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

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FOREWORD

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1. Wheat Statistics for North Dakota, Agricultural Economics Report No. 20, August, 1961.
2. Protein Content of North Dakota Wheat, North Dakota Farm Research, March-April, 1962.
3. Market Factors of North Dakota Hard Red Spring Wheat, Agricultural Economics Report No. 21, April, 1962.
4. North Dakota Hard Red Spring Wheat Shipments, North Dakota Farm Research, September-October, 1962.
5. Durum Market Factors, 1962, North Dakota Farm Research, January-February, 1963.
6. Quality Factors of North Dakota Durum Shipments, 1960, 1961, 1962, Agricultural Economics Report No. 26, January, 1963.
7. Durum Data, Agricultural Economics Report No. 27, February, 1963.
8. Market Factors of North Dakota Hard Red Spring Wheat, 1962 Shipments, Agricultural Economics Report No. 28, February, 1963.
9. Market Factors of North Dakota Hard Red Spring Wheat, 1963 Shipments, Agricultural Economics Report No. 33, March, 1964.
10. Market Factors of North Dakota Durum Wheat, 1963 Shipments With Comparisons, Agricultural Economics Report No. 34, April, 1964.
11. Quality of Commodity Credit Corporation Wheat in North Dakota Country Warehouses and Subterminals, North Dakota Farm Research, May-June, 1964.
12. Movement of North Dakota Grain by Truck, October-November, 1963, 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 Economic Implications of the Wheat Sedimentation Test on the North Dakota Economy, Clinton D. Kurtz, unpublished Master's thesis, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, October, 1964.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. Market Factors of North Dakota Durum Wheat Shipments, July-December, 1964, Agricultural Economics Report No. 42, June, 1965.
15. Market Factors of North Dakota Hard Red Spring Wheat Shipments, July-December, 1964, Agricultural Economics Report No. 43, June, 1965.

16. Trends in Shipping Grain by Motor Carrier From North Dakota Origins, 1956-57 Through 1963-64, Bulletin No. 462, December, 1965.

17. Addendum to Bulletin No. 462, Agricultural Economics Report No. 44, January, 1966.

18. Market Factors of North Dakota Durum Wheat Shipments, July-December, 1965, Agricultural Economics Report No. 45, April, 1966.

19. Market Factors of North Dakota Hard Red Spring Wheat Shipments, July-December, 1965, Agricultural Economics Report No. 48, July, 1966.

20. The Importance of the Export Market to the North Dakota Wheat Producer, North Dakota Farm Research, November-December, 1966.

21. Durum Yields Increasing, North Dakota Farm Research, March-April, 1967

22. Trends in the Flow of Wheat Exports in the World Market, Agricultural Economics Report No. 56, August, 1967.

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.

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.

AN ECONOMIC ANALYSIS OF THE COSTS OF OPERATING GRAIN TRUCKING FIRMS IN NORTH DAKOTA

Kenneth L. Casavant and David C. Nelson[1]

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

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[2]A 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.[3] 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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[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.

[5] Nelson, 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.

[6] Kurtz, Clinton D., and Fred R. Taylor, "Truck Transportation of North Dakota Grain", Reprint No. 619, from March-April, 1964, Farm Research, North Dakota Agricultural Experiment Station, Vol. No. 6, pp. 23-27.

[7] Taylor, Fred R., and David C. Nelson, Trucking Shipment of Grain From 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.

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

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.

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:

1. To identify the characteristics of the North Dakota grain trucking industry and indicate any general trends.

2. To identify major factors affecting costs of operation and some possible methods for reducing these costs.

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

4. To determine if more efficient methods of firm operation are available in the industry.

METHOD OF STUDY

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[10] and from interviews with mechanics of the equipment dealers mentioned above.

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.

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

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[9]Companies 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 Smith Inc., all of Fargo.

[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.

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.

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

Size of Category	Number of Firms
Group I	19
Group II	16
Group III	8
All Firms	43

[11]Many 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.

[12]Of 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.

Size of Firm

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.

Miles Traveled

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

Size Category	Firm	Vehicle
	000 miles	
Group I	147	70
Group II	228	56
Group III	394	52
All Firms	222	61.4

[13] See "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 tractor-trailer 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

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[15]Two 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., Industrial Organizations, John Wiley and Sons, Inc., New York, August, 1965, pp. 358-360.

[16]In 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., The Role of Truck Brokers in the Movement 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.

Trade Area Covered

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.

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[17]A 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.

TABLE 3. INTRASTATE MILEAGE AND LENGTH OF MOST COMMON TRIP, SIZE CATEGORY, SAMPLE FIRMS, NORTH DAKOTA GRAIN TRUCKING INDUSTRY, 1966

Size Category	Intrastate Mileage	Length of Most Common Trip
	per cent	miles
Group I	74	450
Group II	69	435
Group III	63	520
All Firms	89	465

Backhauls

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]

[19]The 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.

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

[21]Nelson, David C., Statement in NL G-21-8561 Hearing, 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.

Leasing

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.

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

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

TABLE 4. LENGTH OF TIME IN BUSINESS, BY SIZE CATEGORY, SAMPLE FIRMS, NORTH DAKOTA GRAIN INDUSTRY, 1966

Tenure Category	Group I		Group II		Group III		Total	
	Actual	Percentage	Actual	Percentage	Actual	Percentage	Actual	Percentage
5 years or more	16	84	14	87.5	8	100.0	38	88
10 years or more	11	58	12	75.0	7	87.5	30	70
15 years or more	6	32	8	50.0	5	62.5	19	44
20 years or more	4	21	4	25.0	5	62.5	13	30
25 years or more	1	5	1	6.0	3	37.5	5	12
30 years or more	1	5	0	0.0	0	0.0	1	2

TABLE 5. TOTAL LABOR REQUIREMENTS, BY SIZE CATEGORY, SAMPLE FIRMS, NORTH DAKOTA GRAIN TRUCKING INDUSTRY, 1966

Size Category	Number of Employees
Group I	2.3
Group II	5.2
Group III	11.4
All Firms	5.1

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.

Price Policy

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] 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 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.

[24]Baker, Forrest S., Transportation Packaging and Other Innovations Affecting Structure and Efficiency, November, 1965, p. 1.

Credit Policy

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.

MODEL GRAIN TRUCKING FIRMS

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.

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).

Investment Costs

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: 1 Tractor - 1 Trailer Firm

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

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[25] The 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.

TABLE 6. TOTAL, PER UNIT, AND PER MILE INVESTMENT COSTS, MODEL TRUCKING FIRMS[a]

Cost Component	Model 1 Tractor - 1 Trailer	3 Tractor - 4 Trailer	6 Tractor - 8 Trailer	12 Tractor - 16 Trailer
	dollars			
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 Investment	27,900	26,725	25,780	25,223
Per Mile Investment	18.6	17.8	17.2	16.8

[a]The 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 tractor-trailer 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.

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

[27]Estimates 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.

Model II: 3 Tractor - 4 Trailer Firm

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. 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.

Model III: 6 Tractor - 8 Trailer Firm

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.

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

Operating costs are the components of both fixed (sunk) and variable (out of-pocket) costs. Each of these components is included in the following analysis.

Depreciation

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 straight-line method over the 10 years. The building is depreciated by the straight-line method over a 25-year period.[28]

Taxes

Tax expenditures are items which must be paid regardless of level of output. No real estate tax is paid on the tractor or trailer because it is considered 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 tax 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 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.[29]

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[28]Under 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 be used.

[29]These 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. 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 tractor-trailer 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.

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.

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 driven in that state. A certain period before he pays his license, the owner-operator 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 per year.

Telephone

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

In most cases the firm must borrow some money in order to cover the total investment. Interest paid for the use of this money must be considered a cost

[30]These 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.

Utilities

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.

Return to Management

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.

Variable Costs

Taxes

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

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.

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[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.

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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[32]Throughout 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.

