AN ANALYSIS OF THE COST OF ASSEMBLING GRAIN BY FARM TRUCK IN MANITOBA

A Thesis

Presented to

The Faculty of Graduate Studies and Research

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

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August 1966

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to all persons who assisted and guided him in this project. Financial contributions for the study were received from the Department of Agricultural Economics and the Winnipeg Grain Exchange.

Particular thanks are due to Dr. A.W. Wood, under whose supervision the project took place. His rigorous inspection and constructive comments were invaluable in completing this study.

The author is also very grateful to Messrs. Gary Zilkey and Jim Ross who carried out the survey for this study and to Mrs. Fran Powell and Mrs. Norma Kristjanson for typing of the manuscript.

AN ANALYSIS OF THE COST OF ASSEMBLING

GRAIN BY FARM TRUCK IN MANITOBA

Kenneth Boyd Young

The possible serious and disruptive implications of the proposed abandonment of railway branch lines in Western Canada warrant careful study. The additional cost to grain producers, other inhabitants of rural communities, and elevator firms should be taken into consideration as well as savings resulting from abandonment. This study on grain assembly costs of producers in Manitoba was predicated on this proposed action and its implications for farmers.

Most cost data for the study are taken from a random survey of 89 Manitoba farms conducted in 1965. The survey was supplemented by information from published sources in respect to truck prices and labor cost. The time period covered in the study was the crop year August 1, 1964 to July 31, 1965.

Methodology followed in this cost study included an evaluation of depreciation and interest on investment costs basis the market revaluation method. Labor cost in grain assembly was determined by simple regression analysis, treating round-trip time to and from the delivery point as a function of delivery distance, and then imputing a cost estimate for labor. In view of the fact that the custom rate of one-half cent per bushel-mile has been generally accepted as the cost of grain delivery, average assembly cost in the sample of trucks obtained in the survey was compared to this custom rate, using a statistical test of difference between means. Truck size and distance of haul were felt to have a significant effect on assembly cost. Their relationship to cost was determined by multiple regression analysis. The function fitted in testing this relationship has also been used to predict change in average total assembly cost for changes in these

variables. Additional variable cost for increased distance of haul has been estimated on the basis of the computed average variable cost of assembly by farm trucks in this study and findings of other cost studies concerning repair and labor costs.

Major direct findings of this cost study are:

1. Average total cost of grain assembly by farm trucks in the survey was equal to the custom rate of one-half cent per bushel-mile.

2. Estimated additional variable cost of assembly for increased distance of haul was .3 cents per bushel-mile.

3. Average loading and unloading time in grain assembly was 23 minutes per truck. There was no noticeable difference in this time between different sizes of trucks.

4. Average speed in making a round trip to the elevator was 16 miles per hour. There was no noticeable difference in this speed between different sizes of trucks.

5. Size of truck and distance of haul have significant effects on the average cost of assembly per bushel-mile.

TABLE OF CONTENTS

APPENDICES PAGE

LIST OF TABLES

APPENDIX C PAGE

LIST OF FIGURES

FIGURE

CHAPTER I

INTRODUCTION

THE GENERAL PROBLEM

Farm trucks in Manitoba currently perform an essential marketing service in assembling grain from farms to country elevators. In 1964 there were 38,388 trucks registered as farm trucks in this province.[1] Many farmers also depend on custom trucking for their hauling needs. Regardless of who actually performs this service, the cost of grain assembly is incurred directly by the grain producers.

Responsibility for transporting grain the remaining distance to terminal elevators at Churchill, the Lakehead and Vancouver, has historically been assumed by railway firms. The cost of rail transportation of grain has also been charged to the grain producer at an agreed rate structure which has been relatively fixed through time.[2]

The spatial aspect of the present branch line problem has a logical foundation. As related by Easterbrook and Aitkens, excessive construction of rail lines occurred with wasteful duplication and uneconomic use of lines. There was also extensive construction of grain handling facilities. Elevators were erected in this early period

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[1]Obtained by personal interview at the Winnipeg Motor Vehicle Branch, June 3, 1965. This figure overstates the actual number involved as some farm trucks are not used for hauling grain. This is at least partly offset, however, by the number of non-farm trucks hired for this purpose.

[2]The railroads agreed to haul grain at a fixed rate structure in return for certain considerations and aid in financing construction of rail lines. See for example, W. T. Easterbrook and H. G. J. Aitkens, <u>Canadian Economic History</u>. (Toronto: The MacMillan Company of Canada Ltd., 1958)

along rail branch lines at intervals of seven to twenty miles so that producers were required to haul grain a maximum distance of twelve to fifteen miles from their farms.[3] The present location of these rail branch lines is not fixed by binding agreement as in the case of the freight rate structure for grain but their removal does require approval of government through the medium of the Board of Transport Commissioners.

The rate structure for grain, to which the railways are currently committed, has been a point of grievance for them in recent years. They charge that these rates are not fully remunerative. Their discontent is further aggravated by the fact that the sole traffic in many rural areas (where the most wasteful line construction originally occurred) is grain.

Railway firms have attempted to evade or at least alleviate their alleged "plight" of being permanently committed to haul grain on inefficient branch lines at fixed unremunerative rates through various means:

1. They are reluctant to commit sufficient boxcars to the grain trade to satisfy requirements as they can earn more revenue in other activities, e.g. hauling ore.[4]

2. They have set rates on different classes of freight (other than grain), not on the basis of cost, but relative to the value of the goods handled in order to raise their overall revenue on branch lines. This policy has contributed to the aggravation of their problems cited previously

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[3]W. A. Mackintosh, Prairie Settlement, (Toronto: The MacMillan Company of Canada, 1934), P. 55.

[4]This view has been widely held during periods of heavy grain movement and box-car shortage.

since the motor truck and private automobile have competitively displaced many of the most profitable services of railways.[5]

3. Railways have applied to abandon lines where there is apparently little traffic other than grain. [6]

In respect to the third procedure, the Canadian Pacific and Canadian National Railway Companies have submitted applications to government for abandonment of certain branch lines serving country elevators. A Royal Commission on Transportation has recommended in effect that the railways be allowed to shift their responsibility for grain hauling to producers on all lines shown to be "uneconomic". The Commission appears to have accepted the balance sheets of railway firms as sufficient criteria for approval of their demands for discontinuance of service on these lines.

The Report of the Royal Commission on Transportation and the subsequent proposed legislation within Bill C-120 for establishment of a "Branch Line Rationalization Authority" implied that there would be large scale abandonment of branch lines in Western Canada. Since the defeat of Bill C-120 no further legislation has been proposed or action publicly contemplated on the part of government to deal with this important problem of rail line abandonment other than the approval of abandonment of these lines on the basis of railway balance sheets presented.

The possible serious and far-reaching disruptive implications of this

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[5]For a more detailed explanation of the weakened competitive position of the railways the reader may refer to: The Report of the Royal Commission on Transportation, Vol. 1, March 1961. Queen's Printer, pp. 27-28.

[6]*Ibid.*

proposed action warrants a more thorough study of the problem, taking into consideration the additional cost to grain producers, other inhabitants of rural communities and elevator firms as well as the savings to railways resulting from abandonment. This is the point at which the present study enters into the broad problem of rail line abandonment. Assuming that the intended overall objective of society is the attainment of a balanced efficient transportation system for grain, operating at minimum social cost, what are the respective economic efficiencies of transporting grain by truck versus rail in view of present technology and predictable technological changes?

STATEMENT OF THE PROBLEM

It is generally accepted that branch line abandonment will occur. In Manitoba the projected loss of elevator points on lines proposed for abandonment is estimated to be 105 or 27.8 per cent of total points in the province.[7] This means that the producers currently delivering to these points would be compelled to go to alternative points. Their additional transportation cost represents a real increase in farm cost whereas the savings to railway firms from abandonment of these uneconomic lines would constitute a decrease in social cost. The latter factor appears to have been foremost in the minds of policy makers in considering rail line abandonment though the former may be equally important, at least in the case of particular branch lines, and it therefore warrants equal consideration.

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[7]B. G. Lagace, Some Implications of Railway Branch Line Abandonment For Location and Capacity of Country Elevators in Western Canada, (Unpublished M.Sc. Thesis), The University of Manitoba, March 1963), Table VI, p. 30.

This problematic situation indicates a definite need for empirical investigation of the following specific questions:

1. What are the present costs associated with ownership and operation of trucks on Manitoba farms?
2. What is it currently costing producers to deliver grain from their farms to country elevators?
3. What would be the probable additional cost for increased distance of haul?

IMPORTANCE OF THE PROBLEM

An analysis of farm truck costs is clearly relevant to the problem of rail line abandonment as producer grain hauling costs will be affected if delivery distance is increased. The argument for abandonment has been predominantly an economic one, based on the profit and loss statements of railway firms. It is evident that comparable statements on operating costs of farm trucks are at most inadequate, if they exist, as the best estimate quoted on trucking cost has been one half-cent per bushel-mile, a Saskatchewan custom rate.[8]

This view is supported by Gilson in a presentation to the Winnipeg Chamber of Commerce Farm and Business Forum:

> It should be noted at this point (Implications of rail line abandonment for Farmers) that there has been some debate as to whether the figure of

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[8]Custom Rates per Acre in the Province of Saskatchewan as shown by Mail Questionnaire Survey through Wheat Pool Locals, (Department of Farm Management, University of Saskatchewan and Dom. Economics Branch, Saskatoon, Saskatchewan), p. 2.

one-half cent per bushel per mile for hauling grain is the correct one. It would seem that a comprehensive study is needed on this very important issue.[9]

The present study aims at presenting factual information on truck hauling costs which, it has been shown, is crucial to an objective evaluation of the rail line abandonment problem.

OBJECTIVES

The objectives of this study were:

1. To evaluate existing data on truck costs.
2. To determine empirically, the costs of ownership and operation of trucks used for hauling grain to country elevators.
3. To determine the influence of various factors affecting costs.
4. To estimate additional cost likely to be incurred by producers for increased distance of haul.

HYPOTHESES

The general expectation in the study is that the producers will experience increased grain hauling costs for extended distance of delivery to the elevator if rail lines are abandoned. More specifically, the working hypotheses used to guide the study on trucking costs are as follows:

1. Average cost of grain assembly by farm truck in Manitoba is

[9] J. C. Gilson, " The Economic Effect of Rail Line Abandonment In the Prairie Provinces", Proceedings of the Sixth National Farm & Business Forum, The Winnipeg Chamber of Commerce, March 25 - 26, 1965. p.5.

equal to the average reported custom rate of one-half cent per bushel-mile.

2. Average assembly cost per bushel-mile varies with distance travelled to delivery point.

3. Average assembly cost per bushel-mile varies with size of truck used, in terms of load capacity for grain.

ASSUMPTIONS

Certain conditions were assumed to exist in testing the empirical validity of the preceding hypotheses which could not, for practical reasons, be tested. It is important, however, that these assumptions have empirical validity for conclusions drawn from the analysis to be valid.

Basic assumptions in the study are:

1. The market structure for new and used trucks is homogeneous in the province. This assumption is important since depreciation and interest on investment costs are determined from average market prices of trucks in 1964 and 1965. If real differences in market prices existed between different areas of the province, the cost estimates derived from the average level may be in error.

2. Farmers haul grain at maximum box capacity, irrespective of the type of grain, provided there are no restrictions on supply or delivery. The number of trips incurred by each truck in hauling grain has been estimated on the basis of its reported box capacity and other factors. However, working capacity of a truck could vary with different types of grain since some grains are heavier than others. This possible error is at least partially offset in the

analysis because of other allowances made for segregating different grains and time of delivery.

3. The cost of making a round trip to the elevator in delivering a truck-load of grain is charged as a marketing cost. There may be times when a farmer does other business in town after making delivery, or brings feed and supplies back to the farm on the return trip. The cost of each trip is wholly attributed to grain hauling in the analysis although other possible benefits may be derived from the trips.
4. Joint overhead and variable costs of farm trucks are allocated according to the mileages incurred in performing different tasks. Farm trucks are commonly used for a variety of tasks besides grain hauling. Grain hauling, however, may involve more heavy use, with higher operating cost, than most other uses on the farm. It is also likely that some trucks may be purchases exclusively for grain hauling and would probably not be owned at all, were it not for this necessary function. Overhead costs could be entirely attributed to grain hauling in such cases. It was not possible within the scope of this study to analyze the importance of these factors in grain hauling cost. If they are important there may be merit in use of a weighted cost estimate for grain hauling.

SCOPE

The study is primarily of an exploratory nature. Although rail line abandonment concerns grain producers in all prairie provinces, the study is confined to a small sample of Manitoba producers delivering grain to a random sample of five different elevator points in the crop year 1964-65. It is unlikely, however, that conditions in other provinces affected would vary significantly from those found in this sample.

The study is basically concerned with grain hauling cost. Therefore, the scope of inquiry is limited. Other studies have been made on the physical results of abandonment and the probable diversion of grain deliveries resulting therefrom.[10] The usefulness of these studies is presently limited because of lack of information on grain hauling costs likely to be incurred by producers and the cost of constructing new elevator facilities. Results of this study should help to overcome the first problem.

SOURCE OF INFORMATION

Most cost data for the study were obtained from a survey of 89 farms in Manitoba conducted during the months of July and August, 1965. Data on truck prices and labor cost are taken from published sources.

The population under survey consisted of all farmers registered in the province by the Canadian Wheat Board,[11] except those delivering to points

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[10] B. G. Lagace, Some Implications of Railway Branch Line Abandonment For Location and Capacity of Country Elevators in Western Canada, (Unpublished M.Sc. Thesis, The University of Manitoba, Winnipeg, March, 1963) and E.B.Riordan, Spatial Competition and Division of Grain Receipts Between Country Elevators, (Unpublished M.Sc. Thesis, The University of Manitoba, Winnipeg, February,1965)

[11] A list of permit holders was obtained directly from the Canadian Wheat Board Office in Winnipeg. The Board requires that all grain producers register for delivery permits each year. This permit entitles them to sell grain at the elevator subject to delivery restrictions imposed by the Board.

within Manitoba census divisions 12, 14, 15, 16, 17, 19 and part of 18.[12] The latter were excluded from the survey because of their long distance from survey headquarters. All census divisions included in the study area are shown in heavy outline in Figure I.

A random sample of one hundred farmers was chosen from the population as defined, by means of the following procedure:

1. Five delivery points were selected at random from 287 total points in the survey area by use of random number tables.[13]
2. Producers were selected at random, also by use of random number tables, from those delivering to these five points, subject to the condition that the number drawn at each point represent 12 per cent of all producers delivering thereat.

Information was obtained from 89 of the farmers selected, by the personal interview method using the questionnaire shown in Appendix A.[14] The remaining 11 farmers could not be contacted or were unwilling to co-operate in the survey. Only 66 of the farmers in the survey owned trucks. All others relied on custom hauling for delivering their grain to the elevator, except for two farmers who used their tractors. Information on delivery methods and sizes of trucks used for hauling grain in the survey is shown in Appendix B, Tables I and II. It may be observed in Table II that most of the survey trucks are larger than the average size of farm truck in the province

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[12]Dominion Bureau of Statistics, 1961 Census of Canada, Agriculture, Manitoba Bulletin 5.3-1 (Ottawa: Queen's Printer and Controller of Stationery,1963)

[13]The number of delivery points is determined from a list of all licenced elevators in Manitoba. The reference is: Board of Grain Commissioners for Canada, Grain Elevators in Canada (Ottawa:Queen's Printer and Controller of Stationery, 1964-65 Edition)

[14]The questionnaire was used to obtain information on the use of grain storage facilities as well as trucking costs. Therefore, some of it is not applicable to this study.

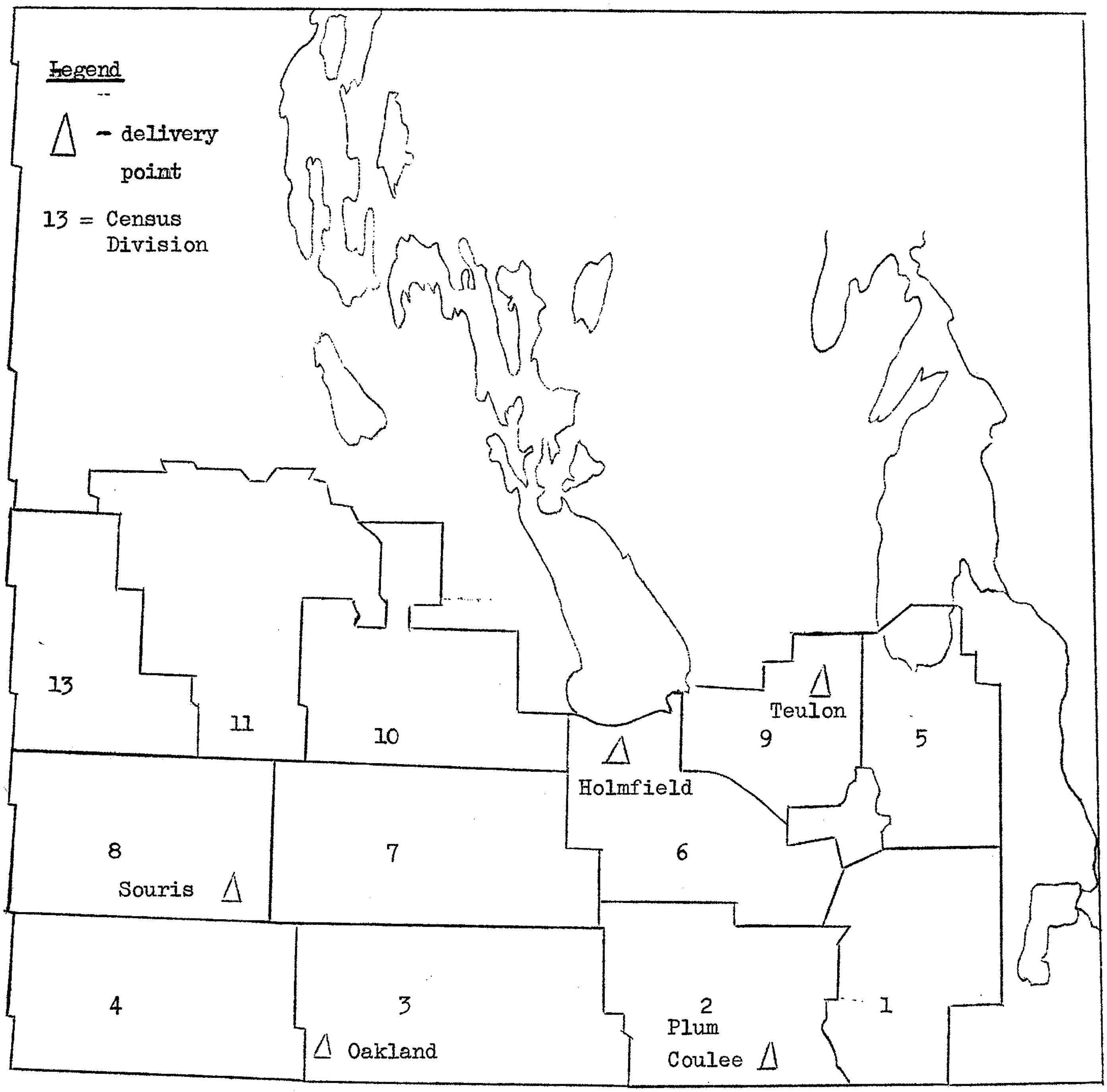

Figure 1

LOCATION OF SURVEY

as the bigger sizes are probably preferred for hauling grain. The one-ton size seems to be especially popular for this task.

Other attributes of the survey will be referred to in later stages of the study.

METHODOLOGY

The methodology involved in testing hypotheses of the study includes a test for significant difference between means in the case of Hypothesis I and multiple regression analysis in the case of Hypotheses II and III. The function derived in testing the latter is also used to predict change in total assembly cost per bushel-mile for change in distance of haul and change in size of truck, in terms of capacity.

CHAPTER II

LITERATURE REVIEW

SOME ESTIMATES OF ADDITIONAL COST

In respect to the additional cost expected to be shouldered by producers following the proposed abandonment of rail branch lines, it has been estimated that "rail line abandonment in Manitoba would mean that 10,000 farmers would have to truck 20 million bushels an average increased distance of ten miles. This would represent an annual minimum cost to the farmers of one million dollars for grain hauling alone."[1]

This is the only known aggregate estimate of additional cost for producers in this province. Other studies have reported on the expected impact of rail line abandonment on producers. For example, a Saskatchewan study estimates that:

> If current applications for abandonment in Saskatchewan become effective, many farmers will have to truck their wheat an average of eighteen miles to elevators, compared to six miles now. It is estimated that the average age of farm trucks in Saskatchewan is twelve years and the average size is around one ton. Farmers will need newer and bigger trucks for the longer hauls.[2]

THE BASIS OF CURRENT ESTIMATES

In discussion of rail line abandonment costs for producers, re-

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[1]J. C. Gilson, op. cit., p. 5. The estimate is believed to have originated from a special C.B.C. program, May 10, 1964, no details offered.

