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

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SUMMARY

Limited economies of size exist in the trucking industry in North Dakota.
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, it can be said that the optimum size firm is
at least this large. Beyond this level, little further economies of size are
realized. This relationship would indicate 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 are: investment costs per mile
do not decrease to any large degree as firm size is increased, and the lack of
increased efficiency of labor as firm size is increased.

The 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 the new equipment investment was more economical than investing
in used equipment. Due to the higher variable costs of the used equipment, the
new equipment firm had lower costs at all levels of capacity utilization. It
can therefore, be said that, if the capital is available, new equipment should
be purchased.

The average operating costs of the firms in the sample appeared to be
considerably higher than the model costs. The industry costs for the livestock
trucking firms ranged from 18.46 cents to 35.44 cents per mile with a mean of
26.56 cents and a median of 29.47 cents. Analysis of the data indicates that
little economies of size can be realized by increasing firm size.

Comparing the model and industry costs appears to indicate that there
are efficiency improvements that could be made in the industry. However, due
to the present level of capacity utilization, the industry is operating effi-
ciently. The statement is supported by the fact the industry compares favor-
ably with the models at both the 45 per cent and 100 per cent capacity levels.
However, to obtain minimum operating costs, the North Dakota livestock trucking
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. 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 livestock hauls
and accurately relaying backhaul traffic information. This is particularly
important because the data from the industry indicated the difference in cost
between traveling loaded or empty is slight.

The 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 the 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.

There is a substantial degree of stability as measured by length of time in the North Dakota livestock trucking industry. This would seem to 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
FIRMS IN NORTH DAKOTA OPERATING LIVESTOCK TRUCKING

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 has 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. During this period the railroads were finding 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 livestock at negotiated rates, often much lower than the prevailing rail rates.

Another feature that caused motor carriers to become competitive to the railroads was the many innovations in the trucking industry. Livestock trucks of the early 1920's had simple stake and rack bodies without tops, and were predominately straight trucks.[2] At the present time, livestock 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.

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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.

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 has increased greatly, 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 has 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.

Since the demand for trucking services is a derived demand,[5] an examination of the number of livestock produced in North Dakota can indicate the rising absolute demand for livestock trucking. Most of the livestock produced in this state are consumed in other areas and they are commonly trucked to these areas. Therefore, as more livestock are produced, more trucking services will be required. The number of livestock produced in North Dakota rose from 1,296,000 in 1935 to 2,303,000 in 1965.[6]

OBJECTIVES

Transportation costs are an important part of the price of any commodity. In an agricultural state, such as North Dakota, transportation costs of products can affect the state's relative competitive position with other states and production areas. If transportation costs can be lowered, it could result in a number of alternatives: (1) A noticeable drop in the ultimate consumer price of farm products, resulting in an improvement in the competitive position of North Dakota producers; (2) A 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 is to discover the actual per mile operating costs of the North Dakota livestock trucking industry. The specific objectives are:

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[3]American Trucking Trends, American Trucking Associations, 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]A derived demand in this instance means the demand for the trucking services is derived from or is a result of the demand of the commodity hauled.

[6]Various issues of Livestock Market News Statistics, Agricultural Marketing Service, United States Department of Agriculture, Washington, D.C.

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

2. To identify the major factors affecting the 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 transportation firms were set up to determine the 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.[7] The various 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 mentioned above.[8]

A survey of firms in North Dakota was conducted to discover the actual costs of operating tractor-trailer combinations hauling livestock 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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[7]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., Bartel's Equipment Co., and Smith, Inc., all of Fargo.

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

equipment would have incomparable costs.[9] The list obtained from the P.S.C. 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 37 questionnaires usable for this livestock trucking study were obtained.[10] Data received from these 37 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 the North Dakota livestock 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. Size categories were selected on the basis of tractor-trailer units per firm. The 37 firms were divided into the three following groups: Group I, one to three tractor-trailer units; Group II, four to seven tractor-trailer units; and Group III, seven or more tractor-trailer units (Table 1).

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

Size Category	Number of Firms
Group I	26
Group II	8
Group III	3
All Firms	37

[9]Many of the firms obtaining licenses from the 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.

[10]Of the 138 firms contacted, 43 were grain 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

Average size of all firms in the sample was a three tractor-four trailer firm, with the firms commonly having a straight truck as a "convenience" vehicle.[11] 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 a one tractor-trailer unit and the average size four tractor-trailer units.

Ten of the 37 firms in the sample indicated they had expanded the size of their firm in the last 5 to 10 years. Only three of the 37 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 each group's size. 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 the obtaining of a "special permit"[12] as reason for their actions.

Miles Traveled

The 37 firms in the study traveled an average of 165,000 miles per year the miles traveled per firm ranged from 22,000 to 850,000 miles per year.

Annual mileage per vehicle as a measure of utilization of equipment is commonly used when examining the concept of excess capacity.[13] 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. Results of the study show that the per cent of capacity utilization is inversely related to size of firm (Table 2).

Excess Capacity

A substantial amount of excess capacity exists in the North Dakota livestock trucking industry. It is theoretically possible for an individual

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[11]A convenience vehicle is usually a straight truck used to assemble small lots into one full trailer load. Use of a convenience vehicle cuts the trucker's use of the tractor-trailer, and improves his "public image" with the shipper, due to speed, reliability, and availability of service.

[12]See "Special Permits", p. 12.

[13]DeWolfe, Mildred R., For-Hire Motor Carriers Hauling Exempt Agricultural Commodities, Marketing Research Report No. 585, Marketing Economics Division, Economic Research Service, United States Department of Agriculture, Washington, D.C., January, 1963, p. 3.

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

Size Category	Firm	Vehicle
	000 miles	
Group I	135	65
Group II	208	52
Group III	328	41.5
All Firms	165	60.3

tractor-trailer unit to travel 150,000 miles per year. This figure is based
on a distance traveled of 500 miles per day, operating 300 days per 12-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 60.3 thousand miles.
This indicates that only 45 per cent of the available capacity was utilized.
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 livestock trucking industry.[14] The pros and cons of these char-
acteristics 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, the manager can decide at what capacity to
operate.

[14]Two points of view can be considered when examining the desired
capacity of an industry characterized by high seasonality of demand. One view-
point holds that the 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 the capac-
ity of the industry should be such that the 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
Organization, John Wiley and Sons, Inc., New York, August, 1965, pp. 358-360.

Estimated Ton-Miles

The concept of ton-mileage is used extensively in most analysis of costs and description of characteristics of most transportation modes.[15] 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 then multiplying the result by the average load size. The average livestock load was about 12 tons.[16] 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 1,090,000 per firm. Average ton-miles per vehicle was 400,000. 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 that of extreme flexibility of operation. The North Dakota livestock 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 West Fargo, North Dakota.

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

Size Category	Intrastate Mileage	Length of Most Common Trip
	per cent	miles
Group I	92	240
Group II	81	275
Group III	79	260
All Firms	89	252

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, 92 per cent. Group II and III firms had corresponding percentages, 81 per cent for Group II and 79 per cent for Group III. Overall, livestock truckers had 89 per cent intrastate mileage.

[15]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.

[16]The average livestock load was obtained from Mr. Herman England, Hartford Insurance Company, Union Stockyards, West Fargo, North Dakota.

Backhauls

The North Dakota livestock trucker seldom hauls commodities on his return trip. Added effort in this area may offer high potential increased efficiency. Of the total mileage driven, only 62 per cent were loaded miles. This means that only 24 per cent of the return trip mileage were loaded miles.[17] 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 livestock hauls and accurately relaying backhaul traffic information. This is particularly important because the difference in cost between traveling loaded or empty is slight.[18] 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.

Three tentative explanations could be offered for the North Dakota live-stock trucker's low-backhaul percentage: (1) Some one-way loads may be due to faulty deployment of the equipment supply among the markets because of the lack of knowledge of possible backhaul loads, (2) The use of specialized equipment for hauling livestock limits the use of such equipment for transporting other exempt commodities on the backhaul,[19] (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,[20] it seems of little importance to the North Dakota livestock trucking industry. None of the 37 truckers in the sample leased their equipment to the firms and only one firm leased vehicles for its own use. However, this firm used leasing extensively, with 80 per cent of its total firm mileage accumulated by leased vehicles. The major explanation for leasing by this firm offered by the firm manager was that he felt he could make more use of managerial ability as well as provide more flexibility as to firm size and potential volume.

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[17]The average annual mileage per firm was 196,000 miles, of which 50 per cent or 98,000 miles was assumed to be return trip mileage. Twelve per cent or 23,520 miles of the 196,000 total miles was 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.

[18]All but one of the firms in the sample indicated they felt there was no difference in operating costs between traveling loaded or empty. The one firm that indicated there was a difference noted only a one half gallon per mile difference between loaded and empty.

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

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

Length of Time in Business

A substantial degree of stability as measured by length of time in business exists in the North Dakota livestock trucking industry. This observation is supported by an analysis of the sample data (Table 4). Seventy per cent of the truckers in the sample had been in business five years or more, 43 per cent 10 years or more, 24 per cent 15 years or more, and even 8 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.

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

Size Category	Number of Employees
Group I	2.2
Group II	5.4
Group III	11.5
All Firms	3.6

A close relationship between capital investment and labor requirement is probably 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 bookeeper; 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-relationshp of driver to vehicle. For this reason, little economies of scale to labor exist in the North Dakota livestock trucking industry.

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

Tenure Category	Group I Actual	Group I Percentage	Group II Actual	Group II Percentage	Group III Actual	Group III Percentage	Total Actual	Total Percentage
5 years or more	16	63	7	87.5	3	100	26	70
10 years or more	8	31	5	62.5	3	100	16	43
15 years or more	4	15	3	37.5	2	67	9	24
20 years or more	1	4	1	12.5	1	33	3	8
25 years or more	0	0	0	0.0	1	33	1	3
30 years or more	0	0	0	0.0	0	0	0	0

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Price Policy

One reason for the initially slow growth progress of the truck form of transportation was the structural restraints of having adopted railbased tariffs as a rate and costing procedure.[21] When the trucking industry 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 livestock trucker. Even though most truckers 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, it can be said that a combination of a cost-plus-margin price and competitive forces decide the final rate the firm will charge for its services. Due to the characteristic of easy entry into and exit out of the industry the rate charged the shipper usually is 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.

Credit Policy

None of the trucking firm managers reported that credit and uncollected accounts were any special problem. Two livestock truckers extended credit to their customers. The livestock trucker's charges are usually deducted from the shipper's receipts at the terminal shipment point, so credit was seldom necessary. The two livestock truckers that did give credit provided it to only a few select large and reliable customers. Twenty of the livestock truckers indicated they would provide some credit if it was 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.

