AN ANALYSIS OF CATTLE TRANSPORTATION RATES CHARGED BY KANSAS TRUCKERS

by

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CHAPTER I

INTRODUCTION

The cattle industry has been of great importance to the state of Kansas for many years. It has recently become the state's largest industry with sales of cattle and calves accounting for an average of 43 per cent of farmer's cash receipts.[1] Production of cattle increased from 4,429,000 head in 1960 to 5,564,000 head in 1969.[2] Cattle marketed for slaughter increased 97.65 per cent during this same period. There are essentially three reasons for this tremendous growth in the Kansas cattle industry. They are: (1) the development and wide acceptance of hybrid grain sorghums which have increased the amount of feed available for livestock, (2) the increased use of irrigation in the state which provides a stable feed supply in many counties and (3) the expanding demand for high quality beef. Irrigated cropland in Kansas totaled 1.2 million acres in 1966 and is projected to exceed 2.8 million acres in 1980.[3] Erickson and Phar estimated that in 1968 enough grain and forage was produced in Kansas to feed the equivalent of 4,976,500 head of cattle for 120 days.[4] Based on this estimate Kansas has the potential

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[1]Kansas State Board of Agriculture, Farm Facts 1968-69.

[2]Kansas Crop and Livestock Reporting Service, "Annual Livestock Report", Kansas State Board of Agriculture 1961 and 1970.

[3]Donald B. Erickson and Phil Phar, Guidelines for Developing Commercial Feedlots in Kansas, Dept. of Economics, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, p. 11.

[4]Ibid., p. 15.

to substantially increase its production of grain fed cattle beyond the nearly 1,450,000 head marketed in 1968.[5]

Kansas cattlemen realizing this potential for beef production began taking advantage of production opportunities along with new technology by constructing large feedlots capable of handling many thousands of head of cattle at one time. In 1969, 67.4 per cent of all cattle on feed were in lots with capacities in excess of 1,000 head (Table 1). The estimated average total capacity of lots of over 1,000 head increased from 240,000 head in 1962 to just over one million head in 1969. In 1969 less than 1.4 per cent of the feedlots accounted for over two-thirds of all grain-fed cattle marketed.[6] This represents a decline of about 7.8 per cent per year in the marketings of the small, on-the-farm feeders for the period 1962-69. Instead of a farmer raising calves and feeding them to slaughter weight, the calves are now being sent to large commercial feedlots for fattening. With the increased capacity of feedlots local production of feeder cattle has not been sufficient to satisfy feedlot demand. Indications are that cattle are beginning to move into Kansas from considerable distance for feeding and eventual slaughter (Table 2). Continued development of the livestock and related industries may be influenced significantly by the conditions under which transportation services are provided. Minimizing costs of moving cattle through efficient use of transportation modes and appropriate transportation regulation is in the interest of society and likely to be of specific benefit to Kansas cattle feeding and slaughtering industries.

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[5]Kansas Crop and Livestock Reporting Service, "Kansas Cattle Marketing Statistics", Kansas State Board of Agriculture, 1964-1969.

[6]Ibid., 1968.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

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Table 1.--Total Number of Cattle on Feed in Kansas By Quarter, 1958-1969, (1000 head)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1 January	180	234	275	337	383	443	447	451	480	586	610	766
1 April	175	209	237	289	317	391	421	342	484	521	507	650
1 July	153	157	168	196	225	296	312	311	463	402	421	618
1 October	222	225	230	263	291	364	373	321	476	468	570	745

Table 1a.--Per cent of Total Cattle on Feed in Lots of 1,000 Head or More Capacity

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Total	26.8	28.9	32.6	36.7	40.4	52.2	53.2	55.3	63.1	67.4

Source: Kansas Crop and Livestock Reporting Service, "Kansas Cattle Marketing Statistics", Kansas Dept. of Agriculture, December, 1969, p. 9.

Table 2.--Cattle Shipped into Kansas by State of Origin, 1964-1968, (1000 Head)

	1964	1965	1966	1967	1968
Oklahoma	391.9	475.5	479.0	429.1	469.5
Texas	312.4	321.1	352.5	373.2	316.3
Missouri	174.9	215.9	199.9	171.5	173.2
Colorado	121.0	115.4	148.1	136.4	162.9
Arkansas	61.2	106.4	107.0	106.4	119.3
New Mexico	99.0	91.2	100.1	74.6	108.4
Mississippi	49.3	89.3	82.8	88.0	100.8
Alabama	48.4	69.1	60.3	62.5	92.5
Nebraska	40.7	46.8	34.1	35.8	37.9
Louisiana	17.5	37.5	44.9	47.1	34.8
Tennessee	5.3	18.1	15.1	15.3	24.4
Kentucky	8.7	12.1	6.9	3.5	8.5
Wyoming	10.3	11.9	13.4	8.3	13.3
Arizona	7.6	7.2	5.9	5.6	5.9
Montana	3.3	6.6	13.8	8.5	11.4
Other States & Canada	25.5	37.8	40.3	35.2	10.8
Total	1377	1662	1704	1601	1690

Source: Kansas Crop and Livestock Reporting Service, "Kansas Cattle Marketing Statistics," Kansas Department of Agriculture, December, 1969, p. 7.

Motor carriers are the principal carriers of livestock. In 1968, trucks hauled 94.4 per cent of all cattle and 94.9 per cent of all calves delivered to major markets in the United States.[7] Motor carrier rates are not regulated on interstate hauls, consequently published rates are not available. Data on trucking rates are not available from secondary sources. There is essentially no published information on interstate livestock shipments or on rates charged. Rates charged by for-hire carriers on interstate hauls provide an accurate determination of the cost of moving cattle by truck. Lack of regulation of entry into trucking plus cost economies for the industry that embody very small economies of scale, if any, result in a highly competitive industry in which rates charged are highly indicative of costs, taking into consideration conditions of terrain, roads, availability of backhaul and other conditions which affect the cost of providing the primary livestock haul.

Objective

Transportation plays a vital role in the Kansas cattle industry and is one of the major marketing costs. Transportation costs can drastically affect the relative competitive position of Kansas livestock producers with respect to other producing areas. Transportation has influenced the development of the marketing organization and structure and the location of marketing facilities used by the cattle industry. If the Kansas cattle industry is to continue to expand it will require the movement of feeder

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[7] American Trucking Trends 1969, Dept. of Research and Transportation Economics, American Trucking Association, Inc. Washington, D. C. 1969, p. 21.

cattle into the state from greater distances. Transportation cost and the price spread between feeder and fat cattle may well be the factors which determine the extent of the area from which feeder cattle will be drawn to Kansas.

With these facts in mind, the objectives of this study are: (1) to examine and describe the structure of existing truck rates for interstate and intrastate movements of cattle, (2) to develop characteristic rate functions for livestock hauls based on those factors which may influence rates, such as distance hauled, net weight of the cattle hauled, number of head hauled, type of equipment used and other factors, (3) to compare Kansas intrastate rates with the regulated rates of surrounding states and with the rate functions developed for interstate hauls, (4) to compare the cost of interstate movement of cattle by truck with similar movement by rail, and (5) to determine the distance feeder cattle can profitably be moved given the price margins between potential sources and local sources of feeder cattle and the price margin between feeder cattle and slaughter cattle.

This study will also provide information necessary for further study of the beef cattle industry in Kansas. Although about 95 per cent of all cattle movement is by truck there is very limited information available on the rates charged for or the rate structure of interstate livestock hauls by Kansas truckers. A knowledge of transportation rates is essential in determining if a community has an economic advantage for the location of segments of the cattle industry. Other things being equal, feedlots and packing plants, for example, will locate where they can minimize total transport cost. The ability to estimate transportation

rates can assist regional and community planners as well as potential investors in determining the optimal location of various sectors of the cattle industry.

The location of a commercial feedlot and/or packing plant in a community can mean many additional jobs and millions of dollars of new cash flow. A 10,000 head capacity commercial feedlot in one Kansas community added twenty new jobs and developed a monthly cash flow of nearly $3 million.[10]

This study can also be used as a source of information by shippers and truckers in negotiating rates. Alternative modes of transporting cattle can be compared as well as rates on similar hauls, in other words, individual parties in specific contract situations of interstate hauls can benefit through more complete knowledge of rates and rate structures.

Many commercial truckers hauling livestock operate in a mixed regulatory environment. Section 203, (b) (6) of the Motor Carrier Act of 1935 specifically exempts motor carriers hauling livestock interstate from economic regulation. Rates in Kansas are currently regulated by the Kansas Corporation Commission under the provisions of the Kansas Motor Carrier Association, Agent, Motor Freight Tariff 50-C, KCC No. 62 which was effective February 15, 1970.

This study can be of help to such regulatory agencies. The objective of regulating an industry, such as the livestock trucking industry, is to protect both the shipper and the trucker from wildly fluctuating rates, ruinous competition, and unfair practices. To effectively regulate the

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[10]Frank Lessiter, "Cooperatively-Owned Feedlots Can Be a Boom to Your Town," National Livestock Producer, Vol. 49, Jan. 1971, No. 3, p. 6.

trucking industry, the regulatory agency must know the rate structure as it exists in a competitive environment. The results of an essentially purely competitive model, such as the one in this study for interstate rates, could be used by regulatory agencies in "zeroing in" on their objectives of effective and fair regulation.

Procedure and Method of Analysis

Data on interstate shipments of livestock by truck was obtained by personal interviews with a select sample of thirteen livestock trucking firms headquartered in Kansas. The firms selected were recommended by Mr. George Hutchins, Tariff Manager for the Kansas Motor Carriers Association, as ones who did a considerable amount of interstate hauling and who were located in all areas of the state. In all cases the owners and/or managers of the firms interviewed allowed the author to take information direct from shipping tickets and records of actual interstate hauls made by the firm in 1970.

Intrastate truck rates and tariff schedules in effect in 1970 were obtained from the Motor Carrier Associations in Kansas, Colorado, and Oklahoma. Data on intrastate truck shipments for Nebraska and Missouri was not available.

Railroad companies supplied data on twenty four interstate rate shipments of cattle to and from points commonly used by Kansas shippers.

Interstate and intrastate truck rate data was initially analyzed using scatter diagrams and simple arithmetic means. To refine the analysis an IBM-contributed, KSU - revised stepwise multiple regression computer program was used to help explain the rate structure and to develop rate functions. Two basic models were used in performing the regression analysis.

The first model had as its dependent variable the rate charged per mile for livestock trucks and the second model used the rate charged per hundredweight as the dependent variable. Extensive variation of models and transformation of variables were made in an attempt to find those functions that best described the data. The rate functions will be discussed in detail in a later section.

CHAPTER II

REVIEW OF LITERATURE

Competition in the Livestock Trucking Industry

There are several factors which are necessary if an industry is to be considered competitive. First, the product of that industry must be the same for all firms. Second, there must be enough producers and consumers that no one of them can influence the market. Third, there must be free entry and exit from the industry, in other words, there must not be economies of size such that a new entrant would be unable to compete with established firms.

The livestock trucking industry meets these criteria. The service all trucking firms sell is essentially the same, the movement of livestock. There will be some differences in the quality of this service but not to the extent that it could lead to monopoly type actions by one firm.

There are certainly enough trucking firms in operation that no single firm can influence the price of its service to the point that it makes unreasonable profits normally associated with unregulated monopoly. In Kansas there were nearly 400 farm to market carriers in 1968, any one of whom could easily convert to haul livestock if he did not already. In addition there were nearly 177,000 farm trucks registered in Kansas in 1969. A large number of these trucks could also haul livestock. Also truckers based in other states compete with Kansas truckers for interstate hauls into and out of the state.

Entry and exit from this industry is relatively free. There is no economic regulation on trucking firms engaged in the interstate transportation of livestock and no limitations to entry other than normal fees and

registrations for operation that apply to all firms. Casavant and Nelson in a study of the cost of operating livestock trucking firms in North Dakota found that economies of size in livestock trucking firms were realized at about 450,000 miles of annual operation. Thus a new firm could achieve economies of size as readily as an established firm.[1] They also found that excess capacity existed in the industry. This was attributed to (1) seasonality of the commodity hauled and (2) saturation of the local trade areas. These facts indicate that there is a high degree of competition in the livestock trucking industry. However, Casavant and Nelson also concluded that there was a substantial degree of stability in the industry when measured by length of time in business and that there did not appear to be excessive competition nor an entry or exit rate into or out of the industry that indicated such.

Another result of this study was that the cost of operation, which ranged from 18.46 cents to 35.44 cents per mile, decreased rapidly as the number of miles hauled by the firm increased.[2] If it is assumed that rates charged follow costs, and they would in a competitive industry, then the results found by this author are in general agreement with those found by the Casavant and Nelson in that rates per mile were found to follow the same pattern.

Regulation of Livestock Truckers

The Interstate Commerce Act, the Motor Carrier Act of 1935, and the Transportation Act of 1958 along with numerous other laws, agency rulings,

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[1]Kenneth L. Casavant and David C. Nelson, "An Economics Analysis of the Costs of Operating Livestock Trucking Firms in North Dakota," Department of Agricultural Economics, Agriculture Experiment Station, North Dakota State University, Agricultural Economics, Report No. 55, 1967, p. V.

[2]Ibid., p. 35.

and court decisions have given livestock truckers and shippers exemption from economic regulation when hauling livestock in interstate commerce. This exemption applies to (1) farm trucks used in ordinary farm business, (2) trucks owned and operated by cooperatives, and (3) common or contract carriers that haul for compensation but carry only exempt cargo. It is with this last group that this study is concerned.

Commodities which are exempt from regulation are determined by the ICC and courts except for those listed in Ruling 107 and in the Transportation Act of 1958. Among the Commodities listed in Ruling 107 under the heading "livestock" is "Ordinary, ie. all cattle, swine, sheep, goats, horses, and mules, except such as are chiefly valuable for breeding, racing, show purposes, and other special uses - Exempt."[3]

An exempt motor carrier is not regulated as to rates or operating authority, i.e. authority to haul over specified routes or between specific points. He is regulated by the ICC and the United States Department of Transportation as to driver qualifications, maximum hours of service for drivers, safety of operation, and standards of equipment.[4] In other words, the trucker can pick up and deliver cattle anyplace in the United States so long as it is interstate at whatever rate he can get for his services.

