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For Check Out Only!

An Economic Analysis of the **Costs of Operating Grain Trucking Firms** in NORTH DAKOTA

KENNETH L. CASAVANT AND DAVID C. NELSON

DEPARTMENT OF AGRICULTURAL ECONOMICS AGRICULTURAL EXPERIMENT STATION NORTH DAKOTA STATE UNIVERSITY OF AGRICULTURE AND APPLIED SCIENCE FARGO, NORTH DAKOTA IN COOPERATION WITH NORTH DAKOTA STATE WHEAT COMMISSION BISMARCK, NORTH DAKOTA

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FOREWORD

This publication represents a continuation of research into the factors affecting the marketing of North Dakota wheat. This study was made possible by a grant provided by the North Dakota State Wheat Commission to the Department of Agricultural Economics. Reports published under this cooperative arrangement are:

- 1. <u>Wheat Statistics for North Dakota, Agricultural Economics Report No. 20,</u> August, 1961.
- 2. <u>Protein Content of North Dakota Wheat</u>, North Dakota Farm Research, March-April, 1962.
- 3. <u>Market Factors of North Dakota Hard Red Spring Wheat</u>, Agricultural Economics Report No. 21, April, 1962.
- 4. <u>North Dakota Hard Red Spring Wheat Shipments</u>, North Dakota Farm Research, September-October, 1962.
- 5. <u>Durum Market Factors</u>, <u>1962</u>, North Dakota Farm Research, January-February, 1963.
- 6. <u>Quality Factors of North Dakota Durum Shipments</u>, <u>1960</u>, <u>1961</u>, <u>1962</u>, Agricultural Economics Report No. 26, January, 1963.
- 7. Durum Data, Agricultural Economics Report No. 27, February, 1963.
- 8. <u>Market Factors of North Dakota Hard Red Spring Wheat</u>, <u>1962</u> Shipments, Agricultural Economics Report No. 28, February, 1963.
- 9. <u>Market Factors of North Dakota Hard Red Spring Wheat</u>, <u>1963 Shipments</u>, Agricultural Economics Report No. 33, March, 1964.

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- 10. <u>Market Factors of North Dakota Durum Wheat</u>, <u>1963 Shipments With Comparisons</u>, Agricultural Economics Report No. 34, April, 1964.
- 11. <u>Quality of Commodity Credit Corporation Wheat in North Dakota Country Ware-</u> houses and <u>Subterminals</u>, North Dakota Farm Research, May-June, 1964.
- 12. <u>Movement of North Dakota Grain by Truck</u>, <u>October-November</u>, <u>1963</u>, North Dakota Farm Research, July-August, 1964.
- 13. Economic Implications of the Wheat Sedimentation Test on the North Dakota Economy, Clinton D. Kurtz, unpublished Master's thesis, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, October, 1964.
- 14. <u>Market Factors of North Dakota Durum Wheat Shipments</u>, <u>July-December</u>, <u>1964</u>, Agricultural Economics Report No. 42, June, 1965.
- 15. <u>Market Factors of North Dakota Hard Red Spring Wheat Shipments</u>, <u>July-De-</u> <u>cember</u>, <u>1964</u>, Agricultural Economics Report No. 43, June, 1965.

- 16. <u>Trends in Shipping Grain by Motor Carrier From North Dakota Origins</u>, <u>1956-</u> <u>57 Through 1963-64</u>, Bulletin No. 462, December, 1965.
- 17. <u>Addendum to Bulletin No. 462</u>, Agricultural Economics Report No. 44, January, 1966.
- 18. <u>Market Factors of North Dakota Durum Wheat Shipments</u>, <u>July-December</u>, <u>1965</u>, Agricultural Economics Report No. 45, April, 1966.
- 19. <u>Market Factors of North Dakota Hard Red Spring Wheat Shipments</u>, <u>July-De-</u> cember, 1965, Agricultural Economics Report No. 48, July, 1966.
- 20. <u>The Importance of the Export Market to the North Dakota Wheat Producer</u>, North Dakota Farm Research, November-December, 1966.
 - 21. Durum Yields Increasing, North Dakota Farm Research, March-April, 1967
 - 22. <u>Trends in the Flow of Wheat Exports in the World Market</u>, Agricultural Economics Report No. 56, August, 1967.

North Dakota State Wheat Commission

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SUMMARY

Limited economies of size exist in the grain trucking industry. This statement is supported by both the industry costs and model costs. Since the industry scale curve levels off and becomes almost horizontal at around the 450,000 level of annual mileage, the optimum size firm is at least this large. Beyond this level, little further economies of size are realized, indicating that a new firm in the industry can realize potential economies of size as readily as an established firm. Several possible reasons for lack of economies of size are: investment costs per mile do not decrease to any large degree as firm size is increased, and there is lack of increased efficiency of labor as firm size is increased.

Initial investment costs of a trucking firm do appear to have some effect on the operating costs of a firm. The higher cost equipment within each type, gas or diesel, showed higher operating costs. However, the low cost diesel tractor firm, due primarily to its lower variable costs, seemed to offer the lowest per mile operating costs. Analysis of simulated firms (models) indicates that new equipment investment was more economical than investing in used equipment. Due to higher variable costs of used equipment, the new equipment firm had lower costs at all levels of capacity utilization. Therefore, if the capital is available, new equipment should be purchased.

Average operating costs of the firms in the sample appeared to be considerably higher than the model costs. Industry costs for grain trucking firms ranged from 17.95 cents to 32.48 cents per mile with a mean and median of 23.42 cents and 39.69 cents, respectively. Analysis of this data indicates that little economies of size can be realized by increasing farm size.

Comparison of model and industry costs appears to indicate that efficiency improvements could be made in the country. However, due to the present low level of capacity utilization in the industry, the costs can be made comparable by simply increasing annual vehicle mileage. Therefore, at the present level of capacity utilization, the industry is operating efficiently. The statement is supported by the fact the industry compares favorably with the model at both the 45 per cent and 100 per cent capacity levels. However, to obtain minimum operating costs, North Dakota firms must increase their annual mileage per vehicle.

The industry does seem to suffer from excess capacity and, as shown by the model costs, excess capacity increases operating costs noticeably. Some possible causes for this high level of excess capacity are: (1) seasonality of commodity hauled, and (2) saturation of local trade area.

Added effort in the area of backhauls may offer high potential increased efficiency. A great deal more needs to be known about the cause of this low backhaul percentage, including the feasibility of truck brokerage becoming more significant in identifying demand for grain loads and accurately relaying backhaul traffic information. This is particularly important because data from the industry indicated the difference in cost between traveling loaded or empty is slight.

Truckers in the sample were doubtful that advertising offered any returns. The only item that seems to differentiate his product is his "public image," but again, this would not remain long under a rate differential. 学习法学的法

Advertising in a wider trade area and increased use of brokers may offer a possible solution to excess capacity. However, a firm with ability to increase its level of output, annual mileage, has a degree of flexibility that can be helpful to the agricultural industry of North Dakota, which is characterized by extreme seasonality of production.

A substantial degree of stability as measured by length of time in business exists in the North Dakota grain trucking industry. This would indicate that the industry does not suffer from excessive competition or a too high rate of entry and exit into and out of the industry.

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is distributions and a second seco A second secon A second secon AN ECONOMIC ANALYSIS OF THE COSTS OF OPERATING GRAIN TRUCKING FIRMS IN NORTH DAKOTA

Kenneth L. Casavant and David C. Nelson

Transportation is the link between production areas and consumption centers in the United States economy. The development of specialized urban and rural areas illustrates the important role that transportation has played in agricultural marketing.

As the Twentieth Century approached, the transportation industry grew progressively more important in relation to the marketing chain as a whole. However, the growth was not spectacular in terms of changes within the industry. The railroad had played a dominant role in extending the area of settlement in this country. Later, motor truck transportation developed as a "feeder", bringing produce from the production areas to the rail sites.

Motor carriers continued this complementary role to the railroad until about the late 1940's and early 1950's when the railroads found it necessary to raise their rates due to rising operating costs. At the same time, transportation by truck was developing as an effective mode. An important reason for this development was the exemption from economic regulation, e.g., rates and specified routes, as outlined in Part II, Section 203, (b) Subsection 6, of the Interstate Commerce Act of 1935. This exemption provides for freedom from economic restrictions in the hauling of unprocessed agricultural products. Since highway transportation of these unprocessed agricultural products was not regulated by the I.C.C., truckers began to haul grain at negotiated rates, often much lower than the prevailing rail rates.

The many innovations in the trucking industry also caused motor carriers to become competitive to the railroads. Grain trucks of the early 1920's were predominantly straight trucks.² At present, grain trucking firms use tractor and trailer combinations which, along with the development of more powerful, less expensive operating engines, have increased the capacity and potential payload of each unit.

The importance of the truck form of transportation to the economies of both the United States and North Dakota has increased greatly in recent years. Vehicle registration in the United States trucking industry increased

¹Casavant is a former Graduate Research Assistant and Nelson is Acting Director, Upper Great Plains Transportation Institute and Associate Professor, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota.

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²A straight truck is defined as a vehicle that has the cab, engine, and box all in one chassis, as compared to a tractor and trailer where the chassis is separated into two units; the tractor comprised of the cab and engine, and the separate trailer. from 4,834,742 in 1945 to 11,000,000 in 1959. The regulated motor carrier industry's percentage of the total intercity freight tonnage increased from 37.6 per cent in 1939 to 56.6 per cent in 1961.4

The volume of agriculturally exempt traffic, which is substantial, appears to be increasing. In 1957-1958 only 27 per cent of the total grain trucked was moved by exempt carriers in North Dakota.⁵ In 1963 the exempt motor carrier hauled 71 per cent of the total grain trucked, 6 The amount of grain hauled by motor carrier increased from 4.8 per cent in 1956-1957 to 22.4 per cent in 1965-1966.7 Nationally, trucks have increased their percentage of total grain hauled, both relatively and absolutely.⁸

OBJECTIVES

Transportation costs are an important part of the price of any commodity. In an agricultural state such as North Dakota, transportation costs of the products can affect the state's relative competitive position with other states and production areas. If transportation costs can be lowered, a number of alternatives could result: (1) A noticeable drop in the ultimate consumer price of farm products, resulting in improvement in the competitive position of North

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The period and easy classification will will be a 3 American Trucking Trends, American Trucking Association, Inc., Washington, D. C., 1959, p. 1.

4 Loomis, Daniel L., Great Railroads for the Great Society, Rutgers University, New Brunswick, New Jersey, April 1, 1965, p. 5.

⁵Nelson, David C., A Study of the Regulations, Costs, Trends, and Factors Affecting the Transportation of Grain from North Dakota, M. S. thesis, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, July, 1960, p. 84.

⁶Kurtz, Clinton D., and Fred R. Taylor, "Truck Transportation of North Dakota Grain", Reprint No. 619, from March-April, 1964, <u>Farm Research</u>, North Dakota Agricultural Experiment Station, Vol. No. 6, pp. 23-27. en no Erestano dese

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1.1.1.1.1.1.13 ⁷Taylor, Fred R., and David C. Nelson, <u>Trucking Shipment of Grain From</u> North Dakota Elevators, 1956-1957, Agricultural Economics Report No. 14, North Dakota Agricultural Experiment Station, Fargo, North Dakota, May, 1959, p. 7; and unpublished data gathered by the Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, April 1, 1967.