TABLE 7. COSTS THAT VARY WITH TYPE OF EQUIPMENT INVESTMENT MADE, MODEL GRAIN TRUCKING FIRMS, 100 PER CENT CAPACITY

	Cost Components					
	Investment	Depreciation	Interest	Fuel Tax Cost Per Mile	Fuel Cost Per Mile	Maintenance Cost Per Mile
				cents	cents	cents
Tractor						
Diesel						
High[a]	21,000	2,100	1,365	1.7	3.0	.90
Low[a]	12,000	1,200	780	1.7	3.0	.90
Gas						
High	13,000	1,300	845	2.1	4.5	1.30
Low	5,000	500	325	2.1	4.5	1.30
Trailer						
High	7,500	750	488	No Effect	No Effect	No Effect
Low	5,200	520	338	No Effect	No Effect	No Effect

[a]High and low refer to the highest and lowest investment cost estimates of the equipment.

Maintenance Costs

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.

TABLE 8. ANNUAL FIXED AND VARIABLE COSTS NOT AFFECTED BY CHANGES IN INVESTMENT ESTIMATES, MODEL GRAIN TRUCKING FIRMS, 100 PER CENT CAPACITY

Cost Component	Model			
	1 Tractor - 1 Trailer	3 Tractor - 4 Trailer	6 Tractor - 8 Trailer	12 Tractor - 16 Trailer
	dollars			
Fixed				
Telephone	60	120	180	240
Taxes	120	120	120	120
Insurance	287	657	1,212	2,322
License	855	2,565	5,130	10,260
Utilities	600	600	600	600
Return to Management	6,500	6,500	6,500	6,500
Total Fixed	8,422	10,562	13,742	20,042
Variable				
Tire Tax	300	900	1,800	3,600
Telephone	300	900	1,800	3,600
Drivers' Wages	7,500	22,500	45,000	90,000
Mechanics' Wages	--	--	6,000	12,400
Tire Cost	3,700	11,250	22,500	45,000
Total Variable	11,850	35,550	77,100	154,600

Model Firms and Indicated Relationships

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.

[33]Brown, 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).

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

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.

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

Cost Components	High Diesel, High Trailer[b]	High Diesel, Low Trailer[b]	Low Diesel, High Trailer	Low Diesel, Low Trailer	High Gas, High Trailer	High Gas, Low Trailer	Low Gas, High Trailer	Low Gas, Low Trailer
	dollars							
Fixed Costs								
Depreciation	2,850	2,620	1,950	1,720	2,050	1,820	1,250	1,020
Interest	1,853	1,703	1,268	1,118	1,333	1,183	813	663
(Other Fixed Costs)[a]	8,422	8,422	8,422	8,422	8,422	8,422	8,422	8,422
Total Fixed Costs	13,125	12,745	11,640	11,260	11,805	11,425	10,485	10,105
Variable Costs								
Fuel Tax	2,550	2,550	2,550	2,550	3,150	3,150	3,150	3,150
Fuel Cost	4,500	4,500	4,500	4,500	6,750	6,750	6,750	6,750
Maintenance	1,350	1,350	1,350	1,350	1,950	1,950	1,950	1,950
(Other Variable Costs)[a]	11,850	11,850	11,850	11,850	11,850	11,850	11,850	11,850
Total Variable	20,250	20,250	20,250	20,250	23,700	23,700	23,700	23,700
Total Costs	33,375	32,995	31,890	31,510	35,505	35,125	34,185	33,805
Average Costs Per Mile								
Fixed	.0875	.0849	.0776	.0750	.0787	.0762	.0699	.0674
Variable	.1350	.1350	.1350	.1350	.1580	.1580	.1580	.1580
Total	.2225	.2199	.2126	.2100	.2367	.2342	.2279	.2254

[a]Explained in detail in Table 8.

[b]High and low refer to the highest and lowest investment cost estimates for the equipment.

TABLE 10. GRAIN TRUCKING FIRMS - COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GAS AND DIESEL TRACTORS, MODEL II, 100 PER CENT CAPACITY

Cost Components	High Diesel, High Trailer[b]	High Diesel, Low Trailer[b]	Low Diesel, High Trailer	Low Diesel, Low Trailer	High Gas, High Trailer	High Gas, Low Trailer	Low Gas, High Trailer	Low Gas, Low Trailer
					dollars			
Fixed Costs								
Depreciation	9,300	8,380	6,600	5,680	6,900	5,980	4,500	3,580
Interest	6,047	5,447	4,292	3,692	4,487	3,887	2,927	2,327
(Other Fixed Costs)[a]	10,562	10,562	10,562	10,562	10,562	10,562	10,562	10,562
Total Fixed Costs	25,909	24,389	21,454	19,934	21,949	20,429	17,989	16,469
Variable Costs								
Fuel Tax	7,650	7,650	7,650	7,650	9,450	9,450	9,450	9,450
Fuel Cost	13,500	13,500	13,500	13,500	20,250	20,250	20,250	20,250
Maintenance	4,050	4,050	4,050	4,050	5,850	5,850	5,850	5,850
(Other Variable Costs)[a]	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550
Total Variable	60,750	60,750	60,750	60,750	71,100	71,100	71,100	71,100
Total Costs	86,659	85,139	82,204	80,684	93,049	91,529	89,089	87,569
Average Costs Per Mile								
Fixed	.0575	.0541	.0476	.0442	.0487	.0453	.0399	.0365
Variable	.1350	.1350	.1350	.1350	.1580	.1580	.1580	.1530
Total	.1925	.1891	.1826	.1792	.2067	.2033	.1979	.1945

[a]Explained in detail in Table 8.

[b]High and low refer to the highest and lowest investment cost estimates for the equipment.

TABLE 11. GRAIN TRUCKING FIRMS - COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GAS AND DIESEL TRACTORS, MODEL III, 100 PER CENT CAPACITY

Cost Components	High Diesel, High Trailer[b]	High Diesel, Low Trailer[b]	Low Diesel, High Trailer	Low Diesel, Low Trailer	High Gas, High Trailer	High Gas, Low Trailer	Low Gas, High Trailer	Low Gas, Low Trailer
	dollars							
Fixed Costs								
Depreciation	18,600	16,760	13,200	11,360	13,800	11,960	9,000	7,160
Interest	12,094	10,894	8,584	7,384	8,974	7,774	5,854	4,654
(Other Fixed Costs)[a]	13,742	13,742	13,742	13,742	13,742	13,742	13,742	13,742
Total Fixed Costs	44,436	41,396	35,526	32,486	35,516	33,476	28,596	25,556
Variable Costs								
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
Maintenance	8,100	8,100	8,100	8,100	11,700	11,700	11,700	11,700
(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.

[b]High and low refer to the highest and lowest investment cost estimates for the equipment.

TABLE 12. GRAIN TRUCKING FIRMS - COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GAS AND DIESEL TRACTORS, MODEL IV, 100 PER CENT CAPACITY

Cost Components	High Diesel, High Trailer[b]	High Diesel, Low Trailer[b]	Low Diesel, High Trailer	Low Diesel, Low Trailer	High Gas, High Trailer	High Gas, Low Trailer	Low Gas, High Trailer	Low Gas, Low Trailer
					dollars			
Fixed Costs								
Depreciation	37,200	33,520	26,400	22,720	27,600	23,920	18,000	14,320
Interest	24,188	21,788	17,168	14,768	17,948	15,548	11,708	9,308
(Other Fixed Costs)[a]	20,042	20,042	20,042	20,042	20,042	20,042	20,042	20,042
Total Fixed Costs	81,430	75,350	63,610	57,530	65,590	59,510	49,750	43,670
Variable Costs								
Fuel Tax	30,600	30,600	30,600	30,600	37,800	37,800	37,800	37,800
Fuel Cost	54,000	54,000	54,000	54,000	81,000	81,000	81,000	81,000
Maintenance	16,200	16,200	16,200	16,200	23,400	23,400	23,400	23,400
(Other Variable Costs)[a]	154,600	154,600	154,600	154,600	154,600	154,600	154,600	154,600
Total Variable Costs	255,400	255,400	255,400	255,400	296,800	296,800	296,800	296,800
Total Costs	336,830	330,750	319,010	312,930	362,390	356,310	346,550	340,470
Average Costs Per Mile								
Fixed	.0452	.0419	.0353	.0320	.0364	.0331	.0276	.0243
Variable	.1419	.1419	.1419	.1419	.1649	.1649	.1649	.1649
Total	.1871	.1838	.1772	.1739	.2013	.1980	.1925	.1892

[a]Explained in detail in Table 8.