However in addition to the ICC and DOT regulations on interstate livestock truckers, each state has its own regulations governing livestock

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[3]Willard F. Williams and Thomas F. Stout, Economics of the Livestock - Meat Industry, The MacMillian Co. New York, 1964, p. 332.

[4]Ibid., p. 333.

hauling within its boundries. Individual states have developed a myraid of laws regulating trucks traveling on their roads regardless of the state of domicile of the trucker. In order for a trucker to be legal on an interstate haul his equipment must meet the most stringent requirements of the states through which he passes and he must have the proper licenses and permits required for each state. Tables 3 and 4 show the limitations placed on size and weight of livestock trucks in selected states.

Table 3.--Size Restrictions on Livestock Trucks by Selected States 1970

State	Height Ft. in.	Width in.	Length (Feet) Semi-trailer	Full Trailer	Tractor & Semitrailer	Truck & Full-Trailer	Tractor, Semi- & Full Trailer
Alabama	13 - 6	96	NR[a]	NR	55	NR	NP[b]
Arizona	13 - 6	96	NR	NR	65	65	65
Arkansas	13 - 6	96	NR	NR	55	65	65
California	13 - 6	96	40	40	60	65	65
Colorado	13 - 6	96	NR	NR	65	65	65
Florida	13 - 6	96	NR	NR	55	55	NP
Georgia	13 - 6	96	NR	NR	55	55	55
Idaho	14	96	NR	NR	60	65	65
Illinois	13 - 6	96	42	42	55	60	65
Iowa	13 - 6	96	NR	NR	55	55	60
Kansas	13 - 6	96	42.5		55	65	65
Kentucky	13 - 6	96	NR	42.5	55	65	65
Louisiana	13 - 6	96	NR	NR	60	65	NP
Minnesota	13 - 6	96	40	NR	55	55	NP
Mississippi	13 - 6	96	NR	40	55	55	55
Missouri	13 - 6	96	NR	NR	55	65	65
Montana	13 - 6	96	NR	NR	60	65	65
Nebraska	13 - 6	96	NR	NR	60	60	65
Nevada	NR	96	NR	NR	70	70	70
New Mexico	13 - 6	96	NR	NR	65	65	65
North Dakota	13 - 6	96	NR	NR	60	60	65
Oklahoma	13 - 6	96	NR	NR	55	65	65
Oregon	13 - 6	96	40	40	60	65	75
South Dakota	13 - 6	96	NR	NR	65	65	65
Tennessee	13 - 6	96	NR	NR	55	55	NP
Texas	13 - 6	96	40	40	55	65	65
Utah	14	96	45	45	60	65	65
Washington	13 - 6	96	40	40	60	65	65
Wisconsin	13 - 6	96	35	35	55	55	NP
Wyoming	13 - 6	96	NR	NR	65	65	65

[a]NR = Not Restricted
[b]NP = Not Permitted
Source: State size, weight and speed maximums for trucks and truck trailers, automotive division, North American Rockwell Corp., Detroit, Michigan, July 1970.

Table 4.--Weight Restrictions on Livestock Trucks by Selected States* 1970

State	Axle load limits (pounds)		Maximum Gross Weight...(pounds)		
			Tractor & Semitrailer		Other Combination
	Single	Tandem	4 Axle[a]	5 Axle[b]	
Alabama	18,000	36,000	63,000	73,280	73,280
Arizona	18,000	32,000	59,000	73,000	76,800
Arkansas	18,000	32,000	59,000	73,280	73,280
California	18,000	32,000	59,000	73,280	73,280
Colorado	18,000	36,000	63,000	68,800	74,600
Florida	20,000	40,000	66,610	66,610	66,610
Georgia	20,340	40,680	70,020	73,280	73,280
Idaho	18,000	32,000	59,000	73,000	76,800
Illinois	18,000	32,000	59,000	73,000	73,280
Iowa	18,000	32,000	59,000	71,612	73,280
Kansas	18,000	32,000	59,000	73,000	73,280
Kentucky	18,000	32,000	60,600	73,280	73,280
Louisiana	18,000	32,000	59,000	73,000	73,280
Minnesota	18,000	32,000	59,000	73,000	73,280
Mississippi	18,000	32,000	59,000	73,000	73,280
Missouri	18,000	32,000	59,000	73,280	73,280
Montana	18,000	32,000	59,000	73,000	76,800
Nebraska	18,000	32,000	59,000	71,446	71,446
Nevada	18,000	32,000	59,000	73,000	76,800
New Mexico	21,600	34,320	64,920	77,400	86,400
North Dakota	18,000	32,000	59,000	64,000	73,280
Oklahoma	18,000	32,000	59,000	73,000	73,280
Oregon	18,000	34,000	63,000	73,280	76,000
South Dakota	18,000	32,000	59,000	73,000	73,280
Tennessee	18,000	32,000	59,000	73,000	73,280
Texas	18,000	32,000	59,000	72,000	72,000
Utah	18,000	33,000	60,000	75,000	79,900
Washington	18,000	32,000	59,000	68,500	76,000
Wisconsin	19,500	32,000	60,500	73,000	73,000
Wyoming	18,000	36,000	63,000	73,950	73,950

[a]2-axle tractor & tandem axle semitrailer

[b]3-axle tractor & tandem axle semitrailer

*Source: State Size, Weight and Speed Maximums for Trucks and Truck Trailers, Automotive Division, North American Rockwell Corporation, Detroit, Michigan, July 1970.

Results of Other Studies

Transportation of Cattle in the West

A western regional research committee conducting a study of livestock transportation in eleven western states used a least squares linear regression analysis to study rates charged for interstate shipments of cattle in 1963.[5] The function used was $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$ where:

Y = rates in cents per hundredweight,

X_1= distance hauled in miles,

X_2= linear length of loading space per truck in feet,

X_3= average weight per head of cattle hauled in pounds,

X_4= average net weight of load in pounds,

b_1, b_2, b_3 and b_4 are partial regression coefficients for X_1, X_2, X_3 X_4. This function was applied to rates from eight states. The results are shown in Table 5. Capener, et. al. concluded that this linear function gave a relatively good description of the data for most of the states and that variables other than distance hauled explained very little of the variation in rates charged.[6]

When Capener considered a function $Y - a + b_1X_1 + b_2X_2$ where Y is rate in cents per hundredweight, X_1 is distance hauled in miles, X_2 is linear length of loading space and b_1 and b_2 are partial regression coefficients for X_1 and X_2 respectively, it was found that the R^2 values were higher for 4 of the 9 states and slightly lower for 5 states for which data was considered. The regression coefficients for X_1 were all positive and significant at the 1% level. The coefficients for X_2 were significant in 3 states, one at the 1% level and 2 at the 5% level.

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[5]William N. Capener, William P. Stephens, James S. St. Clair, Harold Abel, "Transportation of Cattle in the West", Agri., Experiment Station, University of Wyoming, Research Journal 25, January, 1969.

[6]Ibid., p. 15.

Table 5.--Estimates of Linear Regression Parameters for Interstate Truck Rates for Hauling Cattle, Eight Western States

State	No. of Rates	a	b_1 Distance Hauled (miles)	b_2 Length of Loading Space (ft)	b_3 Avg. Weight per Head (pounds)	b_4 Total Net Weight of Load (lbs)	R^2
Colorado	147	26.5880	.1825** (.0054)	.0383 (.1702)	.0070 (.0056)	-.0007** (.0003)	.9017
Idaho	42	30.8810	.1469** (.0105)	.4098 (.9026)	.0205 (.0144)	-.0001 (.0012)	.9004
Montana	238	79.4132	.1055** (.0039)	.3973** (.1947)	-.0077 (.0051)	-.0002 (.0003)	.7790
Nevada	104	66.6834	.1973** (.0256)	2.8159 (3.2464)	.0293 (.0170)	-.0066** (.0008)	.6310
New Mexico	169	26.6415	.1964** (.0043)	.6414** (.2415)	-.0058 (.0042)	-.0019 (.0004)	.9332
Utah	59	125.1574	.1104** (.0346)	2.5645 (1.4259)	.0332 (.0291)	.0021 (.0019)	.1910
Washington	40	2.4737	.1510** (.0050)	.3188 (.2299)	.0075 (.0042)	-.0001 (.0002)	.9707
Wyoming	106	8.7380	.1990** (.0075)	1.0984 (1.9384)	.0251 (.0774)	-.0008 (.0030)	.8797
Region	905	48.6400	.1547	.5383	.0008	-.0017	

**Significant at 1% level

Source: Capener, et.al., "Transportation of Cattle in the West," p. 15.

The b_2 values were negative in some states and positive in other. Thus the length of loading space had opposite effects on rates in different states.[7] In those states for which the b_2 value was significant the value was positive thus indicating that the larger the truck the higher the rate.

[7] Ibid., p. 15.

This committee also studied the intrastate transportation of cattle in the eleven western states. Eight of the eleven states had established economic regulations on intrastate hauls of livestock. Tariff schedules were obtained from the state regulatory agencies where available and from privately published tariffs of individual trucking firms and actual hauls in states where rates were not regulated.

Regression analysis was used to study the data for each state. The model considered was $Y = a + bX$ where Y = rate in cents per hundredweight and X = the distance hauled in miles. This model was applied to two different load sizes. First it was applied to data for loads nearest to the 20,000-pounds minimum weight limit for the various states. This function gave a relatively good description of the data. The Y-intercepts were positive ranging from three cents to seventeen cents and R^2s ranged from .948 to .999. A rate of increase per 100 miles ranging from 21.82 cents to 35.69 cents was indicated by the various linear functions. All of these coefficients were significant at the one per cent level. The model was also applied to the largest minimum load classification for each state. Again the function fit the data well with 10 of the 11 R^2 equal to .95 or better. The remaining R^2 equalled .76. The Y-intercept ranged from 1.8 to 20.4 cents and b values ranged from .1660 to .2863.[8]

Capener, et. al. also tested the difference in rates charged per hundredweight on intrastate hauls and concluded that a significant difference existed at the one per cent level in 52 of the 66 between-state comparisons, six were significantly different at the five per cent level.

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[8]Ibid., p. 26.

The function $Y = a + b_1X$ was also applied to interstate rail rate data where Y = rate in cents per hundredweight and X = distance hauled in miles. Y-intercepts for slaughter cattle shipped by rail varied from 43 cents to 69 cents and the slope varied from .0640 to .0957. R^2s ranged from .77 to .978 for the 11 states.[9]

When applied to feeder cattle the function yielded similar type relationships but about 15 per cent lower than for slaughter rates.

In all, five rate functions were developed for the western region. One for interstate truck shipments of cattle, two for rail shipments and two for intrastate truck shipments for different size groups of trucks.

The functions were alike in several ways but were significantly different in values. B values for the variable, miles hauled, indicated that the rate per hundredweight increased most rapidly for intrastate truck shipments and least rapidly for rail shipments.

For distances under 125 miles, intrastate truck rates were lowest. Rates were lowest for interstate trucks relative to the others when distances of 125 to 225 miles were considered. When hauls of feeder cattle over 225 miles were considered railroads offered the lowest rates. Rail also had the lowest rates for slaughter cattle hauled over 400 miles.[10]

Economics of Transporting Idaho Beef Cattle

Lindeborg and Purnell studied the Idaho cattle industry with special emphasis on transportation.[11] Their objective was to describe and analyze

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[9]Ibid., p. 34.

[10]Ibid., p. 43.

[11]Karl H. Lindeborg and Glen R. Purnell, "Economics of Transporting Idaho Beef Cattle," Idaho Agricultural Experiment Station, University of Idaho, Bulletin 413, 1963.

the movement of feeder and slaughter cattle and to describe and analyze the rail and truck transportation rate structures for cattle and calves.

They found that the majority of cattle shipped between points in the state in 1958 moved by truck. Rates on intrastate shipment were regulated by the Idaho Public Utilities Commission. Two tariffs were in effect at the time of the study. One was based on a minimum weight of load and loaded miles traveled with the rate given in cents per hundredweight. The other rate was based on the feet of loading space and loaded miles traveled.

Data was gathered by use of a questionnaire survey sent to 750 ranchers and 272 feedlots. Responses of 35 and 38 per cent were obtained from the respective groups. Thirty commercial livestock truckers were interviewed and rail rate data was obtained from the three railroads operating in Idaho.

Three equations were developed using multiple regression techniques. The function $Y = a + b_1X_1 + b_2X_2$, where Y = cents per hundredweight, a = constant, b_1 and b_2 = regression coefficients, X_1 = length of trailer in feet and X_2 = miles hauled.

First the function was applied to intrastate rate data from the tariff based on feet of loading space and loaded miles. The resulting equation was $Y = 6.86 - 0.25X_1 + 0.31X_2$ with an R^2 of .997. The larger the truck the lower the rate per cwt charged was indicated by the negative coefficient of the length of loading space variable.

Next the function was applied to the intrastate tariff based on minimum weight and distance hauled. The resulting equation was $Y = 47.85 - 0.54X_1 + 0.14X_2$ with an R^2 of .96.

The function was then applied to data obtained from ranchers and feedlot operators. The resulting equation was $Y = 48.11 - 0.36X_1 + 0.13X_2$ with and R^2 of .75.[12]

Lindeborg and Purnell concluded that Idaho truckers engaged in interstate transport of cattle followed the tariffs set by the Idaho Public Utilities Commission and that the tariff followed was the one based on a minimum weight and loaded miles traveled.

Rates for rail and truck transportation of cattle were also compared with the results being that generally rates for trucks were lower in intrastate movement and up to 1000 miles in interstate movement. At distances greater than 1000 miles rail rates were more favorable.[13]

Interstate Transportation for Nevada Cattle

Edward R. Barmettler, working as part of the western regional committee, studied the transportation of cattle in Nevada.[14]

Four hundred shipments of cattle were studied to determine the effect that the size of the animal hauled had on weight displacement for various sizes of equipment. He found that heavier cattle displace more weight per unit of loading surface than lighter cattle. Thus the heavier cattle are more efficient in using the available loading space. The payload of the truck or rail car is greatly affected by the type of cattle transported. A truck with 55 feet of loading space was capable of holding

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[12]Ibid., p. 30.

[13]Ibid., p. 25.

[14]Edmund R. Barmettler, "Interstate Transportation for Nevada Cattle," Max, C. Fleischmann College of Ag., U. of Nevada, Bulletin 234, 1964.

