THE COST AND OPERATIONS OF EXEMPT MOTOR CARRIERS IN NORTH DAKOTA

By

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INTRODUCTION

The state of North Dakota is heavily dependent on agriculture. In 1976, over 70 percent of the state's new wealth of $2.7 billion was generated by the agricultural sector. The transportation of agricultural crops from producer to ultimate consumer is essential to the viability of the agricultural sector and its resultant generation of new wealth. Without a low cost method of transporting North Dakota's crops, well over 50 percent of the state's new wealth would be jeopardized.

During the 1976-77 crop year[1] North Dakota farmers shipped 306 million bushels of grain to market. The exempt agricultural motor carrier plays an extremely important role in the transportation of North Dakota's agricultural production. Exempt carriers accounted for over 100 million bushels or one-third of the total grain movement from North Dakota. This movement resulted from an approximate 109,000 trips to market by an estimated 750 exempt motor carriers. The agricultural sector of North Dakota's economy generated over $1.3 billion in 1976, and since the exempt carrier transported one-third of agriculture's production, the exempt carrier had a role in the creation of approximately $430 million of North Dakota's new wealth.

North Dakota agricultural producers pay in excess of $100 million per year in freight rates for the transportation of their crops to market. Rail and truck transportation are the only two transportation alternatives available to the North Dakota agricultural producer. Since rails are allowed to set their rates in concert among themselves, trucks provide the only direct competitive barrier shielding North Daktoa from a complete rail monopoly. Supporting this contention is the observation that the railroads serving North Dakota have on numberous past occasions and are currently contemplating reduced freight charges to meet motor carrier competition. Thus, it may be argued that the exempt carrier, to a substantial degree,sets and maintains grain freight rates in North Dakota and, as such, contributes significantly to the economic viability of the state.

Although the exempt motor carrier plays an important role in North Dakota's grain marketing system, very little is known about the exempt carrier industry. This is due in part to the agricultural carrier's exemption from Interstate Commerce Commission regulation and his extreme independent nature. This study will examine North Dakota's exempt motor carrier industry. Specifically, this study will analyze the structure, characteristics, and the costs of operation of the exempt motor carrier transporting grain from the state of North Dakota.

For-hire motor carriers that haul unprocessed agricultural products are exempt from Interstate Commerce Commission (ICC) economic regulation and, as such, are referred to as exempt motor carriers.[2] The exempt carrier, unlike the ICC regulated common carrier, has freedom of entry and exit and is free to determine his own rates and routes. This leads to open market competition between the exempt motor carriers themselves and also with other modes of transport.

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[1]A crop year is from July of one year to June of the next year.

[2]See Part II, Section 203, (b), Subsection 6, of the Interstate Commerce Act of 1935 for further explanation.

In the last three crop years, over 25 percent of the grain transported from North Dakota was moved by truck.[3] This translates into an estimated gross revenue, for the exempt carrier industry in North Dakota, of over $29 million. The relative importance of truck movements in the total movement of grain out of North Dakota to each major terminal market for the crop years 1973-74, 1974-75 and 1975-76 are presented in Table 1.

TABLE 1. TRUCK VERSUS RAIL MOVEMENTS OF GRAIN FROM NORTH DAKOTA TO EACH OF THE STATE's FOUR MAJOR MARKETS

Destination	1973-74		1974-75		1975-76	
	Rail	Truck	Rail	Truck	Rail	Truck
	(thousand bushels)					
Minneapolis-St. Paul	97,664 (79%)	26,501 (21%)	90,556 (84%)	17,537 (16%)	83,290 (79%)	21,610 (21%)
Duluth-Superior	112,434 (68%)	52,647 (32%)	88,428 (81%)	21,157 (19%)	110,012 (72%)	42,502 (28%)
West	49,690 (86%)	7,922 (14%)	17,148 (72%)	6,679 (28%)	15,376 (70%)	6,654 (30%)
Miscellaneous	31,024 (69%)	14,109 (31%)	25,790 (76%)	8,192 (24%)	27,813 (68%)	13,027 (32%)
TOTAL	290,812 (74%)	101,179 (26%)	221,922 (81%)	53,565 (19%)	236,491 (74%)	83,793 (26%)

Source: Cosgriff, John G., "North Dakota Grain Transportation Statistics, 1975-76," UGPTI Report No. 30, Upper Great Plains Transportation Institute, North Dakota State University, Fargo, North Dakota, April, 1977.

Over the past three crop years (1973-74, 1974-75, 1975-76), truck movements have been the strongest into the Duluth-Superior and miscellaneous markets. It is interesting to note that the truck share for the Pacific Northwest market has been continually rising for the past three years. Overall, rail shipments to all markets have averaged 76 percent of the total grain movement from North Dakota for the past three crop years while truck shipments have averaged 24 percent of the total grain movement.

Truck transportation of grain provides several benefits through its services to the North Dakota grain producer. The first service is the provision

[3]North Dakota Public Service Commission's "Grain Movement Report."

of an alternative mode for transporting grain to market. The second service is the additional capacity for grain movements provided by trucks. Finally, through a combination of the first two services, the exempt grain hauler exerts competitive pressure on the railroads serving the state. The combination of these services together with the absolute movement of grain by truck casts the exempt motor carrier as a vital cog in North Dakota's grain transportation system.

Need for the Study

Trucks play an important role in North Dakota's grain marketing system. However, due to thier exemption from ICC regulation, very little data are recorded or available on the exempt motor carrier industry. Generally, the exempt motor carrier industry in North Dakota is characterized as a relatively large number of independent owner-operators interacting in a competitive field. However, very little else is known about these truckers. For example, currently there is no accurate census of the number of size of the exempt carrier firms serving the North Dakota grain producer.

Although there is little information available on the industry, the effects that the exempt carrier has upon the performance of the grain marketing system is readily apparent. As discussed previously, trucks provide the only competitive force on the railroads that serve North Dakota. Trucks may be viewed as placing an upper limit on rail rates. In order for the railroads to remain competitive and transport grain, their rates must approach or equal the competing truck rate. According to Locklin, it is generally conceded that trucks are the higher costs mode of transporting grain for relatively long distances.[4] Based on this contention, rail rates cannot continually exceed the truck costs of moving grain by a substantial margin in the long run or the competitive exempt trucking industry would soon eliminate or substantially reduce the rail's market share of North Dakota's grain movement. Thus, the upper limit on rail rates in the long run is truck costs. In turn, truck rates cannot, under normal conditions, substantially and continually exceed rail rates. Thus, through the competitive interaction of rails and trucks each mode constrains the others rates. Additionally, the exempt carrier industry adds capacity and flexibility to the grain transportation system in North Daktoa. Overall, trucks plan an important role in the performance and conduct of the grain marketing system of North Dakota. Increased knowledge of the exempt carrier industry will provide a better understanding of the total grain marketing system in North Dakota. Information of this type will help to analyze and/or further develop the grain transportation and marketing system serving North Dakota

In arguing that the grain producer will benefit from this study it should be pointed out that the farmer (producer) pays the freight bills and therefore, has a pecuniary stake in the transportation industry of North Dakota. The reason that farmers pay the freight costs, as opposed to the buyers paying it, may be attributed to the observation that the producers are scattered throughout a wide geographical area, but must sell their produce in a centralized market.[5] In order for the farmer to sell his grain, he must place it at the central market and take the competitive market price for his product. If he produces his product 250 or 500 miles from market the price he receives for the grain is the same but the transportation costs differ. Thus, the farmer pays the transportation to the market and receives the same price as all other

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[4]For Further explanation, see Locklin, Op. Cit., p. 654.

[5]Op. Cit., Locklin, D.P. pp. 49-65.

producers regardless of their proximity to the market. This is exemplified by the manner in which the country price of grain is determined; i.e., the producer receives the terminal market price less transportation costs to that market. Therefore, the freight rates charged by the transportation industry in North Dakota have a direct influence on the farmers' total costs. The farmer's total costs affect his profits which in turn affects the economy of the state. Thus, the state, as well as the individual producer, will benefit through increased knowledge of the exempt motor carrier industry in North Dakota.

Objectives

The overall objective of the study is to determine and evaluate the structure and the cost of operation of that portion of the exempt for-hire motor carrier industry which provides a transportation service for the marketing system of North Dakota grain from country elevators to terminal markets. The specific objectives are to:

1. Investigate the market structure of the exempt motor carrier industry in North Dakota.

2. Determine the costs of transporting grain by exempt motor carrier.

This study is primarily concerned with eastbound grain movements by truck from North Dakota. The survey data were collected during the spring of 1977.

Since the data were drawn during only one season, it must be recognized that there may be some bias. A future follow-up survey would reveal if this factor significantly biased the results of the study. Again, it must be noted that the study dealt only with North Dakota and that ohter states and areas may have differences in regulation, geography, etc., that maysubstantially affect the market structure and operations of the exempt carrier industry in that territory.

Conceptual Framework

All costs incurred in production are usually divided into either fixed or variable costs. Fixed costs are those costs which do not vary with output. Variable costs are those costs which increase as the level of output increases. Fixed costs can occur only in the short run, since in the long run all costs may be considered as variable.

The theorectical economic cost concepts are readily adaptable to the per unit costs of transporting grain by truck. The main problem area is how to quantify the output of transportation.[6] In the majority of transportation economics texts the abscissa of the cost diagrams are usually labeled output, with no attempt made to define the content of that unit of output. Utility theory states that transportation creates "place utility." That is, transportation provides utility to the extent that it moves a good from an area of lower relative value (for example, a production point) to an area of higher

[6]Much of the following discussion is drawn from: Wilson, G.W., Essays on Some Unsettled Issues in the Economics of Transportation, Foundation for Economic and Business Studies, Indiana University, 1963, 182 pp.

relative value (a consumption point). Thus, an attempt to measure the output of transportation or any other "utility" producing industry involves an attempt to measure utility. Without a cardinal measure of utility or a standard "util", the measurement of transportation's output in terms of creating place utility becomes dubious at best.

Since utility is an abstract concept which defies cardinal measurement, a proxy variable must be used to estimate transportation's output. Initially, mileage may seem to be the appropriate variable to measure transportation's output. Using this concept, output would be measured by the distance a good was moved by a transport firm. The weakness of using distance as the proxy variable to measure output is the problem of comparing the output of two transport firms, one who moves one unit X miles while the other moves two units the same X miles. Relying on distance alone as a measure of output would mean both firms were producing an equal output of X miles. However, one firm will have moved twice as many goods as the other firm and, as such, cannot be producing an equal amount of place utility. Thus, the proxy variable used to measure transportation's output must also include a volume or weight factor. To this end, the ton-mile unit has been developed and used to measure transportation's output. A ton-mile is defined as the movement of one ton of a good one mile. A ten ton shipment transportation five miles would equal 50 ton-miles of output. Using the previous example, the firm transporting two units X miles would yield 2X ton-miles of output while the other firm would only be producing 1X ton-miles of output. Thus, the firm moving the larger volume of goods an equal distance produces a larger output. Therefore, the ton-mile may be used as an adequate proxy variable to measure the output of place utility created by transportation.

However, the ton-mile is not a perfect measure of transportation's output. Other consideration, such as the quality of service (involving such factors as loss and damage, speed of delivery and flexibility of service) and the type of commodity or good transported are not included in the ton-mile unit. One ton-mile of output requiring a week to produce cannot be the same output as one ton-mile produced in a day. Neither can a ton-mile of output involved in transporting oranges be said to create the same place utility as a ton-mile of output involved in transporting apples. Thus, the ton-mile unit may be said to be less than a perfect proxy variable with which to measure and allow easy comparisons of the transportation industry's output. Presently, however, the ton-mile is the variable best suited to fill the needs of the proxy variable necessary to measure transportation's output of place utility and will be used in this study.

Industrial Organization

The branch of economics referred to as industrial organization analyzes the effects of market structure upon a firm or industry. The theory of industrial organization provides a basis for analyzing the market structure of an industry and allows for prediction and understanding of its resultant effects upon the conduct and performance of the industry. In analyzing market structure, numberous characteristics of the industry are considered.[7] The most important of these characteristics include the following items.

1. Cost conditions.

2. Pricing behavior.

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[7]Needham, Douglas, Economic Analysis and Industrial Structure, Holt, Rhinehard and Winston, New York, 1969.

3. Product differentiation.

4. Concentration.

5. Barriers to entry.

6. Vertical integration.

7. Diversification.

For the purpose of analyzing the market structure of the exempt grain carrier industry in North Dakota, each of the above listed characteristics will be developed and analyzed. Additionally, characteristics unique to the grain trucking industry will be presented and analyzed.

Sources of Data

Four primary data sources were utilized in this study. The first source of data was the North Dakota Public Service Commission's "Grain Movement Reports." From this source the name, address, and truck shipments of all the elevators in the state of North Dakota were drawn. The second source of data was a mail survey questionnaire sent to every elevator in North Dakota. The elevator survey was designed to determine the elevator operator's perspective of the exempt carrier industry. The third data source was developed from personal interviews with grain truckers passing through the Ports of Entry at Grand Forks and Fargo, North Dakota. The personal interviews were designed to provide rates and a general background of the grain trucking industry. During the personal interviews a return mail questionnaire was given to the grain truck drivers if they were owner-operators. If the truck was owned by someone else the questionnaire was sent to the owner. The returns from this questionnaire comprise the fourth data source for the study. The trucker questionnaire was designed to identify characteristics, market structure, and cost of operation of the exempt carrier industry.

In total, there was a 32 percent return on the elevator questionnaire. Personal interviews with truckers comprising a total of 205 were completed and 84 of a total 600 truck questionnaires were completed and returned.

Cost Components

In conducting the cost analysis for both the economic-engineering and reported cost data, costs were separated into fixed and variable costs. Fixed costs consisted of depreciation, interest on investment, license fees, insurance, management and administration, housing, and miscellaneous expenses. Variable costs included tires, fuel, maintenance and repairs, and driving labor.[8]

The fixed cost components were defined as follows.

Depreciation. A decrease or loss in value because of wear and/or age and other causes. Every capital asset that is not totally consumed in one accounting period (typically one year) must be depreciation to apportion that amount of the good that was consumed to the corresponding year it was utilized.

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[8]Much of the following analysis is modeled after: Griffin and Tosterud, "Grain Transportation Costs and Characteristics for North Dakota Farm Trucks," UGPTI Report No. 28, Upper Great Plains Transportation Institute, North Dakota State University, Fargo, North Dakota, 1975.

Several methods such as sum of the years digits, declining balance, and straight-line depreciation are used to estimate the amount of the capital asset that has been consumed in one period and, as such, should be charged off as an expense.

