5 significance level, the null hypothesis that the coefficients equal zero is rejected as the c statistic of 65.75 is greater than the critical square statistic of 12.84.

7.3.2. Sensitivity Analyses: Effect of Point and Elevator Characteristic Levels on Probability of Elevator Closure in Alberta

Sensitivity analyses were performed to determine the effect of the magnitude of the explanatory variables on the probability of elevator closure. Each explanatory variable RQI, ELEVCAP and COMPVOLA is individually assessed in scenarios 1 through 3, respectively. As the values of the remaining other variables also affect the probability of closure, three sets of explanatory variables values are assessed. The three sets of values, sample N, and subsamples n1, Y=1 and n2, Y=0 mean values are assessed in the base frame and frame C1 and C2, respectively[4]. The N sample, n1 and n2 mean values are presented in Table 7.15.

Table 7.15 Variable Mean values within Alberta Closure Model, Sample and Subsamples.

Sample	RQI	ELEVCAP	COMPVOLA
n2, Y=0	8	5100	22
n1, Y=1	5	2700	8
N, (Y=0), (Y=1)	7	3700	13

[4]The probabilities arising when only one of the remaining variable values is changed to n1 or n2, mean values while the other remaining variable continues to assume N mean values are presented in frames A1, A2, B1 and B2 in Appendix A.

7.3.2.1. Road Quality: Scenario 1

In scenario 1, road quality index values of 2, 4, 6, 8, 10, and 12 were analyzed. Table 7.16 lists the probability of closure and the change in probability arising from each increment in the road quality index within each frame. As the RQI increased, the probability of elevator closure decreased, however, the effect of RQI on the probability of closure varied widely from frame to frame. The greatest change in probability occurred in the base frame, as the probability of closure declined 58 percent, changing the outcome. Smaller decreases in the probability of closure occurred in frame C1 and C2, the probability of closure falling only 11.7 and 1.7 percent, respectively over the range of road quality access analyzed.

These results suggest that road quality access plays a significant role in the decision to close an elevator when performance indicators such as elevator capacity and annual deliveries lie near industry averages. However, when performance indicators such as elevator capacity and annual deliveries fall below or rise above industry averages, the effect of road access improvements on managements' decision to close an elevator are secondary. For example as in frame C2, 5100 tonne elevators are generally newer, and less likely to be rationalized, consequently the size of elevator would likely receive greater consideration than road quality. Similarly, with smaller older elevators, the size and age would be paramount to the decision to close and road quality of lesser importance. The probability of closure within frames C1 and C2 attests to this, as the probability of closure was 99 percent and 2 percent, respectively, at an RQI of 2 indicating that road quality had little effect on

Table 7.16 RQI Sensitivity Analysis, Alberta Closure Model.

Frame	RQI	ELEVCAP	COMPVOLA	Z Value	Prob	▲ Prob
Base	2	3700	13	1.2713	0.7810	
	4	3700	13	0.7438	0.6778	0.1031
	6	3700	13	0.2163	0.5539	0.1240
	8	3700	13	-0.3111	0.4228	0.1310
	10	3700	13	-0.8386	0.3018	0.1210
	12	3700	13	-1.3660	0.2033	0.0986
						0.5777
C1	2	2700	8	4.5646	0.9897	
	4	2700	8	4.0371	0.9827	0.0070
	6	2700	8	3.5096	0.9710	0.0117
	8	2700	8	2.9822	0.9518	0.0192
	10	2700	8	2.4547	0.9209	0.0309
	12	2700	8	1.9273	0.8729	0.0480
						0.1168
C2	2	5100	22	-3.9579	0.0187	
	4	5100	22	-4.4853	0.0111	0.0076
	6	5100	22	-5.0128	0.0066	0.0045
	8	5100	22	-5.5403	0.0039	0.0027
	10	5100	22	-6.0677	0.0023	0.0016
	12	5100	22	-6.5952	0.0014	0.0009
						0.0173

the ultimate outcome.

7.3.2.2. Elevator Capacity: Scenario 2

Elevator capacity values of 2,300, 3,000, 3700, 4,400, 5100 and 5,800 were analyzed in scenario 2. Within all three frames in Table 7.17, the probability of elevator closure declined when elevator capacity increased. Changes in the probability of elevator closure attributed to elevator capacity were largest in the base frame and frame C1 where the probability of closure declined, 89 and 82 percent over the range of elevator capacities assessed. The change in the probability of closure was much less in frame C2, falling only 29 percent.

In frame C1, a 2,300 tonne elevator receiving 8,000 tonnes annually had a 99 percent probability of closure. Despite implied lower turnover rates, raising elevator capacity to 5,800 tonnes reduced the probability of closure to 16 percent.

This suggests that elevator capacity and investment in a structure is of greater importance to the decision to close than average turnover. Smaller elevators are likely older and incur higher maintenance and repair expenses. Older facilities are probably fully depreciated whereas newer larger facilities still incur principal and interests costs. The older facility is probably also technologically obsolete and the rail sidings inadequate for assembling multicar shipments. In addition, many of the costs such as elevator manager's salary, licensing fees and head office administration costs are quasi-fixed, and vary little with volume or turnover levels. Management may then be more inclined to maintain larger elevator facilities hoping that deliveries will improve with continued rationalization.

Table 7.17 ELEVCAP Sensitivity Analysis, Alberta Closure Model.

Frame	ELEVCAP	RQI	COMPVOLA	Z Value	Prob	▲ Prob
Base	2300	7	13	2.3984	0.9167	
	3000	7	13	1.1755	0.7641	0.1526
	3700	7	13	-0.0474	0.4882	0.2760
	4400	7	13	-1.2703	0.2192	0.2689
	5100	7	13	-2.4932	0.0763	0.1429
	5800	7	13	-3.7161	0.0238	0.0526
						0.8930
C1	2300	5	8	4.4722	0.9887	
	3000	5	8	3.2493	0.9626	0.0261
	3700	5	8	2.0264	0.8835	0.0791
	4400	5	8	0.8035	0.6907	0.1928
	5100	5	8	-0.4194	0.3967	0.2941
	5800	5	8	-1.6423	0.1621	0.2345
						0.8266
C2	2300	9	22	-0.9124	0.2865	
	3000	9	22	-2.1353	0.1057	0.1808
	3700	9	22	-3.3582	0.0336	0.0721
	4400	9	22	-4.5811	0.0101	0.0235
	5100	9	22	-5.8040	0.0030	0.0071
	5800	9	22	-7.0269	0.0009	0.0021
						0.2856

This pattern was repeated in the base frame and in frame C2. Holding all other variables constant within each frame, the model predicted larger elevators were less likely to close.

Using interpolation techniques, an elevator capacity of 3,639 and 4,859 tonnes, respectively was required to change the outcome in the base frame and frame C1. Consequently, raising the volume of deliveries 5,000 tonnes to 13,000 tonnes, reduced the elevator capacity at which the outcome changed by approximately 1,200 tonnes. Raising the volume to 22,000 tonnes in frame C2, reduced the probability of closure for a 2,300 tonne elevator to 29 percent[5].

In summary, elevator capacity appears to be critical to the decision to close an elevator, particularly when deliveries are 13,000 tonnes or less. However, at points receiving higher volumes, e.g. 22,000 indicated in frame C2, the probability of elevator closure is low regardless of the elevator capacity.

7.3.2.3. Company Annual Volume: Scenario 3

Table 7.18 lists the probability of closure when annual company volume is raised from 3,000 tonnes to 28,000 tonnes in 5,000 tonne increments. Over the range of company volumes analyzed, the probability of closure declined between 52 and 95 percent, changing the outcome in each frame.

The base frame and frame C1 illustrate that at a volume of 3,000 tonnes, the probability of closing a 3700 and 2700 tonne elevator were 95 and 99 percent,

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[5] It is unlikely a 2300 tonne elevator would receive volumes of 22,000 tonnes yielding a turnover of 9.6.

Table 7.18 COMPVOLA, Sensitivity Analysis, Alberta Closure Model.

Frame	COMPVOLA	RQI	ELEVCAP	Z Value	Prob	▲ Prob
Base	3	7	3700	3.0452	0.9546	
	8	7	3700	1.4989	0.8174	0.1372
	13	7	3700	-0.0474	0.4882	0.3293
	18	7	3700	-1.5937	0.1689	0.3193
	23	7	3700	-3.1400	0.0415	0.1274
	28	7	3700	-4.6863	0.0091	0.0324
						0.9456
C1	3	5	2700	5.3197	0.9951	
	8	5	2700	3.7734	0.9775	0.0176
	13	5	2700	2.2271	0.9027	0.0749
	18	5	2700	0.6808	0.6639	0.2387
	23	5	2700	-0.8655	0.2962	0.3677
	28	5	2700	-2.4118	0.0823	0.2139
						0.9128
C2	3	9	5100	0.0720	0.5180	
	8	9	5100	-1.4744	0.1863	0.3317
	13	9	5100	-3.0207	0.0465	0.1398
	18	9	5100	-4.5670	0.0103	0.0362
	23	9	5100	-6.1133	0.0022	0.0081
	28	9	5100	-7.6596	0.0005	0.0017
						0.5175

respectively. Raising the volume to 28,000 tonnes, reduces the probability of these same elevators closing to 1 and 8 percent, respectively.

The model estimated the probability of closing a 5100 tonne receiving 3,000 tonnes in frame C2 was 52 percent. Raising delivery volumes to 8,000 tonnes reduced the probability of closure to 19 percent thus changing the outcome. Further increases in the company volume only validated the outcome, reducing the probability of elevator closure to less than 1 percent at a company volume of 28,000 tonnes.

These results indicate that the volume of deliveries has a significant impact on the probability of elevator closure, particularly for smaller elevators. These results also confirm the results obtained in scenario 2, that at points with a large elevator, elevator capacity is of greater consequence to the decision to close an elevator than the volume.

7.3.3. Alberta Closure Model Summary

The results of the scenario analyses permit several conclusions to be drawn. First, the change in probabilities over the range of RQI increments indicate road quality access may be of secondary importance when performance indicators, such as elevator capacity and company volume deliveries, lie below or above industry averages. Although an increase in the road quality access can reduce the probability of closure, it did not change the outcome. The probability of closure, hence the outcome, has already been determined by company volume and elevator capacity values.

Second, elevator capacity and investment in the structure has a greater impact on the probability of elevator closure than average turnover or volume particularly for large elevators at points with volumes less than 13,000 tonnes.

Third, volume has a significant impact on the probability of elevator closure at points with elevators less than 3700 tonnes capacity.

Table 7.19 summarizes these results and indicates the levels of the variables at which the probability of closure exceeds 50 percent.

Table 7.19 Turning Point Values of Explanatory Variable where Predicted Outcome Becomes Y= 1, Alberta Closure Model.

Sample	n1	N	n2
Variable	RQI = 5.0 ELEVCAP =2700 COMPVOLA = 8	RQI = 7.0 ELEVCAP =3700 COMPVOLA =13	RQI = 9.0 ELEVCAP =5100 COMPVOLA = 22
	Variable Turning Point Values		
RQI	More than 12. Not in range of analysis	6-8	Elevator will not close regardless of RQI.
ELEVCAP	4,400-5100 tonnes	3,000-3700 tonnes.	Less than 2,300 tonnes. Not in range of analysis
COMPVOLA	18 - 23 thousands of tonnes	8 - 13 thousands of tonnes	3 - 8 thousands of tonnes

Tables 7.20 and 7.21 list each variable's contribution to the Z value measured at the subsample mean values[6]. Elevator capacity contributes more to the Z value

[6]Note that the impact of variable values on Z values is linear but the effect on the probability of closure is nonlinear. The ultimate impact depends on the values of all the explanatory variables, as the change in probability increases as Z values approach zero.

at the variable means, followed by company volume. Road quality access while statistically significant to the model estimated, has a small impact on the probability of elevator closure relative to company volume and elevator capacity.

Table 7.20 Contribution of Subsample n1 Mean Variable Values to Z Value, Alberta Closure Model.

Variable	Unit Measure	Variable Coefficient	Variable Mean Range	Change in Z Value
Road Quality Access	1 RQI	-.26373	5	-1.336
Elevator Capacity	1 tonne	-.001747	2700	-4.717
Company Volume	1,000 tonnes	-.30926	8	-2.474

Table 7.21 Contribution of Subsample n2 Mean Variable Values to Z Value, Alberta Closure Model.

Variable	Unit Measure	Variable Coefficient	Variable Mean Range	Change in Z Value
Road Quality Access	1 RQI	-.26373	9	-2.406
Elevator Capacity	1 tonne	-.001747	5100	-8.910
Company Volume	1,000 tonnes	-.30926	22	-6.804

Tables 7.22 lists the total change in Z values that can be expected over the range of variable values observed in the sample data and Table 7.23 lists the change in Z values over the range of variable values analyzed in the scenarios. Over the range of explanatory variable values existing in the sample and analyzed in the scenarios, extreme changes in company volume can feasibly exert greater changes in the probability of elevator closure than does elevator capacity. This illustrates the need to individualize assessments of the probability of elevator closure.

Table 7.22 Breadth of Possible Changes in Z Values Associated with Low and High Values of Alberta Model Variables.				
Variable	Unit Measure	Variable Coefficient	Variable Values Range	Change in Z Value
Road Quality Access	1 RQI	-.26373	1 - 17	-4.48340
Elevator Capacity	1 tonne	-.001747	780 - 11,780	-19.2170
Company Volume	1,000 tonnes	-.30926	.7 - 82.5	-25.29755

Table 7.23 Breadth of Possible Changes in Z Values Associated with Range of Values Analyzed in Scenarios.				
Variable	Unit Measure	Variable Coefficient	Variable Values Range Analyzed	Change in Z Value
Road Quality Access	1 RQI	-.26373	2 - 12	-2.637
Elevator Capacity	1 tonne	-.001747	2,300 -5,800	-6.114
Company Volume	1,000 tonnes	-.30926	3 - 28	-7.731

7.4. **Saskatchewan Closure Model Results**

7.4.1. Statistical Inference of Saskatchewan Closed Model

The following logit model predicting the probability of closing Saskatchewan elevators was derived.

$$Z = 9.0408 - .16098\ RQI - .0021193\ ELEVCAP - .83413\ AAVGTURN + 3.1849\ REPRATIO$$

where

Z	< .5 elevator would not be predicted to close.
Z	≥ .5 elevator would be predicted to close.
RQI	= road quality index.
ELEVCAP	= sample elevator capacity in tonnes.

AAVGTURN	= average turnover rate at the sample point.
REPRATIO	= representation ratio of the grain company in terms of number of elevators on the market fringe.

7.4.1.1. Signs and Significance of Coefficients in Saskatchewan Closure Model.

Variables road quality access, elevator capacity and average turnover all had negative signs as expected indicating that as the values associated with these variables increased, the probability of closure would decrease. The representation ratio had an expected positive sign indicating the probability of closure would increase as this variable increased.

As the direction of the effect of variables RQI, ELEVCAP, AAVGTURN and REPRATIO were anticipated, the significance of the coefficients was determined using a one-tailed t-test. The null hypotheses that each slope coefficient equalled zero was rejected for RQI, ELEVCAP, AAVGTURN and REPRATIO at a significance level of .025. The t-statistics and the significance level for each coefficient are listed below.

	T statistics	Significance Level
RQI	1.6902	.100
ELEVCAP	4.8773	.005
AAVGTURN	4.2301	.005
REPRATIO	2.4592	.010

7.4.1.2. Model Goodness of Fit

One test of goodness of fit evaluates the joint hypothesis that all the coefficients except the intercept are zero, H^0 : RQI = ELEVCAP = AAVGTURN = REPRATIO = 0. A c statistic is calculated from the maximum value (L^0) of the constrained log likelihood function (LLC) and the log likelihood (L^2) of the now unconstrained equation (LLUC).

$$c = -2 (LLC - LLUC)$$

$$c = -2 (-87.337 -(-43.346)) = 87.982$$

Based on four degrees of freedom and a 99.5 significance level, the null hypothesis that the coefficients equal zero is rejected as the c statistic of 87.982 is greater than the critical square statistic of 14.86.

The percent correct predictions is another measure of the model's explanatory power. Of the 126 observations, the correct outcome was predicted 83 percent of the time. Table 7.24 presents the percent predicted for each subsample, Y=0 and Y=1. The model correctly predicted 41 or 77 percent of the elevators would not close. The model also correctly predicted 64 or 88 percent of the elevators that closed.

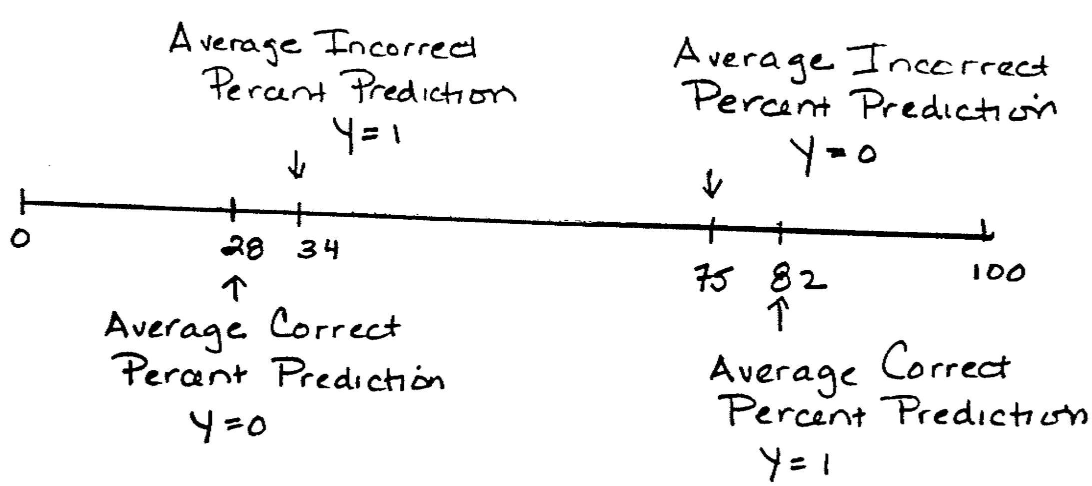
Table 7.24 Predictions for Each Subsample of Saskatchewan Closure Model.

Actual	Predicted		Total
	0	1	
0	41	12	53
1	9	64	73
			126

The average forecast errors about the correct predictions for subsamples n2, Y=0 and n1, Y=1 were .28 and .18, respectively. Given 0 and 1 are the true probabilities of the events occurring, this can be interpreted to mean the average predicted probability of closure at points where elevators were not closed averaged 28 percent, and the predicted probability of closure at points where elevators were closed averaged 82 percent (1-.18). The errors in the forecasts for Saskatchewan, are greater than their Alberta counterparts. The average predicted probability of closure error for subsamples n2 and n1 in the Alberta model were 16 and 89 percent, indicating there was possibly less variation in variable values between sample observations.

The predicted probabilities of the incorrect outcomes did not fall near the 50 percent probability level. The average forecast error of the incorrect predictions was .66 for Y= 1 and .75 for Y=0. Similar to the Alberta model, these results indicate that defining a range of indecision would actually reduce the percent correct predictions by 9 percent. Both the placement of the average incorrect predicted probabilities and the average correct predicted probabilities are shown in Figure 7.2.

Figure 7.2. Average Correct and Incorrect Predicted Probabilities of Closure for Subsamples Y=0 and Y=1.



7.4.2. Sensitivity Analyses: The Effect of Saskatchewan Elevator Characteristic Levels on the Probability of Closure

To determine the effect of the variable values on the probability of closure, sensitivity analyses were performed. Four scenarios follow, one for each of the variables RQI, ELEVCAP, AAVGTURN and REPRATIO. Within each scenario, the value of the principal variable is raised in equal increments to determine the effect of the variable values on the probability of elevator closure. The explanatory variable values in the base frame and frame D1 and D2 assume N sample and n1 and n2 subsample mean values, respectively[7].

7.4.2.1 Road Quality: Scenario 1

In all the frames in Table 7.25, the probability of elevator closure decreased as road quality increased. The total effect of raising road quality access from 2 to 12 varied from frame to frame but not as widely as in the Alberta model.

Similar to the Alberta model, the greatest change in probability occurred in the base frame. Over the range of RQI analyzed, the estimated probability of closure declined 38 percent, the outcome changing between RQI 4 - 6.

The probability of closure at RQI 2 in frame D1 was 94 percent. An increase in the RQI from 2 to 12 had no impact on the outcome as the predicted probability of closure declined only to 76 percent. It can be concluded that road quality access plays a minor role in the probability of closure when other elevator characteristics

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[7] The probabilities occurring when only one of the remaining variable values is changed to n1 or n2 mean values, while the remaining two variables continue to assume N mean values, are presented in frames A1, A2, B1, B2, C1 and C2 in Appendix C.

Table 7.25 RQI Sensitivity Analysis, Saskatchewan Closure Model.

Frame	RQI	ELEVCAP	AAVGTURN	REPRATIO	Z Value	Prob	▲ Prob
BASE	2	2800	4.1	0.47	0.8618	0.7030	
	4	2800	4.1	0.47	0.5398	0.6318	0.0713
	6	2800	4.1	0.47	0.2179	0.5542	0.0775
	8	2800	4.1	0.47	-0.1041	0.4740	0.0803
	10	2800	4.1	0.47	-0.4261	0.3951	0.0789
	12	2800	4.1	0.47	-0.7480	0.3213	0.0738
							0.3818
D1	2	2200	3.6	0.53	2.7415	0.9394	
	4	2200	3.6	0.53	2.4195	0.9183	0.0211
	6	2200	3.6	0.53	2.0976	0.8907	0.0276
	8	2200	3.6	0.53	1.7756	0.8552	0.0355
	10	2200	3.6	0.53	1.4537	0.8106	0.0446
	12	2200	3.6	0.53	1.1317	0.7562	0.0544
							0.1833
D2	2	3700	4.9	0.39	-1.9677	0.1226	
	4	3700	4.9	0.39	-2.2897	0.0920	0.0307
	6	3700	4.9	0.39	-2.6116	0.0684	0.0236
	8	3700	4.9	0.39	-2.9336	0.0505	0.0179
	10	3700	4.9	0.39	-3.2555	0.0371	0.0134
	12	3700	4.9	0.39	-3.5775	0.0272	0.0099
							0.0955

values are below average industry levels.