[b]High and low refer to the highest and lowest investment cost estimates for the equipment.

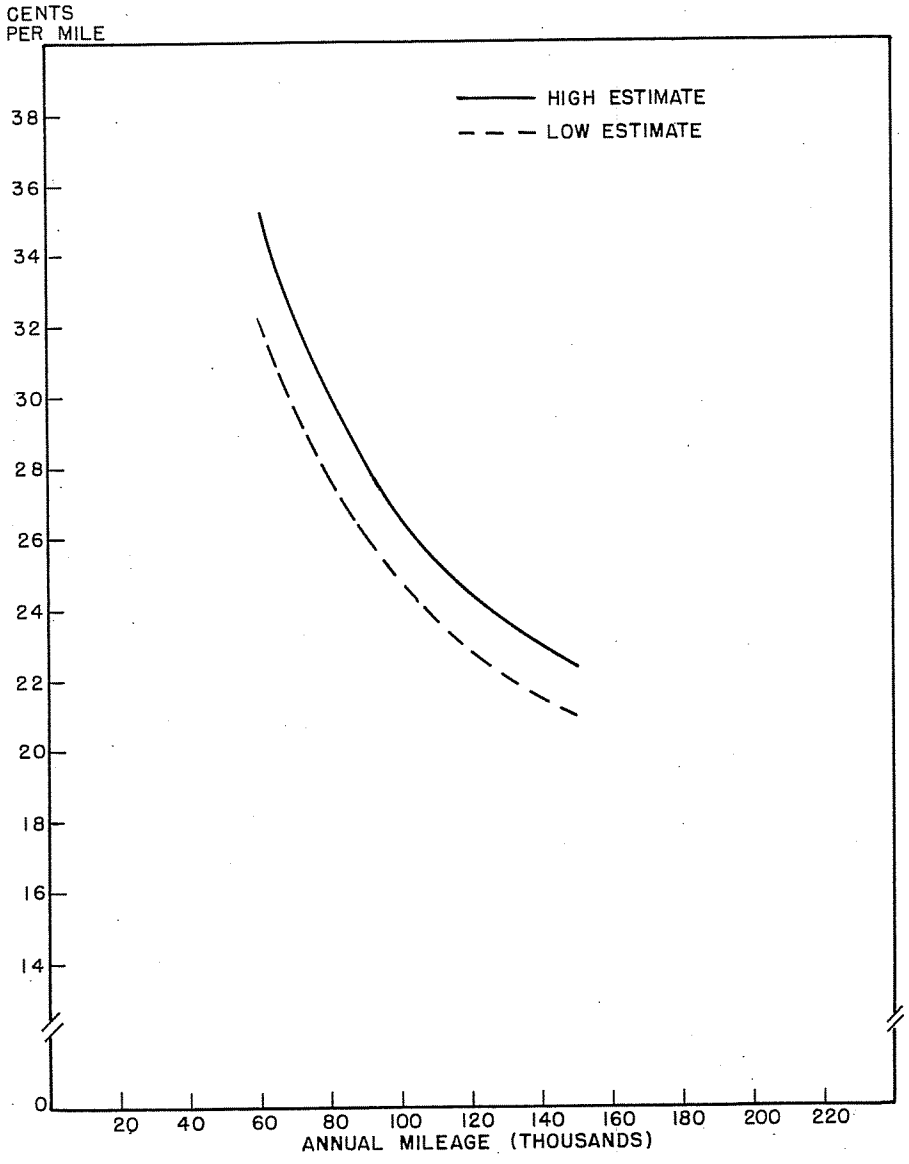

Figure 1. Annual Average Operating Costs of One Tractor-One Trailer Grain Firm Operating Diesel Tractors, High and Low Estimates.

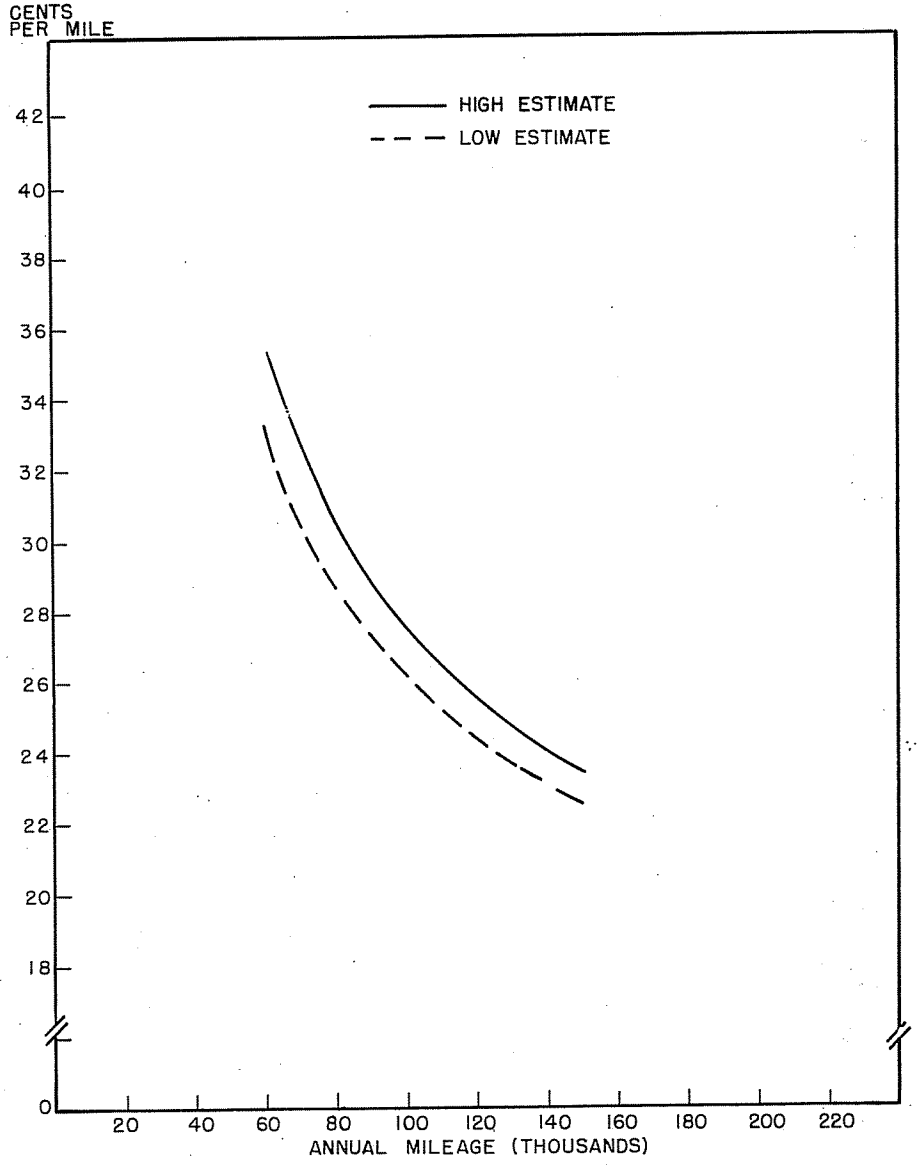

Figure 2. Annual Average Operating Costs of One Tractor-One Trailer Grain Firm Operating Gasoline Tractors, High and Low Estimates.