33 head of 1250 pound cattle for a net weight of about 41,250 pounds but a truck of 71 feet of loading space would be needed to hold enough calves to get the same net weight.[15]

Barmettler also studied the relationship of cost of transportation to the price of cattle. The relationship between purchase price plus transportation cost divided by the selling price and the quotient subtracted from one hundred gave the per cent margin that the selling price had to be above the purchase price to pay for transportation. This margin is relatively large at low prices and decreases as prices increase. Therefore Barmettler concluded that the transportation cost and the price relationship work to limit the distance from which a particular market will draw cattle.[16]

The transportation rate most commonly found for the period 1956-1960 was 65 cents per loaded mile for equipment with 50 feet of loading space. Transforming this rate into a rate per hundredweight for fat cattle and for calves and comparing them with actual rail rates, Barmettler found that rates were lower on fat cattle hauled by truck up to 650 miles and lower on calves hauled by truck up to 525 miles than when hauled by rail over those distances.[17]

It was also concluded that Nevada shippers have an advantage in moving cattle by truck because trucks generally had a relative distance traveled advantage over rail as well as a definite advantage in transit time.

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[15] Ibid., p. 20.

[16] Ibid., p. 27.

[17] Ibid., p. 31.

Cattle Transportation in Washington

In studing the transportation of cattle in Washington, J. B. Wyckoff found that costs of operating farm trucks capable of hauling 12,000 pounds ranged from four cents per hundredweight on a 10-mile haul up to 92 cents per hundredweight on a 300-mile haul. Converted to cents per mile the range would be 48 to 37 cents per mile hauled.[18] The cost for commercial haulers, using equipment capable of carrying 22,000 pounds was found to be about 42 cents per mile.[19]

Shrinkage during movement was considered by Wyckoff also. He found that fat steers lost 3% of their body weight during the first 100 miles hauled and about 1.03% for each additional 100 miles up to 300 miles. During the period April to August shrinkage averaged about one per cent more than during other times of the year.[20]

In comparing truck and rail hauling of cattle Wyckoff listed the following advantages for each mode:[21]

Truck

1. Availability at ranch headquarters.
2. Availability at any time.
3. Faster service.
4. Generally lower rates on short hauls.

Railroads

1. Good facilities for loading, handling, feeding and rest stops on long hauls.
2. Grazing or feeding (transit) privileges.
3. Market testing privileges.

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[18] J. B. Wyckoff, "Cattle Transportation in Washington," Washington Agricultural Experiment Station Bulletin 636, April 1962, p. 11.

[19] Ibid., p. 17.

[20] Ibid.

[21] Ibid., p. 25.

Montana Livestock Transportation

Harston and Richard found that in Montana, where intrastate rates are not regulated, the rate per mile did not show any definite relationship to distance and that there were extreme variations in rates charged.[22] This was attributed to extensive negotiations that occurred between shippers and truckers.

However, for interstate shipments it was found that rate per ton-mile decreased as distance increased. The rates decreased rapidly as distance increased to about 250 miles and then decreased more slowly. Rail rates followed this same pattern but leveled off at about 900 miles. Harston and Richards concluded that trucks had to compete with rail shipments on interstate hauls, therefore the rate patterns were the same.[23]

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[22]Clive R. Harston and Jack Richards, "Montana Livestock Transportation," Agricultural Experiment Station., Montana State College, Bulletin No. 592, April 1965.

[23]Ibid., p. 22.

CHAPTER III

INTERSTATE HAULS OF CATTLE BY KANSAS TRUCKERS

Characteristics of the Kansas Livestock Trucking Industry

In 1968 three hundred ninty-nine trucking firms filed statistical reports with the Kansas Corporation Commission as farm to market carriers hauling agricultural commodities both intrastate and interstate. These carriers reported that 64 per cent of their revenue from trucking operations came from other than Kansas intrastate hauls. Twenty-one of the farm to market carriers reported gross revenue greater than $200,000 for 1968 with 78 per cent of it coming from other than hauls within Kansas. Thirty carriers reported gross revenues of $110,001 to $200,000 with 56 per cent coming from other than intrastate hauls in Kansas.[1]

The two groups (51 trucking firms) with gross revenue over $110,000 accounted for 84.5 per cent of the total revenue reported from other than Kansas intrastate hauls. They accounted for 56.2 per cent of all intrastate revenue reported and 74.4 per cent of total revenue reported.

From these facts we can conclude that less than 8 per cent of the carriers certified as farm to market carriers did the majority of interstate hauling for hire of agricultural commodities that was done by Kansas carriers.

Eight of the thirteen trucking firms that provided data for this study were in the group of 51 firms which had gross revenue of more than $110,000. Five of the firms interviewed had gross revenues of

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[1]Statistics furnished by the Kansas Motor Carriers Association, Inc., Topeka, Kansas.

greater than $200,000 in 1968 and three had gross revenues of $110,000 to $200,000 for 1968. This represents a 24 per cent and 10 per cent sample respectively of these two groups.

The thirteen firms interviewed varied considerably in time in business and size. The firms' time in business ranged from five years for a corporately-owned firm to forty-nine years for a family-owned and operated firm. The average time in business was 21.7 years. Size of the firm was measured by the number of livestock semi-trailers used by the firm. The number of trailers ranged from 5 to 25 with an average of thirteen.

All of the firms interviewed used drop center type semi-trailers that were 40 to 42 feet long. These trailers, commonly called "pots" or "possum bellies", are capable of being double decked to give from 60 to 68 feet of loading space. The size of the cattle, being hauled determines the amount of the trailer that is double decked. If mature cattle, cows or slaughter cattle, are being hauled normally only that portion of the trailer above the drop center can be double decked. This gives about 60 feet of loading space which is room enough to haul 35 to 40 head. A load of this size brings the truck very near the maximum legal weight limit in Kansas. When hauling calves or other light-weight cattle the front and rear ends of the trailer as well as the area over the drop center can be double decked giving approximately 68 feet of loading space. This allows the truck to carry over 100 head of calves which also brings the gross weight near the legal maximum.

In addition to the "pots" ten of the thirteen firms also used floor trailers. These are semi-trailers which normally cannot be double decked.

The loading space in this trailer depends on it's length. Those used by firms in this study varied from 40 to 45 feet of linear loading space. This size truck commonly hauls about 25 head of mature cattle and about 70 head of calves.

Of the 169 trailers operated by firms interviewed in this study only 37 of them were floor trailers with the remainder being the drop center "pot" trailers. Several of the truckers indicated that they used the floor trailers on relatively short hauls and to accommodate shipments that were too small for a pot trailer and too large for a straight truck.

All of the trucking firms also owned or had ready access to one or more straight trucks. These trucks are used primarily as convenience vehicles to haul small lots of cattle short distances. This type truck will not be considered in this study.

Other Enterprises

Nine of the thirteen, or 69 per cent of the truckers interviewed operated other enterprises in addition to livestock hauling. Four of them hauled only livestock, five were equipped to haul grain as well as livestock and three of the firms interviewed hauled all types of commodities, ICC exempt and nonexempt. Next to other types of hauling, the enterprise most frequently engaged in was farming. Three of the thirteen truckers also farmed. Other enterprises engaged in included motor company dealerships, service stations and restaurants and equipment sales.

Cost of Operation

Detailed cost of operation data was not gathered nor was it the purpose of this study to do so. However, truckers were asked to give an

estimate of the total cost per mile of operation of their trucks. These estimates ranged from a low of 23¢ per mile to a high of just over 35¢. The most common estimate given was 30-35¢ per mile.

Procedure for Obtaining Data

Data on 50 to 100 interstate hauls of cattle was obtained from each trucking firm. Data was taken direct from shipping tickets and/or haul record books. Shipping tickets and/or records of hauls from which data was taken were selected at random for each month of 1970.

Information collected included: Date of haul, origin and destination, miles hauled, size of truck (linear feet of loading space), number of head hauled, net weight of the shipment, rate charged per CWT. and/or mile, the average speed traveled, and the total charge for the shipment. All of the desired information was not available in every case.

Evaluation of Data

From the data collected, 475 shipments contained the necessary information to derive a rate function on a hundredweight basis. Four hundred forty-two hauls had the required information for derivation of a rate-per-mile function. These data were broken into two classes by size of truck used; shipments in trucks with 60 or more linear feet of loading space (pots) and trucks with less than 60 feet of loading space (primarily 40 and 42 feet floor trailers). The average interstate haul for all sizes of trucks was 272.93 miles. The longest average hauls were made by the 60-foot class of trucks charging a per-mile rate and the shortest were made by the 40-foot class charging on a per-mile basis (Table 6).

Table 6.--Average Interstate Truck Shipments by Kansas-based Truckers

	No. of Hauls in Sample	Avg. Loaded Distance Hauled (miles)	Avg. Linear Length of Loading Space(feet)	Avg. No. of Head per load	Avg. Net Weight per load (pounds)	Avg. Rate (cents)
40' class						
Rate/CWT	83	215.06 (124.05)	42.08 (1.33)	41.12 (20.85)	30285.63 (5932.73)	45.42 (21.08)
Rate/Mile	88	214.49 (124.27	42.03 (1.35)	42.03 (20.56)	30549.28 (6129.86)	74.55 (29.03)
60' class						
Rate/CWT	392	324.36 (184.95)	62.04 (2.00)	49.29 (18.81)	39382.65 (6974.42)	57.10 (28.75)
Rate/Mile	354	337.36 (180.53)	62.03 (2.00)	58.17 (74.28)	43284.20 (41040.22)	72.21 (18.89)

Generally speaking two-thirds of the hauls made by the 40-foot trucks were between 90 and 340 miles and hauled between 22 and 66 head per haul. The 60-foot class of trucks had both a greater range in length of haul and greater variation in the number of head hauled. This can be partially explained by the fact that the 60-foot trailers can carry loads which allow the trucker to reach maximum legal weight limits with all types of cattle at operating costs only slightly higher than those for 40-foot trailers.

Interstate Rates

When the shipments considered in this study were categorized by distance hauled and rate per mile charged the most common rate was 70 cents per mile with rates between 60 and 70 cents the next most common for 60-foot trailers (Table 7). Rates in the range from 50 to 60 cents per

Table 7.--Rates per Mile by Distance for Interstate Hauls by 60-ft. Trailers

Length of Hauls (miles)	Total No. of Sample Rates	Rate/Mile (cents)								
		20	30	40	50	60	70	80	90	More than 100
Less than 100	26				1		5	5		15
100-199	66	2	2	2	5	6	22	14	10	1
200-299	65			1	7	15	34	4	2	2
300-399	57		3	3	2	25	20	4		
400-499	94			3	8	43	38	2		
500-599	29				5	10	10	4		
600-699	10				1	3	5			1
700-799	1						1			
800-899	1					1				
900-999	5					1	4			
More than 1000	2						2			
Totals	356	2	5	9	29	104	141	33	12	18

mile were most common when 40-foot trailers were used (Table 8). Rates charged per hundredweight were more directly correlated with distance hauled but the most frequently charged rates were in the 50 to 70 cent per hundredweight range for 60-foot trucks (Table 9).

Table 8.--Rates per Mile by Distance for Interstate Hauls by 40-ft. Trailers

Length of Haul (miles)	Total No. of Sample Rates	Rate/Mile (cents)								
		20	30	40	50	60	70	80	90	More than 100
Less than 100	20					1	1	3	2	13
100-199	17		1	1	1	3	4	3	3	1
200-299	28		2	4	11	2	4	5		
300-399	15			2	7	1	5			
400-499	7			2	4		1			
500-599	1				1					
Total	88		3	9	24	7	15	11	5	14

Table 9.--Rates per Hundredweight by Distance for Interstate Hauls by 60-ft. Trailers

Length of Haul (miles)	Total No. of Sample Rates	Rate/CWT (cents)										
		5	10	20	30	40	50	60	70	80	90	More than 100
Less than 100	33	2	24	4	1	1	1					
100-199	70			24	40	4	1	1				
200-299	83			1	12	36	28	2	3	1		
300-399	64				2	7	24	23	6	2		
400-499	93					1	5	16	52	18	1	
500-599	28						2			14	7	5
600-699	10								2			8
700-799	3											3
800-899	1											1
900-999	4											4
More than 1000	3											3
Total	392	2	24	29	55	49	61	42	63	35	8	24

Table 10.--Rates per Hundredweight by Distance for Interstate Hauls by 40-ft. Trailers

Length of Haul (miles)	Total No. of Sample Rates	Rate/CWT (cents)										
		5	10	20	30	40	50	60	70	80	90	More than 100
Less than 100	18		7	9	2							
100-199	17			2	12			3				
200-299	28				3	19	3	3				
300-399	11						5	2	4			
400-499	8						1		1	5		1
500-599	1							1				
Total	83	0	7	11	17	19	9	9	5	5	0	1

Statistical Rate Functions

Data on interstate livestock shipments made on a hundredweight rate basis were analysed using a stepwise multiple regression technique. The initial function considered was $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$ where:

Y = rate per hundred weight in cents

X_1= distance hauled in miles

X_2= linear feet of loading space per truck

X_3= Number of head hauled per load

X_4= Net weight per load

b_1, b_2, b_3 and b_4 = partial regression coefficients for X_1, X_2, X_3, and X_4. Initially all truck sizes were considered as being one sample population and were assumed to be fully loaded as was indicated by the average net weight and number of head hauled per load. The equation which resulted was $Y = 0.2073 + 0.0008X_1 + 0.0001X_2 + 0.0005X_3 + 0.0000X_4$.

The t-statistic calculated indicated that b_1 was significant at the .001 level. None of the other coefficients were significant at or below the .10 level. The F-statistic value of 91.0184 was significant at the .01 level. R^2 for the regression was .4334. This indicates that only, 43.34 per cent of the variation in rates was explained by the independent variables. Distance hauled, alone, accounted for 42.91 per cent of the explanation of the rate per cwt. As indicated by the t-test none of the other independent variables were significant and added little or nothing to the explanation of the rate charged. In terms of rates charged, the Y intercept of this function indicated that 21 cents, per hundredweight would be charged for such things as loading, unloading and other handling charges. The rate per hundredweight would then increase 8 cents for each 100 miles traveled.

When fitted to the data on a scatter diagram this function ($Y = 0.2073 + 0.0008X_1$) appeared to have too high an intercept and to little slope. Essentially the only thing that can be concluded from this function is that a linear function fits the data relatively well and that distance hauled is the independent variable which explains more of the variation in rates charged per hundredweight than any other identified variable.