The smallest total change in probability due to better road access occurred in frame D2. At an RQI of 2 the probability of closure was only 12 percent. Raising the RQI to 12 reduced the probability of closure to 3 percent. These results also suggest road quality is of little importance when elevator and point characteristic values exceed industry averages.

7.4.2.2. Elevator Capacity-Scenario 2

In scenario 2, as illustrated in Table 7.26, elevator capacity values of 1500, 2000, 2500, 3000, 3500 and 4000 tonnes were analyzed. At an elevator capacity of 2000 tonnes, regardless of the other explanatory variable values, the model predicted an elevator would close. However, the outcome changed in all frames as elevator capacity increased. The level at which the outcome changed, however, depended on the values assumed for the remaining variables.

In the base frame, the probability of closure fell to below fifty percent when elevator capacity increased to between 2500 and 3000 tonnes. Using interpolation techniques, an elevator capacity of 2902 tonnes will generate a probability of closure of 50 percent[8].

In frame D1 where all the explanatory variables assumed less desirable mean values, the outcome changed at 3266 tonnes. The larger elevator required when the turnover rate was reduced suggests that some minimum volume is required to induce

[8]Interpolation techniques can be used due to the linear relationship between Z values and variable values.

Table 7.26 ELEVCAP Sensitivity Analysis, Saskatchewan Closure Model.

Frame	ELEVCAP	RQI	AAVGTURN	REPRATIO	Z Value	Prob	Δ Prob
Base	1500	6	4.1	0.47	2.9729	0.9513	
	2000	6	4.1	0.47	1.9133	0.8714	0.0799
	2500	6	4.1	0.47	0.8536	0.7013	0.1701
	3000	6	4.1	0.47	-0.2060	0.4487	0.2527
	3500	6	4.1	0.47	-1.2657	0.2200	0.2287
	4000	6	4.1	0.47	-2.3253	0.0890	0.1310
							0.8623
D1	1500	5	3.6	0.53	3.7421	0.9768	
	2000	5	3.6	0.53	2.6824	0.9360	0.0409
	2500	5	3.6	0.53	1.6228	0.8352	0.1008
	3000	5	3.6	0.53	0.5631	0.6372	0.1980
	3500	5	3.6	0.53	-0.4965	0.3784	0.2588
	4000	5	3.6	0.53	-1.5562	0.1742	0.2042
							0.8026
D2	1500	8	4.9	0.39	1.7289	0.8493	
	2000	8	4.9	0.39	0.6692	0.6613	0.1879
	2500	8	4.9	0.39	-0.3904	0.4036	0.2577
	3000	8	4.9	0.39	-1.4501	0.1900	0.2136
	3500	8	4.9	0.39	-2.5097	0.0752	0.1148
	4000	8	4.9	0.39	-3.5694	0.0274	0.0478
							0.8219

grain companies to maintain elevator operations.

When all the explanatory values alternatively assumed the more desirable n2 mean values in D2, the outcome changed between 2000 and 2500 tonnes. These results indicate that as the point and elevator characteristic values increase, the probability of closing smaller elevators falls to 40 percent. Frame D2 suggests that elevators between 2000-2500 tonnes may survive rationalization if they have turnovers exceeding 4.9, since the probability of closure fell below fifty percent at 2315 tonnes.

The total change in the probability of closure as a result of raising elevator capacity from 1500 to 4000 tonnes within each frame is large and remarkably similar between frames. This illustrates the importance of elevator capacity in the decision to close a Saskatchewan elevator at the RQI, AAVGTURN and REPRATIO levels tested.

7.4.2.3 Average Turnover: Scenario 3

Table 7.27 shows that an increase in the average turnover reduced the probability of elevator closure. This is to be expected because handling costs /tonne decline as grain throughput increases. With the exception of frame D2, an increase in the average turnover rate altered the predicted outcome.

In the base frame representing a 2800 tonne elevator, the probability of closure fell below 50 percent between 4.1 and 5.1 average turns, reversing the outcome at a turnover over 4.4. In terms of the volume delivered, the outcome changed at a volume of 12,320 tonnes[9].

[9] 12,320 tonnes = 4.4 x 2,800 tonne capacity

Table 7.27 AAVGTURN Sensitivity Analysis, Saskatchewan Closure Model.

Frame	AAVGTURN	RQI	ELEVCAP	REPRATIO	Z Value	Prob	CH Prob
Base	2.1	6	2800	0.47	1.8861	0.8683	
	3.1	6	2800	0.47	1.0520	0.7412	0.1272
	4.1	6	2800	0.47	0.2179	0.5542	0.1869
	5.1	6	2800	0.47	-0.6163	0.3506	0.2036
	6.1	6	2800	0.47	-1.4504	0.1899	0.1607
	7.1	6	2800	0.47	-2.2845	0.0924	0.0975
							0.7759
D1	2.1	5	2200	0.53	3.5098	0.9710	
	3.1	5	2200	0.53	2.6756	0.9356	0.0354
	4.1	5	2200	0.53	1.8415	0.8631	0.0724
	5.1	5	2200	0.53	1.0074	0.7325	0.1306
	6.1	5	2200	0.53	0.1732	0.5432	0.1893
	7.1	5	2200	0.53	-0.6609	0.3405	0.2027
							0.6304
D2	2.1	8	3700	0.39	-0.5980	0.3548	
	3.1	8	3700	0.39	-1.4321	0.1928	0.1620
	4.1	8	3700	0.39	-2.2663	0.0940	0.0988
	5.1	8	3700	0.39	-3.1004	0.0431	0.0509
	6.1	8	3700	0.39	-3.9345	0.0192	0.0239
	7.1	8	3700	0.39	-4.7687	0.0084	0.0108
							0.3464

Frame D1 shows that a 2200 tonne capacity elevator with an average turn of 2.1 had a 97 percent probability of closing. Only when the average turn increased to 6.3 did the outcome change. Frames D2 indicates that it is improbable that a 3700 tonne elevator would close at a turnover rate of 2.1. and that the change in probability associated with each incremental increase in turnover becomes less significant to the probability of closure.

The 7,800 tonne volume estimate[10] required to keep a 3700 tonne elevator operational seems incredibly low. This perverse result may occur because of the investment sunk in large elevators. The trend on the Prairies has been to build larger elevators, therefore it can be assumed that larger elevators are new elevators which have not been fully depreciated. The smaller, older elevators probably require extensive repairs, therefore greater volumes may be required to justify continued operation.

Another explanation lies in the realism of the data values assessed. Larger elevators achieving turnovers of less than 2.1 are not a frequent occurrence. A review of the sample data indicates that the average probability of closure for the 24 elevators exceeding 3700 tonnes capacity was 6 percent. Based on an average turnover of 4.2 and an average capacity of 4,900 tonnes, these 24 elevators received, 20,500 tonnes on average annually. Consequently, given an average turnover of 2.1 for a 3700 tonne elevator, the model generates a predicted probability based on the relationship which best fits the data. In reality, this situation is not likely to occur too

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[10] 3700 * 2.1 = 7,770 tonnes

often, nor did it in the sample data.

Given the capacity and turnover changes in scenario 2 and 3, the volume and turnover required of the different elevator capacities to generate a 50 percent probability of closure are listed in Table 7.28. It appears that a 'critical' volume of grain deliveries of approximately 12,000 tonnes is required for elevators to remain operational.

Table 7.28 Average Tonnes Required to Reverse Predicted Outcome of Closure.

Frame	Elevator Capacity	Average Turnover	Tonnes 50 Percent Probability
Sc 3:Base	2800	4.4	12,320
Sc 2:Base	2902	4.1	11,900
Sc 2:D1	3266	3.6	11,760
Sc 2:D2	2315	4.9	11,340

7.4.2.4. Representation Ratio: Scenario 4

Five frames are listed in Table 7.29. The sample N and subsample n1 and n2 mean values are portrayed in the base frame and in frames D1 and D2, respectively. Frames A1 and A2 have been added to show the effect road quality access has on the probability of closure across different representation ratio values, when elevator capacity and average turn values maintain N sample mean values. The RQI values in Frames A1 and A2 assume the n1 and n2 subsample mean values.

Table 7.29 shows that as a company's representation ratio increases, the probability of closure increases. This relationship is based on the assumption that

Table 7.29 REPRATIO Sensitivity Analysis, Saskatchewan Closure Model.							
Frame	REPRATIO	RQI	ELEVCAP	AAVGTURN	Z Value	Prob	CH Prob
Base	0.27	6	2800	4.1	-0.4191	0.3967	
	0.37	6	2800	4.1	-0.1006	0.4749	-0.0781
	0.47	6	2800	4.1	0.2179	0.5542	-0.0794
	0.57	6	2800	4.1	0.5363	0.6310	-0.0767
	0.67	6	2800	4.1	0.8548	0.7016	-0.0706
	0.77	6	2800	4.1	1.1733	0.7637	-0.0622
							-0.3670
A1	0.27	5	2800	4.1	-0.2582	0.4358	
	0.37	5	2800	4.1	0.0603	0.5151	-0.0793
	0.47	5	2800	4.1	0.3788	0.5936	-0.0785
	0.57	5	2800	4.1	0.6973	0.6676	-0.0740
	0.67	5	2800	4.1	1.0158	0.7342	-0.0666
	0.77	5	2800	4.1	1.3343	0.7916	-0.0574
							-0.3557
A2	0.27	8	2800	4.1	-0.7411	0.3228	
	0.37	8	2800	4.1	-0.4226	0.3959	-0.0731
	0.47	8	2800	4.1	-0.1041	0.4740	-0.0781
	0.57	8	2800	4.1	0.2144	0.5534	-0.0794
	0.67	8	2800	4.1	0.5329	0.6302	-0.0768
	0.77	8	2800	4.1	0.8514	0.7009	-0.0707
							-0.3781

Frame	REPRATIO	RQI	ELEVCAP	AAVGTURN	Z Value	Prob	▲ Prob
D1	0.27	5	2200	3.6	1.4305	0.8070	
	0.37	5	2200	3.6	1.7490	0.8518	-0.0448
	0.47	5	2200	3.6	2.0675	0.8877	-0.0359
	0.57	5	2200	3.6	2.3860	0.9158	-0.0280
	0.67	5	2200	3.6	2.7045	0.9373	-0.0215
	0.77	5	2200	3.6	3.0229	0.9536	-0.0163
							-0.1466
D2	0.27	8	3700	4.9	-3.3158	0.0350	
	0.37	8	3700	4.9	-2.9973	0.0475	-0.0125
	0.47	8	3700	4.9	-2.6788	0.0642	-0.0167
	0.57	8	3700	4.9	-2.3603	0.0863	-0.0220
	0.67	8	3700	4.9	-2.0418	0.1149	-0.0286
	0.77	8	3700	4.9	-1.7233	0.1514	-0.0366
							-0.1164

grain producers located within the catchment area of an elevator to be closed will patronize the same company's elevators in the surrounding the catchment area. The likelihood of maintaining customers if an elevator closes increases as the representation ratio increases, as access is facilitated[11].

The probabilities listed in the base frame indicate that elevator closure would be predicted between representation ratios of .37-.47. When the RQI was reduced to 5 in frame A1, the outcome changed at a representation ratio between .27 and .37. Conversely, when the RQI was raised to 8, the outcome changed at a representation ratio between .47 and .57 . These three frames indicate an elevator company may be more amenable to maintaining an elevator in a well represented market area if the site has good road access. A site with poor road access is more likely to lose business as the rationalization process continues, as it will be less able to draw farmers from greater distances.

In frame D1, the model predicted that a 2200 tonne elevator with a turnover of 3.6 had a 80 percent probability of closing at the lowest representation ratio, .27. The outcome was validated with each subsequent representation ratio increment, increasing the probability of closure to 95 percent. Even when the company was not represented in a market area, REPRATIO=0, the probability of the elevator closing was 64 percent. It is apparent that at points with small capacity elevators or lower

[11]Often grain producers are annoyed when the elevator they customarily deliver to closes. Some opt to deliver to another company in retaliation rather than go to an alternative elevator of the same company. However, the higher the representation ratio, the less opportunity they have to deliver to other elevators because in doing so they may incur additional transportation costs.

turnover, the representation ratio is of little significance.

In frame D2, the level of the representation ratio also had no effect on the predicted outcome of a 3700 tonne capacity elevator with a turnover of 4.9. Increasing the representation ratio to .77 only raised the probability of closure to 15 percent. Even at a representation ratio of 1.0, the probability of elevator closure was only 27 percent.

It would appear that the representation ratio is unimportant to management's decision to close an elevator when either elevator capacity is small or turnover is low, as other factors have already determined its fate. The same appears true for larger elevators with higher turnover values. However, for moderate sized elevators with turnover rates of 4.1 or greater, a representation ratio between .37 and .47 is required before management will consider closing an elevator.

7.4.2.5. Relationship between Volume Handled and Representation Ratio

Although the above model does not consider volume handled directly in assessing the probability of elevator closure, it is possible to make some crude estimate of the relationship between volume and the representation ratio when the probability of closure is fifty percent (Z=0). Volume data is obtained by multiplying the three mean average turnover values 3.6, 4.1 and 4.9 by elevator capacity values ranging between 2200 and 3700 tonnes capacity[12]. Given each combination of turnover and elevator capacity, the Saskatchewan closure model was used to derive

[12] Beginning with a 2200 tonne elevator, capacity was raised in increments of 100 to 3700 tonnes resulting in 16 elevator capacity values for each average turnover rate.

Z values over the range of representation ratios, .27-.77. From the Z values obtained and using interpolation, the representative ratio at which the probability of closure equalled fifty percent, Z=0, was derived. Thus for each combination of average turnover and elevator capacity, a unique representation ratio was calculated at which the probability of closure was 50 percent. To then determine the relationship between volume and the representation ratio, Ordinary Least Squares (OLS) regression analysis was performed. The following straight line was fitted[13].

REPRATIO = -.76271 + .103854 VOLUME   n=48

The negative intercept indicates that even in areas where the company has no other elevators (representation ratio =0), elevators handling less than 7344 tonnes[14] have a fifty percent probability of being closed. The positive slope indicates that as volume increases so must the representation ratio before management will consider closing the elevator.

As higher average turnovers result in increased elevator efficiency, the volume/representation ratio relationship may vary with the underlying average turnovers and elevator capacity values. Separate OLS regressions were estimated for each level of average turnover. The following three relationships were derived.

Average turn = 3.6 REPRATIO = -1.1873 + .148008 VOLUME n=16
Average turn = 4.1 REPRATIO = -1.09133 + .131339 VOLUME n=16
Average turn = 4.9 REPRATIO = -0.84112 + .104838 VOLUME n=16

[13] Note that the use of Ordinary Least Squares regression technique does not assume a causal relationship. The technique was used to show a relationship.

[14] Derived by dividing .7621 by .103854.

As elevator capacity also affects unit costs, elevator capacity must directly be addressed in the interpretation. This is accomplished by keeping the size of elevator constant at one capacity across the three models. For example, given a 2800 tonne elevator, the volume is calculated by multiplying the average turnover in each model by the elevator capacity. In this example, the following volume and representation ratios are calculated.

Average turn 3.6	Volume 10,080	Representation ratio .30
Average turn 4.1	Volume 11,480	Representation ratio .42
Average turn 4.9	Volume 13,720	Representation ratio .60

Given a 2800 tonne elevator and a representation ratio of .3, a minimum of 10,080 tonnes delivered is required to keep the elevator open. The same size elevator in a market where the representation is .6 requires a minimum throughput of 13,720 tonnes. Therefore, in a specified market area with a known representation ratio, the minimum volume required to maintain an elevator of given capacity can be estimated.

7.4.3 Saskatchewan Closure Model Summary

Several conclusions can be drawn from the scenario analyses. First, road quality access may be of secondary importance when performance indicators such as elevator capacity and average turnover lie above or below N sample means.

Second, RQI only becomes pertinent to the decision to close at elevators exhibiting average or moderate elevator capacities and turnover values around 2800 tonnes and 4.4, respectively. At these values, the decision to close becomes more complex.

Third, when an elevator company is well represented in an area, it is more inclined to keep an elevator open as road quality access improves. The lower the RQI, the greater the probability of closure since poor road access discourages deliveries.

Fourth, elevator capacity is critical to the decision to close an elevator, particularly for elevators of less than 2500 tonnes capacity.

Fifth, based on average turnover and elevator capacity values, it appears that a 'critical' volume of approximately 12,000 tonnes is required for elevators to remain operational.

Sixth, although it is improbable that an elevator 3700 tonnes or larger would close at a turnover of less than 2.1, this conclusion is of little practical importance. The sample data indicate that it is unusual for large elevators to have turnovers less than 2.1

Seventh, at sites with small elevators and low turnover, grain companies would be inclined to close the elevator even if the company is not represented in the market area, REPRATIO =0. Conversely, if elevator capacity is large and the turnover high, it is improbable that a company will close the elevator even if the REPRATIO =1. However, for moderate sized elevators with turnover rates of 4.1 or greater, a representation ratio between .37 and .47 is required before management will consider closing an elevator.

Table 7.30 summarizes these results indicating the variable values at which the probability of closure falls to 50 percent.

Table 7.30 Turning Point Values of Explanatory Variable in Saskatchewan Closure Model where Predicted Outcome Becomes Y= 0.

Sample	n1	N	n2
Variable	RQI = 5.0 ELEVCAP =2200 AAVGTURN = 3.6	RQI = 6.0 ELEVCAP =2800 AAVGTURN = 4.1	RQI = 8.0 ELEVCAP =3700 AAVGTURN = 4.9
	Variable Turning Point Values		
RQI	More than 12. Not in range of analysis	6-8	Elevator will not close regardless of RQI.
ELEVCAP	3,000-3,500 tonnes	2,500-3,000 tonnes.	2,000 - 2,500 tonnes
AAVGTURN	5.1 - 6.1	4.1 - 5.1	Less than 2.1
REPRATIO	Less than .27	.37 - .47	Elevator will not close regardless of REPRATIO.

Tables 7.31, 7.32, 7.33 and 7.34 show the relative importance of each variable in determining the probability of closure. Tables 7.31 and 7.32 list each variable's contribution to the Z value measured at the subsample mean values. Table 7.33 lists the total change in Z values that can be expected over the range of variable values observed in the sample data and Table 7.34 over the range of variable values analyzed in the scenarios.

Tables 7.31 to 7.34 illustrate that elevator capacity is the single most important characteristic in determining the probability of closing an elevator. Average turnover was the second most important characteristic. It is not unexpected that elevator size and average turnover would be the most important variables to affect the decision

Table 7.31 Contribution of Subsample n1 Mean Variable Values to Z Value, Saskatchewan Closure Model.

Variable	Unit Measure	Variable Coefficient	Variable Mean Value	Change in Z Value
Road Quality Access	1 RQI	-.16098	5	-0.80
Elevator Capacity	1,000 tonnes	-.0021193	2,200	-4.66
Average Turnover	1	-.83413	3.6	-3.00
Representation Ratio	1	3.1849	.53	-1.69

Table 7.32 Contribution of Subsample n2 Mean Variable Values to Z Value, Saskatchewan Closure Model.

Variable	Unit Measure	Variable Coefficient	Variable Mean Value	Change in Z Value
Road Quality Access	1 RQI	-.16098	8	-1.29
Elevator Capacity	1,000 tonnes	-.0021193	3700	-7.84
Average Turnover	1	-.83413	4.9	-4.09
Representation Ratio	1	3.1849	.39	-1.24

Table 7.33 Breadth of Possible Changes in Z Values Associated with Low and High Range Values of Saskatchewan Explanatory Variable.

Variable	Unit Measure	Variable Coefficient	Value Range Analyzed	Change in Z Value
Road Quality Access	1 RQI	-.16098	1- 17	-2.58
Elevator Capacity	1,000 tonnes	-.0021193	840 -11,200	-21.96
Average Turnover	1	-.83413	.56 - 11.2	-8.88
Representation Ratio	1	3.1849	0 -1.0	3.18

Table 7.34 Breadth of Possible Changes in Z Values Associated with Range of Values Analyzed in the Scenarios, Saskatchewan Closure Model.				
Variable	Unit Measure	Variable Coefficient	Value Range Analyzed	Change in Z Value
Road Quality Access	1 RQI	-.16098	2- 12	-1.61
Elevator Capacity	1,000 tonnes	-.0021193	1,500 -4,000	-5.30
Average Turnover	1	-.83413	2.1 - 7.1	-4.17
Representation Ratio	1	3.1849	.27 -.77	-1.59

to close an elevator as they both directly affect unit costs. Market representation ratio and road quality access were also significant but their end effect is limited relative to elevator capacity and turnover.

7.5 Alberta Saskatchewan Closure Model Results

7.5.1. Statistical Inference of Alberta Saskatchewan Closure Model

Data from the Saskatchewan and Alberta data base were combined to determine if an increased number of observations resulted in a better model with improved forecasting ability. Based on the combined data set of 195 observations, the following logit model predicting the probability of elevator closure in Saskatchewan and Alberta was chosen.