⁸Corley, Joseph R., <u>The Changing Transportation Structures and Rates</u> and Their Implications, United States Department of Agriculture, August 15, 1963, p. 2.

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Dakota producers, (2) Lower freight cost to the primary producer, resulting in higher farm product prices, or (3) An increased margin to the trucker, resulting in increased profits. A betaller vicebaux ever eaxit scart to ingle vicehit bas

The general purpose of this study was to discover the actual per mile operating costs for the North Dakota grain trucking industry. Specific objectives were:

TWO REPAY OF A CONTRACTORS

1. To identify the characteristics of the North Dakota grain trucking industry and indicate any general strends is puede concel at alight ports

-North Debots prain courses as exercises of the character of the 2. To identify major factors affecting costs of operation and some possible methods for reducing these costs and tools avon antonnel of inless ad

To determine if economies of size exist in the industry. 3. signation of First in Sample

4. To determine if more efficient methods of firm operation are available in the industry, as signars and at beau pubycong istant our

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Various models of tranportation firms were set up to determine changes in cost as size of firm changed for the trucking industry in the state. Equipment prices for the models were obtained by averaging prices supplied by various equipment dealers in Fargo and Moorhead.⁹ Cost components, such as labor, repairs, and licenses, were obtained through estimates and interviews with people associated with each cost component. The relevant cost components of the used equipment model were obtained from the National Automobile Dealers Association used car guide, and from interviews with mechanics of the equipment dealers men-1. CHOID tioned above. arois

A survey of firms in North Dakota was conducted to discover the actual costs of operating tractor-trailer combinations hauling grain in the state and to obtain information helpful in describing the characteristics of the industry. A list of motor carriers licensed in the state was obtained from the Motor Carrier Division of the Public Service Commission in Bismarck, North Dakota. Since all truckers operating intrastate and interstate are subject to the Public Service Commission's safety regulations and must obtain an operating license from the Commission, it was felt this list would provide the population from which a representative sample could be drawn. Statistics the safe sade 1.00 in the Nerth Category tracking industry and

The firms used for this sample were accepted as usable if they operated at least a one tractor-one trailer unit. It was felt that firms with less bodonicol esclib dél odé.

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⁹Companies providing estimates were: Thompson Motor Service, Balmer Motor Co., both of Moorhead; B. H. Chesley Co., Branick - Swedberg Implement Co., W. W. Wallwork Muscatell Chevrolet, Inc., Barter's Equipment Co., and . There a both the area of signals Smith Inc., all of Fargo.

deployed to complete the schedule, 38 were convinging

10 Relevant cost components are fixed and variable factor costs. Discussion of these concepts is presented later.

equipment would not have comparable costs.¹¹ The P.S.C. list contained the names of 318 firms in North Dakota, one in Montana, and one in Minnesota. One Hundred and thirty eight of these firms were randomly selected and 43 questionnaires usable for this grain trucking study were obtained.¹² Data received from these 43 firms were the basis of the industry costs used in this study.

4 -

INDUSTRY CHARACTERISTICS

Since little is known about the nature and extent of the operations of North Dakota grain carriers, an examination of the characteristics of this industry, such as length of time in business, size of firm, and price policy, will be useful in learning more about this industry.

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Classification of Firms in Sample

The initial grouping used in this analysis was by size of firm. The size categories were selected on the basis of tractor-trailer units per firm. The 43 firms were divided into the three following groups: Group I, 1-3 tractor-trailer units; Group II, 4-7 tractor-trailer units; and Group III, 7 or more tractor-trailer units (Table 1).

TABLE 1. SIZE OF FIRMS IN SAMPLE, NORTH DAKOTA GRAIN TRUCKING INDUSTRY, 1966

	egory				Number of Firms	97
Group I Group II Group III		*****			19 16 8	
All Firms			· · · ·		4 3	* 1

¹¹Many of the firms obtaining licenses from P.S.C. hauled only for their neighbors on a small part-time basis. The vehicle they used for hauling was usually a straight truck actually considered part of their farm enterprise. These firms were not included in the study because of the small role they played in the North Dakota trucking industry and because the costs of these firms were entirely different from the majority of firms in the industry.

¹²Of the 138 firms contacted, 37 were livestock trucking firms, two declined to complete the schedule, 38 were considered not large enough for this study, and 18 had quit the trucking business from the time the list was obtained from the Public Service Commission to the time of the interview, a period of 11 months. Of the 18 who were no longer trucking, only four would have been large enough to use in this study.

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The average size of all firms in the sample was a three tractor - four trailer firm. There was a considerable range in the size of firms, from one tractor-trailer unit to 58 tractor-trailer units, with the most common size one tractor-trailer unit and the average size four tractor-trailer units.

Ten of 43 firms in the sample indicated they and expanded the size of their firm in the last 5-10 years. Only three of the 43 firms indicated they planned to expand the size of their firm in the future. The remaining firms had not and did not plan on increasing their firm size. The trend of past and future expansion was the same for all group sizes. The major reason offered for not expanding the firm was the feeling of the manager that his local trade area appeared to have little further traffic available. Other reasons offered were that management would get too complicated and price competition was too intense. All firms which had expanded firm size and planned on further expansion in the future mentioned obtaining of a "special permit"¹³ as a reason for their actions.

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The 43 firms in the study traveled an average of 222,000 miles per year. Miles traveled per firm ranged from 60,000 to 5,200,000 miles per year.

Annual mileage per vehicle as a measure of utilization of equipment is commonly used when examining the concept of excess capacity.¹⁴ Comparison of average mileage shows that Group I firms had the highest average annual mileage, Group II firms second highest, and Group III firms lowest. Per cent of capacity utilization is inversely related to size of firm (Table 2).

TABLE 2. FIRM AND VEHICLE ANNUAL MILEAGE, BY GROUP SIZE, SAMPLE FIRMS, NORTH DAKOTA GRAIN TRUCKING INDUSTRY, 1966

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Group I Group II Group III	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
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13See "Special Permits", p. 12. 14 DeWolfe, op. cit., p. 3.

A substantial amount of excess capacity exists in the North Dakota grain trucking industry. It is theoretically possible for an individual tractortrailer unit to travel 150,000 miles per year, based on a distance traveled of 500 miles per day, operating 300 days per twelve month period. Some firms in the sample did operate their vehicles 120,000 miles each per year while others had as low as 20,000 miles per year. The North Dakota trucks in the sample traveled an overall average of 61.4 thousand miles. Groups I, II, and III had a percentage capacity utilization of 48 per cent, 43 per cent, and 37 per cent, respectively. It can therefore be shown that a direct relationship exists between excess capacity and size of firm in the North Dakota grain trucking industry.15

Some possible causes for operating at such a high level of excess capacity could be: (1) seasonality of commodity handled and (2) saturation of local trade area. Since both reasons for this large excess capacity are concerned with the amount of business or size or trade, a possible solution is for the firm to combine increased advertising with increased use of truck brokers.¹⁶

However, a firm with the ability to increase its level of output (annual mileage) has a degree of flexibility that can be helpful to the agricultural industry in North Dakota. Grain production is characterized by extreme seasonality of production. In times of high seasonal demand, the trucking firm

¹⁵Two points of view can be considered when examining the desired capacity of an industry characterized by high seasonality of demand. One viewpoint holds that capacity of the industry should be such that the lowest average per unit cost for output is obtained over all stages of the demand fluctuation, even though some shortage of capacity and slightly higher prices may occur at times of peak demand. The other viewpoint says that capacity of the industry should be such that peak demand could be met without price-elevating shortages, even though average per unit costs of supplying the aggregate demand may be raised above the minimum attainable cost.

In this study the first viewpoint was chosen as the framework for analysis of the trucking industry. It was felt that not only could 150,000 annual miles per vehicle be attained, but that even though these firms often were running at full capacity during periods of high seasonal demand, the low mileage of the firms during the slack periods was still indicative of excess capacity.

For a discussion of these viewpoints, see Bain, Joe S., <u>Industrial Organizations</u>, John Wiley and Sons, Inc., New York, August, 1965, pp. 358-360.

¹⁶In 1959 only 20 per cent of the total grain shipped by truck from the North Central States was booked by brokers. A truck broker is a person who arranges transportation by truck for shippers or receivers of maturing perishables and other exempt commodities for movement to storage, processing points, and market areas. See Hunter, J. H., <u>The Role of Truck Brokers in the Movement</u> of Exempt Agricultural Commodities. MED, ERS, USDA, Washington, D. C. can feasibly increase its output by increasing the mileage of each vehicle in the firm. Also, if one vehicle breaks down, the unused or underused equipment could be brought into use and output (mileage) could remain at the same level while the breakdown is corrected.

The pros and cons of these characteristics of excess capacity must be judged by the individual firm manager. The manager should examine the organization of the firm, size of the market, structure of the industry, and seasonality of the commodity handled. Then, on the basis of these elements, he can decide at what capacity to operate.

Estimated Ton-Miles

The concept of ton-mileage is used extensively in most analyses of costs and description of characteristics of most transportation modes.¹⁷ The data obtained from this sample were converted into ton-miles by taking the annual mileage times the per cent the truck was loaded, and multiplying the result by the average load size. Average grain load size was 783 bushels of wheat, or about 22 tons.¹⁸ One hundred and twenty thousand miles or about 62 per cent of the annual firm miles driven were loaded miles. This percentage was about even in the three group sizes cited earlier. Average ton miles were about 2,930,000. Average ton-miles per vehicle were 810,500. The three size groups had ton-mileage in the same proportion as annual mileage.

A characteristic often used to describe the exempt trucking industry is extreme flexibility of operation. The North Dakota grain trucking industry possesses this characteristic. Using the length of the most common haul as an indication, no relationship between size of firm and length of haul was established (Table 3). The trade area covered by the trucker ranged from a local area of 100 miles to a 48 state area. The most common trip was to either Minneapolis-St. Paul or Duluth, Minnesota.

There seems to be a definite inverse relationship between size of firm and per cent of intrastate mileage. Group I firms had the highest percentage of intrastate mileage, 74 per cent. Group II and III firms had corresponding percentages, 69 per cent for Group II and 63 per cent for Group III. Overall, truckers had 70 per cent intrastate mileage.

¹⁷A ton-mile is a statistical unit employing weight and distance. One ton-mile is one ton transported one mile, 200 pounds transported 10 miles, etc.

18 The average grain load was derived from information gathered from truckers passing through North Dakota weigh stations, October-November, 1963.

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Size Category	Intrastate Mileage	Most Common Trip
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Group II	69	435
Group III	63	520
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TABLE 3. INTRASTATE MILEAGE AND LENGTH OF MOST COMMON TRIP, SIZE CATEGORY, SAM-PLE FIRMS, NORTH DAKOTA GRAIN TRUCKING INDUSTRY, 1966

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The North Dakota grain trucker seldom hauls commodities on his return trip. Added effort in this area may offer high potential increased efficiency. Of the total mileage driven, 62 per cent were loaded miles. This means that only 24 per cent of the return trip mileage were loaded miles.¹⁹ Needless to say, a great deal more needs to be known about the cause of this low backhaul percentage, including the feasibility of truck brokerage becoming more significant in identifying demand for grain and accurately relaying backhaul traffic information. This is particularly important because the difference in cost between traveling loaded or empty is slight.²⁰ Obtaining a return haul and the resultant revenue can cause a substantial increase in round trip profits. In some cases a backhaul can mean the difference between returns below costs or returns above costs.

