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An Analysis of the Elasticity of Demand for Rail Transportation of HARD RED SPRING WHEAT

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E R R A T A

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Some errors occurred in the first paragraph under the section entitled Price Elasticity of Demand for Rail Transportation of HRS Wheat - North Dakota, 1965-1967 on page 10.

The first sentence of this section should read as follows (changes are underscored):

> Price elasticities[9] of demand for rail transportation for 1965 indicated that a one percent decrease in rail rates would result in a 2.4 to 2.9 percent increase in the quantity of HRS shipped by rail/elevator on the average other things equal[10] (Table 2).

For example, in 1965 had the rails increased rail rates by one percent, the quantity handled by rails would decrease by approximately 2.4 thousand bushels/elevator on the average. A decrease of one percent in 1965 would result in an increase of approximately 2.4 thousand bushels/elevator on the average.

Price elasticities for 1967 ranged from 1.9 to 2.1 percent for a one percent price increase and 1.8 to 1.9 for a one percent price decrease on the average.

The lower valued price elasticities (less elastic) in 1967 as compared to 1965, could have been caused by the decrease in average marketable HRS/elevator (Table 3), the supply of rail cars and trucks, and the rail and truck rates. This does not imply that other factors did not cause the change in price elasticities (demand curve).

The interaction of the marketable HRS/elevator, supply of rail cars and trucks, and the truck rates caused a shift in the demand curve for rail transportation (Figures 2-3). The change in North Dakota rail rates (4.0 percent increase from 1965 to 1967 versus a 2.0 percent increase in truck rates in the same period) caused a movement along the demand curve for rail transportation. The end result of the shift and movement along the demand curve for rail transportation was a less elastic demand for 1967. This indicated that shippers do not react to rail rate increases per se, but that other factors compete in the shippers' choice of transportation.

Price elasticities of demand for rail transportation were not estimated for 1966 due to the statistical insignificance of the price-quantity relationship that existed.

Four price elasticity equations were employed to estimate the price elasticity of demand for rail transportation. The four equations were point, arc and two average arc (calculated in different manners) elasticities.

TABLE 3. PERCENTAGE OF AVERAGE MARKETABLE HARD RED SPRING WHEAT SHIPPED BY RAIL PER ELEVATOR TO THE DULUTH-SUPERIOR MARKET FROM SAMPLED NORTH DAKOTA AND MINNESOTA ELEVATORS, 1965, 1966, AND 1967

Item	North Dakota			Minnesota			Two-State Area (N.D. - Minn.)		
	1965	1966	1967	1965	1966	1967	1965	1966	1967
Average Elevator Shipment by Rail (000 Bushels)	85.0	101.3	79.2	117.9	112.7	118.2	93.5	103.2	88.9
Average Marketable HRS Wheat/Elevator (000 Bushels)	226.1	244.2	214.4	209.3	210.0	235.8	219.4	232.9	219.1
Percent of Marketable HRS Wheat Shipped by Rail/Elevator[a]	37.6	41.4	36.9	56.3	53.7	50.1	42.6	44.3	40.6

[a]The remaining marketable hard red spring wheat was available to trucks for shipment to the Duluth-Superior market or to any non-Duluth-Superior market by either mode of transportation.

These equations were employed to indicate that price elasticities of demand would vary to some degree depending on the method used to calculate the value. In other words a policymaker (representative of the producer) would utilize the higher elasticity coefficients to encourage a rate decrease. The railroad rate analyst would utilize the lower valued elasticity coefficient to discourage a rate decrease (especially if the railroad held a major share of the market).

Minnesota HRS, 1965-1967

The direct relationship between Y and X_3 indicated that an increase in marketable HRS/elevator for the specific years (1965, 1966, and 1967) would be associated with an increase in quantity of HRS shipped by rail/elevator. The data suggest that over the longer three-year period (1965-1967) the quantity shipped by rail/elevator decreased as marketable HRS/elevator increased. The time period analyzed was too short to predict whether this trend would continue. For example, in 1965 the rails handled an average of 117.9 thousand bushels of HRS/elevator to the Duluth-Superior market or 56.3 percent of the average marketable HRS/elevator, available for shipments to Duluth-Superior versus 50.1 percent of the average marketable HRS/elevator, available for shipments to Duluth-Superior in 1967 (Table 3).