[2]J. Schriener, "Problem: Grain Elevators without track," The Financial Post. Dec. 5, 1964.

ference has been made to studies which have shown that the cost of hauling grain in a one-ton farmer owned truck amounts to approximately 1/4 cents per bushel per mile.[3] The Board of Transport Commissioners however, has preferred to accept the figure of one-half cent per bushel-mile as the cost of additional haul, based on a survey of average custom hauling rates in Saskatchewan, as it has been shown that a number of farmers do not currently own trucks suitable for grain hauling.

One estimate of grain hauling cost which has been used in abandonment hearings is that from a study undertaken by I.F. Furniss on a Canada Department of Agriculture Illustration Station Farm Unit in north-central Saskatchewan.[4] Furniss has confirmed that his figures have been quoted in at least one railway line abandonment application hearing as evidenced by the following quotation from correspondence with the author in a letter dated June 16, 1965.

> The figures given in this report (Cost Accounting for Agriculture, Part I) were cited in a case a few years ago before the Board of Transport Commissioners involving an application of the C.P.R. to abandon the Snowflake-Windygates-Fallison Line.

Furniss based his estimate on the annual costs of operation of a one-ton 1954 truck, with a replacement value of $2,800.00, in the years 1955 and 1956. Operating costs in these years are shown in Table I.

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[3] W. C. Bowra, "Regional Impact", Proceedings of the Sixth National Farm and Business Forum, p. 5.

[4] I. F. Furniss, Cost Accounting for Agriculture, Part I. Illustration Stations Division, Canada Department of Agriculture, Feb., 1958.

TABLE I

COST OF TRUCK OPERATION, BRAESIDE[a], SASK., 1955-56*

Make	Size: 1 ton	Year: 1954	Replacement Value: $2,800

Item	1955 Cost	1956 Cost
	(........dollars	............)
Fixed Costs:		
Interest	84.00	84.00
Depreciation	420.00	420.00
Repairs:		
Parts and Hired Labor	145.08	160.61
Own Labor	2.85	5.70
Tires	0.00	143.96
Housing	14.00	14.00
Licence and Insurance	27.00	27.00
Antifreeze	2.75	6.49
Total Fixed Cost	695.68	861.76
Operating Costs:		
Fuel	374.53	385.63
Oil, Grease and Filters	36.88	28.69
Total Operating Cost	411.41	414.32
TOTAL COST	1,107.09	1,276.08
Total Miles Operated	9,000 miles	9,301 miles
Cost Per Mile	12.3 cents	13.7 cents
Miles Operated on Business	7,000 miles	7,500 miles
Cost of Operating Truck on Business	$861.00	$1,027.50
Share of Truck Expenses to Crops[b]	41.7%	51.7%
Total Truck Expenses on Crops	$359.04	$531.22
Truck Expenses per Cultivated Acre	$0.81	$1.20

*Source: Furniss, *op. cit.*, Tables VI and XIX.

[a] This is a fictitious name.

[b] Share of truck expenses allocated to crops was calculated on the basis of the proportion of cash income derived from crop production in the year concerned.

It is suggested that the method followed in Table I of allocating truck expenses to the crop enterprise on the basis of farm income derived from this source was not validated by additional supporting data. Also the item, tires, which has been treated as a fixed cost in this analysis, should probably have been allocated to more than one year of use rather than entirely charged to the year 1956.

No figures are given for crop production in the first year of the study. In 1956, acreages of crops harvested were: wheat - 51 acres, oats - 148 acres, barley - 81 acres and rapeseed - 40 acres, for a total of 320 acres in crop as compared with 443 total cultivated acres on the farm. The respective yields were: 27.5 tons (917 bu.) 65.3 tons (3,841 bu.) 64.2 tons (2,675 bu.) and 17.2 tons (688 bu.).[5]

Furniss has not presented his estimate on a cost per bushel-mile basis. However, it is suggested that the latter figure can be calculated from the data as shown in Table II.

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[5]*Ibid.*, Table XXII, p. 33. These crop yields for different grains were converted from total tonnage reported by Furniss to total bushels on the basis of average weight per bushel of the crops.

TABLE II

COST OF HAULING GRAIN WITH A ONE-TON TRUCK*

Item	Estimated Quantity or Cost of Item
1. Total Grain Hauled	174.2 tons
2. Truck Capacity	3.0 tons
3. Number of Loaded Trips[a]	59 trips
4. Ave. No. of Bushels Per Trip[b]	138 bushels
5. Cost Per Mile of Truck Operation	13.7 cents
6. Cost Per Mile of Haul	27.4 cents
7. Cost Per Bushel-Mile[c]	0.199 cents

*Source: Computed from data in Furniss, op. cit.

[a]Taken directly from Furniss with the exception that the number of loads for each type of grain was raised to a whole number rather than the fraction shown in the original data since it is unfeasible to make an incomplete trip.

[b]The average number of bushels per trip is estimated by dividing total bushels by the number of trips.

[c]Cost per bushel-mile is calculated by dividing (6) by (4).

The calculated figure of one-fifth cent per bushel-mile is for truck operating cost alone and does not include any value for the driver's time. Furniss estimated that the labor time required for loading and hauling grain was one hour per truck-load.[6] But it is not possible to compute labor cost per bushel-mile from his data directly since he did not report how far the load was hauled. A reasonable estimate of hauling distance may be 6 miles, the reported average figure in Saskatchewan.[7] Using this estimate, labor cost per bushel-mile would be $0.95, the cost of labor per hour, divided by (138 bushels x 6 miles) = 0.114 cents in addition to the cost of truck operation. It should also be emphasized that the estimate of cost represents the minimum cost of trucking grain in that the minimum possible number of trips were made. In a situation where different grains, and possibly grades, are hauled at different times in the year from several storage bins, it is likely that considerably more trips were necessary. It would seem that the major limitation of this study is that the data are based entirely on the cost of operation of one truck which had probably much more annual use than the average truck encountered on Manitoba farms. It would also be of interest to quote a passage from the Foreword of the report which is relevant to this review.

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[6]Furniss, op. cit., Table XXII, p. 33. There was an apparent error in the footnote reference to this table in respect to the time per load.

[7]Schriener, op. cit.

Data as used in this monograph applied to an Illustration Station farm unit in north-central Saskatchewan. These data should not be considered as standards in any respect but only to illustrate the methodology that may be employed in determining costs of crop production in detail.[8]

FARM MANAGEMENT STUDIES

Most farm management studies provide very little detail on trucking costs as their major objective is usually an overall analysis of the farm business and this item merely represents one of the cost input factors. A common limitation of these studies has also been the fact that rather arbitrary methods have been used in calculating depreciation and budgeting repair cost.

Findings of two different studies are discussed below, one undertaken at one point in time, i.e., one year, and the second is based on five years' data.

A study on trucking costs was completed in Central Illinois in 1951. Truck records were stratified into two size groups on the hypothesis that the cost per mile is largely governed by the number of miles a truck is driven in a year's time, and by the size of truck. In view of the former, the trucks were further stratified: (1) those driven fewer than 5,000 miles and (2) those driven 5,000 or more miles per year. Results of this study are presented in Table III.

It is difficult to evaluate this study as very little de-

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[8]Furniss, *op. cit.*, Foreword.

TABLE III

ANNUAL TRUCK COST BY SIZE OF TRUCK AND NUMBER OF MILES DRIVEN DURING 1951*

	Truck Size and Mileage in 1951			
	3/4 and 1 Ton		1 1/2 and 2 Ton	
	<5000 Miles	>5000 Miles	<5000 Miles	>5000 Miles
Number of trucks	12	10	6	8
Operating Costs per Truck				
Gasoline, Oil, Grease	$ 67.53	$137.05	$ 76.64	$189.13
Repairs	111.84	137.52	99.02	115.06
TOTAL OPERATING COSTS	$179.37	$274.57	$175.66	$304.19
Fixed Costs per Truck				
Depreciation	191.22	214.03	213.00	329.71
Interest on Investment	48.73	65.27	35.37	80.05
Licence	17.90	18.30	49.00	57.56
Insurance	18.47	29.63	9.80	33.50
Shelter	19.86	20.69	8.76	13.36
Antifreeze and miscellaneous	18.27	21.10	25.60	24.98
TOTAL FIXED COSTS	$314.45	$369.02	$341.53	$539.16
TOTAL COSTS	$493.82	$643.59	$517.19	$843.35
Average miles driven in 1951	3,242 mi.	6,896 mi.	3,238 mi.	7,010 mi.
Total cost per mile driven	$ 0.15	$ 0.09	$ 0.16	$ 0.12
Operating cost per mile	0.05	0.04	0.05	0.04
Fixed cost per mile	0.10	0.05	0.11	0.08

*Source: R. H. Wilcox and R. A. Hinton, Detailed Cost Study for Central Illinois, A. E. 2907, Agricultural Experiment Station, University of Illinois, Urbana, Illinois. Nov. 1951. Table 22, p. 35.

tail is given on methods of computation. Depreciation was the major cost item yet no explanation was given as to how it was calculated. The cost per mile of trucks driven less than 5,000 miles per year compares closely with the figure calculated by Furniss for a truck driven about twice that distance. This is in line with expectations as costs have risen since 1951 and U.S. prices of trucks are generally lower than Canadian prices.

A similar study on farm truck costs was conducted by C. D. Kearl in 1958 basis the records of 43 New York State farms. However, the study covered a period of five years 1954-1958 inclusive, during which time there was some tendency for cost to increase. His findings are shown in Table IV.

Again, very little or no detail is given as to the method followed in calculating such factors as average value and depreciation.

AN ANALYSIS OF COST BEHAVIOUR

One of the most complete studies available on the cost of farm trucks, which is cognisant of behaviour of cost as well as just the simple average of data, is an Arkansas study by D. F. Capstick. Capstick surveyed 30 half-ton and 31 one and one-half ton farm trucks. The smaller trucks were driven an average of 20,000 miles annually and generally traded every four years. The range in length of ownership was from one to ten years and the use ranged from 5,000 to 30,000 miles per annum. Costs per mile for the small trucks are shown in Table V.

TABLE IV

ANNUAL AVERAGE TRUCK COSTS, WEIGHTED BY NUMBER OF TRUCKS IN EACH SIZE GROUP*

Year	Average Value	Depreciation & Cash Repairs	Fuel	All Other	Miles of Use per Truck	Miles per Gallon of Gas [a]	Average Cost Per Mile of Use[a]
	$	$	$	$	(miles)	(miles)	(cents)
1958	749	301	150	209	5,116	8	12.7
1957	735	318	141	195	5,173	9	11.9
1956	811	304	129	202	5,233	9	13.0
1955	832	298	117	186	5,067	10	11.8
1954	765	298	121	195	5,758	9	11.5

*Source: C. D. Kearl, Overhead Costs From Farm Accounts A. E. Res. 33, Cornell University, Ithaca, New York, Nov. 1959, p. 18.

[a]Based on 47 trucks with known mileage.

TABLE V

AVERAGE COSTS PER MILE FOR SMALL TRUCKS IN ARKANSAS STRATIFIED BY AGE AND LEVEL OF ANNUAL USE*

Years of Use	Miles driven per year 5,000	10,000	15,000	20,000	25,000	30,000
	(cents per mile)[a]					
1	20.7	11.4	8.4	7.5	6.8	6.1
2	18.0	10.6	8.2	7.1	6.5	6.0
3	16.0	9.8	7.8	6.8	6.3	6.0
4	15.3	9.4	7.7	6.7	6.2	
5	14.5	9.1	7.4	6.5		
6	13.7	8.8	7.3			
7	13.0	8.5				
8	12.6	8.4				
9	12.2	8.1				
10	11.9	7.9				

*Source: D. F. Capstick, Cost of Owning And Operating Farm Trucks in Eastern Arkansas, Agricultural Experiment Stn. Fayetteville, Arkansas, Table I. New cost was estimated at $2,100.00.

[a]Cost was not computed beyond 100,000 miles of total use or 10 years of age.

The larger trucks were driven an average of 6,000 miles per year and were generally traded every 6 years. Length of ownership ranged from 1 to 16 years and level of annual use ranged from 2,000 to 12,000 miles per year as shown in Table VI.

In the case of both sizes of trucks there were obvious economies with increased distance of travel per year.

In evaluating repair and maintenance costs, Capstick obtained data from dealers and farmers in the survey concerning annual truck use and the frequency and cost of making different repairs and performing maintenance. A three-year moving average was used in computing these costs so as to avoid sharp fluctuations. This approach allows operating cost to increase or decrease with added miles of use. It is a definite improvement in methodology over typical farm management studies which have generally relied on rather arbitrary procedures in evaluating this item.[9]

In the present investigation, objectives are to calculate the present average costs of farm trucks and also to estimate the increase in various components of cost for increased distance of haul. The latter will require a similar type of investigation of cost behaviour as undertaken by Capstick. It would be quite useful also, to quantify repair cost as a function of mileage. This analysis will likely be difficult in a random survey, however, since mileage is highly correlated with age whereas both factors probably have important independent effects on repair cost.

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[9]See for example, W. Kalbfleisch and A. I. Magee, Cost of Operating Farm Machinery: Eastern Canada, Can. Agric. Pub. 750, Aug. 1953, or J. L. Thompson and A. Wenhardt, Cost Charges For Agricultural Machinery: Western Canada, Can. Agric. Pub. 881, July 1954.

TABLE VI

AVERAGE COSTS PER MILE FOR LARGE TRUCKS IN ARKANSAS STRATIFIED BY AGE AND LEVEL OF ANNUAL USE*

Years of Use	Miles driven per year 2,000	4,000	6,000	8,000	10,000	12,000
	(cents per mile)[a]					
1	68.6	36.2	25.4	20.0	16.7	14.7
2	59.6	31.2	22.4	18.6	15.6	14.5
3	52.2	28.0	20.8	17.4	14.7	14.2
4	48.6	26.3	20.3	17.0	14.8	13.5
5	45.1	25.3	19.6	16.2	14.2	13.2
6	42.2	24.5	18.3	15.6	14.0	12.8
7	39.9	24.0	17.8	15.4	13.5	12.7
8	38.0	22.0	17.4	15.0	13.4	12.7
9	36.4	21.8	17.1	14.6	13.2	
10	35.7	21.3	16.7	14.4	13.1	
11	33.8	20.3	15.8	13.9		
12	33.6	20.1	15.6	13.8		
13	32.8	19.7	15.4			
14	31.8	19.1	15.3			
15	31.0	18.9	15.2			
16	30.4	18.9	15.2			

*Source: Capstick, op. cit. Table II. New cost was estimated at $2,850.00

[a]Cost was not computed beyond 100,000 miles of total use or 16 years of age.

Attention will be later devoted to the behaviour of repair and maintenance costs in Capstick's study prior to estimating additional cost of grain assembly as it is the variable cost factor which will be affected by increase in annual mileage. This component of variable trucking cost is unique in that it does not necessarily vary directly with increase in mileage as does fuel and lubrication. The latter are relatively unaffected by age, as was shown in Capstick's study, and therefore are a constant function of mileage.

THE EFFECT OF VARIATION IN THE RATE DIMENSION ON COST

In a recent study undertaken at the University of Manitoba, Riordan improvised an estimate of truck operating costs for use in Manitoba. He defined operating costs as: "Outlay on fuel, lubrication, tires, maintenance and depreciation due to use."[10] Costs of truck operation over different road surfaces were taken directly from a U.S. Highway Engineering Handbook with the exception of the figure for earth roads.

Table VII shows his cost calculation using the Engineering Data plus an allowance for truck stop and start costs, and labor costs. The costs were basis speeds of 40, 30 and 20 m.p.h. on the three road surfaces. However, Riordan has added an additional two cents per mile to the figure for earth roads on the basis that a separate study on Rural Mail Vans indicated a different ratio of operating costs. The ratio in that case was 1:1.25:2.00.

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[10] E. B. Riordan, Spatial Competition and Division of Grain Receipts Between Country Elevators (Unpublished M.Sc. Thesis, University of Manitoba, Winnipeg. February, 1965) p. 29.

TABLE VII

COSTS FOR ONE MILE OF TRAVEL BY FARM TRUCKS
ACCORDING TO ROAD SURFACE*

Item	Paved	Road Surface Gravel	Earth
Average Running Speed	40 m.p.h.	30 m.p.h.	20 m.p.h.
Driving Time	1.5 mins.	2.0 mins.	3.0 mins.
Truck Running Cost	3.942¢	4.738¢	5.382¢
Truck Stop and Start Costs	0.318¢	0.239¢	0.24¢
Labor cost @ 1.5¢ a min.	2.25¢	3.00¢	4.5¢
Total cost rounded	6.5¢	8¢	10¢
Ratio between total costs	1 :	1.23 :	1.54

*Source: Riordan, op. cit., p. 44.

His further justification for adjusting the figure for earth roads is that "Impressions gained in interviews with farmers indicate that paved and gravel roads are greatly preferred to unsurfaced earth roads."

However, this adjustment is open to question as there is no evidence that the mail vans were also travelling at these particular speeds on the three road surfaces. Riordan has stated the limitations of the Engineering Data for Manitoba conditions, namely; (1) dissimilarity in operating conditions, and (2) differences in the prices paid for inputs.

Delineation of operating costs for different road surfaces and rates of speed adds an important dimension to trucking costs which few, if any, farm cost studies have indicated. Most cost studies have assumed some constant or average rate of output and have attempted to measure cost variation for change in mileage or time. Implications of changes in both dimensions, i.e., the time and rate dimension will be discussed in the subsequent chapter on theory.

IMPLICATIONS OF LITERATURE REVIEW

The present study is basically similar to most cost studies reviewed in this chapter since its first major objective is to determine current fixed and variable truck costs. Findings of the Illinois study and Capstick's study support hypotheses proposed in Chapter I that size of truck and distance of haul, which is directly related to annual mileage, have significant effects on average cost per bushel-mile. However, increase in cost for larger trucks will not likely be as important as increase in capacity. Therefore, expectations are that assembly cost per bushel-mile will decrease with increase in both hypothesized factors.

Capstick's findings concerning the relationship of variable costs and annual mileage levels will be clearly useful as a guide in estimating additional variable cost for increased distance of haul. They will again be reviewed in the process of computing an estimate in this study.

Driving time is an important component of grain assembly cost as shown in Riordan's study. Furniss estimated labor time in his study to be one hour per 100 bushel truck-load, including loading, unloading, waiting and driving. Unfortunately, he did not state how far the grain was being hauled. Special attention will be devoted in this study to labor cost in grain assembly since current knowledge of this factor seems especially limited.

The literature review has revealed some practical considerations in analysis of trucking costs. The nature of some of these cost characteristics, evaluated from a theoretical point of view, is discussed in the following chapter.

CHAPTER III

THEORETICAL CONSIDERATIONS

CONCEPTS OF COST

The primary purpose of this chapter is to clarify the nature of costs associated with ownership and use of farm trucks. It also develops the conceptual framework for design and interpretation of the empirical cost study.

Two types of elements in total cost have been identified in economic theory: (1) "those such as wages which take the form of contractual payments have been designated as expenditure or outlay costs, and (2) those which, when covered, accrue directly with no contractual obligations for payment involved, termed non-expenditure or implicit costs."[1]

The first group consists of the items usually treated as costs in financial accounting. In analysis of trucking costs this would include fuel, hired labor, repairs, insurance, licence fees and maintenance. Measurement of the total magnitudes of these direct outlay costs is a matter of basic accounting procedures.

The two major non-expenditure items in the second group are depreciation and an average or normal return on the money capital employed in ownership. Although depreciation and return on investment are not contractual or immediate obligations, they do represent costs which must be considered if a farmer is to continue owning a truck.

Of fundamental importance in an economic analysis of cost is the

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[1]J. F. Due, Intermediate Economic Analysis (Illinois: Richard D. Irwin Inc., 1956), p. 149.

extent to which cost inputs vary with output over time. Over a long period of time, the quantities of all factors can be adjusted, and thus all costs are variable, in the sense that they change as output changes. The concept of the long-run period is used in economic analysis with reference to a period of time sufficiently long to allow the quantities of all factors to be adjusted. In contrast, in a shorter period of time, some factor units are not adjustable in amount. The term "short-run period" is used for this time interval which involves both fixed and variable costs.[2]

The total cost of owning and operating farm trucks is the sum of fixed and variable costs. For trucks, the fixed costs are associated with ownership *per se* and will be incurred regardless of whether a truck is operated in a short-run period. Fixed cost includes both immediate expenditure and non-expenditure items as covered in the subsequent discussion.

There are two major categories of fixed costs. Costs in the first category are of a recurrent nature, involving actual outlay of money during the short-run period. Those in the second category are known as allocable fixed costs, consisting of shares of long-run capital expenditures allocated over several periods of use.[3] For example, the cost of a new truck is normally incurred at one time for the benefit of use during several time periods. Included in recurrent fixed costs are license fees and insurance. Allocable fixed costs include depreciation, interest on investment, and possibly some types of repairs in the case of individual trucks. The latter present a special difficulty as some arbitrary judgment may be necessary in weighting these items for a short-run period. This was a methodological problem involved in the study.

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[2] *Ibid.*, p. 152.

[3] Ibid., p. 153.

Variable costs or operating costs of trucks are theoretically dependent in total magnitude upon the amount of use or number of miles driven in a short-run period. The concept of "variable" in respect to these costs refers to the behaviour of the costs when output changes and has no relationship to changes in cost figures due to variation in wages, fuel and other factor costs per unit of factor. The major short-run variable costs for trucks are the amounts paid for repairs, maintenance, fuel and labor. Others may be partly variable, e.g., depreciation due to use.