By removing the assumption of all shipments being in one population and dividing the data into shipments by 40-foot trucks and 60-foot trucks, a much better explanation of rates per hundredweight was achieved.

The function $Y = a + b_1X_1 + b_2X_2 + b_3X_3$ was considered on data from 83 hauls by 40-foot trailers. Where:

Y = Rate/hundredweight

X_1= Distance hauled in miles

X_2= Number of head hauled per load

X_3= Net weight per load in 1,000 pounds

b_1, b_2, b_3 = partial regression coefficients for X_1, X_2, and X_3.

Multiple regression analysis yielded the equation $Y = 0.1906 + 0.0015X_1 + 0.0015X_2 - 0.0042X_3$. The t-statistic gave values of 18.6744 for the coefficient of X_1; 2.7566 for the coefficient of X_2 and -2.1285 for the coefficient of X_3. The distance hauled variable was significant at the 0.1 per cent level, the number of head hauled variable at the one per cent level and the net weight per load variable was significant at the five per cent level: The F-statistic with a value of 119.1103 with (3, 79) degrees of freedom indicated a linear function fit the data very well. The multiple correlation coefficient (0.90496) indicated that 81.90 per cent of the variation in rates charged per hundredweight was explained by the independent variables

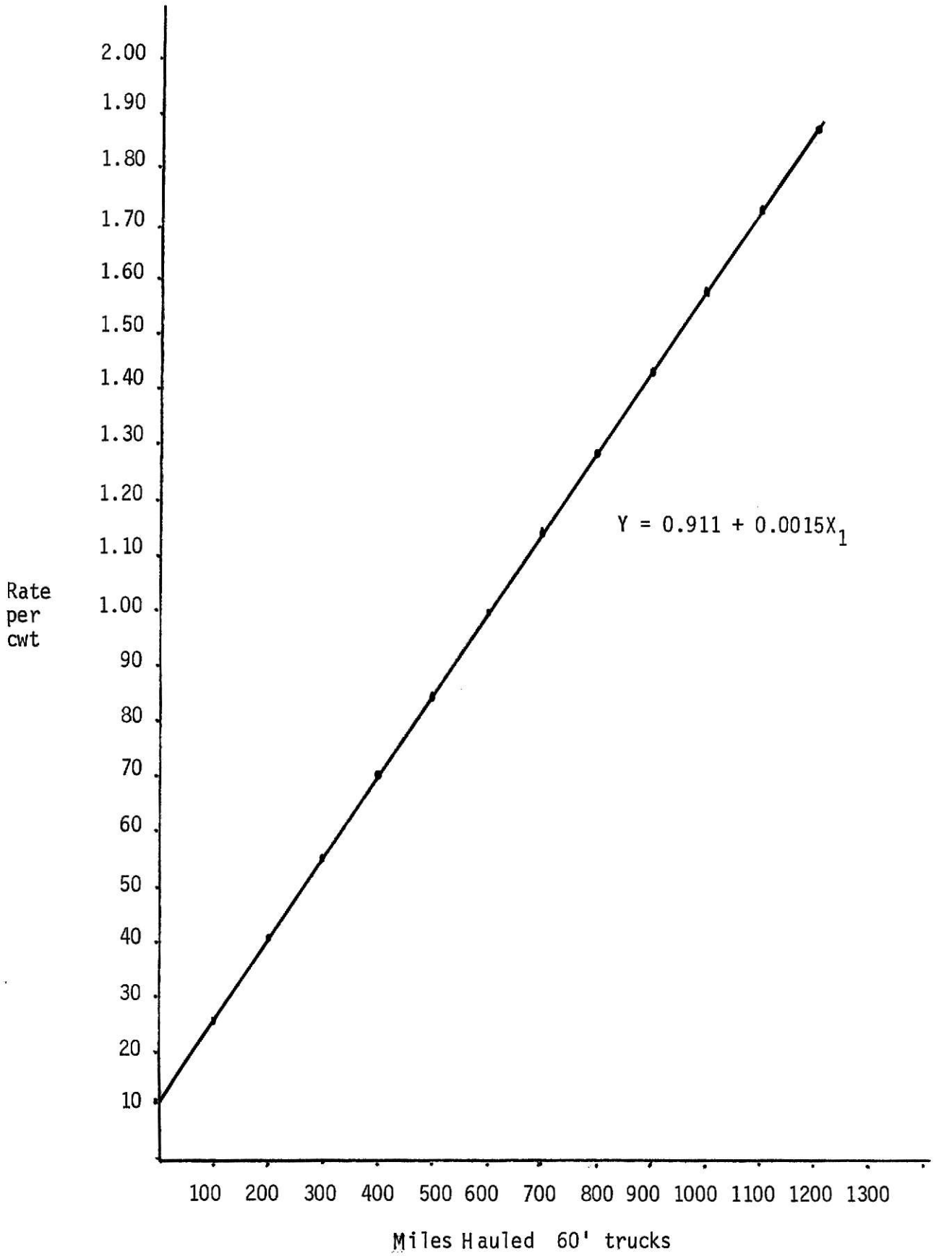
When only the distance hauled variable was considered the equation $Y = 0.1273 + 0.0015X_1$ resulted and had an R^2 of .7998. When the number of head hauled was added the regression, the equation became $Y = 0.0883 + 0.0015X_1 + 0.0009X_2$ with an R^2 of .8086. These equations indicate that: 1) a fixed cost of eight to nineteen cents is built into the rate structure to account for such things as loading, unloading and other handling charges, 2) the rate per hundredweight increases fifteen cents for each 100 miles hauled, 3) an increase of 10 head in the number of cattle hauled increases the rate by 1.5 cents, and an increase of 10,000 pounds in net weight decreases the rate charged per hundredweight by 4.2 cents.

Sixty-Foot Truck Hundredweight Function

The function $Y = a + b_1X_1 + b_2X_2 + b_3X_3$ was also applied to data on interstate shipments of cattle in semitrailers with 60 or more linear feet of loading space, where Y_1 X_1, X_2 and X_3 have the same meaning as above. The equation which resulted from multiple regression analysis was $Y = 0.2015 + 0.0015X_1 + 0.0007X_2 - 0.0040X_3$. T-statistic values were 63.2435, 3.1156, and -6.0102 for the coefficients of X_1, X_2 and X_3 respectively. The coefficients of X_1 and X_3 were significant at the 0.1 per cent level and the coefficient of X_2 at the one per cent level. This equation explained 91.42 per cent of the variation in the rates per hundredweight charged for interstate hauls of livestock.

The equation $Y = 0.0911 + 0.0015X_1$, based on distance hauled, explained 90.58 per cent of the variation in rates per hundredweight charged for interstate livestock hauls made in 60-foot semitrailers. This function

Figure 1--Rates Charged for Interstate Hauls of Cattle in 60-Foot Trucks



the five per cent level with the coefficient of X_1 being significant at the 0.1 per cent level. The multiple correlation coefficient of 0.67793 indicated that 45.96 per cent of the variation in rates was explained by these variables. The F-statistic was significant at 0.5 per cent indicating that the equation fit the data relatively well.

When this function was applied to data for 40-foot trucks the resulting equation was $Y = 0.5768 + 20.2347\frac{1}{X_1} - 0.0158X_2 + 0.0013X_3 + 0.0000X_4$. The T-test indicated that the coefficients of X_1 and X_4 were significant at the 0.1 per cent level. The F-test also was significant. These variables explained 66.28 per cent of the variation in rates charged per mile when 40-foot semitrailers were used.

The coefficient of the net weight variable was significant according to the T-test but not enough significant digits were carried to give a coefficient other than zero. To correct this situation the net weight hauled per load was divided by 1,000 so the resulting coefficient would give the change in rate due to a 1,000 pound change in net weight. Also in an attempt to improve the explanation of the data, the distance hauled variable was transformed to give three variables, $\frac{1}{X_1}$, $\frac{1}{X_2}^2$, $\frac{1}{X_3}^3$. This transformation was added to improve the explanation of the data in the 100 to 300 mile range.

The function $Y = a + b_1\frac{1}{X_1} + b_2\frac{1}{X_2}^2 + b_3\frac{1}{X_3}^3 + b_4X_4 + b_5X_5 + b_6X_6$, where Y = rate per mile in cents, X_1 = distance hauled in miles, X_2 = distance hauled squared, X_3 = distance hauled cubed, X_4 = length of loading space in feet, X_5 = number of head hauled per load, X_6 = net weight per load, was applied to data for both 40 and 60-foot semitrailers.

A stepwise multiple regression produced the equation $Y = 0.0834 + 68.4586 \left(\frac{1}{X_1}\right) - 1914.6859 \left(\frac{1}{X_2}^2\right) + 17924.2132 \left(\frac{1}{X_3}^3\right) - 0.0054X_4 + 0.0012X_5 + 0.0154X_6$ for the 40-foot class of trailers. The T-test indicated that the coefficients of variables X_1, X_2, X_3 and X_6 were significant at the one per cent level in explaining the variation in the rate charged per mile. The multiple correlation coefficient of .86374 indicated that 74.60 per cent of the variation was explained by the six variables.

When only the four variables with significant coefficients are considered the equation becomes $Y = -0.1478 + 69.4569 \left(\frac{1}{X_1}\right) - 1950.1351 \left(\frac{1}{X_2}^2\right) + 18244.9173 \left(\frac{1}{X_3}^3\right) + 0.0170X_6$. These four variables explained 74.01 per cent of the variation of Y, which is not significantly lower than the above R^2. The F-statistic value of 59.0872 with (4, 83) degrees of freedom was significant at the 0.5 per cent level, indicating that the curve resulting from the equation fit the data well.

The above function was also tested using data from the 60-foot class of semitrailers. The resulting equation was $Y = 0.5766 + 16.9177 \left(\frac{1}{X_1}\right) + 465.6525 \left(\frac{1}{X_2}^2\right) - 8220.7932 \left(\frac{1}{X_3}^3\right) + 0.0003X_4 - 0.0007X_5 + 0.0016X_6$. Of the six variables, five of their coefficients were significant at or below the 10 per cent level, with three being significant at or below the five per cent level. The value of the F-test also was significant below the one per cent level. The six variables explained 50.81 per cent of the variation in Y.

The equation $Y = 0.6132 + 15.2587 \left(\frac{1}{X_1}\right) + 522.4885 \left(\frac{1}{X_2}^2\right) - 8739.7694 \left(\frac{1}{X_3}^3\right) + 0.0004X_4$ resulted when only the variables above which had significant coefficients were considered in the regression. All coefficients

in this equation were significant at or below the five per cent level and the multiple correlation coefficient was not significantly smaller at the five per cent level. The F-statistic value was also highly significant.

This function indicates that as the distance increases from zero the rate per mile will decrease rapidly until a haul of about 200 miles is reached. Then the rate will begin to level off and become nearly stable. The functions which have been developed to estimate rates charged for interstate shipments of livestock are summarized in Tables 11 and 12.

Table 11.--Estimates of Multiple Regression Parameters for Interstate Truck Rates per Hundredweight

Truck Size	a	Standard error of Estimate	b_1 Distance Hauled (miles)	b_2 Number of Head per Load	b_3 Net Weight per Load (1000 lbs)	R^2
40 ft.	0.1906	0.09140	0.0015** (0.0001)	0.0015** (0.0006)	-0.0042* (0.0020)	.8190
	0.0883	0.09340	0.0015** (0.0001)	0.0009 (0.0005)		.8086
	0.1273	0.09492	0.0015** (0.0001)			.7998
60 ft.	0.0911	0.08836	0.0015** (0.0000)			.9058
	0.2137	0.08547	0.0015** (0.0000)		-0.0034** (0.0006)	.9121
	0.2015	0.08453	0.0015** (0.0000)	0.0007** (0.0002)	-0.0040** (0.0007)	.9142

**Significant at 1 per cent
*Significant at 5 per cent

Analysis of Interstate Rate Functions

Several things are readily apparent from the functions in Tables 11 and 12. First, in the rate-per-hundredweight functions the independent variables explain much more of the variation in the dependent variable than do those in the rate-per-mile function. Therefore, for the purpose of estimating rates or transportation costs the rate-per-hundredweight function for the desired truck size would appear to be the more reliable.

Second, the distance hauled variable is responsible for the majority of the explanation of the variation of the dependent variable. In the rate-per-hundredweight function for 60-foot trucks, distance hauled accounts for 99.1 per cent of the 91.42 per cent explained variation in the rate charged. In the rate per mile function, distance hauled accounts for 44.87 per cent of the 50.81 per cent or 88 per cent of the explained variation of the dependent variable which is explained by the function for 60-foot trucks. The same relationship is found in the functions for 40-foot trucks.

Third, there is an inverse relationship between the number of head hauled and the net weight of the load. This would indicate that a lower rate is charged for heavier loads of fewer cattle. This would reflect the efficiency of heavier cattle in making up a load as was found by Barmettler.[2] Expressed another way, the cost of loading and unloading goes up as the number of head per truck load increases.

The standard error of estimate for the rate-per-hundredweight functions for both 40 and 60-foot trucks was about 0.09 or nine cents per

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[2]Barmettler, "Transportation for Nevada Cattle," p. 23.

Table 12.--Estimates of the Multiple Regression Parameters for Interstate Truck Rates per Mile

Truck Size	a	Standard Error of Estimate	b_1 Distance Hauled (miles)	b_2 Distance Hauled Squared	b_3 Distance Hauled Cubed	b_4 Linear ft. of Loading Space	b_5 Number of Head	b_6 Net Weight	R^2
40 ft.	0.5768	0.17259	20.2347**			-0.0158	0.0013	0000**	.6628
			(1.8463)			(0.0147)	(0.0011)	(0000)	
	0.3411	0.18078	76.1148**	-2066.3731**	17426.4019**				.6256
			(12.4739)	(576.6520)	(6616.8241)				
	0.1467	0.15153	69.4569**	-1950.1351**	18244.9123**			.0170**	.7401
			(10.5130)	(483.7199)	(5547.7362)			(.0028)	
	0.0834	0.15162	68.4586**	-1914.6859**	17924.2132**	-0.0054	0.0012	.0154**	.7460
60 ft.	0.6360	0.14047	17.0230**						.4487
			(1.0057)						
	0.5823	0.13968	17.3065**			0.0004	-0.0006	0000*	.4596
			(1.0176)			(0.0039)	(0.0004)	(0000)	
	0.6311	0.13481	15.2751**	514.9066**	-8647.1148**				.4951
			(4.9415)	(238.9496)	(2736.5859				
	0.5957	0.13345	16.9092**	466.5438	-8230.2688**	0.0003	-0.0007	.0016*	.5081
			(4.9680)	(238.3782)	(2722.4043)	(0.0039)	(.0004)	(.0007)	

**Significant at 1 per cent level
*Significant at 5 per cent level

hundredweight. The rate-per-mile functions for 40-foot trucks had a standard error of estimate which ranged from .15 to .18 or 15 to 18 cents per mile. The function based on distance and net weight had a standard error of 15 cents. In the 60-foot class, standard errors ranged from 13 to 14 cents per mile.