An across the board decrease in Minnesota rail rates would be associated with an increase in quantity shipped by rail/elevator from Minnesota for 1966 (Figure 4). For example, had rails decreased rates (across the board) by .25 cents/ton mile, the quantity shipped by rail/elevator would increase by 55 thousand bushels.

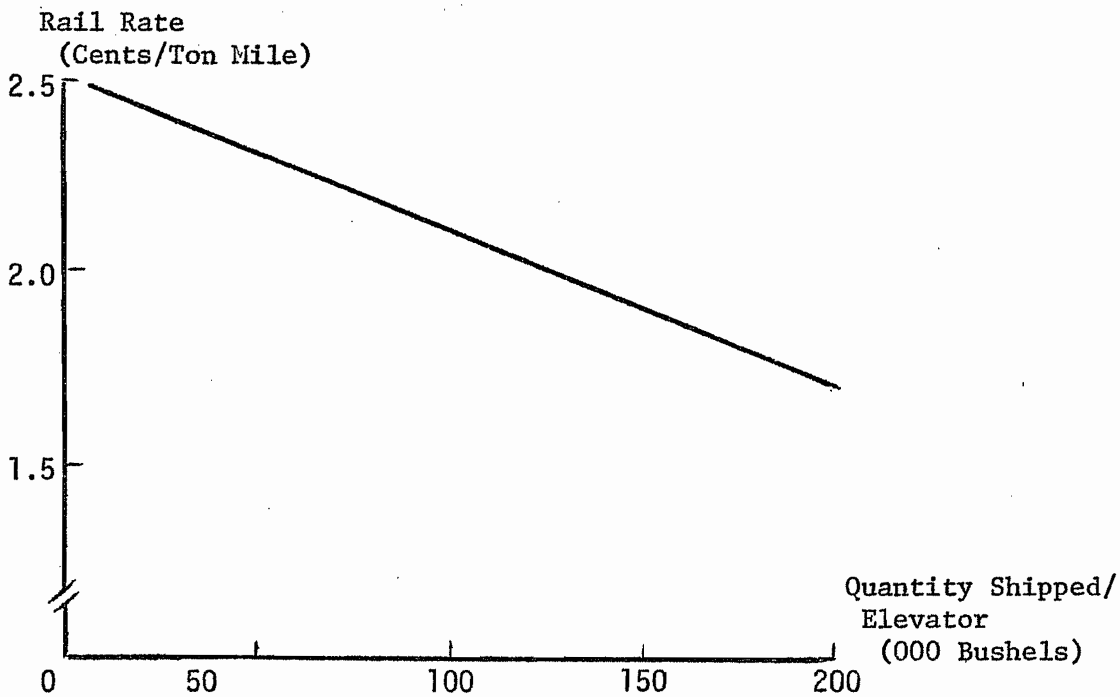

Figure 4. Demand Curve for Rail Transportation of HRS Wheat to the Duluth-Superior Market, Minnesota, 1966

The unexpected relationship between Y and X_2 indicated that rails would increase the quantity handled/elevator by approximately 15 thousand bushels had truckers decreased truck rates across the board by .20 cents/ ton mile in 1967. This relationship could have been caused by irrational decision making by shippers or that railroads were retaining the inherent advantage of long-haul shipments; i.e., if the rail rates decrease at a faster rate than truck rates, then the shipper may be justified to ship by rail, considering other factors.

Nine different elevator locations were selected (three different areas with three elevators in an area, equal-distance apart) to test the above hypothesis. In one area rail rates decreased and truck rates increased as distance increased from the Duluth-Superior market. The elevator managers in this area utilized rails almost 80 percent of the time. In the second area rail rates decreased then increased and truck rates remained constant then decreased as distance increased from the market. The elevator managers in this area utilized rails almost 100 percent of the time. In the third area rail rates increased then decreased and truck rates decreased as distance increased from the market. Elevator managers in that area utilized rails almost 90 percent of the time.

The inherent advantage (rail costs/unit decline at a faster rate than truck costs because of the high fixed cost nature of railroad cost structures) was displayed at certain locations, but the irrationality of shippers was also evident. Therefore, a combination of the two factors could be the cause for the inverse relationship between Y and X_3. This does not imply that other factors were not influencing this relationship.

