CHANGING COSTS AND CHARACTERISTICS OF OPERATING MOTOR CARRIERS: A CASE STUDY OF GRAIN TRUCKING FIRMS IN NORTH DAKOTA

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Kenneth L. Casavant, Wesley Wilson
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INTRODUCTION

The performance of the motor carrier industry has been a recurrent theme in the transportation literature. The studies have sometimes conflicted in findings of the degree of economies of size and/or stability in the industry. Motor carriage of grain in North Dakota, exempted from economic regulation by Title 49, Section 10526 of the revised Interstate Commerce Act, has become increasingly important. It appears motor carriers have been quite successful in capturing grain shipments over the years since both absolute and relative (to railroad) increases have occurred in the last six years, except for the crop year, 1979-80 (Table 1).

TABLE 1. NORTH DAKOTA GRAIN AND OILSEED SHIPMENTS BY RAIL AND TRUCK.				
CROP YEAR	RAIL	TRUCK	TOTAL	TRUCK
	(thous. bu.)	(thous. bu.)	(thous. bu.)	Percentage
1974-75	221,922	53,565	275,487	19
1975-76	236,491	83,793	320,284	26
1976-77	205,129	100,783	305,912	33
1977-78	235,178	123,426	358,604	34
1978-79	271,069	185,165	456,234	41
1979-80	294,342	181,724	476,066	38

SOURCE: Gene C. Griffin, "North Dakota Grain and Oilseed Transportation Statistics, 1979-80." UGPTI Report No. 35. December 1980.

Even as motor carriers are increasing in importance to the grain shipper the competitive environment surrounding the transportation industry is undergoing substantial changes. The Staggers Rail Act and the Motor Carrier Act of 1980 created or allows a more flexible and uncertain competitive structure. These changes in regulation and competitive response may affect the performance and role of this "exempt motor carrier" in moving North Dakota grain products. These new regulatory changes, when combined with inflationary cost increases, energy cost increases, and potentially higher highway user fees creates a need for information on the cost structure and operating characteristics of the motor carrier industry serving the North Dakota grain industry. Further, examining this industry over time will allow a dynamic evaluation of the performance of a sector of the motor carrier industry.

OBJECTIVES

The general purpose of this paper was to evaluate the performance and operating characteristics of the motor carrier industry serving North Dakota. Specific objectives are:

1) To evaluate the existing grain motor carrier industry in North Dakota as to operating characteristics and stability.

2) To evaluate the changes in this industry over a 15 year period.

3) To develop implications for performance and viability in the future.

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DATA SOURCE

The primary source of data for this paper was a mail survey of selected motor carriers carrying North Dakota grain conducted in late 1980. Surveys were sent to 744 known carriers with 144 or 19 percent returning questionnaires. Of these 144, 75 or 52 percent contained enough completed information to develop costs and operating characteristics.

The availability of two previous cost studies, when added to this recent study, allowed a unique opportunity to trace changes in characteristics of the industry over time, thus giving an insight into industry viability and competitive capability. The two previous studies were (1) Casavant, Ken L. and David Nelson, An Economic Analysis of the Costs of Operating Grain Trucking Firms in North Dakota, Agricultural Economics Report #54, North Dakota State University, Fargo, North Dakota, July 1967, and Cosgriff, John G., The Cost and Operations of Exempt Motor Carriers in North Dakota, UGPTI Report #33, North Dakota State University, Fargo, North Dakota, November 1978. The three data sets are then for the years 1966, 1978, and 1980, a span of 15 years.

SURVEY RESULTS (1980)

The characteristics reported in this paper are based upon responses collected from trucking firms operating as interstate agricultural carriers in North Dakota during 1980. The responses were collected from two mailings. Test statistics were performed on several key variables, e.g., annual miles, ton miles, number of tractors, etc., to test for

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potential survey bias.* Results indicated no severe bias and the responses from the two mailings could be pooled, without adjustment, and the pooled data can tentatively and reasonably be identified as characteristics of the entire population and industry.