Advertising

The primary objective of advertising a firm's product is to differentiate its product from that of competitors. Little advertising is done in the North Dakota livestock trucking industry. None of the trucking firms in the sample used salesmen and only two used radio advertisements, and this was only to a small extent. The advertising that did occur was primarily advertisements in the local newspaper or distribution of pens with the firm's name and telephone number on it to the firm's customers. The amount of annual advertising expenditures ranged from zero to $250. The modal and median advertising expense was $50. Over three-fourths of the 37 firms in the sample either did not advertise at all, or spent $50 or less. There was no relationship between advertising expenditures and size category. Further, when advertising was practiced, the trucker seemed to be rather doubtful concerning the benefits received.

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[21]Baker, Forrest S., *Transportation Packaging and Other Innovations Affecting Structure and Efficiency*, Oregon State University, Corvallis, November, 1965, p. 1.

The final conclusion is that advertising does little to differentiate the North Dakota livestock trucker's product, his services. This means that the demand for his service is such that if he raises his price, the buyer of that service, the shipper, will usually go to another seller. In other words, price competition is the main type of competition in the livestock trucking industry.

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 livestock 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 of these truckers, 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 to increase the size of the firm had special permits and cited the obtaining of these permits as a primary reason for planned expansion.

MODEL LIVESTOCK TRUCKING FIRMS

One of the basic forms of methodology used in economic analysis is the model. An economic 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 decisions 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 livestock trucking firm should be reviewed. The livestock 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. The formation of livestock trucking firm will be affected by several variables. The most important variables to be considered when establishing a trucking firm 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 will suggest 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.

The 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 is also 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 the management of a firm, is readily available in most areas. The quantity as well as quality of labor in the firm also is important to the firm's operational efficiency.

Investment in road equipment is the major form of investment in any trucking firm. The type and quality of equipment needed by the firm are 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 were also desired. The final result of this stratification was the model firm sizes used in the study: A one tractor-

one trailer model, a three tractor-four trailer model, a six tractor-eight trailer model, and a twelve tractor-sixteen trailer model. As the 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. If extra trailers are available, the tractor driver need not wait for his trailer to be loaded, but can pick up a trailer that had been loaded while he was still on the road, and begin moving again. Also, in time 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 and Interstate Commerce Commission's legal and safety regulations. A straight truck to be used as a convenience vehicle is included in each of the model livestock trucking firms.

When determining the 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 the 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 will 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 per cent to 95 per cent of the total investment per firm. Due to this importance of the tractor and trailer cost relative to total investment requirements, the range of investment is predominantly determined by the quantity and quality of the tractors and trailers in the firm.

As a result of 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 trailers were used. Costs for diesel and gasoline tractors also were considered. In the final construction of the model firms, the operating cost per mile was calculated for diesel and gasoline tractors, and high and low investment estimates, and the various combinations of their components for each model. In considering the specific costs of each type of model, not only depreciation on investment, but interest, fuel, fuel tax, and maintenance costs were also considered to vary with type of investment estimate made (Table 7). The 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 have higher maintenance costs. The shorter life of the equipment would affect the fixed costs of operation, while the increase in maintenance costs would affect the variable costs.

Even 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 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 what type of equipment is being considered.

Estimating investment costs also is necessary to provide some criterion 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 9-16).

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. The investment cost per unit decreases slightly as the size of the firm increases.[22] 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.

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[22]The number of units in a firm is based on the number of tractors available, i.e., one unit in the one tractor-one trailer model, six units in the six tractor-eight trailer model, and so forth.

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

Model One: One Tractor-One Trailer Firm

The total estimated investment costs of establishing the one tractor-one trailer model firm ranged from $20,150 to $49,400.

This range indicates that the costs of entering the trucking industry in North Dakota are not prohibitive.[23] The cost varies considerably, but even the upper range is not prohibitive, at least from a relative cost of entry point of view.[24] 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, the office facilities would be part of the owner's home. Only one telephone was assumed to be necessary for the operations of this firm. The recommended building for use as a garage and workshop for this firm is a 30' X 80' building. The range of investment in the building was $3,500 to $7,500. The highest estimate was a prefabricated steel building and

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[23]The investment estimates for the straight truck ranged from $3,800 to $4,700. Included in the $4,700 figure was:

Cab and chassis, six cylinder engine, four speed transmission	$3,225
Heater, heavy duty brakes and battery	116
Two speed rear axle, 15,000 pound capacity, and 7,000 pound front suspension	284
Heavy duty cast wheels, 6.5" rims, 8.25 X 20, 10 ply tires	249
West coast mirrors and transportation charges	143
SUBTOTAL	$4,017
long wheel base	103
16' combinations fold down grain and livestock body	792
	$4,912
minus 9½ per cent cash discount	465
plus 3 per cent sales tax	133
plus license	123
	$4,701

The figure for the lower estimate was obtained by taking the same equipment, but using less expensive components.

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

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

| | Model | | | |
Cost Component	One Tractor- One Trailer	Three Tractor- Four Trailer	Six Tractor- Eight Trailer	Twelve Tractor- Sixteen Trailer
	dollars			
Equipment				
Tractor	14,000	42,000	84,000	168,000
Trailer	8,000	32,000	64,000	128,000
Office Facil- ities	100	375	375	375
Garage Equip- ment	300	300	800	800
Buildings	5,500	5,500	5,500	5,500
Total Invest- ment	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. (The straight truck is not considered in this example.)

the lowest estimate was a wood frame building, both with 16 foot high doors.[25] 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, the larger firms could use part of the building as an office.

Operating this one tractor-one 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 required by this firm. As the 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.

[25]The estimates for this building were obtained from Mr. Edward Williams, Gateway Construction Company, and Mr. Roland Krueger, Leo Lumber Company, both of Fargo, North Dakota.

Model Two: Three Tractor-Four Trailer Firm

According to the estimates received from the various dealers and equipment manufacturers, it would be possible to begin operation of the three tractor-four trailer livestock trucking firm with an investment of $52,775 to $135,240. This firm could operate at 450,000 total miles per year. It was assumed that the 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 in this firm.

Labor requirements for this firm 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 Three: Six Tractor-Eight Trailer Firm

It was estimated that the six tractor-eight trailer livestock trucking firm would be put into operation for $97,775 to $256,340. This firm is designed to operate at 900,000 miles per year. The 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 secretary will be employed to handle the telephones and correspondence, and also to keep books. It was assumed she would only work half-time. Three telephones were assumed to be necessary for a firm of this size.

Model Four: Twelve Tractor-Sixteen Trailer Firm

An investment cost of $187,775 to $498,400 would be needed to put this twelve tractor-sixteen trailer livestock trucking firm in operation. The firm is designed to operate at 1,800,000 total miles per year. The office facilities and building investment have the same range as the six tractor-eight trailer firm. The telephone requirements for this firm were assumed to be 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.

Fixed Costs

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 being considered is the basis used for spreading out these investment costs. The depreciation rates for the tractors and trailers in this study were recommended by the manu-facturers and by the 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 em-ployed 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. The equipment in the trucking firm (including such items as 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.[26]

Taxes

Tax expenditures are items which also 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 and the excise tax on the tractor and trailer were included as fixed costs. 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 the present time 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.[27]

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[26]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.

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

Cargo insurance also is carried by the trucker. Since this is paid annually on each vehicle, it is also considered a fixed cost. The North Dakota Public Service Commission requires a minimum of $1,000 coverage on each tractor-trailer unit. The livestock trucker traditionally carries only the minimum required. The insurance rate is $12 per $1,000 of coverage. An average rate of $20 per vehicle was used in this study.

Insurance premiums on the building are also considered a fixed cost. In this study a rate of $1.70 per $100 investment was used.[28] This insurance covers the building and anything within the building proper, including garage equipment.

License

The 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 pro-rating that the firm does. Prorating refers to the situation where the license fees the North Dakota trucker pays to each state are 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'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.

The license fees vary from state to state and vehicle to vehicle; there-fore, 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. The total license cost used in this study was $855 per vehicle unit per year.

Telephone

The telephone cost to the firm was considered partially fixed and par-tially variable. If the firm cuts back production, the base 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.

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[28]These rates were obtained from the Fire Underwriters Insurance Company.

Interest

In most cases the firm must borrow some money to cover the total investment. The interest paid for the use of this money must be considered a cost 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 was also 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. Electricity and heating fuel are the main components of this cost. In this study the assumption is that the total utility bill was $50 per month, or $600 annually.

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 their firm comparable to the role of the owner-operator in the livestock trucking firms.[29] 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 the fuel used by the firm. 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 ten cents per gallon for both diesel and gasoline.

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[29]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.

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 cents per mile.

Wages

The cost of all labor in a typical livestock trucking firm was considered a variable cost. The two classes of labor costs used were driver's wages and mechanic's 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 the most common rate being five cents per mile. This five cent rate was used in this study. Mechanic and secretarial help wages also are considered variable costs. It was assumed they would be paid an hourly wage and, as production is cut back, these individuals will 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. The required work is assumed to vary closely with annual mileage. The wages used in this study were $1.75 and $1.25 an hour for mechanics and secretarial help, respectively.

Fuel

One of the major costs incurred by a trucking firm is the fuel expense. The price per gallon in North Dakota, excluding taxes, is approximately 15 cents for diesel fuel and 22 cents for gasoline. The 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 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.[30]

Tire Cost

Tire cost also is considered a variable cost because of its direct relationship to annual mileage. It is one of the more important variable costs

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[30]Throughout this discussion the terms, high gas tractor will refer to the highest investment estimate for a gas tractor, low diesel tractor will refer to the lowest estimate for a diesel tractor, and so forth.

to the trucker and is also one that varies considerably. Truckers in the industry were asked to estimate the mileage life of the tires on their vehicles. The estimates of tire life ranged from 50,000 miles to 200,000 miles per tire with a mean of 140,000 miles. The median and modal estimate was 100,000 miles per tire.

Many factors result in wear on the tire. When the tire is first placed on the vehicle, tire wear is comparatively rapid. As the tire wears down the rate of wear slows down appreciably. Due to this factor and the other conditions affecting tire wear, tire cost at each specific mileage could not be determined. Instead, a cost per mile of 2.5 cents was used in this study. This cost was arrived at by dividing the mileage per tire into the average purchase per tire multiplied times the number of tires on each tractor-trailer combination.

Maintenance Costs

Maintenance costs also are costs which vary with level of production. Included in maintenance costs are 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.[31] The survey sample cost data of North Dakota livestock truckers indicated a maintenance cost of 1.58 cents per mile. The maintenance cost for the livestock sector was assumed to be .95 cents per mile for a diesel engine tractor and 1.35 cents for a gasoline engine tractor.

Model Firms and Indicated Relationships

Gasoline Versus Diesel Tractors

A comparison of the diesel tractor investment estimates with the comparable gasoline tractor investment estimates indicates a lower operating cost for the diesel tractor firms throughout all four models (Tables 9-16). The low cost gas firm's operating cost was greater than the high cost diesel firm's operating cost in the one tractor-one trailer livestock model. In the other three livestock models the operating costs of the low cost gas firm were only slightly cheaper than the high cost diesel, i.e., two cents per mile difference throughout.