Let us presume the trucker has a haul from Minot, North Dakota, to Head of the Lakes, roughly 475 miles. At 22 cents per mile his total one-way cost would be about \$104.50. Presuming the trucker returned empty, his cost would be 22 cents for 950 miles or \$209. Assuming an average load of 780 bushels, he must have about 14 cents per bushel or about 23 cents per hundredweight to cover the round trip cost. Presuming the truck rate is about 10 cents below rail, or about \$16.72 difference for the round trip, the trucker is losing about four cents per hundredweight or about 2.5 cents per bushel to all costs at present maximum rates. If a return haul is obtained, returns should exceed all costs.²¹

¹⁹The average annual mileage per firm was 196,000 miles, of which 50 per cent or 98,000 miles were assumed to be return trip mileage. Twelve per cent or 23,520 miles of the 196,000 total miles were loaded return trip mileage. So, of the total return trip mileage, 24 per cent (23,520 divided by 98,000) were loaded return trip miles.

²⁰All of the 43 firms in the sample indicated they felt there was no difference in operating costs between traveling loaded or empty.

²¹Nelson, David C., Statement in <u>NL G-21-8561</u> <u>Hearing</u>, St. Paul, Minnesota, February 24, 1966, p. 6. Three tentative explanations could be offered for the North Dakota grain trucker low backhaul percentage: (1) Some one-way loads, (2) Use of specialized equipment for hauling grain limits the use of such equipment for transporting other exempt commodities on the backhaul,²² (3) The possibility of obtaining a load on the backhaul is further reduced by restriction of the trucker to hauling exempt agricultural commodities.

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Although leasing was a subject of controversy in the early 1950's,²³ it seems of little importance to the North Dakota grain trucking industry. None of the 43 truckers in the sample leased their equipment and only four firms leased vehicles for their own use. However, these four truckers used leasing extensively, with 80 per cent of their total firm mileage accumulated by leased vehicles. The extent of leasing practices appeared to be associated with size of firm. All four truckers were in Group III. The major explanation offered by the firm managers for leasing by these firms was that they felt they could make more use of managerial ability as well as provide more flexibility as to firm size and potential volume.

Length of Time in Business

A substantial degree of stability as measured by length of time in business exists in the North Dakota grain trucking industry. This observation is supported by an analysis of the sample data of (Table 4). Eighty-eight per cent of the truckers in the sample had been in business five years or more, 70 per cent 10 years or more, 44 per cent 15 years or more, and 30 per cent had been in business 20 years or more.

The different size groups also showed a definite relationship to length of time in business; generally, as size of firm increases, length of time in business increases. Group III firms had the highest percentage of truckers in all tenure groups. Group II firms had the second highest incidence and Group I firms the lowest.

Labor Requirements

The average number of men employed full time by the three groups varied directly with size of firm. When comparing the three size groups as to potential output (mileage) and employee requirements, little increase in efficiency of labor is indicated (Table 5). The average labor requirements of firm operation in all three size groups appear closely related to the number of vehicles per firm.

²²Such as products requiring refrigeration or protection from weather elements.

²³Black, Guy, "Agricultural Interest in the Regulation of Truck Transportation", <u>Journal of Farm Economics</u>, Vol. 37, August, 1955, pp. 439-451.

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TABLE 4. LENGTH OF TIME 1966		Tenure Category	5 years or more	10 years or more	15 years or more	20 years of more	25 years or more	30 years or more	er octool edd alle Flike y Arceled Medikel teg ay octo abled et sociol watte los of sociol satte los
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TABLE 5. TOTAL LABOR REQUIREMENTS, BY SIZE CATEGORY, SAMPLE FIRMS, NORTH DAKOTA GRAIN TRUCKING INDUSTRY, 1966

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Size Category of stab guilled alt mort below with	Tel vin Number of Employees
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A close relationship between capital investment and labor requirement probably is responsible for this lack of increased efficiency of labor. For each additional lump sum of capital investment, usually in the form of another vehicle, a corresponding increase in labor, the driver of the new vehicle, is needed. Also, in the smaller firms the owner acts as manager, driver, mechanic, and bookkeeper; but, as the size of the firm increases, these different duties become too complex and time consuming. Therefore, an increase in the labor force is required. The expected increase in efficiency as a result of this specialization of labor is partially absorbed by the required one-to-one relationship of driver to vehicle. For this reason, little economies of scale to labor exist in the North Dakota grain trucking industry. Therefore, and the second to you have and second to price policy as a result of the second to you have a second to be a start of the second to you have a start of scale to labor exist in the North Dakota grain trucking industry. The one to you be second to you have a start of the second to you have a start of second to you have a start of the second to you have a start of second to you have a start of the second to you have a start of a second to you have a start of the second to you have a start of a second to recommend to a start for the second to you have a start you as a second to you have a start you a second to you have a start of a second to you have a start you have a start of the second to you have a start you have a start you have a start you have a start of the second to you have a start you have a star

One of the reasons for the initially slow growth progress of truck transportation was the structural restraints of having adopted rail based tariffs as a rate and costing procedure. 24⁻¹ When the trucking industries began using their own costs as the basis for their rates they soon became competitive with the railroads. This cost-plus-margin method of arriving at rates seems to be the method used by the North Dakota grain trucker. Even though most truckers in the sample said they were just accepting the traditional rate, most managers we had a general knowledge of costs and what revenue was necessary to return a normal profit.

In general, a combination of a cost-plus-margin price and competitive forces decides the final rate the firm will charge for its services. Due to easy entry into and exit out of the industry, the rate charged the shipper is usually forced down to a rate that yields returns just high enough to keep those factors of production in operation (in economic terminology, "normal profit"). No noticeable difference was found between group sizes as to method of establishing rates.

24Baker, Forrest S., <u>Transportation Packaging and Other Innovations</u> <u>Affecting Structure and Efficiency</u>, November, 1965, p.01. Structure and Efficiency is to destructions and of accession and the second in the second structure and structure and

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TABLE 5. TOTAL LABOR REGULTEMENTS X37109 HIDEYS COST, SAMPLE FIEME, NO. 74 DASOTA GRAIN TRUCKING INDUSTRY, 1900

None of the trucking firm managers reported that credit and uncollected accounts were any special problem. Five grain truckers extended credit to their customers, usually only for the period from the billing date to payment at the end of the same month. Twenty-four of the grain truckers indicated they would provide some credit if it were desired by the customer. The amount and terms of the credit would vary with the individual customer's importance to each trucking firm, but the length of the credit period would usually be less than six months.

Special Permits

A "special" license is an operating authority granted by the Motor Carrier Division of the Public Service Commission in North Dakota. It is granted for particular commodities to be hauled from a stated geographical area. This authority is good for only those commodities stated in the permit, and only when these commodities are carried within North Dakota between the specific geographical points stated in the permit.

Although the special permit is not part of the interstate agricultural exemption, it is mentioned here because of its importance to the North Dakota grain trucker. The special license has an important influence on the backhaul percentage. Of those truckers with larger backhaul mileage than the average in the study, 74 per cent, or nearly three-fourths, had special permits for hauling one commodity or another. This availability of backhauls, as noted before, increases the revenue substantially. Also, all three of the firms which planned on increasing in size had special permits and cited obtaining of these permits as a primary reason for planned expansion.

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One of the basic forms of methodology used in economic analysis is the model. An economical model is simply a blueprint or picture of the firm as it would appear in the real world. It includes all the equipment, labor, and other components necessary to produce a given quantity of product, in this case a certain level of annual firm mileage. A series of model grain trucking firms will be used to determine the costs of operation as firm size increases.

Although model building is extremely helpful in any economic analysis, any conclusions drawn from them must be modified before they can be applied to the real world. The assumptions of the model describe the world to which the model will apply. Assumptions are limitations and, as a result, the conclusions may not fit all situations but can serve as a guideline to planning changes.

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Trucking Firms in General

Before considering the specific models in this study, some general conditions relevant to the establishment of a grain trucking firm should be reviewed. The grain trucking firm is different from the ordinary concept of a firm in that little of its investment goes into physical facilities, such as warehouses and production plant facilities. Formation of a grain trucking firm is affected by several variables, the most important of which are:

1. The presence and extent of competition in the trade area.

2. The potential volume of the trade area.

3. The rate structure in the trade area for motor carriers and other competitive forms of transportation.

4. The availability of labor: mechanics, drivers, and secretarial staff.

The profitability of establishing a new trucking firm or increasing the size of an existing firm is jointly determined by the rates in the trade area and by the market share available to the individual trucking firm. In turn, market share is determined by the presence and extent of competition and the potential volume of the trade area.

The potential volume must be large enough to allow the trucking firm to operate its vehicles at an efficient level of annual mileage. The presence of competition in the trade area suggests the size of firm by the available market share of the trucking firm. Also, competition and potential volume of trade acquire a role of increased importance if the margin of rates above costs is small.

Availability of labor also is important. People who can drive trucks are easily found, but people who drive carefully and efficiently are harder to find. Since a major portion of the firm's investment, the tractor-trailer unit, is in the hands of the driver, the ability and trustfulness of this driver becomes very important to the firm's economic health. Availability of mechanics also is important. Any problem that holds a tractor-trailer unit off the road for an extended period of time, (called "down-time") affects the efficiency of that firm. For this reason, a good mechanic or driver-mechanic is an integral part of a firm's labor force. The secretarial staff, an invaluable aid to management of a firm, is readily available in most areas. The quality as well as quantity of labor in the firm is also important to the firm's operational efficiency.

Road equipment is the major investment in any trucking firm. The type and quality of equipment needed is dictated by volume and type of business, characteristics of the trade area, and the financial position of the new firm. If desired, equipment requiring a lower investment can be used in establishing a new firm.

Since one of the methods of analysis in this study is to compare the series of model firms to the industry, the firm sizes of the models were chosen to parallel the firm sizes found in the industry. Models approximating Groups I, II, and III in the industry also were desired. The final result of this stratification was the model firm sizes used in the study: A 1 tractor - 1 trailer model, a 3 tractor - 4 trailer model, a 6 tractor - 8 trailer model, and a 12 tractor - 16 trailer model. As size of the models increases, a decrease in the ratio of tractor to trailer was used. This change in ratio was suggested by the managers of trucking firms in the state and by equipment dealers. The increase in loading time needed and increased area of trade are the reasons for this desired ratio. With extra trailers available, the tractor driver need not wait for his trailer to be loaded, but can pick up a trailer loaded while he is still on the road, and begin moving again. Also, in terms of high seasonal demand, tractors for the extra trailers could be leased, thus temporarily increasing the firm size.

The models in this study are stated as tractor-trailer units, with the understanding that potential output is directly related to firm size (150,000 miles per year times number of tractors). These models are assumed to comply with all Public Service Commission's and Interstate Commerce Commission's legal and safety regulations.

When determining labor requirements of each of the models, a one-to-one ratio between drivers and tractors was used. Mechanics and secretarial staff were added as suggested in the interviews with mechanics and salesmen of the trucking equipment. Since it is seldom that theoretical requirements for a certain size firm will match the actual labor used in a firm in the real world, only average figures can be used. Labor requirements vary from day to day and particularly from season to season, since men must be provided to handle unforeseen demands. In the smaller size firms the drivers, as well as the owner-manager are assumed to work, when needed, as mechanics.