FIRM SIZE AND CONCENTRATION

The motor carriers were segmented into three size strata, owner-operator (one tractor), medium-sized firms (two to four tractors, and large firms (five or more tractors). Almost 50 percent or 37 of the firms were medium size, compared to 37 percent and 13 percent for the owner-operator and large firms respectively (Table 2). The larger firms traveled more annual miles per firm, over 1 million, as expected, but also obtained more mileage per vehicle per year, over 90,000 miles, than did the smaller size firms (Table 3). Owner-operator vehicles traveled an average of 87,000 miles, quite close to that realized by the medium sized firms.

TABLE 2. MOTOR CARRIER SIZE RESPONDENTS.		
CATEGORY	# OF FIRMS	PERCENTAGE
Owner-Operators (1 tractor)	28	37
Medium (2-4 tractors)	37	49
Large (5 or more tractors)	10	13
All firms	75	100%

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* The t-statistic formula is given below:

$$t = \frac{\overline{x}_1 - \overline{x}_2}{{}^{s}DX}$$

Where: $\overline{x}_1$ is the mean on the first mailing,
$\overline{x}_2$ is the mean on the second mailing,
${}^{s}D\overline{X}$ is the standard error of the difference
between two means.

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TABLE 3. AVERAGE YEARLY FIRM MILEAGE AND YEARLY VEHICLE MILEAGE, BY FIRM SIZE.		
SIZE	PER-VEHICLE (ANNUAL MILES)	PER-FIRM
Owner-Operators	87,379	87,379
Medium	88,261	234,347
Large	90,180	1,130,200
All Firms	88,188	298,926

A noticeable degree of concentration in loaded mileage exists (Table 4). The largest firm captured almost 15 percent of the mileage in this sample while the largest four firms had almost 40 percent of the mileage. Significantly, the largest 20 of the 75 firms had over 70 percent of the total loaded mileage, leaving 30 percent of the loaded mileage for the other 55 firms. Although this ratio may appear high, the geographical and seasonal dispersion and extreme mobility of the motor carrier industry in North Dakota probably negates the perceived market power associated with such concentration ratios.

TABLE 4. DISTRIBUTION OF LOADED MILES BY SELECTED CONCENTRATION STRATA.		
# OF CARRIERS	LOADED MILES	PERCENTAGE
Total	16,417,463	100%
Largest	2,500,000	15.2
Largest Four	6,480,000	39.5
Largest Eight	9,317,750	56.8
Largest Twenty	11,699,169	71.3

BACKHAUL AND TRADE AREAS

The ability to get loads in both directions of a movement has a strong impact on firm efficiency and competitive ability. There appears to be significant market economies available to large firms since this size category has 59 percent of their return mileage loaded or 80 percent of total miles loaded (Table 5). Owner-operators and medium sized firms had only 24 and 25 percent of their return trip mileage loaded respectively.

TABLE 5. TOTAL AND RETURN MILES TRAVELED, LOADED AND UNLOADED, BY FIRM SIZE.		
	PERCENT LOADED MILEAGE	
SIZE CATEGORY	RETURN TRIP	TOTAL MOVEMENT
Owner-Operators	24	62
Medium	25	63
Large	59	80
Industry	29	65

Another indication of the success and or activity level of motor carrier firms is the area from which loads are generated and the average length of haul. The average trade area served was a radius of 310 miles with a tremendous difference between small and larger firms (Table 6). The medium size firms averaged only 216 miles as a radius while the large firms averaged 721 mile radius for a market area, almost three times larger than the other firms.

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TABLE 6. TRADE AREA SERVED BY RADIUS, BY FIRM SIZE.	
FIRM SIZE	**TRADE AREA SERVED (MILES)**
Owner-Operators	275
Medium	216
Large	721
Industry	310

The location of the firm affects the length of haul but this variable also indicates the trade area served by the firm. As indicated in Table 7, larger firms have a substantially longer length of haul, 635 miles, compared to 434 and 469 miles for the owner-operator and medium size firms, respectively.

TABLE 7. AVERAGE LENGTH OF HAUL, BY FIRM SIZE.	
FIRM SIZE	**TRIP MILEAGE**
Owner-Operators	434
Medium	469
Large	635
Total	478

LENGTH OF TIME IN BUSINESS

One measure of the performance of the motor carrier industry is the stability of the firms in the industry as measured by the length of time a firm had been in business at the time of the survey. As indicated in Table 8, the average age of these motor carriers was 8½ years. Seventy-eight percent of the firms had been in business for five years or more and over one-third had been in the trucking business for over ten years.