This difference in operating cost is 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 a gasoline tractor, thus resulting in higher average total costs for the

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[31]Brown, James H., Field Manager, Motor Truck Division, International Harvester Company, December 21, 1966.

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
	dollars					
Tractor						
Diesel						
High[a]	21,000	2,100	1,365	2.0¢	3.0¢	.95¢
Low[a]	12,000	1,200	780	2.0¢	3.0¢	.95¢
Gas						
High	13,000	1,300	845	2.2¢	5.0¢	1.35¢
Low	5,000	500	325	2.2¢	5.0¢	1.35¢
Trailer						
High	14,500	1,450	942	No Effect	No Effect	No Effect
Low	7,500	750	488	No Effect	No Effect	No Effect
Straight Truck						
High	4,700	470	348	No Effect	No Effect	No Effect
Low	3,800	380	306	No Effect	No Effect	No Effect

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

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

Cost Components	Model			
	One Tractor- One Trailer	Three Tractor- Four Trailer	Six Tractor- Eight Trailer	Twelve Tractor- Sixteen 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	3,750	11,250	22,500	45,000
Total Variable	11,850	35,550	77,100	154,600

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 9-16).

High Cost Versus Low Cost Trailer Investment Estimates

Employing the higher cost trailer in the model resulted in an increase in the livestock model firms' operating costs of .68 cents to 1.02 cents from the smallest to the largest model, with an average increase for all investment estimate combinations of .93 cents per mile. The difference of high cost versus low cost trailer investment had, as expected, more effect on the three larger models than on the one tractor-one trailer model. This occurred because of the higher relative importance of trailer costs to the firms 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 will cause a noticeable variation in operating costs.

This occurs because percentages of total investment are used to determine some components of each model's operating costs. There was not, however, a direct relationship in all cases. Within a certain model, i.e., a livestock, diesel, one tractor-one trailer model, 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.

Observation of Tables 9-16 and Figures 1-8 indicates that the per mile operating costs for the highest and lowest investment estimates for each specific model are substantially different. The difference ranged from 1.74 cents per mile for Model I operating gasoline tractors, to 2.04 cents per mile for Model II operating diesel tractor for the livestock trucking firm with an average change of 1.78 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 3.6 cents.

Excess Capacity

The operating costs per mile are increased greatly when excess capacity exists. Data presented in Tables 11, 18, 19, and 20 support this conclusion and provide the information necessary for construction of short-run average cost curves. 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 livestock firm operating high cost diesel tractors increases his per mile operating costs by 6.79 cents or 28 per cent. Data presented in Tables 17, 18, 19, and 20 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 cost remains the same on a per mile basis because it has been assumed that 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

The short-run average cost curves are presented in Figures 1-8. These curves are shown for the highest and lowest operating cost estimate for each

TABLE 9. LIVESTOCK TRUCKING FIRMS – COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GASOLINE TRACTORS, MODEL ONE, 100 PER CENT CAPACITY

Cost Components	High Gas, High Trailer, High Straight Truck[b]	High Gas, High Trailer, Low Straight Truck[b]	High Gas, Low Trailer, High Straight Truck	High Gas, Low Trailer, Low Straight Truck	Low Gas, High Trailer, High Straight Truck	Low Gas, High Trailer, Low Straight Truck	Low Gas, Low Trailer, High Straight Truck	Low Gas, Low Trailer, Low Straight Truck
					dollars			
Fixed Costs								
Depreciation	3,220	3,130	2,520	2,430	2,420	2,330	1,720	1,630
Interest	2,135	2,093	1,681	1,639	1,615	1,573	1,161	1,119
(Other Fixed Costs)[a]	8,422	8,422	8,422	8,422	8,422	8,422	8,422	8,422
Total Fixed Costs	13,777	13,645	12,623	12,491	12,457	12,325	11,303	11,171
Variable Costs								
Fuel Tax	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300
Fuel Costs	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
Maintenance	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025
(Other Variable Costs)[a]	11,850	11,850	11,850	11,850	11,850	11,850	11,850	11,850
Total Variable Costs	24,675	24,675	24,675	24,675	24,675	24,675	24,675	24,675
Total Costs	38,452	38,320	37,298	37,166	37,132	37,000	35,978	35,846
Average Costs Per Mile								
Fixed	.0918	.0909	.0841	.0832	.0830	.0821	.0753	.0744
Variable	.1645	.1645	.1645	.1645	.1645	.1645	.1645	.1645
Total	.2563	.2554	.2486	.2477	.2475	.2466	.2398	.2389

[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. LIVESTOCK TRUCKING FIRMS — COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, DIESEL TRACTORS, MODEL ONE, 100 PER CENT CAPACITY

Cost Components	High Diesel, High Trailer, High Straight Truck[b]	High Diesel, High Trailer, Low Straight Truck[b]	High Diesel, Low Trailer, High Straight Truck	High Diesel, Low Trailer, Low Straight Truck	High Diesel, High Trailer, High Straight Truck	High Diesel, High Trailer, Low Straight Truck	High Diesel, Low Trailer, High Straight Truck	High Diesel, Low Trailer, Low Straight Truck
				dollars				
Fixed Costs								
Depreciation	4,020	3,930	3,320	3,230	3,120	3,030	2,420	2,330
Interest	2,665	2,613	2,201	2,159	2,070	2,028	1,616	1,574
(Other Fixed Costs)[a]	8,422	8,422	8,422	8,422	8,422	8,422	8,422	8,422
Total Fixed Costs	15,107	14,965	13,943	13,811	13,612	13,480	12,458	12,326
Variable Costs								
Fuel Tax	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Fuel Cost	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Maintenance	1,425	1,425	1,425	1,425	1,425	1,425	1,425	1,425
(Other Variable Costs)[a]	11,850	11,850	11,850	11,850	11,850	11,850	11,850	11,850
Total Variable Costs	20,775	20,775	20,775	20,775	20,775	20,775	20,775	20,775
Total Costs	35,882	35,740	34,718	34,586	34,387	34,255	33,233	33,101
Average Cost Per Mile								
Fixed	.1000	.0997	.0929	.0920	.0907	.0898	.0830	.0821
Variable	.1385	.1385	.1385	.1385	.1385	.1385	.1385	.1385
Total	.2385	.2382	.2314	.2305	.2292	.2283	.2215	.2206

[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. LIVESTOCK TRUCKING FIRMS – COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GASOLINE TRACTORS, MODEL TWO, 100 PER CENT CAPACITY

Cost Components	High Gas, High Trailer, High Straight Truck[b]	High Gas, High Trailer, Low Straight Truck[b]	High Gas, Low Trailer, High Straight Truck	High Gas, Low Trailer, Low Straight Truck	Low Gas, High Trailer, High Straight Truck	Low Gas, High Trailer, Low Straight Truck	Low Gas, Low Trailer, High Straight Truck	Low Gas, Low Trailer, Low Straight Truck
				dollars				
Fixed Costs								
Depreciation	10,170	10,080	7,370	7,280	7,770	7,680	4,970	4,880
Interest	6,651	6,609	4,835	4,793	5,091	5,049	3,275	3,233
(Other Fixed Costs)[a]	10,562	10,562	10,562	10,562	10,562	10,562	10,562	10,562
Total Fixed Costs	27,383	27,251	22,767	22,635	23,423	23,291	18,807	18,675
Variable Costs								
Fuel Tax	9,900	9,900	9,900	9,900	9,900	9,900	9,900	9,900
Fuel Cost	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500
Maintenance	6,075	6,075	6,075	6,075	6,075	6,075	6,075	6,075
(Other Variable Costs)[a]	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550
Total Variable Costs	74,025	74,025	74,025	74,025	74,025	74,025	74,025	74,025
Total Costs	101,408	101,276	96,792	96,660	97,448	97,316	92,832	92,700
Average Costs Per Mile								
Fixed	.0608	.0605	.0505	.0503	.0520	.0517	.0417	.0415
Variable	.1645	.1645	.1645	.1645	.1645	.1645	.1645	.1645
Total	.2253	.2250	.2150	.2148	.2165	.2162	.2062	.2060

[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. LIVESTOCK TRUCKING FIRMS — COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, DIESEL TRACTORS, MODEL TWO, 100 PER CENT CAPACITY.

Cost Components	High Diesel, High Trailer, High Straight Truck[b]	High Diesel, High Trailer, Low Straight Truck[b]	High Diesel, Low Trailer, High Straight Truck	High Diesel, Low Trailer, Low Straight Truck	Low Diesel, High Trailer, High Straight Truck	Low Diesel, High Trailer, Low Straight Truck	Low Diesel, Low Trailer, High Straight Truck	Low Diesel, Low Trailer, Low Straight Truck
				dollars				
Fixed Costs								
Depreciation	12,570	12,480	9,770	9,680	9,870	9,780	7,070	6,980
Interest	8,211	8,169	6,395	6,353	6,456	6,414	4,640	4,598
(Other Fixed Costs)[a]	10,562	10,562	10,562	10,562	10,562	10,562	10,562	10,562
Total Fixed Costs	31,343	31,211	26,727	26,595	26,888	26,756	22,272	22,140
Variable Costs								
Fuel Tax	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Fuel Cost	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500
Maintenance	4,275	4,275	4,275	4,275	4,275	4,275	4,275	4,275
(Other Variable Costs)[a]	35,550	35,550	35,550	35,550	35,550	35,550	35,550	35,550
Total Variable Costs	62,325	62,325	62,325	62,325	62,325	62,325	62,325	62,325
Total Costs	93,668	93,526	89,052	88,920	89,213	89,081	84,597	84,465
Average Costs Per Mile								
Fixed	.0696	.0693	.0593	.0591	.0597	.0594	.0494	.0492
Variable	.1385	.1385	.1385	.1385	.1385	.1385	.1385	.1385
Total	.2081	.2078	.1978	.1976	.1982	.1979	.1879	.1877

a Explained in detail in Table 8.

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

TABLE 13. LIVESTOCK TRUCKING FIRMS - COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GASOLINE TRACTORS, MODEL THREE, 100 PER CENT CAPACITY

Cost Components	High Gas, High Trailer, High Straight Truck b	High Gas, High Trailer, Low Straight Truck b	High Gas, Low Trailer, High Straight Truck	High Gas, Low Trailer, Low Straight Truck	Low Gas, High Trailer, High Straight Truck	Low Gas, High Trailer, Low Straight Truck	Low Gas, Low Trailer, High Straight Truck	Low Gas, Low Trailer, Low Straight Truck
				dollars				
Fixed Costs								
Depreciation	19,870	19,780	14,270	14,180	15,070	14,980	9,470	9,380
Interest	12,954	12,912	9,322	9,280	9,834	9,792	6,202	6,160
(Other Fixed Costs)a	13,742	13,742	13,742	13,742	13,742	13,742	13,742	13,742
Total Fixed Costs	46,566	46,434	37,334	37,202	38,646	38,514	29,414	29,282
Variable Costs								
Fuel Tax	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800
Fuel Cost	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Maintenance	12,150	12,150	12,150	12,150	12,150	12,150	12,150	12,150
(Other Variable Costs)a	77,100	77,100	77,100	77,100	77,100	77,100	77,100	77,100
Total Variable Costs	154,050	154,050	154,050	154,050	154,050	154,050	154,050	154,050
Total Costs	200,616	200,484	191,384	191,252	192,696	192,564	183,464	183,332
Average Costs Per Mile								
Fixed	.0517	.0516	.0414	.0413	.0429	.0428	.0326	.0325
Variable	.1712	.1712	.1712	.1712	.1712	.1712	.1712	.1712
Total	.2229	.2228	.2126	.2125	.2141	.2140	.2038	.2037

aExplained in detail in Table 8.