Conceptually, a given truck may be considered as a fixed cost factor and the items - fuel, labor, repairs and maintenance as variable cost factors in a short-run schedule. Figure 2 represents a typical pattern of cost curves encountered in economic theory.

The average cost curve is determined by dividing total cost for a period by the number of miles driven; as is the case with total cost, it can be separated into two elements, average fixed cost (e.g., total fixed cost divided by mileage) and average variable cost (total variable cost divided by mileage). Since all cost items are, by definition, either fixed or variable costs, average cost is the sum of AFC and AVC. Marginal cost consists solely of variable cost; since total fixed cost remains the same regardless of the amount of use, any increase in cost associated with additional mileage is necessarily in variable cost.

It is suggested that this theoretical concept of average, variable and marginal cost does not typify trucks in reality but is rather, a special case.[4] The typical variable cost schedule for trucks in the short-run is

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[4] The "special case" referred to here will be discussed on page 37.

hypothesized to approximate a horizontal straight line. Since the average fixed cost schedule would remain basically the same, the slope and convexity of the average cost curve will tend to approximate it; the difference being a constant average variable cost.

This hypothesized pattern of cost curves for trucks in the short-run is presented in Figure 3.

The hypothesized schedule illustrated for average variable cost will depend on certain assumptions for this short-run cost behaviour:[5]

1. The truck investment represents a fixed cost in the period.
2. A certain minimum complement and quality of variable factor units are given for efficient operation of the truck.
3. Variable input factors are divisible into infinitesimally small units.
4. Technological conditions and factor input prices are given, including labor.
5. Successive variable factor input units are of equal efficiency.
6. A relatively constant rate of performance is achieved.[6]

Besides explaining the probable behaviour of farm truck costs, Figure 3 is the theoretical basis for the first hypothesis proposed in Chapter I. It was hypothesized that the average cost of grain assembly by farm truck in Manitoba is equal to the average reported custom rate of one-half cent per bushel-mile.

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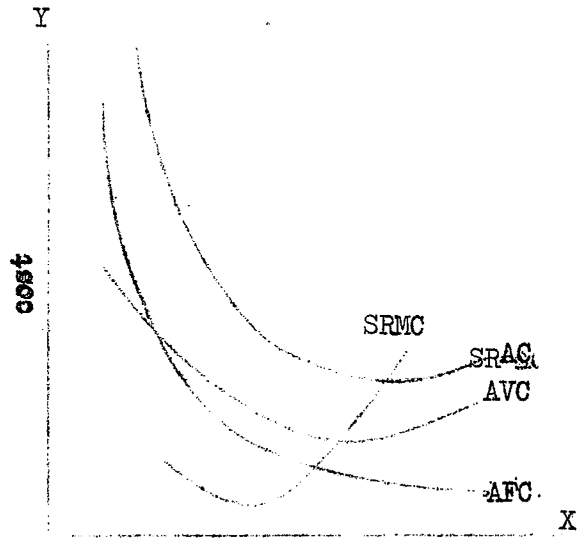
[5]These first five assumptions are commonly associated with short-run cost behaviour. They are taken from Due, op. cit., pp. 157 - 158. The sixth, however, is an addition.

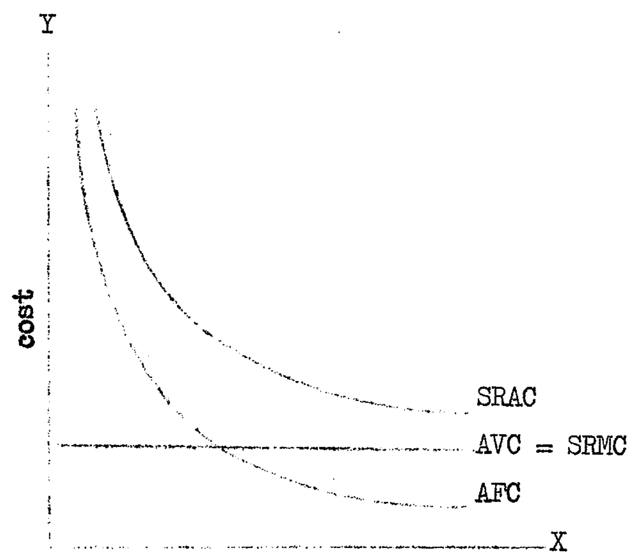
[6]This relates to the special case of variation in the rate dimension to be covered in a subsequent section of this chapter.



units of output

Figure 2

SHORT-RUN COST CURVES



number of miles of use

Figure 3

HYPOTHESIZED CONCEPT OF
ANNUAL TRUCKING COSTS

Because each custom truck may be expected to have a downward-sloping average cost schedule, there should be an intense desire among custom truckers to utilize their trucks as fully as possible. This tendency, combined with the fact that there is no legislative, special skill or deterrent financial barrier to entry into custom hauling, should theoretically keep rates down to the average cost level of operation. However, as is true of most industries with no barrier to entry, it is likely that there will be too many custom trucks in use for each to be fully utilized. Therefore their average cost level, while probably below that of most farm trucks since they are utilized more fully, would likely be greater than at optimal utilization. Custom truckers may also have some additional expense for travelling to the farm at which they will haul grain and higher license and insurance rates, so it is unlikely that the average cost level of their trucks will be significantly below that of farm trucks. Since competition should keep rates in line with average cost of custom trucks, the custom rate should theoretically not differ significantly from average cost of farm trucks.

THE TIME AND RATE DIMENSION

The difference between the typical pattern of cost curves encountered in economic theory and the hypothesized schedule for trucks may be attributed to variations in the rate and time dimension, respectively. French, Sammet and Bressler have demonstrated the necessity of important modifications to conventional marginalist economic theory in view of the distinction between the rate and time dimension for cost analysis.

The distinction between these two dimensions is illustrated in Figure 4.

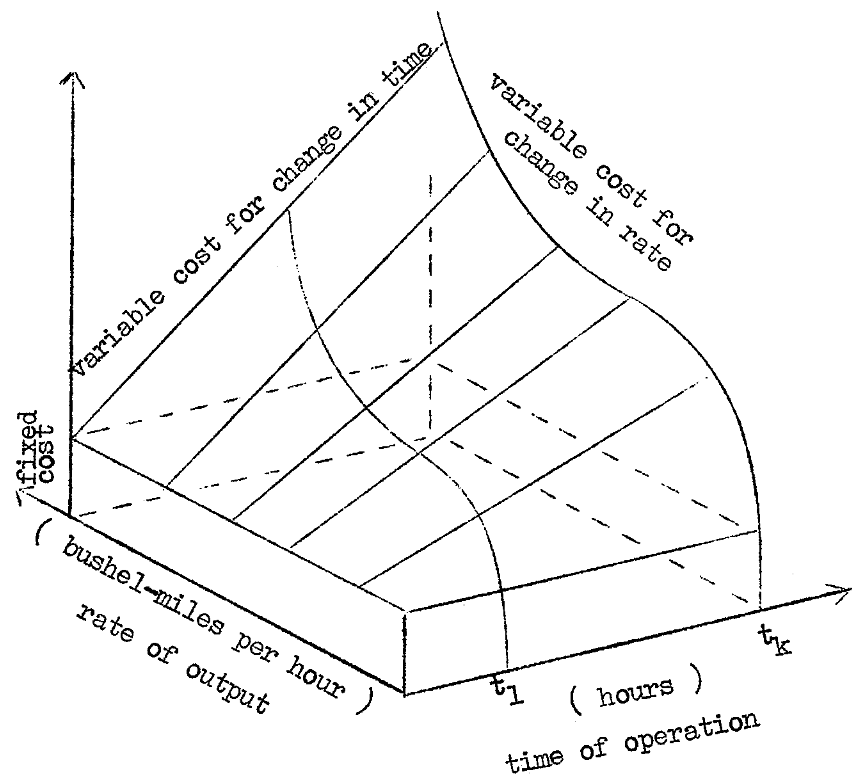


Figure 4

EFFECT OF CHANGE IN THE RATE AND TIME DIMENSION ON COST OF HAULING GRAIN BY TRUCK

Source: B. C. French et. al., "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears", Hilgardia, Vol. 24, No. 19, (Berkeley Ag. Exp. Stn., University of California, July, 1956), p.547.

If the rate of output per hour is held constant and total output varies as a function of time, _e.g._, hours worked or distance travelled, the uniform level of intensification in the rate of output can be expected to produce constant marginal cost and linear variable cost. Whereas if rate of output varies and time is held constant, the cost function is curvilinear as in conventional economic theory. French _et. al._ have identified a vague distinction between the rate and time dimensions as the source of much controversy and confusion concerning the nature of cost curves.[7] In addition, there is often inherent difficulty in separating these dimensions as significant variation in output may result from changes in rate of output as well as from changes in hours of operation. In the engineering data cited previously, the effect of rolling resistance on travel over earth roads was a significant factor affecting rate of output and cost of operation.[8]

Some economists, A. R. Ferguson for example, have achieved moderate success in quantifying the cost effect of the rate dimension.[9] In his algebraic derivation of a fuel equation for aircraft, he was able to determine quantitatively that the marginal real cost of fuel is linear in the case of changes in hours of operation, and curvilinear, "with cost

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[7] _Ibid._, p. 573.

[8] E. B. Riordan, _Spatial Competition and Division of Grain Receipts Between Country Elevators_, p. 44.

[9] A. R. Ferguson, "Multidimensional Marginal Cost Function", Econometrica. V18, 1950. Also see P. O. Roberts, _Fortran Program for Vehicle Simulation and Operating Cost_, M.I.T. Civil Engineering Dept., Available in IBM Systems Reference Library, File No. 1620/1710-20, Form C20-1603-3.

increasing as the square of weight, for changes in weight carried".[10] However, as he admitted in the publication, "the chief disadvantage of the method is the large amount of effort required to carry it out."[11]

It was not possible, within the scope of the present project, to define quantitatively the precise relationship of changes in the rate and time dimension to truck operating costs. Where there is engineering data available on these relationships, there may be merit in considering the implications of the rate dimension, but this task cannot be undertaken on the basis of data collected by sample survey. The task is further complicated by the fact that grain hauling is only one function, and may be a fairly minor one, of some trucks in use on farms.

THE EFFECT OF ADDITIONAL DISTANCE

Having hypothesized that variable costs are relatively constant per unit of output with minimal variation in the rate dimension, the concept is applied in Figure 5 to a model involving an elevator point surrounded by several grain producers.

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[10]Ferguson, op. cit., p. 233.

[11]Ibid.

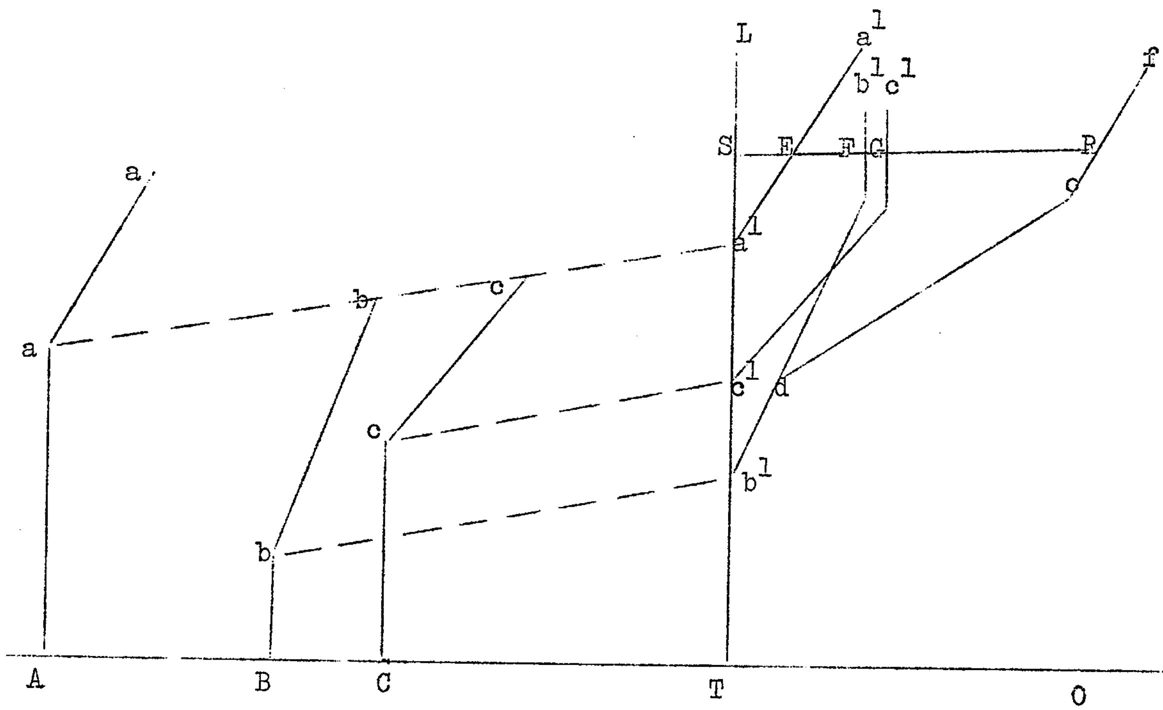

Figure 5

HYPOTHETICAL MODEL OF ADDITIONAL ASSEMBLY COST ASSOCIATED WITH ELEVATOR POINT DISLOCATION

Source: E. Esard, Location and Space Economy, (New York: Press of M.I.T. and J. Wiley and Sons Inc.), pp. 155-157.

Point T is the site of an elevator. Points, A, B and C represent producers located at AT, BT and CT, respectively, distances from T. Producer A has a supply curve for wheat "aa" equal to his marginal cost curve. Similarly "bb" and "cc" represent marginal cost curves for producers B and C. Cost is measured along vertical lines passing through A, B, C and T; Quantity is measured along ABCTO. Dash-dot transportation cost gradient lines are constructed to indicate transport cost. The quantities supplied by producers A, B and C are additive beginning at T as is the sum of their respective marginal costs. The supply curves at point T are now "a^1 a^1," "b^1 b^1" and "c^1 c^1". The aggregate supply curve is b^1deRf. Quantity supplied is SEFGR at price ST, as A,B and C furnish, respectively, SE, SF and SG quantities (SR = SE + SF + SG). With the aid of this diagram it is easily demonstrated how producers' costs shift upwards at an elevator point with increased distance of haul. The implications of a linear relationship between variable cost and distance are also evident. If CT represents additional distance resulting from rail line abandonment and the average slope of the transportation gradient line for producers is known, then the additional cost can be estimated for any elevator point dislocation.

The major task of this study is to estimate the slope or rate of increase in the transportation gradient line for increase in distance of delivery. This model is presented solely to demonstrate the importance of having a reliable estimate of additional cost and how it is relevant to rail line abandonment.

CHAPTER IV

METHOD OF EVALUATING FIXED COSTS

It may be recalled from the previous chapter that fixed costs can be divided into two categories: (1) those of a recurrent nature, involving simple accounting procedures, and (2) allocable fixed costs which are incurred at one point in time for the benefit of use during several time periods. The items in the first category, namely: license and insurance costs, are clearly necessary costs involved in ownership and require no explanation. It is proposed that they be simply taken as reported in the empirical analysis of this study. The items in the second category, however, deserve special consideration as some judgment is involved in their evaluation.

The present chapter is devoted to a critical evaluation of all items falling within the province of allocable fixed costs. The evaluation will be based on empirical findings in the study survey and other relevant information. Items to be evaluated include housing, repair costs, depreciation charges and interest on investment. Conclusions reached in this evaluation will be applied in a later comprehensive analysis of truck cost data obtained in the survey.

HOUSING COST

The survey taken in conjunction with this study indicated that only 16 out of 69 farm trucks taken in the sample were protected from the weather. The proportion compares closely with that found by Capstick in Arkansas. He reported: "Only 27 percent of the half-ton trucks and 19 percent of the $1\frac{1}{2}$ ton trucks were ever sheltered."[1] Because shelter was not a typical cost for the trucks studied, he did not include a cost for truck shelter in his analysis.

Other studies have generally included some arbitrary charge for this service. For example in Table I of Chapter II, Furniss used a figure of 0.5 percent of truck replacement value for housing cost in his computation.[2]

The fact, however, that most farmers interviewed did not house their trucks suggested that this practise is not necessary unless there are particular logical economic grounds for it. In further investigation of this matter no such grounds were established. On the contrary, a Kansas study has reported: "Most attempts to determine the value of sheltering farm machinery have not obtained conclusive evidence that it is profitable." [3]

Having found no evidence to support the thesis that housing for trucks is a necessary cost, it was decided that no charge should be incorporated into the analysis for this item.

REPAIR COST

Some difficulty was experienced in determining whether certain

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[1]Capstick, op. cit. p. 4.

[2]Furniss, op. cit., p. 6. This figure was also used by W. Kalbfleisch, and A. I. Magee, Cost of Operating Farm Machinery: Eastern Canada (Can. Agric. Pub. 750, August - 1953).

[3]L. M. Hoover, Farm Machinery - To Buy or Not to Buy, (Manhattan: Agricultural Experimental Station, Bulletin 379, Kansas State College, March 1956), p. 4.

repair costs belonged in the allocable fixed cost category. There is no doubt that most, if not all, repair costs are incurred through use rather than ownership. Yet it seems illogical to assign the entire cost of a major repair to the particular short-run period in which it was incurred when it obviously developed through several periods of use. Nor should this observation be strictly limited to major repairs; such items as batteries, tires, universals and even antifreeze, could be treated similarly.

There is apparent justification, at least in the case of individual trucks, in allocating these costs over some longer period of time than the particular year in which they are incurred. That is not to say, however, that they should be placed in the allocable fixed cost category. The problem arises only because of the periodic nature of these costs. Repair cost is incurred through use whereas fixed costs are associated with ownership. They have quite different connotations. For this reason, repair costs have been excluded from the fixed cost category and will be evaluated in the subsequent chapter on variable costs.

DEPRECIATION CHARGES

Depreciation represents the amount which would have to be paid into a fund each year to provide a cash reserve for replacement of the truck. A truck represents a fairly durable item which will provide useful service for several years but it will ultimately have to be replaced. The problem of allocating a proper charge for annual depreciation is complicated by the fact that many farmers trade in trucks which are still serviceable. Unquestionably, reliability is impaired with advancing age of a truck and therefore many farmers find it expedient to replace a truck long before it is completely worn out. Therefore, it is difficult to allocate depreciation charges without *a priori* knowledge of what farmers will do with their trucks in the future.

There have been several methods proposed for computing depreciation depending mainly on the rate at which an asset loses its value and also the relative ease of computation.

Hopkins and Heady have described five methods used in farm accounting. They are as follows:[4]

1. Annual Revaluation: The method here is to make an independent revaluation of the asset each year and from the differences between these valuations to find depreciation figures consistent with the market values of the asset.
2. Straight-Line Method: This involves dividing the total anticipated depreciation by the number of years the machine is expected to last to find the depreciation for each year.
3. Diminishing Balance Method: By this method, a percentage of the remaining value is deducted each year for depreciation.
4. Sum-of-Year Digits Method: By this method, the total amount W, that is to be distributed as depreciation, is first computed. Next, a depreciation rate base is determined by adding up the number of successive remaining life periods. If the asset is expected to last 10 years, the base is the sum of 10, 9, 8, 7 ......,1 = 55. Now, for the first year the depreciation is computed by taking 10/55 of the total; for the 10th year it amounts to 1/55 of the depreciation sum.

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[4] J. A. Hopkins, and E. O. Heady, Farm Records and Accounting, (Ames: The Iowa State University Press, 1961), pp. 72-77.

5. Compound Interest Method: This method assumes that the depreciation fund will be reinvested in the business and will grow there at compound interest. Consequently, the annual sums charged as depreciation are increased each year in accordance with the rate of interest adopted. The underlying assumption here is, in the opinion of Hopkins and Heady, "a very unreal assumption for a farm, where there is practically never a separate and identifiable fund for deprecia tion."[5]

Each of the above methods of computing depreciation has some shortcomings, the last one being probably the least practical. Obviously, the straight-line method is the simplest to compute but it results in depreciation charges which are too small in respect to actual market depreciation the first few years and which are too large in the last years. The remaining methods generally attempt to approximate the decline in market value over time. Hopkins and Heady have criticized the annual revaluation method on the grounds that "equipment is purchased to be used by the farm as long as it lasts, and no resale is intended."[6] This may be true for some types of equipment but not necessarily for trucks for reasons already discussed. In the view of the writer, annual revaluation represents the best method of calculating depreciation charges for farm trucks. The bases for this choice are as follows:

1. The change in market prices over a period represents the most realistic method, having definite empirical justification.
2. Interest on farm investment is usually calculated on the basis of interest paid for operating capital. The collateral value of a truck would be determined by its current market price so why not its inventory value?

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[5] Ibid., p. 78.

[6] Ibid., p. 72.

3. This method does not depend on the arbitrary assumption that a truck will be kept for some definite period of time in the future.

4. In this method, depreciation is not only related to the particular purchase price of the truck now owned, but also to current prices of both new and used trucks in the market. This is important from the point of view of replacement cost.