Depreciation has two aspects - time and usage. This means that depreciation due to time should be recorded as a fixed expense (it does not vary with output) while depreciation due to usage should be recorded as a variable expense. However, the actual apportionment of depreciation into the category of fixed or variable cost is in many cases impractical. For that reason, depreciation was considered as a fixed cost. The reason for this is based on the assumption that the grain trucking firms in the study are "going concerns," utilizing their equipment on a daily basis. Thus, the age of the truck would yield a fairly accurate prediction of the truck's usage and as a result the truck's present value.

Of the various depreciation methods available, the straightforward simple method of straight-line depreciation was used. Straight-line depreciation is based on the difference between purchase price and present value and the years of ownership.

Interest on Investment. Interest on investment is the interest payment due on an investment. If a capital asset is debt financed, in whole or in part, there is an explicit interest payment made on the principal of the loan. If, however, the captial asset is purchased outright, there is an imputed opportunity cost on that investment. This opportunity cost may be viewed as the return on investment available if the money was not used to purchase the particular capital asset but rather invested in its next best opportunity.

Interest on investment was calculated at ten percent of the capital investment in the business.

License Fees. License fees are paid on an annual basis having no relationship to total utilization of the truck and, therefore, were defined as fixed costs. Most North Dakota grain haulers are base plated in North Dakota and prorated in Minnesota. Under the prorate system, a trucker pays a percentage of each state's license fees based on the number of miles driven in that state each year. For example, a North Dakota grain hauler traveling 50,000 miles per year in North Dakota and 70,000 miles per year in Minnesota would pay 42 percent of North Dakota's license fees and 52 percent of Minnesota's license fees. The prorate system, while based on the mileage driven in each state, does not vary with the total mileage driven and, therefore, leaves license fees as a fixed cost item. However, since different truckers travel different mileages within each state and each state's license fees vary, the total license fees paid by various truckers will differ.

In North Dakota, the license fee for a semi-tractor is based on the vehicle's year and the gross vehicle weight. Most grain haulers in North Dakota are licensed for either 73,280 pounds (Minnesota's maximum allowable weight) or 80,000 pounds (North Dakota's maximum allowable weight). In North Dakota trailer license fees are based on a flat rate of ten dollars.

Insurance. Insurance premiums, like license fees,are a recurring expense that can only be avoided by shutting down operation, and therefore, were classified as fixed cost.

Management. Management expenses were classified as a fixed cost since they do not vary greatly with output.

Housing. Housing costs are also incurred on a fixed basis and do not vary with the utilization of the vehicle. Therefore, housing was classified as a fixed cost. Housing costs were based on the value of the building used

for housing the truck, the percentage of the total space occupied by the truck and a ten percent rate of interest. If the building was rented, the annual rent paid and the percentage of the total space occupied by the truck were used to determine the housing costs.

Miscellaneous Expense. Miscellaneous expense items such as tarps, miscellaneous permits, telephone and utilities were classified as a fixed cost.

The variable cost components were defined as follows.

Tires. Tires were considered as a variable cost item since a tire's life is based primarily on usage.

Fuel. Fuel consumption is directly related to the use of the truck and was defined as a variable expense. Fuel costs were based on an average price of 58 cents per gallon and an average consumption of 4.5 miles per gallon.

Maintenance and Repairs. Maintenance and repair expenses were classified as a variable expense. The two categories were combined due to the lack of specific budgets for repairs and routine maintenance. However, both maintenance and repairs vary directly with the usage of the truck and, therefore, were classifed as a variable cost item.

Driving Labor. Driving labor costs vary directly with the usage of the equipment, and therefore, were defined as a variable cost. The cost per mile for driving labor was developed from interviews with various trucking firms and the opportunity costs reported by owner-operators on the questionnaire.

Cost Calculations

Cost calculations for each firm responding to the questionnaire were based on its variable and fixed cost components and then averaged for an industry wide figure. For the engineering study, the costs were developed for a low, average, and high estimate of the given cost categories. For trucks hauling both grain and other goods the costs were weighted to reflect the costs incurred by the grain hauling operation.

Formulas for developing the per unit costs are as follows.

1. Average total costs =
   Average fixed costs + average variable costs (eq. 3.1)
2. Average fixed costs =
   Depreciation + interest on investment + license fees + management + housing + miscellaneous (eq. 3.2)
3. Average variable costs =
   Tires + fuel + maintenance + driving labor (eq. 3.3)
4. Average total costs per mile =
   $$\frac{\text{Average total costs}}{\text{Total yearly mileage}}$$ (eq. 3.4)
5. Average fixed costs per mile =
   $$\frac{\text{Average fixed costs}}{\text{Total yearly mileage}}$$ (eq. 3.5)
6. Average variable costs per mile =
   $$\frac{\text{Average variable costs}}{\text{Total yearly mileage}}$$ (eq. 3.6)

Chapter II

MARKET STRUCTURE

As a prelude to the market structure analysis the chronological sequence of a typical grain trucking trip will be presented. Assuming the trucker has already set up his grain load with the elevator, the initial part of this trip is from his home to the country elevator to load. The trucker arrives at the elevator at 8:00 a.m., Tuesday. Loading takes one hour and the trucker departs the elevator at 9:00 a.m. By noon the trucker is reporting at a weight station where the truck is weighed to determine if he is within legal weight limits. He departs from the weigh station at 12:15 p.m. By 3:00 p.m. the truck requires refueling. The trucker adds approximately 70 gallons of fuel at a cost of $40.00. At 3:30 p.m., after a cup of coffee, the trucker is on the road again. He reaches the terminal elevator in Duluth, Minnesota, at 6:00 p.m. and takes his place in back of the trucks ahead of him. The trucker must now wait until the elevator opens the next morning. After spending the night in his truck in the sleeper, at 7:30 a.m. on Wednesday morning the trucker rolls back his tarp to enable elevator personnel to probe for a sample from his load of grain. The sample is then checked to determine its quality. At 9:00 a.m. the first truck is dumped. Assuming the lines are not too long and there are no problems with the elevator, the truck is dumped by 10:00 a.m. and departs for North Dakota. A fuel stop is required at 12:30 p.m. where 60 gallons of fuel are added at an approximate cost of $35.00. At 1:00 p.m. the trucker departs from the truck stop. By 3:00 p.m. he is back at the weigh station and since the truck is empty he is usually waved through and is back on the road by 3:05 p.m. Finally, at 6:00 p.m., Wednesday, the trucker has completed the trip and returned home. Once he is home, the trucker adds 60 gallons of fuel at a cost of approximately $35.00 and checks and prepares his equipment for the next trip. In total, the trucker was on the road for approximately 34 hours and used approximately 190 gallons of fuel to deliver an average payload of 912 bushels. During the 1975-76 crop year, 91,894 truck trips were made from North Dakota to terminal markets. Presented in Table 2 are the total number of truck trips and total bushels transported by truck for the last four crop years.

TABLE 2. TOTAL TRUCK SHIPMENTS OF GRAIN FROM NORTH DAKOTA BY CROP YEAR.

Crop Year	Number of Truck Shipments of Grain	Bushels	Percent of Total Grain Movement
1975-76	91,894	83,792,893	26
1974-75	67,276	61,928,507	21
1973-74	114,136	111,480,789	27
1972-73	114,479	109,924,961	25

Source: North Dakota Public Service Commission, Grain Movement Reports.

Industry Characteristics

There is no census of exempt carriers in the state of North Daktoa. Wyckoff and Maister estimated in 1974 that there were 98,000 independent owner-operators in the United States, with exempt carriers representing 40,000 of this total.[9]

From the data presented in Table 2 an estimate of the number of exempt carriers operating in the state of North Dakota may be obtained. Assuming three loads per week, 50 weeks per year, one truck at maximum capacity could haul 150 loads per year. In the 1975-76 crop year, 91,894 loads of grain were transported from the state. Assuming maximum utilization per truck, the minimum number of trucks required to transport the given quantity of grain for the 1976 crop year is 613 trucks. However, it is unlikely that all trucks were used at their maximum capacity. If, however, a lower level of utilization is assumed, then there would have to be more carriers serving the state. For example, if the exempt motor carrier averaged two loads per week, then a higher estimate of 919 truckers is developed. In any case, it seems likely that during the 1975-76 crop year there were between 600 and 1,000 trucks utilized in the transportation of North Dakota's grain to terminal markets. Presented in Table 3 are the low and high estimated number of trucks serving North Dakota for the last four crop years.

TABLE 3. ESTIMATED NUMBER OF EXEMPT CARRIERS HAULING GRAIN IN NORTH DAKOTA.

Crop Year	Low Estimate[a]	High Estimate[b]
1975-76	613	919
1974-75	449	672
1973-74	761	1,115
1972-73	763	1,099

[a]Based on three loads per week, 50 weeks per year.
[b]Based on two loads per week, 50 weeks per year.

Data on 219 trucks representing 84 firms were available from the exempt carrier mail survey. Of these, 54 percent of the firms were owner-operators (one tractor), 34 percent were small firms (two to five tractors), and 12 percent were large firms (over five tractors). The average size firm for the total sample was a three tractor, four trailer firm.

Owner-operators average seven years in business while the small firms averaged nine years and the large firms 17 years in business. The average length of time in business for the total sample was nine years. It is interesting to note, however, that the mode of the years of service was four years. In fact, over 50 percent of the sample had been in business less than five years.

The North Dakota grain trucking industry is primarily made up of North Dakota truckers, Minnesota truckers, elevator owned trucks and common carriers hauling grain as a back haul. The percentage of the total truck movements performed by each of these groups is presented in Table 4.

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[9]Op. Cit., Wyckoff and Maister, The Owner-Operator: Independent Trucker, Lexington, Massachusetts, 1977.

TABLE 4. GRAIN MOVEMENTS FROM NORTH DAKOTA BY TYPE OF TRUCKER.

Item	Percent of Total Truck Loads of Grain to Terminal Markets
North Dakota Truckers	55.7
Out-of-State Truckers	35.7
Elevator Owner Trucks	2.2
Common Carriers	6.5

Very few elevators own and/or lease trucks for the purpose of hauling grain to terminal markets. Based on data developed from the mail survey of North Dakota elevators, only 6.6 percent of the elevators in the state owned and/or leased tractor trailer rigs for the purpose of transporting grain to terminal markets.

Typically, grain truckers may haul exempt agricultural goods, livestock or other unregulated goods. Agricultural goods and livestock are exempted from ICC economic regulation. Regulated goods are typically any commodity whose transportation is subject to ICC regulation. The breakdown by percentage of total mileage by type of good transported for North Dakota grain haulers is presented in Table 5.

TABLE 5. COMMODITIES HAULED BY PERCENT OF TOTAL MILEAGE FOR NORTH DAKOTA GRAIN HAULERS.

Type of Good Hauled	Percent of Total Mileage
Exempt Agricultural Goods	78.5
Livestock	2.7
Other Commodities	17.8

Total mileage varied somewhat with the size of firm. Presented in Table 6 is the average total yearly mileage for each size category of grain trucking firm.

TABLE 6. AVERAGE TOTAL YEARLY MILEAGE BY FIRM SIZE.

Size of Firm	Total Yearly Mileage
Owner-Operator	94,555
Small Firm	83,673
Large Firm	73,269
Total Sample	81,911

Grain trucking firms that have an established business usually have a definite trade area. Of the truckers surveyed, 92.8 percent reported that they served one or a few elevators on a regular basis. On the average, these "regular" elevators represented 80 percent of the total trucking business which indicated the existence of established trade areas for North Dakota grain trucking firms.

Several characteristic changes have taken place in the grain trucking industry in North Dakota since a study of the industry was done by Casavant[10] in 1967. The average size of all firms has remained constant at a three tractor - four trailer firm. Annual vehicle mileage for all firm sizes has increased from 61,400 miles reported in Casavant's study to 81,911 total yearly miles per vehicle. In addition to the increase in yearly mileage, the average load size has increased from 22 tons in 1967 to 24 tons in 1977.[11] As a result of these changes, the average ton-miles of grain per vehicle has increased from a 1967 figure of 810,500 to 982,932[12] ton-miles of grain per vehicle. Back hauls for all firms have decreased on the average from 24 percent of the return trip mileage in 1967 to 20 percent of 1977. However, there was considerable variation in back hauls between firm sizes. The percent of return trip miles which were loaded miles for each size category of grain trucking firms is presented in Table 7. The owner-operators had the least amount of back hauls.

TABLE 7. LOADED BACK HAULS AS A PERCENT OF RETURN TRIP MILEAGE BY FIRM SIZE.

Size of Firm	Percent of Return Trip Mileage which was Loaded Return Trip Miles
Owner-Operators	8
Small Firms	11
Large Firms	34
Total Sample	20

There has been a substantial change in the length of time in business since Casavant's 1967 study. Casavant reported that "eighty-eight percent of the truckers in the sample had been in business five years or more, 70 percent, ten years or more, 44 percent, 15 years or more and 30 percent had been in business 20 years or more."[13] Following this methodology, only 62 percent of the truckers in the present sample have been in business five years or more, 36 percent, 10 years or more, 22 percent, 15 years or more, and 13 percent,

[10]Casavant, K.L., and Nelson, D.C., "An Economic Analysis of the Cost of Operating Grain Trucking Firms in North Dakota," Agricultural Economics Report No. 54, Department of Agricultural Economics, Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, 1967.

[11]North Dakota Public Service Commission, Grain Movement Report, 1976-77.

[12]Based on 50 percent grain miles, 24 tons average load and 81,911 average total miles traveled per year.

[13]Op. Cit., Casavant, p.9.

20 years or more. The decline in each category indicates that a more rapid entry and exit rate exists in the industry today than in 1967. As discussed previously, 50 percent of the sample had been in business five years or less. This leads to the conclusion that something has altered the structure of the industry since 1967 which has resulted in realtively less stability in terms of the length of time in business. The change in age distribution may possibly be attributed to 1) an increased number of new entrants, 2) a decrease in older established truckers, or 3) a combination of the two. The present data are not sufficient to determine what factors have caused this shift in age distribution. However, one readily identifiable cause of the shift may be conceptually eliminated. That reason being an increase in new entrants due to an absolute increase in volume of movement by truck. In the 1967-68 crop year, 75,330[14] truck loads of grain were transported to terminal markets while during the 1976-77 crop year, 91,894 loads were transported, or an increase of 18 percent. Casavant reported that the exempt carrier industry was operating at the 45 percent level of capacity[15] in 1967. Thus, given the existing excess capacity in the industry it is doubtful that an 18 percent increase in volume would lead to a substantial shift in the age distribution due to new entrants within the industry. Therefore, the increased volume of grain transported may be conceptually dismissed as the cause of the age distribution shift.

Market Structure

Cost Conditions

The cost conditions that the exempt carrier industry faces vary somewhat from traditional economic cost concepts. This is due to the contention that for a firm to increase its output it must at some point add additional trucks. Assuming that variable costs per truck remain relatively constant and there is no excess capacity, the addition of another truck to a firm tends to increase the firm's fixed costs. Therefore, for a one truck firm, average fixed costs will be reduced with increased output up until the point of maximum utilization is reached. At this point another truck must be purchased and fixed costs will increase to a new higher level due to the second truck. As output is then further increased, average fixed costs will again decline until the maximum utilization for two trucks is reached. This results in a discontinuous cost function[16] (see Figure 1).