Range and Use of Investment Estimates of Models

There was a considerable range between the high and low investment cost estimates for each of the four models. The quality of the equipment used in the trucking firm's operation is the main factor accounting for this difference. The tractor and trailer investment make up 85 to 95 per cent of the total investment per firm, so total investment is predominantly determined by the quantity and quality of the tractors and trailers in the firm.

With this large investment range, an average figure for tractor and trailer cost could not be used. Instead, within each model the high and low investment estimates for tractors and tailers were used. Costs for diesel and gasoline tractors also were considered. In the final construction of the model firms, operating cost per mile was calculated for diesel and gasoline tractors, high and low investment was estimated, and various combinations of their components determined for each model. In considering specific costs of each type of model, not only depreciation on investment, but interest, fuel, fuel tax, and maintenance costs also were considered to vary with type of investment estimate made (Table 7). Other fixed and variable costs were not considered to vary (Table 8). Low priced tractors and trailers usually can perform the same service as higher cost equipment, but they sometimes are considered to be shorter-lived and to have higher maintenance costs. The shorter life of the equipment would affect the fixed costs of operation, while increase in maintenance costs would affect the variable costs. Though definite investment figures are difficult to arrive at because of variations in cost, general relationships in the industry can be defined with the aid of these estimates. For example, when the potential output of a firm is doubled, the investment required for each firm size is approximately doubled also, due to the large portion of total investment made up by the investment in tractors and trailers. This is indicated in Table 6, using only an average investment figure for each model. This relationship is consistent throughout the following analysis, regardless of the type of equipment considered.

Estimating investment costs also is necessary to provide some criteria for establishing costs, such as depreciation, interest, taxes and insurance. Without these cost estimates, an economic analysis of the trucking firms would be useless because the short-run costs necessary for average cost computations could not be presented.

Although the range of investment estimates looks rather wide to serve a useful purpose, the increase in fixed costs by higher investment is tempered by a decrease in variable costs. The highest estimate of investment is the high cost diesel tractor, but inherent in the operation of a diesel tractor are lower fuel and maintenance costs per mile, thus tempering the effect of the increased depreciation and interest charges (Tables 9-20).

An average tractor and trailer investment figure for each model, along with the other investments necessary for the models, is shown in Table 6. This average investment figure is used only in this example. Investment cost per unit decreases slightly as size of the firm increases.²⁵ From the smallest to largest firm there is only a 9.5 per cent decrease in per unit investment, from \$27,900 to \$25,223. The investment cost per mile follows the same pattern; the per cent decrease from the smallest to the largest model is only 9.7 per cent, from 18.6 cents to 16.8 cents. Only a small decrease in investment costs per mile occurs because of the necessary increase in number of tractor-trailer units needed to attain the desired annual mileage. This pattern, shown in Table 6 by an average investment figure, remained approximately the same when comparing the possible combinations of investment costs for each model.

As stated previously, the assumptions of these models are limitations. Now, considering these limitations, the various investment estimates can be analyzed.

Model I: <u>1 Tractor - 1 Trailer Firm</u> Lied shall Vietne date

Total estimated investment costs of establishing the 1 tractor - 1 trailer model firm ranged from \$14,050 to \$37,700.

²⁵The number of units in a firm is based on the number of tractors available, i.e.,: one unit in the 1 tractor - 1 trailer model, six units in the 6 tractor - 8 trailer model, and so forth.

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Equipment				
Tractor	14,000	42,000	84,000	168,000
Trailer	8,000	32,000	64,000	128,000
Office Facilities	100	375	375	375
Garage Equipment	300	300	800	800
Buildings	5,500	5,500	5,500	5,500
Total Investment	27,900	80,175	154,675	302,675
Per Unit	NAGET ANGELL	teo Inventorio.	a an an an Anna an Ann An Anna an Anna	1
Investment	27,900	26,725	25,780	25,223
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Investment	18.6	17.8	17.2	16.8
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TABLE 6. TOTAL, PER UNIT, AND PER MILE INVESTMENT COSTS, MODEL TRUCKING FIRMS

^aThe tractor and trailer investment costs shown here are simple investment averages for diesel and gasoline tractors, and for high and low investment estimates.

This range indicates that costs of entering the trucking industry in North Dakota are not prohibitive. The cost varies considerably, but even the upper range is not prohibitive, at least from a relative cost of entry point of view.²⁶ This firm is designed to operate at an output of 150,000 annual miles. Of this 150,000 miles, 50 per cent or 75,000 miles are assumed to be loaded. The costs considered here make no distinction between running under a full load or running empty because, as indicated by the cost data of the North Dakota industry, these costs are about the same.

Only a small cost of from \$50 to \$200 for office facilities investment was allocated to this firm since it is assumed that, other than a filing cabinet and adding machine, office facilities would be part of the owner's home. Only one telephone was assumed necessary for operation of this firm. The recommended building for use as a garage and workshop for this firm is a 30' x 80' building at a range of investment from \$3,500 to \$7,500. The highest estimate was a prefabricated steel building and the lowest a wood frame building, both with 16 foot high doors.²⁷ This building investment estimate was used for all four models. The building is large enough for a tractor and trailer, and it was assumed that even the largest firm would need to do major repair work on only one tractortrailer unit at any one time. This size building also has enough room so, as more office space becomes necessary, larger firms could use part of the building as an office.

²⁶These costs were considered not to be prohibitive relative to the costs of entering other industries, e.g., farming, automobile manufacturing.

²⁷Estimates for this building were obtained from Edward Williams, Gateway Construction Company, and Roland Krueger, Leo Lumber Company, both of Fargo, North Dakota. Operating this 1 tractor - 1 trailer firm requires the services of only one man, the owner-operator. The owner-operator was assumed to do all the driving, bookkeeping, and repair work. As firm size increases, the owner-operator assumes the exclusive role of manager. He will usually be involved in sales and business generating activities and administrative functions.

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According to estimates received from various dealers and equipment manufacturers, it would be possible to begin operation of the 3 tractor - 4 trailer grain trucking firm with an investment of \$39,775 to \$102,540. This firm could operate at 450,000 total miles per year. It was assumed that office facilities investment needed for the model would range from \$175 to \$540.1 The building investment would be the same as the other models. Two telephones were assumed to be used.

Labor requirements would be three drivers and the owner-operator. The owner-operator is assumed to do some work as a mechanic as well as his managerial duties.

It was estimated that the 6 tractor - 8 trailer grain_trucking firm would be put into operation for \$75,575 to \$195,640, for the livestock firm. This firm is designed to operate at 900,000 miles per year. Investment in buildings is assumed the same as the other models. The labor requirement for this firm is six drivers, one full-time mechanic, and the owner-operator. In a firm of this size, it is possible that a half-time secretary will be employed to handle the telephones and correspondence and also to keep books. Three telephones were assumed necessary for a firm of this size.

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Model IV: 12 Tractor - 16 Trailer Firm

An investment cost of \$147,175 to \$381,640 would be needed to put this 12 tractor - 16 trailer grain trucking firm in operation. The firm is designed to operate at 1,800,000 total miles per year. Office facilities and building investment have the same range as the 6 tractor - 8 trailer firm. This firm was assumed to need four telephones. Labor requirements would be 12 drivers, two full-time mechanics, one full-time secretary, and the owner-operator. In this firm the owner-operator would be concerned only with managerial and business generating duties.

Operating costs are the components is included in the following analysis.

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onet is allocated to each year of use. With annual scares (a de

Depreciation

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The total investment costs calculated for each of the four models are not amortized in one year. Therefore, they are not considered as a single entry in the books of the firm. The usable life of the item considered is the basis used for spreading out these investment costs. The depreciation rates for the tractor and trailers in this study were recommended by manufacturers and by managers in the North Dakota trucking industry. The Public Service Commission dictates the maximum depreciation allowed per time period. The shortest depreciation period allowed is approximately six years. However, after discussing this matter with the equipment manufacturers who provided the initial investment estimates, a usable life of 10 years was employed for the tractor and trailer depreciation schedules because it was felt this gave a more realistic estimate of the actual life of the equipment. This 10-year life was used for all types of tractors and trailers. Equipment in the trucking firm (including office facilities and garage equipment, tools, and air compressor) is depreciated by the straightline method over the 10 years a The building is depreciated by the straight-line method over a 25-year period.

Taxes

Tax expenditures are items which must be paid regardless of level of out-No real estate tax is paid on the tractor or trailer because it is considput. ered personal property. The real estate tax on the building was included as a fixed cost, as well as the excise tax on the tractor and trailer. The rate used for the property and real estate tex was \$20.00 per \$1,000 of investment. The sales tax rate, both excise and use tax, is at present approximately 3 to 4 per cent. Although the tax rate in North Dakota varies from year to year, the rate used in this study was 3 per cent. The sales tax on the tractors and the trailers in each firm was considered to be included in the investment estimates.

Insurance

Insurance rates for the trucker vary greatly in response to such items as record of drivers, type of load, length of haul, and type of insurance carried. Liability insurance must be paid regardless of level of output. The most common liability insurance carried is \$50,000/100,000 bodily injury and \$10,000 property damage. This amount of coverage costs the trucker about \$185 per year per vehicle.

Augenmente - Flor plane des freues dé rélieurs presentes de la sign a sais ²⁸Under the straight-line method of depreciation an equal amount of the cost is allocated to each year of use. This annual amount is determined by dividing the initial investment figure by the years of usable life of the item being considered. For example, if a tractor costs \$20,000 and was to be depreciated out over a 10-year period, an annual depreciation charge of \$2,000 would ນໜຶ່ງໃນມື້ນຶ່ງສາຍຄະລັດ ຮມສະຫາງະດາ ສານ ອະດ ສະຫະຄະ ອະດີນສະຫ be used. T al Luluiope at victorette est the sark

²⁹These insurance rates were obtained from Herman England, The Hartford Insurance Company, Union Stockyards, West Fargo, North Dakota.

Cargo insurance also is carried by the trucker is Since this this is paid annually on each vehicle, it also is considered a fixed cost. The North Dakota Public Service Commission requires a minimum of \$1,000 coverage on each tractortrailer unit. The grain trucker, due to the higher value of his load at times. carries \$2,000 coverage. The insurance rate is \$15 per \$1,000 of coverage. An average rate of \$20 per vehicle was used in this study.

One also considered insurance premiums on the building a fixed cost. In this study a rate of \$1.70 per \$100 investment was used.³⁰ This insurance covers the building and anything within the building proper, including garage equipment. distingues of a section in 054 to 1914 willing later a volume and so referred to the section of basses son lost prisent ber rototracele toi vir pr

License

License fees for the typical trucking firm are the same regardless of the level of output per unit of time. Therefore, license fees are considered fixed. Increases to blot of t air usual gableutt out to interregoments off restriction inte activices. This expanse is a fixed cost to the line response is a

The actual license fee of the trucker varies, depending upon the prorating that the firm does. Prorating refers to the situation where the license fees - the North Dakota trucker pays to each state is based on the number of miles the driven in that state. A certain period before he pays his license, the owneroperator estimates the annual miles he will travel and the percentage of those miles expected to be in each state. Then, the license bureaus of North Dakota and the other states pay each other for the miles driven in the corresponding states by their respective drivers. These fees are paid as a fixed amount by the trucker to the trucker's home state and the portion of the total license fee paid to each state is based on the percentage of that firm's miles driven in each state.