The major limitation of the annual revaluation method is its dependence upon sufficient price data. After a truck has reached a certain age in its life it becomes increasingly difficult to identify any change in the truck's market value with general market prices of trucks of the same vintage. The current state of repair may become more important in the valuation than the age, causing wide variations in comparative truck price data. It is even possible that a truck may increase in market value because of a major improvement in its condition. The dominant factor affecting market depreciation is obsolescence for the first few years of age but thereafter serviceability becomes more important. Therefore, it is suggested that average market prices are a good indication of a truck's value for the first few years but subsequently there is merit in using a formula method for approximating further loss in market value.

It is proposed that the annual revaluation method for calculating depreciation be used in the truck cost analysis of this study basis the time period, August 1, 1964 to July 31, 1965. Farmers interviewed in the survey were asked to state the years of purchase and prices paid for their trucks. This information is presented in Table VIII, and is stratified by size and age at time of purchase.

Considerable variation in prices was observed, mainly because of differences in time of purchase and also terms of sale, i.e., trade-in versus cash purchases. Many farmers were unable to remember the price paid for their trucks. This is understandable as some of these trucks were purchased up to 20 years prior to the survey. As indicated in the table, the two oldest trucks were purchased at 16 years of age and cost $250. There were no prices reported for trucks purchased between 8 and 15 years of age although several had been also purchased in this age-group.

The price data reported by producers were not considered adequate for computing average depreciation changes over the time period August 1 to July 31. It was therefore necessary to refer to other sources of information on truck prices. The best source for this computation was considered to be the Canadian Red Book commonly used by vehicle finance, insurance and used truck firms in evaluating used vehicles.[7] The prices in this publication are based on a large volume of retail sales data reviewed continuously throughout the year and so may be accepted as reliable. The only alteration made in this data (listed in Appendix C, Tables I - III) and the instructions for use of it was a percentage markup for Manitoba of 10 percent over Toronto price in lieu of the suggested 8 percent. This was done on the advice of a Winnipeg insurance firm actively using this data. The adjusted new prices were compared with local list prices of two truck dealers in Winnipeg and compared closely. The Red Book covers only one-half to one-ton trucks up to four years of age. Dealer list prices were used for larger trucks and discounted for depreciation charges at the same rate as for the one-ton trucks.

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[7] Canadian Red Book - Official Used Car Valuations (Toronto: National Automotive Publishers Ltd.). Reference Editions, August 1 - September 30, 1964 and 1965.

TABLE VIII

AVERAGE PRICES PAID BY PRODUCERS FOR TRUCKS STRATIFIED BY SIZE AND AGE AT TIME OF PURCHASE*

Age	Number observed[a]	½ Ton	1 Ton	Size 1½ Ton	2 Ton	3 Ton
(years)	(........................dollars........................)					
0	18	2,225	2,491	2,100[b]	3,650	4,000
1	3	1,800	2,400	—	2,700	—
2	7	—	1,771	—	—	—
3	4	—	—	1,325	—	—
4	2	—	1,200	1,800	—	—
5	2	—	—	—	1,400	1,350
6	3	—	1,217	—	—	—
7	1	—	1,300	—	—	—
8 - 15	0	—	—	—	—	—
16	2	—	—	250	—	250

*Source: Study survey. Not all trucks in the survey are included in this table since some producers could not remember prices paid for their trucks.

[a] The number observed refers to the number of trucks for which prices were reported. In each age bracket, the number includes all sizes of trucks for which average prices are shown.

[b] This figure appears to be in error as it is lower than the average price of new half-ton trucks. However, the 1½ ton trucks were generally purchased around 1950 when prices of all trucks were lower than they have been in more recent years.

It was thought that the larger trucks might depreciate faster but a review of used truck prices obtained from these dealers showed that this was not the case.

New list prices caused particular concern as it is commonly known that most truck buyers receive a substantial discount from list prices. Two new truck dealers approached on this subject stated that they would willingly reduce their asking prices by up to 20 percent below list in the case of "no-trade-in" purchases. However, the published retail prices for used trucks may also contain the same degree of artificial inflation equal to excessive valuation of the prospective buyer's trade-in. This is suggested by a difference of about 20 percent between Red Book Average Retail and Wholesale prices of reconditioned used trucks. It is likely that many used truck dealers would accept less than a 20 percent commission. A decision had to be made whether to use the new list and used retail prices or the new list less 20 percent and used wholesale prices. The first alternative was selected on the basis that these prices compared more closely with the prices reported by producers in the survey. It was also felt that although most producers probably receive some discount from list prices, they tend to buy some additional equipment for their trucks which would largely offset savings on the purchase price.

In Appendix C, Tables 1, 2 and 3, new suggested retail prices and used average retail selling prices have been taken from the Aug. 1 - Sept. 30, 1964 and Aug. 1 - Sept. 30, 1965 editions of the Red Book. These editions were chosen to coincide with the beginning and end of the crop year 1964 - 1965. The differences in prices for particular makes, models and sizes of trucks between these two editions are assumed to represent depreciation charges by the market revaluation method.

As stated previously, the published values cover trucks up to four years of age only. Since some trucks in the study were over 16 years of age, some alternative method of approximating market depreciation beyond 4 years had to be used. It was decided that producer reported prices, although admittedly sparse, would be used as a guide in the selection of a method.

Figure 6 depicts the relationship of reported producer prices for various ages of trucks expressed as a percent of new 1964 list prices. Changes in average Red Book prices between 1964 and 1965 for trucks up to four years of age are also plotted. For the sake of comparing various methods of computing depreciation, schedules for a 15 percent reducing balance, a 20 percent reducing balance, 16 year sum-of-digits and 10 year straight-line computations have been included in the figure.

It may be observed that many of the prices reported by producers are widely scattered about the published prices for trucks up to four years of age. The published prices for 1961 to 1964 trucks were accepted as more accurate as they are based on actual market prices during the particular time period of study. The problem was to determine the change in market values during the crop year 1964-1965 for trucks aged five to sixteen years since no published prices were available for trucks over four years of age. The reported prices by producers for trucks aged sixteen years old were accepted as fairly reliable as these trucks had been purchased within two years prior to the study and did not involve "trade-ins". Considerable variation in reported prices of trucks five to seven years of age is evident in the figure due to widely scattered dates of purchase. In estimating further drop in market price, the published price schedule was completed to sixteen years by application of a 15 percent reducing

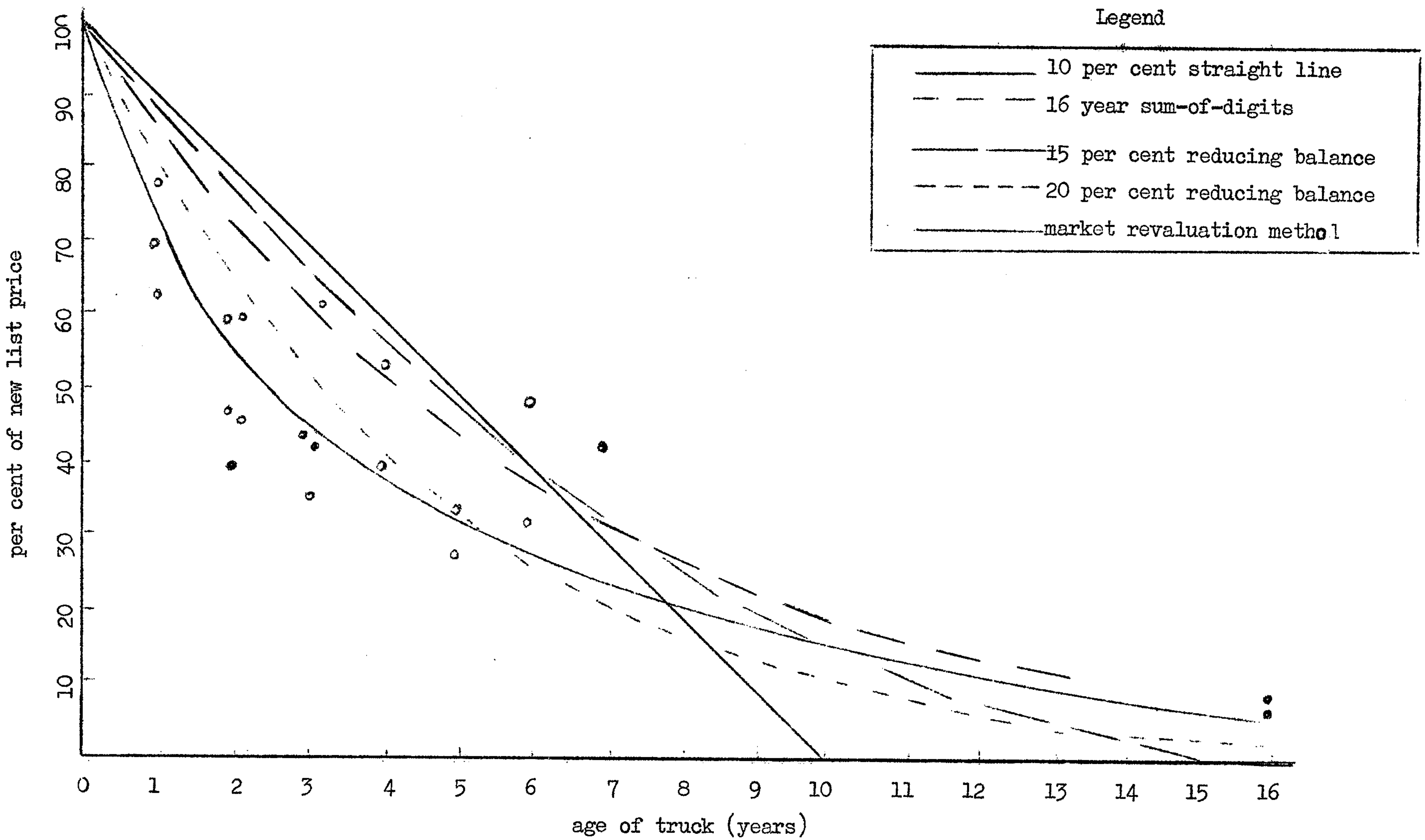

Figure 6

METHODS OF COMPUTING DEPRECIATION

balance formula basis the market price in the fourth year. As shown in Appendix C, Table IV, it may be observed that this schedule ended in close proximity to the last two reported prices which, as stated previously, were among the most reliable of the reported prices. The whole schedule may be computed fairly accurately by using the diminishing balance formula of 15 percent plus a correction factor $\frac{1}{x}(15\%)$ for $x \leq 3$, years with x representing the age of truck.

In comparison with the other methods depicted in the figure, the 20 percent reducing balance shows the fall in market values more accurately than the others but even it does not allow enough depreciation in the early years whereas it falls off too rapidly in the later years. The other methods show greater deviation from average market values. Computations for all methods demonstrated in the figure are shown in Table IX.

A brief recapitulation of the method followed may be beneficial at this point. Average market values of trucks, stratified by size, have been computed basis average Red Book prices for the first four years of age and thereafter by application of a 15 percent reducing balance up to the age of twenty years. Differences between the values corresponding to the beginning and end of the crop year 1964 - 1965 are the basis of depreciation charges used in the analysis of trucking costs in this thesis. The calculated values are shown in Appendix C, Table IV.

INTEREST ON INVESTMENT

There is usually an opportunity cost associated with commitment of farm capital in the purchase of a truck. The opportunity cost of money used for this purpose will vary among producers depending on the alternative uses they have for investment of this sum. One would have to make a comprehensive

TABLE IX

DEPRECIATED TRUCK VALUES BASED ON FIVE METHODS OF COMPUTATIONS *

Truck age	Market Revaluation Method Plus 15% Red. Bal.	16 Year Sum-of-digits	10% St. Line	15% Red. Bal.	20% Red. Bal.
(years)	(....................per cent of new list price...............)				
0	100	100	100	100	100
1	70	88	90	85	80
2	56	77	80	72	64
3	45	67	70	61	51
4	38	57	60	52	41
5	32	48	50	44	33
6	28	40	40	37	26
7	23	30	30	31	21
8	20	26	20	26	17
9	17	20	10	22	13
10	14	15	0	19	11
11	12	11	---	16	9
12	10	7	---	14	7
13	9	4	---	12	6
14	7	2	---	10	4
15	6	1	---	8	4
16	5	0	---	7	3

* Source: Hopkins and Heady, Loc. cit. and Red Book, op. cit. Methods are adapted as explained in the text.

study of each producer's farm operation, including assets, debts and the relative profitability of each individual enterprise, in order to obtain a valid estimate of the opportunity cost of money for that particular producer. A more practical approach would be to evaluate it in terms of the interest paid for operating capital. Thompson and Wenhardt have suggested that: "The best method for determining the proper rate to charge is the current rate at which farm working capital may be borrowed from the local bank."[8] The current bank interest rate of 6 percent on regular commercial loans for farm operating capital has been used in the present study.

This interest rate is charged on the average truck investment during the crop year 1964 - 1965. Since beginning and end year values were obtained previously for calculating depreciation charges, the interest charge computation is quite straightforward. In Appendix C, Tables V and VI, beginning and end year values have been averaged and interest rates computed basis these average values. The interest charges shown in these tables have been applied to trucks obtained in the survey.

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[8]Thompson and Wenhardt. Cost Charges for Agricultural Machinery: Western Canada, Can. Agric. Pub. 881, July 1954. p. 6.

CHAPTER V

VARIABLE TRUCKING COSTS

The present chapter describes the method followed in estimating variable trucking costs, excluding labor cost. The variable labor cost component in trucking grain will be deferred to a subsequent chapter. Since repair and maintenance costs of trucks are immeasurably more complex in behaviour than fuel and lubrication costs, they will take up the bulk of the discussion to follow. This chapter will also include an estimate of additional variable trucking cost which would be incurred if present annual levels of truck use should be increased. This would be the case for some trucks if certain grain delivery points are closed down because of rail-line abandonment.

FUEL COSTS

Prices paid for gasoline in the trucking cost survey ranged from 39 to 46 cents per gallon. The average is 42 cents. On the basis of these prices and reported total fuel costs for 1964-65, fuel consumption rates were calculated for all trucks in the survey. The average rate for each size-group of truck is: 1/2 - 3/4 ton, 13.2 miles per gallon; one ton, 12.2 miles per gallon; 1½ ton, 11.4 miles per gallon; 2 - 2½ ton, 9.8 miles per gallon and three ton, 10 miles per gallon. The 3 ton trucks were four years newer on the average than the next largest size category which may explain their slightly lower fuel consumption. The smallest trucks had higher fuel consumption than one would probably expect in comparison to larger sizes, presumably because they are often used for numerous short trips such as hauling fuel to the field whereas the larger trucks are generally utilized in longer hauls. Fuel costs per mile for the different sizes of trucks are; 3.3 cents, 3.4 cents, 3.8 cents, 4.4 cents and 4.8 cents per mile, respectively. The 3 ton trucks tended to use higher priced fuel, hence fuel costs were higher than the 2 - 2½ ton size category although their rate of fuel consumption was slightly lower.

The reported total fuel costs in 1964 - 65 and mileages of trucks in the crop year are used for calculating fuel cost per mile in grain hauling and also for additional grain hauling cost should distance of delivery be increased. It is recognized that these average figures are based on all uses of trucks while grain hauling may involve more heavy use than average with correspondingly higher fuel consumption. This is at least partly offset, however, as grain hauling is usually done on improved roads which is not the case with most on-farm use of trucks. Therefore the average figure for fuel cost per mile during the year should be reasonably accurate for evaluating the cost of grain hauling.

LUBRICATION COSTS

Many farmers in the survey did not report any lubrication costs for their trucks. Since they tend to purchase lubricants in bulk form for use in tractors, combines, automobiles and general farm equipment as well as trucks, it is understandable why they experienced difficulty in estimating the truck's share of lubricant cost. The average of reported costs for lubrication and filters is one-half cent per mile for all trucks. This figure has been used in all records where no cost estimate was reported for this item. As in the case of fuel cost it is assumed that lubrication cost per mile will be unaffected by increase in annual mileage in estimating additional cost for greater distance of delivery.

REPAIR AND MAINTENANCE COSTS

Repair costs are dissimilar to fuel and lubrication costs as they are usually incurred at sporadic intervals of time. This presents no difficulty in analyzing current repair costs of a number of trucks as the extreme fluctuations in the cost data should be evenly distributed within a random sample of trucks. The estimate of average cost for repairs derived from the sample may not be accurate for projecting additional cost associated with increased annual mileage unless it can be shown that there is a constant relationship between annual mileage and repair cost per mile. This was found to be difficult to test on the basis of the survey data because of the presence of other factors affecting the level of cost. The survey sample was too small to quantify the effect of each of these factors on repair cost. Therefore, the only analysis attempted was that of the two most important factors affecting the level of repair cost, the relationship of age and total mileage. This will be discussed shortly.

The first procedure in the evaluation of repair costs was to determine their average level for different sizes of trucks. Average costs of repairs, fuel and lubrication for each size-group of trucks in 1964-65 are shown in Tables X and XI. The $1\frac{1}{2}$ ton trucks have noticeably higher repair costs per mile than other sizes, although they are no older on the average. This may be explained by the fact that they were more overloaded than the other trucks. The $1\frac{1}{2}$ ton trucks carried an average of 196.8 bushels of grain per trip while the 3 ton trucks for example, with twice the rated load capacity, carried only 244.9 bushels. This constitutes still another possible important factor affecting repair costs which, however, was also impossible to quantify because of the small sample obtained. Size of trucks

TABLE X

AVERAGE VARIABLE TRUCK COSTS IN 1964-65
STRATIFIED BY SIZE OF TRUCK *

Size of truck	Number in survey	Ave. age	Ave. total mileage	Ave. 64-65 mileage	Ave. fuel cost	Ave. lub. cost	Ave. repair cost	Ave. total variable cost
(tons)		(years)	(000 miles)	(miles)	(........dollars			..............)
1/2-3/4	8	6	39	3,167	104	17	47	168
1	29	10	43	3,086	105	15	92	212
1½	11	10	40	1,391	53	12	137	202
2-2½	11	14	56	3,318	146	17	224	387
3	9	9	66	3,556	172	15	163	350

*Source: Study survey.

TABLE XI

AVERAGE VARIABLE TRUCK COSTS PER MILE IN
1964-65 STRATIFIED BY SIZE OF TRUCK *

Size of truck	Average Variable Cost Per Mile			
	Fuel	Lubrication	Repairs	Total
(tons)		(cents)		
1/2-3/4	3.30	.53	1.48	5.30
1	3.40	.49	2.97	6.86
1½	3.78	.90	9.84	14.52
2-2½	4.39	.50	6.77	11.66
3	4.82	.42	4.60	9.84

*From Table X.

did not appear to have any major effect on the level of repair costs in the study. However, this is again not conclusive, because of the limited sample size.

The effect of age and total mileage on the level of repair costs in 1964-65 was next analyzed. Study of the effect of total mileage was hampered, however, because 18 of the 68 trucks had broken speedometers or had unknown mileages when purchased. Therefore, farmers were unable to report the total mileages of these trucks.

The trucks were stratified by age from one to twenty years, respectively, and average repair costs were calculated for each stratum. These average values are shown in Table XII.

A regression line was fitted to the average repair cost data taking repair cost per mile in 1964-65 as a function of age. The fitted line is shown in Figure 7. The coefficient of determination for the independent variable (age) is .6412. This determination shows that 64 per cent of the variation in average repair costs is explained by age. However, total mileage was highly correlated with the age variable and it is difficult to evaluate the individual effects of these two factors on repair cost. Therefore, the increasing repair cost schedule shown in Figure 7 is determined by total accumulated mileage as well as age. In testing the strength of the relationship between age and total mileage of the 51 trucks in the sample with known mileage, a correlation coefficient value of .6293 was calculated. This indicates that 63 per cent of the variation in total mileage is associated with variation in age.

As stated previously, there was no particular problem in evaluating repair cost per mile for trucks in 1964-65 as the wide fluctuations in repair cost data should theoretically offset each other in a random sample.