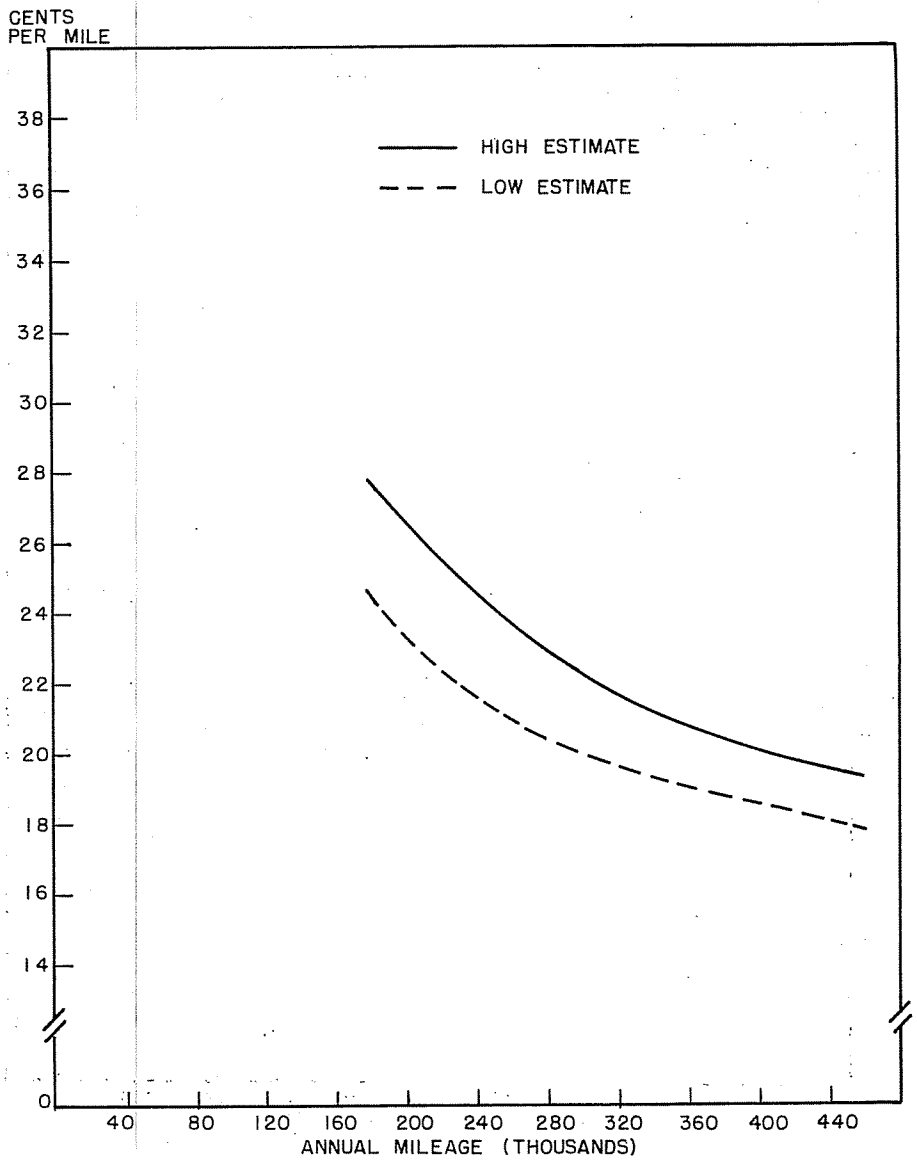

Figure 3. Annual Average Operating Costs of Three Tractor-Four Trailer Grain Firm Operating Diesel Tractors, High and Low Estimates.

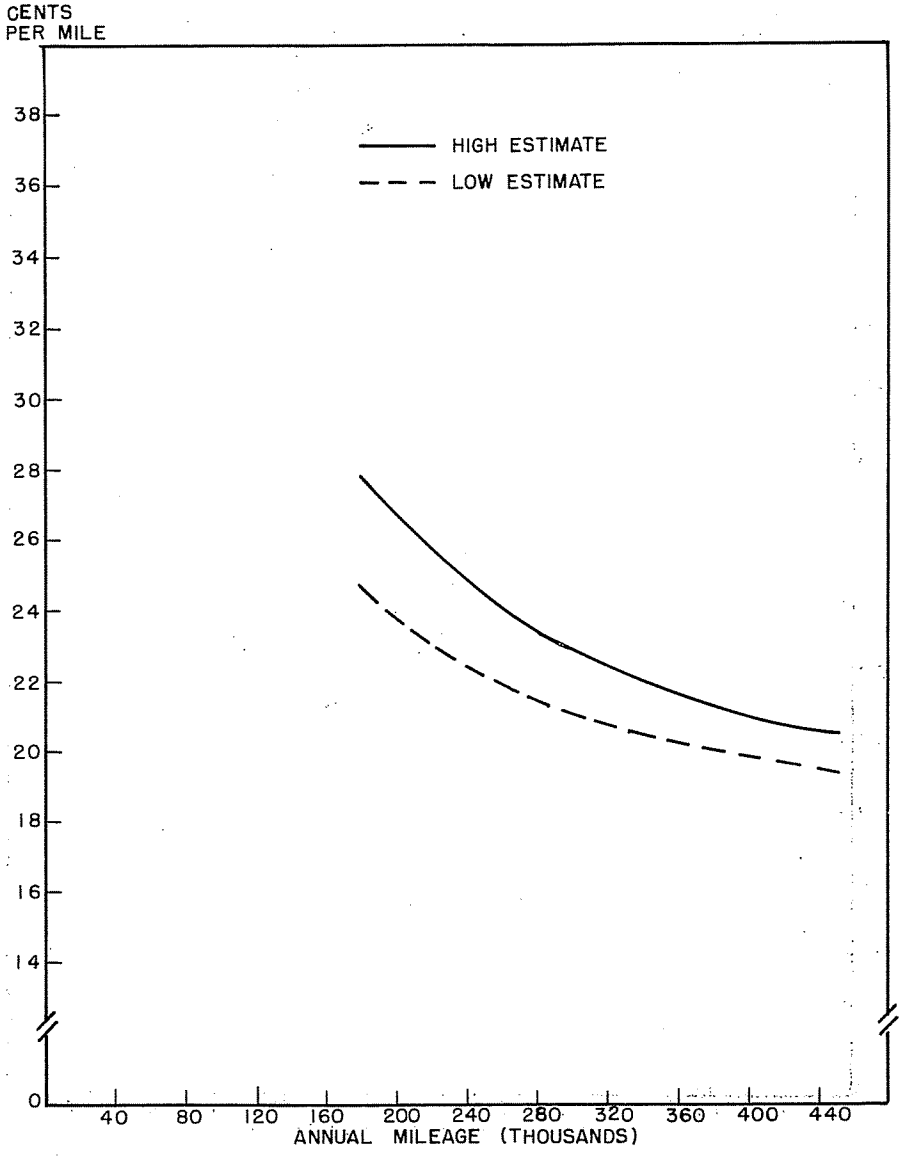

Figure 4. Annual Average Operating Costs of Three Tractor-Four Trailer Grain Firm Operating Gasoline Tractors, High and Low Estimates.