There are several assumptions encompassed in Figure 1. The first assumption is that the maximum output attainable by one truck per year is 1,500,000 ton-miles. This is based on a maximum capacity of three grain loads per week from North Dakota, 50 weeks per year, traveling an average 422 miles loaded with 24 tons of grain. The second assumption is that average variable costs remain constant per truck for any size firm. The third assumption is that the addition of another truck will increase fixed costs above the previous level. Thus, the discontinuous cost function for exempt carriers portrays only diseconomies of scale (curve ABC).

The data of the present study were not sufficiently complete to enable the statistical analysis of the discontinuous cost function illustrated in Figure 1. However, the available data does lend support to this type of cost function. Further discussion of this topic is left to the discussion

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[16]For a more in-depth discussion of this theory, see Brems, Hans, "A Discontinuous Cost Function," American Economic Review, Volume 42, 1952.

of truck costs based on reported data. Additionally, the actual industry make up supports the contentions that there are very few, if any, economies of scale. This is exemplified by the findings that over 70 percent of the total output produced in the North Dakota grain trucking industry is produced by small firms or owner-operators.

Pricing Behavior

One of the initial questions in the pricing behavior of exempt carriers is who sets the rate? The responses by elevator operators to this question are presented in Table 8. The trucker's response to the rate setting question is presented in Table 9. As shown in Tables 8 and 9, there is no clear cut answer to the rate setting question. However, a majority of both the truckers and the elevator operators cite "negotiation" and "set by the elevator" as the method by which rates are determined. If the rate is negotiated, 42 percent of the elevator operators and 46 percent of the truckers indicated that the "time of year" and "availability of rail cars" affect the level of the truck rate (see Table 10).

Relatively few of either the truckers or the elevator operators feel that truckers set the rate. However, 27 percent of the elevator operators and 50 percent of the truckers surveyed felt that elevators set the rates. This indicates very little rate setting power on the part of the truckers which points to a purely competitive market structure.

Conceptually, competition sets truck rates. From the trucker survey, however, it was found that 93 percent of the truckers serve one or a few elevators on a regular basis. Thus, potential competition must be viewed as the primary rate determinant. Due to the great amount of flexibility in the exempt carrier industry, it is unlikely that a trucker could successfully charge a rate above the competitive rate without soon attracting additional truckers to the area and, as a result, force the rate down. In support of this contention are the findings that 63 percent of the elevator operators felt that truckers compete with each other sufficiently to provide good service at reasonable rates. When asked if truckers generally compete for their business, 65 percent of the elevator operators reported that they did not. This supports the hypothesis that it is potential rather than actual competition that affects rates.

As discussed previously, rail rates tend to set an upper limit on truck rates. When questioned, 56 percent of the elevator operators said that they preferred rail shipment over truck shipments when the rates are equal while 24.2 percent reported that they were indifferent between rail and truck shipments providing the rates were equal. Thus, it may be implied that 81 percent of the elevator operators would ship by rail if truck rates exceeded rail rates. Typically, truck rates are somewhat lower than rail rates. In fact, the reported average reduction in truck rates necessary to make an elevator operator indifferent between truck and rail shipments was six cents per hundredweight.

Comparative rate profiles between truck and rail rates for wheat and barley shipped to Minneapolis and Duluth are presented in Figures 2 through 5. Truck rate data was developed from the elevator surveys. Rail rate data was drawn from the Minneapolis Grain Exchange, "Grain Rate Book Number 13." Regression analysis was then used to develop the rate comparisons. To allow for a proper comparison between the rates both the truck rates and rail rates are shown in relation to shortest single line rail miles. In the shipment of wheat to Duluth and Minneapolis, truck and rail rates are approximately equal

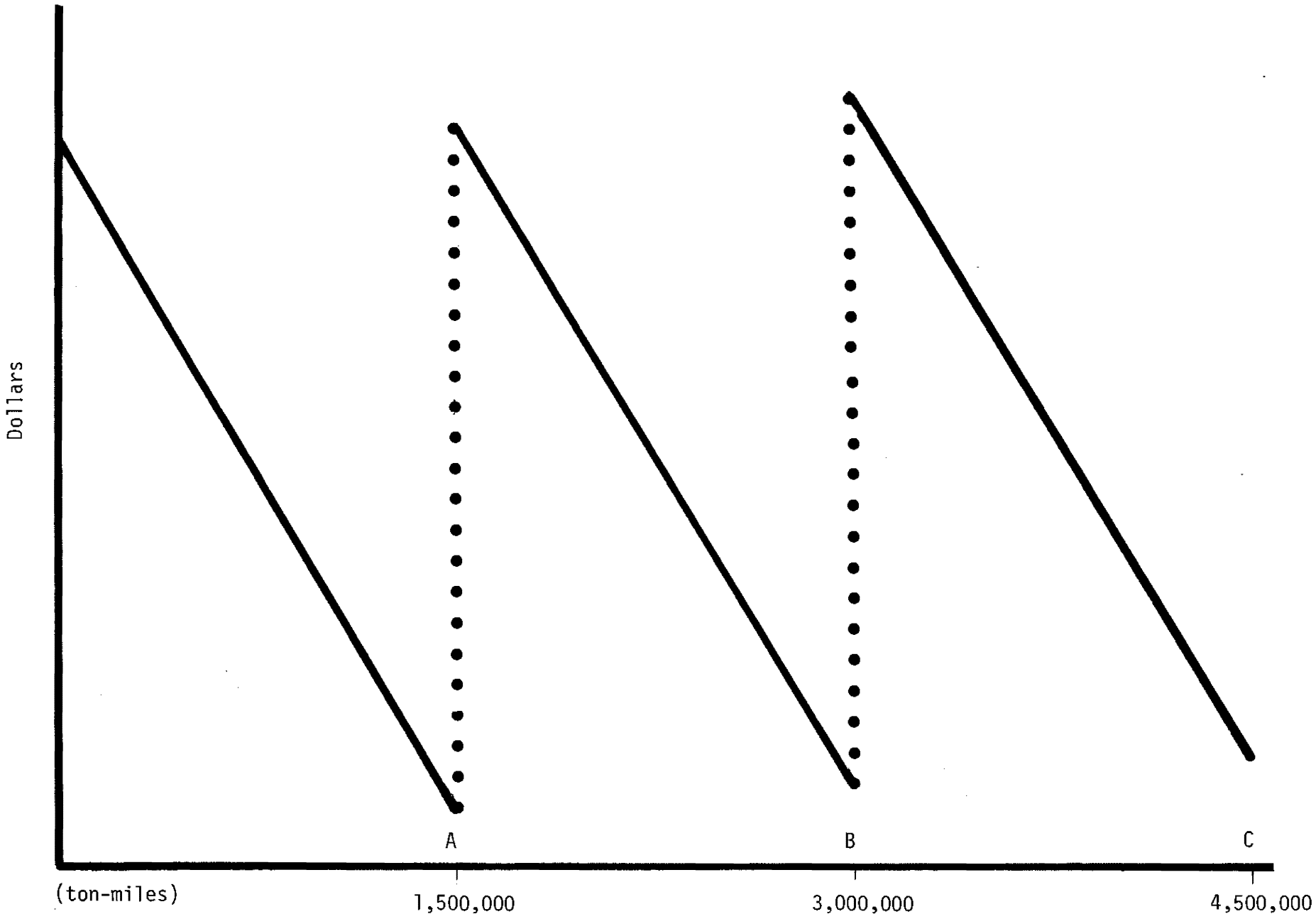

Figure 1. Hypothetical Discontinuous Cost Function

TABLE 8. ELEVATOR OPERATORS RESPONSE TO: "HOW ARE RATES DETERMINED?"

Response	Percentage
Negotiated	31.8
Set by Commission Firm	8.9
Set by Truckers	9.6
Set by the Elevator	26.8
Same or Close to the Rail Rate	21.5
Do not Know	0.66
Other	0.66

TABLE 9. TRUCKERS RESPONSE TO: "HOW ARE RATES DETERMINED?"

Response	Percentage
Negotiated	18.8
Set by Commission Firm	11.1
Set by Truckers	2.6
Set by the Elevator	50.4
Same or Close to the Rail Rate	14.5
No Opinion	1.7
Other	0.85

TABLE 10. RESPONSES TO "WHAT FACTORS AFFECT THE LEVEL OF THE TRUCK RATE?"

Response	Elevator Operators	Truckers
	(percent)	(percent)
Time of year	23.3	23.8
Availability of rail cars	19.0	22.6
Price of grain	10.6	17.9
Speed of delivery	14.1	8.3
Service of the trucks	16.8	N.A.
Service of the railroads	10.6	11.9
Don't know	3.8	11.9
Other	1.9	3.6