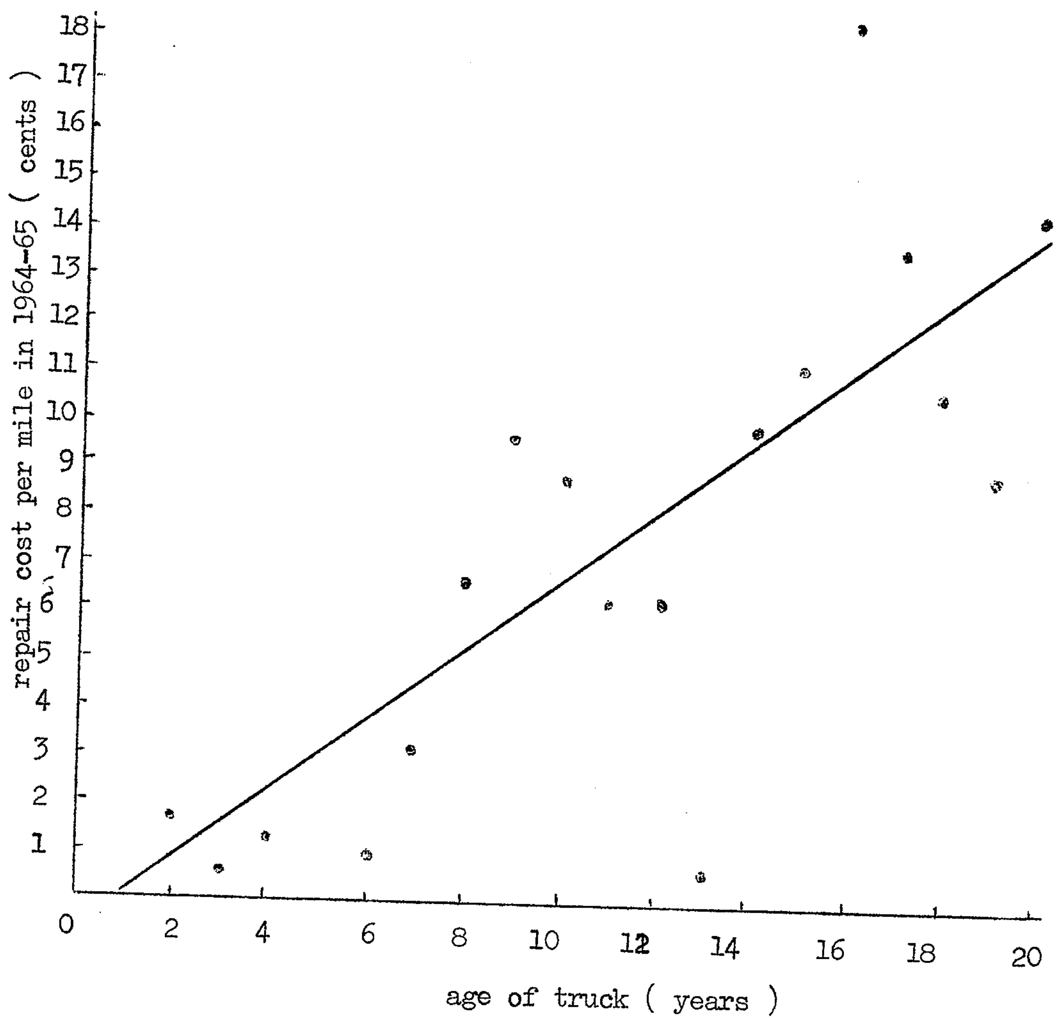

Figure 7

RELATIONSHIP OF AVERAGE REPAIR COSTS PER MILE AND AGES OF TRUCKS IN THE 1964-65 CROP YEAR

TABLE XII

AVERAGE REPAIR COSTS AND TOTAL MILEAGES OF TRUCKS STRATIFIED BY AGE*

Age of trucks	Number of trucks	Number with known mileage	Average total mileage	Average total repair cost	Average repair cost per mile
(years)			(miles)	(dollars)	(cents)
1	2	2	7,750	20.00	.15
2	1	1	11,000	50.00	1.67
3	2	2	14,750	13.50	.45
4	4	4	31,000	34.25	1.24
5	1	1	21,000	50.00	5.00
6	8	6	32,167	18.50	.91
7	2	2	40,500	50.50	3.09
8	4	3	31,100	238.50	6.58
9	3	2	73,000	186.67	9.69
10	2	2	64,500	252.00	8.80
11	5	4	62,250	129.60	6.25
12	3	3	46,333	157.00	6.22
13	4	3	59,667	31.25	.54
14	7	6	57,213	190.68	9.83
15	8	5	49,853	140.69	11.05
16	1	1	69,000	219.60	18.30
17	4	0	n.a.[a]	153.50	13.63
18	3	1	33,000	155.00	10.67
19	3	2	77,500	112.00	8.98
20	1	1	100,000	570.00	14.25
All	68	51	46,393	123.62	6.86

*Source: Study survey.

[a] Information on total mileage was not available.

It is necessary, however, to have some estimate of the functional relationship between repair cost and the number of miles driven in a year in order to project additional repair cost likely to result from driving an increased number of miles. This would be the case for extended distance of grain delivery.

Because the presence of these other factors affecting repair costs in the random sample of trucks caused wide fluctuations in the data, it was not possible to quantify the relationship of annual mileage and repair cost on the basis of the survey data. An alternative approach to estimating this relationship was to analyze the findings of other cost studies with respect to repair cost and mileage.

ESTIMATED ADDITIONAL REPAIR COST

The average age of the 68 trucks in the survey is 10.5 years. Average mileage is 46,271 miles. Since repair cost data from the survey was not suitable for evaluating the effect of annual mileage on the level of repair costs, cost data is taken from Capstick's study for similar trucks.[1]

In Figure 8, accumulated total repair costs are plotted on the Y axis and accumulated total mileage is plotted on the x axis for $1\frac{1}{2}$ ton trucks travelling distances of 2,000, 4,000, 6,000, 8,000, 10,000 and 12,000 miles per year. The dots in each schedule represent increasing years of age for use at these respective annual levels. All values are computed from Capstick's data.

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[1]D. F. Capstick. Cost of Owning and Operating Farm Trucks In Eastern Arkansas, Table 4.

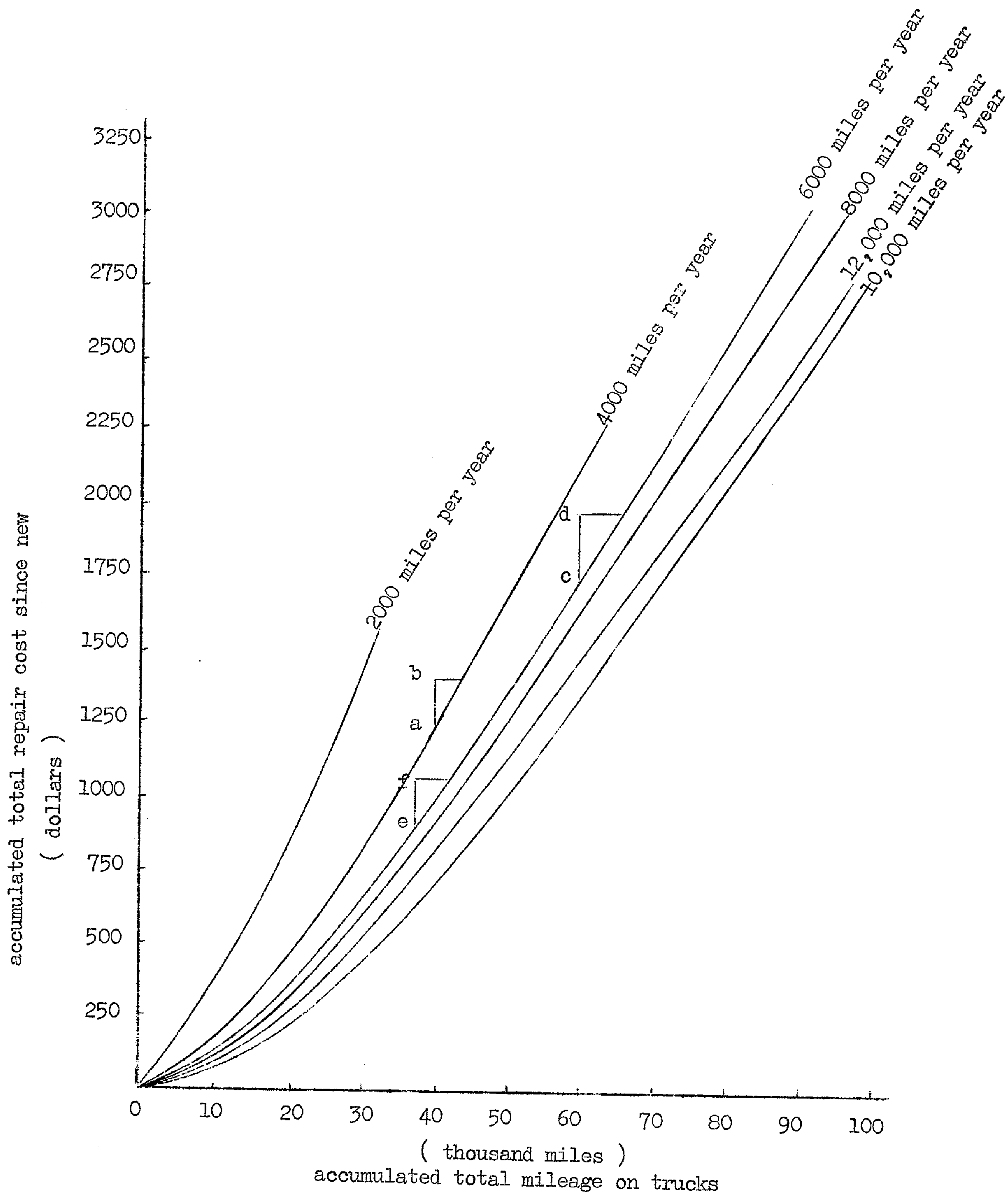

Figure 8

RELATIONSHIP OF ACCUMULATED TOTAL MILEAGE AND REPAIR COST FOR PARTICULAR LEVELS OF ANNUAL USE

Consider point a on the 4,000 mile schedule shown in the figure. This represents trucks with an average accumulated total mileage of 40,000 miles and ten years of age. They are similar in respect to total mileage and age to the trucks in the present study. If these trucks were to travel another 4,000 miles next year their expected repair cost would be equal to ab or $173.53 according to Capstick's figure.

The problem is to estimate the increase in repair cost if they were to travel a greater mileage, e.g., 6,000 miles next year. On the basis of this data it seems obvious that the expected repair cost for 6,000 miles of travel next year must be within the following two limits.

1. The maximum expected repair cost would be that of a truck travelling 6,000 miles and is the same approximate age as trucks in the present study, namely 10 years. The maximum limit is depicted by point c in the figure. The expected repair cost for this truck for 6,000 miles of travel is cd or $237.61.
2. The minimum expected repair cost is for that of a truck also travelling 6,000 miles per year and having an accumulated total mileage of 36,000 miles, slightly less than that of trucks in the present study, but which is only six years of age. Its position on the schedule is depicted by point e in the figure. The expected repair cost for this truck travelling an additional 6,000 miles next year would be ef or $203.71.

The expected repair costs of the three cases presented are shown in Table XIII. The last two cases are compared with the first case in order to evaluate the additional repair cost associated with increase in mileage from 4,000 to 6,000 miles per year. The two differences, namely 3.20 cents and 1.51 cents per mile represent the maximum-minimum limits of

TABLE XIII

DIFFERENCES IN REPAIR COST FOR INCREASE
IN MILEAGE FROM 4,000 TO 6,000 MILES PER YEAR*

Total Mileage	Age of truck	Increase in mileage	Increase in age	Additional repair cost	Repair cost per mile	Difference in repair cost total	Difference in repair cost per mile
(miles)	(years)	(miles)	(years)	(dollars)	(cents)	(dollars)	(cents)
40,000	10	4,000	1	$173.53	4.34	0	0
60,000	10	6,000	1	237.61	3.96	$64.08	3.20¢
36,000	6	6,000	1	203.71	3.40	30.18	1.51

* Source: Capstick, Table 4.

additional cost for the 50 per cent increase in annual mileage. Since it has been shown that age is highly correlated with cost it is likely that the case of a truck of the same age would be more similar in behaviour than that of a much newer truck. Therefore, it is probable that expected repair costs of trucks in the survey should tend to increase at the higher rate of approximately 75 per cent of present average repair costs if annual mileage is increased by 50 per cent. It is unlikely, however, that these trucks would increase their annual mileage by as much as 50 per cent because of rail-line abandonment since present mileage incurred in grain hauling comprises only about 10 per cent of their annual mileage. Consequently, all that can be inferred here is that repair cost per mile may drop to 75 per cent for a 50 per cent increase in annual mileage but for any increase less than 50 per cent, repair cost per mile should be affected to a lesser extent. Another consideration that was mentioned previously is that grain hauling may involve more intensive use than average. The average cost per mile figure therefore may slightly undervalue the cost of repairs in grain hauling.

It is therefore proposed that the average repair cost per mile figure be taken as the rate for additional repair cost if annual mileage is increased. This procedure will be followed in estimating additional total assembly cost for increased distance of haul in Chapter VII.

CHAPTER VI

LABOR COST IN ASSEMBLING GRAIN

The objective of the present chapter is to estimate the average amount and cost of labor required for assembly of grain by farm truck during the crop year 1964-1965. This requires an analysis of average wages paid during this period, the distribution of grain deliveries during that crop year, and actual time involved in grain assembly. The cost estimates computed in this chapter will be incorporated in the comprehensive analysis of grain hauling costs to be covered in Chapter VII.

THE COST OF FARM LABOR

It is commonly known that on most Manitoba farms, the farm operator and members of his family provide most of the labor required for grain hauling. Hired labor is utilized to a lesser extent. Although hired labor represents a minor part of the total supply of labor used in grain hauling, the cost of all labor might be valued in terms of hired labor as the farm family should theoretically earn the same wage level if employed elsewhere in farm labor.

In the analysis to follow, it is assumed that an average of wages paid within the crop year, together with a figure for average productive farm labor output per man equivalent, will provide a realistic measure of the cost of labor used in trucking grain to the elevator.

The most satisfactory estimate of average farm wages during the 1964-1965 crop year appears to be that by Johnson in a farm organization study undertaken after harvest in 1964.[1] Although this study relates to only one part of the province, it borders on much of the survey area for the present study and is broad enough to be fairly representative of the province. Johnson selected 93 farms at random from an area in the south-west part of the province and divided them into types and size groups as follows:[2]

1. Grain-livestock farms;
   - (a) 26 small farms (240-401 total acres)
   - (b) 26 medium farms (402-561 total acres)
   - (c) 22 large farms (562-1,120 total acres)
2. Cash-grain farms;
   - (a) Eight small farms (240-401 total acres)
   - (b) 11 large farms (402-874 total acres)

Average wages paid by each type and size group are shown in Table XIV.

Considerable variation in average wages paid by the different categories is evident. The smaller grain-livestock farms and grain farms tended to pay higher wages than the others, presumably because they generally hired temporary hired help periodically during the year. The larger grain - livestock farms were frequently able to employ help on a more regular basis hence they were not compelled to pay as high a wage per month as for temporary hired help. It was also felt that wage rates may vary according to the season of the year. Thus if farms employed temporary help at busy times of the year they would likely have to pay a higher wage than during a relatively slack period. Johnson has also investigated the seasonal distribution of hired labor in his study. His findings for the different farm categories are shown in Table XV.

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[1]L. M. Johnson, Changes in Farm Organization: Sumerset-Manitou Area, Manitoba, 1964, (Winnipeg: Canada Dept. of Agriculture, Economics Division).

[2]Ibid, Cash grain farms were defined as having two-thirds or more of their income derived from grain sales. Grain-Livestock farms are those with less than two-thirds of their income derived from grain sales.

TABLE XIV

AVERAGE WAGES PAID FOR HIRED LABOR BY FIVE CATEGORIES OF SOUTH-WESTERN MANITOBA FARMS DURING THE PERIOD AFTER HARVEST 1963 TO AFTER HARVEST 1964*

Category of farm	Time employed	Payment reported[a]	Monthly wage[b]
	(months)	(dollars)	(dollars)
Grain-livestock:			
Small	0.40	76	190
Medium	0.86	152	177
Large	1.04	190	183
Cash-grain:			
Small	0.27	80	296
Large	1.19	289	243

*Source: Johnson, Ibid., Tables 11A, 11B, 11C, 11D and 11E.

[a]Includes the value of board estimated at 40 dollars per month.

[b]Monthly wage is computed by dividing payment reported by time employed.

TABLE XV

SEASONAL DISTRIBUTION OF HIRED LABOR ON FIVE CATEGORIES OF FARMS IN SOUTH-WESTERN MANITOBA*

Category of farm	Average Time Of Employment Of Hired Labor During				
	Spring	Summer	Fall	Winter	Total Year
		(months)			
Grain-livestock:					
Small	0.05	0.08	0.16	0.11	0.40
Medium	0.15	0.24	0.41	0.06	0.86
Large	0.24	0.25	0.32	0.23	1.04
Cash-Grain					
Small	0.06	0.15	0.06	0	0.27
Large	0.27	0.24	0.68	0	1.19

*Source: Johnson, loc. cit.

The distribution of hired labor is somewhat unbalanced throughout the year in the case of cash-grain farms and medium-sized grain-livestock farms. The cash-grain farms did not hire any labor during the winter period. Small and large-sized grain-livestock farms had a relatively evenly balanced distribution of hired labor.

The discussion thus far respecting differences in wages paid by cash-grain farms versus grain-livestock farms and small farms versus large farms would appear to justify the stratification of records taken in the present trucking cost survey into similar farm categories for the purpose of imputing a weighted cost estimate for labor. An average labor cost estimate, weighted in terms of the number of farms in each category, would take into account the obvious differences in wages paid between categories. Since the proposed use of the labor cost estimate was for evaluation of grain hauling costs, only those farms with trucks were selected. It may be recalled that 66 farms out of the total of 89 farms surveyed, owned trucks. The former were stratified according to Johnson's criteria:[3]

1. Grain-livestock farms
   - (a) 25 small farms (240-401 total acres)
   - (b) 7 medium farms (402-561 total acres)
   - (c) 13 large farms (Over 562 total acres)
2. Cash-grain farms
   - (a) 11 small farms (240-401 total acres)
   - (b) 10 medium-large farms (Over 402 total acres)

A weighted average of hired labor cost for these farms was computed from the wage data given in Johnson's study. This was accomplished by multiplying the average reported wage figure for each category of Johnson's data

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[3]This stratification is only approximate as no actual figures on farm income were available. Farm income from the crop versus the livestock enterprise has been estimated by comparing quantity sold and using an average value for sale of crop and livestock. A few large farms exceeded the upper acreage limits of the Johnson sample.

by the frequency proportion of similar categories occuring in the present study. As stated previously, only those farms having trucks were stratified on this basis. The remaining 33 farms in the study relied on custom trucking for hauling grain to the elevator and therefore no labor cost estimate for grain hauling was necessary for these farms. Computations for the weighted average of hired labor cost are shown in Table XVI.

TABLE XVI

COMPUTATIONS OF A WEIGHTED ESTIMATE OF HIRED LABOR COST FOR FARMS PER HOUR*

Category of farm	Monthly wage[a]	Hourly wage[b]	Frequency of category	(Hourly wage in category) X (Frequency of category)
	(dollars)	(dollars)		(dollars)
Grain-livestock:				
Small	190	.97	.379	.368
Medium	177	.91	.106	.096
Large	183	.94	.197	.185
Cash-grain:				
Small	296	1.52	.167	.254
Large	243	1.25	.152	.190
Total				1.093

*Source: Johnson, *Loc. cit.*,

[a]From Table XIV

[b]The hourly wage is computed by dividing the monthly wage by 195.

In Table XVI, the computed estimate of hired labor cost is approximately $1.09 per hour. The only new information involved in making the estimate is the assumption of an average productive work week per man equivalent of forty-five hours for all farms. This figure is derived from a study by MacKenzie and Brown[4] which determined that a man-equivalent works an average of 45 hours per week on the farm over an entire year. This level of labor output has been assumed as grain deliveries are also relatively spread out during the entire year as shown in Table XVII.

Only 42 records could be used in computing the delivery pattern as some farmers could not remember what quantities of grain were delivered in each period. The pattern of deliveries from the 42 farms is relatively evenly distributed throughout the crop year. Lightest deliveries were generally made direct from the combine during August 1 to September 31, and the heaviest deliveries were made during January 1 to March 31. Since there is no extreme concentration of deliveries in any one period of the year, the assumption of an average level of labor output of 45 hours per week seems reasonably well founded.

ESTIMATING LABOR COST IN GRAIN ASSEMBLY

Having valued labor at approximately two cents per minute, the next procedure involved estimating the time required for loading, unloading and driving when making a delivery to the elevator.

Farmers were asked in the questionnaire to report the average time taken to complete a round trip to the elevator, including loading and unloading time. They also reported the distance and type of road surface to

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[4]J. G. MacKenzie and J. C. Brown, How Labor Is Used On Red River Valley Farms, (Winnipeg: Canada Department of Agriculture, Economics Division, Pub. 923, 1955, Queen's Printer), p. 55.

TABLE XVII

DELIVERY PATTERN OF GRAIN DURING THE 1964-65 CROP YEAR, STRATIFIED BY SIZE OF TRUCK USED IN MAKING DELIVERY*

Size of truck	Number of trucks	Delivery Periods								Total bushels
		Aug.1-Sept.31		Oct.1-Dec.31		Jan.1-Mar.31		Apr.1-July 31		
(tons)		(bus.)	(%)	(bus.)	(%)	(bus.)	(%)	(bus.)	(%)	(bus.)
½	5	1,050	8.7	3650	30.3	5750	47.7	1590	13.2	12040
1	16	9355	13.1	22150	31.2	20425	28.7	19001	26.7	70931
1½	8	1760	11.1	4400	27.9	6830	43.3	2770	17.5	15760
2-2½	8	10646	27.1	10550	26.8	14634	37.2	3415	8.7	39245
3	5	4535	16.2	5400	19.3	5650	20.2	12300	44.1	27885
All	42	27346	15.2	46150	27.1	53289	35.5	39076	22.1	165861

* Source: Study survey.

delivery points used. Average distances and assembly times at five elevator points are shown in Table XVIII.