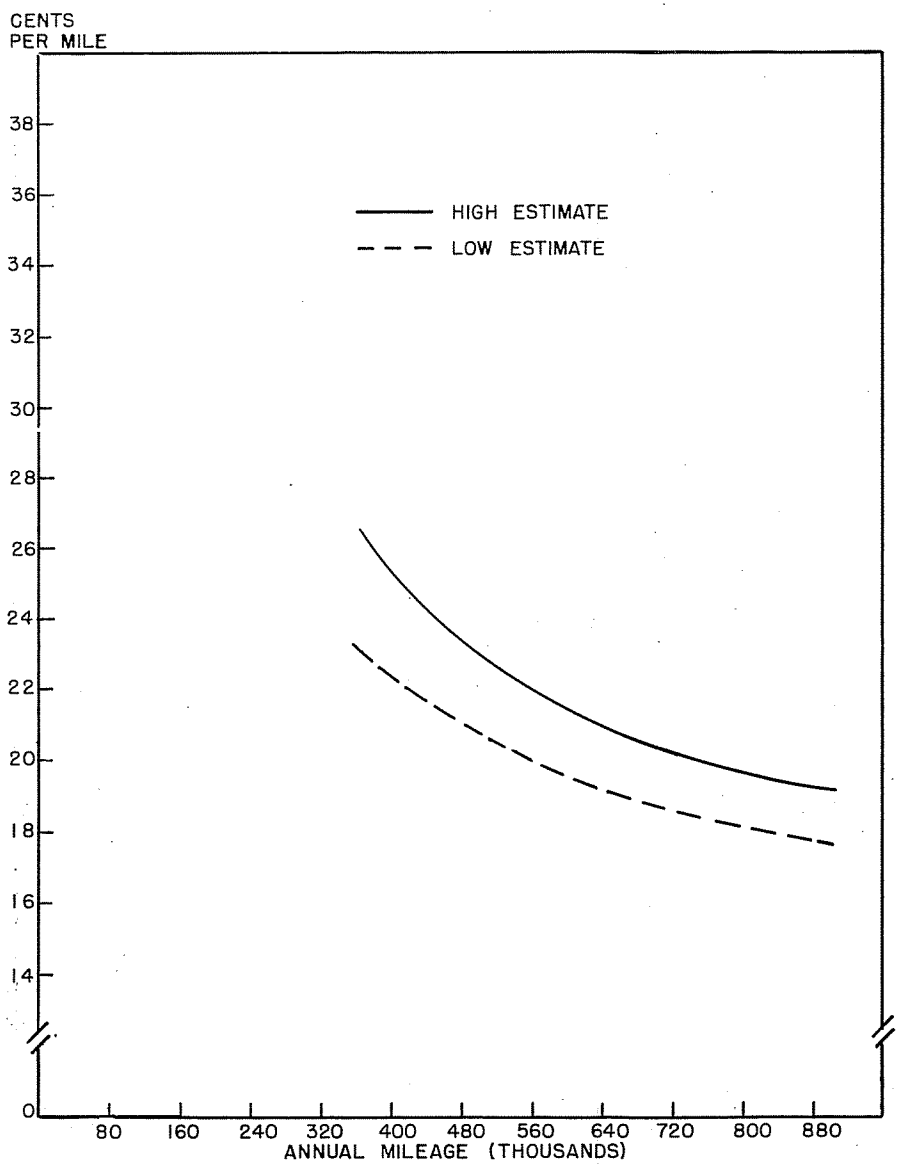

Figure 5. Annual Average Operating Costs of Six Tractor-Eight Trailer Grain Firm Operating Diesel Tractors, High and Low Estimates.

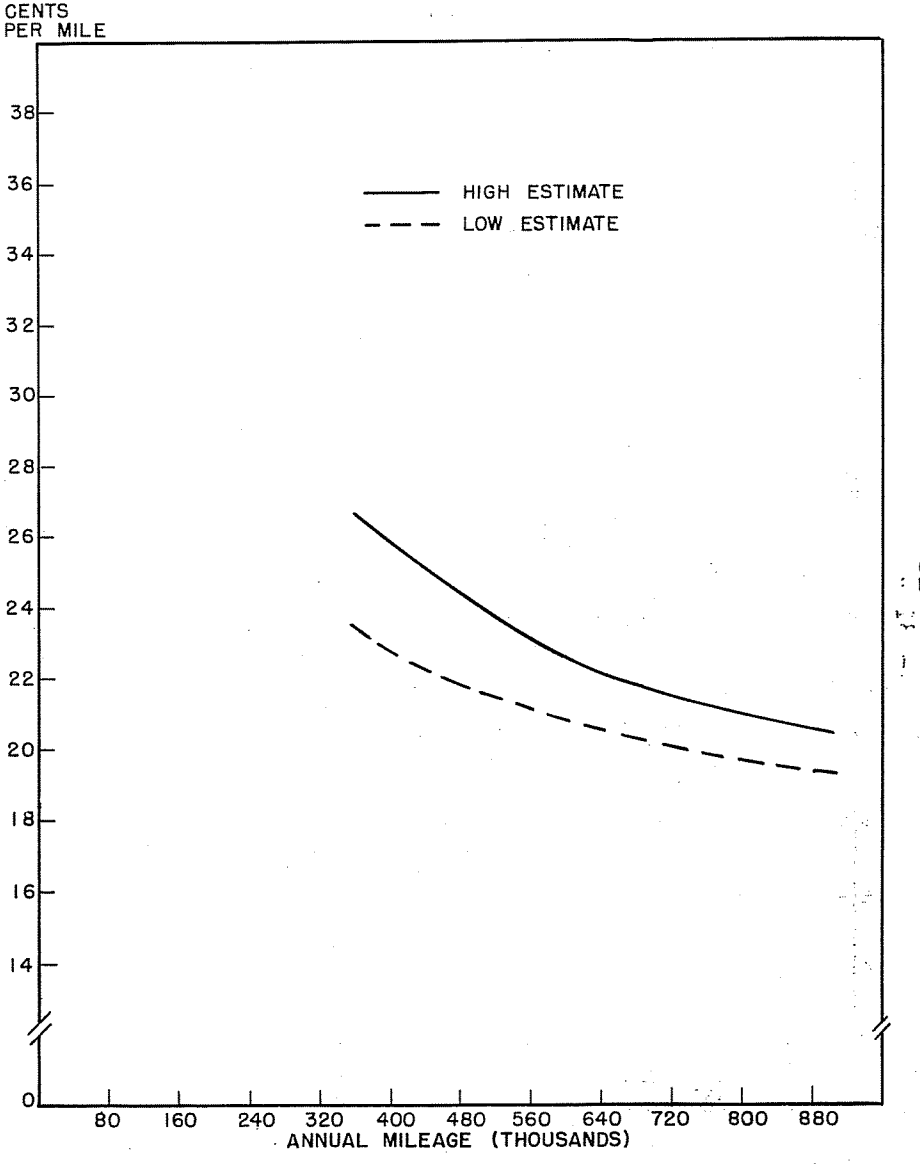

Figure 6. Annual Average Operating Costs of Six Tractor-Eight Trailer Grain Firm Operating Gasoline Tractors, High and Low Estimates.