License fees vary from state to state and vehicle to vehicle; therefore, no specific cost can be applied to each individual case. A license cost of \$800 was assigned to each vehicle. Other license fees also are fixed. The trucker pays an agricultural permit fee of \$30 and, if applicable, a "special" permit fee of \$25. Total license cost used in this study was \$855 per vehicle unit a per year. why add makends and the same when any the year. Indiana the period funt fax cost was assured to be 10 years are milled for Beth alread you that first

Telephone

Tolophone

Telephone cost to the firm was considered partially fixed and partially variable. If the firm cuts back production, the base charge for the telephone service must still be paid. The fixed portion of the telephone cost is assumed to be \$5 per month or \$160 per year per telephone. The telephone fixed cost was assumed to increase in direct proportion to the number of phones in use.

Interest of clears the specific and stor cotacities subjyour series to be active to the second series of the second secon investment. Interest paid for the use of this money must be considered a cost

³⁰These rates were obtained from the Fire Underwriters Insurance Company.

to the firm. The annual interest charge paid by the trucker was usually 6.5 per cent on the tractor investment and 7 per cent on the trailer. Capital owned by the firm could, if invested in some other enterprise, yield a return of 6 per cent, so a charge on this investment also was made. The interest charge used in this study was 6.5 per cent for the total investment.

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Utility costs for the trucking firm will not vary with the level of production. In this study a total utility bill of \$50 per month or \$600 annually mainly for electricity and heating fuel was assumed.

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Return to Management off and out? gaidours isology that the cost stands to broke sat stands to be and the sate of the set be the two funder to be a sate

The owner-operator of the trucking firm, in his role of manager, must receive payment for his services. This expense is a fixed cost to the firm as it does not vary with level of production. It is, however, not an accounting cost that appears on the books of the firm. This expense was assessed for this study through comparison with returns on alternative forms of employment. Various commercial trucking firms were asked to estimate the wages paid to individuals doing a job in their firm comparable to the role of the owner-operator in the livestock and grain trucking firms.³¹ These estimates were the basis of the \$6,500 annual return to management used in this study.

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Taxes when the summer consider there as an edge, mostly year gash of each

The only specific taxes to be considered as variable costs in this study

are the excise tax on the tires bought by the firm each year and the state and Federal taxes on fuel used. The tire tax was assumed to be 8 per cent, paid on both the original tires and replacement tires bought during the year. The total fuel tax cost was assumed to be 10 cents per gallon for both diesel and gasoline.

Telephone

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Any telephone expense above the base charge was considered a variable cost. As the level of output increases, there is a corresponding increase in long-distance telephone charges. The telephone cost assigned to the firms in this study was \$2 per thousand miles, or \$.002 per mile.

³¹ Firms providing estimates were Union Storage and Transfer Company, Peterson Mayflower Transfer and Storage, Consolidated Freightways, and United Buckingham Freight Lines, all of Fargo, North Dakota.

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Wages

The cost of all labor in a typical grain trucking firm was considered a variable cost. The two classes of labor costs used were drivers' wages and mechanics' wages. Included in mechanics' wages were any secretarial or office help required.

Wages paid to drivers ranged from 4.5 cents to 6.5 cents per mile, with 5 cents the most common rate. This 5 cents rate was used in this study. Mechanics' and secretarial helps' wages also were considered variable costs. It was assumed they could be paid an hourly wage and, as production is cut back, would be dismissed and their duties taken over by the owner-operator.

Wages paid to mechanics and secretaries in these models are based on salaries being paid to individuals in comparable roles in the North Dakota trucking industry. Both the mechanic and secretarial help are assumed to work only the necessary hours to complete the needed work, which would vary closely with annual mileage, and wages were \$1.75 and \$1.25 an hour for mechanics and secretarial help, respectively.

Fuel

A major cost incurred by a trucking firm is fuel expense. The price per gallon in North Dakota, excluding taxes, is approximately 15 cents for diesel fuel and 22 cents for gasoline. Fuel cost per mile is greatly affected by the type of engine used in the tractor. A diesel tractor commonly traveled five miles per gallon in the trucking industry, while the gasoline tractor traveled 4 to 4.5 miles per gallon. The fuel cost used in this study was 3 cents per mile for diesel and 4.5 cents per mile for a gasoline tractor. Little difference in fuel consumption was noticed between the high and low priced diesel or gasoline tractors.³²

Tire Cost

Tire cost is also considered an important variable cost because of its direct relationship to annual mileage. Truckers were asked to estimate the mileage life of the tires on their vehicles, and those ranged from 50,000 miles to 200,000 miles per tire with a mean of 140,000 miles. The median and model estimate was 100,000 miles per tire.

Many factors result in wear on the tire. When the tire is first placed on the vehicle, wear is comparatively rapid. As the tire wears down the rate of wear slows appreciably. A cost per mile of 2.5 cents was used, arrived at by dividing the mileage per tire into the average purchase price per tire multiplied times the number of tires on each tractor-trailer combination.

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32Throughout this discussion the Terus, high-gas tractor will refer to the higest investment estimate for a gas tractor, low-diesel tractor will refer to the lower estimate for a diesel tractor, and so forth.

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TABLE 7. COSTS THAT VARY CENT CAPACITY		en lunger yabed 2 in district vag sed 2:3ems add game : Prefaere <mark>a</mark> ddaa an	ar i sanar i tari. Antopico si tari, ,	ula <mark>p</mark> iev ois no evele 3200 to t <mark>G</mark> atblokk ys t <mark>H</mark> andd ballt and th

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Maintenance Costs in the Jahurigo , anti publicut rite, teles at al

Maintenance costs also vary with level of production, and include oil, oil filters, fuel filters, corrosive resistant elements, normal preventive inspections, and repairs. Repairs include all costs of engine and chassis upkeep necessary in the 10-year life of the tractor and trailer. Information received from engine manufacturers indicated a .9 cent per mile maintenance cost for engines.³³ The survey sample cost data of North Dakota grain truckers indicated a maintenance cost of .95 cents per mile. The grain trucker was assumed to have maintenance costs of .9 cents per mile for diesel and 1.3 cents per mile for gasoline tractors.

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TABLE 8. ANNUAL FIXED AND VARIABLE COSTS NOT AFFECTED BY CHANGES IN INVESTMENT ESTIMATES, MODEL GRAIN TRUCKING FIRMS, 100 PER CENT CAPACITY server the backed best the served add to instite order better as the intervisional talkets isoo

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Gasoline Versus Diesel Tractors

A comparison of the diesel tractor investment estimates with those for a comparable gasoline tractor indicates a lower operating cost for the diesel tractor firms throughout all four models.

³³Brown, James H., field manager, Motor Truck Division, International Harvester Company, December 21, 1966. In the model grain trucking firms, operating cost of the low cost gas firm was greater than the high cost diesel firm in all four models, caused by the higher variable cost charged to the gasoline tractor. This increase in variable costs offsets the lower fixed costs obtained by lower depreciation and interest charges on the gasoline tractor, thus resulting in higher average total costs for the gasoline tractor firm. This difference in operating costs between the comparable diesel and gas investment estimates remains approximately the same throughout all four models (Tables 9-12).

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High Cost Versus Low Cost Trailer Investment Estimates

Employing the higher cost trailer in the model resulted in an increase of .25 cents in Model I, to .34 cents per mile in Model IV, with the average change being .32 cents per mile (Tables 9-12). The difference of high cost versus low cost trailer investment had, as expected, more effect on the three larger models than on the 1 tractor - 1 trailer model because of the higher relative importance of trailer costs to the firm's overall costs as firm size increases.

High Cost Versus Low Cost Investment Estimates

Costs applicable to the different investment estimates indicate that a variation in investment causes a noticeable variation in operating costs because percentages of total investment are used to determine some components of each model's operating costs. There was not, however, a direct relationship between increased investment in that type of equipment and increased operating costs does occur. However, when comparing a firm operating diesel tractors with a firm operating gasoline tractors, the added expense of the increased investment necessary to obtain diesel tractors is more than offset by the decrease in variable costs.

Tables 9 through 12 and Figures 1 through 8 indicate that the per mile operating costs for the highest and lowest investment estimates for each specific model are substantially different. The difference for the grain trucking firms was 1.13 cents per mile for Model I operating gasoline tractors to 1.33 cents per mile for Model II operating diesel tractors and an average change in operating costs between the highest and lowest investment estimates of 1.25 cents per mile.

The change in operating costs as a result of investing in diesel tractors instead of gasoline tractors is noticeable. The difference between diesel and gasoline tractor firms was approximately 2.6 cents.

Excess Capacity and the second s

Operating costs per mile are increased greatly when excess capacity exists. Data presented in Tables 13, 14 15, and 16 support this conclusion and provide the information necessary for construction of short-run average cost curves.

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IS, GAS AND DIESEL TRACTORS,	
TABLE 9. GRAIN TRUCKING FIRMS - COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES,	MODEL I, 100 PER CENT CAPACITY
TABLE 9.	MODEL

^bHigh and low refer to the highest and lowest investment cost estimates for the equipment.

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MODEL II, 100 PER CENT CAPACITY

		- 26 -			
Low Gas, Low Trailer	3,580 2,327 10,562	16,469 9,450 20,250 35,550	71,100 87,569	<u>•1530</u> •1945	
Low Gas, High Trailer		17,989 9,450 5,850 35,550	71,100 89,089 .0399	.1979	ouii nmont
High Gas, Low Trailer	5,980 3,887 10,562	20,429 9,450 5,850 35,550	71,100 91,529 0453	. 2033	for the east
High Gas, High Trailer	dollars 6,900 4,487 10,562	21,949 7 20,250 9,450 20,250 35,550 35,550	71, 100 93, 049 0487	1580 2067	
Low Diesel, Low Trailer	5,680 3,692 10,562	19,934 7,650 13,500 4,050 <u>35,550</u>	60, 750 30, 684 04,22	2 • 1350	ad lound damoetmost soct soctimeted
Low Diesel, High Trailer	6,600 4,292 10,562	21,454 7,650 13,500 4,050 <u>35,550</u>	60,750 82,204 0476	.1350	n e e e e e e e e e e e e e e e e e e e
High Diesel, Low Trailer ^b	8,380 5,447 10,562	24,389 7,650 13,500 4,050	60,750 85,139 0541	00	
High Diesel, High Trailer ^b	6,047 50,047 50,047	125,909 125,909 13,500 13,500 13,500	60,750 86,659	.1350 .1925 11 in Table	
Cost Components	Fixed Costs Pepreciation Interest (Other Fixed Costs) ^a	Variable Costs Fuel Tax Maintenance (Other Variable Costs) ^a	Corpete Total Variable Thorsess DebessTotal Costs Average Costs Per Mile	Total Total able Total in Table	and an anna anna anna anna anna anna an

OSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GAS AND DIESEL TRACTORS,	
RMS COSTS PER MILE . ALL POSSIBLE INVESTMENT	ENT CAPACITY
TABLE 11. GRAIN TRUCKING FI	MODEL III, 100 PER CENT CA

	High	High	Low	Low	High	High	-Low.	Low	31
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Cost Components	Trailerb	Trailer ^b	Trailer	Trailer	Trailer	Trailer	Trailer	Trailer	
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Depreciation College	18,600	16,760	13,200	्11 , 360	13,800	11,960	6 ,000	_~ 7,160	
Interest (Other Fixed Costs) ^a	12,094 - 2 <u>13,742</u>	10,894 <u>13,742</u> 0	8,584 13,742	7,384 <u>13,742</u>	8,974 13,742	7,774 13,742	5,854 13,742	4,654 13,742	
Total Fixed Costs	44,436	41,396	35,526	32,486	35,516	33,476	28,596	25,556	
Variahle Costs								2. 	
Fuel Tax	15,300	15,300	15,300	15,300	18,900	18,900	18,900	18,900	
Fuel Cost	27,000	27,000	27,000	27,000	40,500	40,500	40,500	40,500	i laa
Maintenance	8,100	8,100	8,100	8,100	11,700	11,700	11,700	11,700	27
(Other Variable Costs) ^a	77,100	77,100	77,100	77,100	77,100	77,100	77,100	77,100	-
Total Variable Costs	127,500	127,500	127,500	127,500	148,200	148,200	148,200	148,200	
Total Costs	171,936	168,896	163,026	159,986	184,716	181,676	176,796	173,756	
Average Cost Per Mile									
Fixed	.0493	.0460	.0395	.0361	.0405	.0372	.0318	.0284	
Variable	.1417	.1417	.1417	.1417	.1647	.1647	.1647	.1647	
Total	.1910	.1877	.1812	.1778	.2052	.2019	.1965	.1931	
^a Explained in detail in Table 8.	in Table 8.								