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

TABLE 14. LIVESTOCK TRUCKING FIRMS -- COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, DIESEL TRACTORS, MODEL THREE, 100 PER CENT CAPACITY

Cost Components	High Diesel, High Trailer, High Straight Truck[b]	High Diesel, High Trailer, Low Straight Truck[b]	High Diesel, Low Trailer, High Straight Truck	High Diesel, Low Trailer, Low Straight Truck	Low Diesel, High Trailer, High Straight Truck	Low Diesel, High Trailer, Low Straight Truck	Low Diesel, Low Trailer, High Straight Truck	Low Diesel, Low Trailer, Low Straight Truck
				dollars				
Fixed Costs								
Depreciation	24,670	24,580	19,070	18,980	19,270	19,180	13,670	13,580
Interest	16,074	16,032	12,442	12,400	12,564	12,522	8,932	8,890
(Other Fixed Costs)[a]	13,742	13,742	13,742	13,742	13,742	13,742	13,742	13,742
Total Fixed Costs	54,486	54,353	45,254	45,122	45,576	45,444	36,344	36,212
Variable Costs								
Fuel Tax	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000
Fuel Cost	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000
Maintenance	8,550	8,550	8,550	8,550	8,550	8,550	8,550	8,550
(Other Variable Costs)[a]	77,100	77,100	77,100	77,100	77,100	77,100	77,100	77,100
Total Variable Costs	130,650	130,650	130,650	130,650	130,650	130,650	130,650	130,650
Total Costs	185,136	185,003	175,904	175,772	176,226	176,094	166,994	166,862
Average Costs Per Mile								
Fixed	.0605	.0603	.0502	.0501	.0506	.0504	.0403	.0402
Variable	.1452	.1452	.1452	.1452	.1452	.1452	.1452	.1452
Total	.2057	.2055	.1954	.1953	.1958	.1956	.1855	.1854

[a]Explained in detail in Table 8.

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

TABLE 15. LIVESTOCK TRUCKING FIRMS — COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, GASOLINE TRACTORS, MODEL FOUR, 100 PER CENT CAPACITY

Cost Components	High Gas, High Trailer, High Straight Truck[b]	High Gas, High Trailer, Low Straight Truck[b]	High Gas, Low Trailer, High Straight Truck	High Gas, Low Trailer, Low Straight Truck	Low Gas, High Trailer, High Straight Truck	Low Gas, High Trailer, Low Straight Truck	Low Gas, Low Trailer, High Straight Truck	Low Gas, Low Trailer, Low Straight Truck
				dollars				
Fixed Costs								
Depreciation	39,270	39,180	28,070	27,980	29,670	29,580	18,470	18,380
Interest	25,560	25,518	18,296	18,254	19,320	19,278	12,056	12,014
(Other Fixed Costs)[a]	20,042	20,042	20,042	20,042	20,042	20,042	20,042	20,042
Total Fixed Costs	84,872	84,740	66,408	66,276	69,032	68,900	50,568	50,436
Variable Costs								
Fuel Tax	39,600	39,600	39,600	39,600	39,600	39,600	39,600	39,600
Fuel Cost	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000
Maintenance	24,300	24,300	24,300	24,300	24,300	24,300	24,300	24,300
(Other Variable Costs)[a]	154,600	154,600	154,600	154,600	154,600	154,600	154,600	154,600
Total Variable Costs	308,500	308,500	308,500	308,500	308,500	308,500	308,500	308,500
Total Costs	393,372	393,240	374,908	374,776	377,532	377,400	359,068	358,936
Average Costs Per Mile								
Fixed	.0471	.0471	.0369	.0368	.0383	.0383	.0281	.0280
Variable	.1714	.1714	.1714	.1714	.1714	.1714	.1714	.1714
Total	.2185	.2185	.2083	.2082	.2097	.2097	.1995	.1994

[a] Explained in detail in Table 8.

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

TABLE 16. LIVESTOCK TRUCKING FIRMS – COSTS PER MILE, ALL POSSIBLE INVESTMENT ESTIMATES, DIESEL TRACTORS, MODEL FOUR, 100 PER CENT CAPACITY

Cost Components	High Diesel, High Trailer, High Straight Truck[b]	High Diesel, High Trailer, Low Straight Truck[b]	High Diesel, Low Trailer, High Straight Truck	High Diesel, Low Trailer, Low Straight Truck	Low Diesel, High Trailer, High Straight Truck	Low Diesel, High Trailer, Low Straight Truck	Low Diesel, Low Trailer, High Straight Truck	Low Diesel, Low Trailer, Low Straight Truck
				dollars				
Fixed Costs								
Depreciation	48,870	48,780	37,670	37,580	38,070	37,980	26,870	26,780
Interest	31,800	31,758	24,536	24,494	27,900	27,858	20,636	20,594
(Other Fixed Costs)[a]	20,042	20,042	20,042	20,042	20,042	20,042	20,042	20,042
Total Fixed Costs	100,712	100,580	82,248	82,116	86,012	85,880	67,548	67,416
Variable Costs								
Fuel Tax	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Fuel Cost	54,000	54,000	54,000	554,000	54,000	54,000	54,000	54,000
Maintenance	17,100	17,100	17,100	17,100	17,100	17,100	17,100	17,100
(Other Variable Costs)[a]	154,600	154,600	154,600	154,600	154,600	154,600	154,600	154,600
Total Variable Costs	261,700	261,700	261,700	261,700	261,700	261,700	261,700	261,700
Total Costs	362,412	362,280	343,948	343,816	347,712	347,580	329,248	329,116
Average Costs Per Mile								
Fixed	.0560	.0559	.0457	.0456	.0478	.0477	.0375	.0374
Variable	.1454	.1454	.1454	.1454	.1454	.1454	.1454	.1454
Total	.2014	.2013	.1911	.1910	.1932	.1931	.1829	.1828

[a] Explained in detail in Table 8.

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

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

Figure 1. Annual Average Operating Costs of One Tractor-One Trailer, Live-
stock Firm Operating Diesel Tractors, High and Low Estimates, North Dakota,
1966.

CENTS
PER MILE

ANNUAL MILEAGE (THOUSANDS)

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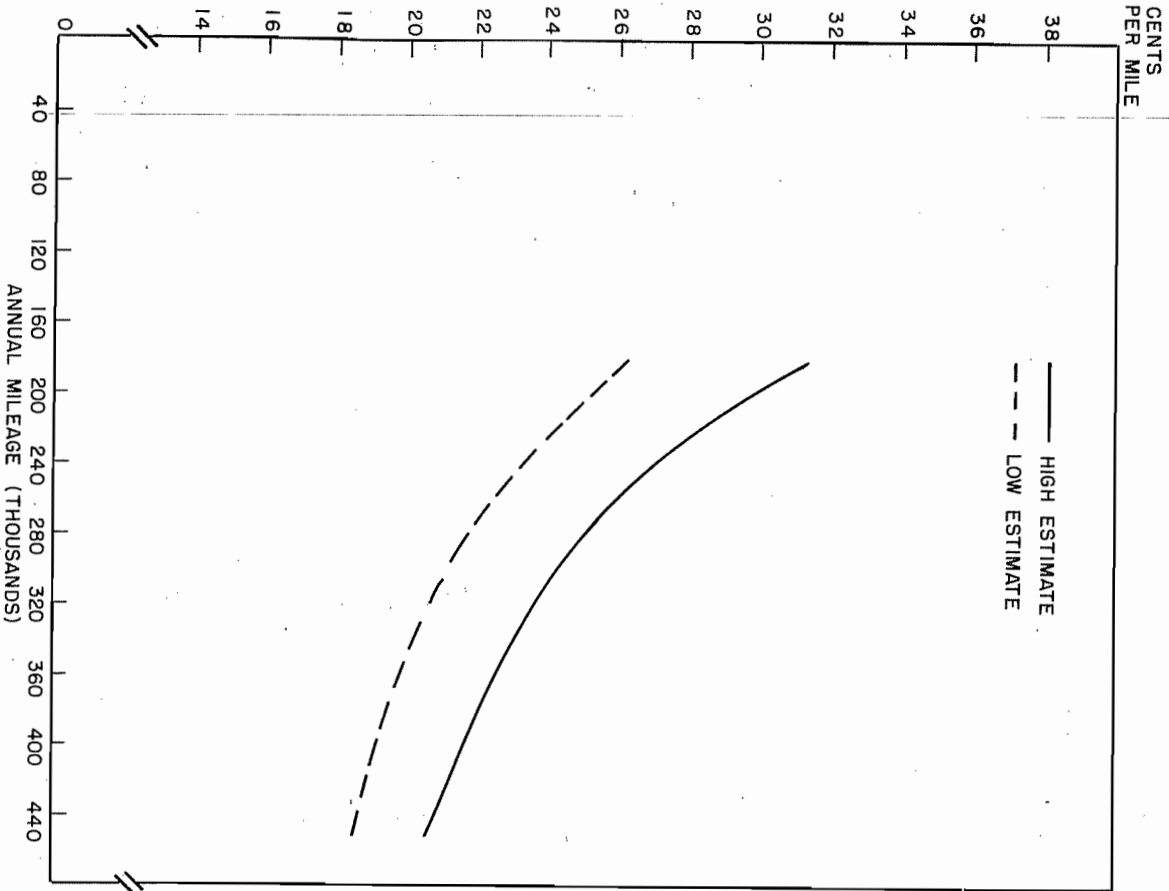
Figure 3. Annual Average Operating Costs of Three Tractor-Four Trailer
Livestock Firm Operating Diesel Tractors, High and Low Estimates.