Z= 8.7262 -.19206 RQI -.0016794 ELEVCAP -.82454 AAVGTURN +2.5006 REPRATIO

where

Z < .5 Model predicts elevator would not be closed.

Z	$\geq .5$ Model predicts elevator would be closed.
RQI	= Road Quality Index
ELEVCAP	= Elevator capacity in tonnes.
AAVGTURN	= Annual average turnover at the sample point.
REPRATIO	= Number of elevators operated by sample company as a percent of total number of elevators in market fringe.

The combined Alberta-Saskatchewan model contained the same variables as the Saskatchewan model but only the road quality index and elevator capacity variables appeared in the Alberta closure model. It is logical that the model should more closely resemble the Saskatchewan model, as Saskatchewan data comprised 65 percent of the total.

7.5.1.1. Signs and Significance of Model Coefficients

Variables road quality access, elevator capacity and average turnover had negative signs as expected indicating that as the values associated with these variables increased, the probability of closure would decrease. In contrast, the representation ratio had an expected positive sign indicating the probability of closure would increase as the market representation ratio increased.

As the direction of the effect of variables RQI, ELEVCAP, AAVGTURN, and REPRATIO is anticipated, the significance of the coefficients is based on a one-tailed t-test. The null hypotheses that each slope coefficient equals zero is rejected.

The coefficients are all significant at the following significance levels.

	T statistics	Significance Level
RQI	2.6688	.005
ELEVCAP	5.7951	.005
AAVGTURN	5.1025	.005
REPRATIO	2.6075	.005

7.5.1.2. Goodness of Fit of Alberta-Saskatchewan Model

Table 7.35 presents the number of correct predictions for each subsample, Y=0 and Y=1 and the total sample. The model correctly predicted that 63 or 78 percent of the 81 sample elevators would not close, Y=0. The model also correctly predicted the outcome at 103 or 90 percent of the 114 elevators which did close, Y=1. Of the 195 observations, the outcome was correctly predicted 85 percent of the time.

Table 7.35. Predictions for Each Subsample of Alberta-Saskatchewan Combined Closure Model.

Actual	Predicted		Total
	0	1	
0	63	18	81
1	74	103	114
			195

Overall, combining the data sets did not improve the percent correct predictions. Rather, the percent correct predictions dropped from 94 percent in the Alberta closed model to 85 percent, but increased slightly from 83 percent in the Saskatchewan model to 85 percent in the combined model. The almost 2 percent increase in correct predictions in the combined model was due to an improvement in the ability to predict those elevators which would close, Y=1. The predictions concerning which elevators would not close, Y=0, were virtually the same, for the Saskatchewan and Alberta-Saskatchewan closed models, 77.4 and 77.8 percent, respectively.

A second goodness of fit test, examines the joint hypothesis that all the coefficients except the intercept are zero, H^0 : RQI = ELEVCAP = AAVGTURN = REPRATIO=0. A c statistic is calculated from the maximum value (L^0) of the constrained log likelihood function (LLC) and the log likelihood (L^2) of the now unconstrained equation (LLUC).

$$c= -2 (LLC - LLUC) = 134.59$$

Based on four degrees of freedom and a 99.5 significance level, the null hypothesis that the coefficients equal zero is rejected as the c statistic of 134.59 is greater than the critical square statistic of 14.86.

7.5.2. Summary

The Alberta-Saskatchewan closure logit model based on 195 observations achieved a lower percentage of correct predictions than the individual Alberta model estimated, and yielded marginally improved proportion of correct predictions of the Saskatchewan elevators which closed. Based on these results and the additional expense and time required to collect REPRATIO and AAVGTURN data for Alberta, individual provincial models are more suitable for forecasting elevators that companies might choose to close.

CHAPTER 8 FORECAST OF ELEVATOR CONSTRUCTION AND CLOSURE

In this chapter, the models predicting the probability of elevator construction and elevator closure are evaluated using out-of-sample and *ex pos*t forecasts. An out-of-sample forecast involves predicting the value of the dependent variable for observations not included in the study sample but occurring during the estimation time period. An *ex post* forecast predicts the value of the dependent variable for observations occurring beyond the time period which the models were estimated, but for which the results are known. In this study, the estimation period was between 1980 and 1990 and the *ex post* observations occurred between crop years 1990/91 and 1994/95. In both out-of-sample and *ex post* forecasts, the predictions can be checked against existing data which is known with certainty.

Ex ante forecasts are also conducted of selected delivery points which were operating as of 1994/95. At these points there is no a priori information concerning grain elevator companies future investment or rationalization plans. However in many instances, knowledge concerning the delivery points and the elevators at those points can help either to verify the model or uncover problems associated therewith.

The chapter is divided into four sections. In the first two sections, the Manitoba and Saskatchewan open logit models estimated are tested. The Manitoba and Saskatchewan closure logit models are examined in the last two sections.

8.1 Manitoba Open Model

Based on the estimated logit model predicting the probability of elevator construction at individual points in Manitoba, the probability of opening an elevator at 2 out-of-sample and 4 *ex post* elevators[1] was determined. The following probabilities were attained.

Elevator Point	Year	Company	Probability of Construction
Out-of Sample			
Graysville	1984	Stow Seed Co.	73.2
Elgin	1986	Stow Seed Co.	17.8
Ex post			
Fannystelle	1993	UGG	71.7
Starbuck	1993	MPE	95.7
Dundonald	1994	UGG	91.4
Winkler	1994	Keystone Grain[2]	70.6

Based on the probabilities obtained, the model predicted that elevators would be constructed at five of the six elevator points. At the sixth point, Elgin, the model predicted that an elevator would not be constructed. The probability of construction at Elgin was low because the estimated volume per company was low and the fringe elevator capacity high relative to other elevators. The elevators owned by Stow Seeds, however, did not provide full elevator service and dealt primarily in specialty seeds, therefore the elevator was not typical of grain elevators in Manitoba. MPE has since acquired these elevators and offers full elevator services.

The probabilities of various grain companies constructing an elevator at

[1]Only four points were analyzed as there was no further information concerning elevator construction at other Manitoba points.

[2]Keystone Grain Ltd is not affiliated with Keystone Agricultural Producers. The elevator handles mostly specialty seeds particularly sunflower and buckwheat.

selected delivery points in the future were also forecasted. The point/company pair chosen for the *ex ante* forecast 1) were located either on a main or secondary rail line, 2) were not included in the sample used to establish the model predicting the probability of elevator construction and 3) were located either at major road intersections or on major highways. The only exceptions to these criteria were Clearwater, MacGregor and Treherne which were not located at major road intersections. These three points were adjacent to other points selected and were included for comparison purposes. The probability of elevator construction at each of the 20 points is given in Table 8.1.

The model predicted that future construction would take place at 90 percent, 18 of the 20 points. Only at Boissevain and MacGregor does the probability of construction fall below fifty percent due to a high coverage value. A comparison of the *ex ante* delivery point means and the means at delivery points where elevators were constructed, listed below, support the predictions.

	RQI	VOLCO	CF	COV
Subsample n2 Means	9.6	18.3	32.3	.043
Ex ante Means	9.7	28.5	30.8	.035

The *ex ante* VOLCO mean is higher than in subsample n2 thus contributing to a higher probability of construction. The *ex ante* CF and COV means are lower than in subsample n2 which also contribute to a higher probability of construction due to the negative relationship between these variables and the probability of

Table 8.1 Forecast of Future Probability of Elevator Construction at the Following Manitoba Grain Delivery Points, Based on 1994/95 data.

Station	Comp	RQI	VOLCO 3 yr Avg	CF	COV	PRES	% Prob
BOISSEVAIN	MPE	8	32.8	66.2	0.0952	0	16.6
MACGREGOR	MPE	8	19.5	26.9	0.0909	0	45.4
GREGG	MPE	6	30.0	32.0	0.0476	0	68.1
CLEARWATER	MPE	7	21.6	23.7	0.0259	0	70.7
SOURIS	UGG	11	23.3	37.3	0.0294	0	71.9
SIDNEY	CARG	8	16.2	13.8	0.0222	0	77.9
AUSTIN	MPE	12	17.6	25.2	0.0385	0	78.4
RIVERS	CARG	9	32.3	38.8	0.0300	0	80.6
PILOT MOUND	MPE	9	28.0	29.9	0.0389	0	81.2
TREHERNE	MPE	7	31.1	27.9	0.0223	0	85.1
MORDEN	MPE	10	24.9	37.8	0.0565	1	62.7
CRYSTAL CITY	MPE	10	22.1	17.8	0.0389	0	87.2
VIRDEN	UGG	11	25.2	28.4	0.0216	0	87.3

Station	Comp	RQI	VOLCO 3 yr avg	CF	COV	PRES	% Prob
BINSCARTH	MPE	12	22.9	23.2	0.0476	0	87.6
MORDEN	UGG	10	24.9	37.8	0.0185	1	72.8
CARBERRY	MPE	10	19.0	8.6	0.0000	0	93.9
CARBERRY	UGG	10	19.0	8.6	0.0000	0	93.9
HOLLAND	MPE	12	38.4	37.1	0.0273	0	95.2
ELM CREEK	MPE	12	64.5	57.4	0.0202	0	99.0
HOLLAND	PAT	12	57.1	37.1	0.0348	0	99.4
Averages		9.7	28.5	30.8	.035	0	

construction. It is interesting to note that the RQI means for both these samples are essentially identical yet the volume at the *ex ante* delivery points is so much greater as well as the fringe capacity and coverage value so much lower. The differences in the mean values show the effect of elevator closure and rail line abandonment on the Manitoba elevator system.

Consistency in the model predictions can also be checked by comparing the probabilities of construction between 1) companies at the same point and 2) neighbouring delivery points at which a company is located. The model predicted that MPE would not construct an elevator at Boissevain or MacGregor. Elevator capacity in the market area surrounding Boissevain is substantial, discouraging further building. MPE also has a relatively new elevator facility adjacent to Boissevain at Ninga with an average age of 10.7 years yielding a coverage measure of .0952. These two factors and a below average road quality index with respect to subsample n2 average RQI of 9.7, would likely discourage construction at this point. Similarly, the road quality index at MacGregor was low as it was not located at the intersection of major highways. Also the MPE Burnside facility adjacent to MacGregor was relatively new, being 11 years old. These two factors reduced the probability of elevator construction at MacGregor.

MacGregor was included in the *ex ante* forecast to compare the probability of construction at MacGregor with that of Austin, two towns which are in proximity to each other. The probability of construction at Austin was greater, 78.4 percent compared to 45.4 percent at MacGregor. This is partially due to better road access at Austin and the MPE facilities in the area surrounding Austin being older. The MPE facility in Austin averaged 44 years of age and its adjacent point MacGregor, 26 years of age while the adjacent point to MacGregor, Burnside was 11 years of age.

Clearwater was included in the study to compare the probability of MPE building an elevator at this point relative to Pilot Mound and Crystal City. The model estimated that the probability of MPE building an elevator was lowest at Clearwater, 70.7 percent, followed by Pilot Mound and Crystal City with estimated probabilities of 81.2 and 87.2 percent, respectively. The road quality access is poorest at Clearwater, followed by Pilot Mound. However the estimated volume per company for those companies on the Pilot Mound fringe was determined to be higher than at Crystal City. This was offset by a lower fringe capacity surrounding Crystal City raising the probability of elevator construction in Crystal City 6 percent above that for Pilot Mound.

Treherne was also included in the analysis in order to compare the probability of MPE building at Treherne and Holland. The estimated probability of construction was high at both points, 85.1 percent at Treherne and 95.2 percent at Holland. The higher estimated probability at Holland is attributed to improved road access and a higher estimate of volume handled per company.

Both Morden and Holland are listed twice in the analysis. The probabilities of MPE and UGG each building an elevator at Morden and MPE and Paterson each building an elevator at Holland were examined. The road quality access, volume per company and fringe capacity at each of these points would be identical for each company. The only value which varies, hence yielding different probabilities, is the COV variable indicating the average age of each company's newest elevator at the sample point and adjacent rail points. UGG only has an elevator at Morden which averaged 54 years of age, and had no elevators at the adjacent rail points, Darlingford or Winkler. On the other hand, MPE has three elevators, one at each of these points but the newest facility is at Winkler and averaged only 17.7 years of age. Consequently, the probability of UGG constructing an elevator at Morden was 72.8 percent, almost 10 percent higher than MPE at 62.7 percent.

It is difficult to assess the forecasting ability of the Manitoba open model on the basis of the 6 out-of-sample and *ex post* delivery points predictions. However, comparison of the probability of construction between 1) companies at a point and 2) neighbouring points at which at company is located are consistent throughout the *ex ante* observations. Also the mean values for the *ex ante* delivery points are higher than the means of the subsample of elevators constructed in the 1980s which would support the predictions. However, it is possible that as a result of elevator closure and rationalization, the predicted probabilities may somewhat overestimate the probability of construction in the 1990s, but too few observations exist to determine if structural changes as occurred. Only the passage of time will verify or repudiate the predictions.

8.2 Saskatchewan Open Model

The Saskatchewan open logit model was evaluated on 12 out-of-sample delivery points[3] and 3 *ex post* delivery points, White Star, Wadena and Dixon. The model was then used to forecast *ex ante,* the probability of elevator construction at 17 selected elevators.

The model correctly predicted that elevators would be constructed at 14 of the 15 out-of-sample and *ex post* delivery points. At White Star, the model predicted the probability of elevator construction was 24.8 percent. A low probability was obtained primarily because the point capacity at White Star prior to construction was zero.

Year	Elevator Point	Probability of Construction
Out-of-Sample		
1981	Aberdeen	90.8
1982	Wakawa	98.5
1983	Minton	91.1
1983	Woodrow	55.3
1984	Debden	59.4
1984	St. Louis	90.1
1985	Hamlin	87.6
1985	Lucky Lake	94.6
1985	Marsden	86.1
1986	Eastend	96.9
1988	Unity	99.6
1989	Biggar	100.0
Ex post		
1992	White Star	24.8
1993	Wadena	99.8
1994	Dixon	71.3

[3]These twelve points were the remaining twelve points from the population of elevators constructed in Saskatchewan that were not included in the sample.

This emphasizes a weakness of the model. The model cannot predict elevator construction at newly created delivery points and can only predict the probability of construction at existing elevator points. This is not perceived as a major obstacle as the investment behaviour exhibited by grain elevator companies throughout Saskatchewan in the eighties indicates that investment normally takes place at existing elevator points[4].

The probabilities of construction at Woodrow and Debden were slightly over 50 percent. All the explanatory variables values associated with Woodrow were below the average values of the 12 out-of-sample points tested. Similarly with Debden, the road quality, point capacity and age of own elevators at either the sample or adjacent rail points were lower.

Ex ante forecasts of the probability of elevator construction at 17 Saskatchewan points were also undertaken. The points selected were located 1) at major intersections or on a major highway and 2) on main or secondary rail lines. The company/delivery point pairs were not included in the study sample. The estimated probability of construction at each point is listed in Table 8.2.

Based on the probabilities estimated and assuming probabilities exceeding 50 percent suggest elevator construction, elevators would be constructed at all 17 Saskatchewan points. The lowest estimates of the probability of constructing a new

[4]Of the 50 elevators constructed in Saskatchewan through the 1980s only one elevator was built at a newly created elevator point.

Table 8.2 Forecast of Future Elevator Construction at Saskatchewan Grain Delivery Points, Based on 1994/95.						
Station	Comp	RQI	PTCAP	FTOVER Annual	POST	Prob
ABERNETHY	UGG	7	5.8	4.3	59.8	94.9
ALSQUITH	SWP	10	4.4	6.3	27.0	89.0
BALCARRES	CARG	10	8.3	4.9	27.3	86.9
BALGONIE	SWP	9	2.2	7.4	39.6	96.1
BREDENBURY	SWP	10	6.5	7.0	7.0	75.9
CHAMBERLAIN	SWP	12	2.8	5.6	31.8	91.2
ELFROS	SWP	12	2.9	5.8	39.9	96.4
GRENFELL	UGG	10	15.7	6.2	40.8	99.7
ITUNA	CARG	13	10.0	6.1	36.9	99.4
KENASTON	UGG	13	10.3	4.4	20.7	91.7
MAIDSTONE	PION	12	10.3	5.2	39.4	98.8
QU'APPELLE	SWP	12	1.6	7.9	39.6	98.9
STOUGHTON	UGG	15	11.9	6.7	31.0	99.8
WATROUS	SWP	11	5.5	5.6	23.0	84.9
WHITEWOOD	UGG	12	13.0	4.2	18.5	90.7
WILCOX	SWP	6	11.3	5.9	40.3	96.0
YELLOW GRASS	SWP	8	12.2	5.0	6.0	53.3
Average		10.7	7.9	5.8	31.1	

elevator were at Bredenbury and Yellow Grass, 76 and 53 percent, respectively. The presence of newer SWP facilities in Weyburn and Langenburg[5] lowered the

[5]Saskatchewan Wheat Pool has elevator facilities at Weyburn adjacent to Yellow Grass and an elevator at Langenburg adjacent to Bredenbury that average 6

probability of elevator construction.

These *ex ante* forecasts point to another limitation of the estimated Saskatchewan open logit model. The positioning variable POST, which reflects the age of the newest elevator at either the sample or adjacent rail points, may also overestimate the probability of elevator construction at delivery points. For example, if the contribution of elevator age were excluded from the model, the probability of elevator construction at Abernethy drops to 6 percent from 95 percent. The RQI, PTCAP and FTOVERA values are low indicating that this point is not particularly desirable. However, the elevator located at that point is approximately 60 years old and UGG has no other facility adjacent to it. Therefore a POST value of 60 raises the predicted probability of construction and possibly overestimates the real future probability of elevator construction.

The mean fringe market turnover of 5.8, of the *ex ante* delivery points is higher than the average fringe market turnovers of 4.0 and 4.1 for the study sample, N, and the subsample of elevators that were constructed, n2. Due to rationalization and increasing grain deliveries, it appears there has been structural change over time to larger fringe market turnover levels. Consequently, the fringe turnover values in the model may overestimate the probabilities of new elevator construction. Lack of sufficient observations during the first half of the 1990s prohibit validation of this and any estimation of a new logit model. To summarize, in certain circumstances, the

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and 7 years old, respectively.

Saskatchewan open model may tend to overestimate the probability of construction; predictions must therefore be tempered by knowledge of the individual point characteristics.

8.3 **Alberta Closure Model**

The Alberta closure model was evaluated using 6 out-of-sample delivery points[6] and 9 ex post delivery points. Ex ante forecasts are also made of the probability of 28 elevators operating in 1995, closing in the future.

Table 8.3 lists 6 out-of-sample delivery points at which elevators were closed in Alberta between 1980/81 and 1989/90. Of these out-of-sample points, the model would not have predicted the closure of the Cargill elevator in Legal. Both elevator

Table 8.3 Probability of Elevator Closure at Specified Delivery Points in Alberta, 1980/81 through 1989/90.

Station	Company	ELEVCAP	RQI	VOLCOA	Prob
Out-of- Sample					
BARONS	PION	2200	9	13.1	88.2
HIGH RIVER	PION	2040	11	13.1	85.5
KIRKALDY	CARG	620	6	1.3	100.0
LEGAL	CARG	3100	9	17.5	28.7
LINDEN	CARG	1630	4	4.0	99.9
PROVOST	PION	2460	11	15.8	54.9

[6]The population of elevators closed which this study used does not include 1) elevators closed as a result of rail line abandonment, 2) between company trades or 3) elevators that were closed only to be replaced by new facilities at existing sites.

capacity and the estimated volume handled per company, were considerably greater than were the explanatory variable values for the other out-of-sample points, thus yielding the lower estimated probability of closure of 29 percent. Discussions with Cargill indicated the elevator was old and they were consolidating their elevators in the area.

Table 8.4 lists 9 *ex post* sample points at which elevators were closed between 1990/91 and 1994/95 and the logit model's estimated probability of closure. The

Table 8.4 Estimated Probability of Elevator Closure at Specified Delivery Points Closed in Alberta between 1989/90 and 1994/95.

Station	Company	ELEVCAP	RQI	VOLCO	Prob
EXPOST					
ACME	UGG	2280	7	8.8	97.7
ALCOMDALE	UGG	2160	4	3.9	99.8
BENTON	AWP	2910	6	5.4	98.1
BERWYN	AWP	1460	6	6.3	99.8
BLUESKY	AWP	2760	6	7.7	97.1
BUFORD	AWP	1600	6	11.9	98.6
CARSTAIRS	PION	1710	8	21.8	60.9
CREMONA	PION	3670	8	4.2	92.1
RED WILLOW	CARG	3580	5	6.1	94.4
Average		2460	6.2	7.6	

model correctly predicted all elevators would close. At 8 of the 9 *ex post* points the predicted probability of elevator closure exceeded 90 percent. The estimated probability of closure of the Pioneer elevator at Carstairs was lower, 61 percent, because the estimated volume per company and the road quality index were greater than the values for the same variables of the other *ex post* points.

The 28 elevators selected for *ex ante* forecasting were chosen to provide varying magnitudes of elevator capacity, and volume of deliveries for the various grain elevator companies. Large established delivery points at which companies are not expected to close their elevators were included among the selected elevator observations for comparison purposes. The delivery points and the predictions concerning the probability of closing a specific elevator at these points are presented in Table 8.5.

The model predicted 13 elevators would be closed in the future and the remaining 15 elevators would remain operational. Elevators at large established delivery points such as Camrose, Fairview, Vulcan, Wrentham and Cereal had probabilities of closure less than 1 percent. The average variable values for elevators which were predicted to close and those that were not are listed below.