While the standard error of estimate indicates that 68 per cent of the actual rates would be within plus or minus the standard error of the rate estimated, the error becomes smaller proportionally as the rate increases. When estimating rates per hundredweight, the standard error would become smaller proportionally or less important as the distance hauled increased. The opposite is true when estimating the rate per mile. As the distance hauled increases the standard error becomes larger with respect to the rate charged.

Estimated Rates

To estimate the rates charged in 1970 by Kansas based truckers for interstate hauls of cattle the following functions will be used: for 40-foot semitrailers, $Y = 0.1906 + 0.0015X_1 + 0.0015X_2 - 0.0042X_3$; for 60-foot semitrailers, $Y = 0.2015 + 0.0015X_1 + 0.0007X_2 - 0.0040X_3$ where Y = rate per hundredweight, X_1 = distance hauled in miles, X_2 = number of head hauled per load, and X_3 = net weight per load. To estimate the rate per mile the functions $Y = -0.1467 + 69.4569 (\overline{X}_1^{1}) - 1950.1351 (\overline{X}_2^{1}{}^2) + 18244.9173 (\overline{X}_3^{1}{}^3) + 0.0170X_6$ and $Y = .5957 + 16.9092 (\overline{X}^{1}) + 466.5438 (\overline{X}_2^{1}{}^2) - 8230.2688 (\overline{X}_3^{1}{}^3) - 0.0007X_5 + .0016X_6$ will be used for 40 and 60-foot semitrailers respectively, where Y = rate per mile, X_1 = distance hauled in miles, X_2 = distance hauled squared, X_3 = distance hauled cubed, X_5 = number of head per load, and X_6 = net weight per load in thousands of pounds.

To facilitate comparison of rates, a common load for 40-foot semitrailers consisted of 44 head of cattle with a net weight of 30,400 pounds and for 60-foot semitrailers the load consisted of 54 head and had a net weight of 42,000 pounds. The rate per hundredweight was calculated using the above functions and also derived from the rate-per-mile function by multiplying the calculated rate per mile by the number of miles hauled and dividing by the net weight in hundredweights. The rates per mile were also derived by multiplying the calculated rate per hundredweight by the net weight in hundredweights and dividing by the number of miles hauled.

From Table 13 it can be seen that rates per hundredweight calculated from the function and then converted to a per mile rate tend to be higher than those calculated from the rate per mile function. There is an exception to this in the case of the 40-foot class of semitrailers in that up to 200 miles there is not a consistent relationship between the two functions. However at distances greater than 200 miles the rates derived from the hundredweight function are higher.

Selecting a Function

In selecting a rate function to use for estimating transportation costs several things must be considered. The hundredweight functions for both classes of trucks have the more favorable R^2s and the more favorable value of the F-test.

When converting from rates per hundredweight to rates per mile the variance increases at the shorter distances and decreases at the longer distances. The opposite is true when converting to rates per hundredweight

Table 13.--Estimated and Derived Rates for Hauling Cattle Interstate by Kansas Based Truckers

Truck Size	Distance Hauled (miles)	Calculated Rate/Cwt (cents)	Derived Rate/Cwt (cents)	Calculated Rate/Mile (cents)	Derived Rate/Mile (cents)
40 ft.	50	20.39	18.50	112.51	123.97
	100	27.89	29.21	88.79	84.79
	200	42.89	44.13	67.08	65.19
	300	57.89	57.20	57.97	58.66
	400	72.89	69.93	53.15	55.40
	500	87.89	82.43	50.12	53.44
60 ft.	50	14.63	12.90	108.40	118.69
	100	22.13	19.83	83.27	92.95
	200	37.13	34.30	72.03	77.97
	300	52.13	48.87	68.42	72.98
	400	67.13	63.82	67.02	70.49
	500	82.13	78.66	66.08	68.99
	600	97.13	93.51	65.46	67.99
	700	112.13	108.32	65.03	67.28
	800	127.13	123.21	64.69	66.74
	900	142.13	137.97	64.39	66.33
	1000	157.13	152.85	64.20	65.99

from the rate-per-mile function. When actual rate observations are plotted against distance hauled on scatter diagrams the rate-per-hundredweight observations appear to have a more uniform variance about the regression line at all points along the line. The rate-per-mile observations are more scattered, have greater variance, for distances less than 450 miles than for greater distances. This would indicate that converting to rates-per-mile from the hundredweight function would yield more reliable rates than converting to rates per hundredweight from the rate-per-mile function. This appears true at the greater distances but at the shorter distances the rate-per-mile function gives an estimate which is closer to reality because this function will pass through the true means of the observations and have the least variance possible.

However, the variance of the rate-per-mile model does not appear to be homogeneous. The variance is greater at the shorter distances and less at the greater distances thus the problem of heteroscedasticity probably exists.

Given the problem of heteroscedasticity the rate-per-mile model becomes a biased estimator of the rates per mile. Therefore calculating rates for distances greater than 450 miles from the rate-per-hundredweight function gives a more reliable estimate of rates per mile than does the rate-per-mile function.

Generally the rate-per-hundredweight functions are more reliable than the rate-per-mile functions. If rates per mile are desired then a combination of the two functions can be used to give a realistic estimate of rates.

CHAPTER IV

INTRASTATE HAULS OF CATTLE IN KANSAS

To develop intrastate rate estimates information on load and distance characteristics was taken from 68 actual interstate hauls. This information included the distance hauled, size of truck used, number of head hauled, and the net weight of the load. The rate-per-hundredweight for these shipments was calculated using Kansas Motor Carrier Association, Inc., Motor Freight Tariff No. 50-C, KCC. No. 62, which is the tariff currently in effect for shipments made by truck between points in Kansas.

Simple averages were the first means used to analyze the data on intrastate hauls. These averages are shown in Table 14.

Table 14.--Averages and Standard Deviations of Kansas Intrastate Hauls of Cattle

Rate per cwt. (cents)	Miles Hauled	Linear Feet of Loading Space	Number of Head Hauled	Net Weight (pounds)
0.5537 (0.3042)	269.8382 (169.5696)	56.7353 (10.0723)	52.4706 (28.2238)	35707.6176 (7272.2348)

Intrastate hauls in this study ranged from 16 miles to 674 miles. The largest group of hauls was in the 100-300 mile range. This distance range would include the majority of hauls from feeder cattle producing areas to feedlot areas as well as from feedlots to major slaughter markets within the state.

The size of trucks used on these hauls ranged from 40 - 64 linear feet of loading space and carried from 23 to 102 head of cattle. The net weights of the hauls ranged from 15,100 pounds to 46,200 pounds.

The rates applicable on these hauls ranged from $0.06 to $1.21 per hundredweight. As can be seen from Table 15 the rates are closely correlated with the distance hauled.

Table 15.--Number of Rates Per Hundredweight by Distance and Amount for Kansas Intrastate Hauls

Length	Total Number of Rates	Rate per Hundredweight (cents)											
		5	10	20	30	40	50	60	70	80	90	100	110
0-49	3	1	2										
50-99	9		5	4									
100-199	14			1	10	3							
200-299	13					7	6						
300-399	7						2	4	1				
400-499	14								3	8	3		
500-599	6										3	2	
600 +	2												2
Total	68	1	7	5	10	10	8	4	4	8	6	2	2

Intrastate Rates

Rates applicable to livestock in Motor Tariff No. 50-C are calculated for individual shipments on minimum weight plus mileage bases. Each size of truck or semitrailer is assigned a weight which represents a minimum full-load net weight for that truck, ie. a 40-foot semitrailer is assigned a minimum weight of 26,000 pounds and a 60-foot trailer is assigned a minimum weight of 37,000 pounds. If a shipper orders a 40-foot trailer to haul a load of cattle and the net weight of the cattle is less than 26,000 pounds he then pays the designated rate per hundredweight on 26,000 pounds or 260 hundredweight rather than on the actual net weight. If the net weight of the load is more than 26,000 pounds the rate is paid on the actual net weight of the load.

The rate per hundredweight varies with the distance hauled. In Tariff 50-C rates per hundredweight are given for distances from 5 to 600 miles and for minimum weights ranging from less than a truckload (less than 5,000 lbs.) to 25,000 pounds (See Appendix 1).

To determine the rate per hundredweight to be charged on a load of cattle with a net weight of 40,000 pounds being hauled 100 miles in a 60-foot semitrailer, the rate per hundredweight given in the tariff for a minimum weight of 25,000 pounds and 100 miles (26¢) would be used. The total cost would then be calculated by multiplying this rate times the net weight of the load in hundredweights or \$.26 X 400 = \$104.00.

Intrastate Rate Function

A stepwise multiple regression was run on data for 68 intrastate shipments of cattle to further explain the structure of Kansas intrastate rates. The function considered was $Y = a + b_1X_1 + b_2X_2 - b_3X_3$ where Y = rate per hundredweight, X_1 = distance hauled in miles, X_2 = number of head hauled per load, X_3 = net weight per load, and b_1, b_2 and b_3 = partial regression coefficients for X_1, X_2 and X_3 respectively. The equation which resulted was $Y = 0.0750 + 0.0018X_1 + 0.0005X_2 - 0.0010X_3$. The standard error of estimate of this equation was 0.02444. This equation explained 99.38 per cent of the variation in Kansas intrastate rates. The t-test, when applied to the coefficients of the variables, indicated that both the coefficient of X_1 and X_2 were significant at the .001 level and that the coefficient of X_3 was significant at the .05 level.

When only distance hauled was considered as the independent variable the equation became $Y = 0.0716 + 0.0018\ X_1$. The multiple correlation

coefficient indicated that 99.16 per cent of the variation in the rate per hundredweight was explained by the distance a load was hauled. The standard error of estimate was 0.02814.

When both distance hauled and number of head hauled were considered the F-test results indicated that the function fit the data extremely well. The standard error of estimate dropped to 0.02521 or about 2.5 cents which indicates that there was very little variation in rates about the regression line. When all three variables were considered the standard error of estimate dropped to 0.02444.

This equation indicated that a fixed cost of five to seven cents per hundredweight was charged for such things as loading, unloading and other operations. The rate then increased 18 cents for each one hundred miles hauled and 0.5 cents for each 10 head of cattle hauled and decreased one cent for each 10,000 pounds of net weight. Actual rates set by tariff 50-C do not follow this pattern exactly. They increase 16 cents per hundredweight for each 100 miles up to 300 miles and then increase at the rate of 19 cents per hundredweight up to 500 miles. The increase from 500 to 600 miles is 25 cents. This pattern would indicate a slightly curvilinear relationship rather than a strictly straight line relationship between distance hauled and rate charged per hundredweight.

Trucks with a lower minimum weight were assigned rates per hundredweight that were considerably higher than those for trucks with higher minimum weights. The relationship between rates and distance hauled was also different. The rates charged per hundredweight for the smaller trucks increased more rapidly as distance hauled increased than did the

rates for larger trucks. One of the principle reasons for this is that not all truck operating costs vary directly with the size of load hauled. Drivers' salary, for example, would be about the same if he drove a truck hauling 40,000 pounds as it would be for a truck hauling 20,000 pounds.

Table 16.--Interstate and Intrastate Rates for Kansas 25,000 Pounds or Greater Minimum Load

Distance Hauled (miles)	KCC Rate/cwt (cents)	Derived Intrastate Rate/cwt (cents)	Interstate Rate/cwt 60 ft. Trucks (cents)	Interstate Rate/cwt 40 ft. Trucks (cents)
50	15	15	17	19
100	26	24	25	27
200	42	42	40	42
300	58	60	55	57
400	77	78	70	72
500	96	96	85	87
600	121	114	100	102

Kansas Intrastate and Interstate Rates Compared

The rate-per-hundredweight functions developed for interstate and intrastate hauls of cattle are very similar in that the distance a load is hauled accounts for nearly all of the variation in the rate charged. The R^2 values were relatively high, 0.9938 for the intrastate function, 0.9142 for the interstate 60-foot truck function and 0.8190 for the interstate 40-foot truck function. The Y-intercept was positive in all three cases ranging from 0.0750 for the intrastate function to 0.2015 for the 60-foot interstate function. The intercept for the 40-foot function was 0.1906. This indicates that a loading and unloading fee is built into the rate structures for both the regulated and nonregulated hauls and

that it varied with the size of load. The Kansas tariff states, "the carrier will load livestock from pens of shippers into carriers's trucks and will unload livestock from carrier's truck into pens of consignee without additional charge, provided that pens are directly accessible to trucks for loading and unloading."[1] It is also common practice for truckers hauling interstate shipments of livestock to load and unload them without additional charges above the rate per hundredweight charged.

The big difference in structure between interstate and intrastate rates is the rate of increase over distance. Both the 60-foot and 40-foot interstate rate-per-hundredweight functions increased 15 cents for every 100 mile increase in distance hauled. The intrastate function increased 18 cents for every 100 mile increase in distance hauled.

Table 16 shows the rates for interstate and intrastate hauls. The rates for shorter hauls generally were higher for interstate hauls than for intrastate but were lower at greater distances. As the distance hauled increased the spread between interstate and intrastate rates widened. This was especially true in the case of the 60-foot class of semitrailers used for interstate hauls.

Another important area to be considered when comparing nonregulated interstate rates is the standard error of estimate associated with the regression. The standard error of estimate measures the variation of the data about the regression line, thus giving an indication of the variation in rates.

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[1]Kansas Motor Carriers Association, Inc., Motor Freight Tariff No. 50-C. Topeka, Kansas, Jan. 1970, p. 9.