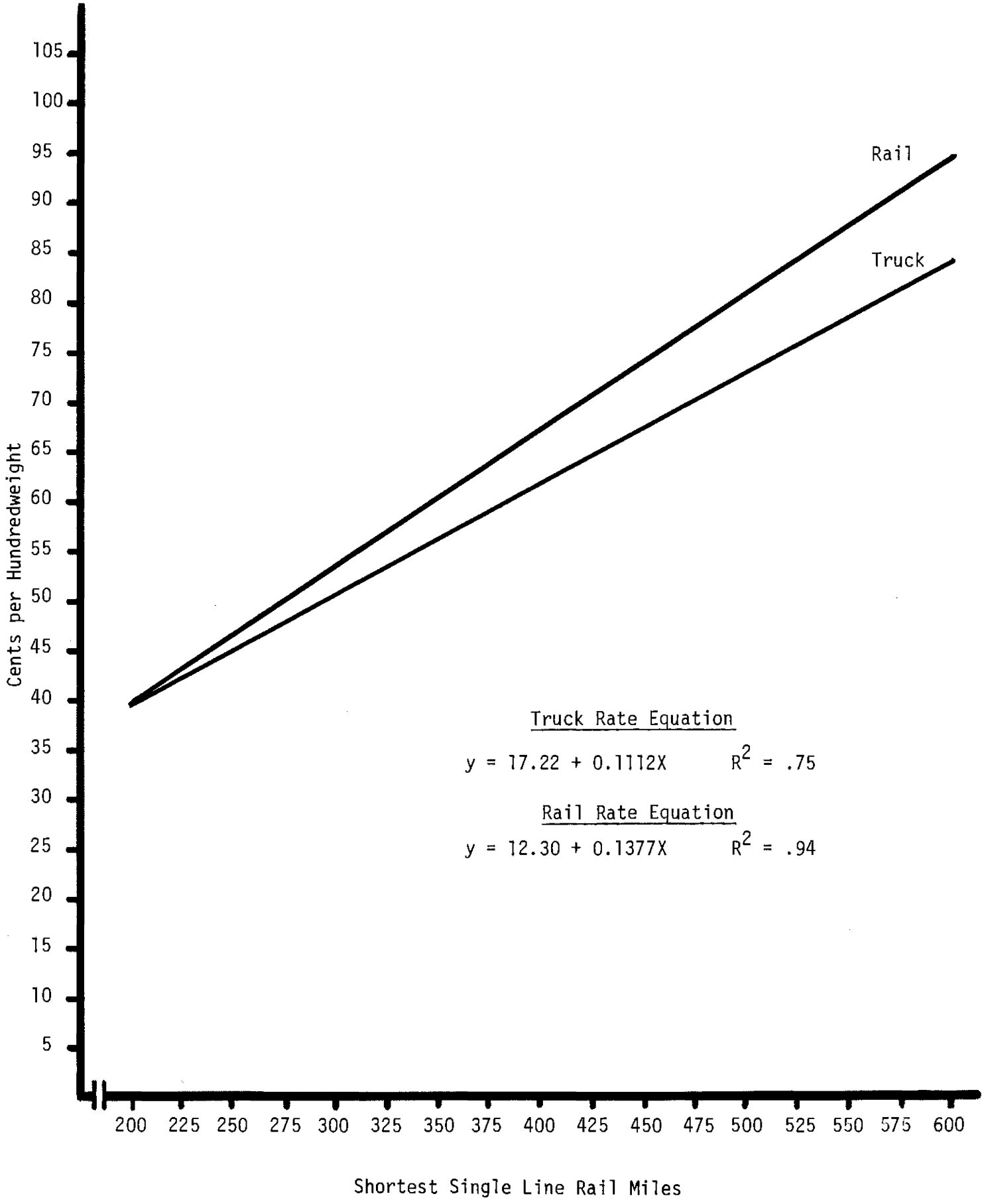

Figure 2. Truck Versus Rail Rates for Wheat Shipments to Minneapolis

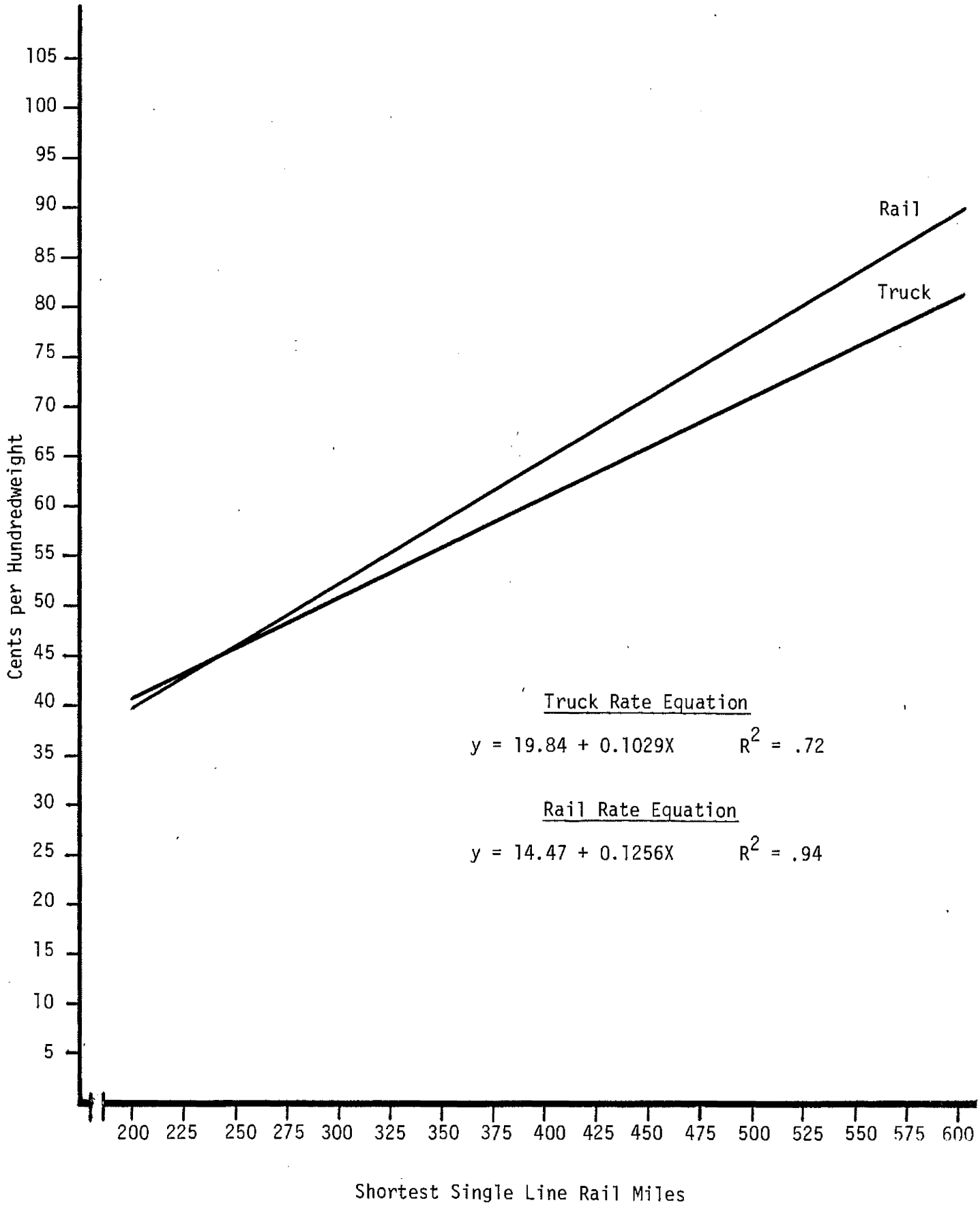

Figure 3. Truck Versus Rail Rates for Wheat Shipments to Duluth

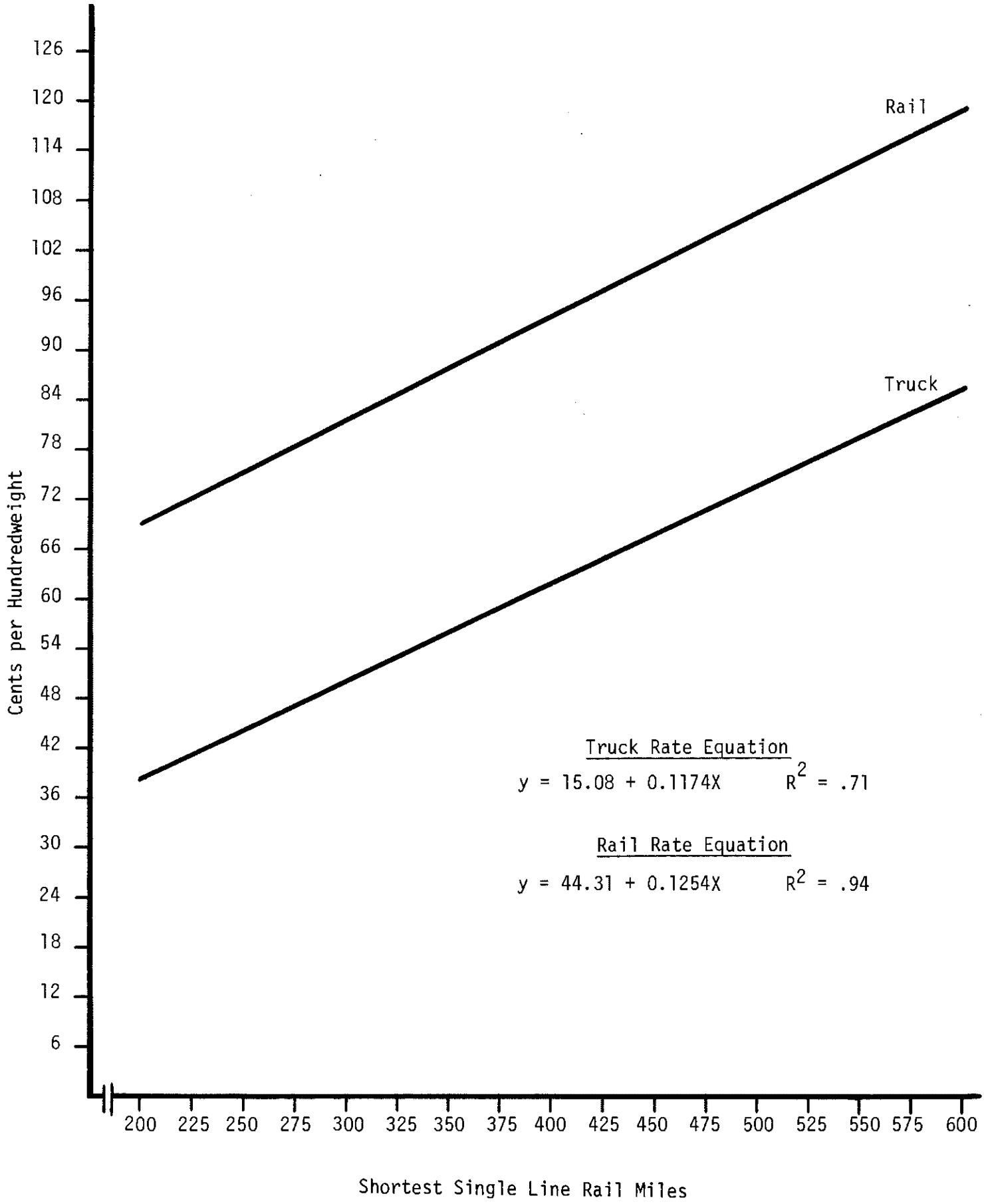

Figure 4. Truck Versus Rail Rates for Barley Shipments to Minneapolis

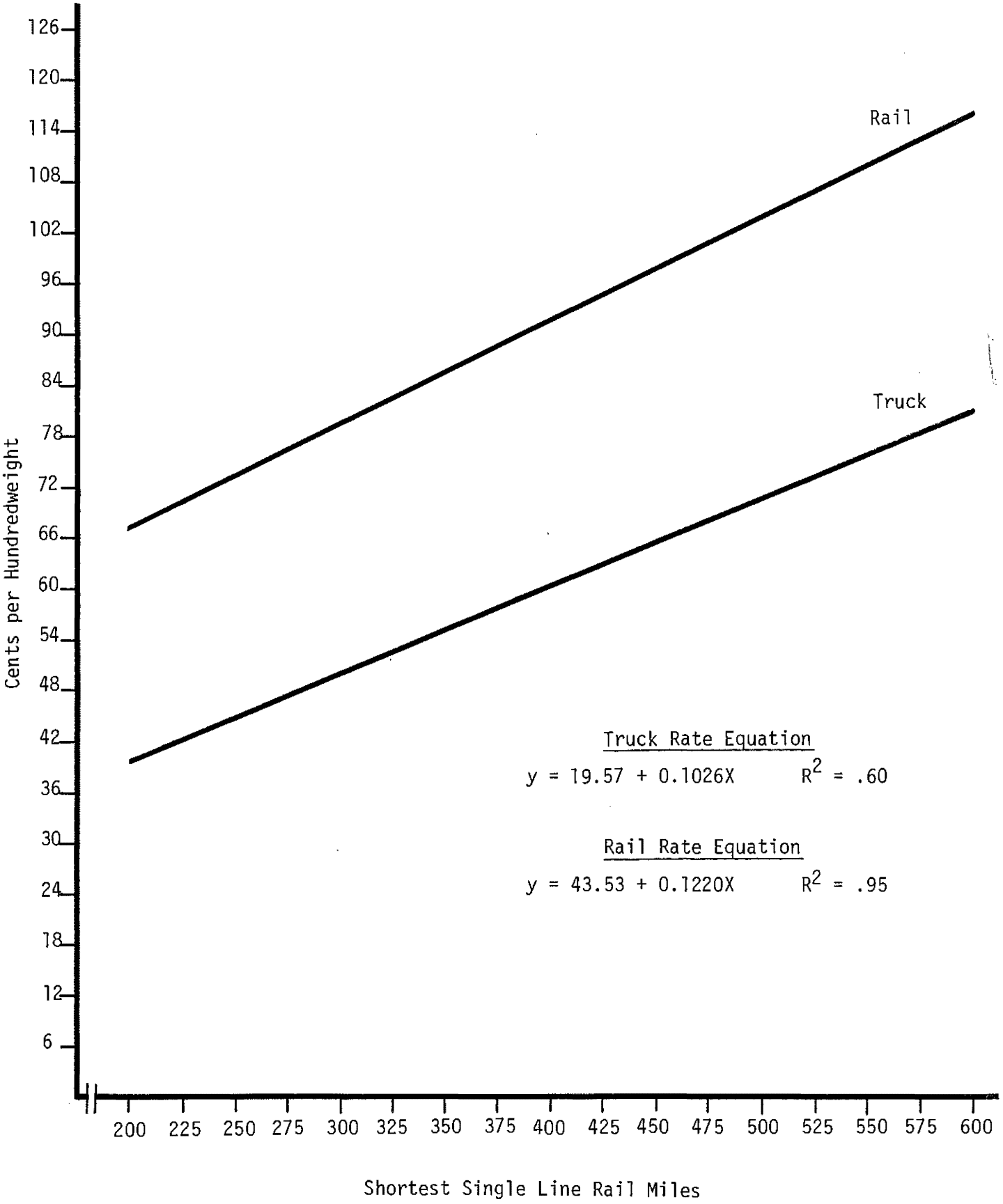

Figure 5. Truck Versus Rail Rates for Barley Shipments to Duluth

at 200 miles from their respective markets. However, rail rates tend to increase faster leaving an approximate eleven cents per hundredweight gap between truck and rail rates 600 miles from the markets.

Rail barley rates are much higher than rail wheat rates. The barley rate profiles illustrate the higher rail barley rates. It is interesting to note, however, that truck barley rates are nearly the same as truck wheat rates. This observation lends support to the contention that truck rates are competitively determined while rail rates are sheltered in a monoply.

Product Differentiation

Product differentiation is said to exist if in the eyes of the buyers the products of each firm in an industry are not substitutes. It is very difficult for an exempt grain hauler to differentiate his product through advertising, style change or research and development. Therefore, very few exempt trucking firms attempt to differentiate their product through these means. A trucker may, however, build goodwill with a shipper and, as such, differentiate his product. The elevator study revealed that 79 percent of the elevator operators surveyed preferred to do business with selected truckers. On the other hand, only 16 percent of the elevator operators reported that under normal conditions they would not ship grain with a totally new trucker. Thus, goodwill may be viewed as one of the few methods available for truckers to differentiate their service. However, based on the survey results, goodwill cannot be said to be a strong method of product differentiation. As a result, very little product differentiation exists in the grain trucking industry in North Dakota.

Concentration

Seller concentration deals with the number and output of firms within an industry. If an industry has a relatively few number of firms producing the majority of the industry's output, the industry is said to be concentrated. The extent to which an industry is concentrated affects the industry's behavior.

The grain trucking industry in North Dakota is characterized by a large number of small firms. Using loaded grain miles as the size variable and defining the industry as any semi tractor trailer hauling grain from the state of North Dakota facilitates the determination of the concentration of the industry. Market shares (based on loaded grain miles) for the three firm sizes discussed earlier are presented in Table 11.

TABLE 11. MARKET SHARES BASED ON LOADED GRAIN MILES FOR THE THREE FIRM SIZES.

Size of Firm	Total Loaded Grain Miles In Sample	Market Share Percentage
Owner-Operators	1,635,874	34
Small Firms	1,739,824	36
Large Firms	1,430,271	29

Since owner-operators or small firms account for over 70 percent of the industry's output, the grain trucking industry in North Dakota may be viewed as a relatively unconcentrated industry and, as such, is dominated by a relatively large number of small producers.

Barriers to Entry

A barrier to entry is any obstacle that would prevent a new firm from entering an existing industry. Typically, if an industry's prices exceed the average cost of production in the long run, barriers to entry are said to exist. The amount that the price exceeds that average cost of production is determined by the height (strength) of the barriers to entry.

The exempt trucking industry in North Dakota does have some barriers to entry. However, it is unlikely, in most cases, that these barriers are significant enough to hold price much above the average cost of production. Some barriers, such as capital investment and expertise within the field are common to most industries. However, the capital investment requirements of the exempt carrier industry are not excessive enough to create a significant barrier to entry. In addition, the expertise necessary to run an exempt carrier business may be developed by working for another trucking firm while accumulating the necessary capital to enter the industry.

The three main categories of barriers to entry are 1) preference of buyers, 2) absolute cost advantages, and 3) economies of scale.[17] In the area of buyer preference, 79 percent of the elevator operators surveyed reported that there are certain truckers with whom they prefer to do business. The main reason cited by 70 percent of the elevator operators is that they know those truckers are reliable. When asked if under normal conditions they would be willing to ship grain with a totally new trucker, 16 percent responded no. The primary reason for the reluctance cited by 73 percent of the elevator operators was the lack of knowledge as to whether the new trucker was reliable. Thus, the new entrant in the industry faces a barrier in the form of buyer preferences due to the elevator operator's knowledge of existing trucker's performance and reliability. This barrier, however, cannot be viewed as being very significant sine 81 percent of the elevator operators reported that they would or might be willing to ship grain with a totally new trucker.

In addition to an elevator operator's preference for certain truckers, 57 percent of the elevator operators surveyed reported that they prefer rail shipments. Presented in Table 12 are the reasons, other than rate considerations, which influence elevator operators to ship by rail.

TABLE 12. ELEVATOR OPERATORS RESPONSE TO WHAT FACTORS, OTHER THAN RATE CONSIDERATIONS, INFLUENCE THEM TO SHIP BY RAIL.

Factors	Percentage
Dislike truckers	2
Larger shipments by rail	79
Better service by rail	4
Lower loss and damage by rail	4
No opinion	8
Other considerations	4

[17] Op. Cit., Needham, p. 99.

Rail preference creates an effective barrier to entry. However, the preference for rail is faced by the trucking industry as a whole and cannot be seen as a barrier only to new entrants. Additionally, 43 percent of the elevator operators either preferred trucks or were indifferent between the two modes. Presented in Table 13 are the factors, other than rate consideration, which influence elevator operators to ship by truck.

TABLE 13. ELEVATOR OPERATORS RESPONSE TO WHAT FACTORS, OTHER THAN RATE CONSIDERATION, INFLUENCE THEM TO SHIP BY TRUCK.