CENTS
PER MILE

ANNUAL MILEAGE (THOUSANDS)

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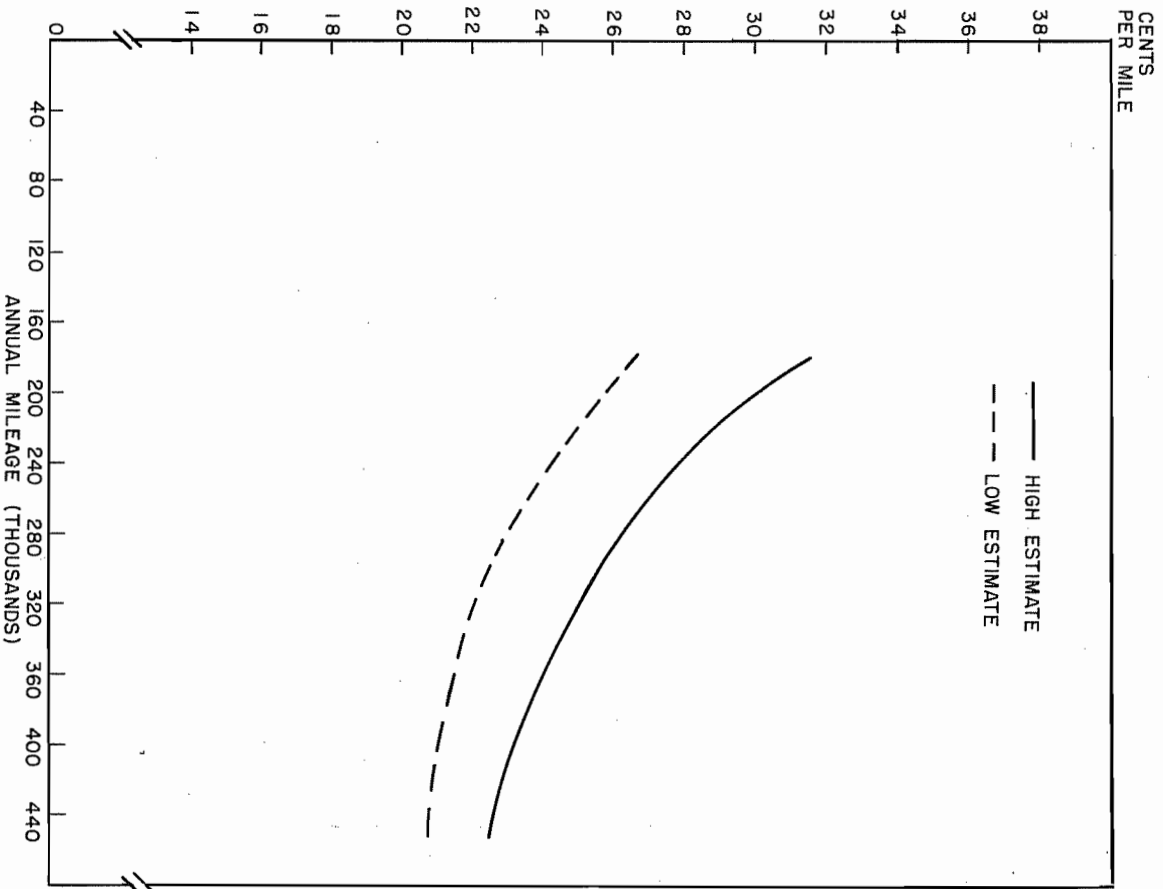
Figure 4. Annual Average Operating Costs of Three Tractor-Four Trailer
Livestock Firm Operating Gasoline Tractors, High and Low Estimates.

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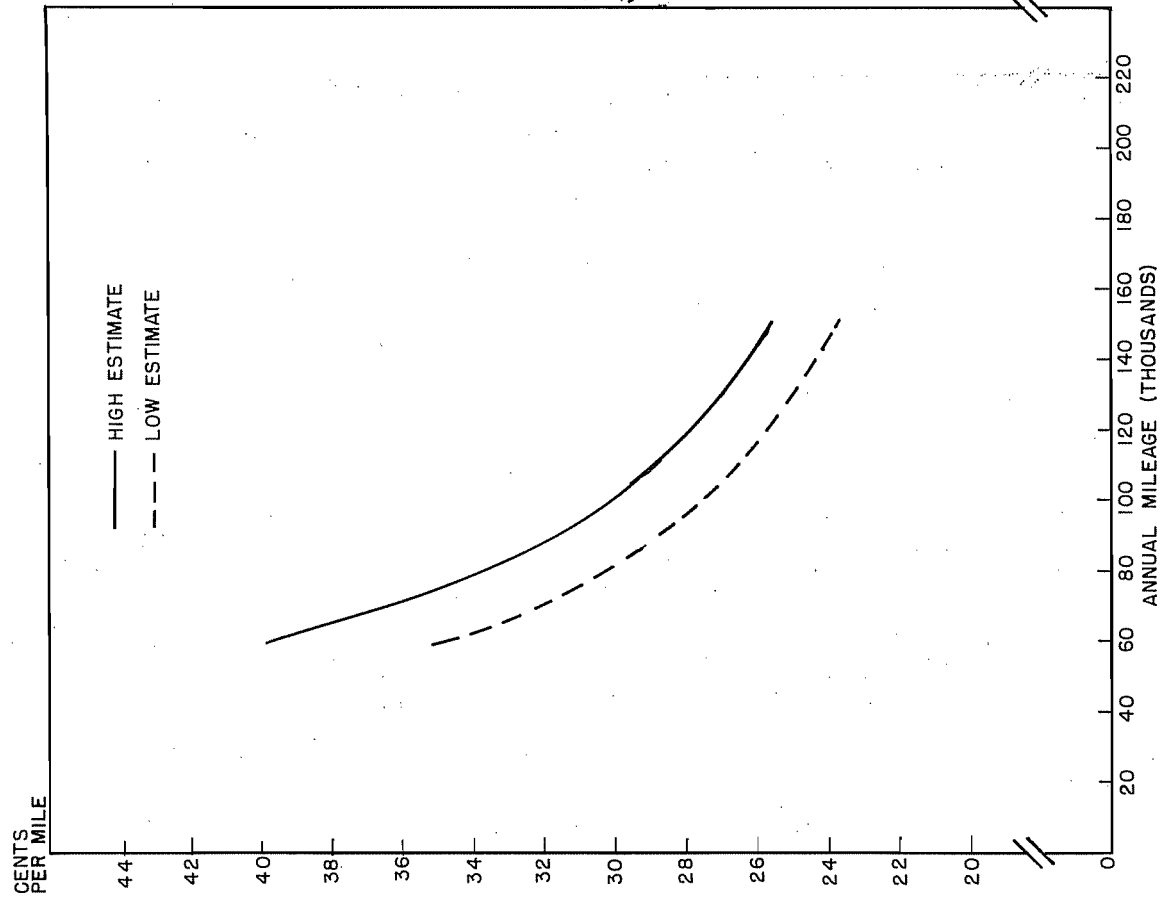

Figure 6. Annual Average Operating Costs of Six Tractor-Eight Trailer Livestock Firm Operating Gasoline Tractors, High and Low Estimates.