In the case of the intrastate function the standard error of estimate was 0.02444 or about two cents while that of the interstate function was 0.08453. This indicates that there is nearly 3.5 times as much variation in nonregulated rates as in the regulated rates for hauls of the same distance and load characteristics.

There are several factors which could cause this variation. Probably the most obvious reason is that interstate rates are negotiated between the shipper and the trucker for individual hauls. This would cause rates to vary depending on who had the stronger bargaining position at the particular time and place. Another reason could be the differences in cost of operation in different states. Each state has its own set of regulations governing truckers operating in or through it. There are special taxes and fees which must be paid that vary from state to state as well as variation in legal weight limits, etc. which cause changes in the cost of operation which in turn are reflected in the interstate rate which is agreed upon.

In general the interstate rate functions have a higher Y-intercept but increase at a slower rate than the Kansas intrastate function. A number of truckers commented to this author during interviews that the intrastate rates were too low at short distances to adequately cover their cost of operation. Therefore on nonregulated interstate hauls of short distances truckers negotiate a higher rate. In the regression this would tend to cause a higher Y-intercept. Interstate rates then increase at a rate three cents less for every 100 miles than do the intrastate rates. This indicates that for interstate hauls, price competition plays a definite role.

Comparison of Kansas, Colorado, and Oklahoma Regulated Intrastate Rates

Of the states surrounding Kansas, Colorado and Oklahoma regulate rates on all intrastate livestock hauls, Missouri regulates rates on specific hauls and Nebraska does not regulate rates on intrastate livestock hauls.

Tariff schedules were obtained for Colorado and Oklahoma from the respective motor carriers associations. Rates from these tariff schedules were calculated for 68 hauls with the same load and distance characteristics as were used to compare Kansas intrastate with interstate hauls.

Colorado, due to its particular topography, had essentially two different rate schedules. One for the plains areas and one for the mountain areas.

In order to get comparisons of rates on like hauls the plains area rates were used from the Colorado tariff schedule. These rates are set on a rate per hundredweight basis subject to a minimum weight per load. Rates were given for less than truck load lots, 8,000, 16,000, 20,000 and 25,000 pound minimum weights. These rates apply to trucks with loading space of less than 20, 30, 40 feet and greater than 40 feet respectively. Since all of the hauls in this study qualified for at least the 25,000 pound minimum weight, this was the rate used from the Colorado tariff schedule.

Oklahoma also has two different rate schedules for intrastate livestock hauls. One schedule provides rates for shipments of ordinary livestock to and from commercial feedlots, licensed sale barns, packing houses and terminal markets. This is the schedule which this study was concerned with. Rates were set on a rate-per-hundredweight basis for

minimum weights of less than truckloads, 12,000, 16,000, 20,000, 25,000 and 38,000 pounds. Single decked trailers of more than 38 feet in length are charged on 25,000 pounds and double deck trailers of 38 feet or more are charged on 38,000 pounds minimum weight. A schedule of rates was also given for shipments of livestock between points other than to or from commercial feedlots, sale barns, packing plants or terminal markets. These rates were given in a rate-per-vehicle used based on the length of loading space and distance hauled.

In Kansas and Colorado rates were given starting at five miles and went up to 600 miles. Oklahoma rates were given starting at 20 miles and went up to 600 miles.

Simple arithmetic means were the first method of analysis and comparison used. The average rate per hundredweight for 68 hauls in Kansas was 55.37 cents, in Oklahoma 51.88 cents, and in Colorado the average rate was 67.62 cents per hundredweight. Colorado rates averaged 12.25 cents higher than Oklahoma rates. Kansas rates averaged 3.49 cents higher than Oklahoma rates. All other aspects of the hauls were the same in all states and were given in Table 14.

The next step in the analysis and comparison of rates and rate structures in these three states was to apply a stepwise multiple regression to the data. The function considered was the same as that used on the Kansas intrastate data, $Y = a + b_1X_1 + b_2X_2 + b_3X_3$ where Y = rate per hundred weight in cents, X_1 = distance hauled in miles, X_2 = number of head per load, X_3 = net weight per load in 1,000 pounds, b_1, b_2 and b_3 = partial regression coefficients of X_1, X_2 and X_3 respectively.

When applied to Oklahoma data the equation which resulted was

$$Y = 0.0707 + \underset{(0.0000)}{0.0017X_1} - \underset{(0.0001)}{0.0002X_2} - \underset{(0.0005)}{0.0000X_3}.$$

Results of the T-test indicated that only the coefficient of X_1 was significant at or below the 10 per cent level. When only X_1 was used in the regression the equation became $Y = 0.0600 + \underset{(0.0000)}{0.0017X_1}$.

Both the T-test and F-test values were highly significant (0.1 per cent level) and the multiple correlation coefficient indicated that 99.16 per cent of the variation in the rate charged per hundredweight was explained by the distance the load was hauled. The standard error of estimate was 0.02651 or about three cents. This indicates that there is very little variation in rates other than that explained by the distance hauled.

This equation is very similar to the one derived for Kansas. The Y-intercept is one cent lower and the slope is one cent less when based on distance hauled. When the actual printed rates are compared it was found that for a 25,000 pound minimum load the given rates were identical for Kansas and Oklahoma. The difference in the function must then be explained by the fact that Oklahoma has set rates for a 36,000 pound minimum load and Kansas has not. The rates set for the 36,000 pound minimum load average about seven per cent more than the rates for the 25,000 pound load in Oklahoma. The load, however, is 30 per cent greater, thus there are some very definite economies of size indicated by the rate structure. This could be the reason that the Oklahoma rate function is slightly lower than the Kansas intrastate function. The standard error of estimate is nearly the same for Kansas and Oklahoma.

When the function $Y = a + b_1X_1 + b_2X_2 + b_3X_3$ was applied to Colorado data the equation $Y = 0.2491 + \underset{(0.0001)}{0.0021X_1} + \underset{(0.0007)}{0.0063X_2} - \underset{(0.0029)}{0.0134X_3}$ resulted. The T-test indicated that all coefficients were significant at the 0.1 per cent level as was the value of the F-test. The multiple correlation coefficient indicated that 84.93 per cent of the variation in rates was explained by the three variables, distance hauled, number of head hauled and net weight of the shipment. The standard error of estimate was 0.1549 or about 15.5 cents. Thus there was considerable variation in the data about the regression line.

The stepwise regression indicated that the distance hauled variable explained slightly over 65 per cent of the variation in the rate charged per hundredweight, the number of head hauled explained an additional 14.8 per cent and the net weight of the load explained 5.06 per cent.

The Y-intercept for Colorado was considerably higher than for either Kansas or Oklahoma. However the net weight variable was considerably more significant and it had a negative correlation with the rate charged per hundredweight. For each 10,000 pounds of net weight the rate would decrease 13.4 cents. The number of head hauled had a positive correlation and each 10 head hauled increased the rate by 6.3 cents. If the Y-intercept is to be considered as the fee for loading and unloading then the size of the load will affect it. If a 40,000 pound load of 52 head is considered then the fixed charge is about four cents per hundredweight for loading, unloading or other fees. This figure is very close to the one for Kansas and Oklahoma.

The coefficient for the distance hauled variable indicated that rates for the plains area of Colorado increased three to four cents faster per 100 miles than did the rates in Kansas and Oklahoma. The number of head hauled also affected the rate charged slightly more in Colorado than it did in Kansas, about five cents more for every ten head hauled. This variable was not significant in the Oklahoma rate function. The net weight per load also decreased the rate per hundredweight considerably more in the Colorado function than in the Kansas function.

The standard error of estimate was also considerably greater for the Colorado function than the other two intrastate functions. This, along with the lower R^2, indicates that there are probably additional variables that were considered when formulating Colorado rates.

Comparison of Interstate and Intrastate Rate Functions

The rate functions to be compared are $Y = 0.2015 + 0.0015X_1 + 0.0007X_2 - 0.0040X_3$ for interstate hauls, $Y = 0.0750 + 0.0018X_1 + 0.0005X_2 - 0.0010X_3$ for Kansas intrastate hauls, $Y = 0.0600 + 0.0017X_1$ for Oklahoma intrastate hauls and $Y = 0.2491 + 0.0021X_1 + 0.0063X_2 - 0.0134X_3$ for Colorado intrastate hauls where Y = rate in cents per hundredweight, X_1 = distance hauled in miles, X_2 = number of head hauled, and X_3 = net weight per load. These functions will be applied to a load of 56 head of cattle with a net weight of 36,000 pounds being hauled in a 60-foot semitrailer. Table 17 shows the rates that would be charged for this load hauled various distances.

As can be seen from Table 17, the interstate rates were considerably lower than intrastate rates especially at distances of over 200 miles. The interstate rates average about six cents lower than Kansas rates, two cents lower than Oklahoma rates, and twenty cents lower than Colorado rates.

Table 17.--Rates for Interstate and Intrastate Hauls of Cattle

Distance Hauled (miles)	Rate in Cents for CWT			
	Interstate	Kansas Intrastate	Oklahoma Intrastate	Colorado Intrastate
50	17	16	15	22
100	25	25	23	33
200	40	43	40	54
300	55	61	57	75
400	70	79	74	96
500	85	97	91	117
600	100	115	108	138

At shorter distances interstate rates are slightly higher than intrastate rates. In many cases truckers interviewed indicated that they used intrastate rates on short interstate hauls. Some truckers also felt that intrastate rates for short hauls were too low and charged slightly higher rates.

The rate structures were similar in that for a given size of load the distance it was hauled accounted for the majority of the variation in rates. With the exception of Colorado, the standard error of estimate indicated very little variation in rates about the regression line for intrastate functions. The interstate function had a standard error of estimate of 8.45 cents which was 3.5 times more than the Kansas and

Oklahoma standard errors and a little over half as much as the standard error of estimate for the Colorado function.

Capener, et.al., developed an intrastate rate function for Colorado using the plains area rates which were in effect in 1963 and found the equation to be $Y = 6.9491 + .2114X_1$ where Y = rate per hundredweight in cents and X_1 = distance hauled in miles. The correlation coefficient indicated that 99.9 per cent of the variation in rates was explained by the distance traveled.[2]

Generally it can be concluded that interstate rates are lower than regulated intrastate rates for hauling cattle. Also the interstate rates tend to have more variation than intrastate rates. This variation could be caused by differences in costs of operation in various states through which the shipment passes on interstate hauls. Bargaining between the shipper and the trucker introduces another source of variation which is present for interstate but not intrastate hauls. A third source of variation in interstate rates is the carrier who is not licensed to operate intrastate but who can operate interstate. Such a carrier may haul, for example, feeder cattle to Kansas from Mississippi and to prevent running back empty may haul a load of slaughter cattle to Memphis for a very low rate.

From the intrastate functions it appears that shippers in Kansas and Oklahoma have definite economic advantage over those in Colorado as far as intrastate shipments are concerned. However, data for this study

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[2]Capener, Stephens, St. Clair and Abel, "Transportation of Cattle in the West," p. 26.

was obtained for hauls to and from Kansas, from and to all surrounding states. Thus cattle producers in surrounding states pay about the same transportation rates as Kansas producers on interstate hauls.

CHAPTER V

COMPARISON OF RAIL AND TRUCK RATES

Railroad rate data was collected for shipments of cattle to and from points commonly used by Kansas producers. Truck rate data was also available for shipments to the same points.

Eighteen shipments averaged 360 miles in length and the average rate per hundredweight charged by the railroads was $1.24. The average time in transit was 67.4 hours for the rail shipments.

This data was based on shipments in railcars 40 feet 7 inches long and 8 feet 5 inches wide with a minimum weight of 24,400 pounds and a maximum capacity of 30,000 pounds. The railroads estimated that 40 to 50 head of 500 to 700 pound feeders or 30 head of 1000 pound slaughter cattle could be loaded per car. This is about the same capacity that the 40-foot class of trucks considered in this study were capable of hauling.

When comparing rates and rates estimated from functions it must be kept in mind that the rate functions best explain and describe the relationships between rates and distance and other variables over the range for which actual data was included. Projection of rates beyond the range of the data may or may not be completely accurate and reliable.

There were only two truck shipments and only two rail shipments of over 1,000 miles. There were twenty-six truck hauls and no rail shipments of less than 100 miles considered in this study.

With these cautions in mind rail rates and truck rates for hauling cattle interstate were compared.

The rates charged for 40-foot trucks on the same eighteen hauls for which rail data was available averaged 87 cents per hundredweight or about 37 cents less than the average rail rate. When 60-foot trucks were used on these same hauls the rate was 80 cents per hundredweight or 44 cents less than the average rail rate.

When distances of less than 300 miles were considered rail rates averaged 83 cents per hundredweight, 40-foot trucks, 48.5 cents, and 60-foot trucks 41.5 cents. Truck rates were 58.4 per cent and 50 per cent of the rail rates respectively.

Table 18.--Average Truck Rates as Per Cent of Rail Rates

Distance (miles)	Average Rail Rate (cent/cwt)	Average 40' Truck Rate (cents/cwt)	Per Cent of Rail	Average 60' Truck Rate (cents/cwt)	Per Cent of Rail
Less than 300	83	48.5	58.4	41.5	50
300-399	119	68	57.1	61	51.3
400-499	122	85	69.7	78	63.9
500-999	152	120	78.9	113	74.3
1000+	258	202	78.3	195	75.6

As the distance hauled increased, the spread between truck and rail rates tended to become less. However, truck rates at 1000 miles were still about 25 per cent less than rail rates.

This finding was not completely consistent with the findings of studies in the western states. Capener et. al. found that truck rates start lower than rail and that the two approach each other and cross at about 225 miles for feeder cattle and 400 miles for slaughter cattle with rail rates then becoming lower.[1] This was the pattern found throughout the western states.

[1]Capener, Stephens, St. Clair, and Able, "Transportation of Cattle in the West," p. 43.

From the following scatter diagram (Figure 2) it can be seen that there is relatively little variation in rail rates other than that related to distance. However with the limited number of observations an accurate measure of variation and trends was very difficult to make.

Per Car Rates

One of the railroads from whom data was obtained for this study has special rail cattle cars. This special car can be double decked for hauling both feeder and slaughter cattle. Suggested loading capacities per deck were given as 50 head of 500 pound feeders down to 30 head of 1000 pound slaughter or mature cattle, with a maximum weight limit of 80,000 pounds. No minimum weight was considered as the rate charged was a per car charge.