^bHigh and low refer to the highest and lowest investment cost estimates for the equipment.

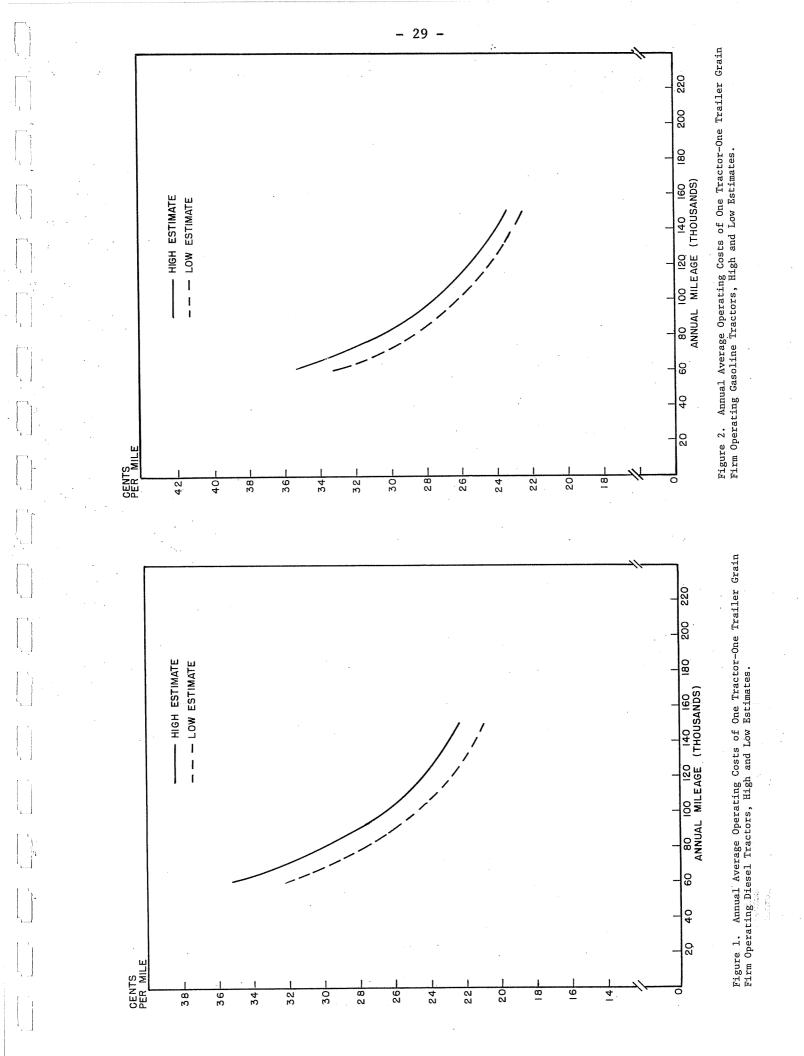
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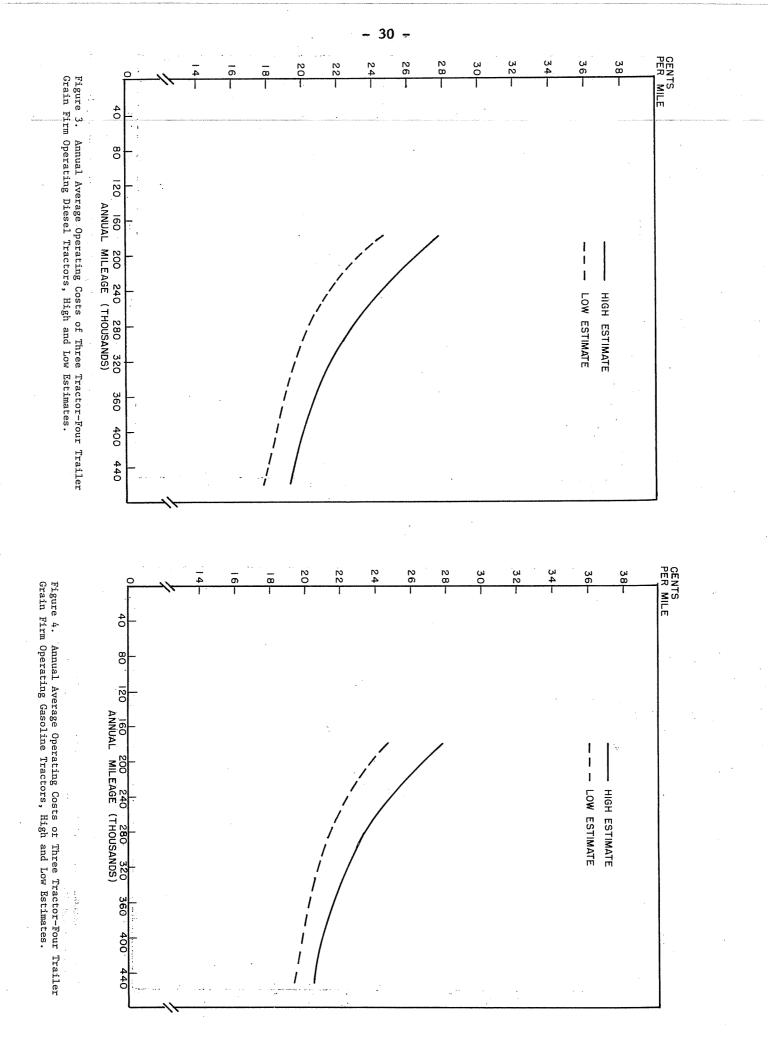
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12.	MODEL IV, 100 PER CENT CAPACITY
TABLE 12.	MOD
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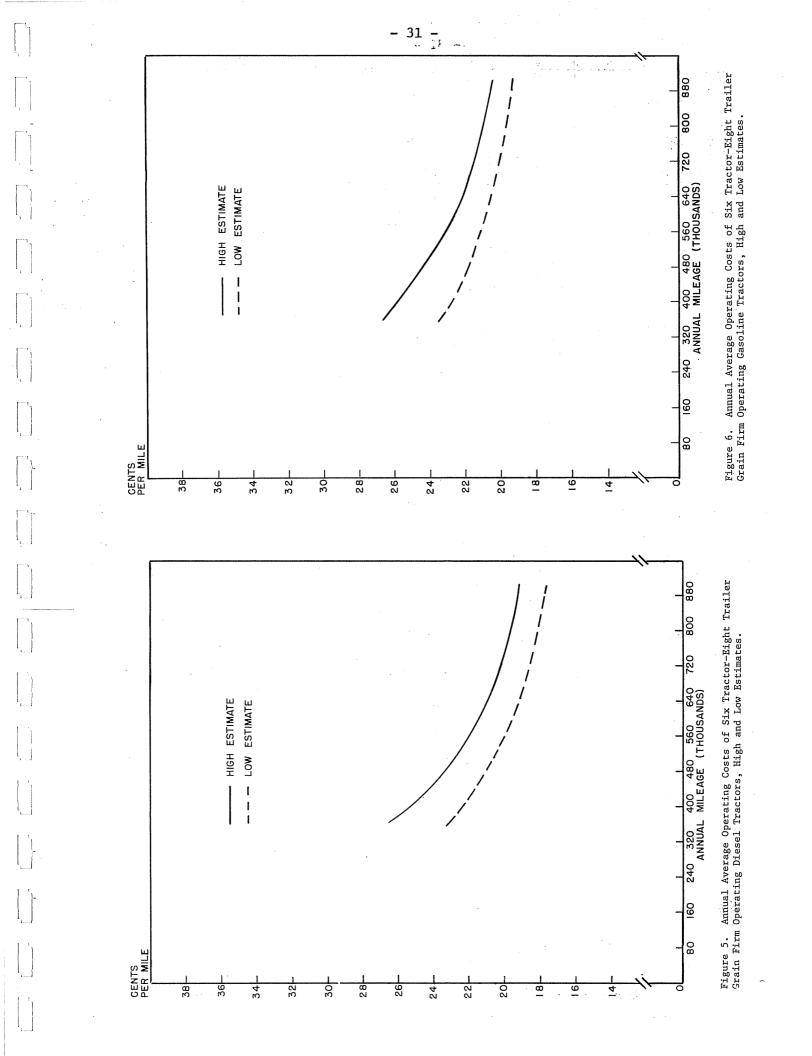
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	High	Low Low	High	Low Low	High	Low .	H1gh	Low
Cost Components	Trailerb	Trailer ^b		Trailer	Trailer	Trailer	Trailer	Trailer
	1 A MAR	ter er			dollars			1000 1000 1000 1000 1000 1000 1000 100
The Cost of the Co	37,200	33,520	26,400	22,720	-27,600	23,920	18,000	14, 320
Interest (Other Fixed Costs) ^a		21,788 20,042	17,168 20,042	14,768 20,042	17,948 20,042	15,548 20,042	11,708 20,042	9,308 20,042
Total Fixed Costs	1.997 1.294 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	75,350	63,610	57,530	65,590	59,510	49,750	43,670
					t di Tana Sana Sana Sana Sana Sana Sana Sana Sana Sana Sana Sana			
Fuel Tax	30, 600	30,600	30,600	30,600	37,800	37,800	37,800	37,800
Fuel Cost	54,000 16,200	54,000	54,000	54,000	81,000 23,400	81,000 23,400	81,000 23.400	81,000
(Other Variable Costs) ^a 154,600	ts) ^a <u>154,600</u>	154,600	154,600	154,600	154,600	154,600	154,600	154,600
Total Variable Costs 255,400	its 255,400	255,400	255,400	255,400	296,800	296,800	296,800	296,800
a state Total Costs	336.830	330.750	319,010	312,930	362°390	356.310	346,550	340,470
and the Market of the Den Mile					•	•		
Average costs fet mile Fixed	.0452	.0419	.0353	.0320		.0331	.0276	.0243
Variable	.1419	.1419	.1419	.1419	.1649	.1649	.1649	.1649
Total	.1871	.1838	.1772	.1739	.2013	.1980	.1925	.1892