Outcome	ELEVCAP	RQI	VOLCOA
Elevator Predicted to Close	2,500	7.6	9.8
Elevator Predicted to Remain Open	5,200	8.5	18.5

By virtue of the out-of-sample and *ex post* predictions, the Alberta closure model appears to have a high degree of accuracy. Inspection of the *ex ante* probabilities at large delivery points and the differences in variable mean values for the two outcomes, suggest the model is suitable for forecasting the probability of

Table 8.5 Probability of Future Elevator Closure at Specified Delivery Points in Alberta, Based on 1994/95 data.

Station	Company	ELEVCAP	RQI	VOLCO	Prob
BIG VALLEY	AWP	3000	7	10.4	87.9
BRUCE	AWP	2760	8	11.1	87.2
CAMROSE	UGG	4650	10	24.9	0.2
CEREAL	AWP	6260	8	29.0	0.0
CHINOOK	AWP	2030	6	8.8	98.8
CLANDONALD	AWP	3670	4	14.4	58.9
CROSSFIELDS	UGG	4700	10	12.9	7.2
FAIRVIEW	CARG	5700	11	24.1	0.0
GIBBONS	UGG	2760	11	10.7	77.7
HAY LAKES	AWP	2860	8	13.3	74.3
HAYTER	PION	3920	6	14.4	35.7
HUGHENDEN	AWP	5250	7	12.9	6.1
JOFFRE	UGG	4630	2	13.1	40.5
LOUGHEED	PION	3550	8	17.1	21.1
LOUSANA	AWP	2020	8	6.6	99.0
MUNSON	AWP	4250	7	9.8	49.5
RADWAY	UGG	2420	6	19.3	62.3
RANFURLY	AWP	3640	6	13.7	52.6
RIMBEY	UGG	2830	10	6.4	93.9
SIBBALD	PION	2910	8	24.2	8.3
SWALWELL	AWP	2490	6	5.2	99.1
TABER	UGG	3560	13	19.2	3.5
TORRINGTON	PION	4060	8	14.6	19.5
VULCAN	AWP	13600	10	16.6	0.0

Station	Company	ELEVCAP	RQI	VOLCO	Prob
WARSPITE	AWP	300	10	3.0	100.0
WELLING	AWP	2180	9	4.9	99.0
WILLINGDON	PION	3650	9	12.8	39.5
WRENTHAM	AWP	7630	10	32.6	0.0

elevator closure in Alberta. Only time will reveal the accuracy of the forecasts made.

8.4 Saskatchewan Closure Model

The Saskatchewan closure model was evaluated using 28 out-of-sample and 13 ex post delivery points. Predictions are also made on the probability of 25 elevators operating in 1995 closing in the future.

The twenty eight elevators included in the out-of-sample forecasts were elevators among the population of elevators[7] closed between 1980/81 and 1989/90, but not included in the logit model estimation sample. The out-of-sample elevator points, the corresponding company and the estimated probability of elevator closure are provided in Table 8.6

The model predicted 26 of the 28 out-of-sample elevators would close. The model did not predict the closure of the SWP elevator in Cedoux or Pioneer's elevator in Cadillac. Their elevator capacities were 4,010 and 5,600 tonnes

[7]Approximately 65 percent of the study sample elevators belonged to SWP as did 64 percent of the 28 out-of-sample elevators. The large proportion of SWP elevators occurred because SWP closed more elevators in the eighties than all other Saskatchewan grain elevators combined.

Table 8.6 Out-of-Sample Forecasts of Saskatchewan Elevators Closed Between 1980/81 and 1989/90.

Year	Station	Comp[1]	ROI	ELEVCAP	AVGTURN	REPRATIO	Prob
82/83	RHEIN	4	6	3020	3.2	0.400	57.1
82/83	PARKSIDE	2	7	2440	2.6	0.200	77.0
83/84	CAVALIER	4	6	1960	1.4	0.667	99.5
83/84	KENDAL	2	8	1790	2.6	0.300	94.0
83/84	TUBEROSE	4	6	1910	4.7	0.600	88.9
84/85	ARBUTHNOT	3	6	2740	1.2	0.200	87.0
84/85	HAMTON	4	2	2600	2.6	0.364	90.2
84/85	MENNON	4	3	1430	4.1	0.500	97.8
84/85	SNIPE LAKE	3	7	1560	3.8	0.429	94.3
84/85	WHITE FOX	2	9	1570	2.9	0.00	86.4
85/86	HEWARD	4	8	2840	2.6	0.500	77.6
85/86	HUNTOON	4	4	1430	3.8	0.667	99.0
86/87	CADILLAC	3	12	5600	1.4	0.429	1.0
86/87	DENNY	4	6	1880	3.7	0.500	93.4
86/87	MENDHAM	3	4	2590	3.4	0.250	70.4

Year	Station	Comp	RQI	ELEVCAP	AVGTURN		
87/88	Boharm	4	2	2410	2.8	.333	91.8
87/88	FIFE LAKE	4	6	2100	1.4	0.500	98.7
87/88	HARDY	4	4	1820	0.8	0.667	99.8
87/88	KHEDIVE	4	7	2180	1.7	0.667	98.8
87/88	LEMSFORD	4	8	3280	1.5	0.667	88.0
87/88	RAVENSCRAG	3	2	2470	0.6	0.500	99.3
88/89	FORGAN	4	8	2830	1.8	0.500	88.6
88/89	HAGUE	4	8	1540	3.3	0.400	95.5
88/89	KRYDOR	4	8	2050	5.0	0.500	67.8
89/90	CEDOUX	4	7	4010	2.6	0.500	26.1
89/90	GUERNSEY	4	10	1180	5.5	0.833	96.1
89/90	HAZENMORE	3	7	2020	2.7	0.500	95.7
89/90	POLWARTH	2	7	1400	5.0	0.333	86.3
			6	2248	3	0.461	

1 .Company codes: UGG=1, Carg=2, Pion=3, SWP=4, Pat=7

respectively, were large relative to the average capacity, 2195 tonnes, of the elevators closed in the study sample. Discussions with Pioneer and SWP indicated that the elevators were closed because the primary house at each of these delivery points was small, the facilities were old and the turnover low. At these two points, the positive correlation presumed to exist between elevator capacity, and age and technological obsolescence did not exist. The large capacities at these points was due to the presence of many old annexes.

The *ex post* forecasts indicating the probability of closure at Saskatchewan elevators closed between 1990/91 and 1994/95 are presented in Table 8.7. Based on the probabilities estimated, the model predicted elevator closure at only 7 of the 13 *ex post* delivery points. Elevator closures would not have been predicted at Saltcoats, Tugaske, Sylvania, Shackleton, Sovereign and Findlater. Saltcoats, Tugaske and Sylvania were not predicted to close due to relatively high turnover rates. On the other hand, Shackleton, Sovereign and Findlater were not projected to close due to relatively large elevator capacity.

The grain companies who owned these facilities were contacted to determine why the facilities were closed. Pioneer indicated that Sylvania was closed because the facility was old and delivery volumes did not warrant new construction given they had an alternative elevator in Crooked River. Sovereign was also closed because the facility was old and volumes were low. Pioneer indicated that the market tended to be pulling to Rosetown and that the company had alternative viable elevators at Milden and Rosetown, both adjacent to Sovereign. SWP indicated that the Tugaske

Table 8.7 *Ex post* Forecasts of Saskatchewan Elevators Closed Between 1990/91 and 1994/95.

Year	Station	Comp	RQI	ELEVCAP	AAVGTURN	REPRATIO	Prob
91/92	SALTCOATS	2	9	2520	7.0	0.100	3.7
92/93	TUGASKE	4	9	3440	5.8	0.500	5.0
94/95	SYLVANIA	3	7	2130	5.6	0.100	27.6
93/94	SHACKLETON	1	8	3420	3.4	0.500	33.2
94/95	SOVEREIGN	3	8	3750	2.0	0.375	34.4
94/95	FINDLATER	7	10	3110	1.3	0.000	43.5
91/92	BURR	4	7	2780	4.6	0.667	58.3
93/94	PHIPPEN	1	7	2150	3.4	0.167	74.7
92/93	MOSELY	4	6	2250	3.7	0.333	78.3
92/93	CARMEL	4	7	1900	3.7	0.429	89.4
94/95	GRAYSON	1	8	1600	2.6	0.167	93.8
90/91	TUFNELLL	4	8	1810	3.0	0.625	96.8
94/95	LIPSETT	4	2	1700	2.8	0.400	98.3
	Average		7.4	2505	3.8	0.340	

1 .Company codes: UGG=1, Carg=2, Pion=3, SWP=4, Pat=7

elevator was closed because the facility was old and they were consolidating their elevators in the area. The primary house was small, the platform and scales too small and the head room too short for larger trucks to dump their load. Despite the volume handled, the expense of a new pit and drive shed was also not warranted given alternative elevators in Girvin and Eyebrow. Paterson closed their facility in Findlater although they had no alternative elevator in the area due to lack of business and the cost of operation. The primary house was also very small and old. Two large annexes contributed to the capacity at Findlater therefore the association between elevator capacity and technological obsolescence was low. UGG closed their facility in Shackleton because the facility was obsolete and they had an alternative elevator in Cabri. Cargill similarly closed their facility in Saltcoats as the facility was old and they had an alternative elevator in Yorkton.

The mean value of each explanatory variable within each subsample and the *ex post* delivery points are listed below. A comparison of the mean *ex post* explanatory variable values and the mean values of the study sample elevator which closed, n1, indicate that road quality access, elevator capacity and annual turnover

	RQI	ELEVCAP	AVGTURN	REPRATIO
Ex Post Means	7.4	2505	3.8	.34
Subsample n1 Means	5.5	2195	3.6	.53
Subsample n2 Means	7.8	3697	4.9	.39

were greater for the *ex post* elevators. The *ex post* REPRATIO value of .34, a measure of the degree of company representation in a market area, was even lower than the mean value of those elevators which continue to operate, .39 in subsample n2. The combined result is a lower predicted probability of elevator closure.

It is possible that elevator rationalization has resulted in structural change, and that the estimated coefficients based on 1980s data are no longer accurate for the 1990s. The Saskatchewan elevators closed in the eighties were smaller, had poorer road access and lower annual turnover. The rationalization of these elevators was a cleansing process, clearing the "deadwood". In comparison, the elevators closed thus far in the 1990s have been larger, had better road access and higher turnovers due to fewer elevators and increased deliveries. Rationalization of these elevators may be considered more of a streamlining process.

Aside from the structural changes that have possibly occurred, Saskatchewan Wheat Pool's dominant position in Saskatchewan imposed another limitation on the estimated logit model. Due to the fact that 65 percent of the sample observations were of SWP elevator closures,[8] the model predictions were more indicative of a SWP rationalization process than that of Saskatchewan grain elevator companies in total. This is reflected in the significance of the explanatory variable REPRATIO. The explanatory variable REPRATIO, a measure of a company's representation in the market fringe, was significant due to the large proportion of SWP observations

[8]AWP comprised 43 percent of the observations in the Alberta elevator closure data.

in the sample, and their extensive primary elevator network which gave rise to higher representation ratios[9]. The average representation ratio for the SWP elevators was .49 compared to .20 for the other companies. Five of the 6 elevators which the model predicted would not close belonged to companies other than SWP. As a result of lower representation ratios, the model generated lower probabilities of closure.

Ex ante forecasts predicting the probability of closure at 25 elevators currently operating in Saskatchewan are listed in Table 8.8. These particular elevators were chosen because they had lower capacities, therefore were probably older, and would likely be assessed in the near future concerning possible alternative investment opportunities or elevator closure. The model predicted that 9 of the 25 elevators listed would likely be closed.

The turnover ratio of these 25 elevators averaged 5.7 which is higher than that of the elevators operating in the 1980s of 4.9. The increase in the average turnover rate and the increase in the other mean values of the *ex post* and *ex ante* sample elevators suggest that the model coefficients estimated may no longer be appropriate if structural change has occurred throughout the primary elevator network.

To determine if structural change has occurred, the 13 *ex post* and 25 *ex ante* points relating to the 1990s, were added to the 126 study sample observations. The new logit model to be estimated incorporated the same four explanatory variables

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[9]In 1980/81, SWP was located at 614 or 90 percent of the total 683 delivery points. Despite elevator closures, they continued to be represented at 87 percent of the 472 points existing in 1994/95. Pioneer, the second largest grain company in Saskatchewan, was located at 27 percent of the points in 1994/95.

Table 8.8 *Ex ante* Forecasts of Probability of Saskatchewan Elevators Closing.

Year	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	Prob
94/95	FORT QU'APPELLE	2	15	2780	8.4	0.111	0.3
94/95	FLEMING	1	8	2740	8.0	0.000	0.9
94/95	CODETTE	1	8	3600	6.3	0.167	1.0
94/95	FORT QU'APPELLE	4	15	1900	8.4	0.556	6.4
94/95	BRADWELL	4	3	2800	8.0	0.444	6.9
94/95	VALPARAISO	2	8	2960	4.5	0.000	9.5
94/95	HARPTREE	1	2	3110	5.8	0.167	9.9
94/95	GRAND COULEE	3	6	2540	5.0	0.000	18.6
94/95	AMERSTERDAM	4	6	2150	8.5	0.800	25.7
94/95	ARCOLA	4	8	1910	7.2	0.429	28.0
94/95	FROBISHER	1	8	1960	6.4	0.250	28.7
94/95	INCHKEITH	1	6	2990	3.4	0.143	34.5
94/95	SHEHO	4	9	2250	6.5	0.714	41.5

Year	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	Prob
94/95	PLUNKETT	1	10	1820	4.6	0.000	43.5
94/95	RAMA	4	8	2020	8.1	1.000	47.5
94/95	NORQUAY	4	10	2570	4.3	0.500	49.2
94/95	OSLER	3	7	2380	4.0	0.167	51.6
94/95	DUNBLANE	3	1	2600	3.8	0.000	54.8
94/95	ALSASK	4	9	1740	5.7	0.333	55.1
94/95	DRINKWATER	3	6	2270	4.0	0.167	62.1
94/95	ZELMA	4	5	2100	6.0	0.556	62.5
94/95	LOVE	1	7	2200	3.7	0.200	69.4
94/95	KEELER	4	8	2280	3.4	0.333	76.0
94/95	HUBBARD	4	8	2070	4.4	0.500	78.7
94/95	THACKERAY	4	2	2120	5.0	0.500	83.3
	AVERAGE		7.3	2394	5.7	0.321	

1 .Company codes: UGG=1, Carg=2, Pion=3, SWP=4, Pat=7

RQI, ELEVCAP, AVGTURN and REPRATIO used in the original Saskatchewan closure model, and five dummy variables, one for the intercept and one for each of the explanatory variables. The dummy variables assume values of either 0 or 1 and are multiplied by the appropriate quantitative explanatory variable. In this model, the dummy variables is assigned a value of 0 if the elevator observation pertains to the 1980s and a value of 1 if the observation occurs in the 1990s. If the dummy variables are statistically significant, then structural change has occurred. The following reestimated model was derived.

$$Z = 9.0408 - .16098\ RQI - .002193\ ELEVCAP - .83413\ AAVGTURN + 3.1849\ REPRATIO - 8.1055\ D_1C + .28423\ D_2RQI - .0024947\ D_3ELEVCAP - .046986\ D_4AAVGTURN - .92646\ D_5REPRATIO$$

The coefficients, standard error and the t-statistic for each variable are shown in Table 8.9. The dummy variables coefficients DRQI and DELEVCAP were significant at a significance level of .10 and .005, respectively, indicating there had been structural change in terms of the effect of these variables on the decision to close. The coefficients of the dummy variables AAVGTURN and DREPRATIO were not significant indicating there had been no structural change in terms of the effect of these two variables.

The coefficients of the intercept and the first four variables are the same as in the original Saskatchewan model. For those elevators closed in the eighties, the original Saskatchewan model is the appropriate estimating model as the dummy variables assume a value of 0, therefore, the net change arising from the dummy

Table 8.9 Reestimated Saskatchewan Closure Model, Dummy Variables 0=1980s Data, 1= 1990s Data.			
Parameter	Estimate	Standard Error	T- Statistic
C	9.0408	1.7946	5.0379
RQI	-.16098	.095243	-1.6902
ELEVCAP	-.0021193	.0004345	-4.8773
AAVGTURN	-.83413	.19719	-4.2301
REPRATIO	3.1849	1.2951	2.4592
DC	-8.1055	2.9787	-2.7211
DRQI	.28426	.20075	1.4158
DELEVCAP	.0024947	.0008956	2.7855
DAAVGTURN	-.046986	.37084	-.12670
DREPRATIO	-.92646	2.3473	-.39470

variables is 0. For those elevators examined in the 1990s, the dummy variables assume a value of 1, therefore, the original four explanatory variables and all five dummy variables are included in the logit model estimating the probability of closure at these elevators. As the explanatory variables and their corresponding dummy variable coefficients are additive, the following reestimated logit model predicting the probability of elevator closure in the 1990s was derived.

Z = .9353 + .1233 RQI - .0004 ELEVCAP - .8811 AAVGTURN + 2.2584 REPRATIO

The predicted probabilities of closure for the 13 *ex post* and 25 *ex ante* elevator points were calculated using the reestimated logit model and are presented in Table 8.10. The reestimated Saskatchewan model was superior to the original

Table 8.10 *Ex post* and *Ex ante* Forecasts of the Probability of Elevator Closure at Saskatchewan Elevators Points, Based on Reestimated Logit Model.

Ex Post	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	Prob
91/92	SALTCOATS	2	9	2520	7.0	0.100	5.1
92/93	TUGASKE	4	9	3440	5.8	0.500	34.5
94/95	SYLVANIA	3	7	2130	5.6	0.100	10.7
93/94	SHACKLETON	1	8	3420	3.4	0.500	79.9
94/95	SOVEREIGN	3	8	3750	2.0	0.375	92.0
94/95	FINDLATER	7	10	3110	1.3	0.000	89.8
91/92	BURR	4	7	2780	4.6	0.667	58.0
93/94	PHIPPEN	1	7	2150	3.4	0.167	50.4
92/93	MOSELY	4	6	2250	3.7	0.333	50.4
92/93	CARMEL	4	7	1900	3.7	0.429	54.7
94/95	GRAYSON	1	8	1600	2.6	0.167	64.4
90/91	TUFNELL	4	8	1810	3.0	0.625	80.0
94/95	LIPSETT	4	2	1700	2.8	0.400	57.1

Ex ante	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	Prob
94/95	FORT QU'APPELLE	2	15	2780	8.4	0.111	3.3
94/95	FLEMING	1	8	2740	8.0	0.000	1.6
94/95	CODETTE	1	8	3600	6.3	0.167	13.2
94/95	BRADWELL	4	3	2800	8.0	0.444	2.5
94/95	FORT QU'APPELLE	4	15	1900	8.4	0.556	6.4
94/95	HARPTREE	1	2	3110	5.8	0.167	8.2
94/95	VALPARAISO	2	8	2960	4.5	0.000	28.8
94/95	GRAND COULEE	3	6	2540	5.0	0.000	14.5
94/95	AMSTERDAM	4	6	2150	8.5	0.800	3.8
94/95	ARCOLA	4	8	1910	7.2	0.429	6.0
94/95	FROBISHER	1	8	1960	6.4	0.250	8.4
94/95	INCHKEITH	1	6	2990	3.4	0.143	53.1
94/95	SHEHO	4	9	2250	6.5	0.714	22.4
94/95	RAMA	4	8	2020	8.1	1.000	10.0
94/95	PLUNKETT	1	10	1820	4.6	0.000	23.1

	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	PROB
94/95	NORQUAY	4	10	2570	4.3	0.500	61.1
94/95	OSLER	3	7	2380	4.0	0.167	38.8
94/95	DUNBLANE	3	1	2600	3.8	0.000	21.1
94/95	ALSASK	4	9	1740	5.7	0.333	17.1
94/95	ZELMA	4	5	2100	6.0	0.556	15.0
94/95	DRINKWATER	3	6	2270	4.0	0.167	35.8
94/95	LOVE	1	7	2200	3.7	0.200	45.8
94/95	KEELER	4	8	2280	3.4	0.333	63.2
94/95	HUBBARD	4	8	2070	4.4	0.500	49.2
94/95	THACKERAY	4	2	2120	5.0	0.500	20.7

closure model as 10 of the 13 *ex post* delivery points, 77 percent, were predicted to close, up 3 or 23 percent from the original model. The number of *ex ante* elevators predicted to close, however, fell from 9 to 3. Based on the *ex ante* elevators average elevator capacity and turnover rate of 2,400 and 5.7, respectively, an average volume of 13,600 tonnes would be handled. This volume is consistent with the information determined in the sensitivity analyses that elevators less than 2,800 tonnes required a minimum volume between 11,000 and 13,000 tonnes if they were to remain open. It is possible that as the older smaller elevators have been rationalized through the 1970s and 1980s, the presumption concerning the correlation between elevator age and technological obsolescence with elevator capacity is weakened. Therefore, the smaller remaining elevators operating in the 1990s, may not be so old they would be closed given the average turnover rates at the points.

In the reestimated Saskatchewan closure model, the ELEVCAP coefficient is very small resulting in a very small change in the Z value due to elevator capacity. The sign of the RQI coefficient has changed and the magnitude of the coefficient is smaller. As these were the two variables which had undergone significant structural change, another logit model was estimated for the explanatory variables AAVGTURN and REPRATIO using the 13 *ex post* and 25 *ex ante* elevator observations. The following revised Saskatchewan closure model was estimated resulting in 87 percent correct predictions.

$$Z = 2.5614 - .85054\ \text{AAVGTURN} + 2.2561\ \text{REPRATIO}$$

The coefficients, which are very similar to the Saskatchewan reestimated closure model predicting the probability of elevator closure in the 1990s, were significant at a .10 and .005 significance level. The outcomes and the probability of closure, at each of the 13 *ex post* and 25 *ex ante* elevators, are presented in Table 8.11. This revised Saskatchewan closure model mirrored the results of the reestimated Saskatchewan model.