Figure 7. Annual Average Operating Costs of Twelve Tractor-Sixteen Trailer Livestock Firm Operating Diesel Tractors, High and Low Estimates.
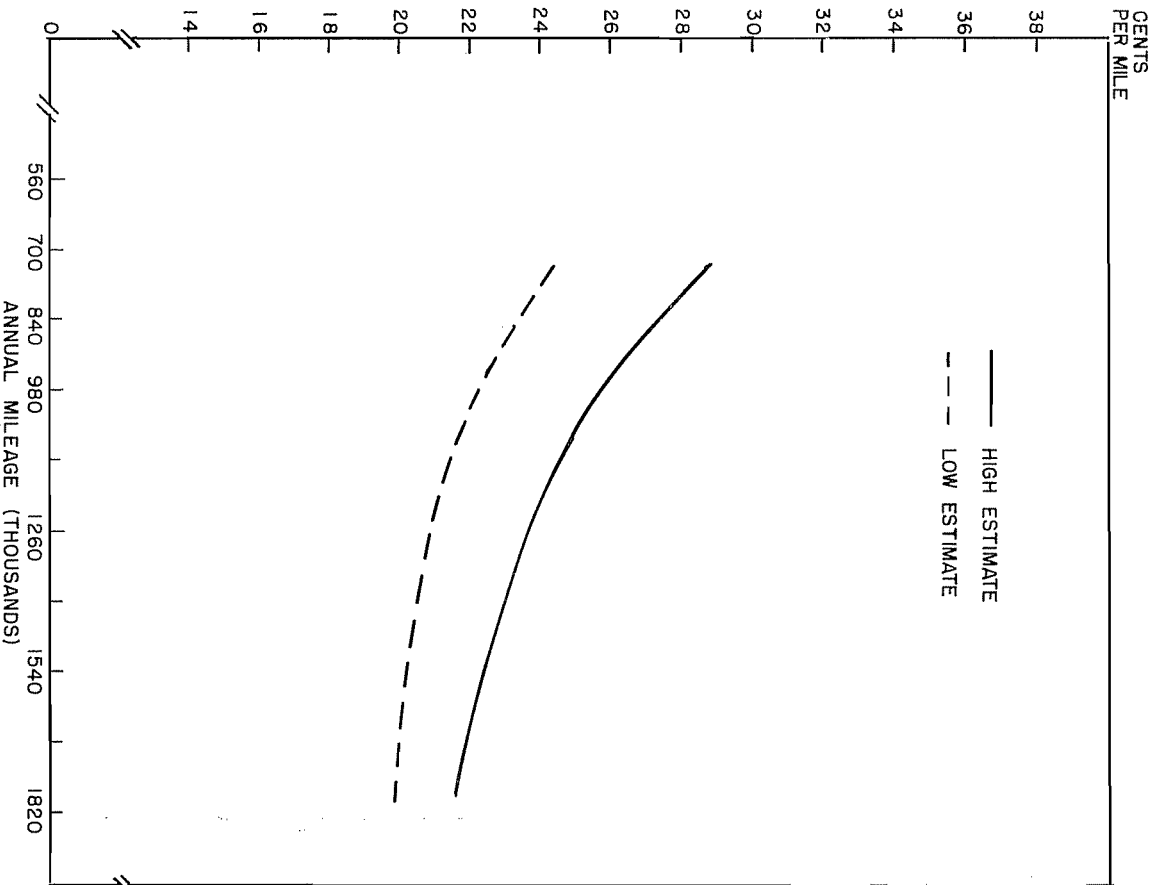
Figure 8. Annual Average Operating Costs of Twelve Tractor-Sixteen Trailer Livestock Firm Operating Gasoline Tractors, High and Low Estimates.
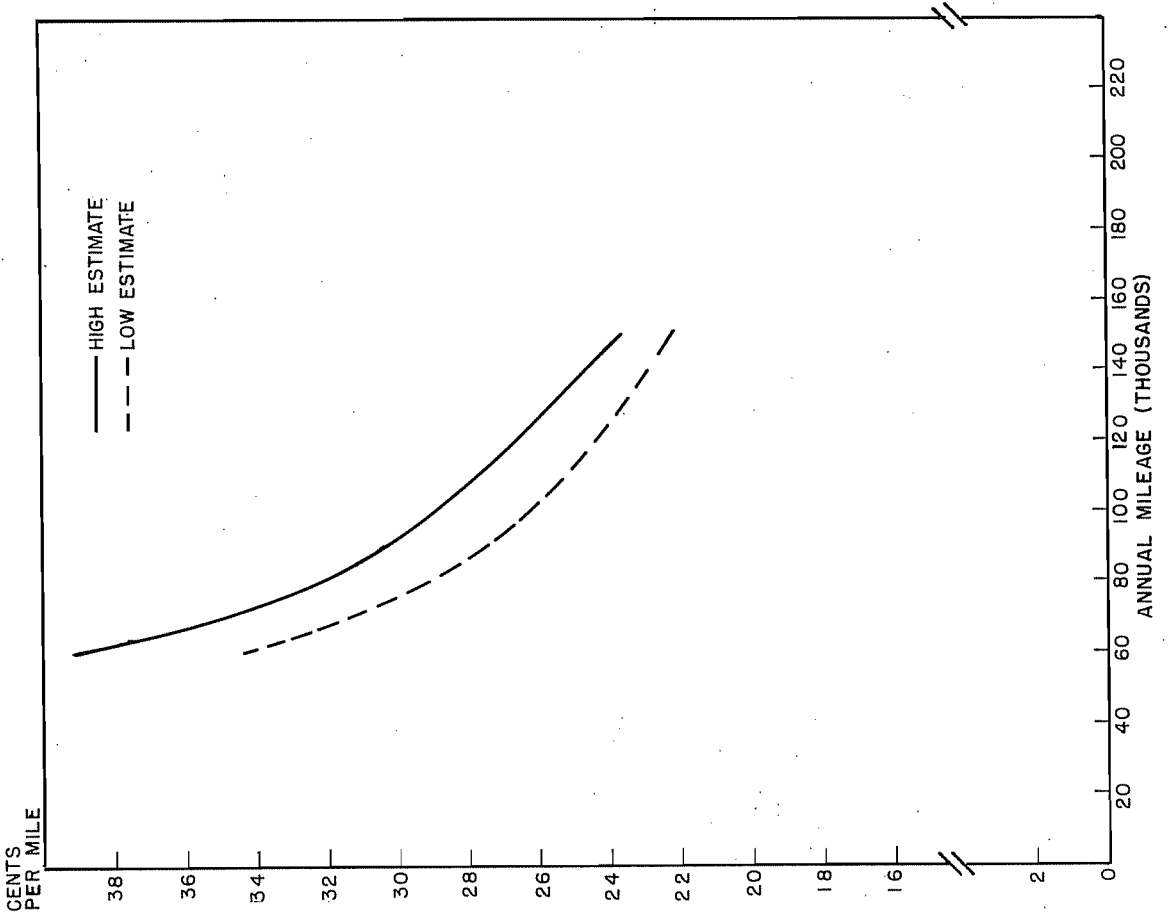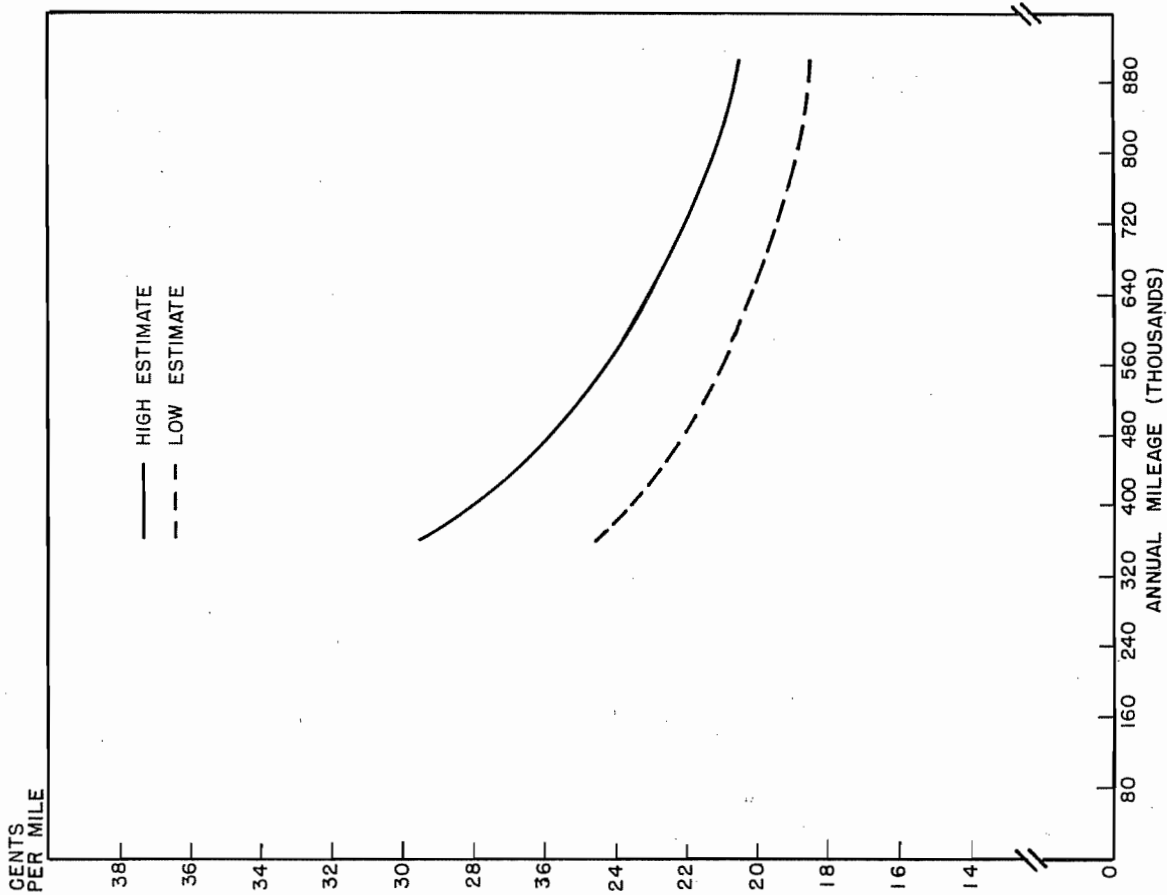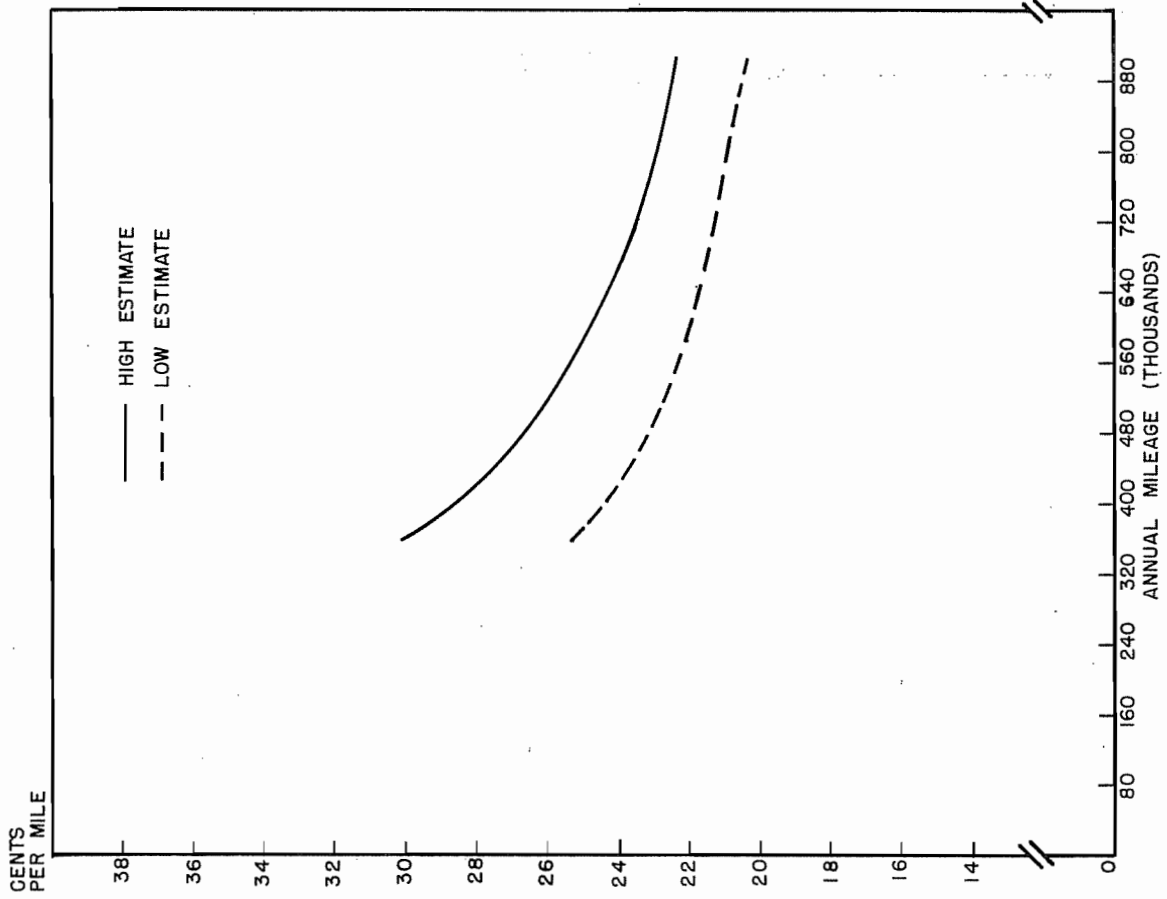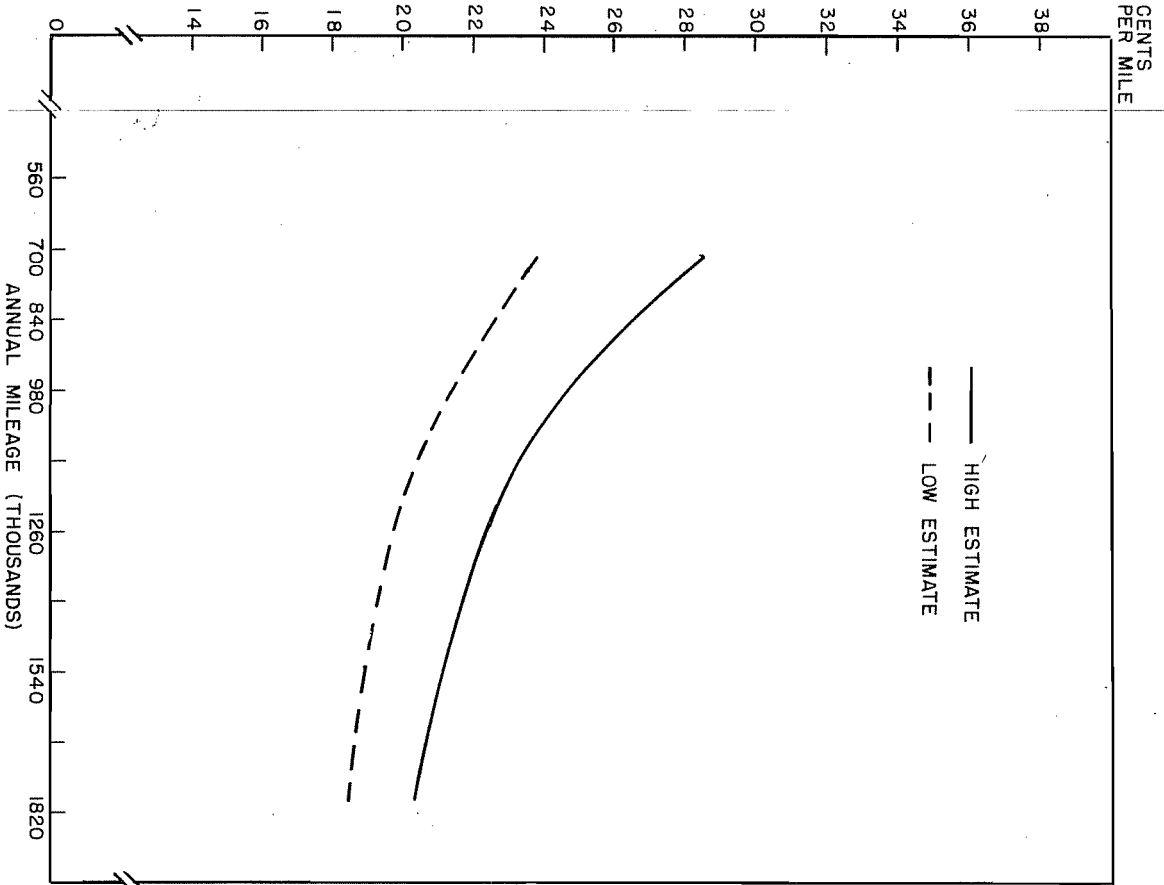
TABLE 17. ANNUAL OPERATING COSTS, ONE TRACTOR-ONE TRAILER MODEL LIVESTOCK TRUCKING FIRMS