The range in distance to delivery point for 65 trucks was from one to twenty-one miles. Round trip time varied from 25 minutes to 180 minutes. It was necessary to omit three of the 68 trucks in the survey because information on distance and round trip time was not complete for these trucks. There was no noticeable difference between estimates of delivery time for different sizes of trucks and for varying road conditions. Since neither of these factors appeared to affect the estimates given, it was decided that the data for custom trucks could be included with the data for the 65 trucks to provide more estimates for special study of the relationship between time and distance. A total of eighty estimates of these factors was thus obtained. The relationship between time and distance was approximately linear. A linear regression line was fitted to the data according to the formula :

$Y = a + bx$ where

$Y =$ round trip time in minutes

$a =$ constant value for loading and unloading time

$b =$ rate of increase in on-road time for increase in delivery distance and

$x =$ the distance to the delivery point in miles.

The fitted regression line and data are shown in Figure 9.[5] The constant value is 22.6 minutes for loading and unloading time. The b value or slope is 7.6460, indicating that if distance to delivery

[5] The regression line was a relatively good fit to the data. The R^2 value is .7772. The b value for the independent variable tests significantly at or below the 2 per cent level. This R^2 value indicates that 78 per cent of the variation in round trip time is explained by variation in distance of haul.

TABLE XVIII

RELATIONSHIP OF ROUND TRIP TIME AND DISTANCE TO DELIVERY POINT AT FIVE ELEVATOR POINTS.*

Elevator point	Number of trucks	Trucks using route with proportion paved of:[a]				Average distance	Average time	Average size of truck
		0-25%	25-50%	50-75%	75-100%	(miles)	(minutes)	(tons)
A	5	5	0	0	0	3.9	52.0	1.8
B	4	4	0	0	0	7.8	77.5	1.4
C	19	9	2	1	7	7.4	61.6	1.3
D	18	14	0	2	2	5.1	68.3	2.0
E	19	6	3	6	4	11.5	118.4	1.3
All	65	38	5	9	13	7.7	80.3	1.5

* Source; Study survey.

[a]This refers to the proportion of the road paved to the elevator point. The remainder was usually gravel.

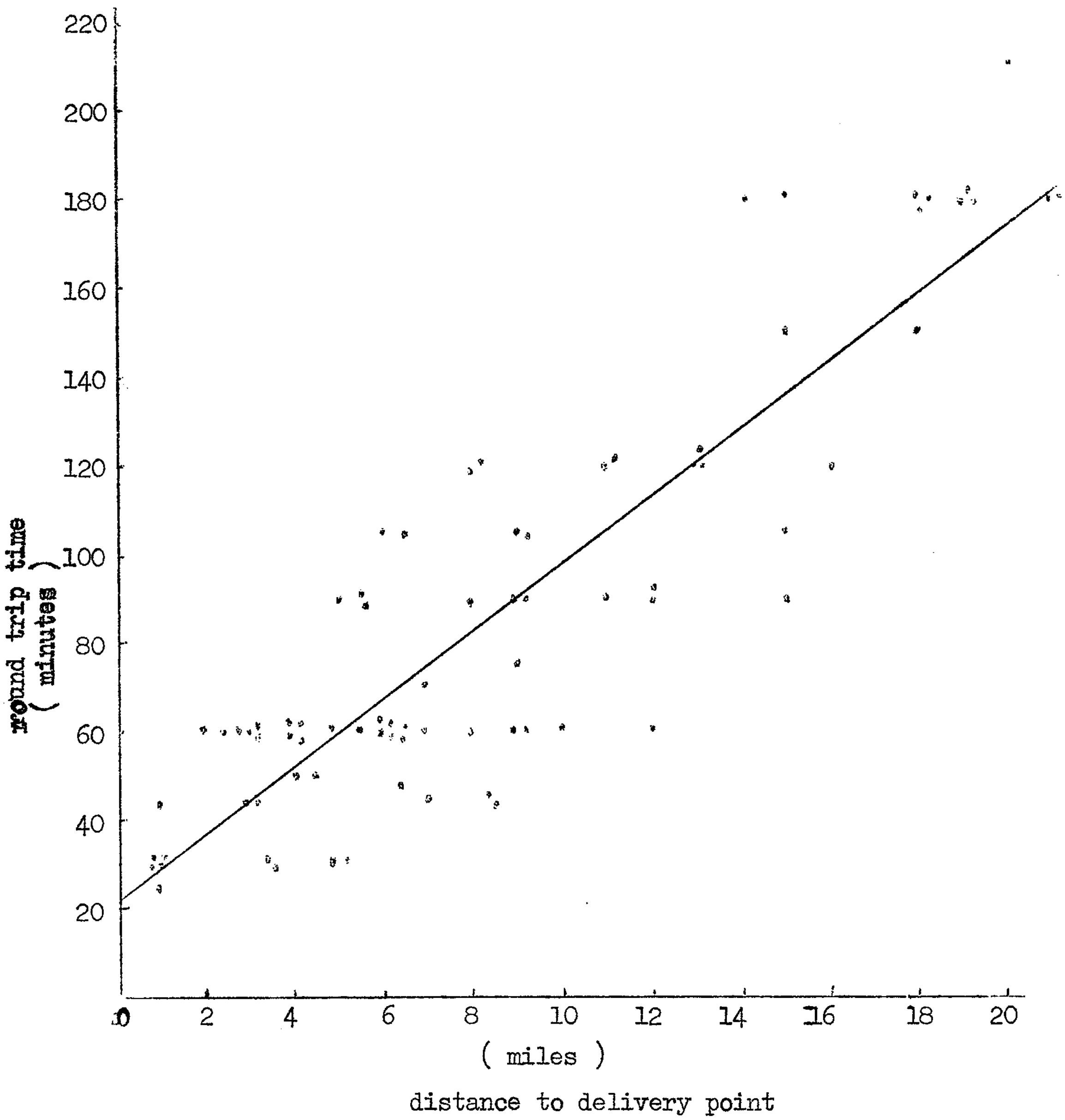

Figure 9

RELATIONSHIP OF ROUND TRIP TIME IN GRAIN DELIVERY

AND DISTANCE TO THE DELIVERY POINT

point increases by one mile, the additional on road time would be about 7.6 minutes. Of course this would really represent an increase of two miles in total distance, including one extra mile coming back from the elevator point. Average speed for all trucks both going to and coming back from the delivery point is 16 miles per hour. Average distance from farm to delivery point for the 80 estimates is 8.6 miles and average round trip time is 88.3 minutes. This compares closely with the averages for the 65 farm trucks shown in Table XVIII.

Now imputing the labor cost estimate of two cents per minute, labor cost of loading and unloading a truck load of grain is 45.2 cents. The cost for additional driving time if distance to point is increased by one mile, is 15.2 cents, i.e., 7.6 minutes at 2 cents per minute. This includes coming back one mile from the elevator. Average labor cost per mile of distance to delivery point is 7.6 cents for all trucks.

The estimates for hauling time and labor cost derived in this chapter will be incorporated in a comprehensive estimate of all costs involved in hauling grain. This will be the task of the next chapter.

CHAPTER VII

EMPIRICAL ANALYSIS OF GRAIN HAULING COST

Three previous chapters have outlined methods of evaluating fixed and variable truck expense and labor cost in grain assembly during the crop year 1964-65. In the present chapter, these methods are applied in a comprehensive estimate of all costs incurred in grain assembly. Following this estimate, the next task is to determine the probable increase in cost per bushel-mile should distance of delivery be extended for trucks in the study.

AVERAGE TRUCKING COSTS IN 1964-65

Computed average expenses for the 68 trucks in the 1964-65 survey are shown in Tables XIX and XX. Depreciation and interest costs have been estimated from values calculated in Appendix C. The remaining costs were obtained from the survey. The one and one-half ton trucks have the highest average total cost per mile of all sizes. Fixed cost per mile is high for this group because of the small number of miles driven and repair costs are also much higher than average. It seems obvious that fixed cost per mile would be considerably reduced for all trucks if they were utilized more fully, since average mileage in 1964-65 is only 2,924 miles.

MILEAGE INCURRED IN GRAIN DELIVERY

It is necessary to determine the mileage incurred by trucks in delivering grain to the elevator throughout the year before the cost of this task can be estimated. The principal factors determining mileage are the total number of bushels hauled during the year, average box

TABLE XIX

AVERAGE TOTAL ANNUAL COSTS OF TRUCK OPERATION

Size of Trucks	Number of Trucks	Average Fixed Cost Dep.	Int.	Lic.	Ins.	Total	Average Variable Costs Fuel	Lub.	Repairs	Total	Total Cost
(tons)		(dollars									)
1/2-3/4	8	206	54	15	15	290	104	17	47	168	458
1	29	95	35	22	17	169	105	15	92	212	381
1½	11	86	35	26	23	170	53	12	137	202	372
2-2½	11	70	26	40	23	159	146	17	224	387	546
3	9	270	67	47	18	402	172	15	163	350	752
All	68	127	40	28	19	214	112	15	124	251	465

*1964-65 Study survey.

TABLE XX

AVERAGE FIXED AND VARIABLE COSTS PER MILE OF TRUCK OPERATION

Size of Trucks	Avge. Age of Trucks	Avge. Mileage 1964-65	Avge. Var.Cost Per Mile	Avge. Fixed Cost Per Mile	Avge. Total Cost Per Mile
(tons)	(years)	(miles)	(cents		)
1/2-3/4	6	3167	5.30	9.16	14.46
1	10	3086	6.86	5.49	12.35
1½	10	1391	14.52	12.23	26.75
2-2½	14	3318	11.66	4.72	16.38
3	9	3556	9.84	11.25	21.09
All	10.5	2924	8.58	7.32	15.90

*From Table XIX.

capacity in bushels and distance to the delivery point. There are in addition two other practical factors affecting mileage which must be considered. These are: the need for segregating different types and grades of grain, and the pattern of delivery of these different grains over the crop year. The latter is largely determined by delivery quota restrictions of the Canadian Wheat Board.

To illustrate the nature of the first problem, assume that a given truck has a load capacity of 200 bushels and the farmer has 100 bushels of wheat, 50 bushels of rye and 50 bushels of oats to deliver. It would be false to assume that this grain could all be delivered in one trip. This is clearly impractical as separate truck box partitions would be required for segregating the different grain each time such circumstances evolved. On the other hand, the elevator facilities would not permit handling of different grains from a single load. Therefore, the truck would have to make three separate trips to the elevator, carrying a different type of grain each time. The same case could apply to different grades of one kind of grain.

Associated with the problem of segregating different grains are certain restrictions on time of delivery. The Canadian Wheat Board is a compulsory marketing agency for wheat, oats and barley. This Board has been given authority, in carrying out its function, to regulate the movement of all western grain from farms to elevators through quota allocations. Control is exercised over both volume and time of delivery of different types and grades of grain. Since farmers are usually anxious to sell their grain as soon as delivery restrictions permit them to do so, they may at times deliver partial loads in order to fill their quotas. Consequently, these delivery restrictions could add substantially to the number of trips required in delivering a year's crop.

In order to account for the effect of these factors on mileage, the approximate delivery pattern of different grains during 1964-65 was determined from the questionnaire for each truck. Divisions in the delivery pattern are: August 1st - September 30th, when most grain was hauled direct from the combine, October 1st - December 31st, January 1st - March 31st and April 1st - July 31st. The number of trips made within each of these time periods has been estimated basis the quantities of different grains delivered therein and the respective load capacity of each truck.

Estimated total mileages for grain delivery and the number of required trips for each size-group of trucks are shown in Table XXI. The average values computed for distance and capacity in Table XXI are simple averages of each truck size group. Additional mileage incurred for delivery of different types of grain and because of delivery restrictions, is about 3 per cent on the average. The effect of different grades has not been considered; however, it is doubtful if this would have made a significant difference to the estimates.

There are also other possible factors which may affect the number of trips, for example, rejected deliveries on account of dampness, etc., which may also be attributed to the cost of grain hauling. It does not seem possible however, to differentiate between bad management and unavoidable circumstances in evaluating such cases. In any event, this occurrence would probably be a very minor factor.

TABLE XXI

ESTIMATED NUMBER OF DELIVERIES AND MILEAGE INCURRED BY TRUCKS IN HAULING GRAIN DURING THE 1964-65 CROP YEAR*

Size of Trucks (tons)	No. of Trucks	Avge. Cap. of Trucks (bus.)	Avge. Distance of Haul (miles)	Total Grain Delivered (bus.)	Total Bu. Miles	Min. Possible Trips	Min. Possible Miles	Est. No. Trips	Est. No. Mi.	Ratio Est./Min.
1/2 -3/4	8	76	8	12550	90170	178	2426	185	2508	1.04
1	29	123	7	120760	694669	1105	12950	1128	13240	1.02
1½	11	197	10	29850	250370	165	2668	174	2786	1.05
2-2½	11	218	7	51240	348145	239	3183	250	3348	1.05
3	9	258	6	47465	249995	196	2144	200	2204	1.02
All	68	163	8	261865	1633349	1883	23371	1937	24086	1.03

*Source: Study survey.

ESTIMATED COST OF GRAIN ASSEMBLY

Having determined the number of trips and mileage incurred by each truck in hauling grain during 1964-65, it is now possible to estimate the cost of performing this task from information analyzed previously. Total cost of grain assembly is calculated by multiplying the mileage incurred by each truck in grain hauling by its respective cost per mile and then adding labor costs. Labor costs were estimated in Chapter VI to be 45.2 cents per trip for loading and unloading plus 7.6 cents per mile for driving. Average assembly costs computed by this method are shown in Tables XXII and XXIII. The weighted average of grain assembly cost for all trucks is .4713 cents per bushel-mile. This figure compares very closely with the reported average custom rate for grain hauling discussed in Chapter II. Average mileage incurred in grain hauling was 355 Miles in the crop year 1964-65. This is 12.14 per cent of average total mileage driven in that period.

TABLE XXII

TOTAL COSTS OF GRAIN ASSEMBLY IN 1964-65

Size of Truck	Number of Trips	Mileage Hauling Grain	Variable Truck Expenses	Fixed Truck Expenses	Loading-Unloading Cost	Cost of Labor	Total Assembly Cost
(tons)		(miles)	(........	....	dollars	....	........)
1/2-3/4	185	2508	150	292	84	192	717
1	1603	13252	1386	653	537	1013	3589
1½	174	2786	779	368	79	213	1439
2-2½	250	3377	429	239	113	258	1039
3	200	2204	323	333	90	169	915
All	2412	24127	3066	1883	903	1845	7698
Ave.	35	355	45	28	13	27	113

TABLE XXIII

AVERAGE ASSEMBLY COST PER BUSHEL-MILE

Size of Truck	Average Bushel Miles	Variable Tr. Expense Per Bu.Mile	Fixed Tr.Expense Per Bu.Mi.	Loading-Unloading Cost Per Bu. Mi.	Labor Cost Per Bu. Mi.	Total Cost Per Bu. Mi.
(tons)		(		cents		)
1/2-3/4	11271	.1660	.3236	.0927	.2127	.7951
1	23954	.1994	.0938	.1043	.1459	.5167
1½	22761	.3110	.1471	.0314	.0851	.5747
2-2½	31650	.1232	.0685	.0325	.0742	.2984
3	27777	.1291	.1331	.0362	.0674	.3658
All	24020	.1876	.1153	.0553	.1129	.4713

In Figure 10, components of grain assembly cost per bushel-mile are shown as percentages of average total assembly cost. Fixed and variable truck expenses represent 24.78 per cent and 39.83 per cent, respectively, of grain assembly costs. Labor comprises 35.39 per cent of this cost on the average, basis an estimated price of approximately $1.20 per hour.

The additional cost for hauling grain an increased distance to the elevator may be determined for all trucks by simply omitting all fixed cost components from the estimate, including loading and unloading cost per bushel-mile. Estimated average additional hauling cost for the trucks in the survey is .3007 cents per bushel-mile. It is expected that this rate should be relatively constant for increased distance of haul provided that the resultant change in annual mileage is fairly minor, e.g., less than 50 per cent. This does not mean that costs, in practise, would not vary considerably about this estimated value, but that the average cost per bushel-mile should approximate the same level for increased distance of haul.

This chapter concludes the discussion on methodology followed and report of empirical findings in the survey, which began in Chapter IV. A weighted average of assembly cost per bushel-mile and additional cost for increase in distance of haul has been estimated. All cost data are now compiled in suitable form for evaluating the hypotheses set out in Chapter I.

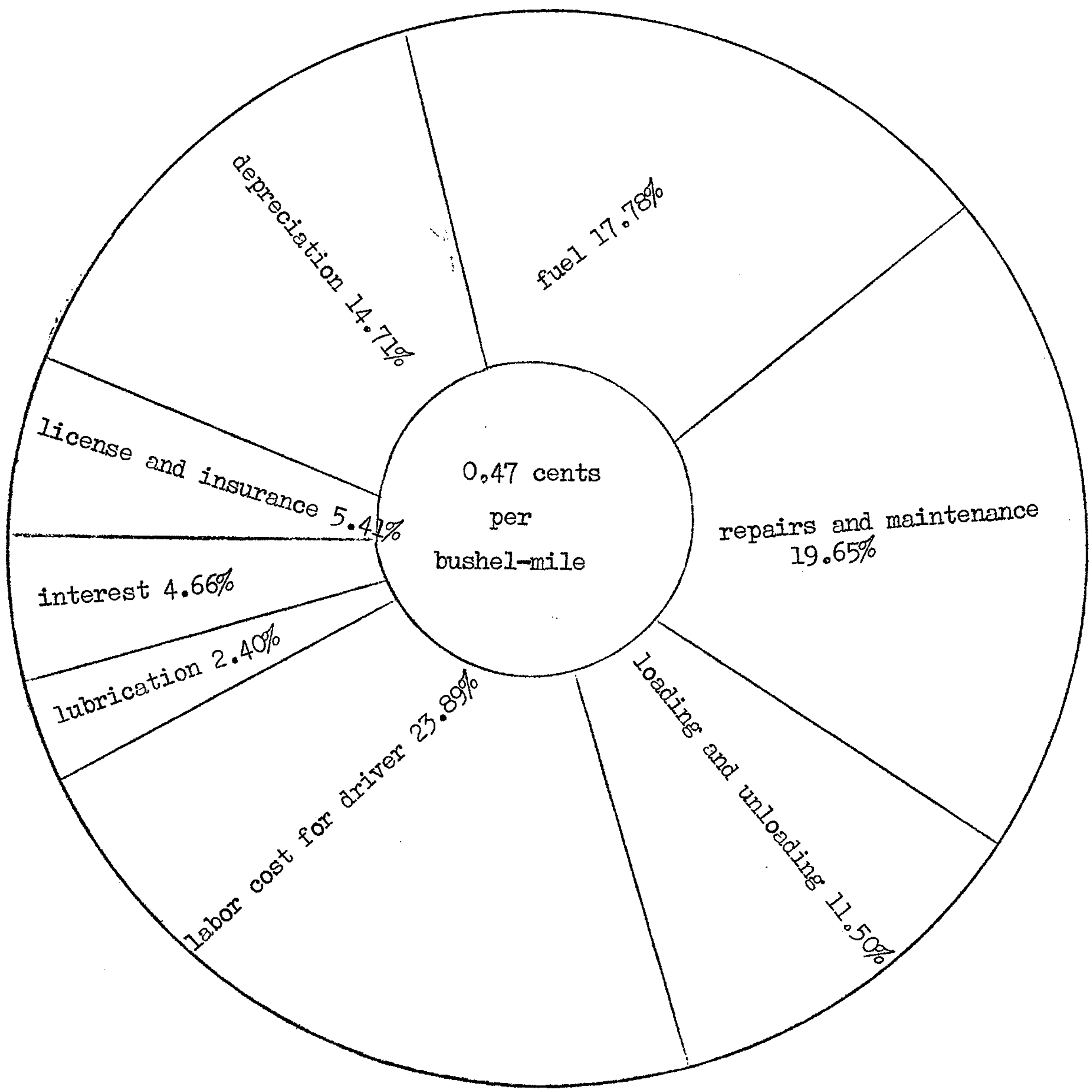

Figure 10

AVERAGE COMPONENTS OF GRAIN ASSEMBLY
COST FOR 68 FARM TRUCKS 1964-65

Source: From Tables X1X and XX111.

CHAPTER VIII

EVALUATION OF HYPOTHESES

Three hypotheses were proposed at the outset of this study which served to guide the empirical investigation of grain assembly costs. In the present chapter, these hypotheses are tested for their empirical validity on the basis of findings in the investigation. Hypothesis I will be examined first and the last two hypotheses will then be examined together. Implications of the tests will also be discussed.

AVERAGE TOTAL COST OF GRAIN ASSEMBLY

It was hypothesized that average cost of grain assembly by farm truck in Manitoba is equal to the average reported custom rate of one-half cent per bushel-mile. The hypothesis is supported theoretically in Chapter III, assuming that custom trucking is fairly competitive with no barrier to entry, and that each custom truck has a downward-sloping average cost schedule. The weighted average of assembly cost per bushel-mile for all trucks in the sample was calculated to be .4713 cents in Chapter VII.

For the purpose of testing this hypothesis, however, it was more convenient to use the simple average of assembly costs for the 68 trucks in the sample. That is, average cost for the 68 trucks. This figure was calculated to be .5234 cents per bushel-mile. Variance is .0876 cents and Standard Deviation is .2960 cents. The high variance may be explained by differences between different sizes of trucks, differences in ages and annual mileage, and large variation in repair costs.