Factor	Percentage
Dislike railraods	1
Better service by truck	9
Faster speed of delivery by trucks	22
More frequent service by trucks	11
Lack of railroad service	19
Lower loss and damage by truck	10
Like to keep truckers available	23
No opinion	2
Other considerations	2

In regard to an existing trucker's control of an area, only two percent of the elevator operators surveyed reported that certain truckers control their area and keep other truckers from servicing their elevator. Additionally, while 93 percent of the truckers surveyed serve one or a few elevators on a regular basis, only 11 percent of these truckers reported that they attempt to prevent other truckers from servicing their regular elevators. Thus, regional monopolies may not be said to be a substantial barrier to entry in the North Dakota grain trucking industry.

Absolute cost advantages are said to exist if the costs of the established firms in an industry are substantially lower than the costs of new or possible entrants into the field. In the exempt carrier industry in North Dakota there is no evidence to suggest that absolute cost advantages exist. If there were definite cost advantages in the industry, one would expect to find lower costs for older firms. However, the reported cost data did not support a relationship between these two variables. Therefore, absolute cost advantages are unlikely to be a barrier to entry in the North Dakota grain trucking industry.

A declining long run average cost curve would be an effective barrier to entry. However, there seems to be a few economies of scale present in the exempt carrier industry in North Dakota. One needs only to look at the dominance of the small producers in the industry to pragmatically determine the lack of economies of scale, as the industry exists today.

Finally patents and/or other legal restrictions are often cited as barriers to entry. In the exempt carrier industry in North Dakota anyone is free to enter the field. Since agricultural goods shipped interstate are exempt from ICC regulation there is no need to obtain operating authorities. The only legal restrictions imposed on the exempt carriers are the federal Department of Transportation safety regulations and insurance requirements. This is not the case in all states. For example, in Minnesota most of the

grain is transported intrastate and, as such, trucks are regulated and required to obtain operating rights from the state. For North Dakota, however, there are no substantial legal barriers to entry in the exempt grain trucking industry.

Overall, there are no substantial barriers to entry in the exempt carrier industry in North Dakota. Of the three main categories of barriers to entry, buyers preference is the most dominant. There are relatively small barriers to entry in the form of absolute cost advantages and economies of scale. However, in total, barriers to entry do not have a significant effect on the North Dakota exempt carrier industry.

Summary and Effects of the Market Structure and Industry Characteristics

Each of the variables discussed in this chapter individually and collectively affects the performance of the grain trucking industry in North Dakota. Basically, the industry may be characterized as a relatively large number of small producers interacting in a competitive atmosphere with easy entry into and exit from the industry. Individually, each trucker has little power to affect his rates and, as such, under normal conditions must accept the market determined rate. If any trucker attempted to raise his rates substantially, another trucker would move in and take his business away.

Judging from the response of the elevator operators, the exempt carrier industry in North Dakota is adequately serving their needs. On the average, over five truckers offered their services to each elevator. Additionally, 63 percent of the elevator operators surveyed reported that they felt that truckers compete with each other sufficiently to provide good service at reasonable rates. Thus, the agricultural exemption and resultant market structure of the exempt carrier industry in North Dakota appears to be fulfilling the present needs of the country elevators in the state. However, this is not an assurance that the exempt carrier will continue to be able to adequately perform the services required by the North Dakota country elevator. Several changes in the market structure since Casavant's 1967 study indicate that the exempt carrier industry in North Dakota should be viewed with vigilance. The most important of these being the shift in the age distribution towards newer entrants. This shift indicates an increased turnover rate in the industry and may be due to several factors. If the increased turnover is due to the cost and profit conditions within the industry, it indicates that the older firms that realize they cannot maintain a profitable business leave the industry and are replaced by new less experienced firms that could eventually be forced out of the industry due to the cost and profit conditions. Thus, the increased turnover rate could foreshadow the eventual decline of the exempt carrier industry in North Dakota.

The market structure of the exempt carrier industry in North Dakota may be said to tend toward ruinous competition rather than pure competition. The argument is that since most grain haulers are faced with large monthly payments, they will, in slow times tend to price on the basis of covering short run out-of-pocket costs. This could enable truckers to enter and stay in the industry in the short run but be forced into financial problems in the long run. If this indeed does exist in the industry today, it offers yet another cause of the shift in the age distribution towards newer entrants.

However, only 2.4 percent of the truckers surveyed indicated that they would lower rates to undercut another trucker and 68 percent reported that they based the minimum rate on anything above fuel costs, wages, average repair, maintenance and depreciation for the round trip. This, however, must be taken under normal conditions and provides no guarantee as to what would happen if the trucker was faced with defaulting on his payments.

Lastly, some additional aspects and characteristics of the grain trucking industry that do not fit well within the market structure framework will be discussed. In the sample of the trucking firms, 69 percent reported that they derived their main source of income from exempt trucking. The 31 percent who reported that exempt trucking was not their main source of income have a pronounced effect upon the industry. Those trucking firms primarily haul regulated commodities or have other full time jobs, such as farming that provide their main source of income. The regulated firms hauling grain as a back haul are in a position to charge lower rates than an exempt carrier hauling grain as a front haul. This is due to the fact that the regulated carrier has to return to his origin whether he is loaded or not. If, however, the regulated carrier loads with grain, any revenue received will increase the carrier's total revenue for the round trip. Therefore, the regulated carrier at a minimum can charge a rate that need only cover the increased expenses associated with running the truck loaded versus unloaded. Any return above this level adds to the carrier's profit for the total trip. The elevator survey revealed that 6.5 percent of the grain moved by truck in the crop year 1975-76 was transported by common carrier.

Loading and unloading times represent down time during which the trucking firms receive no direct pecuniary benefit. The average loading time reported by the elevators was 38 minutes from the time a truck reaches the elevator until the truck departs loaded with grain. Unloading time, however, consumes much more of the truckers time. The average unloading time reported by the truckers was ten hours and 40 minutes from the time a truck arrived at the terminal elevator until he departed empty. The average longest time to unload was 2.2 days while the average shortest unloading time was one hour. Therefore, loading and particularly unloading time tends to constrain the maximum obtainable capacity per truck of the exempt carrier firms.

The survey of the truckers revealed that less than eight percent of their loads were set up through brokers. Thus, brokers do not play a large part in the North Dakota exempt carrier industry. The majority of the loads, 78 percent, are arranged directly between the trucker and elevator. Presented in Table 14 are the trucker's response to the question, "How are most of your loads set up?"

TABLE 14. HOW GRAIN LOADS ARE SET UP BETWEEN TRUCKERS AND ELEVATORS

Setting up Load	Percentage
Elevator calls trucker	35
Trucker calls elevator	43
Commission firms calls trucker	2.5
Trucker calls commission firm	9
Broker calls a trucker	2
Trucker calls a broker	6
Other	2.5

Finally, 80 percent of the truckers surveyed reported that there was a slack season for hauling grain from North Dakota. Presented in Table 15 are the percentage of trucker's responses to when these slack periods occur.

TABLE 15. SLACK SEASON FOR GRAIN HAULING.

Month	Percentage	Month	Percentage
January	19	July	7
February	15	August	1
March	10	September	0
April	11	October	1
May	12	November	3
June	9	December	12

Chapter III

ECONOMIC-ENGINEERING APPROACH TO TRUCK COSTS

The economic-engineering approach to truck costs uses a synthetic cost analysis based upon data obtained from local equipment dealers, tire dealers, insurance agencies and various studies to develop costs. Estimates, where applicable, for each cost component were obtained for a low, average, and high range of the cost.

The first major cost confronting the exempt carrier is the cost of acquiring his equipment. Four local truck dealers[18] were asked to supply a low, average, and high estimate of the purchase prices of both new and used equipment. A simple average of the four estimates was then taken to develop the range of equipment costs presented in Table 16.

TABLE 16. NEW AND USED EQUIPMENT PURCHASE PRICE ESTIMATES.

Equipment	Low	Average	High
		(dollars)	
1977 Average Tractor	36,500	43,600	51,400
1977 Average Trailer	11,300	12,500	16,000
Average Used Tractor	6,100	14,800	27,500
Average Used Trailer	1,700	6,100	8,000

Depreciation for tractors was calculated using straight-line depreciation based on a four year depreciation period and a 30 percent of original purchase price salvage value. For trailers, the depreciation period was six years with a 25 percent of original purchase price salvage value. The depreciation periods were based on allowable depreciation periods set forth by the Internal Revenue Service. The salvage values were estimated using the average present value of new equipment and the average present price of a four year old unit. Based on used tractor prices, reported in "Transport Topics,"[19] it was established that the average price for a 1973 tractor was $13,313 in 1977. It was assumed that a 1973 unit is comparable to a 1977 unit which allowed comparison between the prices of the two units in terms of 1977 dollars. Given that the average 1977 tractor sold for $43,600 and that the average 1973 tractor sold for $13,313, the salvage value for a four year old tractor would be approximately 30 percent of its original purchase value in 1977 dollar terms. For six year old trailers, salvage value was estimated to be 25 percent of their original purchase price.[20] The depreciation costs for new equipment are presented in Table 17, and for used equipment in Table 18.

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[18] Wallwork's, Chesley, Midwest Mack, and Peterbilt, all of Fargo.

[19] "Transport Topics," national newspaper of the Motor Freight Carriers, February, 1977, March, 1977, April, 1977, and May, 1977.

[20] Op. Cit., Wyckoff and Maister.

Interest on investment was calculated on the basis of purchase price and salvage value of the equipment. Average investment was determined by dividing total investment (purchase price plus depreciation) by two which yields the average investment in the equipment over its life span. Interest was calculated on the basis of an average required rate of return of ten percent. In addition to equipment, an interest on investment charge was developed for working capital invested in the business. Interest on investment costs for new equipment are presented in Table 19 and the interest on investment costs for used equipment are presented in Table 20.

Typically, a North Dakota grain hauler will be "base-plated" in North Dakota and prorated in Minnesota. A Minnesota trucker would be "base-plated" in Minnesota and prorated in North Dakota. A truck is usually "base-plated" in the owner's state of residence and then prorated for other states in which he travels. Under the prorate system a trucker pays a proportion of each state's license fees in direct proportion to the percentage of his total mileage driven within each state. For the purpose of this analysis it was assumed that half of the total mileage is traveled in North Dakota and the other half in Minnesota. This results in the trucker paying 50 percent of North Dakota's and 50 percent of Minnesota's license fees. For license fees, only a low and average estimate of these costs was developed because the license fee for a 1971 or newer tractor in Minnesota is a flat fee. In North Dakota a 1975 or newer tractor is covered by a flat rate. For North Dakota and Minnesota the license fee for trailers is $10 and $11 respectively, regardless of the year of the trailer. This results in very little variability in license fees except for older equipment. The low and average estimates of the license fees incurred by grain haulers are presented in Table 21.

Insurance costs may be broken into three categories: 1) liability, 2) physical damage, and 3) cargo insurance. Liability insurance is required by law and cannot be avoided. Cargo insurance is usually required by shippers and, as such, must be obtained. If the equipment is financed, the owner is normally required to carry physical damage insurance. Only if the equipment is owned outright may the trucker avoid this expense and bear the risks of physical damage himself. Typically, however, most truckers have all three types of insurance and estimates of this cost are presented in Table 22.

Not all truckers provide housing for their equipment. However, due to the cold weather and the need for a place to work on their equipment, it was determined that housing costs were a legitimate expense and, as such, were included in the analysis. The range of estimates for housing costs per year are presented in Table 23. Estimates of miscellaneous costs such as telephone, lights, tarps, etc., are presented in Table 24.

Management and overhead expenses were based on broker's charges for their services. Brokers supply information, administration, and overhead in the service they perform. The broker effectively assumes the management function for the trucker. Although brokers are not frequently used in North Dakota's exempt carrier industry, their rates provide the best base on which to estimate the cost of management, administration, and overhead. Typically, brokers charge eight percent of the revenue of an agricultural load for the provision of their services.[21] Thus, the management function may be estimated

[21]Scott, Truck Brokers, selected agricultural products.

TABLE 17. DEPRECIATION COSTS FOR NEW EQUIPMENT

Item	Estimates		
	Low	Average	High
		(dollars)	
Tractor	36,500.00	43,600.00	51,400.00
Salvage Value	10,950.00	13,080.00	15,420.00
TOTAL DEPRECIATION	25,550.00	30,520.00	35,980.00
Depreciation Per Year	6,387.50	7,630.00	8,995.00
Trailer	11,300.00	12,500.00	16,000.00
Salvage Value	2,825.00	3,125.00	4,000.00
TOTAL DEPRECIATION	8,475.00	9,375.00	12,000.00
Depreciation Per Year	1,412.50	1,562.50	2,000.00

TABLE 18. DEPRECIATION COSTS FOR USED EQUIPMENT

Item	Estimates		
	Low	Average	High
		(dollars)	
Tractor	6,100.00	14,800.00	27,500.00
Salvage Value	1,830.00	4,440.00	8,250.00
TOTAL DEPRECIATION	4,270.00	10,360.00	19,250.00
Depreciation Per Year	1,067.50	2,590.00	4,812.50
Trailer	1,700.00	6,100.00	8,000.00
Salvage Value	425.00	1,525.00	2,000.00
TOTAL DEPRECIATION	1,275.00	4,575.00	6,000.00
Depreciation Per Year	212.50	762.50	1,000.00

TABLE 19. ANNUAL INTEREST ON INVESTMENT COSTS FOR NEW EQUIPMENT

Item	Estimates		
	Low	Average	High
Tractor			
Cost	$36,500.00	$43,600.00	$51,400.00
Salvage Value (30%)	10,950.00	13,080.00	15,420.00
Total Investment	47,450.00	56,680.00	66,820.00
Average Investment	23,725.00	28,340.00	33,410.00
Interest on Investment (10% rate of return)	2,372.50	2,834.00	3,341.00
Trailer			
Cost	$11,300.00	$12,500.00	$16,000.00
Salvage Value (25%)	2,825.00	3,125.00	4,000.00
Total Investment	14,125.00	15,625.00	20,000.00
Average Investment	7,062.50	7,812.50	10,000.00
Interest on Investment (10%rate of return)	706.25	781.25	1,000.00
Working Capital			
Amount	$ 3,000.00	$ 3,000.00	$ 3,000.00
Interest on Investment	300.00	300.00	300.00
Total Interest on Investment	$ 3,378.75	$ 3,915.25	$ 4,641.00

TABLE 20. ANNUAL INTEREST ON INVESTMENT COSTS FOR USED EQUIPMENT

Item	Estimates		
	Low	Average	High
Tractor			
Cost	$ 6,100.00	$14,800.00	$27,500.00
Salvage Value (30%)	1,830.00	4,400.00	8,250.00
Total Investment	7,930.00	19,200.00	35,750.00
Average Investment	3,965.00	9,600.00	17,875.00
Interest on Investment (10% rate of return)	396.50	960.00	1,787.50
Trailer			
Cost	$ 1,700.00	$ 6,100.00	$ 8,000.00
Salvage Value (25%)	425.00	1,525.00	2,000.00
Total Investment	2,125.00	7,625.00	10,000.00
Average Investment	1,062.50	3,812.50	5,000.00
Interest on Investment (10% rate of return)	106.25	381.25	500.00
Working Capital			
Amount	$ 3,000.00	$ 3,000.00	$ 3,000.00
Interest on Investment (10% rate of return)	300.00	300.00	300.00
Total Interest on Investment	$ 802.75	$ 1,641.25	$ 2,587.50

TABLE 21. LICENSE FEE EXPENSES

	Estimates	
	Low	Average
	(dollars)	
Tractor		
North Dakota	440.00	550.00
Minnesota	315.00	525.00
TOTAL	755.00	1,075.00
Trailer		
North Dakota	5.00	5.00
Minnesota	5.50	5.50
TOTAL	10.50	10.50
TOTAL FEES	765.50	1,085.50

TABLE 22. INSURANCE COSTS AND AMOUNT OF COVERAGE FOR NEW AND USED EQUIPMENT

Item	Insurance Cost	Insurance Coverage
	(dollars)	(dollars)
New Equipment		
Low Estimate	3,960	48,000
Average Estimate	4,482	56,000
High Estimate	4,923	67,000
Cargo Insurance	75	
Used Equipment		
Low Estimate	1,974	7,800
Average Estimate	2,579	21,000
High Estimate	3,335	35,500
Cargo Insurance	75	

*Personal interview, Darrel J. Buethner, Vice President, Dixon Insurance, Incorporated, Fargo, North Dakota; Liability and Physical Damage Insurance, based on a 500 mile radius, limits of 100/300/50.