In summary, the original Saskatchewan logit model adequately predicted the probability of elevator closure in the 1980s. However, through the rationalization process, the prairie primary elevator system has undergone structural changes and the model does not adequately forecast the probability of closure in the 1990s. The reestimated Saskatchewan logit closure model verifies that structural change has indeed occurred and its ability to forecast the probability of elevator closure in the 1990s is superior to the original model. Considering the cost and the time associated with data collection, the revised Saskatchewan model, excluding the variables RQI and ELEVCAP is preferred to the reestimated Saskatchewan model. It generates the same results but is easier to use due to fewer data requirements.

Table 8.11 *Ex post* and *Ex ante* Forecasts of the Probability of Elevator Closure at Saskatchewan Elevators Points, Based on Revised Logit Model.

Ex Post	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	Prob
91/92	SALTSCOAT	2	9	2520	7.0	0.100	4.1
92/93	TUGASKE	4	9	3440	5.8	0.500	22.5
94/95	SYLVANIA	3	7	2130	5.6	0.100	12.1
93/94	SHACKLETON	1	8	3420	3.4	0.500	69.8
94/95	SOVEREIGN	3	8	3750	2.0	0.375	84.9
94/95	FINDLATER	7	10	3110	1.3	0.000	80.8
91/92	BURR	4	7	2780	4.6	0.667	54.5
93/94	PHIPPEN	1	7	2150	3.4	0.167	51.9
92/93	MOSELY	4	6	2250	3.7	0.333	54.2
92/93	CARMEL	4	7	1900	3.7	0.429	58.7
94/95	GRAYSON	1	8	1600	2.6	0.167	67.1
90/91	TUFNELL	4	8	1810	3.0	0.625	80.8
94/95	LIPSETT	4	2	1700	2.8	0.400	75.3

Ex ante	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	PROB
94/95	FORT QU'APPELLE	2	15	2780	8.4	0.111	1.2
94/95	FLEMING	1	8	2740	8.0	0.000	1.4
94/95	CODETTE	1	8	3600	6.3	0.167	8.3
94/95	BRADWELL	4	3	2800	8.0	0.444	3.9
94/95	FORT QU'APPELLE	4	15	1900	8.4	0.556	3.3
94/95	HARPTREE	1	2	3110	5.8	0.167	11.6
94/95	VALPARAISO	2	8	2960	4.5	0.000	22.4
94/95	GRAND COULEE	3	6	2540	5.0	0.000	15.6
94/95	AMSTERDAM	4	6	2150	8.5	0.800	5.2
94/95	ARCOLA	4	8	1910	7.2	0.429	6.9
94/95	FROBISHER	1	8	1960	6.4	0.250	9.2
94/95	INCHKEITH	1	6	2990	3.4	0.143	49.8
94/95	SHEHO	4	9	2250	6.5	0.714	20.2
94/95	RAMA	4	8	2020	8.1	1.000	11.2
94/95	PLUNKETT	1	10	1820	4.6	0.000	20.6

	Station	Comp	RQI	ELEVCAP	AVGTURN	REPRATIO	PROB
94/95	NORQUAY	4	10	2570	4.3	0.500	50.3
94/95	OSLER	3	7	2380	4.0	0.167	38.6
94/95	DUNBLANE	3	1	2600	3.8	0.000	33.7
94/95	ALSASK	4	9	1740	5.7	0.333	17.7
94/95	ZELMA	4	5	2100	6.0	0.556	20.9
94/95	DRINKWATER	3	6	2270	4.0	0.167	39.5
94/95	LOVE	1	7	2200	3.7	0.200	47.0
94/95	KEELER	4	8	2280	3.4	0.333	60.6
94/95	HUBBARD	4	8	2070	4.4	0.500	49.1
94/95	THACKERAY	4	2	2120	5.0	0.500	35.3

8.5 Summary

Open Logit Models

Although few observations were available to verify the Manitoba open logit model, a comparison of the probabilities of construction between 1) companies at a point, and 2) neighbouring points at which a company is located, are consistent with expectations. This suggests the model could be used to forecast the probability of elevator construction in Manitoba in the 1990s. However, there is some evidence of structural change which may result in predictions that overestimate the probability of construction

Few ex post observations were available to verify if the Saskatchewan open logit model was suitable to forecast the probability of elevator construction in the 1990s. However, mean ex ante 1) RQI and POST variable values, were comparable and 2) the FTOVERA value greater, than the mean variable values at delivery points elevators were constructed in the 1980s. The higher turnover value associated with the ex ante observations explains why elevator construction was predicted to occur at all the points. Analysis of the ex ante observations indicate that care must be used when forecasting with the Saskatchewan open logit model. When either 1) POST and 2) RQI, FTOVERA and PTCAP variables as a group, assume opposite extreme high and low values, the probability of construction can be overestimated. Consequently, knowledge of the contribution of the variables to the probability of construction is required to verify the likelihood of the probabilities attained.

A comparison of mean ex ante variable values and the mean values of elevators constructed in Saskatchewan and Manitoba in the 1980s indicates there is evidence of structural change in the relationship between the explanatory variables and the probabilities of construction. Too few observations between 1990/91 and 1994/95 prohibit reestimation of either the Manitoba or Saskatchewan model. If structural change has indeed occurred, the present models would tend to overestimate the probability of construction.

Closure Logit Models

The Alberta closure model appears to have a high degree of prediction accuracy. As there is no evidence of structural change between the explanatory variables and the probability of closure estimated, the model is suitable to forecast the probability of elevator closure in Alberta in the 1990s.

In Saskatchewan there is evidence of structural change in terms of the effect of RQI and ELEVCAP on the decision to close an elevator. Using only the variables AAVGTURN and REPRATIO, a revised Saskatchewan logit model was estimated from 1990/91 to 1994/95 data. The revised model generated a slightly higher percent correct predictions and was easier to use as less data was required. For forecasting purposes, the revised logit model is preferable to the original Saskatchewan logit model.

CHAPTER 9. STUDY SUMMARY AND CONCLUSIONS

The purpose of this research is to identify the market, point and elevator characteristics that grain elevator companies consider in their decisions to close or to build elevators at delivery points. To accomplish this goal, several objectives were outlined: 1) to analyze grain elevator closure and construction statistics to ascertain if closure or investment patterns could be observed, 2) to develop models that would predict the probability of elevator closures based on elevator and point characteristics which grain companies would consider when deciding to close an elevator, 3) to develop models that would predict the probability of elevator construction based on market and delivery point characteristics which grain companies would consider in their decision to build an elevator, 4) using the models developed, forecast the probability of elevator closure and construction at selected delivery points and 5) to determine if Thiessen polygons are an appropriate means of identifying the spatial market. This chapter summarizes the study and its results, reports the conclusions, and discusses need for further research.

9.1 Summary

9.1.1. Study Approach Summary

The major grain elevator companies in Alberta, Saskatchewan and Manitoba were contacted to obtain lists of the elevators they had closed and constructed between 1980/81 and 1989/90. Through discussions with grain companies and from various indirectly related studies, point and market characteristics and alternative marketing strategies which grain companies may consider in their investment and rationalization decisions were ascertained.

Separate models were identified for those elevators which closed and those which were constructed as the decisions to close and construct an elevator are separate decisions and not alternatives. Multiple regression analysis was used to develop four logit models, a Manitoba open model and a Saskatchewan open model, a Saskatchewan closure model and an Alberta closure model. As the relationship between the explanatory variables in the logit models and the probability of elevator closure or construction is nonlinear, sensitivity analyses were conducted to assess the impact of changes in explanatory variable values on the predicted probabilities.

The open and closure logit models were then evaluated comparing the predictions based on 1980/81 to 1989/90 out-of-sample and 1990/91 to 1994/95 *ex post* observations against known outcomes. *Ex ante* forecasts were also conducted of selected delivery points for which there was no a priori information concerning grain company plans at these delivery points. Based on the forecasts, each model was assessed regarding its ability to forecast elevator construction or closure in the 1990s.

9.1.2. Results Summary

9.1.2.1. Manitoba and Saskatchewan Open Models

Summary Statistics

Several patterns were identified from the summary statistics concerning delivery points and type of elevators that were constructed. First, elevator companies tend to build replacement elevators, elevators built at a point at which the company is already located, as opposed to expansion elevators, these being elevators constructed at a point where a company has no experience. Two thirds of the elevators constructed in Manitoba and 92 percent of those elevators constructed in Saskatchewan in the 1980s were replacement elevators.

Second, replacement elevators tended to be larger than expansion elevators. Deliveries and patronage expectations are more certain and less risky in existing markets than new markets, therefore it is logical that the replacement elevators constructed are larger than the expansion elevators. Elevators constructed in Manitoba were also on average 20 percent larger than those in Saskatchewan. Not only did SWP tend to build smaller elevators on average than MPE, but UGG, Pioneer and Cargill also built smaller elevators in Saskatchewan than in Manitoba.

Third, in Saskatchewan elevator companies tend to build elevators at multicompany points. In Saskatchewan, Pioneer led the ranks building all 11 of their new elevators at multicompany points, followed by UGG building 9 out of 10, Cargill 5 out of 6 and SWP 15 out of 22.

In Manitoba, 58 percent of the elevators constructed were at multicompany points as compared to the 84 percent in Saskatchewan. Two investment strategies became apparent in Manitoba, clustering and spatial monopoly. Cargill built exclusively at competing points which is indicative of clustering. UGG built 5 of their 7 elevators at multicompany points. Manitoba Pool investment strategy was indicative of a spatial monopolist as they built 10 of their 17 elevators at single points where there were no competitors. However, one reason MPE built new elevators at single points was they did not have to compete for carspots. A large track of land is necessary to lay the lengths of track necessary for multicar shipments.

Fourth, over one half of the single company points at which elevators were constructed in Manitoba were newly created points. Specifically, the statistics indicated that Manitoba Pool created 5 of the 8 newly created delivery points and all their expansion elevators were located at these new points. Manitoba Pool's strategy of building expansion elevators only at new points rather than at existing delivery points may be indicative of 1) a reluctance to compete with other elevator companies at the same point and 2) an attempt to preempt other companies locating there. Conversely, Cargill built all three of their expansion elevators in Manitoba at multicompany points.

Fifth, Cargill tends to build their elevators in Manitoba on rail mainlines. On the other hand, Pioneer built 10 of their 11 their elevators in Saskatchewan on branch lines. The other grain elevator companies do not appear to differentiate between mainlines and branch lines in either province.

The Models and the Impact of Explanatory Variable Values

Manitoba Open Model

The explanatory variables in the logit model predicting the probability of elevator construction in Manitoba were road quality index, RQI; expected volume per company, VOLCO3; fringe elevator capacity, CF; company market coverage, COV; and the presence of a competitive elevator either at the sample or adjacent delivery points, PRES. The probability of elevator construction increased as road quality access and expected volume per company increased. Conversely, the probability of construction declined when fringe elevator capacity and coverage values increased. If a new competitive elevator had been built the probability of construction increased. The COV and PRES explanatory variables reflect Manitoba grain companies' investment strategies. In Manitoba, establishing a market presence in terms of location and size of elevator was prevalent, a 'keep up with the Jones' behaviour. Market coverage also seemed to be a goal of Manitoba companies, whereby firms replaced existing elevators or expanded into new market areas.

The variable RQI is a measure of a point characteristic whereas the variables VOLCO3, COV and PRES were linear market measures as they pertained to the sample point and adjacent rail points. The only spatial market measurement pertained to fringe elevator capacity, CF. If fringe market capacity is a reasonable measure of the perceived competition in a market area, it makes sense that an elevator company would take this factor into account in their decision to build an elevator as farmers are not restricted as to where they can deliver their grain.

Sensitivity analyses were performed to determine what impact the level of each variable value had on the probability of elevator construction in Manitoba. The following results were determined.

• The scenario results repeatedly indicate that the presence of a new competitive elevator at either the delivery point in question or at adjacent points are often pivotal to the decision to construct. This suggests that maintaining company image, through a 'keeping up with the Jones' is an important factor in the decision where to locate an elevator.

• At points with low to moderate point characteristic values, the quality of road access is an important decision variable which can affect the decision to build. At more desirable points, road quality access is a decision variable if there is no new competitive elevator at either the point in question or at adjacent points. Conversely, if a new competitive elevator exists, road quality access is not a decision variable as the decision to construct an elevator had already been made on the basis of the values of the other variables. Thus a higher road quality index only validates the decision to build.

• At points with less desirable characteristics, expectations of higher elevator volumes were required to induce companies to construct an elevator as market risks may be considered greater and market coverage already sufficient. Assuming there was no new competitive elevator present, elevator volumes between 18,000 and 21,000 tonnes were required at moderately desirable points before an elevator would be constructed. If a new competitive elevator was present, the probability of construction surpassed the 50 percent mark at 12,000 tonnes, approximately 6,000 to 9,000 tonnes lower than if the competitive elevator had not been present. These results emphasize the importance of the presence of a new competitive elevator.

• The negative relationship between market fringe elevator capacity and the probability of construction suggests that in Manitoba, grain elevator companies consider increased elevator capacity to be synonymous with increased competition. Increased elevator capacity in an area signifies larger elevators and more competitors.

It may also be associated with overcapacity. In the absence of a new competitive elevator, the probability of construction fell below 50 percent at a poor to moderately desirable point when fringe capacity increased to between 20,000 and 30,000 tonnes. At more desirable points, the model predicted construction would proceed until fringe capacity reached 30,000 to 40,000 tonnes.

• When a new competitive elevator was present, greater fringe elevator capacities were tolerated. At less desirable points, the fringe capacity could increase to between 30,000 and 40,000 tonnes before the probability of construction fell below 50 percent. Similarly, at moderate to more desirable points, construction would proceed as long as fringe capacities encircling the point did not exceed 40,000 to 50,000 and 50,000 to 60,000 tonnes, respectively.

• If a new competitive elevator is not present, at points with less desirable characteristic values, companies are not likely to build an elevator to replace their own old existing elevators. Nor are they likely to build an elevator at such a point even if they do not have an alternative elevator at adjacent points. On the other hand, the model predicts that at more desirable points, a company may construct an elevator even if they have a facility only 12 to 16 years old at an adjacent point.

• It appears that when there is the influence of a new competitive elevator, the presence of an existing viable own company elevator is largely irrelevant to the decision to construct an elevator in Manitoba, particularly at points having desirable characteristics.

• The model predicted that an elevator would be constructed at 5 of the 6 out-of-sample and *ex post* Manitoba delivery points at which elevators were built. Although few observations were available to verify the Manitoba open model, an evaluation of the *ex ante* forecasts of various delivery points and the mean variable values of these points indicate that the model could be used to forecast Manitoba elevator construction. However, caution is advised as there is some evidence of structural change which may result in predictions that overestimate the probability of construction in the 1990s.

Saskatchewan Open Model

The explanatory variables in the logit model predicting the probability of elevator construction in Saskatchewan were road quality index, RQI; point capacity, PTCAP; market fringe capacity turnover a measure of market area performance, FTOVERA; and the age of the newest alternative company elevator at either the sample point or adjacent points, POST. The variable POST was intended as a measure of market maintenance behaviour. In all cases, the probability of elevator construction increased as the value of each explanatory variables increased.

The following results were obtained from the sensitivity analyses conducted.

• The impact of road quality access on the decision to construct an elevator in Saskatchewan was similar to the Manitoba results. Overall, road quality access was predicted to have a greater impact on the probability of construction at delivery points with less desirable characteristic values. At more desirable points, road quality access is not a decision variable as the decision to construct an elevator is based on the values of the other variables.

• The Manitoba RQI coefficient of .22960 is smaller than that of the Saskatchewan RQI coefficient of .34827. This indicates that road quality access has a greater impact on the decision to construct an elevator in Saskatchewan than in Manitoba.

• The probability of elevator construction at a point in Saskatchewan increases if there are many competitors located at the point. This is illustrated by the positive relationship between the number of competitors and point capacity, and the subsequent positive relationship between point capacity and the probability of construction. Centres where all or most of the major competitors are located may be viewed by the producer as a desirable feature. If large multicompany points are able to attract producers who might otherwise deliver to smaller centres, there may be more incentive to locate at such points.

• Assuming a point capacity of 3,000 tonnes is indicative of a single company delivery point, grain companies would build at a single company point if the other variable values were satisfactory.

• At less desirable delivery points, construction would proceed at points with fringe capacities between 9 to 11 thousand tonnes, if the point were perceived as being competitive.

• Fringe turnover was less significant than the RQI or POST variable values in determining the locations at which construction will occur.

• At moderate to more desirable points, the probability of construction exceeded 50 percent at a turnover of 3.0. Increasing the turnover rate, only validated the prediction of probable elevator construction. However, at less desirable points a turnover rate of 4.5 to 5.0 was required before the probability of construction reached 50 percent.

• It was hypothesized that if a company wished to maintain market representation in an area, the probability of construction increased as the age of the newest own viable elevator at either the sample or adjacent points increased. The model indicated that at less desirable points, elevator companies were reluctant to construct an elevator if they had a viable elevator less than 40 years of age. However, as point characteristics improved, the age of the newest alternative elevator became less significant to the decision to construct an elevator.

• The POST variable identifies the market area a company may wish to build an elevator if they are to maintain market representation in the long run. On the other hand, the variables RQI, PTCAP and FTOVERA identify desirable point locations. When 1) the POST and 2) RQI, PTCAP and FTOVERA variables as a group, assume opposite extreme high or low values, the probability of construction in the 1980s can be overestimated. Knowledge of the point and the individual contribution of each variable value to the probabilities attained is a necessary check.

• Too few elevators were constructed between 1990/91 and 1994/95 to verify the potential of the Saskatchewan open model to forecast elevator construction in the

1990s. A comparison of mean *ex ante* variable values and the mean values of elevators constructed in Saskatchewan in the 1990s also indicates there is evidence of structural change. If structural change has occurred the present model would tend to overestimate the probability of construction.

9.1.2.2. Alberta and Saskatchewan Closure Models

Summary Statistics

The summary statistics indicate that a greater proportion of elevators were closed at single company elevator points than at multicompany points. In both provinces, 63 percent of the elevators closed were located at single company points. The two Pools closed proportionally more single company points; 80 and 92 percent of the elevators closed by SWP and AWP respectively, were located at single company points. On the other hand, 8 of the 9 Saskatchewan sample elevators closed by Cargill and 12 of the 15 elevators closed by UGG in Saskatchewan and Alberta were located at multicompany points. This is because both Cargill and UGG tend to be located at multicompany points, therefore in consolidating their primary elevator networks, the elevators closed were primarily at multicompany points.

Just as smaller elevators were constructed in Saskatchewan, the elevators closed in Saskatchewan were also smaller than in Alberta. The elevators SWP closed were approximately 600 tonnes lower in capacity than those AWP closed. Elevators closed by Pioneer and Cargill in Saskatchewan were 650 and 1100 tonnes smaller than their counterparts in Alberta. Although there were few UGG elevators closed in Saskatchewan, the UGG elevators closed in Alberta were approximately the same capacity as those closed in Saskatchewan.

The Models and the Impact of Explanatory Variable Values

Alberta Closure Model

The explanatory variables in the logit model predicting the probability of elevator closure in Alberta were road quality access, RQI; elevator capacity, ELEVCAP; and company volume, COMPVOLA. A negative relationship existed between each of these variables and the probability of closure. As the values of the explanatory variables increased the probability of elevator closure at a point declined. The following results were obtained from the sensitivity analyses.

- Road quality access plays a significant role in the decision to close an elevator when performance indicators such as elevator capacity and company volume levels are near industry averages. However, when these performance indicators fall below or rise above industry averages, road access is no longer a decision variable, the decision being based on the level of the performance indicators.

- Elevator capacity has a greater impact on the probability of elevator closure at points where companies receive less than 13,000 tonnes than does average turnover or the volume. For example, a 2300 tonne elevator receiving 8,000 tonnes, equivalent to an annual turnover of 3.5, had a 99 percent probability of closure. Holding the volume fixed at 8,000 tonnes, a 5800 tonne elevator with a turnover of 1.4 had a 16 percent probability of closure. Despite the lower turnover rates, it appears that management is more inclined to maintain larger elevator facilities hoping that deliveries will improve with continued rationalization.

- Volume has a significant impact on the probability of elevator closure in Alberta at elevators with less than 3700 tonnes capacity.

- It is improbable that grain companies in Alberta would close a 3700 tonne elevator receiving a volume in excess of 13,000 tonnes.

- Of the independent variables in the Alberta closure model, elevator capacity has the greatest effect on the decision to close, followed by company volume. Road quality access while statistically significant has a small impact on the probability of elevator closure.

- The out-of-sample and *ex post* predictions indicate the Alberta closure model has a high degree of accuracy. Assessment of the *ex ante* forecasts also supports the model, indicating it is suitable for forecasting the probability of elevator closure in Alberta.

<u>Saskatchewan Closure Model</u>

The explanatory variables in the logit model predicting the probability of elevator construction in Saskatchewan were road quality index, RQI; elevator capacity, ELEVCAP; average point turnover rate, AAVGTURN; and representation ratio for a specific grain company in terms of the total number of elevators on the market fringe, REPRATIO. An inverse relationship existed between RQI, ELEVCAP and AAVGTURN and the probability of construction. A positive relationship existed between the representation ratio and the probability of construction. This relationship is based on the assumption that grain producers, that fall in the catchment area of an elevator to be closed, will alternatively go to elevators of the same company in the surrounding the catchment area. The likelihood of maintaining customers if an elevator closes increases as the representation ratio increases, as access is facilitated. The following results were obtained from the Saskatchewan sensitivity analyses.