The formula used for testing the difference between the custom rate of one-half cent per bushel-mile and average assembly cost of the 68 trucks is:

$$t = \frac{\text{Sample average - Custom rate}}{\text{Standard Deviation of Sample}} \times (\text{Sq. rt. of no. of observations})$$

$$t = \frac{.5234 - 5.000}{.2960} \times 8.2450$$

$$t = .6518$$

Whereas the theoretical t value for 67 degrees of freedom at the 5 per cent level of significance is 2.0003.

Since the calculated t value of .6518 falls within the accepted region of the test, the hypothesis that average assembly cost is equal to the custom rate, is accepted.

A similar test for difference between means was repeated for each size-group of trucks in the sample. Results of tests are shown in Table XXIV.

TABLE XXIV

TESTS OF DIFFERENCES BETWEEN AVERAGE ASSEMBLY COST PER BUSHEL-MILE FOR DIFFERENT SIZES OF TRUCKS AND THE CUSTOM RATE

Size of Truck (tons)	Number in Sample	Mean of Sample Cost (cents)	Variance of Sample Cost (cents)^2	Std. Dev. of Sample Cost (cents)	Calculated t Value	Theoretical t-value (.05)	Test of Ho
1/2-3/4	8	.9681	.2846	.5335	2.4820	2.3646	reject Ho
1	29	.5471	.0834	.2890	.8771	2.0484	accept Ho
1½	11	.5143	.0645	.2541	.1867	2.2281	accept Ho
2-2½	11	.3126	.0054	.0736	- 8.4452	2.2281	reject Ho
3	9	.3205	.1050	.3240	- 1.6620	2.3060	accept Ho
All	68	.5234	.0876	.2960	.6518	2.0003	accept Ho

There is a noticeable tendency in Table XXIV for cost per bushel-mile to decline with increase in size of truck. Cost for the one-half ton trucks is significantly greater than one-half cent per bushel-mile whereas cost for the $2\text{-}2\frac{1}{2}$ ton size-group is significantly lower. While the three-ton trucks also have lower cost, the difference is not significant due to higher fixed costs of this group as compared to the $2\text{-}2\frac{1}{2}$ ton group. Variance in cost is generally higher for size-groups containing a sizeable proportion of new trucks. For example, the half-ton trucks, with highest variance in cost of all groups, are only 6 years old on the average, whereas the $2\text{-}2\frac{1}{2}$ ton trucks, with lowest variance, are 13.5 years of age. This is expected since depreciation and interest charges vary substantially with age.

As indicated in Table XXIV, not all of the size-groups meet the conditions of the hypothesis that average assembly cost per bushel-mile be equal, or nearly equal, to the custom rate of one-half cent per bushel-mile. The one-half ton trucks have significantly higher cost on the average while the $2\text{-}2\frac{1}{2}$ ton trucks have significantly lower cost. However, the hypothesis is confirmed for all trucks on the average at the 5 per cent level of significance.

THE EFFECT OF DISTANCE OF HAUL AND SIZE OF TRUCK, IN TERMS OF LOAD CAPACITY, ON ASSEMBLY COST

It was hypothesized that average cost of grain assembly by farm truck would vary with size of truck used, in terms of load capacity, and average distance of haul to the elevator point of delivery. Cross tabulation analysis of average assembly cost for different size-groups of trucks has already indicated that size has an important effect on cost. However this technique of analysis was not considered sufficient in itself. Further evidence is needed to show that assembly cost, in fact, is significantly affected by size of truck. As for distance, the only analysis undertaken previously was in respect to the relationship of time and distance of haul. It will be remembered that this was necessary for estimating additional variable cost for increased distance of haul. Whether distance has a significant effect on average total cost of assembly, has yet to be investigated.

In view of obvious limitations in the use of cross tabulation analysis for explaining cost relationships of capacity and distance, and predicting change in cost for change in these variables, it was decided to adopt the technique of multiple regression analysis for testing the hypotheses.

To derive a quantitative relationship between assembly cost per bushel-mile and the two hypothesized determining variables, two statistical models were postulated.

Model I $\quad Y = a + b_1x_1 + b_2x_2$

Model II $\quad Y = ax_1^{b_1}x_2^{b_2}$

Where Y is the cost per bushel-mile, x_1 is the capacity of the truck in bushels and x_2 is the distance to the elevator point in miles. The constant "a" positions the function and the regression coefficients "b_1" and "b_2" stipulate the relationship between changes in capacity and distance, and changes in cost.

The two models were fitted to the cost data of 68 trucks in the sample which were used for delivering grain during 1964-65. Coefficients of multiple determination (R^2) were computed and F and t tests were applied to determine the statistical significance of the hypothesized relationships. Table XXV summarizes the results of this statistical test of hypotheses.

The value "R^2", multiplied by 100, shows the per cent of variation in cost explained by variation in capacity and distance. In Table XXV, 32 percent and 46 per cent, respectively, of the variation in cost is explained by these factors using Model I and Model II. The significance of R, the multiple correlation coefficient, is tested by F-test. The F value is first computed by dividing the mean squares due to regression by the mean

TABLE XXV

TESTS OF SIGNIFICANCE OF THE EFFECT OF CAPACITY AND DISTANCE ON THE COST OF ASSEMBLING GRAIN

Model	Estimating Equation	R^2	F_c	F_T	t_{b_1}	t_{b_2}	t_T
I	$1.0084 + .0025 X_1 + .0096 X_2$	.32	15.48*	3.14	5.14*	1.33	2.30
II	$19.93 X_1^{-.6972} X_2^{-.1633}$	.46	27.50*	3.14	6.23*	2.46*	2.30

R^2 = Coefficient of multiple determination.

F_c = Calculated F-value.

F_T = Theoretical F-value at 5 per cent level of significance (2,65 d.f.)

t_{b1} = Calculated t-value for regression coefficient b_1.

t_{b2} = Calculated t-value for regression coefficient b_2.

t_T = Theoretical t-value at 5 per cent level of significance (67 d.f.)

* shows value is significant at 5 per cent level of significance.

squared-deviation about regression. That is:

$$F = \frac{R^2}{p} \div \frac{1-R^2}{n-p-1}$$

where p is the number of independent variables (2) and n is the total number of observations (68). Computed F-values for the two estimating equations are compared with the theoretical F-value for p and n-p-1 degrees of freedom. Since the calculated values are greater than the theoretical value shown in Table XXV, it may be concluded that a significant variation in cost is determined by the two variables. Model II is clearly a better fit to the data than Model I as it has greater R^2 and F values. Therefore it is a better model for explaining variation in cost. In the case of Model II, both regression coefficients are significant at the 5 per cent level of significance since their calculated t-values are greater than the theoretical t-value for 67 degrees of freedom. The test applied here is similar to the test of difference between means used in testing Hypothesis I. The difference is that this test determines whether the regression coefficient differs significantly from zero.

These statistical results confirm the two hypotheses that capacity and distance have significant effects on assembly cost. The estimating equation used in confirming the hypotheses has limited predictive ability, however, since only 46 per cent of the variation in assembly cost is explained. Another limitation is that if simple average values for X_1 and X_2 are used in this function, the estimated cost value will not be a simple average but a geometric mean, due to the nature of the exponential function. However the estimated value should be similar.

The equation was verified as to its empirical value by imputing average figures for capacity and distance of trucks in the sample and comparing the predicted cost with actual average cost. In Table XXI of Chapter VII, average capacity and average distance of haul are 163 bushels and 8 miles, respectively. Now imputing these values into the estimating function, predicted average assembly cost is:

$$Y = 19.93 \times 163^{-.6972} \times 8^{-.1633}$$

converting the function into logarithmic form and solving, the values are:

$$\text{Log } Y = 1.2996 + (-.6972 \times 2.2122) + (-.1633 \times .9031)$$

$$\text{Log } Y = -.3902$$

The antilog of -.3902 is .4071 cents per bushel-mile. This estimated value for Y compares closely with the previously calculated weighted average cost per bushel-mile figure of .4713 cents. Since a geometric mean is calculated in the function from average values of distance and capacity, it is expected that this predicted average figure would be biased downward to some extent from the arithmetic average. The function does not account for variation in age and repair costs so some error in its use will also result because of variation in these variables if they deviate from the average of the sample.

A comparison of predicted assembly costs for different sizes of trucks with the actual average assembly costs of these size-groups is shown in Table XXVI. It may be observed that greatest discrepancies between the figures occurred in size-groups where a sizeable proportion of trucks were relatively new or where, as in the case of the $1\frac{1}{2}$ ton trucks, the level of repair cost differed significantly from the average of all trucks. Another factor causing discrepancy is annual mileage, which was much lower than average in the case of $1\frac{1}{2}$ ton trucks. All estimates in Table XXVI with the exception of that for the $2\text{-}2\frac{1}{2}$ ton trucks, are biased downward because of the nature of the function used in estimating. However, considering the great variability in ages and repair costs, and the unequal distribution of observations among the size-groups, the function does estimate fairly reliably.

The estimating equation was used to derive assembly costs for sizes of trucks varying from 50 to 500 bushels and delivering grain distances of one to twenty-five miles. These cost figures shown in Table XXVII, are calculated from the function by means of logarithms, as was done previously in Table XXVI. It may be observed that cost falls at a diminishing rate for increase in distance and capacity, although the rate of fall is less pronounced in the case of the former. Both rates approach zero at extreme points of the table. Since the maximum distance travelled by trucks in the sample is 21 miles and maximum capacity is 300 bushels, less confidence is

TABLE XXVI

COMPARISON OF ACTUAL AND PREDICTED ASSEMBLY COST FOR DIFFERENT SIZES OF TRUCKS IN THE STUDY*

Size of Truck	Number in Sample	Average Capacity	Average Distance of Haul	Actual Avge.Cost Per Bu.Mile	Predicted Avge.Cost Per Bu.Mile	Discrepancy in Prediction Actual	Per Cent
(tons)		(bu.)	(miles)	(cents)	(cents)	(cents)	(per cent)
1/2-3/4	8	76	8	.7951	.6931	-.1020	-12.8
1	29	123	7	.5167	.5064	-.0103	- 2.0
1½	11	197	10	.5747	.3440	-.2307	-40.1
2-2½	11	218	7	.2984	.3399	.0415	13.9
3	9	258	6	.3658	.3099	-.0559	-15.3
All	68	163	8	.4713	.4071	-.0642	-13.6

* Source: From Chapter VII, Tables XXI and XXIII.

attributed to estimated cost values calculated for factors above these levels in Table XXVII.

The function was also used to predict assembly cost for a 163 bushel capacity truck, which is the average capacity of trucks in the sample. Assembly cost for this capacity at distances varying from 1 to 25 miles is shown in Figure 11. Predicted average total cost is represented in this figure by a dotted line.

It may be recalled that average assembly cost per bushel-mile in the sample was .4713 cents for 8 miles distance of delivery. This cost is depicted in the figure by point A. Point C represents average fixed cost equal to .1608 cents and B represents variable cost equal to .3005 cents. It was estimated in Chapter VII that additional hauling cost for increase in distance of delivery would be average variable cost of .3005 cents per bushel-mile. This level of cost is shown by a horizontal line. The predicted average total assembly cost schedule falls below point A by 13.6 per cent due to the fact that the estimating function produces a geometric mean. The schedule continues to fall at a diminishing rate toward the variable cost level, for greater distance. This is not unrealistic, since fixed cost per bushel-mile would decrease with increased distance of haul. It was estimated formerly that 12.14 per cent of annual mileage in 1964-65 was due to grain hauling for an average distance of 8 miles to the delivery point. Therefore, if distance of haul were to increase by about one-third assuming that annual travel other than grain hauling is not affected, and fixed truck expense per bushel-mile, provided that the trucks are unchanged, would be four-fifths its present level. Also,

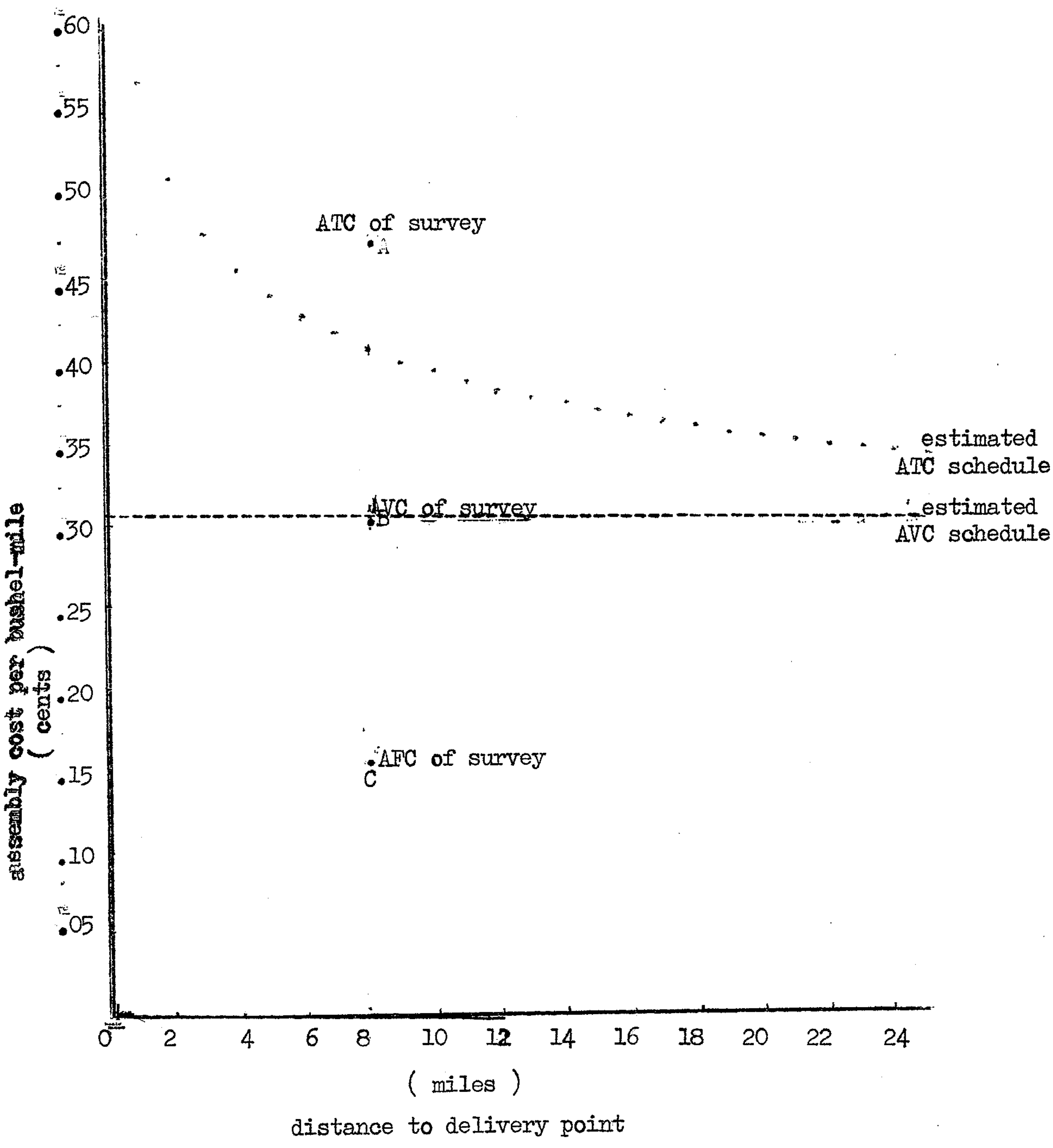

Figure 11

ESTIMATED TOTAL ASSEMBLY COST PER BUSHEL-MILE OF A 163 BUSHEL CAPACITY TRUCK FOR VARYING DISTANCES OF HAUL

TABLE XXVII

PREDICTED ASSEMBLY COST PER BUSHEL-MILE FOR CHANGE IN CAPACITY AND DISTANCE

Distance of Haul	Capacity of Truck in Bushels									
	50	100	150	200	250	300	350	400	450	500
(miles)	(cents per bushel-mile)									
1	1.304	.804	.606	.496	.424	.374	.336	.306	.282	.262
2	1.164	.718	.541	.443	.379	.334	.300	.273	.252	.234
3	1.090	.672	.506	.414	.355	.312	.281	.256	.235	.219
4	1.040	.641	.483	.395	.338	.298	.268	.244	.225	.209
5	1.001	.618	.466	.381	.326	.287	.258	.235	.217	.201
6	.973	.600	.452	.370	.317	.279	.250	.228	.210	.195
7	.949	.585	.441	.361	.309	.272	.244	.223	.205	.191
8	.927	.572	.431	.353	.302	.266	.239	.218	.201	.186
9	.911	.562	.423	.346	.296	.261	.234	.214	.197	.183
10	.895	.552	.416	.340	.291	.257	.230	.210	.193	.180
11	.881	.543	.410	.335	.287	.253	.227	.207	.190	.177
12	.869	.536	.404	.330	.283	.249	.224	.204	.188	.175
13	.857	.529	.399	.326	.279	.246	.221	.201	.185	.172
14	.847	.522	.394	.322	.276	.243	.218	.199	.183	.170
15	.838	.517	.389	.319	.273	.240	.216	.196	.181	.168
16	.829	.511	.385	.317	.270	.238	.213	.194	.179	.166
17	.821	.506	.381	.312	.267	.235	.211	.192	.177	.165
18	.814	.502	.378	.309	.265	.233	.210	.191	.176	.163
19	.806	.497	.375	.306	.263	.231	.208	.189	.174	.162
20	.799	.493	.371	.304	.260	.229	.206	.187	.173	.160
21	.793	.489	.369	.302	.258	.227	.204	.186	.171	.159
22	.787	.485	.366	.299	.256	.226	.203	.185	.170	.158
23	.781	.482	.363	.297	.254	.224	.201	.183	.169	.157
24	.776	.478	.361	.295	.253	.222	.200	.182	.168	.156
25	.771	.475	.358	.293	.251	.221	.198	.181	.167	.155

the cost of loading and unloading per bushel-mile would probably decrease to less than one-third of the present level since distance to point is over three times as far.

It can be concluded from the results obtained in this chapter that size, in terms of capacity, and distance of haul are both significant factors affecting assembly cost. Size is clearly the most significant factor of the two. It is also a strategic factor for adjusting to rail-line abandonment as farmers may reduce their cost of hauling an additional distance by shifting to a larger truck or, if this is not feasible, they may incur less cost by hiring custom trucking, particularly if their present truck is less than one ton in size.

Taking all costs into consideration, there is no significant difference between the custom rate for hauling grain of one-half cent per bushel-mile and average hauling cost of farm trucks according to the results obtained in this study of a random sample of trucks in Manitoba.

CHAPTER IX

SUMMARY AND RECOMMENDATIONS

SUMMARY

A basic premise in the present study has been that many grain producers in Manitoba will be compelled to travel greater distances in delivering their grain to alternative delivery points should their present delivery points be closed down due to rail-line abandonment. Since this additional hauling would inevitably constitute an increase in farm cost, it was felt that policy-makers concerned with abandonment would need to consider an estimate of the probable increase in cost for producers. To date they have generally accepted the average custom rate as the cost of additional hauling though this has not been supported empirically.

In view of this need for factual information on grain hauling costs, a random survey of 89 Manitoba farms was conducted in 1965 to investigate cost of assembling grain by trucks operated on these farms during the crop year 1964-65. Hypotheses used to guide the investigation were that average total cost of assembly would be equal to the custom rate of one-half cent per bushel-mile and that distance of delivery and size of truck, in terms of capacity, would have a significant effect on assembly cost. The survey was supplemented by information from published sources in respect to truck prices and labor cost.

Methodology followed in this cost study included an evaluation of depreciation and interest on investment costs basis the market revaluation method. Labor cost in grain assembly was determined by simple regression analysis, treating round-trip time as a function of delivery distance, and then imputing a cost estimate for labor. In testing hypotheses, average assembly cost in the sample was compared to the custom rate, using a statistical test of difference between means. The relationship of truck size and distance of haul to assembly cost was determined by multiple regression analysis. The function fitted has also been used to predict change in average total assembly cost for changes in these variables. Additional variable cost for increased distance of haul is estimated on the basis of current average variable cost and findings of other cost studies concerning repair and labor costs.

Major direct findings of the cost study are:

1. Average total cost of grain assembly by farm trucks in the survey was approximately equal to the custom rate of one-half cent per bushel-mile.
2. Estimated variable cost of assembly for increased distance of haul was .3 cents per bushel-mile.
3. Average loading and unloading time was 23 minutes per truck. There was no appreciable difference in time between different sizes of trucks.
4. Average speed in making a round trip was 16 miles per hour. There was no appreciable difference in speed between different sizes of trucks.
5. Size of truck and distance of haul have significant effects on average cost of assembly per bushel-mile.

IMPLICATIONS FOR FURTHER STUDY

No aggregate estimate of additional hauling cost for abandonment of branch lines in Manitoba was derived in the present study. This would require detailed point-by-point analysis of deliveries and delivery distances for all elevators located on lines proposed for abandonment. Distances of haul to alternative delivery points would then have to be determined before additional cost could be estimated. It was felt that the magnitude of this task would warrant a further study.