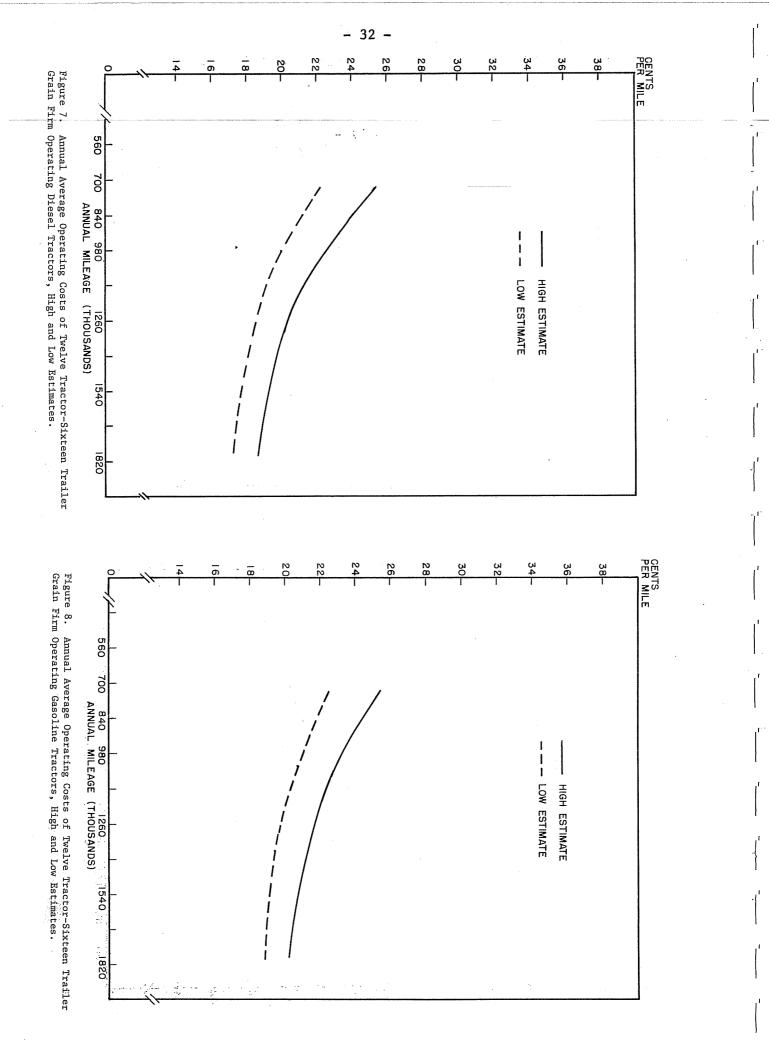
^bHigh and low refer to the highest and lowest investment cost estimates for the equipment.

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1		· · · · · ·			
Average Total		.1910 .2034 53.2239 53.2651	.1778 .1868 .1868 .1868 .1868 .1263	• 2052 • 2154 • 2323 • 2661	.1931 .2001 .2120
Total Cost		171,936 146,460 120,954 95,448	159,986 134,510 20,004 20,83,498 22,223,498	184,716 155,100 125,454 125,454 125,808 27,808 28,808	173,756 144,140 114,494 84,848
Average Variable	1ars ⁼¹ 1680 1280	• 1417 • 1417 • 1417 • 1417 • 1417 • 1417 • • 1417	• 1417 • 1417 • 1417 • 1417 • 1417 • 1417 • 1417 • 1417 • 1417	.1647 .1647 .1647 .21647 .220	.1647 .1647 .1647
Total Variable Sg ² Cost	25,550 doll	127,500 502,024 576,518 51,012 51,012	127,500 102,024 20,516 5160 5160 218 012 012	148,200 118,584 2788,938 2659,292 2022	148,200 118,584 88,938 59,292
Average Fixed	2320 7325 7325	• 0493 • 0617 • 0822 • 1234 • • • 1234	.0361 .0451 0.0601 0.23 0.23	.0405 .0507 .0507 .0507 .014	.0284 .0354 .0473 .0473
Total Fixed		44,436 44,436 44,44,436 44,44,436 44,44,436 44,436 44,436 84,43684,536 84,566 84,566 84,566 84,5666 84,5666666666666666666666666666666666666	32,486 32,486 32,486 32,486 32,486 32,486	36,516 36,516 236,516 236,516 236,516 22 25 216 22 25 216	25,556 25,556 25,556 25,556
Model and Per Cent Utilization of Capacity)		1 High Cost Estimates (900,000) (720,000) (7240,000) (7260,000) (720,000)	ow Cost Est (900, (720,))))))))))))))))))))))))))))))))))))	All High Cost Estimates (900,000) (720,000) (540,000) (360,000)	All Low Cost Estimates (900,000) (720,000) (540,000) (360,000)
Ce Ce			Diesel, Al 100% 80% 0.40% 80% 80% 80%		Gasoline, 1 100% 80% 60% 40%

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	Average Total Cost		9 .1925 900 .2069 900 .2309		4 .1792 4 .1903	費 (S) (位 の (S) (S) 多 (C) (2)			9 2392 9 2799			9 .2037 9 2189	•	capacity
IG FIRMS	Tota1 Cost	an an sta Ser an sta Ser an sta	86,659 74,509 62,359		80,684 68,534	56, 384 44, 234		93,049 78,829	64,609 50,389		87,569	73,349	44,909	
FOUR TRAILER MODEL GRAIN TRUCKING	Average Variable Cost	dollars	.1350 .1350	.1350	.1350	.1350	er 1 Fran Angel Angel Angel A	.1580	.1580	• 20 ¹⁰ • 2010 • 2010 • 10 • 10	.1580	.1580	.1580	s specified levels of
VILER MODEL C	Total Variable Cost		60,750 48,600 36,450	2400 2433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 24433000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 244330000 2443300000 2443300000 244330000000000	60,750 48.600	36,450 24,300		71,100 56,880	42,660 28,440		71,100	56,880 43 660	28,440	produced at the
1	Average Fixed Cost	la fina Secondaria Secondaria Secondaria Secondaria Secondaria	.0575 .0719 .0959	.1439	.0442	.1107		.0487	.0812		.0365	.0457	.0914	l mileage pro
THREE TRACTOR	Total Fixed Cost	an an Staine Staine Staine Staine Staine	25,909 25,909 25,909	22 25 26 00 00 00 00 00 00 00 00 00 00 00 00 00	19,934 19,934	19,934	1122 1222 1224 1224 1225 1225 1225 1225	21,949 21,949	21,949 21,949	- 6. - 2. - 4. - 32. - 7.,	16,469	16,469	16,469	to the annual mileage
ANNUAL OPERATING COSTS,	Model and Per Cent Utilization of Capacity		High Cost Estimates (450,000) (360,000) (270,000)	(100),000) (180(000),000) (180(000),000) (180(000),000)	Low Cost Estimates (450,000) (360,000)	(270,000) (180,000)	(1997년) (1997년) 1997년 - 영양한 1992년 1992년 1997		(270,000) (180,000)		<pre>[1 Low Cost Estimates (450,000)</pre>	(360,000)	(180,000)	res in brackers refer
TABLE 14. A	Mo Cent		Diesel, All 100% 80% 60%	40% 40% 2097 2007	H	60% 90% 90% 90%			20% 70%		Gasoline, All 100%	80%	40%	^a Figu utilization.

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Costs in these tables are derived by holding the variable costs per mile constant and dividing the fixed costs by varying levels of miles traveled per year.

By decreasing the level of production (annual mileage) from 100 per cent of capacity to 60 per cent of capacity, the owner of the one tractor - one trailer grain firm operating high cost diesel tractors increases his per mile operating costs by 5.83 cents, or 26 per cent. Data in Tables 13, 14, 15, and 16 indicate that similar relationships exist in each of the four models.

Since the average fixed cost figure increases as capacity utilization decreases, the average total cost figure increases. The average variable mechanics and secretaries will work just those hours needed to complete the necessary work. Since other variable costs are held constant per mile also, this accounts for the constant per mile average variable cost used in each specific model.

Economies of Size

Short-run average cost curves are presented in Figures 1 through 8. These curves are shown for the highest and lowest operating cost estimate for each of the four models, and are also categorized as to gasoline versus diesel. The most efficient of the cost estimates for each specific model was used for the short-run average cost curves presented in Figures 9 and 10. These figures indicate no noticeable economies of size can be realized by increasing the firm's size beyond the three tractor - four trailer firm. There is substantial drop in operating costs when increasing the firm size from a one tractor - one trailer firm to a three tractor - four trailer firm. For a grain trucker operating diesel tractors at 100 per cent capacity, average operating costs for Models I through IV are 21.00 cents, 17.92 cents, 17.78 cents, and 17.39 cents, respectively. The industry scale curve or the long-run curve is found by simply drawing a line tangent to the four short-run average cost curves shown by the heavy, broken line in Figures 9 and 10.

Since this curve levels off and becomes horizontal at about 450,000 level of annual mileage, it can be concluded that at this point the possible economies of size are utilized to a large extent. From this model, the 3 tractor - 4 trailer firm, on little more economies of size are realized. The longrun planning curve in these figures establishes that, of the four models, only the 1 tractor - 1 trailer model can definitely be said to be less efficient than the others. From the 3 tractor - 4 trailer model to the 12 tractor - 16 trailer model, equivalent to quadrupling the firm size, per mile operating costs are reduced by only .53 cents.

If demand for the trucker's service is present (as assumed in this study), the firm will realize economies of size by increasing its output to a capacity of at least 450,000 miles per year. As long as average total cost continues to be less than average revenue, the firm can and should, in the long-run, continue increasing in size. TABLE 13. ANNUAL OPERATING COSTS, ONE TRACTOR - ONE TRAILER MODEL GRAIN TRUCKING FIRMS

Average Total Cost	1.58 11 2 11 (2225 22443 2808 3537	<u>7 803 (</u> 9V01 () EXCS) ()	.2100 .2288 .2601	0 <u>16 b</u> 776 80 776 80	2202 S	3547 3547	solva Lo př	.2279 27.53	.2745	• 3327	Cosca Siste Cosca
Tota1 Cost		33,375 33,375 29,325 25,275 21,225		31,510 27,460 23,510	адала р 1997 - С 1997 - С 19	35,505 30,765	n. n. n'	nag S Den Li gi Li gi Li si Den Den Den	34,185 20,445	£0. €	19,965	Levels of capa
Average Variable Cost	ars	.1350 - 1350 .1350 - 1350 .1350 - 13500 - 13500 - 13500 - 13500 - 13500 - 13500 - 13500 - 135	Eles Selli Britishe Din Malan Life	.1350 .1350 .1350 .1350			.1580	(37) (49) 7 (57) (17)	.1580	.1580	• 1280 • 1 280 • • •	specified specif
Total Variable Cost	dollars	20,250 20,250 16,200 8,100	<u>e</u> bedsteer istoore og al i osge dr		1990) (1997) 1990 1990 (1990) 1990 (1990) 1990 (1990) 1990 (1990) 1990 (1990)	1980 1980 1980 1980 1980 1980 1980 1980	14,220 9,480	n fa Tachar Facilian f	23,700	14,220	66	pre-
Average Fixed Cost		.0875 .1093 .1458 .2187	sadum) rur ak lumi k lum	.0750 .0938 .1251	• 1846 • 1846 • 1846	• 0787 0083	.1311		.0699	.1165	.1747	
Total Fixed Cost		13,125 13,125 13,125 13,125	N State	0 0 0	11,260	11,805 11,805	11,805 11,805		10,485	10,485	10,485	o the annual
Model and Per Cent Utilization of Capacity		Diesel, All High Cost Estimates 100% (150,000) 80% (120,000) 60% (90,000) 40% (60,000)	All Low Cost		40. 100 1000 (1000) 1000 (100	Gasoline, All High Cost Estimates 100% (150,000) 20% (190,000)	40% (50,000) (40% 000) (50,000)			60% (1770,000) (170,000)	2000 200 2000 2	e a real of the reckets refer to utilization.