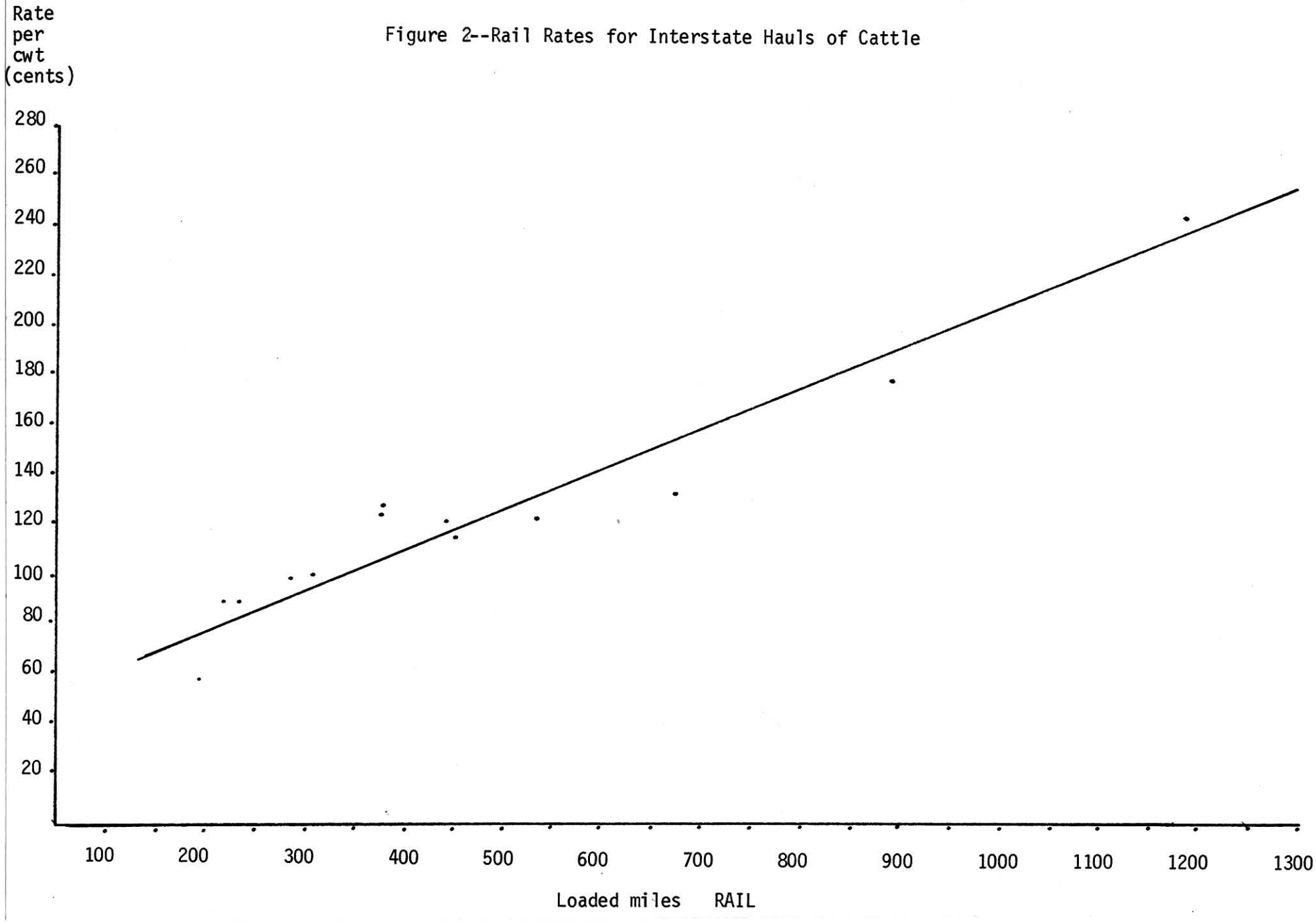
When paying a flat rate for the car from origin to destination it would be to the shippers advantage to load the car to capacity or as near so as possible without over-crowding the cattle. The heavier the car is loaded the less the rate per hundredweight for the shipment.

Rates on these cars were based on the length of the haul. The rate per mile ranged from about 90 cents for a 250 mile haul to 70 cents for a 500 mile haul.

When enough cattle are shipped from point to point at one time, a special train can be made and a rate of about 60 cents per loaded mile charged. This rate would be about 63 cents per hundredweight if the cars were loaded to 60,000 pounds.

At these rates, rail transportation of cattle competes very well with the truck transportation. However the comparison of rates between rail and truck is not the only criteria that must be considered in determining the best mode of transporting cattle.

Figure 2--Rail Rates for Interstate Hauls of Cattle



Time in transit is of vital importance. Harston and Richards state that shrinkage is a function of time in transit with approximately a 5.5 per cent weight loss in the first eight hours of transit and an 8.9 per cent loss in 24 hours.[2] Much of this is excretory shrinkage, particularly in the first hour of transit. Tissue shrinkage also occurs at a slower, undefined rate throughout time in transit. Rail shipments of cattle generally take considerably longer than truck shipments thus greater shrinkage can normally be expected when shipping by rail.

Trucks can normally average 40 to 50 miles per hour on trips in Kansas and surrounding states. A 220 mile cattle shipment, commonly made by truck in five to six hours was made by rail in 16 hours.

When cattle are transported by rail car as part of normal freight trains time in transit is extremely long. The use of special cattle trains shortens the time in transit considerably. These trains, along with using per car rates, tend to make rail more competitve with motor carriers in the transportation of cattle.

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[2]Harston and Richards, "Montana Livestock Transportation," p. 27.

CHAPTER VI

DISTANCE - PRICE MARGIN RELATIONSHIPS

The objective of this chapter is to determine the distance that feeder cattle can profitably be shipped for feeding, given the price margins between feeder and slaughter cattle.

In their search for feeder cattle to keep established feedlots operating at near capacity levels, cattle feeders in Kansas have extended their feeder cattle drawing area. Some cattle feeders are now shipping feeder cattle from as far away as Georgia and Florida.

To determine if shipping cattle this far can be profitable or to determine how far it is profitable to ship feeder cattle a number of factors must be considered. First the purchase price of the cattle must be considered as it is the largest expense. Transportation cost involved in getting the animal to the feedlot is also a large part of the procurement bill. Along with transportation costs, shrinkage and death loss during movement must be considered.

Transportation costs, shrinkage and death loss becomes a greater portion of the total cost at lower cattle prices. If cattle are shipped 500 miles in a truck with 60 foot of loading space the rate charged, according to the rate function developed earlier, would be 83 cents per hundredweight. If the average price of feeder cattle was $31.65, transportation would be 2.6 per cent of the total cost. If the average price was $25.09, transportation becomes 3.3 per cent of the total cost of the feeder cattle.

Viewed another way, the Kansas cattler feeder could have paid 2.6 per cent more or $32.48 for local feeder cattle than for comparable cattle 500 miles away in 1970. If shrinkage is also considered, this figure would be even higher.

The cost of shipping feeder cattle from Georgia to western Kansas feedlots, a distance of about 1,000 miles, would be approximately $1.58 per hundredweight. Shipping to the same area from Kansas City would cost approximately 58 cents per hundredweight. Assuming the same type and grade of cattle could be bought at both locations and considering only transportation costs, feeder cattle would have to be bought for at least one dollar per hundredweight less at the Georgia markets than at the Kansas City market in order to be comparable in price at the feedlot.

Average prices for the past five years reported from Georgia auctions and the Kansas City market for choice feeder steers indicate that a feedlot operator in western Kansas could profitably purchase feeders in the southeastern part of the United States and ship them to Kansas for feeding as opposed to purchasing from the closer Kansas City market. In 1967 the Kansas City price averaged 67 cents per hundredweight higher than the Georgia auctions while in the other four years the average Kansas City price was well over one dollar higher than the Georgia auction prices.[1] If the transportation rate remains constant, cattle buyers would be willing to buy cattle greater distances from their feedlots as the price of cattle

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[1] "Livestock, Meat, and Wool Market News," Livestock Division, Consumer and Marketing Service, U. S. Department of Agriculture, Vol. 35, 1967.

increased. In the case of Georgia and Kansas City feeder cattle markets the one dollar difference in transportation rates represents 3.2 per cent of the total price when cattle are $31.65 per hundredweight but it represents nearly four per cent when the price is $25.09. If the price were to drop to $15.00 per hundredweight transportation would be about 6.7 per cent of the total cost.

When the price of cattle is $25.09 per hundredweight, the average price paid at Georgia auctions in 1967, transportation charges for 1,000 miles would be 6.3 per cent of the total cost or $1.58 per hundredweight. When the price of cattle is $31.65 per hundredweight, average price paid at Georgia auctions in 1970, transportation would have to be $1.99 per hundredweight to be 6.3 per cent of the total cost. It was determined from the rate-per-hundredweight function for 60-foot trucks that a distance of 1,278 loaded miles could be traveled for $1.99 per hundredweight. The cattle feeder could afford to transport cattle an additional 278 miles when cattle prices are $31.65 instead of $25.09 per hundredweight.

The distance that feeder cattle can profitably be shipped depends not only on the transportation rate charged but also on the price relationships between local feeder cattle, other sources of feeder cattle, and slaughter cattle. The cost of transportation from alternative sources for feeder cattle must be calculated and compared. The cost of fattening the feeder steer to slaughter weight must be determined and added to the purchase price of the feeder steer. This sum when subtracted from the revenue of the sale of the slaughter animal would leave an amount which could be used to determine the maximum transportation charges that could be paid, assuming shrinkage and other costs are included in

the cost of fattening the animal.

For example, if both feeder and slaughter cattle were selling for $30.00 per hundredweight and the cost of adding 400 pounds of gain to a 700 pound feeder steer including shrinkage, labor and other associated costs was $100, the cattle feeder would have $20.00 per head from which he could take transportation charges, profit, etc. If all $20.00 was used for transportation the feeder cattle could be shipped 1,854 miles at the breakeven point.

The distance that cattle can profitably be shipped will change as the relationship of the prices change, as transportation rates change, and as the costs of production change. The cattleman must be extremely careful in determining how far he can or should go to purchase feeders for his feedlots.

Prices reported by USDA in 1970 for choice 550-750 pound feeder steers at nine markets were compared with the price reported for Western Kansas, Western Oklahoma and West Texas auctions. At seven of the nine markets the average price for the year was lower than the average for the base market (Table 19).

Transportation rates to ship feeder cattle to Dodge City, Kansas from the various markets shown in Table 19 were calculated for a 60-foot truck hauling 65 head of cattle with a net weight of 42,000 pounds. Based on the average price difference in 1970 and the transportation rates shown in Table 20 and disregarding shrinkage, Kansas cattle feeders could profitably import feeder cattle to the western part of the state from five of the nine markets listed, Amarillo, Oklahoma City, Georgia auctions, Kentucky auctions and Illinois auctions.

Table 19.--Price Difference Between Western Plains Auctions and Other Feeder Cattle Markets by Month for 1970 (dollars)

Market	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Avg.
Amarillo	1.50[c]	1.92	1.53	1.59	1.54	2.44	2.49	2.06	1.53	.82	1.24	1.60	1.69
Kansas City	1.52	.83	.31	.39	-1.08[b]	-.82	-.68	-.28	-.38	.00	.70	.80	.11
Omaha	1.23	1.58	1.72	.02	-1.24	-.94	-.97	-1.56	-2.00	-1.52	-.52	.75	-.34
Sioux City	2.35	2.96	1.28	.40	-1.18	-1.39	-1.37	-2.50	-3.00	-2.77	-.01	1.03	1.35
Oklahoma City	2.17	1.63	1.08	1.46	1.60	1.25	.74	.95	.50	.85	1.40	1.20	1.24
Georgia Auctions	3.04	2.58	2.53	1.27	1.07	2.36	2.19	1.81	2.19	1.23	1.55	1.34	1.93
California[a]	2.16	2.14	2.41	2.21	2.07	2.23	2.00	1.00	1.00	1.23	1.11	.34	1.66
Kentucky Auctions	2.22	2.52	2.03	2.30	.70	.98	1.79	1.12	1.31	1.42	1.68	2.84	1.74
Illinois Auctions	1.38	3.46	2.16	1.27	1.14	.98	1.60	1.56	1.94	2.38	2.99	2.81	1.98

[a]3 per cent shrinkage

[b]Negative figures indicate price was higher than Western Plains Auction prices.

[c]Indicates Western plains auction price averaged $1.50 per CWT above the average Amarillo price in in 1970. Negative numbers elsewhere in the the table indicate Western plain auction prices below other markets.

Table 20.--Transportation Rates for Cattle Shipped to Dodge City, Kansas from Selected Markets, 1970

Market	Rate per CWT (cents)
Amarillo	46
Kansas City	59
Omaha	69
Sioux City	78
Oklahoma City	48
Georgia Auctions (Atlanta)	169
Los Angles	234
Kentucky Auctions (Louisville)	136
Illinois Auctions (Springfield)	106

The month to month variation in prices among markets could result in it being profitable to ship from a market one month and not the next month. This could also be true on a week to week or even on a day to day basis. Therefore a feedlot operator who purchases several thousand head of feeder cattle each month must pay particular attention to the price - transportation relations of the various markets. For example, feeder cattle could have been bought at Kansas City in January 1970 at an average price that was $1.52 per hundredweight less than the Western Plains auction price. The transportation rate was $.59 per hundredweight to Dodge City, site of an auction market and large feedlots. Thus a savings of $0.93 per hundredweight could have been realized by purchasing feeder cattle in Kansas City over locally purchased cattle in January. However in May and throughout the summer months the price of feeder cattle at Kansas City was higher than prices reported at auctions in the western part of Kansas. Thus the more profitable situation would have been to

purchase cattle at local auctions as opposed to the Kansas City market. This same line of reasoning could be applied to each of the other markets.

The prices reported in 1970 and the transportation rates derived indicate that Kansas cattle feeders could profitably ship cattle from the southeastern and southwestern parts of the United States to Kansas for fattening.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The cattle industry is the largest industry in Kansas. Even though 5,564,000 head of cattle were produced in Kansas in 1969 the state still produced an excess of feed grains. Kansas cattle feeders have been and are continuing to expand the production of grain fed cattle. This expansion requires feeder cattle to be shipped into Kansas from ever increasing distances. The transportation of cattle thus becomes increasingly important.