• The Saskatchewan road quality access results are comparable to the Alberta model. Road quality access is of secondary importance when performance indicators such as elevator capacity and average turnover lie much above or below industry averages. RQI only becomes pertinent to the decision to close for those elevators exhibiting moderate elevator capacities and turnover values around 2800 and 4.4, respectively. When the characteristic values are of these magnitudes, the decision to close is less clear and RQI becomes more of a significant factor.

• The Alberta RQI coefficient of .26373 is larger than that of the Saskatchewan RQI coefficient of .16098. This indicates that road quality access has a greater impact on the decision to close an elevator in Alberta than in Saskatchewan.

• A comparison of the RQI coefficients in the Saskatchewan closure and open models indicate that road quality access at a point has a larger impact on the decision to construct an elevator than on the decision to close an elevator.

• The model predicted that elevators with less than 2,000 tonnes storage capacity would close regardless of the other point or elevator characteristic values.

• Elevators between 2000 and 2500 tonnes capacity may survive rationalization if they have turnovers exceeding 4.9.

• A comparison of the Alberta and Saskatchewan ELEVCAP sensitivity analyses results indicate that Alberta grain companies tend to close larger elevators than do Saskatchewan grain companies. At moderately desirable delivery points, the probability of elevator closure in Alberta fell below 50 percent at elevator capacities between 3,000 and 3,700 tonnes as compared to 2500 and 3000 tonnes in Saskatchewan. At less desirable delivery points, the probability of elevator closure fell below fifty percent between 4,400 and 5,100 tonnes in Alberta and between 3000 and 3500 tonnes in Saskatchewan.

• The Alberta ELEVCAP coefficient of .0017474 is smaller than that of the Saskatchewan ELEVCAP coefficient of .0021193. This indicates that elevator capacity has a greater impact on the decision to close an elevator in Saskatchewan than in Alberta. Consequently, greater increases in elevator capacity are required to reduce the probability of elevator closure in Alberta than is the case in Saskatchewan.

• Based on the various average turnover and elevator capacities analyzed in the scenarios, the volume of grain required to reduce the probability of closure below 50 percent was ascertained.

ELEVCAP	AAVGTURN	VOLUME
3266	3.6	11,760
2902	4.1	11,900
2800	4.4	12,320
2315	4.9	11,340

If an elevator is to remain operational, it appears a minimum volume of approximately 12,000 tonnes is required.

• An elevator company may be more prone to maintain an elevator in a well represented market area if the site has good road access. A site with poor road access is more likely to lose business as the rationalization process continues, as it will be less able to draw farmers from greater distances.

• At points with small capacity elevators or low turnover rates, the representation ratio is of little significance. Similarly, the representation ratio is not important to management's decision to close an elevator at points with large elevators or high turnovers.

• At points with moderate sized elevators of 2800 tonnes and a turnover rate of 4.1, a representation ratio between .37 and .47 is required before management would consider closing an elevator.

• To summarize, elevator capacity was the single most important characteristic in Saskatchewan determining the probability of elevator closure. Average turnover was the second most important characteristic. Market representation and road quality access were significant but their end effect is limited.

• The original Saskatchewan closure model estimated was suitable for predicting the probability of elevator closure in the 1980s. However, unlike the Alberta model, the Saskatchewan model did not forecast accurately the probability of elevator closure in the 1990s. Using both 1980s and 1990/91 to 1994/95 data, the Saskatchewan model was reestimated using dummy variables to determine if structural changes had occurred. The model indicated that structural changes had occurred and that the variables RQI and ELEVCAP were no longer significant in predicting elevator closure in Saskatchewan in the 1990s. A revised Saskatchewan closure model incorporating the variables AAVGTURN and REPRATIO was estimated using 1990s observations. It generated the same results as the reestimated Saskatchewan model and was easier to use due to fewer data requirements.

9.2. Conclusions

Suitability of Theissen Polygons

One of the objectives of the study was to determine if the Voloni tessellation procedure used to derive Thiessen polygons was a suitable technique identifying the market areas elevators served. It was presumed that the area within the polygon identified the delivery point collection area and the polygon boundaries identified the delivery points which would compete with the sample point for grain.

Several application problems were encountered. Most of the problems related to the application on the Idrisi/Thiessen polygon approach to the prairie primary elevator system. The first problem arises because most computer programs are generally limited to 90 typed characters ie. lower and upper case letters, numbers and other various characters. In Manitoba, Saskatchewan and Alberta there were up to 235, 690 and 334 delivery points within each province, respectively. As a result, all the polygons had several polygons with the same type character, making it difficult to identify delivery points. Not infrequently, two market areas that bordered each other would have the same type character making it difficult to distinguish boundaries. In Saskatchewan, there were 7 to 8 polygons with the same type character. This made the analysis tedious and often confusing, particularly as the polygons within each province were revised each year in the 1980s to record the dynamic changes in delivery points. Consequently, the type character a particular market was assigned in one year, was not the same in the next year due to rationalization of the elevator system.

Thiessen polygons have been used in supermarket studies to identify market areas and competitors effectively. However, in the studies researched none dealt with more than 90 market areas. Therefore, it is not recommended that this approach be used when there are more than 90 market areas to analyze.

The second problem arises because the tessellation procedure does not recognize geographical barriers such as lakes, hills, rivers and the road grid itself. Therefore, some of the neighbouring delivery points may not be competitors due to these physical barriers. In the study, when these physical barriers were encountered, the neighbouring point was excluded from the analysis. This occurred frequently, particulary in Manitoba, due to the number of lakes and rivers.

This problem is not likely to be as serious a problem in analyses of city markets as geographical barriers can often be circumvented at little monetary or time expense. This, however, is not true of the prairie elevator system. Circumventing geographical barriers or travelling on indirect routes is not only time consuming but costly. Therefore, physical barriers can not be lightly dismissed.

Given the limitations associated with the derivation of the polygons and that the neighbouring points identified may not be competitors, the same outcome could have been accomplished taking a logical approach as to what points are likely to be competitive. This would save a great deal of time spent digitizing the points, transcribing the computer coordinates to ASCI format, printing annual maps and indexes cross referencing type characteristics to delivery points.

Elevator Construction and Closure

Based on the models and the results of the sensitivity analyses, the following conclusions were drawn.

- Various participants in the grain handling and transportation industry have implied that the decision where to locate an elevator is often ' done by the seat of the pants' or according to political pressures. Similar comments have been made concerning companies buckling to political pressures within their organization as to which elevators to close. The significance of the variables in the models and the percent correct predictions should allay these suspicions, as the models indicate that the decision where to locate an elevator or which elevator to close is guided by evaluation of distinct characteristics..

• Alberta and Saskatchewan grain companies primarily look at point and elevator characteristics in their decision to close an elevator. None of the explanatory variables were linear market measures. In consolidating their elevators in an area, Saskatchewan grain companies, however, appear to consider company representation throughout a market area.

• Manitoba grain companies primarily view the market an elevator serves from a linear perspective. The variables PRES, VOLCO3 and COV were linear market measures. However, the results of the sensitivity analyses indicate changes in fringe elevator capacity can have the largest effect on the probability of construction. Therefore, it appears plant utilization from a spatial aspect is also an important factor in the decision where to locate an elevator.

• Saskatchewan grain companies in their decision making process of where to locate an elevator consider all dimensional aspects, point, linear and spatial perspectives. Road quality and point capacity are point characteristics, fringe turnover a spatial market perspective and market maintenance behaviour related to age of a company's own elevator a linear perspective.

• As the rationalization process continues and the distance between delivery points increases, larger farm trucks will continue to be used for hauling grain. As a result road quality access is important to the volume delivered to a point. It is for this reason that road quality access was a significant explanatory variable in both the Saskatchewan and Alberta closure models and in the Saskatchewan and Manitoba open logit models.

• Defining an 'area of indecision' about the 50 percent probability cutoff, does not improve any of the models' forecasting ability.

• MPE 's investment strategy is indicative of a spatial monopolist as it shows a tendency to build at points were there are no other competitors.

• In Manitoba, Cargill appears to be aggressive in facing competition by building exclusively at multicompany points. However, Cargill is also cautious as they also tend to locate on main lines and build significantly smaller elevators at points where they have no experience.

• In Manitoba, an investment strategy of 'keeping up with the Jones' seems to be prevalent. It was observed that elevator companies in Manitoba are more likely to construct an elevator at a site or adjacent to a site that a competitive elevator has been recently built. This 'keep up with the Jones' investment strategy was also observed in the size of elevators built in Manitoba. Elevators constructed by MPE were on average larger than those built by SWP. Cargill, Pioneer and UGG also built larger elevators in Manitoba than they did in Saskatchewan.

• The Saskatchewan elevator system is more extensive that in Manitoba, consequently there are fewer opportunities and less need to create new delivery points.

• Because SWP's primary elevator network is so extensive and they comprise over

60 percent of the sample observations, the predicted probability of closure generated by the Saskatchewan closure model is more indicative of the SWP rationalization process than it is of Saskatchewan grain companies as a whole.

• It appears that a minimum volume of approximately 12,000 tonnes is required if an elevator is to remain open in Saskatchewan.

• The potential for a more competitive environment is evolving in the prairie primary elevator system. Companies are choosing to locate at multicompany points. This is evidenced by the proportion of elevators being built at multicompany points and the proportion of single company points at which elevators are being closed. This clustering of firms at a point will further enhance competition when the Western Grain Transportation Act is repealed effective August 1, 1995 and producers are required to pay full transportation costs for export grains. As companies at a multicompany point are competing for the same grain, producers may observe an increase in discretionary grading and increased price competition to obtain the grain volumes required to secure transportation incentives.

9.3 Model Application

While estimation of the construction and closure models appears complicated, its application is straight forward. Spreadsheet programs such as Quattro Pro or Lotus can be used. For each of the models, the Z value can be calculated by entering the model coefficients and the addresses of the variable values in one cell of the spreadsheet. For example, to derive the probability of an Alberta elevator being closed, the Alberta closure model could be entered in cell D2 to obtain a Z value.

+12.283 -(.26373*A2) - (.0017474*B2) -(.30926*C2)

where RQI, ELEVCAP and COMPVOLA values are entered in cells A2, B2 and C2, respectively. The antilog of Z could then be calculated in cell E2, by inputting " @EXP(D2) ". The value derived is the numerator of the probability ratio. The denominator, calculated in cell F2, is derived by adding a value of one to the antilog, +E2+1. The ratio of the numerator and denominator could be calculated in G2, +E2/F2 which yields the probability of the event occurring. Different Z values and probabilities can be calculated for different variable values and scenario analysis undertaken.

9.4 Need for Further Research

In the next century, the 1990s may well be remembered as a decade of change for the grain handling and transportation sector. The 1990s have brought and will continue to bring many regulatory changes intended to create an environment for a more efficient rail transportation system. Many of the changes, which have been deregulatory in nature, have long run implications. The most prominent changes include 1) the repeal of the Western Grain Transportation Act, 2) changes to the CWB pooling points which will affect grain freight costs particularly in Manitoba, 3) the removal of the prohibition against branch line abandonment in Western Canada effective January 1, 1996 and 4) provision for greater competition in rail freight rates for grain.

These changes plus the removal of maximum tariffs on elevator services proposed under Bill C51 will expedite the dynamic process of change already underway in the prairie primary elevator system. Elevator, delivery point and market characteristics will still be prominent variables affecting the decisions concerning which elevators to close and where to locate a new elevator. However, the relationships between these decision variables and the probability of the events occurring will undoubtedly undergo change. Further research will be needed into the extent of these changes and other facets that may enter the picture.

REFERENCES

Alberta Wheat Pool. Primary and Terminal Elevator Costs and Charges in Western Canada. Submission to the Canadian Grain Commission Hearing: Calgary, April, 1984.

Aldrich, John H. and Forrest D. Nelson. Linear Probability, Logit and Probit Models. Series: Quantitative Applications in the Social Sciences, Sage University: Beverly Hills, California, 1984

Allison, Paul D. Event History Analysis: Regression for Longitudinal Event Data. University of Pennsylvania. 1984.

Araji, Ahmed A. and Richard G. Walsh, " Effect of Assembly Costs on Optimum Grain Elevator Size and Location". Canadian Journal of Agricultural Economics. 17 (1969)

Benson, Bruce L. Merle D. Faminow and Timothy J. Fik. "Conduct in Spatial Markets: An Empirical Analysis of Spatial Pricing Behaviour". Papers in Regional Science. Vol 71, 1992. pp. 15-30.

Brandon Area Study Committee. The Grain Handling and Transportation System in the Brandon Area Winnipeg, Manitoba: April 1974.

Bressler, Raymond and Richard King. Markets, Prices and Interregional Trade. John Wiley and sons, Inc.: New York, 1970.

Brigham, Eugene, Kahl, Alfred L. and Rentz, William F. Canadian Financial Management Theory and Practice. Ottawa: Holt, Rinehart and Winston of Canada, Limited, 1982.

Brouwer, Floor and Peter Nijkamp. "Linear Logit Models for Categorical Data in Spatial Mobility Analysis". Economic Geography. Vol 60(2), 1984. pp 102-110.

Brown, William S. Introducing Econometrics. West Publishing Company: St. Paul, Minnesota. 1991.

Canada Grain Commission. Grain Deliveries at Prairie Points. Crop Years 1976/77 to 1992/93. Winnipeg, Manitoba.

Canada Grain Commission. Grain Elevators in Canada. Crop Years 1976/77 to 1994/95. Winnipeg, Manitoba.

Canada Grains Council, Grain Handling and Transportation:Definition of the Problem (Winnipeg: Manitoba Canada Grains Council, 1975.

Casavant, Ken and Gene Griffin. Structure and Operating Characteristics of the North Dakota Grain Elevator Industry. Upper Great Plains Transportation Institute Report No. 47. Agricultural Economics Report No. 166: Fargo, North Dakota, p.1. December 1983

Chern, Wen-Fhyong and Leo Polopolus. "Discontinuous Plant Cost Functions: Modifications of the Stollsteimer Location Model" American Journal of Agricultural Economics. Vol 52, Nov. 1970.

Coursey, Don, R. Mark Isaac, Margaret Luke and Vernon Smith. "Market Contestability in the Presence of Sunk (Entry) Costs." Rand Journal of Economics. Vol 15 (1), 1984. pp. 69-84.

Deily, Mary E. "Exit Strategies and Plant-Closing Decisions: the Case of Steel", Rand Journal of Economics . Vol. 22(2), 1991, pp.250-263.

Deloitte, Haskins and Sells. "Determination Of Features Considered By Farmers When Selecting A Grain Company". Winnipeg, January, 1984.

Devine, Grant and S.N. Kulshreshtha. Performance of Grain Elevators in Saskatchewan. Department of Agricultural Economics, University of Saskatchewan, Saskatoon, Saskatchewan, June 1979.

Devletoglou, N.E. "A Dissenting View of Duopoly and Spatial Competition". Economica, Vol 32,

Dietrich, J. Kimball and Eric Sorensen. " An Application of Logit Analysis to Prediction of Merger Targets" Journal of Business Research. Vol 12. 1984.

Eaton, Curtis B. and Richard G. Lipsey. " Exit Barriers are Entry Barriers: The Durability of Capital as a Barrier to Entry". Bell Journal of Economics. Vol 11, 1980.

Earl, Paul. " Incentive Rates: A Grain Company Perspective." Winnipeg: 1989.

Fetter, Frank A. " The Economic Law of Market Areas. "Spatial Economic Theory. ed. Robert D. Dean, William H. Leahy, and David L. McKee, New York: The Free Press, 1970.

Fleming, M.S. and P.A. Yansouni, Economic Feasibility of Off-Track Elevators, Canadian Transport Commission, August 1980.

French, Ben C. " The Analysis of Productive Efficiency in Agricultural Marketing: Model, Methods and Progress", Volume I, A Survey of Agricultural Economics Literature. St. Paul, Minnesota: University of Minnesota Press, 1977.

Gilbert, Richard J. and Marvin Lieberman. "Investment and Coordination of Oligopolistic Industries". Rand Journal of Economics. Vol 18. No. 1 Spring 1987.

Grains Group. Grain Handling and Transportation Costs in Canada. Toronto, August, 1971.

Grain Handling and Transportation Committee. State of the Industry Report. Winnipeg: Manitoba, Canada Grains Council, 1973.

Grain Transportation Agency. Branch Line Profiles Report. Grain Transportation Agency: Winnipeg, Manitoba, September 1989.

Hopkin, John A.,Barry, Peter J. and Baker C.B. Financial Management in Agriculture. Danville Illinois: The Interstate Printers and Publishers, Inc., 1973.

Hotelling H., " Stability in Competition", The Economic Journal. 1929.

Isard. W. Location and Space Economy. M.I.T. Press: Cambridge Mass., 1956.

Jeffrey, Russell. " Economic Performance in the Western Canadian Primary Elevator Industry". Unpublished M.Sc. Thesis, University of Manitoba, 1985.

Johnson, J. Econometric Methods. McGraw Hill Book Company: New York, 1984.

Karadininis, Konstadinos. " Economic Analysis of the Impact of Variable Freight Rates on the Western Canadian Grain Handling and Transportation System: Area Study" Unpublished Masters Thesis, University of Saskatchewan, July, 1985.

Lytle, P.W. and L. D. Hill. " The Optimum Combination of Resources Within and Among Country Elevators". American Journal of Agricultural Economics. May 1973.

Madill, J. Walter. " Canada's Primary Elevator System." Grains and Oilseeds. third edition, Winnipeg, Manitoba: Canadian International Grains Institute, 1982.

Martin, Larry F. Martin, Grant D. Devine, and Surendra A.Kulshreshtha, " Centralized Prairie Grain Collection: Savings Related to Market Efficiency." Canadian Journal of Agricultural Economics. 26 (2) 1978.

Moore, Gerry. Development in Canada Grain Transportation Policy Proceedings to Development in Canada Grain Transportation Policy, Transport Institute, University of Manitoba: Winnipeg, Manitoba. June 1988.

Olson Fred L. " Location Theory As Applied to Milk Processing Plants" Journal of Farm Economics. December. 1959

Pindyck, Robert S. and Daniel L. Rubinfeld. Econometric Models and Economic Forecasts. McGraw-Hill Book Company: New York, 1981.

Scherer, F. M. Industrial Market Structure and Economic Performance. 2nd ed. Dallas: Houghton Mifflin Company, 1980.

Shephard, William. The Economics of Industrial Organization. Prentice-Hall: New Jersey, 1979.

Smith, David M. Industrial Location: An Economic Geographical Analysis. John Wiley and Sons : New York, 1971.

Tangri, O., D. Zasada and E.W. Tyrchniewicz. Country Grain Elevator Closures: Implications for Grain Elevator Companies. Res. Rep. No. 10, Center for Transportation Studies, University of Manitoba, Winnipeg, Manitoba, January 1973.

Tyrchniewicz, Edward W. and Tosterud, Robert J. " A Model For Rationalizing the Canadian Grain Transportation and Handling System on a Regional Basis." Proceedings of American Agricultural Economics Association. 1973. 805-813.

Van Oppen, Matthias and Hill, Lowell. Grain Elevators in Illinois: Fators Affecting Their Number and Location. Department of Agricultural Economics, University of Illinois: Urbana-Champaign. November, 1970.

Wakefield, Mike. "Primary and Terminal Elevators". Conference on Keeping Canada Competitive: Winnipeg, Manitoba, Date Unknown.

Waithe, Dennis. Evolution of the Primary Elevator System in Western Canada. Working Paper 14/84 Ottawa: Agriculture Canada, Marketing and Economics Branch, October, 1984.

Warrack, A.A. " A Conceptual Framework for Analysis of Marketing Efficiency" Canadian Journal of Agricultural Economics, Vol 20(3), 1972.

West, Douglas S. "Testing for Market Preemption Using Sequential Location Data". Bell Journal of Economics. Vol 12 (1) 1981, p. 129-43.

Wilson, Charles F. Grain Marketing in Canada. Winnipeg, Manitoba: Canadian International Grains Institute, 1979.

APPENDICES

APPENDIX A

The Distribution of Sample Observations between Y=0 and Y=1

1. Dietrich, J. Kimball. "An Application of Logit Analysis to Prediction of Merger Targets". Journal of Business Research. Vol 12, 1984. p.397.

Subsample	Numbers	Percent Distribution
Y=0	37	55
Y=1	30	45

2. Aldrich, John H. and Forrest, Nelson. Linear Probability, Logit and Probit Models. Series: Quantitative Applications in the Social Sciences. Sage University: Beverly Hills, California, 1984.

Subsample	Numbers	Percent Distribution
Y=0	21	66
Y=1	11	34

3. Brouwler, Floor and Perter Nijkamp. " Linear Logit Models for Categorical Data in Spatial Mobility Analysis". Economic Geography Vol p.109.

Analysis of 2600 Dutch households.