TABLE 23. HOUSING COSTS PER YEAR.

Item	Housing Costs Per Month	Housing Costs Per Year
	(dollars)	(dollars)
Low Estimate	$50	$600
Average Estimate	75	900
High Estimate	100	1,200

TABLE 24. MISCELLANEOUS EXPENSES

Item	Miscellaneous Expenses Per Year	Cents Per Mile
	(dollars)	
Low Estimate	$1,000	0.010
Average Estimate	1,500	0.015
High Estimate	2,000	0.020

by increasing the total of all other expenses by 8/92 or 8.7 percent.[22] The average management expenses is thus estimated at $4,300 per year per truck.

In choosing tires, the trucker has a wide range of possibilities. He may choose recapped, fabric, or radial tires for his equipment. Recapped tires are the least expensive to purchase while radial tires are the most expensive. Typically, grain truckers will buy new tires and then recap them to obtain the most use from the tire. Radials, which are the most expensive to purchase, usually are the least expensive in the long run due to the ease of recapping radials and obtaining more mileage from them. Due to the complications of recapping and continued use of tires, only an average estimate of tire costs will be developed. The average expense for tires was estimated to be 2.2 cents per mile.[23]

During the calendar year 1976 to present, number one diesel fuel prices at the wholesale level increased approximately 12.5 percent.[24] Typically, a trucker will burn number one diesel in the winter and the cheaper number two diesel (approximately two cents per gallon cheaper) in the summer. In cold weather, number two diesel will gel and not flow and as a result number one diesel must be used. Attempting to develop a representative diesel fuel price over time is a dubious task at best. The continually changing prices due to changing supplies and demand coupled with different retail dealer

[22] Op. Cit., Wyckoff and Maister, p.33.

[23] Estimates from West Fargo Truck Stop, Ok Tire Company and Firestone Truck Center, all of Fargo.

[24] Personal interview, Alex Sahr, Sahr Oil Company, Fargo, North Dakota.

profit margins and the seasonal use of different grades of diesel fuel make the development of a representative price a risky, if not, an impossible task. A price of 57 cents per gallon was used as the price of diesel fuel and mileage ratings of trucks were provided by truck dealers. Presented in Table 25 are the fuel costs per mile for the various estimates.

Maintenance and repair costs were derived from the Hertz truck cost study.[25] As expected, the study showed that as a truck's age and mileage increased so did its cost of operation. "For a tractor-trailer, maintenance charges alone - including parts, labor, regular checking and service, plus road repairs and towing - topped $11,360 in the fifth running year, some 368 percent above the $2,450 it cost last year to maintain a new unit in its first year of service."[26] Presented in Table 26 are the estimated repair and maintenance figures for a 1976 truck in its first, second, third, fourth, and fifth year of service.

TABLE 25. FUEL EXPENSES PER MILE.

Item	Miles Per Gallon	Fuel Price Per Gallon	Fuel Expense Per Mile
		(cents)	(cents)
Low Estimate	5	57	11.4
Average Estimate	4.5	57	12.7
High Estimate	4	57	14.3

TABLE 26. REPAIR AND MAINTENANCE COSTS FOR A 1976 TRACTOR UTILIZED 100,000 MILES PER YEAR

Year	Repairs	Grease and Oil	Total
	(cents per mile)	(cents per mile)	(cents per mile)
First year	0.0245	0.0044	0.0289
Second year	0.0434	0.0044	0.0478
Third year	0.0988	0.0044	0.1032
Fourth year	0.0799	0.0044	0.0843
Fifth year	0.1146	0.0045	0.1190

Source: "Your $207,000 Truck," Hertz Truck, 1977.

Although the above maintenance figures are somewhat narrow in their application, it was felt that the Hertz study provided the best available data on truck maintenance and repair costs.

[25] "Your $207,000 Truck," Hertz Truck, 1977.

[26] Ibid., p. 3.

Payment to drivers for grain hauling is usually not determined on an hourly basis. Typically, drivers are paid on a cents per mile driven basis with no direct compensation for time requirements. From interviews with truck drivers and managers it was found that two basic methods of driver payment are common. The first method and the one used in this study is simply a rate stated in terms of cents per mile driven. The second method is referred to as "rate plus ten." Under this system, the driver receives the dollar equivalent of the rate plus ten dollars. For example, if the rate for a given mileage were 55 cents per hundredweight, the driver would receive $55 plus $10 or a total payment of $65. For an owner-operator there is no explicit charge for a driver. However, since the owner-operator performs the same duties as a hired driver there should be and is an implicit payment to the owner-operator for the service of driving the truck. Presented in Table 27 is the low, average, and high estimates for driving labor.

TABLE 27. DRIVING LABOR COSTS

Item	Cents per Mile
Low Estimate	10.5
Average Estimate	12.5
High Estimate	14.5

Truck drivers living on the road incur additional living expenses. These on-the-road living expenses are a legitimate expense item. However, as mentioned previously, drivers are paid on a trip basis. There are usually no additional expense payments to the drivers. Thus, on-the-road living expenses may be viewed as an imputed portion of the wage paid the driver and, as such, need not be considered in a separate cost category.

Combining all of the cost categories and converting them to a common basis yields the computation of the per mile total cost for both new and used equipment being driven 75,000, 100,000 and 125,000 miles per year. Presented in Table 28 are the fixed costs for new equipment. Illustrated in Table 29 are the variable costs associated with new equipment. Total per mile costs for new equipment are presented in Table 30. Presented in Tables 31 through 33 are the fixed, variable, and total costs for used equipment.

The average estimated total fixed costs for new equipment was 25.5 cents per mile for a truck being run 100,000 miles per year. For used equipment fixed costs were much lower at a total of 15.1 cents per mile. The lower fixed costs associated with used equipment is primarily due to lower depreciation and interest on investment associated with the smaller capital investment in used equipment.

Variable costs consisting of tire expense, fuel, maintenance and repairs, and driving labor are presented in Table 29 for new equipment and Table 32 for used equipment. The only major difference in variable costs between new and used equipment is in the areas of maintenance and repairs. As would be expected the repair and maintenance figures are substantially higher on used equipment as opposed to new equipment.

TABLE 28. ESTIMATED ANNUAL FIXED COSTS - NEW EQUIPMENT

Item	Low	Average	High
Fixed Costs:			
Depreciation			
Tractor	$6,387.50	$7,630.00	$8,995.00
Trailer	1,412.50	1,562.50	2,000.00
Interest on Investment	3,378.75	3,915.25	4,641.00
License Fees	1,085.50	1,085.50	1,085.50
Insurance	4,035.00	4,557.00	4,998.00
Housing Costs	600.00	900.00	1,200.00
Management	4,300.00	4,300.00	4,300.00
Miscellaneous	1,000.00	1,500.00	2,000.00
Total Fixed Costs	$22,199.25	$25,450.25	$29,219.50
Fixed Cost per Mile:			
75,000 miles per year	$0.296	$0.339	$0.390
100,000 miles per year	0.222	0.255	0.292
125,000 miles per year	0.178	0.204	0.234

TABLE 29. ESTIMATED VARIABLE COSTS PER MILE - NEW EQUIPMENT

Item	Low	Average	High
Variable Costs:			
Tires	$0.0220	$0.0220	$0.0220
Fuel	0.1430	0.1270	0.1140
Maintenance and Repairs	0.0289	0.0289	0.0289
Driving Labor	0.1050	0.1250	0.1450
TOTAL VARIABLE COSTS PER MILE	$0.2989	$0.3029	$0.3099

TABLE 30. ESTIMATED TOTAL COSTS PER MILE FOR NEW EQUIPMENT AVERAGING 75,000 100,000 and 125,000 MILES TRAVELED PER YEAR.

Item	75,000 (miles per year)	100,000 (miles per year)	125,000 (miles per year)
Total Costs			
Low Fixed	$0.296	$0.222	$0.178
High Variable	0.299	0.299	0.299
TOTAL COSTS LOW ESTIMATE	$0.595	$0.521	$0.477
Average Fixed	$0.339	$0.255	$0.204
Average Variable	0.303	0.303	0.303
TOTAL COSTS AVERAGE ESTIMATE	$0.642	$0.558	$0.507
High Fixed	$0.390	$0.292	$0.234
Low Variable	0.310	0.310	0.310
TOTAL COSTS HIGH ESTIMATE	$0.700	$0.602	$0.544

TABLE 31. ESTIMATED ANNUAL FIXED COSTS - USED EQUIPMENT

Item	Low	Average	High
Fixed Costs:			
Depreciation			
Tractor	$1,067.50	$2,590.00	$4,812.50
Trailer	212.50	762.50	1,000.00
Interest on Investment	802.75	1,641.25	2,587.50
License Fees	765.50	765.50	765.50
Insurance	2,049.00	2,654.00	3,410.00
Housing Costs	600.00	900.00	1,200.00
Management	4,300.00	4,300.00	4,300.00
Miscellaneous	1,000.00	1,000.00	1,000.00
Total Fixed Costs	$10,797.25	$15,113.25	$20,075.50
Fixed Cost per Mile:			
75,000 miles per year	$0.144	$0.202	$0.268
100,000 miles per year	0.108	0.151	0.201
125,000 miles per year	0.086	0.121	0.161

TABLE 32. ESTIMATED VARIABLE COSTS PER MILE - USED EQUIPMENT

Item	Low	Average	High
Variable Costs:			
Tires	$0.0220	$0.0220	$0.0220
Fuel	0.1430	0.1270	0.1140
Maintenance and Repairs	0.1190	0.0843	0.0478
Driving Labor	0.1050	0.1250	0.1450
TOTAL VARIABLE COSTS PER MILE	$0.3890	$0.3580	$0.3290

TABLE 33. ESTIMATED TOTAL COSTS PER MILE FOR USED EQUIPMENT AVERAGING 75,000, 100,000 and 125,000 MILES TRAVELED PER YEAR

Item	75,000 (miles per year)	100,000 (miles per year)	125,000 (miles per year)
Total Costs			
Low Fixed	$0.144	$0.108	$0.086
High Variable	0.389	0.389	0.389
TOTAL COSTS LOW ESTIMATE	$0.533	$0.497	$0.475
Average Fixed	$0.202	$0.151	$0.121
Average Variable	0.358	0.358	0.358
TOTAL COSTS AVERAGE ESTIMATE	$0.560	$0.509	$0.479
High Fixed	$0.268	$0.201	$0.161
Low Variable	0.329	0.329	0.329
TOTAL COSTS HIGH ESTIMATE	$0.597	$0.530	$0.490

Estimated total costs for new equipment are presented in Table 30 while estimated total costs for used equipment are presented in Table 33. The low estimate of the variable cost for used equipment is coupled with the high estimate of fixed costs and vice versa. The reason for this is that the newer or higher priced equipment usually has lower variable costs associated with running it. On the average, the estimated total costs are lower on used equipment than on new equipment. However, there are advantages to new equipment, such as less frequent breakdowns, comfort, and handling that are not included in the estimated total cost and may, to some drivers, outweigh the difference in total costs between new and used equipment.

Chapter IV

TRUCK COSTS BASED ON REPORTED DATA

The data for the reported cost analysis were drawn from 84 returned and completed trucker surveys. The 84 firms operated a total of 219 trucks. Each tractor and trailer was considered as a separate and unique observation. Since all respondents did not complete each and every cost category, the sample size for each cost component varies. For each cost variable, where applicable, the low, average, and high observation will be reported. However, caution should be taken in regard to the low and high range of each observation. The low and high range for each variable are totally independent of one another and, as such, may not be summed to provide the low or high range of the total cost.

The sample will be partitioned into three subsamples based on firm size. An analysis of variance will be performed to determine if the mean of each cost component varies significantly between subsamples. If the analysis of variance indicates that the means of the cost components vary significantly, then the cost components may be said to differ according to firm size.

Total mileage per truck per year is a good indication of the level of utilization of equipment. The low, average and highest total yearly mileage by tractor reported for the total sample is presented in Table 34.

TABLE 34. MEAN OF TOTAL YEARLY MILEAGE FROM SURVEY OF TRUCKERS

Item	Low	Average	High
Total mileage per year	5,000	81,911	200,000

The low, average and highest prices paid for tractors and trailers in the sample are presented in Table 35.

TABLE 35. MEAN OF EQUIPMENT PRICE RANGES FROM SURVEY OF TRUCKERS

Item	Low	Average	High
Tractor			
Price	$1,500	$22,643	$60,000
Trailer			
Price	$1,000	$ 7,154	$17,000

Depreciation costs for tractors and trailers were developed in the same manner as in Chapter V. Tractor salvage value was set at 30 percent of the original purchase price and a depreciation period of four years was used.[27] Tractors that had been owned more than four years were assumed to be fully depreciated out and no depreciation costs were included for them. Trailer depreciation was calculated using a 25 percent salvage value and a depreciation period of six years.[28] Any trailer owned more than six years was assumed to be fully depreciated out and no depreciation charge was recorded for it. The average tractor depreciation for the total sample was $3,607.27 while the average trailer depreciation was $870.95 for a total equipment depreciation charge per year of $4,478.22.

Interest on investment costs were developed using the average investment in the equipment, the equipment's salvage value and a ten percent rate of return. The formula used was:

$$\text{Interest on investment} = \left(\frac{\text{Purchase price + salvage value}}{2}\right) \times .10$$

Presented in Table 36 are the interest on investment charges for the total sample.