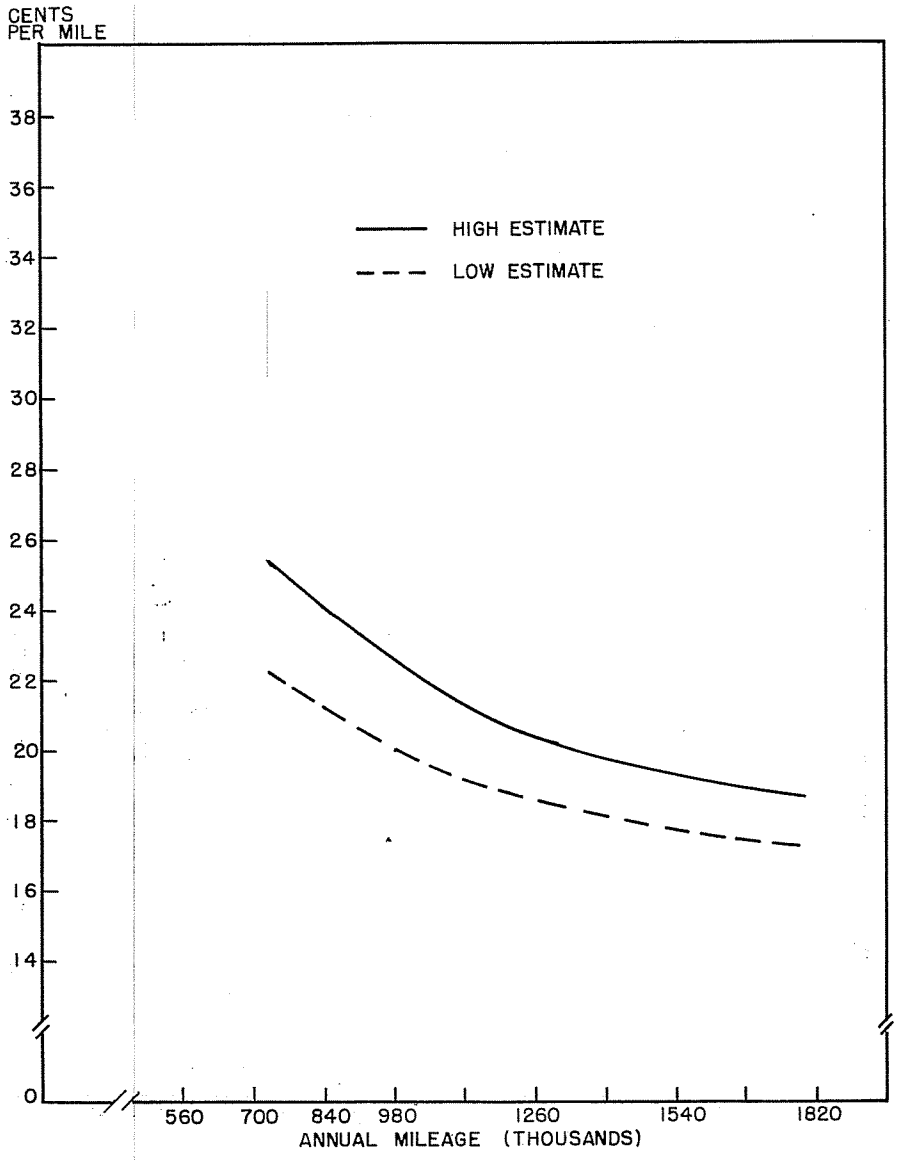

Figure 7. Annual Average Operating Costs of Twelve Tractor-Sixteen Trailer Grain Firm Operating Diesel Tractors, High and Low Estimates.

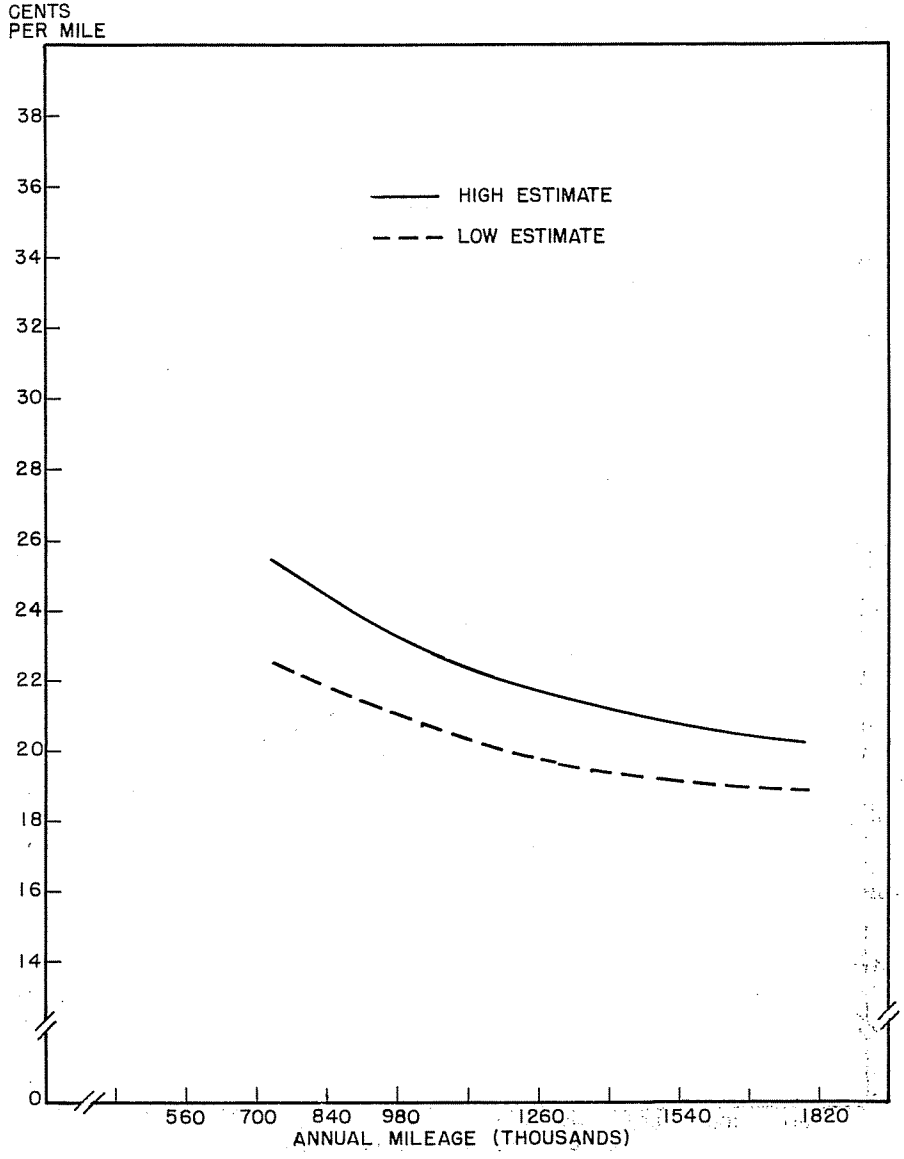

Figure 8. Annual Average Operating Costs of Twelve Tractor-Sixteen Trailer Grain Firm Operating Gasoline Tractors, High and Low Estimates.

TABLE 15. ANNUAL OPERATING COSTS, SIX TRACTOR - EIGHT TRAILER MODEL GRAIN TRUCKING FIRMS

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			
Diesel, All High Cost Estimates							
100%	(900,000)	44,436	.0493	127,500	.1417	171,936	.1910
80%	(720,000)	44,436	.0617	102,024	.1417	146,460	.2034
60%	(540,000)	44,436	.0822	76,518	.1417	120,954	.2239
40%	(360,000)	44,436	.1234	51,012	.1417	95,448	.2651
Diesel, All Low Cost Estimates							
100%	(900,000)	32,486	.0361	127,500	.1417	159,986	.1778
80%	(720,000)	32,486	.0451	102,024	.1417	134,510	.1868
60%	(540,000)	32,486	.0601	76,518	.1417	109,004	.2018
40%	(360,000)	32,486	.0902	51,012	.1417	83,498	.2319
Gasoline, All High Cost Estimates							
100%	(900,000)	36,516	.0405	148,200	.1647	184,716	.2052
80%	(720,000)	36,516	.0507	118,584	.1647	155,100	.2154
60%	(540,000)	36,516	.0676	88,938	.1647	125,454	.2323
40%	(360,000)	36,516	.1014	59,292	.1647	95,808	.2661
Gasoline, All Low Cost Estimates							
100%	(900,000)	25,556	.0284	148,200	.1647	173,756	.1931
80%	(720,000)	25,556	.0354	118,584	.1647	144,140	.2001
60%	(540,000)	25,556	.0473	88,938	.1647	114,494	.2120
40%	(360,000)	25,556	.0709	59,292	.1647	84,848	.2356

[a]Figures in brackets refer to the annual mileage produced at the specified levels of capacity utilization.