It is recommended, in view of the large variance in cost observed in the present study and the fact that there may be errors in some of the estimates of respondents in the survey, that a second larger survey be conducted to confirm the results of this study prior to deriving an aggregate cost estimate for the province. This would also provide an opportunity for testing the formula derived in this study for estimating change in cost for change in capacity and distance. This formula could be very useful for making cost predictions, but it should first be tested on more cost data.

Since truck size, in terms of capacity, has a significant effect on assembly cost, it is possible that large trucks could be effectively used to carry grain from elevators located on branch lines to main line elevators. Findings in the present study suggest that large farm trucks could haul grain for less than one-fifth of a cent per bushel-mile, if utilized more fully. This cost may be reduced still further by using large transport trucks. Perhaps this would be an economical alternative to present rail hauling of grain on lines proposed for abandonment. If so, service at points may be continued even though the line is abandoned. This matter also deserves further study.

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APPENDIX

APPENDIX A

August 1965.

No. ________

Farm Operator Questionnaire

re: grain storage practices and trucking costs.

It is hoped that you will assist the work of the Department of Agricultural Economics of the University of Manitoba by giving your answers to the following questions. Your answers will be treated as confidential information and will be available only to research personnel in the department.

1. Name: ________________________________

   Address: ________________________________

2. Description of land and land use.

	Legal Description							Improved Acres		
No.	Quarter	Sec.	Twp.	Rg	M	O/R	Area (Acres)	Seeded to Grain, 1964	Other	Other Acres

3. Would you please indicate the following features on the accompanying farm plan.

   (a) list each parcel of land by its legal description.

   (b) indicate each land use boundary including all improved land as well as wasteland or bush; also indicate the cropping pattern used in 1964 on these fields.

   (c) locate and number the sites of all of your grain storage facilities and, if these facilities are located off the farmstead grounds, mark in the routes used to reach each of these facilities.

4. We would like to obtain some idea of the size of your farm business. Would you please answer the following questions for the crop of 1964?

   (a) Field Crops

				Disposition at Harvest				Method of Delivery	
				Stored on Farm		Delivered Direct to Elevator			
Crop	Acres Sown	Total Yield (Bus.)	Grade	Bus.	Distance	Bus.	Distance	Truck	Tractor

(b) Livestock

Type	Number July 31, 1965	Estimated Value	No Sold or Died Aug. 1, 1964-July 31, 1965.	No. Bought or Born Aug. 1, 1964-July 31,1965.

5. To what selling points are you presently delivering your grain (i) ________ (ii)__________. How far are you located from this (these) point (s) by your usual delivery route? point (i)_______miles; point (ii)____ miles. Describe the types of road surfaces that you travel over in order to reach each point, indicating the mileage travelled over each type:

6 Please estimate the number of additional bushels of crop delivered to the elevator from on-farm storage between the end of the harvest period 1964 and the beginning of the new crop harvest, 1965.______Bushels. Approximate number of bushels delivered by (i) truck ____, (ii) tractor ____, (iii) custom or neighbor help _________.

7. Description of all trucks used for hauling grain to the elevator.

Truck*	Make	Year	G.W.W.	Load Rating	No. Cylinders	Capacity (Bus.)	Year of Purchase	Price

*Henceforth in this questionnaire please refer to your trucks in the same order as above.

8. Operation of Trucks Described.

Truck	Total Mileage on Truck	Mileage Since August 1, 1964	Licence 1964 Cost	Insurance 1964 Cost	Cost of Fuel Used Since August1,1964	Av.Price Paid per Gallon

9. Joint expenses of trucks apportioned between business (crop and livestock production) and personal use for the period of time from Aug. 1, 1964 to July 31, 1965.

			No. Miles Hauling Grain to Elevator on		
Truck	No Miles Personal Use	Hauling Grain to Elevators	Earth & Gravel Roads	Paved Roads	No. Miles Loaded Use Excluding Grain Hauling

10. If you have records of your truck expenses from August 1, 1964 to July 31, 1965 please indicate.

Truck	Cost of Repair Parts	Garage Labor (hours)	Own Labor (hours)	Housing Cost	Tire Replacement	Oil Grease and Filters	Anti-Freeze	Oth

11. Average time required to complete round trip to the elevator, including loading and unloading is: ________.

12. Would you describe your present grain storage facilities relating the number back to the granaries on your farm plan.

(a)

No.	Stat./Port.	Type of Materials Used in Construction	Year Built	Capacity	Dimensions	Value When New

(b)

No.	Value on Aug.1, 1964	Rate of Depreciation	Amount of Depreciation	Capital Improvements Materials	Capital Improvements Labor	Repairs 1964-65	Value on July 31, 1965

13. The following question deals with the use made of your storage facililities during the past year.

No.	Total Capacity (Bushels)	Type of Grain In Store	Quantity In Store Oct. 1, 1964	Supply and Disposal of Grain: Oct. 1 - Dec. 31 Added	Oct. 1 - Dec. 31 Disposed	Jan. 1 - Mar.31 Added	Jan. 1 - Mar.31 Disposed	Apr.1-July31 Added	Apr.1-July31 Dispose

14. Did you use any temporary or emergency storage facilities for grain storage or thresh grain directly onto the ground in 1964-65? Yes__ No__. If yes, briefly describe the type of temporary storage used, the quantity of grain stored in this manner and the length of time involved. ____________________.

15. Did any of your grain storage facilities have another use in 1964-65? Yes ___ No____. If yes, describe the use to which they were put and the length of time involved. ____________________.

16. The following question deals with special equipment and practices involv-in storage.

Item	No.	Estimated Value	Age of Machine	Cost of Repairs and Maintenance	Est. Operating Costs	Annual Hrs. of Use	Capacity Bus./hr.

17. Do you have any type of insurance coverage on either your grain storage facilities or the grain that you store on your farm?

(i) On the facilities? Yes ____ No ____

(ii) On grain in store? Yes ____ No ____

If either or both of the above are covered by insurance could you describe the type and the value of the insurance, the annual premium cost and, in the case of grain in store, the time period involved____________.

18. We would like to obtain some idea of the supply and disposal of grains on your farm for the crop year of August 1, 1964 - July 31, 1965.

	Wheat	Oats	Barley	Flaxseed	Rye	Other
a) Carryover, Aug. 1, 1964						
b) Farm Production						
c) Purchased During Year						
d) Total Supply						
e) Used on Farm (i) Feed						
(ii) Seed						
f) Sold (a) to elevator co.						
(b) to feed & seed co.						
(c) to other farmers						
g) Carryover, July 31, 1965						
h) Damage and Waste (Residual						
i) Total Disposal						

APPENDIX B

TABLE I

METHODS OF DELIVERY REPORTED IN SURVEY

Name of Delivery Point	Delivery Permits issued at point*	Number of Producers Surveyed	Number in Survey delivering by:			
			Own Truck	Own Tractor	Custom Truck	Neighbor's Truck
Holmfield	39	5	5	0	0	0
Oakland	56	7	7	0	0	0
Souris	156	17	15	0	2	0
Plum Coulee	215	25	18	1	6	0
Teulon	341	35	21	1	6	7
All Points	807	89	66	2	14	7

*List obtained from the Canadian Wheat Board.

TABLE II

COMPARISON OF SIZES OF TRUCKS USED IN SURVEY FOR HAULING GRAIN WITH ALL FARM TRUCKS IN MANITOBA*

Size of Trucks	Number In Survey	Number in Province	Per Cent Proportion in Survey	Per Cent Proportion in Province
1/2 ton	8	16,039	11.59	43.81
3/4 tons	1	6,791	1.45	18.55
1 ton	29	5,272	42.03	14.40
$1\frac{1}{2}$ tons	11	3,215	15.94	8.78
$2-2\frac{1}{2}$ tons	11	2,927	15.94	8.00
3 tons	9	1,597	13.04	4.36
Over 3 tons	0	764	0	2.09
All Sizes	69	36,605	100.00	100.00

*Source: Information on all farm trucks registered in 1963 was obtained directly from the Manitoba Motor Vehicle Branch. One half-ton truck was not used for delivering grain in 1964-65.

APPENDIX B

TABLE III

CHARACTERISTICS OF DELIVERY POINTS IN SURVEY AREA*

Name of point	Total storage capacity at point	Number of elevators at point	Total receipts 1964-65	Average receipts 1954-55 to 1963-64
	(bushels)		(bushels)	(bushels)
Holmfield	50,000	1	165,173	108,603
Oakland	145,100	2	292,925	236,725
Souris	460,600	3	738,831	525,945
Plum Coulee	345,900	4	378,242	360,701
Teulon	224,000	3	428,423	414,582
All points	1,225,600	13	2,003,594	1,646,556

*Source: Board of Grain Commissioners for Canada, Grain Elevators in Canada. (Ottawa: Queen's Printer and Controller of Stationery, 1964-65 Edition), and Board of Grain Commissioners for Canada, Summary of Country Elevator Receipts at Individual Prairie Points, Crop Year 1964-65. (Ottawa: Queen's Printer and Controller of Stationery).

APPENDIX C

TABLE I

CHANGES IN MARKET PRICES OF 1961 to 1964 HALF-TON TRUCKS
DURING THE 1964 - 65 CROP YEAR
STRATIFIED BY MODEL AND MAKE*

Item	Size: One-half ton								
	Model: Chassis & Cab			Swept-side pickup			Wide-side pickup		
	Make: A[a]	B[b]	C[c]	A[a]	B[b]	C[c]	A[a]	B[b]	C[c]
1964 trucks:									
1964 prices[d]	2490	2666	2445	2610	2794	2584	2630	2815	2584
1965 prices[d]	1700	1749	1634	1784	1784	1683	1815	1815	1749
Dif.in prices	790	917	811	826	1010	901	815	1000	835
Dif. as% of 64 prices	31.7	34.4	32.2	31.6	36.1	34.9	31.0	35.5	32.3
1963 trucks:									
1964 prices[d]	1760	1760	1733	1848	1848	1815	1848	1848	1815
1965 prices[d]	1430	1430	1403	1485	1485	1452	1485	1485	1452
Dif. in prices	330	330	330	363	363	363	363	363	363
Dif. as % of 64 prices	18.8	18.8	19.0	19.6	19.6	20.0	19.6	19.6	20.0
1962 trucks:									
1964 prices[d]	1518	1485	1595	1567	1535	1551	1567	1535	1567
1965 prices[d]	1238	1205	1188	1265	1265	1265	1265	1265	1287
Dif. in prices	280	280	407	302	270	286	302	270	280
Dif.as % of 64 prices	18.4	18.9	25.5	19.3	17.6	18.4	19.3	17.6	[illegible]
1961 trucks:									
1964 prices[d]	1237	1139	1155	1320	1188	1205	1320	1188	1221
1965 prices[d]	1018	1045	1045	1100	1100	1100	1100	1100	1100
Dif. in prices	219	94	110	220	88	105	220	88	121
Dif. as % of 64 prices	17.7	8.3	9.5	16.7	7.4	8.7	16.7	7.4	9.9

*Source: Canadian Red Book-Official Used Car Valuations, (Toronto: National Automotive Publishers Ltd.) Ref. Editions Aug. 1 - Sept. 30, 1964 and 1965.

[a] Chevrolet and G.M.C.

[b] Ford and Mercury

[c] Dodge and Fargo

[d] Including 10 per cent adjustment above Toronto prices.

APPENDIX C

TABLE 2

CHANGES IN MARKET PRICES OF 1961 TO 1964 THREE-QUARTER TON TRUCKS DURING THE 1964-65 CROP YEAR, STRATIFIED BY MODEL AND MAKE*

Item	Size: Three-quarter ton					
	Model: Chassis & cab		Swept-side pickup		Wide-side pickup	
	Make: A[a]	B[b]	A[a]	B[b]	A[a]	B[b]
1964 trucks:						
1964 prices[c]	2754	2901	2873	3028	2893	3049
1965 prices[c]	1898	1848	1947	1925	1964	1925
Dif. in prices	856	1053	926	1103	929	1124
Dif. as % of 64 prices	31.1	36.3	32.2	36.4	32.1	36.9
1963 trucks:						
1964 prices[c]	1925	1897	2013	1980	2013	1980
1965 prices[c]	1551	1535	1617	1595	1617	1595
Dif. in prices	374	362	396	385	396	385
Dif. as % of 64 prices	19.4	19.1	19.7	19.4	19.7	19.4
1962 trucks:						
1964 prices[c]	1650	1535	1716	1584	1716	1617
1965 prices[c]	1320	1265	1370	1320	1370	1320
Dif. in prices	330	270	346	264	346	297
Dif. as % of 64 prices	20.0	17.6	20.2	16.7	20.2	18.4
1961 trucks:						
1964 prices[c]	1353	1155	1403	1205	1403	1205
1965 prices[c]	1128	1073	1155	1100	1155	1100
Dif. in prices	225	82	248	105	248	105
Dif. as % of 64 prices	16.6	7.1	17.7	8.7	17.7	8.7

*Source: Canadian Red Book-Official Used Car Valuations (Toronto: National Automotive Publishers Ltd.) Ref. Editions Aug. 1 - Sept. 30, 1964-65.

[a] Chevrolet and G.M.C.

[b] Ford and Mercury

[c] Including 10 per cent adjustment above Toronto prices.

APPENDIX C

TABLE 3

CHANGES IN MARKET PRICES OF 1964, 1963, 1962 AND 1961 ONE-TON TRUCKS BETWEEN 1964 AND 1965 STRATIFIED BY MODEL AND MAKE*

Item	Size: One-ton					
	Model: Chassis & Cab			Wide-side pickup		
Make	A[a]	B[b]	C[c]	A[a]	B[b]	C[c]
1964 trucks:						
1964 prices[d]	2962	3160	2837	3110	3340	2984
1965 prices[d]	2013	2013	1848	2090	2063	1925
Dif. in prices	949	1147	989	1020	1277	1059
Dif. as % of 64 prices	32.0	36.3	34.9	32.8	38.2	39.0
1963 trucks:						
1964 prices[d]	2046	2029	1980	2161	2145	2063
1965 prices[d]	1650	1634	1617	1700	1683	1634
Dif. in prices	396	395	363	461	462	429
Dif. as % of 64 prices	19.4	19.5	18.3	21.3	21.5	20.8
1962 trucks:						
1964 prices[d]	1749	1699	1650	1831	1782	1733
1965 prices[d]	1403	1370	1337	1452	1430	1403
Dif. in prices	346	329	313	379	352	330
Dif. as % of 64 prices	19.8	19.4	19.0	20.7	19.8	19.0
1961 trucks:						
1964 prices[d]	1430	1287	1287	1485	1337	1369
1965 prices[d]	1155	1155	1155	1210	1210	1210
Dif. in prices	275	132	132	275	127	159
Dif. as % of 64 prices	19.2	10.3	10.3	18.5	9.5	11.6

*Source: Canadian Red Book-Official Used Car Valuations (Toronto: National Automotive Publishers Ltd.) Ref. Editions Aug. 1 - Sept. 30, 1964 and 1965.

[a]Cheverolet and G. M. C.

[b]Ford and Mercury

[c]Dodge and Fargo

[d]Including 10 per cent adjustment above Toronto price.

APPENDIX C

TABLE 4

AVERAGE CHANGES IN MARKET PRICES OF ONE-HALF TO THREE-TON TRUCKS BETWEEN 1964 AND 1965.*

Year of truck	Size of truck											
	1/2 ton		3/4 ton		1 ton		11/2 ton		2-21/2 ton		3 ton	
	64 ave. price	Change in price 64-65	64 ave. price	Change in price 64-65	64 ave. price	Change in price 64-65	64 ave. price	Change in price 64-65	64 Ave. price	Change in price 64-65	64 ave. price	Change in price 64-65
	(dollars)											
1964	2624	787	2916	875	3066	920	3420	1026	4350	1305	5000	1500
1963	1837	367	2041	408	2146	429	2394	479	3045	609	3500	700
1962	1470	294	1633	327	1717	343	1915	383	2436	487	2800	560
1961	1176	176	1306	196	1374	206	1532	230	1949	292	2240	336
1960	1000	150	1110	166	1168	175	1302	195	1657	249	1904	286
1959	850	128	944	142	993	149	1107	166	1408	211	1618	243
1958	722	108	802	120	844	127	941	141	1197	180	1375	206
1957	614	92	682	102	717	108	800	120	1017	153	1169	175
1956	522	78	580	87	609	91	680	102	864	130	994	149
1955	444	67	493	74	518	78	578	87	734	110	845	127
1954	377	57	419	63	440	66	491	74	624	94	718	108
1953	320	48	356	53	374	56	417	63	530	80	610	92
1952	272	41	303	45	318	48	354	53	450	68	518	78
1951	231	35	258	39	270	40	301	45	382	57	440	66
1950	196	29	219	33	230	34	256	38	325	49	374	56
1949	167	25	186	28	196	29	218	33	276	41	318	48
1948	142	21	158	24	167	25	185	28	235	35	270	40
1947	121	18	134	20	142	21	157	24	200	30	230	34
1946	103	15	114	17	121	18	133	20	170	26	196	29
1945	88	13	97	15	103	15	113	17	144	22	167	25

*Source: Prices of new 1/2, 3/4 and 1 ton trucks in 1964 are taken from Appendix C, Tables 1, 2 and 3. Prices of new 2 to 3 ton trucks in 1964 were obtained from truck dealers. Average change in prices for 1964, 1963, 1962 and 1961 trucks during 1964-65 were 30, 20, 20, and 15 per cent respectively.

Per cent changes in prices of 1961 to 1964 trucks between 1964 and 1965 are based on average changes in Appendix C, Tables 1, 2 and 3. For trucks older than 1961, the per cent change is estimated at 15 per cent of average price in 1964.

APPENDIX C

TABLE 5

INTEREST ON AVERAGE INVESTMENT IN ONE-HALF, THREE-QUARTER AND ONE-TON TRUCKS OF VARIOUS AGES DURING 1964 TO 1965.*

Year of truck	Age in 1964	1/2 ton Ave. val.[a]	1/2 ton Int.	3/4 ton Ave. val.[a]	3/4 ton Int.[b]	1 ton Ave. val.[a]	1 ton Int.[b]
1964	0	2230	134	2478	149	2606	156
1963	1	1654	99	1837	110	1932	116
1962	2	1323	79	1470	88	1546	93
1961	3	1088	65	1208	72	1271	76
1960	4	925	56	1027	62	1080	65
1959	5	786	47	873	52	918	55
1958	6	668	40	742	44	780	47
1957	7	568	34	631	38	663	40
1956	8	483	29	536	32	564	34
1955	9	410	25	456	27	479	29
1954	10	348	21	388	23	407	24
1953	11	296	18	330	20	346	21
1952	12	252	15	280	17	294	18
1951	13	214	13	238	14	250	15
1950	14	182	11	202	12	213	13
1949	15	154	9	172	10	182	11
1948	16	132	8	146	9	154	9
1947	17	112	7	124	7	132	8
1946	18	96	6	106	6	112	7
1945	19	82	5	90	5	96	6

*Source: Canadian Red Book-Official Used Car Valuations (Toronto: National Automotive Publishers Ltd.) Reference Editions Aug. 1 - Sept. 30, 1964 and 1965.

[a]Average value 1964 - 65 is the average of prices in the two periods Aug. 1 - Sept. 30, 1964 and 1965.

[b]Interest is computed basis the average 1964 - 65 value using a rate of 6 per cent per annum.

APPENDIX C

TABLE 6

INTEREST ON AVERAGE INVESTMENT IN ONE AND ONE-HALF, TWO AND TWO AND ONE-HALF, AND THREE-TON TRUCKS OF VARIOUS AGES DURING 1964 TO 1965.*

Year of truck	Age in 1964	Size of truck: 1 1/2 ton Ave. val. 64-65[a]	Int.	2 - 2 1/2 ton Ave. val.[a] 64-65[a]	Int.[b]	3 ton Ave. val.[a] 64-65[a]	Int.[b]
1964	0	2907	174	3698	222	4250	255
1963	1	2154	129	2740	164	3150	189
1962	2	1724	103	2192	132	2520	151
1961	3	1417	85	1803	108	2072	124
1960	4	1204	72	1532	92	1761	106
1959	5	1024	61	1302	78	1496	90
1958	6	870	52	1107	66	1272	76
1957	7	740	44	940	56	1082	65
1956	8	629	38	799	48	920	55
1955	9	534	32	679	41	782	47
1954	10	454	27	577	35	664	40
1953	11	386	23	490	29	564	34
1952	12	328	20	416	25	479	29
1951	13	278	17	354	21	407	24
1950	14	237	14	300	18	346	21
1949	15	202	12	256	15	294	18
1948	16	171	10	218	13	250	15
1947	17	145	9	185	11	213	13
1946	18	123	7	157	9	182	11
1945	19	104	6	133	8	154	9

*Source: Canadian Red Book-Official Used Car Valuations, (Toronto: National Automotive Publishers Ltd.) Ref. Editions Aug. 1 - Sept. 30.,1964 and 1965.

[a]Average value 1964-65 is the average of prices in the two periods Aug. 1-Sept. 30, 1964 and 1965.

[b]Interest is computed basis the average 1964 - 65 value using a rate of 6 per cent per annum.