Approximately 95 per cent of all cattle and calf movements are by truck but there is very little published information on rates and rate structures for livestock motor carriers. Livestock carriers operating in interstate are specifically exempt from economic regulation by the Motor Carrier Act of 1935. Therefore there are no published rates on interstate shipments of cattle. Each state has its own regulatory agency which may or may not regulate rates for livestock shipments. Each state also has developed laws governing the size and weight of trucks that may travel on its roads.

The livestock trucking industry is highly competitve with relatively easy entry and exit of firms and relatively small economies of size. New firms can easily operate as efficiently as larger well-established firms. This industry approaches the purely competitive model and the objectives of this study were to examine, describe and compare the structure of existing interstate and intrastate truck rates, to compare the cost of

interstate movement of cattle by rail and truck, and to determine the distance that feeder cattle could profitably be moved at given price margins.

Data were collected for interstate hauls of livestock in 1970 from thirteen Kansas based trucking firms by personal interview. Intrastate rate data were obtained from state regulatory agencies. Rail rates were obtained on hypothetical hauls from two railroads serving Kansas.

Multiple regression analysis was used to help describe the data to develop functions that could be used to estimate rates. Independent variables tested were; loaded distance hauled, linear feet of loading space, number of head hauled and the net weight of the load. In all cases loaded distance hauled explained more of the variation in rates than any other identified variable. Rate functions were developed for trucks with 40 and 60 linear feet of loading space using both the rate charged per loaded mile and the rate charged per hundredweight as dependent variables.

Rate functions developed for interstate hauls on a rate-per-hundredweight basis indicated that a linear relationship existed between the rate charged per hundredweight and the independent variables considered. The distance the load was hauled explained about 90 per cent of the variation in the rate charged per hundredweight when 60-foot trucks were used. About 80 per cent of the variation in rates was explained by distance hauled when 40-foot trucks were used.

Increased number of head per load, indicating smaller cattle, showed a tendency to raise the rate per hundredweight. Increased net weight tended to lower the rate per hundredweight. This indicated that larger

cattle made a more efficient load, e.g. more hundredweights per truckload, thus the same revenue per haul could be achieved by charging a lower rate per hundredweight.

The Y-intercept was positive in functions developed for both truck sizes. This indicated that a charge for loading, unloading, and other handling associated with shipping livestock was built into the rate structure. The coefficient of the distance hauled variable was .0015 for both the 40 and 60-foot truck functions. The rate per hundredweight increased 15 cents for every 100 miles the load was hauled.

A relatively small standard error of estimate along with other factors indicated that the rate-per-hundredweight functions were reliable estimators of rates charged. It must be remembered that any function best describes or estimates relationships over the range of the data from which it was derived.

The rate functions developed for interstate hauls with the rate charged per loaded mile as the dependent variable did not do a reliable job of estimating rates. The variation in rates was considerably greater at distances up to 400 miles than at greater distances. This gave rise to the problem of heteroscedasticity, nonhomogeneous variation in the data. Therefore the function developed was a biased estimator of the rate per mile.

Intrastate rate functions were developed for Kansas, Colorado, and Oklahoma from the published rate tariffs. The rate charged per hundredweight was the dependent variable in each case. The distance hauled, the number of head hauled, and net weight per load variables explained

99.38 per cent of the variation in Kansas rates. Distance hauled was the only significant variable in the Oklahoma rate function and it explained 99.16 per cent of the variation in rates. Distance hauled, number of head hauled and net weight per load were all significant in the Colorado function but explained only 65 per cent of the variation in rates charged.

Y-intercepts were all positive, indicating that intrastate rates also had built in charges for such things as loading and unloading.

The rate per hundredweight increased 18 cents for every one hundred miles the load was hauled in Kansas, 17 cents in Oklahoma and 21 cents in Colorado. The number of head hauled had a positive effect on rates in Kansas and Colorado while the net weight had a negative effect. This would indicate that the rate per hundredweight would tend to increase as the number of head per load increased with no change in net weight. However if net weight also increased the rate would tend to decrease.

Comparison of intrastate and interstate rate functions showed that the Y-intercept was higher for the interstate functions than for the intrastate functions. The coefficient of the distance hauled variable is lower for the interstate function than for any of the intrastate functions. The rate per hundredweight does not increase as rapidly for interstate hauls as it does for intrastate hauls as distance increases.

On hauls of less than 100 miles the interstate rate per hundredweight is slightly higher than the intrastate rate for Kansas and Oklahoma but as the distance hauled increases the intrastate rate becomes considerably higher than the interstate rates.

This would indicate that the intrastate rate for short hauls may be low relative to what truckers and shippers feel it could be.

Rail and truck rates were compared for eighteen hauls with common origins and destinations. The rail rates averaged about 37 cents per hundredweight higher than the rates estimated for 40-foot trucks and about 47 cents per hundredweight higher than the rates estimated for 60-foot trucks.

When the volume of cattle moving between any two points is sufficient special cattle cars and/or special cattle trains can be run by the railroads. The special cattle cars can be double decked and a per car rate is charged. This per car rate competes favorably with truck rates.

Time-in-transit when shipping by rail becomes a critical factor. Generally, time-in-transit is considerably longer for rail shipments than for truck shipments.

The distance that cattle can profitably be transported depends on the transportation rate, the level of prices, and the relationship between prices at various markets. As the price of cattle increases, cattle feeders can normally afford to ship cattle greater distances.

The structure of the rates for interstate transportation of cattle is based on a number of factors. Separate rate structures appear to exist for different sizes of trucks. Within these structures the rates depend on nearly the same variables with distance hauled being the most important variable. The number and size of cattle hauled affected the rate charged. A fixed charge is included in the rate structure to cover loading and unloading operations.

There is considerable variation of the rates charged for similar interstate hauls. This variation can be attributed to the negotiation of the rates between the trucker and the shipper, differences in the cost of operation in various states through which interstate shipments pass, and the possibility of backhauls.

Backhauls of either livestock or some other agricultural exempt commodity may be of considerable importance not only as a cause of variation in rates but also as a factor in the overall level of rates. Backhauls in interstate hauling are extremely difficult to define. If a "backhaul" is defined as a shipment from the original destination to the original origin, they are almost nonexistent for livestock truckers. However if a backhaul is defined as a shipment originating at the destination of the primary haul and going to a second destination other than the origin of the primary haul then backhauls are relatively common in the interstate transportation of livestock. If a trucker can originate a haul of any exempt commodity at his primary destination and proceed to any destination nearer his headquarters instead of returning with an empty truck he would normally profit from it. On interstate hauls the trucker is free to charge any rate he can get for hauling exempt commodities. Therefore backhauls may be at very low rates as long as the rate covers the marginal cost associated with hauling the load.

In intrastate transportation of livestock in Kansas backhauls are explicitly defined as a haul originating at the original destination and going to a point within 10 miles of the original point of origin or within 10 miles of the direct route between the original points of destination

and origin or to a point within 10 miles of the carriers terminal or within 10 miles of the direct route to his terminal. The backhaul is further restricted to being a shipment by the same shipper on the same equipment. The rate for this type haul is then 75 per cent of the rate for the original haul and applies only to livestock.[1] This definition makes the possibility of charging a backhaul rate considerably less in intrastate trucking than in interstate trucking. This may well be a major factor in explaining the difference in the level of rates.

Truckers interviewed stated they tried to obtain backhauls but did not plan for them when bargaining on rates. However, the general level of competition could well be based on the possibility of obtaining some backhauls. Additional research should be done to determine the exact affect that backhauls have on the rate structure for interstate and intrastate livestock hauls.

Another factor which may result in a difference in the level of rates between interstate and intrastate hauls of livestock by truck is price competition as opposed to service competition. On interstate hauls truckers are free to compete on rates charged. Thus the level of rates would tend to approach the cost of performing the haul. On intrastate hauls where the rates are regulated the truckers must compete on services rendered to the shipper. Lack of rate competition would also have a stabilizing effect on rates. (This was found in the intrastate rates of Kansas and Oklahoma.)

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[1] Kansas Motor Carriers Association, Inc., Motor Freight Tariff No. 50-C, KCC No. 62, Topeka, Kansas, Jan. 1970.

In this study it was found that for distances up to about 75 miles intrastate trucks with at least 36,000 pound load capacities had the lowest rates. For all distances over 75 miles trucks with 60-feet of loading space operating on interstate hauls offered the lowest rates.

Comparison of the purely competitive interstate truck rates and the Kansas regulated intrastate truck rates indicates that the basic rate structures are much the same. The level of the regulated rates are higher than the unregulated rates. The variation in rates, however, is nearly twice as great in the unregulated structure as in the regulated rate structure. Operating ratios indicate that no excessive profits are being made in either the regulated or the unregulated sectors of the livestock trucking industry. It appears that the only advantage gained by both the shipper and the trucker under a regulated rate structure is more stable rates.

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APPENDIX I

KANSAS DISTANCE COMMODITY RATES
(In cents per 100 pounds)

Rates named in this section apply on all shipments of livestock moving between points in Kansas.

Distance In Miles	Livestock					
	Minimum Weight (in pounds)					
	LTL	5,000	10,000	15,000	20,000	25,000
5	18	12	9	7	6	6
10	22	15	11	9	8	7
15	26	18	13	11	10	8
20	30	21	14	13	11	9
25	35	24	15	14	12	10
30	37	26	17	15	13	11
35	39	28	18	16	14	12
40	41	29	19	17	15	13
45	43	31	20	18	16	14
50	45	33	22	19	17	15
55	47	35	24	21	18	16
60	49	37	26	22	19	17
65	50	39	27	23	20	18
70	51	40	29	24	21	19
75	52	41	30	26	23	21
80	53	--	32	27	24	22
85	54	--	33	28	25	23
90	55	--	34	29	26	24
100	57	--	36	31	28	26
110	58	--	38	33	30	28
120	59	--	40	35	32	30
130	60	--	41	36	33	31
140	61	--	42	37	34	32
150	62	--	43	39	35	33
160	64	--	45	41	37	34
170	66	--	48	42	39	36
180	69	--	51	45	41	38
190	74	--	54	47	42	40
200	77	--	58	49	44	42
210	80	--	61	52	46	44
220	84	--	63	55	48	46
230	87	--	64	58	51	48
240	90	--	65	61	53	50
250	93	--	68	63	55	51
260	97	--	71	66	57	52
270	100	--	75	68	59	53
280	103	--	78	71	62	54

(continued next page)

KANSAS DISTANCE COMMODITY RATES
(In cents per 100 pounds)

Rates named in this section apply on all shipments of livestock moving between points in Kansas.

	Livestock					
Distance	Minimum Weight (in pounds)					
In Miles	LTL	5,000	10,000	15,000	20,000	25,000
290	106	--	81	73	64	56
300	109	--	84	76	66	58
310	112	--	87	79	68	59
320	112	--	90	81	70	61
330	118	--	93	84	73	63
340	121	--	96	86	75	65
350	124	--	97	89	77	67
360	127	--	98	91	79	69
370	130	--	99	94	81	71
380	133	--	100	96	83	73
390	136	--	103	99	85	75
400	139	--	104	101	87	77
410	142	--	107	104	89	79
420	145	--	109	106	91	81
430	148	--	111	109	93	83
440	161	--	114	111	95	85
450	164	--	116	113	97	87
475	172	--	121	115	102	92
500	180	--	127	118	108	96
525	188	--	133	124	114	102
550	196	--	139	130	120	109
575	202	--	147	136	126	115
600	210	--	151	142	132	121

Where exact distance is not shown, use next greater distance which is shown.

AN ANALYSIS OF CATTLE TRANSPORTATION RATES CHARGED BY KANSAS TRUCKERS

by

RICHARD LOY GILLASPIE

B. S., Kansas State University, 1965

AN ABSTRACT OF A MASTER'S THESIS

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requirements for the degree

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Ninety-five per cent of all cattle and calf movement is by truck but there is very little information available on the rates and rate structure for interstate livestock trucking. The purpose of this study was to examine and describe the structure of existing truck rates for interstate and intrastate movements of cattle, to compare these rate structures with each other and with rail rates and to determine rate functions which could be used to determine how far cattle could profitably be shipped. Data was collected by personal interview from thirteen trucking firms and two railroads in Kansas. Multiple regression analysis was used to analyze the data

Data was based primarily on full truck load interstate shipments of cattle in trucks with 40 and 60 linear feet of loading space. Rate functions developed for both sizes of trucks indicated that the distance the load was hauled accounted for the majority of the variation in the dependent variable.

The Y-intercept of the rate per hundredweight functions developed for interstate hauls were positive for both 40 and 60 foot trucks. This indicated a charge for loading, unloading and other handling operations was built into the rate structure. The Y-intercept was about four cents higher for the 40 foot truck rate function than for the 60 foot truck function. Both functions increased at the same rate over distance, 15 cents per 100 miles hauled.

When the rate charged per loaded mile was considered as the dependent variable, the distance the load was hauled accounted for the majority of the variation that was explained. The function developed explained about 50 per cent of the variation in the rate charged per loaded mile. This was due to the problem of heteroscedasticity in the model. The variation

in the data was much greater at distances less than 400 miles than at greater distances. Therefore the function was a biased estimator of rates per mile.

The rate structure of regulated intrastate rates for livestock hauling were similar to the unregulated interstate rate structure. Linear functions fit the data well in both cases and distance hauled explained more of the variation than any other identified variable. The Y-intercept was positive in all cases. The interstate function had an intercept higher than two of the three intrastate functions but it increased less rapidly as distance increased. This caused the rate per hundredweight charged on interstate hauls to be slightly higher than intrastate rates for hauls of less than 100 miles. At greater distances the interstate rate was considerably lower than intrastate rates. Variation in rates charged for similar hauls was considerably greater on unregulated hauls than on regulated hauls.

Per hundredweight rail rates were considerably higher than truck rates. However, special cattle cars were being used by some railroads. The per car rates charged on these cars compared favorably with interstate truck rates.

The distance that cattle can profitably be shipped depends on the transportation rate, the level of cattle prices and the relationship of prices at various markets. Feedlot operators and cattle buyers can normally ship cattle greater distances when prices are high as transportation becomes a smaller portion of the total cost.