Price Elasticity of Demand for Rail Transportation of HRS Wheat - Minnesota, 1965-1967

Price elasticites of demand for rail transportation in 1966 indicated that rails would gain 6.6 to 8.1 percent in quantity handled/ elevator on the average for a one percent price (rate) decrease (Table 2). A one percent increase in price would result in a 8.1 to 13.6 percent loss in volume shipped by rail/elevator on the average. For example, a one percent decrease in rail rates would be associated with an increase of approximately nine thousand bushels of HRS shipped by rail/elevator.

Minnesota rail rates actually increased from an average of 2.02 to 2.10 cents/ton mile or an increase of 3.9 percent from 1965 to 1967. Minnesota truck rates in the same period increased from an average of 1.80 to 1.81 cents/ton mile or an increase of only .5 percent. The data in Table 8 support the price elasticity coefficients in that the rail rates were increased and the average quantity shipped by rail/elevator decreased from 1966 to 1967.

Price elasticities were not estimated for 1965 and 1967 due to the statistical insignificance of the price-quantity relationship that existed.

Two-State Area HRS (N.D.-Minn.), 1965-1967

The direct relationship between Y and X_3 indicated that an increase in marketable HRS/elevator would be associated with an increase in quantity shipped by rail/elevator for the specific years 1965, 1966, and 1967. The time period (1965-1967) was not long enough to indicate a trend in shipping HRS by rail/elevator.

An across the board decrease in rail rates would result in an increase in quantity shipped by rail/elevator for 1965 (Figure 5).

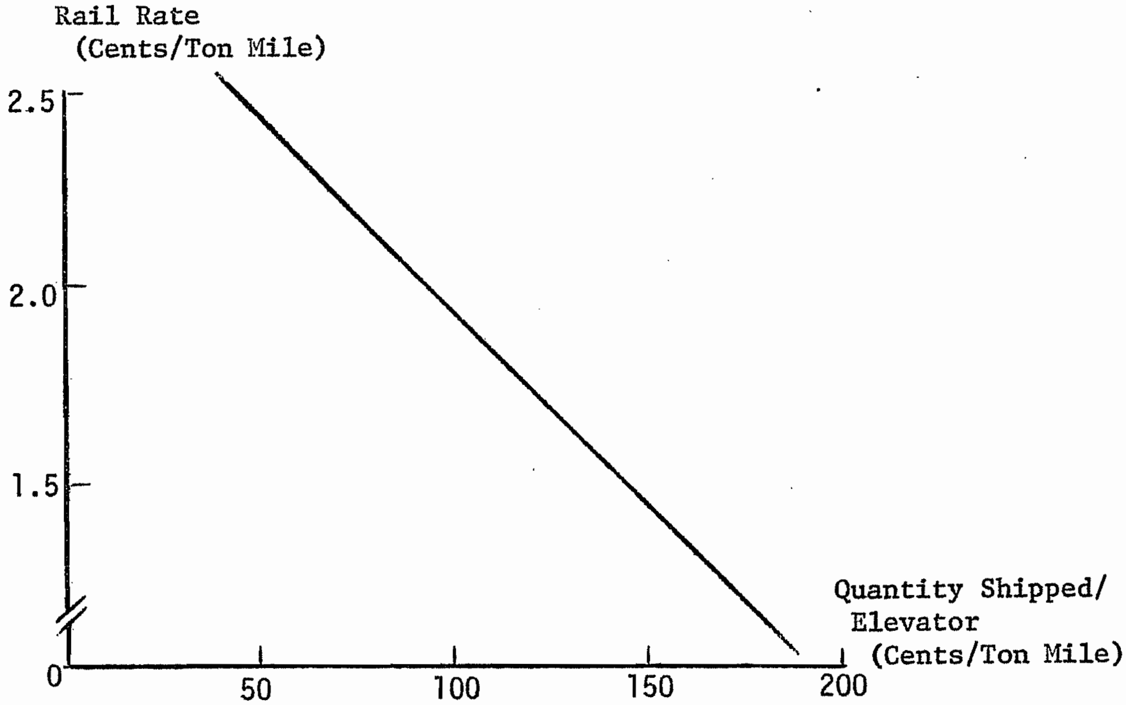

Figure 5. Demand Curve for Rail Transportation of HRS Wheat Shipped by Rail/Elevator to the Duluth-Superior Market, Two-State Area, 1965

The unexpected relationship between Y and X_2 indicated that rails would increase the quantity handled/elevator had truck rates decreased in 1967. The same relationship exists in equation nine as did in equation six (Minnesota HRS, 1967). The same hypothesis can be made as was hypothesized for Minnesota HRS since the relationship that existed for Minnesota shipments would be relevant in this case.