TABLE 36. AVERAGE INTEREST ON INVESTMENT COSTS FROM SURVEY OF TRUCKERS

Interest on Investment	Average
	(dollars per year)
Tractor	$1,490.30
Trailer	458.02
Working Capital[1]	300.00
Total Interest	$2,248.32

[1]Based on estimated working capital requirement of $3,000 per year.

Presented in Table 37 are the license fee expenses for the total sample.

TABLE 37. LICENSE FEE EXPENSES FROM SURVEY OF TRUCKERS

Item	Low	Average	High
		(dollars per year)	
License fees	$393.00	$917.38	$1,646.00

[27]Based on IRS publication No. 534.
[28]Ibid.

Insurance costs for the total sample are presented in Table 38.

TABLE 38. MEAN OF INSURANCE COSTS FROM SURVEY OF TRUCKERS

Item	Low	Average	High
		(dollars per year)	
Insurance costs	$400.00	$2,207.48	$4,800.00

Housing costs were developed from information provided by respondents who have housing for their equipment. The housing expenses based on the total sample are presented in Table 39.

TABLE 39. MEAN OF HOUSING EXPENSES FROM SURVEY OF TRUCKERS

Item	Low	Average	High
		(dollars per year)	
Housing costs	$120.00	$827.28	$1,644.00

Miscellaneous and other costs were combined as miscellaneous expenses. Miscellaneous expenses included telephone, lights, heat, tarps and miscellaneous permits and items. Presented in Table 40 are the miscellaneous costs based on the total sample.

TABLE 40. MEAN OF MISCELLANEOUS COSTS FROM TRUCKER SURVEY

Item	Low	Average	High
		(dollars per year)	
Miscellaneous costs	$100.00	$3,773.09	$8,181.00

Due to the lack of specific budgets regarding management costs, they were estimated in the same manner as in the economic-engineering portion of the study. Thus, average management costs were estimated to be 8.7 percent of all other costs.

Tire costs were developed individually for tractor tires and trailer tires. Presented in Table 41 are the tire expenses based on the total sample.

TABLE 41. MEAN OF TIRE EXPENSES FROM TRUCKER SURVEY

Tires	Low	Average	High
	(dollars per mile)		
Tractor tires(10 tires)	$0.004	$0.019	$0.034
Trailer tires(8 tires)	0.002	0.010	0.043

Fuel costs were derived from the total annual fuel bill and the total mileage driven each year. Therefore, the fuel costs reflect both loaded and unloaded mileage in their actual proportion and there is no need to weigh their respective effects on fuel consumption. Presented in Table 42 are the fuel costs for the total sample.

TABLE 42. MEAN OF FUEL COSTS FROM TRUCKER SURVEY

Item	Low	Average	High
	(dollars per mile)		
Truck costs	$0.06	$0.12	$0.20

Due to the usual lack of specific and separate repair and maintenance budgets, the two categories were combined for the present analysis. Presented in Table 43 are the repairs and maintenance figures reported by the total sample.

TABLE 43. MEAN OF REPAIR AND MAINTENANCE EXPENSES FROM TRUCKER SURVEY

Item	Low	Average	High
	(dollars per mile)		
Repairs and maintenance expense	$0.012	$0.076	$0.189

Driving labor costs were developed from personal interviews with trucking firm managers. Driving labor rates are normally stated in cents per mile with no consideration for the time required to deliver the load. Presented in Table 44 are the driving labor costs developed from the interviews.

TABLE 44. MEAN OF DRIVING LABOR COSTS FROM PERSONAL INTERVIEWS

Item	Low	Average	High
		(dollars per mile)	
Driving labor costs	$0.09	$0.11	$0.14

The fixed cost components presented previously are combined in Table 45 to develop the average fixed costs for the total sample. Presented in Table 46 are the average variable costs while in Table 47 the average fixed costs and average variable costs are combined to develop average total costs.

TABLE 45. TOTAL FIXED COSTS BASED ON AVERAGES FROM TRUCKER SURVEY

Item	Average
	(dollars per year)
Fixed Costs:	
Depreciation:	
Tractor	$ 3,607.27
Trailer	870.95
Interest on investment	2,248.32
License fees	917.38
Insurance	2,207.48
Housing costs	827.28
Miscellaneous	3,773.09
Management	4,300.00
TOTAL FIXED COSTS	$18,751.77
Fixed Costs per Mile:	
75,000 miles per year	0.250 cents per mile
100,000 miles per year	0.188 cents per mile
125,000 miles per year	0.150 cents per mile

TABLE 46. TOTAL VARIABLE COSTS PER MILE - TOTAL SAMPLE

Item	Average
	(dollars per mile)
Variable Cost:	
Tires	$0.029
Fuel	0.120
Repairs and maintenance	0.076
Driving labor	0.110
TOTAL VARIABLE COSTS PER MILE	$0.335

TABLE 47. AVERAGE TOTAL COST PER MILE FOR 75,000, 100,000, AND 125,000 MILES PER YEAR - TOTAL SAMPLE

Item	Miles per Year		
	75,000	100,000	125,000
	(dollars per mile)		
Fixed Costs:			
Depreciation	$0.060	$0.045	$0.036
Interest on investment	0.030	0.022	0.018
License fees	0.012	0.009	0.008
Insurance	0.029	0.022	0.018
Housing	0.011	0.008	0.007
Miscellaneous	0.050	0.038	0.030
Management	0.057	0.043	0.034
TOTAL AVERAGE FIXED COSTS	$0.249	$0.187	$0.150
Variable Costs:			
Tires	$0.029	$0.029	$0.029
Fuel	0.120	0.120	0.120
Repairs and maintenance	0.076	0.076	0.076
Driving labor	0.110	0.110	0.110
TOTAL AVERAGE VARIABLE COSTS	$0.335	$0.335	$0.335
AVERAGE TOTAL COSTS	$0.584	$0.522	$0.485

To facilitate further analysis of the data and determine if in fact there are economies of scale in the exempt grain carrier industry the sample was partitioned, based on firm size, into three subsamples.

The breakdown of the sample into the three size categories was an arbitrary decision based on knowledge of the industry and the sample make up. The first classification included owner-operators, or one truck firms. The second classification, small firms, or two to five truck firms, was set to include the average size firm (three tractors) in the sample. The last classification, large firms, or over five truck firms, was developed to include the largest firms in the sample. Overall, there were 44 owner-operators, 28 small firms, and 10 large firms in the sample.

The average cost components by firm size are presented in Tables 48, 49, and 50. From this data, owner-operators appear to have the lowest average total costs with small firms and large firms each having relatively higher average total costs. However, the differences in each cost component may be due to the possible differences in the sample sizes of each of the size classifications.

TABLE 48. AVERAGE TOTAL COSTS FOR OWNER-OPERATORS FOR 75,000, 100,000 AND 125,000 MILES PER YEAR

Item	Tractor Miles per Year		
	75,000	100,000	125,000
	(dollars per mile)		
Fixed Costs:			
Depreciation	$0.064	$0.048	$0.038
Interest on investment	0.031	0.023	0.018
License fees	0.014	0.010	0.008
Insurance	0.030	0.023	0.018
Housing	0.009	0.007	0.005
Management	0.043	0.043	0.043
Miscellaneous	0.025	0.019	0.015
TOTAL AVERAGE FIXED COSTS	$0.216	$0.173	$0.145
Variable Costs:			
Tires		$0.030	
Fuel		0.121	
Reparis and maintenance		0.062	
Driving labor		0.110	
TOTAL AVERAGE VARIABLE COSTS		$0.323	
AVERAGE TOTAL COSTS	$0.539	$0.496	$0.468

[29]For a more complete discussion of ANOVA, see Bryant, E.C., Statistical Analysis, McGraw-Hill, New York, NY, 1960.

To determine if the individual means of the cost components for each size group differed significantly from the overall mean, an analysis of variance (ANOVA) was performed.[29] The initial ANOVA tested the mean of the total sample and its variance against the means and variances of the firm size categories. If the ANOVA (F value) indicated a significant difference in the means, least significant difference analysis was used to determine if the groups varied among themselves. Least significant difference tests were not performed on any variable having larger than a 20 percent probability that the difference in means was due to chance alone.

TABLE 49. AVERAGE TOTAL COSTS FOR SMALL FIRMS FOR 75,000, 100,000 AND 125,000 MILES PER YEAR

Item	Tractor Miles per Year		
	75,000	100,000	125,000
	(dollars per mile)		
Fixed Costs:			
Depreciation	$0.057	$0.043	$0.034
Interest on investment	0.028	0.021	0.017
License fees	0.013	0.010	0.008
Insurance	0.031	0.024	0.019
Housing	0.008	0.006	0.005
Management	0.043	0.043	0.043
Miscellaneous	0.027	0.020	0.016
TOTAL AVERAGE FIXED COSTS	$0.207	$0.167	$0.142
Variable Costs			
Tires		$0.027	
Fuel		0.119	
Repairs and maintenance		0.088	
Driving labor		0.110	
TOTAL AVERAGE VARIABLE COSTS		$0.344	
AVERAGE TOTAL COSTS	$0.551	$0.511	$0.486

TABLE 50. AVERAGE TOTAL COSTS FOR LARGE FIRMS FOR 75,000, 100,000 AND 125,000 MILES PER YEAR

Item	Tractor Miles per Year		
	75,000	100,000	125,000
		(dollars per mile)	
Fixed Costs:			
Depreciation	$0.059	$0.044	$0.035
Interest on investment	0.031	0.023	0.019
License fees	0.011	0.008	0.006
Insurance	0.026	0.019	0.016
Housing	0.018	0.013	0.011
Management	0.043	0.043	0.043
Miscellaneous	0.077	0.058	0.046
TOTAL AVERAGE FIXED COSTS	$0.265	$0.208	$0.176
Variable Costs:			
Tires		$0.029	
Fuel		0.122	
Reparis and maintenance		0.076	
Driving labor		0.110	
TOTAL AVERAGE VARIABLE COSTS		$0.337	
AVERAGE TOTAL COSTS	$0.602	$0.545	$0.513

The α-level chosen for the analysis of variance was 0.20. This results in an 80 percent probability that the variation in the means is due to significant differences in the data.

Using an α-level of 0.20 results in the following variables being found as differing significantly from their respective overall means:

1. Repairs and maintenance
2. Tractor tire costs
3. Trailer tire costs
4. Trailer depreciation
5. Tractor interest on investment
6. Trailer interest on investment
7. License fees
8. Insurance
9. Storage costs
10. Miscellaneous costs

Least significant difference tests were performed on the above variables. The formula used for least significant difference analysis is basically a student's test using a pooled error variance.[30]

The formula is:

$$\text{Least Significant Difference: } t_{\alpha} = \frac{M_A - M_B}{\sqrt{\frac{MS_R}{N_A} + \frac{MS_R}{N_B}}}$$

where:

M_A = Mean of Group 1. N_A = Sample size of Group A.

M_B = Mean of Group 2. N_B = Sample size of Group B.

MS_R = Mean square of the residual. α = Selected probability level.

Reject if:

Calculated $T \leq T$ and calculated $T \geq T$
Degrees of Freedom = $(N_1 + N_2) - 2$

Presented in Table 51 is a summary of the results of the least significant difference tests. The analysis revealed that the average total cost of owner-operators was 3.5 cents per mile lower than for small firms and 7.2 cents per mile lower than for large firms. The average total cost of small firms was 2.3 cents per mile lower than for large firms.

The results of the least significant difference analysis lend support to the hypothesis that the exempt carrier industry in North Dakota faces the discontinuous cost function discussed previously. The results also indicate that there are no substantial economies of scale in the industry. In terms of the number of tractors utilized by a firm, there appear to be only diseconomies of scale with increases in the number of tractors operated by a firm. Overall, the analysis of variance and the least significant difference analysis indicate that there are significant differences in the average total costs between firms of different sizes. This supports the hypothesis that the exempt carrier industry in North Dakota is faced with a discontinuous cost function as illustrated in Figure 1.

The average total cost for an exempt carrier averaging 100,000 miles per year was 52 cents per mile. Average total costs were found to differ from one firm size to another with owner-operators having the lowest average total costs. Small firms were the next lowest with large firms having the highest average total costs. In the next chapter the economic-engineering costs analysis is compared and contrasted with the reported data cost analysis.

TABLE 51. SUMMARY OF LEAST SIGNIFICANT DIFFERENCES FOR COST COMPONENT VARIABLES BY FIRM SIZE

	Repairs and Maintenance	Tractor Tires	Trailer Tires	Trailer Depreciation	Tractor Interest on Investment	Trailer Interest on Investment	License Fees	Insurance Costs	Storage Costs	Miscellaneous Costs	Total[1] Differences
	($/mile)	($/mile)	($/mile)	($/year)	($/year)	($/year)	($/year)	($/year)	($/year)	($/year)	($/mile)
Owner-Operators Differ From Small Firms	-0.04	N.S.[2]	+0.001	N.S.	+378.16	N.S.	N.S.	N.S.	N.S.	N.S.	-0.035
Owner-Operators Differ From Large Firms	-0.02	-0.003	+0.001	-177.02	N.S.	-127.07	+187.58	N.S.	-714.96	-4,144.50	-0.072
Small Firms Differ From Large Firms	+0.02	-0.002	N.S.	-143.34	N.S.	-122.89	+167.66	+428.89	-750.72	-3,657.50	-0.023

$\alpha = .20$

[1]Assumes 100,000 miles per year for fixed costs.

[2]Not significantly different.

(-) Indicates that the first firm size cost is less than the second firm size cost by the stated amount.

(+) Indicates that the first firm size cost is greater than the second firm size cost by the stated amount.

CHAPTER V

COST ANALYSIS: COMPARISON AND APPLICATION

Presented in this chapter are comparisons and applications of the two methods of cost analysis. Each method has its own strengths and weaknesses, however, they both tend to result in similar costs.

The main problem with reported cost data is the definition of the cost categories. In this study every attempt was made to identify costs in the most clear, concise manner. Compounding the definitional problem is the frequent lack of budgets and records in the exempt carrier industry. Wyckoff and Maister reported that, "relatively few operators knew their actual expenses, and frequently depended on rules of thumb that might well be subject to serious doubt as to timeliness or appropriateness to the operator's specific operation."[31]

The main problem with the economic-engineering approach for estimating costs is the theoretical nature of the analysis. However, it does provide a reasonable range within which the actual costs of operation lie.

Presented in Table 52 are the average total costs by component developed in the engineering study and the reported cost analysis. The reported cost data lies between or clusters closely about either the used or new equipment costs developed in the economic-engineering study. In most cases, the reported costs range closer to the used equipment costs developed in the economic-engineering study. This, however, is not unusual given that the average truck in the sample was a 1972 model. Overall, the close correlation between the two studies provides additional validity and confidence in the results of the cost analysis.