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, High Cost Estimates						
100% (150,000)a	15,107	.1000	20,755	.1385	35,882	.2385
80% (120,000)	15,107	.1259	16,620	.1385	31,727	.2644
60% (90,000)	15,107	.1679	12,465	.1385	27,572	.3064
40% (60,000)	15,107	.2518	8,310	.1385	23,417	.3903
Diesel, Low Cost Estimates						
100% (150,000)	12,326	.0821	20,775	.1385	33,101	.2206
80% (120,000)	12,326	.1027	16,620	.1385	28,946	.2412
60% (90,000)	12,326	.1369	12,465	.1385	24,791	.2754
40% (60,000)	12,326	.2054	8,310	.1385	20,636	.3439
Gasoline, High Cost Estimates						
100% (150,000)	13,777	.0918	24,675	.1645	38,452	.2563
80% (120,000)	13,777	.1148	19,740	.1645	33,517	.2793
60% (90,000)	13,777	.1530	14,805	.1645	28,582	.3175
40% (60,000)	13,777	.2296	9,870	.1645	23,647	.3941
Gasoline, Low Cost Estimates						
100% (150,000)	11,171	.0744	24,675	.1645	35,846	.2389
80% (120,000)	11,171	.0930	19,740	.1645	30,911	.2575
60% (90,000)	11,171	.1241	14,805	.1645	25,976	.2886
40% (60,000)	11,171	.1861	9,870	.1645	21,041	.3506

aFigures in brackets refer to the annual mileage produced at the specified levels of capacity utilization.

TABLE 18. ANNUAL OPERATING COSTS, THREE TRACTOR-FOUR TRAILER MODEL LIVESTOCK 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, High Cost Estimates						
100% (450,000)a	31,343	.0696	62,325	.1385	93,668	.2081
80% (360,000)	31,343	.0870	49,860	.1385	81,203	.2255
60% (270,000)	31,343	.1160	37,395	.1385	68,738	.2545
40% (180,000)	31,343	.1741	24,930	.1385	56,273	.3126
Diesel, Low Cost Estimates						
100% (450,000)	22,140	.0492	62,325	.1385	84,465	.1877
80% (360,000)	22,140	.0615	49,860	.1385	72,000	.2000
60% (270,000)	22,140	.0820	37,395	.1385	59,535	.2205
40% (180,000)	22,140	.1230	24,930	.1385	47,070	.2615
Gasoline, High Cost Estimates						
100% (450,000)	27,383	.0608	74,025	.1645	101,408	.2253
80% (360,000)	27,383	.0760	59,220	.1645	86,603	.2405
60% (270,000)	27,383	.1014	44,415	.1645	71,798	.2659
40% (180,000)	27,383	.1521	29,610	.1645	56,993	.3166
Gasoline, Low Cost Estimates						
100% (450,000)	18,675	.0415	74,025	.1645	92,700	.2060
80% (360,000)	18,675	.0518	59,220	.1645	77,895	.2163
60% (270,000)	18,675	.0691	44,145	.1645	62,820	.2336
40% (180,000)	18,675	.1037	29,610	.1645	48,285	.2682

aFigures in brackets refer to the annual mileage produced at the specified levels of capacity utilization.

TABLE 19. ANNUAL OPERATING COSTS, SIX TRACTOR-EIGHT TRAILER MODEL LIVESTOCK 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, High Cost Estimates						
100% (900,000)[a]	54,486	.0605	130,650	.1452	185,136	.2057
80% (720,000)	54,486	.0756	104,544	.1452	159,030	.2208
60% (540,000)	54,486	.1009	78,408	.1452	132,894	.2461
40% (360,000)	54,486	.1513	52,272	.1452	106,758	.2965
Diesel, Low Cost Estimates						
100% (900,000)	36,212	.0402	130,650	.1452	166,862	.1854
80% (720,000)	36,212	.0502	104,544	.1452	140,756	.1954
60% (540,000)	36,212	.0670	78,408	.1452	114,620	.2122
40% (360,000)	36,212	.1005	52,272	.1452	88,484	.2457
Gasoline, High Cost Estimates						
100% (900,000)	46,566	.0517	154,050	.1712	200,616	.2229
80% (720,000)	46,566	.0646	123,264	.1712	169,830	.2358
60% (540,000)	46,566	.0862	92,448	.1712	139,014	.2574
40% (360,000)	46,566	.1293	61,632	.1712	108,198	.3005
Gasoline, Low Cost Estimates						
100% (900,000)	29,282	.0325	154,050	.1712	183,332	.2037
80% (720,000)	29,282	.0406	123,264	.1712	152,546	.2118
60% (540,000)	29,282	.0542	92,448	.1712	121,730	.2254
40% (360,000)	29,282	.0813	61,632	.1712	90,914	.2525

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

TABLE 20. ANNUAL OPERATING COSTS, TWELVE TRACTOR-SIXTEEN TRAILER MODEL LIVESTOCK 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, High Cost Estimates[a]						
100% (1,800,000)	100,712	.0560	261,700	.1454	362,412	.2014
80% (1,440,000)	100,712	.0699	209,376	.1454	310,088	.2153
60% (1,080,000)	100,712	.0932	157,032	.1454	257,744	.2386
40% (720,000)	100,712	.1398	104,688	.1454	205,400	.2852
Diesel, Low Cost Estimates						
100% (1,800,000)	67,416	.0374	261,700	.1454	329,116	.1828
80% (1,440,000)	67,416	.0468	209,376	.1454	276,792	.1922
60% (1,080,000)	67,416	.0624	157,032	.1454	224,448	.2078
40% (720,000)	67,416	.0936	104,688	.1454	172,104	.2390
Gasoline, High Cost Estimates						
100% (1,800,000)	84,872	.0471	308,500	.1714	393,372	.2185
80% (1,440,000)	84,872	.0589	246,816	.1714	331,688	.2303
60% (1,080,000)	84,872	.0785	185,112	.1714	269,984	.2499
40% (720,000)	84,872	.1178	123,408	.1714	208,280	.2892
Gasoline, Low Cost Estimates						
100% (1,800,000)	50,436	.0280	308,500	.1714	358,936	.1994
80% (1,440,000)	50,436	.0350	246,816	.1714	297,252	.2064
60% (1,080,000)	50,436	.0467	185,112	.1714	235,548	.2181
40% (720,000)	50,436	.0700	123,408	.1714	173,844	.2414

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

of the four models. These curves are also categorized as to gasoline versus
diesel. The most efficient model was used for the short-run average cost
curves presented in Figures 9 and 10. These figures indicate there are no
noticeable economies of size to be realized by increasing the firm's size
beyond the three tractor-four trailer firm. there is a 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 livestock trucker operating
diesel tractors at 100 per cent capacity, the average operating costs for
Models I through IV are 22.06 cents, 18.77 cents, 18.54 cents, and 18.28 cents,
respectively. The industry scale curve or the long-run curve is found by sim-
ply 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 appears to level off and become horizontal at about
the 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 three tractor-four 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 one tractor-one trailer model can definitely be
said to be less efficient than the others. From the three tractor-four trailer
model to the twelve tractor-sixteen trailer model, equivalent to quadrupling
the firm size, per mile operating costs are only reduced by .53 cents.

If the demand for the trucker's service is present (as was 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. And, as long as the average
total cost continues to be less than the average revenue, the firm can and
should, in the long run, continue increasing the size of his firm.

Used Versus New Equipment

Another option in the market place open to the owner-operator when
investing in equipment for his firm is buying used equipment. Data demonstrat-
ing the comparable costs of a three tractor-four trailer firm, hauling live-
stock and using gasoline tractors, when using new versus used equipment are
shown in TAble 21. The fixed costs of the used equipment are lower because
of th reduced depreciation, interest, and license costs. The depreciation
was figured on an estimated eight-year life for the tractor and six-year life
for the trailer. Both estiamtes are considered to be the maximum possible
life for used equipment. The interest charges are the same for used equip-
ment 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 charged to the used model
was lowered as suggested by the North Dakota Fee Schedule. The decrease in
these three components lowered fixed costs $3,527 below the new equipment model
This lowered the average fixed costs by .78 cents, from 3.91 to 3.13 cents.