Six elevator locations in North Dakota were selected (two areas, three elevators in an area, equal-distance apart) to aid in the proof of the hypothesis. In the first area rail rates decreased (from elevator one to two) while truck rates increased, then both rail and truck rates decreased from elevator two to three (rail rates decreased greater than truck rates) as the distance increased from the Duluth-Superior market. The elevator manager at location two shipped the majority of the HRS by truck, whereas the elevator manager at location three shipped the HRS exclusively by rail. In the second area both rail and truck rates increased (rails increased at a greater rate) from elevator one to two, then both rail and truck rates decreased (rail rates decreased faster than truck rates) from elevator two to three as distance increased from the market. The elevator manager at location two shipped the HRS exclusively by truck. The elevator manager at location three shipped approximately 85 percent of the HRS by rail.

The conclusions drawn from the data to support the hypothesis were the same as the conclusion for Minnesota HRS (1967). That is, the combination of the inherent advantage of rails and the irrationality of shippers appear to cause the inverse relationship between Y and X_3.

Price Elasticity of Demand for Rail Transportation of HRS Wheat - Two-State Area (N.D.-Minn.), 1965-1967

Price elasticites of demand for rail transportation in 1965 indicated that rails would gain 2.1 to 2.2 percent in quantity handled/ elevator for a one percent price decrease (Table 2). A one percent price increase would have resulted in a loss of 2.1 to 2.5 percent in quantity shipped by rail/elevator. In other words if rail rates were decreased, railroad revenues would increase and a possible savings could result in terms of reduced transportation cost for the producer.

Rail rates increased from 2.00 cents/ton mile in 1965 to 2.09 cents/ton mile in 1967 or an increase of 4.5 percent. Truck rates in the same period increased from 1.75 to 1.78 cents/ton mile or a 1.7 percent increase. Rail rates did not increase from 1965 to 1966 and the average quantity shipped by rail/elevator increased (Table 8). From 1966 to 1967 the rail rates increased by 4.5 percent and the average quantity shipped by rail/elevator decreased. This indicated that shippers do respond to price changes to some degree.

Price elasticities of demand for rail transportation were not calculated for the years 1966 and 1967 due to the statistical insignificance of the price-quantity relationship that existed.

Minneapolis - St. Paul Market

Equations 10-21 were analyzed for shipments of hard red spring wheat shipped by rail to the Minneapolis-St. Paul market (Appendix Table 2).

North Dakota HRS, 1965-1967

An increase in marketable HRS/elevator would be associated with an increase in quantity shipped by rail/elevator for the specific years 1965, 1966, and 1967. The data suggest that the average quantity shipped by rail/elevator would decrease very little over a longer period of time (1965-1967) as average marketable HRS/elevator increases and decreases (Table 4).

TABLE 4. PERCENTAGE OF AVERAGE MARKETABLE HARD RED SPRING WHEAT SHIPPED BY RAIL PER ELEVATOR TO THE MINNEAPOLIS-ST. PAUL MARKET FROM SAMPLED NORTH DAKOTA, MINNESOTA, AND SOUTH DAKOTA ELEVATORS, 1965, 1966, AND 1967

	North Dakota			Minnesota			South Dakota			Three-State Area (N.D., Minn. & S.D.)		
Item	1965	1966	1967	1965	1966	1967	1965	1966	1967	1965	1966	1967
Average Elevator Shipment by Rail (000 Bushels)	121.0	125.3	112.6	64.6	71.6	81.1	114.5	134.8	126.8	109.6	118.2	110.4
Average Marketable HRS Wheat/ Elevator (000 Bushels)	256.2	270.5	245.7	186.3	194.3	209.8	140.8	170.3	171.1	219.4	236.2	224.3
Percent of Marketable HRS Wheat Shipped by Rail/ Elevator[a]	47.2	46.3	45.8	34.6	36.8	38.7	81.9	79.2	71.6	50.0	50.0	49.2

[a]The remaining marketable hard red spring wheat was available to trucks for shipment to the Minneapolis-St. Paul market or to any non-Minneapolis-St. Paul market by either mode of transportation.