For the purpose of applying the cost analysis, either of the three resultant costs may be chosen depending upon the situation in which they are to be utilized.

For example, in looking at the future viability of the industry, the economic-engineering costs developed for new equipment may be the most appropriate. For another type of analysis, such as a performance study, one of the other costs or a combination of them may be the most useful. Thus, the choice of which cost analysis to use is dependent upon the application of the data.

In applying truck costs in this study a total average cost of 52 cents per hundredweight is used. This is drawn from the reported cost analysis and allows comparison between the present rate and cost structure facing the exempt carrier industry in North Dakota today.

Application of Truck Cost Analysis

Combining the cost analysis with the truck rate profiles developed allows the analysis of the operating margin in the exempt carrier industry. To accomplish this task one assumption must be made. That is, that the costs of operation developed in the analysis may be linearly extrapolated over a range of trip mileages. The total mileage per truck is assumed to be 100,000 miles. The variable factor then is the differing trip mileages given a constant total output per truck. This allows a comparison between the rates and costs incurred for various trips of differing mileage from the terminal market.

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[31] Op. Cit., Wyckoff and Maister, p. 29.

TABLE 52. COMPARISON OF AVERAGE TOTAL COSTS: ECONOMIC-ENGINEERING APPROACH VERSUS REPORTED COST ANALYSIS

Item	Economic-Engineering Approach		Reported Cost Analysis
	Used Equipment	New Equipment	Total Sample
	($/mile)	($/mile)	($/mile)
Fixed Costs: (Based on 100,000 miles per year)			
Depreciation			
Tractor	$0.0259	$0.0763	$0.0361
Trailer	0.0076	0.0156	0.0087
Interest on investment	0.0164	0.0392	0.0225
License fees	0.0077	0.0109	0.0092
Insurance	0.0265	0.0456	0.0221
Housing costs	0.0090	0.0090	0.0083
Management	0.0430	0.0430	0.0430
Miscellaneous costs	0.0150	0.0150	0.0377
TOTAL AVERAGE FIXED COSTS	$0.1511	$0.2546	$0.1876
Variable Costs:			
Tires	$0.022	$0.022	$0.029
Fuel	0.127	0.127	0.120
Maintenance and repairs	0.084	0.029	0.076
Driving labor	0.125	0.125	0.110
TOTAL AVERAGE FIXED VARIABLE COSTS	$0.358	$0.303	$0.335
AVERAGE TOTAL COSTS	$0.509	$0.558	$0.521

Illustrated in Figure 6 is the rate-cost relationship for wheat to Duluth assuming zero back hauls, 50 percent back hauls and 100 percent back hauls. If there is no back haul and the truck must return to North Dakota empty, the actual cost assigned to the front haul is the total cost per running mile of the entire trip. In this case, the operating margin of the firm is dependent upon the rate received on the one-way grain haul and the costs associated with the round trip movement of the truck. Using 52 cents per running mile as the average cost means that the cost per running mile used to compare costs without a back haul with a one-way rate should be $1.04 per running mile. This is twice the cost of the one-way trip since that rate must cover expenses for both the loaded and return trip if there is no back haul.

Truck costs are stated in terms of cents per mile and must be converted to cents per hundredweight to enable a comparison with rates.[32] To accomplish this, it is assumed that an average truck load is 24 tons or 480 hundredweight. To convert costs to a hundredweight basis one simply divides the rate by 480 hundredweights. If 52 cents per running mile is the representative cost for the industry the cost per hundredweight is calculated as follows:

Cost = 52 cents per mile per 480 hundredweights
= 0.11 cents per hundredweight per mile

If there is no back haul then the effective cost becomes:

Cost = 104 cents per mile per 480 hundredweights
= 0.22 cents per hundredweight per mile

If there is a 20 percent back haul then the effective cost becomes:

Cost = (1) (0.11 cents per hundredweight) + (1 - .20) (0.11 cents per hundredweight)
= 0.11 cents per hundredweight + (.80) (0.11 cents per hundredweight)
= 0.198 cents per hundredweight

Illustrated in Figures 6 and 7 are the rate-cost relationships assuming different levels of back hauls for wheat to Minneapolis and Duluth. Based on costs of 52 cents per running mile with a zero back haul a trucker under the present rate structure cannot make a profit on any trip length from 200 to 600 miles from the market. If, however, the trucker can secure back hauls for 50 percent of his loads, all trips up to approximately 300 miles from the market become profitable. Thus, given a cost of 52 cents per running mile and the rate structure developed from the elevator survey, the North Dakota exempt carrier must have back hauls to survive.

Presented in Table 53 are the full cost rates for various one-way trip mileages and different levels of back hauls. These are the rates necessary to cover full costs (based on 52 cents per running mile) and, as such, maintain a healthy industry.

In this chapter the two methods of cost analysis were brought together. The results were then applied in a comparison with reported truck rates. Overall, the rate-cost comparisons illustrate that the exempt carrier in North Dakota must have some back hauls in order to survive.

[32]The data does not lend itself well to conversion to ton-mile and, as such, cents per hundredweight and distance in miles will be used in this analysis

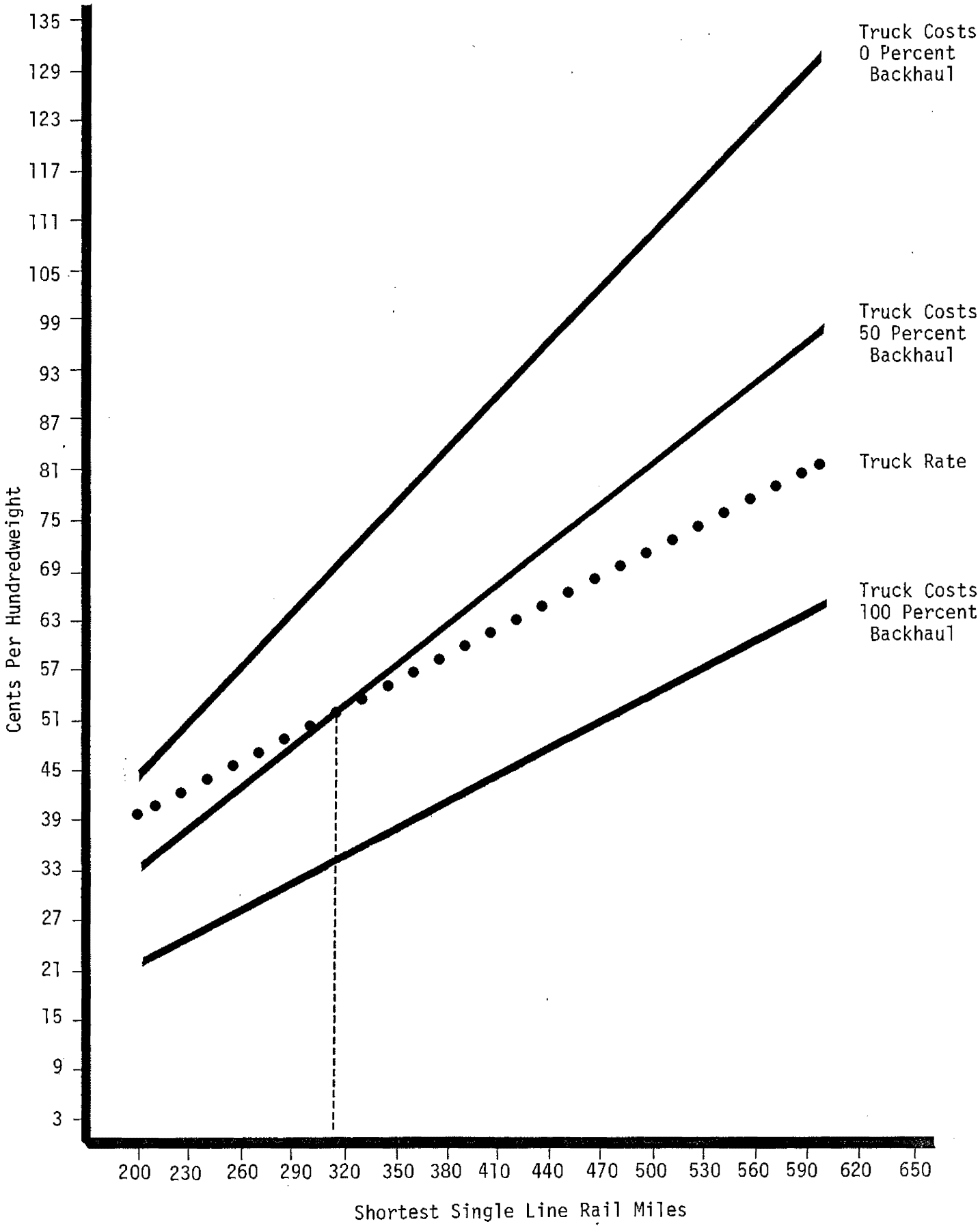

Figure 6. Rate-Cost Relationship
Wheat to Duluth

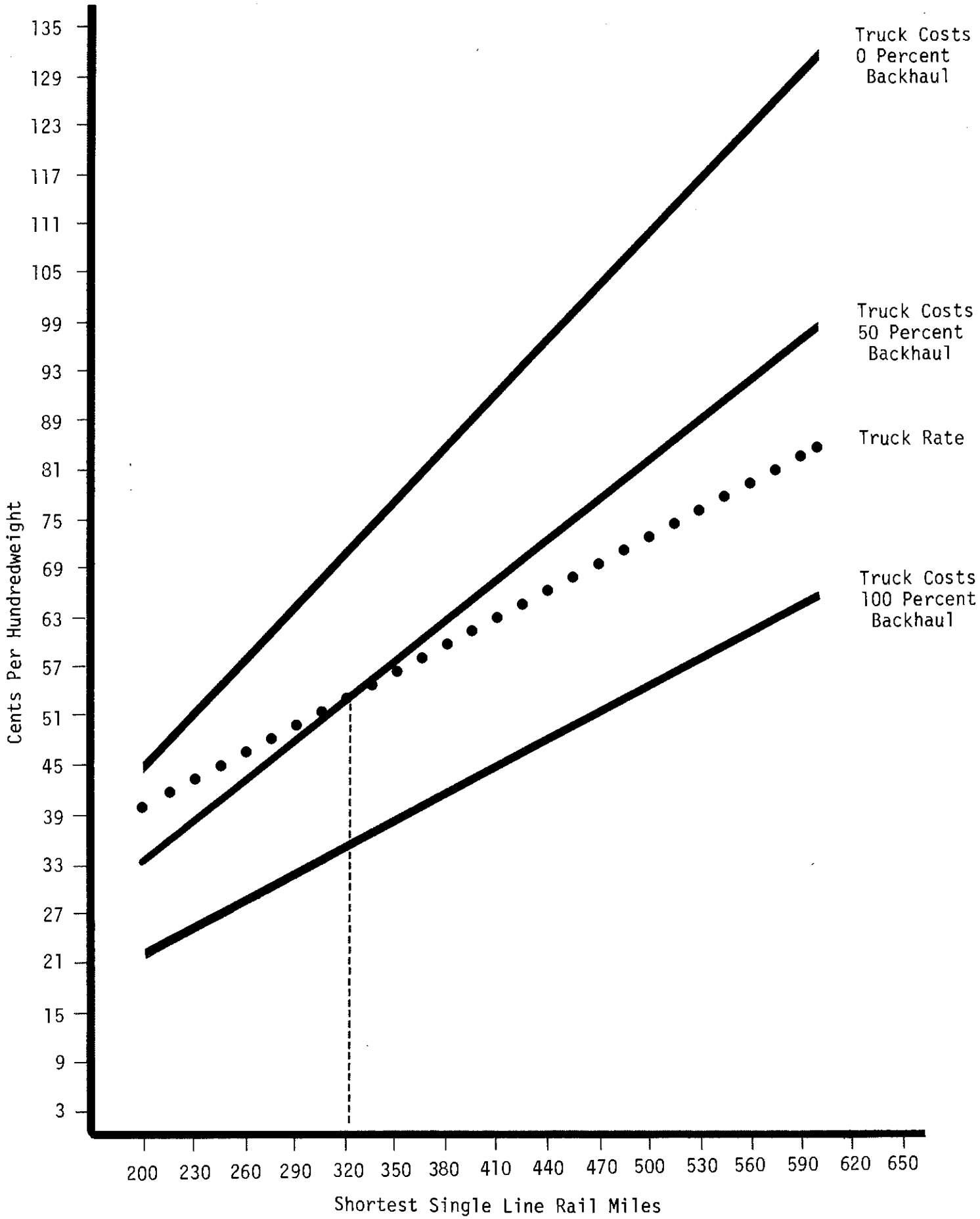

Figure 7. Rate-Cost Relationship
Wheat to Minneapolis

TABLE 53. FULL COST RATES FOR VARIOUS ONE-WAY TRIP MILEAGES AND DIFFERING LEVELS OF BACK HAULS*

One-Way Trip Miles	Back Haul					
	0	10 Percent One out of every ten trips	20 Percent Two out of every ten trips	30 Percent Three out of every ten trips	40 Percent Four our of every ten trips	50 Percent Five out of every ten trips
	(cents per hundredweight)					
200	44	42	40	38	36	33
300	66	63	60	57	54	49.5
400	88	84	80	76	72	66
500	110	105	100	95	90	82.5
600	132	126	120	114	108	99

*Assumes: 1) 52 cents per running mile.

2) 100,000 miles per year.

3) Fully compensatory back haul.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Truck shipments of grain are extremely important to the state of North Dakota. In total, trucks annually transport on the average over 80 million bushels or 25 percent of North Dakota's grain to terminal markets. The exempt carrier provides an alternative mode of transporation to North Dakota grain producers. Trucks thus exert a competitive pressure on the rail movement of grain and, therefore, shield North Dakota from a total transportation monopoly in grain shipments.

The exempt carrier industry in North Dakota is characterized as a large number of small producers interacting in a competitive atmosphere. It was estimated that there are approximately 750 exempt carriers serving North Dakota. Owner-operators accounted for 54 percent of these firms, small firms accounted for 34 percent of the total and large firms represented 12 percent of the total. Owner-operators averaged seven years in business while the small firms averaged nine years and large firms 17 years in business. The average size firm for the total sample was a three tractor, four trailer firm.

For a new truck averaging 100,000 miles per year of output, average total costs were estimated to be 56 cents per mile. For used equipment averaging 100,000 miles per year of output, average total costs were estimated to be 50 cents per mile. From the reported cost data, average total costs were reported to be 52 cents per running mile.

Overall, the ICC exempt agricultural carriers provide adequate service at reasonable rate to the North Dakota grain producer. However, due to the changes indicated by the shift in age distribution to newer carriers the future viability of the exempt carrier industry in North Dakota must be viewed with caution.

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