Model	Y=1	Y=0	Total N	Percent Y=0
Z1	439	1498	1937	77
Z2	1054	779	1833	42
Z3	1370	901	2271	40
Z4	397	594	991	60
Z5	1698	709	2407	29

APPENDIX B1

Manitoba Model: Probability of Elevator Construction

CHOICE	FREQUENCY	PERCENT
0	34	48.5714 (COEFF NORMALIZED TO ZERO)
1	36	51.4286

LOG OF LIKELIHOOD FUNCTION = -35.7454
NUMBER OF CASES = 70
NUMBER OF CHOICES = 140
SUM OF SQUARED RESIDUALS = 11.4388
R-SQUARED = 0.346522
PERCENT CORRECT PREDICTIONS = 81.4286

PARAMETER	ESTIMATE	STANDARD ERROR	T-STATISTIC
C1	- 1.1788	1.2837	-0.91829
RQI1	0.22960	0.91686E-01	2.5042
VOLCO31	0.11848	0.52203E-01	2.2696
CF1	- 0.75394E-01	0.31434E-01	-2.3984
COV	-12.306	6.0559	-2.0320
PRES1	1.3465	0.64784	2.0784

APPENDIX B2

Saskatchewan Open Logit Model

CHOICE	FREQUENCY	PERCENT
0	20	32.7869 (COEFF NORMALIZED TO ZERO)
1	41	67.2131

LOG OF LIKELIHOOD FUNCTION = -23.0583
NUMBER OF CASES = 61
NUMBER OF CHOICES = 122
SUM OF SQUARED RESIDUALS = 7.51323
R-SQUARED = 0.441098
PERCENT CORRECT PREDICTIONS = 81.9672

PARAMETER	ESTIMATE	STANDARD ERROR	T-STATISTIC
C1	-9.5020	2.8997	-3.2769
RQI1	0.34827	0.14998	2.3221
PTCAP1	0.21744	0.11494	1.8917
FTOVERA1	0.72619	0.39637	1.8321
REP1	0.94339E-01	0.35095E-01	2.6881

APPENDIX B3

Manitoba Open Model: Saskatchewan-Manitoba Data Base

Choice	Frequency	Percent
0	54	41.2214
	77	58.7786

LOG OF LIKELIHOOD FUNCTION = -69.2862
NUMBER OF CASES = 131
NUMBER OF CHOICES = 262
SUM OF SQUARED RESIDUALS = 22.4332
R-SQUARED = 0.294101
PERCENT CORRECT PREDICTIONS = 74.0458

Parameter	Estimate	Standard Error	T-Statistic
C	-1.9194	0.93333	-2.0565
RQI	0.25866	0.69193E-01	3.7383
CF	-0.013602	0.014016	-0.97042
V0LCO3	0.068736	0.0369361	1.8610
COV	-17.174	6.0284	-2.8487
PRES	0.73186	0.47311	1.5469

Saskatchewan Open Model: Saskatchewan-Manitoba Data Base

Choice	Frequency	Percent
0	54	41.2214
1	77	58.7786

LOG OF LIKELIHOOD FUNCTION = -70.9498
NUMBER OF CASES = 131
NUMBER OF CHOICES = 262
SUM OF SQUARED RESIDUALS = 24.2079
R-SQUARED = 0.237349
PERCENT CORRECT PREDICTIONS = 73.2824

Parameter	Estimate	Standard Error	T-Statistic
C	-4.6075	1.1544	-3.9914
RQI	0.31096	0.080756	3.8506
PTCAP	-0.020124	0.031582	-0.63719
FTOVERA	0.27432	0.17635	1.5556
POST	0.049233	0.014200	3.4671

APPENDIX C

Appendix C1. RQI Sensitivity Analysis, Manitoba Open Logit Model										
Frame	RQI	VOLCO3	CF	COV	Z1 VALUE	Z2 VALUE	PROB 1	PROB 2	CH PROB	CH PROB
					Array (0)	Array (1)	Array (0)	Array (1)	Array (0)	Array (1)
Base	2	17.1	34.2	0.06	-2.010	-0.664	0.118	0.340		
	4	17.1	34.2	0.06	-1.551	-0.205	0.175	0.449	0.057	0.109
	6	17.1	34.2	0.06	-1.092	0.254	0.251	0.563	0.076	0.114
	8	17.1	34.2	0.06	-0.633	0.714	0.347	0.671	0.096	0.108
	10	17.1	34.2	0.06	-0.174	1.173	0.457	0.764	0.110	0.092
	12	17.1	34.2	0.06	0.286	1.632	0.571	0.836	0.114	0.073
									0.453	0.497
A1	2	15.8	34.2	0.06	-2.164	-0.818	0.103	0.306		
	4	15.8	34.2	0.06	-1.705	-0.359	0.154	0.411	0.051	0.105
	6	15.8	34.2	0.06	-1.246	0.100	0.223	0.525	0.070	0.114
	8	15.8	34.2	0.06	-0.787	0.560	0.313	0.636	0.089	0.111
	10	15.8	34.2	0.06	-0.328	1.019	0.419	0.735	0.106	0.098
	12	15.8	34.2	0.06	0.132	1.478	0.533	0.814	0.114	0.080

									0.430	0.508
A2	2	18.3	34.2	0.06	-1.868	-0.522	0.134	0.372		
	4	18.3	34.2	0.06	-1.409	-0.063	0.196	0.484	0.063	0.112
	6	18.3	34.2	0.06	-0.950	0.397	0.279	0.598	0.083	0.114
	8	18.3	34.2	0.06	-0.491	0.856	0.380	0.702	0.101	0.104
	10	18.3	34.2	0.06	-0.031	1.315	0.492	0.788	0.112	0.087
	12	18.3	34.2	0.06	0.428	1.774	0.605	0.855	0.113	0.067
									0.472	0.483
B1	2	17.1	36.3	0.06	-2.169	-0.822	0.103	0.305		
	4	17.1	36.3	0.06	-1.710	-0.363	0.153	0.410	0.051	0.105
	6	17.1	36.3	0.06	-1.250	0.096	0.223	0.524	0.069	0.114
	8	17.1	36.3	0.06	-0.791	0.555	0.312	0.635	0.089	0.111
	10	17.1	36.3	0.06	-0.332	1.015	0.418	0.734	0.106	0.099
	12	17.1	36.3	0.06	0.127	1.474	0.532	0.814	0.114	0.080
									0.429	0.508
B2	2	17.1	32.3	0.06	-1.867	-0.521	0.134	0.373		
	4	17.1	32.3	0.06	-1.408	-0.061	0.197	0.485	0.063	0.112
	6	17.1	32.3	0.06	-0.949	0.398	0.279	0.598	0.083	0.114

	8	17.1	32.3	0.06	-0.490	0.857	0.380	0.702	0.101	0.104
	10	17.1	32.3	0.06	-0.030	1.316	0.492	0.789	0.112	0.087
	12	17.1	32.3	0.06	0.429	1.775	0.606	0.855	0.113	0.067
									0.472	0.482
C1	2	17.1	34.2	0.07	-2.133	-0.787	0.106	0.313		
	4	17.1	34.2	0.07	-1.674	-0.328	0.158	0.419	0.052	0.106
	6	17.1	34.2	0.07	-1.215	0.131	0.229	0.533	0.071	0.114
	8	17.1	34.2	0.07	-0.756	0.591	0.320	0.644	0.091	0.111
	10	17.1	34.2	0.07	-0.297	1.050	0.426	0.741	0.107	0.097
	12	17.1	34.2	0.07	0.163	1.509	0.541	0.819	0.114	0.078
									0.435	0.506
C2	2	17.1	34.2	0.04	-1.764	-0.418	0.146	0.397		
	4	17.1	34.2	0.04	-1.305	0.041	0.213	0.510	0.067	0.113
	6	17.1	34.2	0.04	-0.846	0.501	0.300	0.623	0.087	0.112
	8	17.1	34.2	0.04	-0.387	0.960	0.405	0.723	0.104	0.100
	10	17.1	34.2	0.04	0.072	1.419	0.518	0.805	0.114	0.082
	12	17.1	34.2	0.04	0.532	1.878	0.630	0.867	0.112	0.062
									0.484	0.470

D1	2	15.8	36.3	0.07	-2.446	-1.099	0.080	0.250		
	4	15.8	36.3	0.07	-1.987	-0.640	0.121	0.345	0.041	0.095
	6	15.8	36.3	0.07	-1.527	-0.181	0.178	0.455	0.058	0.110
	8	15.8	36.3	0.07	-1.068	0.278	0.256	0.569	0.077	0.114
	10	15.8	36.3	0.07	-0.609	0.737	0.352	0.676	0.097	0.107
	12	15.8	36.3	0.07	-0.150	1.197	0.463	0.768	0.110	0.091
									0.383	0.518
D2	2	18.3	32.3	0.04	-1.479	-0.132	0.186	0.467		
	4	18.3	32.3	0.04	-1.020	0.327	0.265	0.581	0.079	0.114
	6	18.3	32.3	0.04	-0.560	0.786	0.363	0.687	0.098	0.106
	8	18.3	32.3	0.04	-0.101	1.245	0.475	0.776	0.111	0.089
	10	18.3	32.3	0.04	0.358	1.704	0.589	0.846	0.114	0.070
	12	18.3	32.3	0.04	0.817	2.164	0.694	0.897	0.105	0.051
									0.508	0.430

Appendix C2. VOLCO3 Sensitivity Analysis, Manitoba Open Logit Model.										
Frame	VOLCO3	RQI	CF	COV	Z1 VALUE	Z2 VALUE	PROB 1	PROB 2	CH PROB	CH PROB
					Array (0)	Array (1)	Array (0)	Array (1)	Array (0)	Array (1)
Base	12	8.8	34.2	0.06	-1.053	0.293	0.259	0.573		
	15	8.8	34.2	0.06	-0.698	0.649	0.332	0.657	0.074	0.084
	18	8.8	34.2	0.06	-0.343	1.004	0.415	0.732	0.083	0.075
	21	8.8	34.2	0.06	0.013	1.359	0.503	0.796	0.088	0.064
	24	8.8	34.2	0.06	0.368	1.715	0.591	0.847	0.088	0.052
	27	8.8	34.2	0.06	0.724	2.070	0.673	0.888	0.082	0.041
									0.415	0.315
A1	12	7.8	34.2	0.06	-1.283	0.064	0.217	0.516		
	15	7.8	34.2	0.06	-0.928	0.419	0.283	0.603	0.066	0.087
	18	7.8	34.2	0.06	-0.572	0.774	0.361	0.684	0.077	0.081
	21	7.8	34.2	0.06	-0.217	1.130	0.446	0.756	0.085	0.071
	24	7.8	34.2	0.06	0.139	1.485	0.535	0.815	0.089	0.060
	27	7.8	34.2	0.06	0.494	1.841	0.621	0.863	0.086	0.048

									0.404	0.347
A2	12	9.6	34.2	0.06	-0.870	0.477	0.295	0.617		
	15	9.6	34.2	0.06	-0.514	0.832	0.374	0.697	0.079	0.080
	18	9.6	34.2	0.06	-0.159	1.188	0.460	0.766	0.086	0.069
	21	9.6	34.2	0.06	0.197	1.543	0.549	0.824	0.089	0.058
	24	9.6	34.2	0.06	0.552	1.899	0.635	0.870	0.086	0.046
	27	9.6	34.2	0.06	0.907	2.254	0.712	0.905	0.078	0.035
									0.417	0.288
B1	12	8.8	36.3	0.06	-1.212	0.135	0.229	0.534		
	15	8.8	36.3	0.06	-0.856	0.490	0.298	0.620	0.069	0.087
	18	8.8	36.3	0.06	-0.501	0.846	0.377	0.700	0.079	0.079
	21	8.8	36.3	0.06	-0.145	1.201	0.464	0.769	0.086	0.069
	24	8.8	36.3	0.06	0.210	1.557	0.552	0.826	0.089	0.057
	27	8.8	36.3	0.06	0.565	1.912	0.638	0.871	0.085	0.045
									0.408	0.338
B2	12	8.8	32.3	0.06	-0.910	0.436	0.287	0.607		
	15	8.8	32.3	0.06	-0.555	0.792	0.365	0.688	0.078	0.081
	18	8.8	32.3	0.06	-0.199	1.147	0.450	0.759	0.086	0.071

	21	8.8	32.3	0.06	0.156	1.503	0.539	0.818	0.089	0.059
	24	8.8	32.3	0.06	0.512	1.858	0.625	0.865	0.086	0.047
	27	8.8	32.3	0.06	0.867	2.214	0.704	0.901	0.079	0.036
									0.417	0.294
C1	12	8.8	34.2	0.07	-1.176	0.170	0.236	0.542		
	15	8.8	34.2	0.07	-0.821	0.525	0.306	0.628	0.070	0.086
	18	8.8	34.2	0.07	-0.466	0.881	0.386	0.707	0.080	0.079
	21	8.8	34.2	0.07	-0.110	1.236	0.472	0.775	0.087	0.068
	24	8.8	34.2	0.07	0.245	1.592	0.561	0.831	0.089	0.056
	27	8.8	34.2	0.07	0.601	1.947	0.646	0.875	0.085	0.044
									0.410	0.333
C2	12	8.8	34.2	0.04	-0.807	0.539	0.308	0.632		
	15	8.8	34.2	0.04	-0.452	0.895	0.389	0.710	0.080	0.078
	18	8.8	34.2	0.04	-0.096	1.250	0.476	0.777	0.087	0.067
	21	8.8	34.2	0.04	0.259	1.606	0.564	0.833	0.088	0.055
	24	8.8	34.2	0.04	0.614	1.961	0.649	0.877	0.085	0.044
	27	8.8	34.2	0.04	0.970	2.316	0.725	0.910	0.076	0.034
									0.417	0.279

D1	12	7.8	36.3	0.07	-1.564	-0.218	0.173	0.446		
	15	7.8	36.3	0.07	-1.209	0.138	0.230	0.534	0.057	0.089
	18	7.8	36.3	0.07	-0.854	0.493	0.299	0.621	0.069	0.086
	21	7.8	36.3	0.07	-0.498	0.848	0.378	0.700	0.079	0.079
	24	7.8	36.3	0.07	-0.143	1.204	0.464	0.769	0.086	0.069
	27	7.8	36.3	0.07	0.213	1.559	0.553	0.826	0.089	0.057
									0.380	0.381
D2	12	9.6	32.3	0.04	-0.480	0.866	0.382	0.704		
	15	9.6	32.3	0.04	-0.125	1.222	0.469	0.772	0.087	0.068
	18	9.6	32.3	0.04	0.231	1.577	0.557	0.829	0.089	0.056
	21	9.6	32.3	0.04	0.586	1.932	0.642	0.874	0.085	0.045
	24	9.6	32.3	0.04	0.941	2.288	0.719	0.908	0.077	0.034
	27	9.6	32.3	.04	1.297	2.643	0.785	0.934	0.066	0.026
									0.403	0.230

Appendix C3. Sensititivity Analysis, CF, Manitoba Open Logit Model

Frame	CF	RQI	VOLCO3	COV	Z1 VALUE	Z2 VALUE	PROB 1	PROB 2	CH PROB	CH PROB
					Array (0)	Array (1)	Array (0)	Array (1)	Array (0)	Array (1)
Base	20	8.8	17.1	0.06	0.621	1.968	0.651	0.877		
	30	8.8	17.1	0.06	-0.132	1.214	0.467	0.771	0.184	0.106
	40	8.8	17.1	0.06	-0.886	0.460	0.292	0.613	0.175	0.158
	50	8.8	17.1	0.06	-1.640	-0.294	0.162	0.427	0.129	0.186
	60	8.8	17.1	0.06	-2.394	-1.048	0.084	0.260	0.079	0.167
	70	8.8	17.1	0.06	-3.148	-1.802	0.041	0.142	0.042	0.118
									0.609	0.736
A1	20	7.8	17.1	0.06	0.392	1.738	0.597	0.850		
	30	7.8	17.1	0.06	-0.362	0.984	0.410	0.728	0.186	0.122
	40	7.8	17.1	0.06	-1.116	0.230	0.247	0.557	0.164	0.171
	50	7.8	17.1	0.06	-1.870	-0.523	0.134	0.372	0.113	0.185
	60	7.8	17.1	0.06	-2.624	-1.277	0.068	0.218	0.066	0.154

	70	7.8	17.1	0.06	-3.378	-2.031	0.033	0.116	0.035	0.102
									0.564	0.735
A2	20	9.6	17.1	0.06	0.805	2.152	0.691	0.896		
	30	9.6	17.1	0.06	0.051	1.398	0.513	0.802	0.178	0.094
	40	9.6	17.1	0.06	-0.703	0.644	0.331	0.656	0.182	0.146
	50	9.6	17.1	0.06	-1.457	-0.110	0.189	0.472	0.142	0.183
	60	9.6	17.1	0.06	-2.211	-0.864	0.099	0.296	0.090	0.176
	70	9.6	17.1	0.06	-2.965	-1.618	0.049	0.165	0.050	0.131
									0.642	0.730
B1	20	8.8	15.8	0.06	0.467	1.814	0.615	0.860		
	30	8.8	15.8	0.06	-0.287	1.060	0.429	0.743	0.186	0.117
	40	8.8	15.8	0.06	-1.040	0.306	0.261	0.576	0.168	0.167
	50	8.8	15.8	0.06	-1.794	-0.448	0.143	0.390	0.119	0.186
	60	8.8	15.8	0.06	-2.548	-1.202	0.073	0.231	0.070	0.159
	70	8.8	15.8	0.06	-3.302	-1.956	0.035	0.124	0.037	0.107
									0.579	0.736
B2	20	8.8	18.3	0.06	0.764	2.110	0.682	0.892		

	30	8.8	18.3	0.06	0.010	1.356	0.502	0.795	0.180	0.097
	40	8.8	18.3	0.06	-0.744	0.602	0.322	0.646	0.180	0.149
	50	8.8	18.3	0.06	-1.498	-0.152	0.183	0.462	0.139	0.184
	60	8.8	18.3	0.06	-2.252	-0.906	0.095	0.288	0.088	0.174
	70	8.8	18.3	0.06	-3.006	-1.660	0.047	0.160	0.048	0.128
C1	20	8.8	17.1	0.07	0.498	1.845	0.622	0.864		
	30	8.8	17.1	0.07	-0.256	1.091	0.436	0.749	0.186	0.115
	40	8.8	17.1	0.07	-1.009	0.337	0.267	0.583	0.169	0.165
	50	8.8	17.1	0.07	-1.763	-0.417	0.146	0.397	0.121	0.186
	60	8.8	17.1	0.07	-2.517	-1.171	0.075	0.237	0.072	0.161
	70	8.8	17.1	0.07	-3.271	-1.925	0.037	0.127	0.038	0.109
									0.586	0.736
C2	20	8.8	17.1	0.04	0.868	2.214	0.704	0.902		
	30	8.8	17.1	0.04	0.114	1.460	0.528	0.812	0.176	0.090
	40	8.8	17.1	0.04	-0.640	0.706	0.345	0.670	0.183	0.142
	50	8.8	17.1	0.04	-1.394	-0.048	0.199	0.488	0.146	0.181
	60	8.8	17.1	0.04	-2.148	-0.802	0.105	0.310	0.094	0.178

	70	8.8	17.1	0.04	-2.902	-1.556	0.052	0.174	0.052	0.135
									0.652	0.727
D1	20	7.8	15.8	0.07	0.115	1.461	0.529	0.812		
	30	7.8	15.8	0.07	-0.639	0.707	0.345	0.670	0.183	0.142
	40	7.8	15.8	0.07	-1.393	-0.047	0.199	0.488	0.147	0.181
	50	7.8	15.8	0.07	-2.147	-0.801	0.105	0.310	0.094	0.178
	60	7.8	15.8	0.07	-2.901	-1.554	0.052	0.174	0.053	0.135
	70	7.8	15.8	0.07	-3.655	-2.308	0.025	0.090	0.027	0.084
									0.503	0.721
D2	20	9.6	18.3	0.04	1.193	2.540	0.767	0.927		
	30	9.6	18.3	0.04	0.439	1.786	0.608	0.856	0.159	0.070
	40	9.6	18.3	0.04	-0.314	1.032	0.422	0.737	0.186	0.119
	50	9.6	18.3	0.04	-1.068	0.278	0.256	0.569	0.166	0.168
	60	9.6	18.3	0.04	-1.822	-0.476	0.139	0.383	0.117	0.186
	70	9.6	18.3	0.04	-2.576	-1.230	0.071	0.226	0.068	0.157
									0.697	0.701

Appendix C4. COV Sensitivity Analysis, Manitoba Open Logit Model.										
Frame	COV	RQI	VOLC03	CF	Z1 VALUE	Z2 VALUE	PROB 1	PROB 2	CH PROB	CH PROB
					Array (0)	Array (1)	Array (0)	Array (1)	Array (0)	Array (1)
Base	0.02	8.8	17.1	34.20	0.043	1.390	0.511	0.801		
	0.04	8.8	17.1	34.20	-0.203	1.143	0.449	0.758	0.061	0.042
	0.06	8.8	17.1	34.20	-0.449	0.897	0.390	0.710	0.060	0.048
	0.08	8.8	17.1	34.20	-0.695	0.651	0.333	0.657	0.057	0.053
	0.10	8.8	17.1	34.20	-0.941	0.405	0.281	0.600	0.052	0.057
	0.12	8.8	17.1	34.20	-1.188	0.159	0.234	0.540	0.047	0.060
									0.277	0.261
A1	0.02	7.8	17.1	34.20	-0.187	1.160	0.454	0.761		
	0.04	7.8	17.1	34.20	-0.433	0.914	0.393	0.714	0.060	0.048
	0.06	7.8	17.1	34.20	-0.679	0.668	0.337	0.661	0.057	0.053
	0.08	7.8	17.1	34.20	-0.925	0.422	0.284	0.604	0.053	0.057
	0.10	7.8	17.1	34.20	-1.171	0.176	0.237	0.544	0.047	0.060