Larger firms, as could be expected, were much more stable than the small firms. For example, 80 percent of the larger firms had been in business for ten or more years compared to 28 and 25 percent for the owner-operator and medium size firms. In every age category, the larger firm was more stable than its smaller competitors.

TABLE 8. LENGTH OF TIME IN BUSINESS, BY FIRM SIZE, BY PERCENTAGE.				
YEARS	OWNER-OPERATORS	MEDIUM	LARGE	ALL
	PERCENT			
Five or more	71	78	100	78
Ten or more	25	28	80	34
Fifteen or more	7	8	40	12
Twenty or more	4	6	30	8
Average Life in Years	7.5	8	13.5	8.5

COST ANALYSIS

The approach to cost analysis was twofold: (1) develop econometric models of the data that define interrelationships between output measures and cost components, and (2) use the economic-engineering method to determine cost relationships for a typical firm.

Economic Analysis

Average total costs per mile were developed for the industry and each of the size categories for total miles, gross ton-miles, net ton-miles, and hundredweight miles. (For a complete discussion of the regression models and structural equations used, see Wilson, Wesley, Gene Griffin, and Ken Casavant, Costs and Characteristics of Operating Interstate Motor Carriers of Grain in North Dakota. UGPTI Report #46, North Dakota State University, Fargo, North Dakota, September 1982.) These costs are indicated in

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Table 9. It is evident that the larger firms experience slightly lower costs per mile (90 cents) on all quantities of output variables, than do smaller firms. The owner-operator firms had a per mile operating cost in 1980 of about 94 cents compared to 92 cents for the medium sized firm.

TABLE 9. ESTIMATED AVERAGE TOTAL COSTS PER MILE, BY FIRM SIZE, 1980.				
REGRESSION NUMBER	INDUSTRY	OWNER OPERATOR	MEDIUM	LARGE
	CENTS PER MILE			
5	91.05	94.30	91.86	89.89
6	91.07	94.12	92.05	89.99
7	91.20	93.92	92.20	90.21
8	91.20	93.92	92.20	90.21

Economic-Engineering Analysis

The economic-engineering approach to cost determination involves synthesizing trucking firms under varying operating characteristics. Cost estimates are obtained by interviewing local equipment dealers, tire dealers, etc. From the assumed operating characteristics (usually derived from a survey) costs for a "typical" trucking firm may be calculated. The model costs here are for a three tractor-four trailer firm approximating the average firm identified in the survey of North Dakota truckers.

Total fixed costs per year were identified at $104,610 including depreciation, interest on investment, license fees, insurance, housing, and management. Variable costs were identified as 52 cents per operating mile, including tires, fuel, maintenance, and labor.

Total trucking costs decrease as annual mileage increases (Table 10). Average per mile costs were estimated at $1.22 when the firm travels only 150,000 miles (50,000 per vehicle), per year. If mileage per firm is increased to 450,000 (150,000 per vehicle), costs decrease 39 percent, to $.75 per mile.

The level of variable costs developed in the economic-engineering technique is substantially lower than that econometricly estimated, 56 percent compared to over 76 percent. However, since depreciation can more correctly be assigned as a function of miles than time, as was assumed in this technique, it is appropriate to consider depreciation expenses as a variable or out-of-pocket expense. This increases the variable cost estimate to 74 percent of total costs, substantially closer to the econometric estimate.

TABLE 10. ANNUAL MILEAGE AND TOTAL TRUCKING COSTS.		
NUMBER OF MILES		
FIRM	VEHICLE	TOTAL COSTS PER MILE
150,000	50,000	$\dfrac{150{,}000\ (\$.52) + \$104{,}610}{150{,}000} = \$1.22$
225,000	75,000	$\dfrac{225{,}000\ (\$.52) + \$104{,}610}{225{,}000} = \$\ .98$
300,000	100,000	$\dfrac{300{,}000\ (\$.52) + \$104{,}610}{300{,}000} = \$\ .87$
450,000	150,000	$\dfrac{450{,}000\ (\$.52) + \$104{,}610}{450{,}000} = \$\ .75$

INDUSTRY CHANGE OVER TIME

The dynamic nature of the motor carrier industry is evident when examining various economic constructs over time. This section of the paper reports on stability, equipment utilization, and backhaul experience.