Variable costs were increased substantially more than fixed costs were
decreased. Fuel tax, fuel, and maintenance costs all increased. These var-
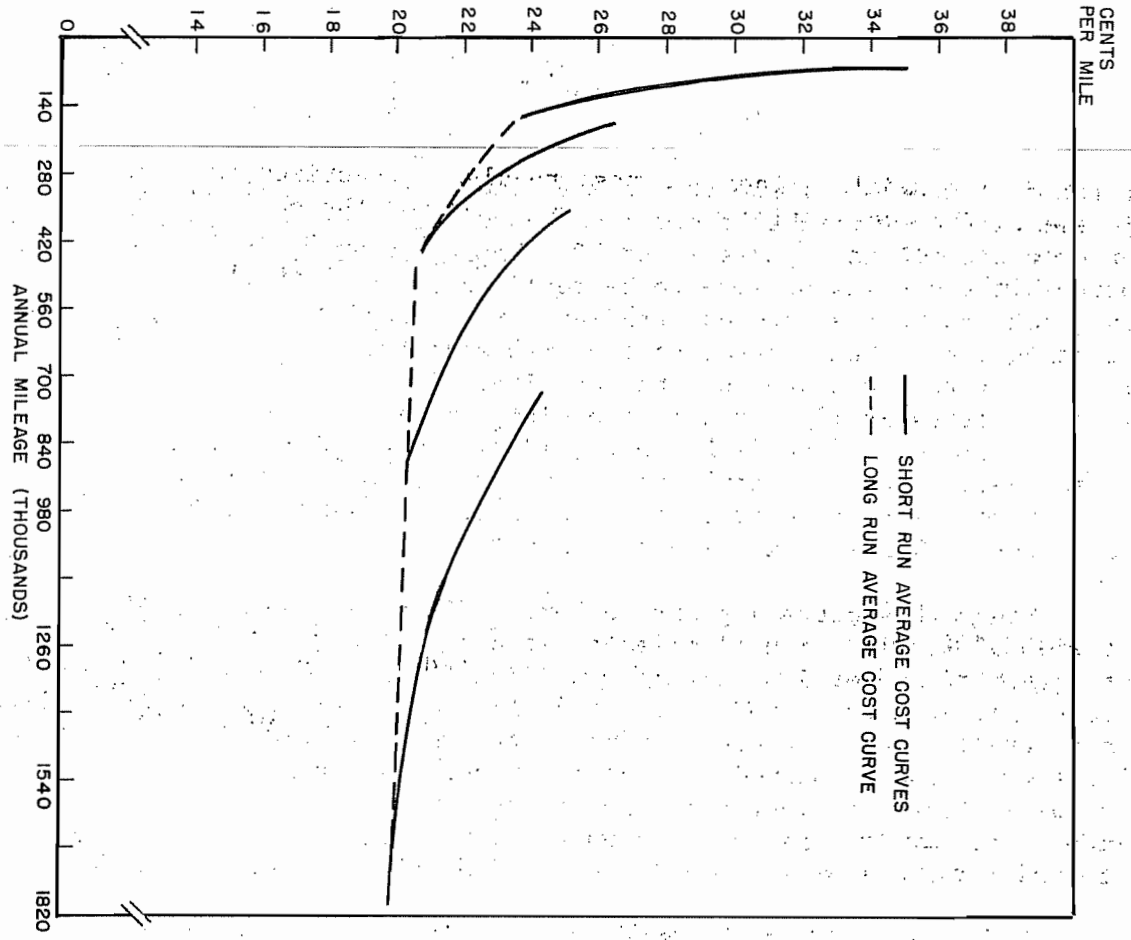iable costs were increased according to the suggestions of mechanics employed

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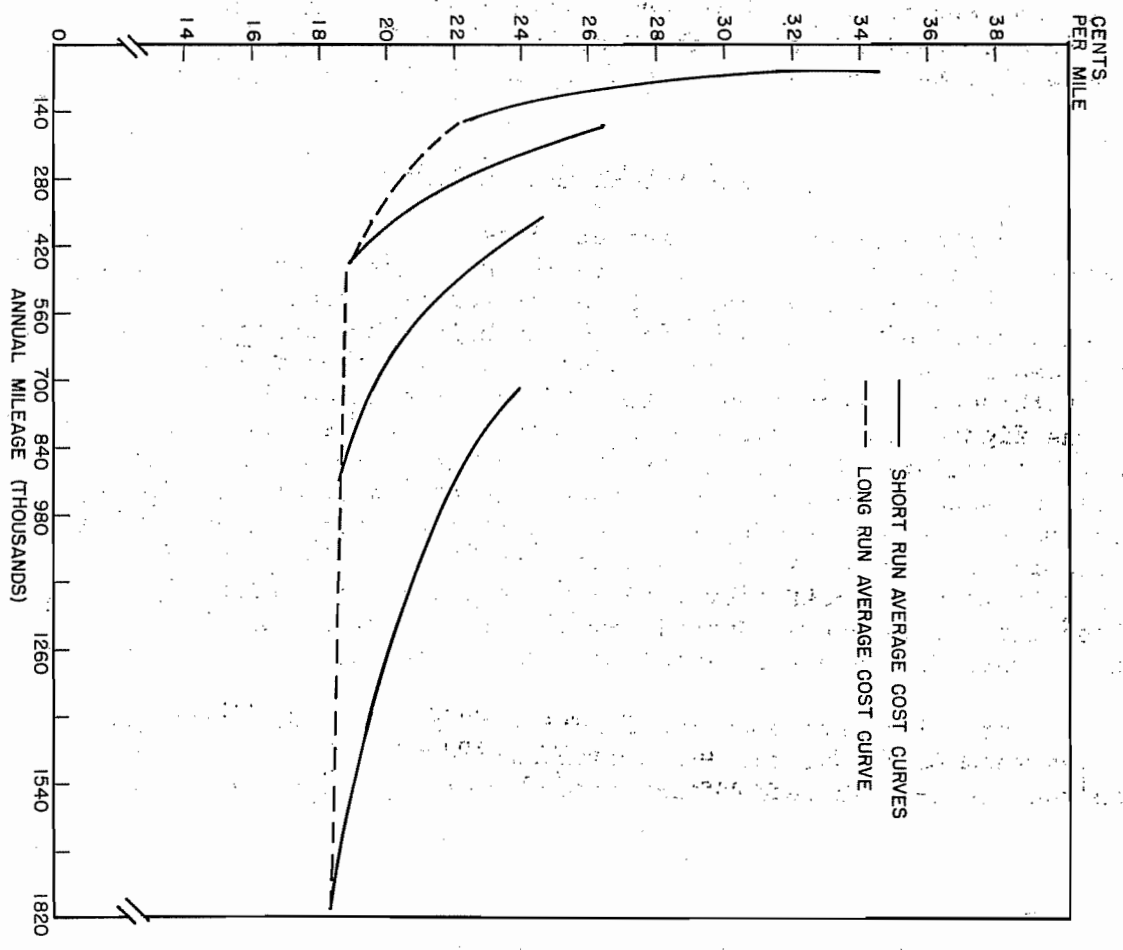

Figure 10. Annual Average Operating Costs of Model Livestock Trucking Firms, Operating Diesel Tractors, Low Investment Estimates.

TABLE 21. ANNUAL OPERATING COSTS OF A LIVESTOCK TRUCKING FIRM, NEW AND USED
EQUIPMENT, THREE TRACTOR-FOUR TRAILER, GASOLINE MODELS, 100 PER CENT CAPACITY

Cost Components	New	Used[a]
	dollars	
Fixed Costs		
Depreciation	4,200	2,688
Interest	2,850	1,400
Telephone	120	120
Taxes	120	120
Insurance	530	530
License	2,565	2,000
Utilities	600	600
Return to Management	6,500	6,500
Total Fixed Costs	17,612	14,085
Variable Costs		
Fuel Tax	11,200	12,050
Fuel	22,400	25,050
Maintenance	6,100	12,000
Tire Tax	900	900
Telephone	900	900
Drivers' Wages	22,500	22,500
Mechanics' Wages	---	---
Tire Costs	11,250	11,250
Total Variable Costs	75,250	84,650
Total Costs	92,862	98,735
Average Fixed Cost Per Mile	.0391	.0313
Average Variable Cost Per Mile	.1672	.1881
Average Cost Per Mile	.2063	.2194

[a]Used tractors priced at $2,500 each; used trailers at $4,000 each.

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.[32]

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

The average total variable costs were raised from 16.72 cents per mile to 18.81 cents per mile. This increase more than offset the decrease in average fixed costs, resulting in an average total cost of 21.94 cents per mile for the used equipment at 100 per cent of capacity utilization, 1.31 cents above the 20.63 cents per mile operating cost for the new equipment model. 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 22). The difference is smaller due to the higher fixed cost of the new equipment, but is still noticeable.

INDUSTRY - MODEL COMPARISONS AND IMPLICATIONS

The per mile operating costs reported by the sample firms in this study appeared to be considerably higher than those computed for the models (Table 23). The actual operating costs for the livestock firm ranged from 18.46 cents to 35.44 cents per mile with a mean of 26.55 cents and a median of 29.47 cents.

Comparing these costs with the costs of the optimum model, the low cost diesel, low cost trailer firm, appeared to indicate that there are efficiency improvements which 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. On the other hand, the North Dakota livestock trucking industry costs do compare favorably with the model costs at 45 per cent of capacity. Furthermore, by increasing their level of capacity utilization to 100 per cent they can actually realize costs slightly lower than the models (Table 23). 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. In order to reach optimum efficiency the North Dakota livestock trucking firms 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.[33] 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 the 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 .33 of a cent while the decrease from Model I to Model IV was 3.78 cents. At the 45 per cent level of capacity the decrease in costs was larger. The industry firms had a decrease of 1.92 cents compared to the model's decrease in costs of 7.02 cents. As shown by this data, the industry firms actually are 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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[33]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 23. 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)	26.88	18.54	Model I (One Tractor– One Trailer)	29.42	22.06
Group II (4-7 Units)	26.24	18.31	Model II (Three Tractors– Four Trailers)	24.63	18.77
Group III (Over 7 Units)	26.14	18.21	Model III (Six Tractors– Eight Trailers)	23.49	18.54
All Firms	26.56	18.49	Model IV (Twelve Tractors– Sixteen Trailers)	22.40	18.38

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

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TABLE 24.   ANNUAL TOTAL AND AVERAGE COSTS OF NORTH DAKOTA LIVESTOCK TRUCKERS, AVERAGE INDUSTRY FIRM SIZE, SAMPLE FIRMS, 1966

Cost Item	Costs (165,000)[a]
Fixed Costs	
Depreciation	$ 5,904
Interest	3,837
Telephone	100
Taxes	175
Insurance	1,036
License	2,375
Utilities	480
Return to Management	6,500
Total Fixed Costs	$21,007
Variable Costs	
Fuel Tax	$ 3,207
Fuel	5,050
Maintenance	2,088
Tire Tax	403
Telephone	228
Drivers' Wages	8,108
Tire Cost	3,737
Total Variable Costs	$22,821
Total Costs	$43,828
Average Fixed Cost Per Mile	.1273
Average Variable Cost Per Mile	.1383
Average Cost Per Mile	.2656

[a]Annual mileage of 165,000 per year.

The specific cost components making up the annual total and average costs for the North Dakota trucking firms are shown in Table 24. As expected, both the average fixed and average variable costs follow closely the costs assigned to the three tractor to four tractor model firm operating at 45 per cent of capacity.