	0.12	7.8	17.1	34.20	-1.417	-0.071	0.195	0.482	0.042	0.061
									0.258	0.279
A2	0.02	9.6	17.1	34.20	0.227	1.573	0.556	0.828		
	0.04	9.6	17.1	34.20	-0.019	1.327	0.495	0.790	0.061	0.038
	0.06	9.6	17.1	34.20	-0.265	1.081	0.434	0.747	0.061	0.044
	0.08	9.6	17.1	34.20	-0.512	0.835	0.375	0.697	0.059	0.049
	0.10	9.6	17.1	34.20	-0.758	0.589	0.319	0.643	0.056	0.054
	0.12	9.6	17.1	34.20	-1.004	0.343	0.268	0.585	0.051	0.058
									0.288	0.243
B1	0.02	8.8	15.8	34.20	-0.111	1.236	0.472	0.775		
	0.04	8.8	15.8	34.20	-0.357	0.989	0.412	0.729	0.061	0.046
	0.06	8.8	15.8	34.20	-0.603	0.743	0.354	0.678	0.058	0.051
	0.08	8.8	15.8	34.20	-0.849	0.497	0.300	0.622	0.054	0.056
	0.10	8.8	15.8	34.20	-1.095	0.251	0.251	0.562	0.049	0.059
	0.12	8.8	15.8	34.20	-1.342	0.005	0.207	0.501	0.043	0.061
									0.265	0.274
B2	0.02	8.8	18.3	34.20	0.185	1.532	0.546	0.822		
	0.04	8.8	18.3	34.20	-0.061	1.286	0.485	0.783	0.061	0.039

	0.06	8.8	18.3	34.20	-0.307	1.040	0.424	0.739	0.061	0.045
	0.08	8.8	18.3	34.20	-0.553	0.793	0.365	0.689	0.059	0.050
	0.10	8.8	18.3	34.20	-0.799	0.547	0.310	0.634	0.055	0.055
	0.12	8.8	18.3	34.20	-1.045	0.301	0.260	0.575	0.050	0.059
									0.286	0.248
C1	0.02	8.8	17.1	36.30	-0.115	1.231	0.471	0.774		
	0.04	8.8	17.1	36.30	-0.361	0.985	0.411	0.728	0.061	0.046
	0.06	8.8	17.1	36.30	-0.607	0.739	0.353	0.677	0.058	0.051
	0.08	8.8	17.1	36.30	-0.854	0.493	0.299	0.621	0.054	0.056
	0.10	8.8	17.1	36.30	-1.100	0.247	0.250	0.561	0.049	0.059
	0.12	8.8	17.1	36.30	-1.346	0.001	0.207	0.500	0.043	0.061
									0.265	0.274
C2	0.02	8.8	17.1	32.30	0.186	1.533	0.546	0.822		
	0.04	8.8	17.1	32.30	-0.060	1.287	0.485	0.784	0.061	0.039
	0.06	8.8	17.1	32.30	-0.306	1.041	0.424	0.739	0.061	0.045
	0.08	8.8	17.1	32.30	-0.552	0.794	0.365	0.689	0.059	0.050
	0.10	8.8	17.1	32.30	-0.798	0.548	0.310	0.634	0.055	0.055
	0.12	8.8	17.1	32.30	-1.044	0.302	0.260	0.575	0.050	0.059

									0.286	0.247
D1	0.02	7.8	15.8	36.30	-0.499	0.848	0.378	0.700		
	0.04	7.8	15.8	36.30	-0.745	0.602	0.322	0.646	0.056	0.054
	0.06	7.8	15.8	36.30	-0.991	0.355	0.271	0.588	0.051	0.058
	0.08	7.8	15.8	36.30	-1.237	0.109	0.225	0.527	0.046	0.061
	0.10	7.8	15.8	36.30	-1.483	-0.137	0.185	0.466	0.040	0.061
	0.12	7.8	15.8	36.30	-1.729	-0.383	0.151	0.405	0.034	0.060
									0.227	0.295
D2	0.02	9.6	18.3	32.30	0.512	1.859	0.625	0.865		
	0.04	9.6	18.3	32.30	0.266	1.613	0.566	0.834	0.059	0.031
	0.06	9.6	18.3	32.30	0.020	1.366	0.505	0.797	0.061	0.037
	0.08	9.6	18.3	32.30	-0.226	1.120	0.444	0.754	0.061	0.043
	0.10	9.6	18.3	32.30	-0.472	0.874	0.384	0.706	0.060	0.048
	0.12	9.6	18.3	32.30	-0.718	0.628	0.328	0.652	0.056	0.054
									0.298	0.213

Appendix C5. Sensititivity Analysis, RQI, Saskatchewan Open Logit Model.

	RQI	PTCAP	FTOVERA	POST	Z VALUE	PROB	CH PROB
Base	2	9.9	4.0	31.7	-0.757	0.319	
	4	9.9	4.0	31.7	-0.061	0.485	0.166
	6	9.9	4.0	31.7	0.636	0.654	0.169
	8	9.9	4.0	31.7	1.332	0.791	0.137
	10	9.9	4.0	31.7	2.029	0.884	0.093
	12	9.9	4.0	31.7	2.725	0.938	0.055
							0.619
A1	2	6.7	4.0	31.7	-1.453	0.189	
	4	6.7	4.0	31.7	-0.757	0.319	0.130
	6	6.7	4.0	31.7	-0.060	0.485	0.166
	8	6.7	4.0	31.7	0.636	0.654	0.169
	10	6.7	4.0	31.7	1.333	0.791	0.137
	12	6.7	4.0	31.7	2.029	0.884	0.093
							0.694
A2	2	11.5	4.0	31.7	-0.410	0.399	
	4	11.5	4.0	31.7	0.287	0.571	0.172

	6	11.5	4.0	31.7	0.983	0.728	0.157
	8	11.5	4.0	31.7	1.680	0.843	0.115
	10	11.5	4.0	31.7	2.377	0.915	0.072
	12	11.5	4.0	31.7	3.073	0.956	0.041
							0.557
B1	2	9.9	3.8	31.7	-0.903	0.288	
	4	9.9	3.8	31.7	-0.206	0.449	0.160
	6	9.9	3.8	31.7	0.490	0.620	0.172
	8	9.9	3.8	31.7	1.187	0.766	0.146
	10	9.9	3.8	31.7	1.883	0.868	0.102
	12	9.9	3.8	31.7	2.580	0.930	0.062
							0.641
B2	2	9.9	4.1	31.7	-0.685	0.335	
	4	9.9	4.1	31.7	0.012	0.503	0.168
	6	9.9	4.1	31.7	0.708	0.670	0.167
	8	9.9	4.1	31.7	1.405	0.803	0.133
	10	9.9	4.1	31.7	2.101	0.891	0.088
	12	9.9	4.1	31.7	2.798	0.943	0.052

							0.607
C1	2	9.9	4.0	24.2	-1.465	0.188	
	4	9.9	4.0	24.2	-0.769	0.317	0.129
	6	9.9	4.0	24.2	-0.072	0.482	0.165
	8	9.9	4.0	24.2	0.625	0.651	0.169
	10	9.9	4.0	24.2	1.321	0.789	0.138
	12	9.9	4.0	24.2	2.018	0.883	0.093
							0.695
C2	2	9.9	4.0	35.3	-0.418	0.397	
	4	9.9	4.0	35.3	0.279	0.569	0.172
	6	9.9	4.0	35.3	0.975	0.726	0.157
	8	9.9	4.0	35.3	1.672	0.842	0.116
	10	9.9	4.0	35.3	2.368	0.914	0.073
	12	9.9	4.0	35.3	3.065	0.955	0.041
							0.558
D1	2	6.7	3.8	24.2	-2.306	0.091	
	4	6.7	3.8	24.2	-1.610	0.167	0.076
	6	6.7	3.8	24.2	-0.913	0.286	0.120

	8	6.7	3.8	24.2	-0.216	0.446	0.160
	10	6.7	3.8	24.2	0.480	0.618	0.172
	12	6.7	3.8	24.2	1.177	0.764	0.147
							0.674
D2	2	11.5	4.1	35.3	0.003	0.501	
	4	11.5	4.1	35.3	0.699	0.668	0.167
	6	11.5	4.1	35.3	1.396	0.802	0.133
	8	11.5	4.1	35.3	2.092	0.890	0.089
	10	11.5	4.1	35.3	2.789	0.942	0.052
	12	11.5	4.1	35.3	3.485	0.970	0.028
							0.470

Appendix C6. Sensitivity Analysis, PTCAP, Saskatchewan Open Logit Model.							
Frame	PTCAP	RQI	FTOVERA	POST	Z1 VALUE	PROB 1	CH PROB
Base	3	9.4	4.0	31.7	0.319	0.579	
	5	9.4	4.0	31.7	0.754	0.680	0.101
	7	9.4	4.0	31.7	1.189	0.767	0.086
	9	9.4	4.0	31.7	1.624	0.835	0.069
	11	9.4	4.0	31.7	2.059	0.887	0.051
	13	9.4	4.0	31.7	2.494	0.924	0.037
							0.345
A1	3	7.0	4.0	31.7	-0.516	0.374	
	5	7.0	4.0	31.7	-0.082	0.480	0.106
	7	7.0	4.0	31.7	0.353	0.587	0.108
	9	7.0	4.0	31.7	0.788	0.687	0.100
	11	7.0	4.0	31.7	1.223	0.773	0.085
	13	7.0	4.0	31.7	1.658	0.840	0.067
							0.466
A2	3	10.6	4.0	31.7	0.737	0.676	

	5	10.6	4.0	31.7	1.172	0.764	0.087
	7	10.6	4.0	31.7	1.607	0.833	0.069
	9	10.6	4.0	31.7	2.042	0.885	0.052
	11	10.6	4.0	31.7	2.477	0.922	0.037
	13	10.6	4.0	31.7	2.912	0.948	0.026
							0.272
B1	3	9.4	3.8	31.7	0.174	0.543	
	5	9.4	3.8	31.7	0.609	0.648	0.104
	7	9.4	3.8	31.7	1.044	0.740	0.092
	9	9.4	3.8	31.7	1.479	0.814	0.075
	11	9.4	3.8	31.7	1.914	0.871	0.057
	13	9.4	3.8	31.7	2.349	0.913	0.041
							0.369
B2	3	9.4	4.1	31.7	0.392	0.597	
	5	9.4	4.1	31.7	0.827	0.696	0.099
	7	9.4	4.1	31.7	1.262	0.779	0.084
	9	9.4	4.1	31.7	1.697	0.845	0.066
	11	9.4	4.1	31.7	2.132	0.894	0.049

	13	9.4	4.1	31.7	2.566	0.929	0.035
							0.332
C1	3	9.4	4.0	24.2	-0.388	0.404	
	5	9.4	4.0	24.2	0.047	0.512	0.108
	7	9.4	4.0	24.2	0.482	0.618	0.106
	9	9.4	4.0	24.2	0.916	0.714	0.096
	11	9.4	4.0	24.2	1.351	0.794	0.080
	13	9.4	4.0	24.2	1.786	0.856	0.062
							0.452
C2	3	9.4	4.0	35.3	0.659	0.659	
	5	9.4	4.0	35.3	1.094	0.749	0.090
	7	9.4	4.0	35.3	1.529	0.822	0.073
	9	9.4	4.0	35.3	1.964	0.877	0.055
	11	9.4	4.0	35.3	2.399	0.917	0.040
	13	9.4	4.0	35.3	2.833	0.944	0.028
							0.285
D1	3	7.0	3.8	24.2	-1.369	0.203	
	5	7.0	3.8	24.2	-0.934	0.282	0.079

	7	7.0	3.8	24.2	-0.500	0.378	0.096
	9	7.0	3.8	24.2	-0.065	0.484	0.106
	11	7.0	3.8	24.2	0.370	0.592	0.108
	13	7.0	3.8	24.2	0.805	0.691	0.100
							0.488
D2	3	10.6	4.1	35.3	1.150	0.759	
	5	10.6	4.1	35.3	1.584	0.830	0.070
	7	10.6	4.1	35.3	2.019	0.883	0.053
	9	10.6	4.1	35.3	2.454	0.921	0.038
	11	10.6	4.1	35.3	2.889	0.947	0.026
	13	10.6	4.1	35.3	3.324	0.965	0.018
							0.206

Appendix C7. Sensititivity Analysis, FTOVERA, Saskatchewan Open Logit Model.							
Variable\ Frame	FTOVERA	RQI	PTCAP	POST	Z VALUE	PROB	CH PROB
Base	3.0	9.4	9.9	31.7	1.094	0.749	
	3.5	9.4	9.9	31.7	1.457	0.811	0.062
	4.0	9.4	9.9	31.7	1.820	0.861	0.050
	4.5	9.4	9.9	31.7	2.183	0.899	0.038
	5.0	9.4	9.9	31.7	2.546	0.927	0.029
	5.5	9.4	9.9	31.7	2.909	0.948	0.021
							0.199
A1	3.0	7.0	9.9	31.7	0.258	0.564	
	3.5	7.0	9.9	31.7	0.621	0.650	0.086
	4.0	7.0	9.9	31.7	0.984	0.728	0.077
	4.5	7.0	9.9	31.7	1.347	0.794	0.066
	5.0	7.0	9.9	31.7	1.710	0.847	0.053
	5.5	7.0	9.9	31.7	2.073	0.888	0.041
							0.324

A2	3.0	10.6	9.9	31.7	1.511	0.819	
	3.5	10.6	9.9	31.7	1.875	0.867	0.048
	4.0	10.6	9.9	31.7	2.238	0.904	0.037
	4.5	10.6	9.9	31.7	2.601	0.931	0.027
	5.0	10.6	9.9	31.7	2.964	0.951	0.020
	5.5	10.6	9.9	31.7	3.327	0.965	0.014
							0.146
B1	3.0	9.4	6.7	31.7	0.398	0.598	
	3.5	9.4	6.7	31.7	0.761	0.682	0.083
	4.0	9.4	6.7	31.7	1.124	0.755	0.073
	4.5	9.4	6.7	31.7	1.487	0.816	0.061
	5.0	9.4	6.7	31.7	1.850	0.864	0.049
	5.5	9.4	6.7	31.7	2.213	0.901	0.037
							0.303
B2	3.0	9.4	11.5	31.7	1.441	0.809	
	3.5	9.4	11.5	31.7	1.805	0.859	0.050
	4.0	9.4	11.5	31.7	2.168	0.897	0.039

	4.5	9.4	11.5	31.7	2.531	0.926	0.029
	5.0	9.4	11.5	31.7	2.894	0.948	0.021
	5.5	9.4	11.5	31.7	3.257	0.963	0.015
							0.154
C1	3.0	9.4	9.9	24.2	0.386	0.595	
	3.5	9.4	9.9	24.2	0.749	0.679	0.084
	4.0	9.4	9.9	24.2	1.112	0.753	0.074
	4.5	9.4	9.9	24.2	1.475	0.814	0.061
	5.0	9.4	9.9	24.2	1.838	0.863	0.049
	5.5	9.4	9.9	24.2	2.201	0.900	0.038
							0.305
C2	3.0	9.4	9.9	35.3	1.433	0.807	
	3.5	9.4	9.9	35.3	1.796	0.858	0.050
	4.0	9.4	9.9	35.3	2.159	0.897	0.039
	4.5	9.4	9.9	35.3	2.522	0.926	0.029
	5.0	9.4	9.9	35.3	2.886	0.947	0.021
	5.5	9.4	9.9	35.3	3.249	0.963	0.015
							0.155

D1	3.0	7.0	6.7	24.2	-1.146	0.241	
	3.5	7.0	6.7	24.2	-0.783	0.314	0.072
	4.0	7.0	6.7	24.2	-0.419	0.397	0.083
	4.5	7.0	6.7	24.2	-0.056	0.486	0.089
	5.0	7.0	6.7	24.2	0.307	0.576	0.090
	5.5	7.0	6.7	24.2	0.670	0.661	0.085
							0.420
D2	3.0	10.6	11.5	35.3	2.199	0.900	
	3.5	10.6	11.5	35.3	2.562	0.928	0.028
	4.0	10.6	11.5	35.3	2.925	0.949	0.021
	4.5	10.6	11.5	35.3	3.288	0.964	0.015
	5.0	10.6	11.5	35.3	3.651	0.975	0.011
	5.5	10.6	11.5	35.3	4.014	0.982	0.008
							0.082

Appendix C8. Sensititivity Analysis, POST, Saskatchewan Open Logit Model.

Frame	POST	RQI	PTCAP	FTOVERA	Z1 Value	PROB 1	CH PROB
Base	10	9.4	9.9	4.0	-0.227	0.443	
	20	9.4	9.9	4.0	0.716	0.672	0.228
	30	9.4	9.9	4.0	1.659	0.840	0.168
	40	9.4	9.9	4.0	2.603	0.931	0.091
	50	9.4	9.9	4.0	3.546	0.972	0.041
							0.529
A1	10	7.0	9.9	4.0	-1.063	0.257	
	20	7.0	9.9	4.0	-0.120	0.470	0.213
	30	7.0	9.9	4.0	0.823	0.695	0.225
	40	7.0	9.9	4.0	1.767	0.854	0.159
	50	7.0	9.9	4.0	2.710	0.938	0.084
							0.681

A2	10	10.6	9.9	4.0	0.190	0.547	
	20	10.6	9.9	4.0	1.134	0.757	0.209
	30	10.6	9.9	4.0	2.077	0.889	0.132
	40	10.6	9.9	4.0	3.021	0.953	0.065
	50	10.6	9.9	4.0	3.964	0.981	0.028
							0.434
B1	10	9.4	6.7	4.0	-0.923	0.284	
	20	9.4	6.7	4.0	0.020	0.505	0.221
	30	9.4	6.7	4.0	0.964	0.724	0.219
	40	9.4	6.7	4.0	1.907	0.871	0.147
	50	9.4	6.7	4.0	2.850	0.945	0.075
							0.661
B2	10	9.4	11.5	4.0	0.120	0.530	
	20	9.4	11.5	4.0	1.064	0.743	0.213
	30	9.4	11.5	4.0	2.007	0.882	0.138
	40	9.4	11.5	4.0	2.951	0.950	0.069
	50	9.4	11.5	4.0	3.894	0.980	0.030
							0.450

C1	10	9.4	9.9	3.8	-0.373	0.408	
	20	9.4	9.9	3.8	0.571	0.639	0.231
	30	9.4	9.9	3.8	1.514	0.820	0.181
	40	9.4	9.9	3.8	2.457	0.921	0.101
	50	9.4	9.9	3.8	3.401	0.968	0.047
							0.560
C2	10	9.4	9.9	4.1	-0.155	0.461	
	20	9.4	9.9	4.1	0.789	0.688	0.226
	30	9.4	9.9	4.1	1.732	0.850	0.162
	40	9.4	9.9	4.1	2.675	0.936	0.086
	50	9.4	9.9	4.1	3.619	0.974	0.038
							0.513
D1	10	7.0	6.7	3.8	-1.904	0.130	
	20	7.0	6.7	3.8	-0.961	0.277	0.147
	30	7.0	6.7	3.8	-0.018	0.496	0.219
	40	7.0	6.7	3.8	0.926	0.716	0.221
	50	7.0	6.7	3.8	1.869	0.866	0.150
							0.737

D2	10	10.6	11.5	4.1	0.611	0.648	
	20	10.6	11.5	4.1	1.554	0.826	0.177
	30	10.6	11.5	4.1	2.498	0.924	0.098
	40	10.6	11.5	4.1	3.441	0.969	0.045
	50	10.6	11.5	4.1	4.385	0.988	0.019
							0.340

APPENDIX D1

Alberta Closure Logit Estimation

CHOICE	FREQUENCY	PERCENT
0	28	40.5797
1	41	59.4203

LOG OF LIKELIHOOD FUNCTION = -14.9498
NUMBER OF CASES = 69
NUMBER OF CHOICES = 138
SUM OF SQUARED RESIDUALS = 4.27256
R-SQUARED = 0.743279
PERCENT CORRECT PREDICTIONS = 94.2029

PARAMETER	ESTIMATE	STANDARD ERROR	T-STATISTIC
C1	12.283	3.4140	3.5979
ROAD1	-0.26373	0.15243	-1.7302
ELEVSIZ1	-0.17474E-02	0.65354E-03	-2.6738
COMPVOL1	-0.30926	0.11335	-2.7284

APPENDIX D2

Saskatchewan Closure Logit Estimation

CHOICE	FREQUENCY	PERCENT
0	53	38.8889
1	73	61.1111

LOG OF LIKELIHOOD FUNCTION = -43.3458
NUMBER OF CASES = 126
NUMBER OF CHOICES = 252
SUM OF SQUARED RESIDUALS = 14.0562
R-SQUARED = 0.530674
PERCENT CORRECT PREDICTIONS = 83.3333

PARAMETER	ESTIMATE	STANDARD ERROR	T-STATISTIC
C1	9.0408	1.7946	5.0379
ROAD1	-0.16098	0.95243E-01	-1.6902
ELEVSIZ1	-0.21193E-02	0.43453E-03	-4.8773
AAVGTUR1	-0.83413	0.19719	-4.2301
REPRATI1	3.1849	1.2951	2.4592

APPENDIX D3.

Table 7. Saskatchewan-Alberta Closure Logit Model

Choice	Frequency	Percent
0	81	39.4872
1	114	60.5128

Log of Likelihood Function = -67.8674
Number of Cases = 195
Number of Choices = 390
Sum of Squared Residuals = 21.2327
R-Squared = 0.544328
Percent Correct Predictions = 85.1282

Parameter	Estimate	Standard Error	T-Statistic
C1	8.7262	1.4021	6.2236
ROAD1	-0.19206	0.071966	-2.6688
ELEVCAP1	-0.0016794	0.0002898	-5.7951
AAVGTUR1	-0.82454	0.16160	-5.1025
REPRATI1	2.5006	0.95899	2.6075