TABLE 14. ANNUAL OPERATING COSTS, THREE TRACTOR - FOUR TRAILER MODEL GRAIN TRUCKING FIRMS

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			
Diesel, All High Cost Estimates							
100%	(450,000)	25,909	.0575	60,750	.1350	86,659	.1925
80%	(360,000)	25,909	.0719	48,600	.1350	74,509	.2069
60%	(270,000)	25,909	.0959	36,450	.1350	62,359	.2309
40%	(180,000)	25,909	.1439	24,300	.1350	50,209	.2789
Diesel, All Low Cost Estimates							
100%	(450,000)	19,934	.0442	60,750	.1350	80,684	.1792
80%	(360,000)	19,934	.0553	48,600	.1350	68,534	.1903
60%	(270,000)	19,934	.0738	36,450	.1350	56,384	.2088
40%	(180,000)	19,934	.1107	24,300	.1350	44,234	.2457
Gasoline, All High Cost Estimates							
100%	(450,000)	21,949	.0487	71,100	.1580	93,049	.2067
80%	(360,000)	21,949	.0609	56,880	.1580	78,829	.2189
60%	(270,000)	21,949	.0812	42,660	.1580	64,609	.2392
40%	(180,000)	21,949	.1219	28,440	.1580	50,389	.2799
Gasoline, All Low Cost Estimates							
100%	(450,000)	16,469	.0365	71,100	.1580	87,569	.1945
80%	(360,000)	16,469	.0457	56,880	.1580	73,349	.2037
60%	(270,000)	16,469	.0609	42,660	.1580	59,129	.2189
40%	(180,000)	16,469	.0914	28,440	.1580	44,909	.2494

[a]Figures in brackers refer to the annual mileage produced at the specified levels of capacity utilization.

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 long-run 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

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			
Diesel, All High Cost Estimates						
100% (150,000)	13,125	.0875	20,250	.1350	33,375	.2225
80% (120,000)	13,125	.1093	16,200	.1350	29,325	.2443
60% (90,000)	13,125	.1458	12,150	.1350	25,275	.2808
40% (60,000)	13,125	.2187	8,100	.1350	21,225	.3537
Diesel, All Low Cost Estimates						
100% (150,000)	11,260	.0750	20,250	.1350	31,510	.2100
80% (120,000)	11,260	.0938	16,200	.1350	27,460	.2288
60% (90,000)	11,260	.1251	12,150	.1350	23,510	.2601
40% (60,000)	11,260	.1876	8,100	.1350	19,360	.3226
Gasoline, All High Cost Estimates						
100% (150,000)	11,805	.0787	23,700	.1580	35,505	.2367
80% (120,000)	11,805	.0983	18,960	.1580	30,765	.2563
60% (90,000)	11,805	.1311	14,220	.1580	26,025	.2891
40% (60,000)	11,805	.1967	9,480	.1580	21,285	.3547
Gasoline, All Low Cost Estimates						
100% (150,000)	10,485	.0699	23,700	.1580	34,185	.2279
80% (120,000)	10,485	.0873	18,960	.1580	29,445	.2453
60% (90,000)	10,485	.1165	14,220	.1580	24,705	.2745
40% (60,000)	10,485	.1747	9,480	.1580	19,965	.3327

[a]Figures in brackets refer to the annual mileage produced at the specified levels of capacity utilization.

TABLE 16. ANNUAL OPERATING COSTS, TWELVE TRACTOR - SIXTEEN TRAILER MODEL GRAIN TRUCKING FIRMS

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			
Diesel, All High Cost Estimates						
100% (1,800,000)	81.430	.0452	255,400	.1419	336,830	.1871
80% (1,440,000)	81,430	.0565	204,336	.1419	285,766	.1984
60% (1,080,000)	81,430	.0753	153,252	.1419	234,682	.2172
40% (720,000)	81,430	.1130	102,168	.1419	183,598	.2549
Diesel, All Low Cost Estimates						
100% (1,800,000)	57,530	.0320	255,400	.1419	312,930	.1739
80% (1,440,000)	57,530	.0399	204,336	.1419	261,866	.1818
60% (1,080,000)	57,530	.0532	153,252	.1419	210,782	.1951
40% (720,000)	57,530	.0799	102,168	.1419	.59,698	.2218
Gasoline, All High Cost Estimates						
100% (1,800,000)	65,590	.0364	296,800	.1649	362,390	.2013
80% (1,440,000)	65,590	.0455	237,456	.1649	303,046	.2104
60% (1,080,000)	65,590	.0607	178,092	.1649	243,682	.2256
40% (720,000)	65,590	.0910	118,728	.1649	184,318	.2559
Gasoline, All Low Cost Estimates						
100% (1,800,000)	43,670	.0243	296,800	.1649	340,470	.1892
80% (1,440,000)	43,670	.0303	237,456	.1649	281,126	.1952
60% (1,080,000)	43,670	.0404	178,092	.1649	221,762	.2053
40% (720,000)	43,670	.0606	118,728	.1649	162,398	.2255

[a]Figures in brackets refer to the annual mileage produced at the specified levels of capacity utilization.

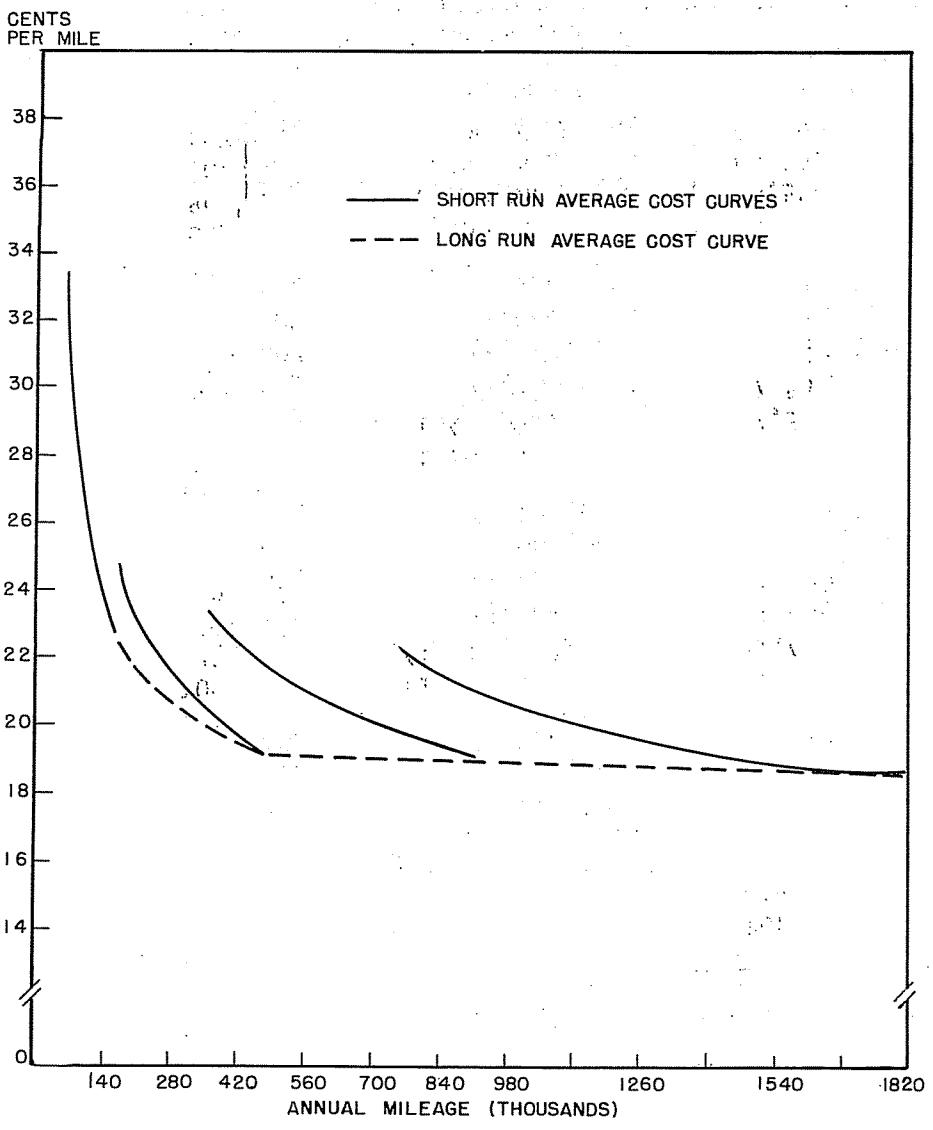

Figure 9. Annual Average Operating Costs of Model Grain Trucking Firms, Operating Gasoline Tractors, Low Investment Estimates.