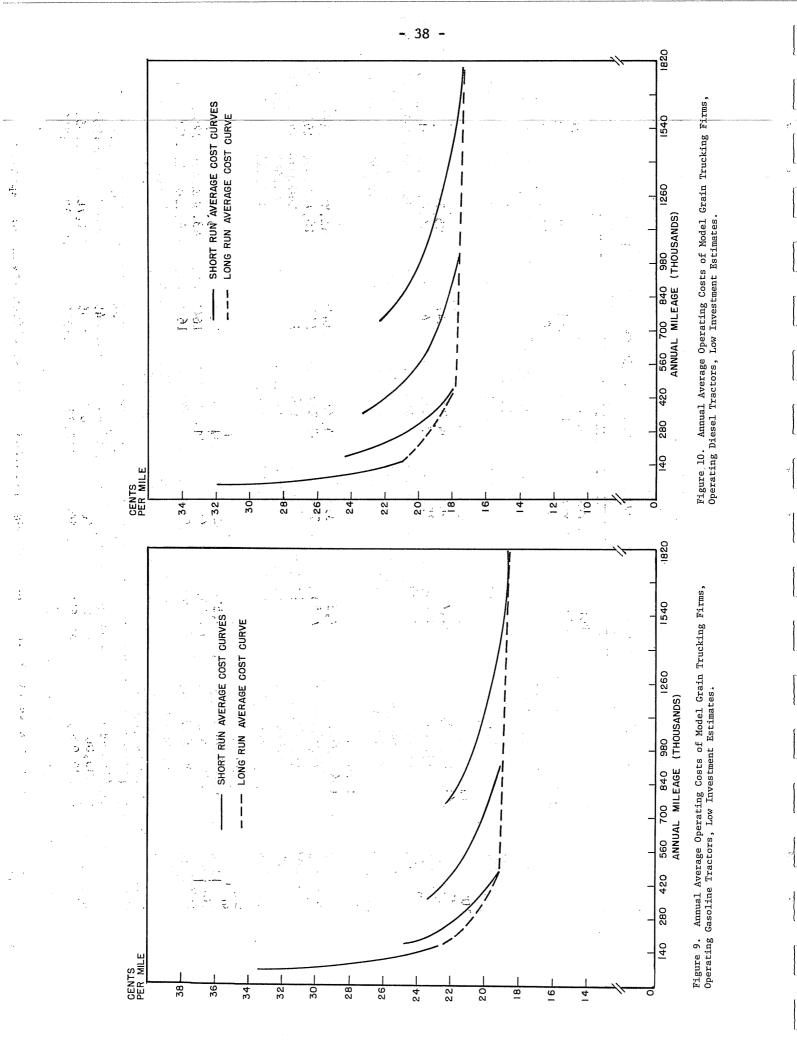
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TABLE 16. AN	ANNUAL OPERATING COSTS,	TWELVE TRACTOR	TOR - SIXTEEN		TRAILER MODEL GRAIN TRUCKING	KING FIRMS	
Model Cent Ut of C	Model and Per Cent Utilization of Capacity	Total Fixed Cost	Average Fixed Cost	Total Variable Cost	Average Variable Cost	Total Cost	Average Total Cost
				dollars	ars		
A11	High Cost Estimates (1,800,000) (1,440,000) (1,080,000)	81.430 81,430 81,430	.0452 .0565 .0753	255,400 204,336 153,252	.1419 .1419 .1419	336,830 285,766 234,682	.1871 .1984 .2172
40%	(000,027)	81,430	.1130	102,168	.1419	183,598	.2549
Diesel, All I 100% 80% 60%	Low Cost Estimates (1,800,000) (1,440,000) (1,080,000)	57,530 57,530 57,530	.0320 .0399 .0532	255,400 204,336 153,252	.1419 .1419 .1419	312,930 261,866 210,782	.1739 .1818
40%	(720,000)	57,530	0799	102,168	.1419	.59,698	.2218
Gasoline, All 100%	Hig	65,590	.0364	296,800	.1649	362,390	.2013
80% 60%	(1, 440, 000) (1, 080, 100)	65,590 65,590	.0607	237,456 178,092	.1649 .1649	303,046 243,682	.2104
40%	(720,000)	65,590	°0100	118,728	.1649	184,318	.2559
Gasoline, All 100%	Low	43,670	.0243	296,800	.1649	340,470	.1892
80% 60%	(1,440,000) (1,080,000)	43,670 43,670	.0303	237,456 178.092	.1649 .1649	281,126 221.762	.1952
%05	(720,000)	43,670	.0606	118,728	.1649	162,398	.2255
^a Figures "Hilization"	in brackets refer	to the annual	the annual mileage produced	at the	specified levels	vels of capacity	city

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Used Versus New Equipment CECASSECCE LATERA CLEAR AND A CARACTER AND A CLEAR A

Another option open to the owner-operator is buying used equipment. Data demonstrating the comparable costs of a 3 tractor - 4 trailer firm, hauling grain and using gasoline tractors, when using new versus equipment are shown in Table 17. Fixed costs of the used equipment are lower because of reduced depreciation, interest, and license costs. Depreciation was figured on an estimated eightyear life for the tractor and six-year life for the trailer. Both estimates are considered to be the maximum possible life for used equipment as for new equipment, i.e., 6.5 per cent. Since license fees are usually based on weight and age of equipment, the license fee charge to the used model was lowered as suggested by the North Dakota Fee Schedule. The decrease in these three cost components lowered fixed costs \$2,977 below the new equipment model. This lowered average fixed costs by .66 cents, from 3.65 to 2.99 cents.

Variable costs were increased substantially more than fixed costs were decreased. Fuel tax, fuel, and maintenance costs all increased. These variable costs were increased according to the suggestions of mechanics employed by various equipment dealers and the managers of North Dakota agricultural trucking firms. Fuel tax and fuel costs were raised from 2.1 and 4.5 cents to 2.3 and 5 cents per mile, respectively. Maintenance charges also had to be increased, from 1.6 to 2.5 cents per mile.³⁴

Average total variable costs were raised from 15.8 cents per mile to 17.7 cents per mile. This increase more than offsets the decrease in average fixed costs, resulting in an average total cost of 20.69 cents per mile for the used equipment at 100 per cent of capacity utilization, 1.24 cents above the 19.45 cents per mile operating cost for the new equipment. This relationship seems to hold for all models and all investment estimates.

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The new equipment model has lower operating costs per mile even when operating at 40 per cent capacity (Table 18). The difference is smaller due to the higher fixed cost of the new equipment, but is still noticeable.

INDUSTRY - MODEL COMPARISONS AND IMPLICATIONS

Per mile operating costs reported by the sample firms in this study appeared to be considerably higher than those computed for the models (Table 19). Actual operating costs for the grain firms ranged from 17.95 cents to 32.48 cents per mile with a mean and median of 23.42 cents and 26.79 cents, respectively.

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Comparing these costs with the costs of the optimum model, the low cost diesel, low cost trailer firm indicated that efficiency improvements could be made in the North Dakota trucking industry. However, the North Dakota trucking firms are only operating at approximately 45 per cent of capacity. The North

³⁴This 2.5 cent cost is again on the low side of the range of maintenance estimates obtained.

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Utilities	600	600
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Fuel	5,850	11,250
Maintenance	uria Far900av Sanaa.	en noterul 900
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Telephone	22,500	22,500
Drivers' Wages	22,500	
Mechanics' Wages Tire Cost	11,250	11,250
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Total Variable Costs	71,100	79,650
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otal Costs		93,142
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verage Fixed Cost Per Mile	.0365	.0299
verage Variable Cost Per Mile	.1580	.1770
	лан, Дайбалан <u>Міс</u> нька; .1945	
		.2069

TABLE 17. ANNUAL OPERATING COSTS OF A GRAIN TRUCKING FIRM, NEW AND USED EQUIP-MENT, THREE TRACTOR - FOUR TRAILER, GASOLINE, MODELS, 100 PER CENT CAPACITY

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Utilization of Capacity		Total Fixed Cost	Average Fixed Cost	Total Variable Cost	Average Variable Cost	Tota1 Cost	Average Total Cost
(450,000) (360,000) (270,000) (180,000)	00) a 00) (00)	16,469 16,469 16,469 16,469 16,469	• 289 967 4 200 (1997) 194 10 (1997) • 091457 • 091457	400 000 000 000 000 000 000 000 000 000	dollars 1280 (batt liderite 1280 (batt liderite 1280 (batt liderite) 1280 (batt lid	icates that the s 65 pex cont lient 23,226 (cic 13,33,226 (cic 13,33,226 (cic 13,33,226 (cic 13,33,226 (cic 13,33,226 (cic 14,53,126 (cic))) (cic 14,	
(450,000) (360,000) (270,000) (180,000)		13,492 13,492 13,492 13,492		31,860 31,860 31,860 31,860	edimi pole en 1. soletito 1. s	aletionet al formation 1421000 - 2000 175320 42322 175320 145 145 145 145 145 145 145 145 145 145	

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Dakota grain trucking industry costs do compare favorably with the model costs at 45 per cent of capacity. Furthermore, buy increasing their level of capacity utilization to 100 per cent they can actually realize costs slightly lower than the models (Table 19). This relationship indicates that the industry firms are operating at nearly optimum efficiency at the 45 per cent level of capacity and can attain optimum efficiency at the 100 per cent level. To reach optimum efficiency, they must increase their annual mileage per vehicle. This could be done by reducing the number of tractor-trailer units per firm while operating at the same annual firm miles or by increasing the annual firm miles while holding firm size constant.³⁵

Data for the industry firms also indicate that little economies of size can be realized by increasing the firm size (Table 19). This relationship coincides with the relationship found in the models. As indicated by the change in operating costs when increasing the level of capacity, substantial internal economies of size can be realized for both industry firms and the models. The decrease in operating costs, at the 100 per cent level of capacity, when increasing firm size from Group I to Group III was only .47 of a cent, while the decrease from Model I to Model IV was 3.61 cents. At the 45 per cent level of capacity the decrease in costs was larger. The industry firms had a decrease of 1.18 cents, compared to the model's decrease in costs of 7.26 cents. As shown by this data, the industry firms are actually realizing less economies of size than did the model firms. Further, just as in the models, the largest decrease in cost occurred between the smallest and next largest firm size. Little economies of size occurred between Groups II and III or between Models II and IV.

³⁵Increasing vehicle annual mileage by reducing the number of tractortrailer units per firm may not be feasible due to the seasonality of demand for the trucker's services, the desire to give good service to the customer, and the reluctance of the trucker to decrease the firm size.

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Tractor - Trailer)	21.00
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III 22.91 Tractors - Trailers)	
IV 21.80 Tractors ~ Trailers)	VA (1971) 34 1995 - 199 1 12
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TABLE 20. ANNUAL TOTAL AND AVERAGE COSTS OF NORTH DAKOTA GRAIN TRUCKERS, AVER-AGE INDUSTRY FIRM SIZE, SAMPLE FIRMS, 1966