The stability of the industry can be evaluated by examining industry for the three time periods as indicated in Table 11. It appears that while stability of the industry may have increased in the last five years, it had significantly decreased from 1966 to 1976 and is still less mature than in 1966. This decrease in maturity, evident throughout the age distribution, was probably caused by new firms entering in the industry during the 1966-76 period. Obviously, since we do not know anything about those firms who entered and exited within the time period, a definite statement cannot be made.

TABLE 11. LENGTH OF TIME IN BUSINESS, THREE TIME PERIODS.			
LENGTH OF TIME	**1966**	**1976**	**1980**
5 years or more	88	62	78
10 years or more	70	36	34
15 years or more	44	22	12
20 years or more	30	13	8
Average (years)	Not Available	9	8

An indication of efficiency and equipment utilization is the annual mileage attained by firms or vehicles. As shown in Table 12, the utilization of equipment has increased steadily over time, increasing from 61,400 miles in 1966 to 88,188 miles in 1980. Total firm mileage also increased from 1966 to 1980, going from 222,000 miles to almost 299,000. In both of these two time periods the average firm size was a three tractor-four trailer firm.

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Another measure of efficiency of market economies is the amount of backhaul mileage that a trucking firm is able to find loads for. The ability of firms to find backhauls appears to have varied over the years (Table 13). The percent of loaded backhaul mileage has increased from 24 percent in 1966 to 29 percent in 1980. The decrease in rate to 20 percent in 1976 suggests that as new firms entered the market, corresponding to the finding on stability, they were less successful in finding backhaul loads. These data also suggest that more mature firms are more capable of increasing loaded backhaul percentage. This is supported by the larger (mature) firms which, in 1980 were able to load 59 percent of return movements compared to medium and small firms which averaged 25 and 24 percent, respectively (Table 5).

TABLE 12. PERCENT OF RETURN TRIP LOADED, THREE TIME PERIOD.	
TIME PERIOD	PERCENT
1980	29
1976	20
1966	24

Implications and Future Viability

The results of the 1980 study indicate at that time exempt motor carriers were more stable than those of 1976, and slightly less than those of 1966. In addition, the truckers appear to have been responsible to a changing cost structure and marketing environment in that they have become more efficient, with greater backhauls and greater utilization of equipment. These factors would suggest favorable implications of the long run viability and performance of the industry. In addition, the viability of the larger firms appears to be enhanced by internal and external economies. However, the viability of the smaller firms is negatively affected by these factors and would suggest growing concentration in

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the industry. However, recent deregulation of both the railroad and motor carrier industries as well as rising capital costs and potentially rising fuel prices may have counterbalancing effects. The full effects of these factors cannot be determined which suggests that no definite statement can be made concerning the long run viability of the exempt trucker.

SUMMARY AND CONCLUSIONS

Contrary to the previous findings of several studies of motor carrier economies, the larger sized trucking firm moving grain from North Dakota may have significant advantages over smaller firms. These advantages arise from internal scale economies. Internally the larger firms appear to have a four cent per mile cost advantage over smaller firms.

Externally, the larger firm had a significantly higher percentage of its backhaul mileage loaded, and operated in a larger trade area, associated with higher equipment utilization (more annual miles per vehicle). These factors could yield a competitive advantage in pricing that may result in even higher concentration ratios in the longer run.

The overall grain trucking industry in North Dakota appears to have become more efficient over the last five years. They have increased the annual mileage per vehicle, and the percentage of return trips that are loaded has also shown an increase from 20 percent in 1976 to 29 percent in 1980.

Finally, the industry appears to have become more mature and stable in recent years after decreasing stability during the 1966-76 period. During 1966-76 a substantial increase in entry of firms occurred but, by 1980, the larger, older firms seem to have regained market share.