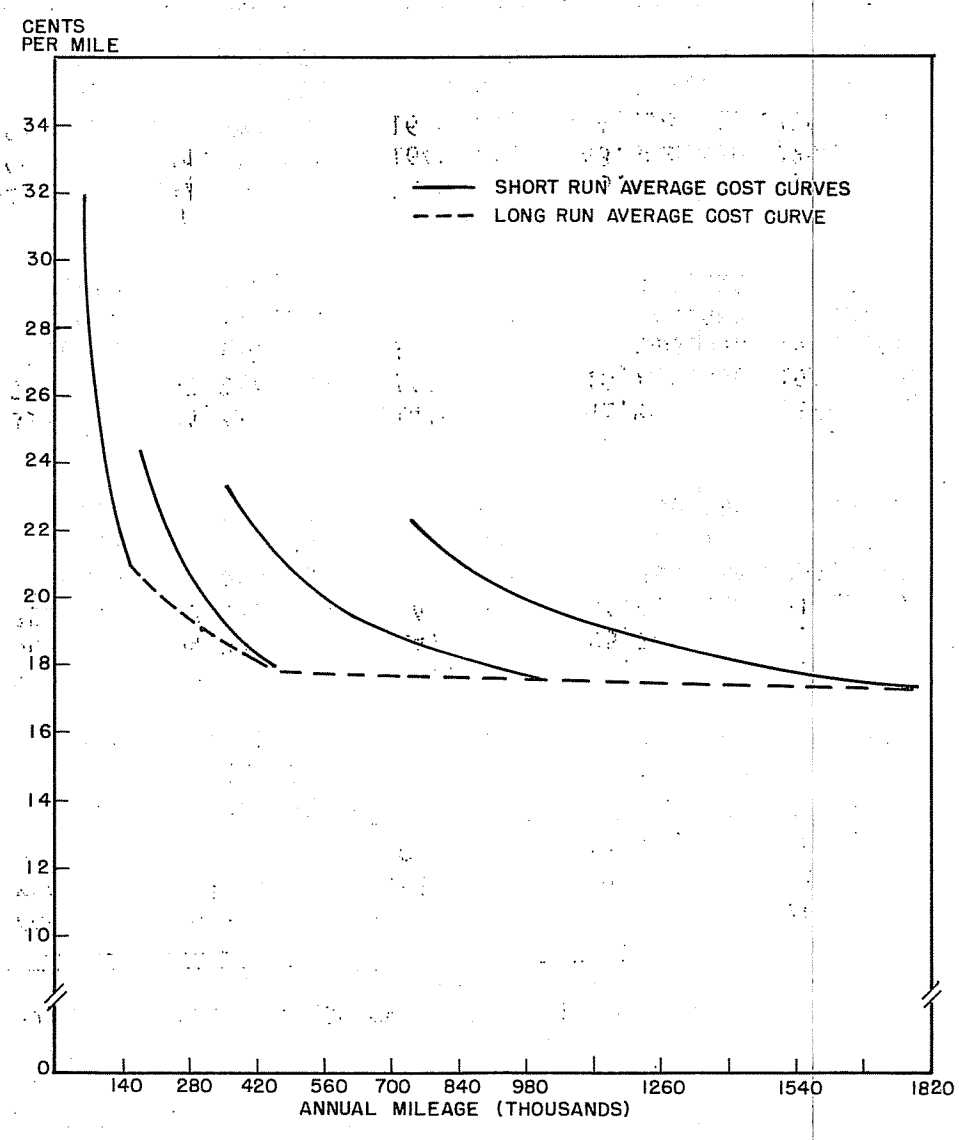

Figure 10. Annual Average Operating Costs of Model Grain Trucking Firms, Operating Diesel Tractors, Low Investment Estimates.

Used Versus New Equipment

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 eight-year 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.

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.

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

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

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

Cost Component	New[a]	Used[b]
	dollars	
Fixed Costs		
Depreciation	3,580	2,488
Interest	2,327	1,007
Telephone	120	120
Taxes	120	120
Insurance	657	657
License	2,565	2,000
Utilities	600	600
Return to Management	6,500	6,500
Total Fixed Costs	16,469	13,492
Variable Costs		
Fuel Tax	9,450	10,350
Fuel	20,250	22,500
Maintenance	5,850	11,250
Tire Tax	900	900
Telephone	900	900
Drivers' Wages	22,500	22,500
Mechanics' Wages	--	--
Tire Cost	11,250	11,250
Total Variable Costs	71,100	79,650
Total Costs	87,569	93,142
Average Fixed Cost Per Mile	.0365	.0299
Average Variable Cost Per Mile	.1580	.1770
Average Cost Per Mile	.1945	.2069

[a]The figures for the new equipment were taken from Table 10.

[b]Used tractors priced at $2,500 each; used trailers at $2,000 each.

TABLE 18. ANNUAL OPERATING COSTS, THREE TRACTOR - FOUR TRAILER MODEL GRAIN TRUCKING FIRM, OPERATING GASOLINE TRACTORS, NEW AND USED EQUIPMENT

Model	Per Cent Utilization of Capacity		Total Fixed Cost	Average Fixed Cost	Total Variable Cost	Average Variable Cost	Total Cost	Average Total Cost
					dollars			
New								
	100%	(450,000)[a]	16,469	.0365	71,100	.1580	87,569	.1945
	80%	(360,000)	16,469	.0457	56,880	.1580	73,349	.2037
	60%	(270,000)	16,469	.0609	42,660	.1580	59,129	.2189
	40%	(180,000)	16,469	.0914	28,440	.1580	44,909	.2494
Used								
	100%	(450,000)	13,492	.0299	79,650	.1770	93,142	.2069
	80%	(360,000)	13,492	.0374	63,720	.1770	77,212	.2144
	60%	(270,000)	13,492	.0499	47,790	.1770	61,282	.2269
	40%	(180,000)	13,492	.0749	31,860	.1770	45,352	.2519

[a]Figures in brackets refer to the annual mileage produced at the specified levels of capacity utilization.

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.

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[35]Increasing vehicle annual mileage by reducing the number of tractor-trailer 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.

TABLE 19. AVERAGE PER MILE OPERATING COSTS, 45 AND 100 PER CENT CAPACITY UTILIZATION, NORTH DAKOTA SAMPLE FIRMS, AND MODEL FIRMS, 1966

Size Group	North Dakota Firms 45%[a]	North Dakota Firms 100%	Size Group	Models-Low Cost Diesel 45%[a]	Models-Low Cost Diesel 100%
Group I (1-3 Units)	24.02	17.69	Model I (1 Tractor - 1 Trailer)	29.07	21.00
Group II (4-7 Units)	23.06	17.44	Model II (3 Tractors - 4 Trailers)	23.84	17.92
Group III (Over 7 Units)	22.84	17.22	Model III (6 Tractors - 8 Trailers)	22.91	17.78
All Firms	23.42	17.57	Model IV (12 Tractors - 16 Trailers)	21.80	17.39

[a]The 45 per cent level of capacity utilization is the actual mileage recorded for the sample firms.

TABLE 20. ANNUAL TOTAL AND AVERAGE COSTS OF NORTH DAKOTA GRAIN TRUCKERS, AVERAGE INDUSTRY FIRM SIZE, SAMPLE FIRMS, 1966

Cost Item	Costs[a]
Fixed Costs	
Depreciation	$ 6,374
Interest	4,848
Telephone	150
Taxes	170
Insurance	1,792
License	2,629
Utilities	507
Return to Management	6,500
Total Fixed Costs	$22,970
Variable Costs	
Fuel Tax	$ 3,874
Fuel	5,882
Maintenance	3,017
Tire Tax	542
Telephone	374
Drivers' Wages	10,046
Tire Cost	5,280
Total Variable Costs	$29,015
Total Costs	$51,985
Average Fixed Cost Per Mile	.1035
Average Variable Cost Per Mile	.1307
Average Cost Per Mile	.2342

[a]Annual mileage of 222,000 per year.