North Dakota rail rates on HRS over the three-year period increased from an average of 2.03 to 2.13 cents/ton mile or a 4.9 percent increase. In the same period North Dakota truck rates increased from an average of 1.66 to 1.71 cents/ton mile or an increase of 3.0 percent.

The percentage of average marketable HRS shipped by rail/elevator decreased from 47.2 to 45.8 percent. The relatively greater increase in rail rates over truck rates associated with the decrease in average marketable HRS shipped by rail/elevator indicated that shippers may respond to price changes to a small degree. Shippers may have responded by shipping the HRS by truck to the Minneapolis-St. Paul market or by shipping the HRS to any non-Minneapolis-St. Paul market by either mode of transportation.[11]

Minnesota HRS, 1965-1967

The relationship that existed between quantity shipped by rail/elevator and rail rates indicated that an across the board increase in rail rates would result in a decrease in quantity shipped by rail/elevator for the years 1966 and 1967 (Figures 6-7).

An across the board increase in truck rates would be associated with an increase in quantity shipped by rail/elevator for the specific years 1965, 1966, and 1967. For example, in 1967 had the truck rates increased (across the board) by .25 cents/ton mile, the rails would have increased the quantity handled by approximately 54 thousand bushels/elevator for that year. The relationship between rail and truck rates for 1966 and 1967 to the quantity of HRS shipped by rail/elevator indicated that rail and trucks were good substitutes.

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[11]Price elasticities of demand for rail transportation were not estimated due to the statistical insignificance of the price-quantity relationship that existed from 1965-1967.

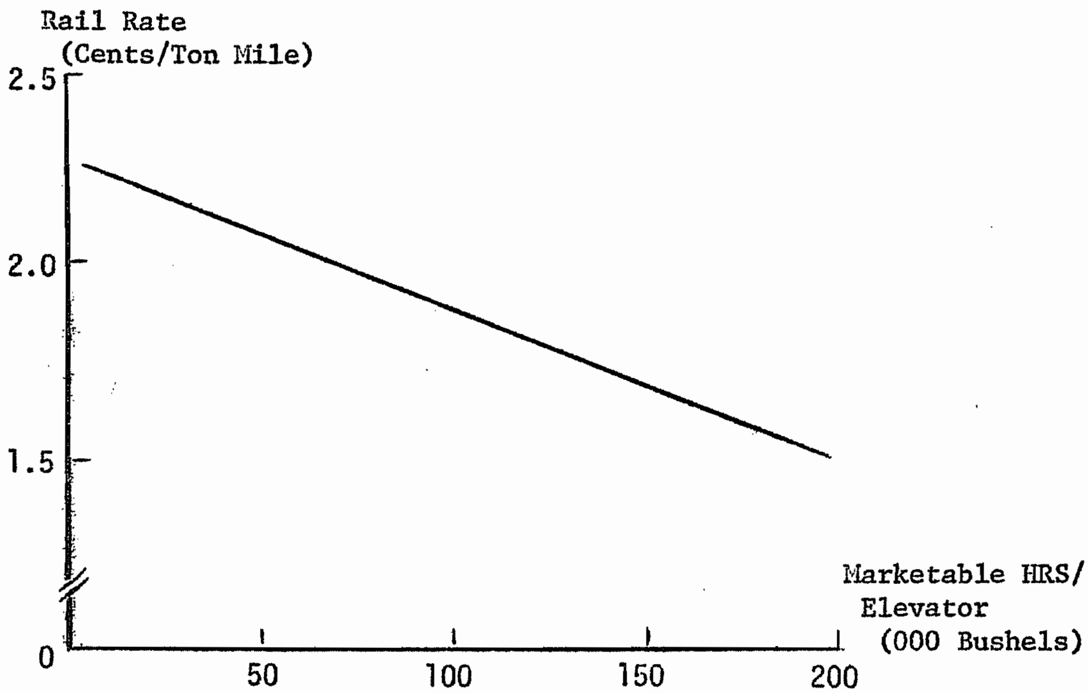

Figure 6. Demand Curve for Rail Transportation of HRS Wheat in the Minneapolis-St. Paul Market, Minnesota, 1966

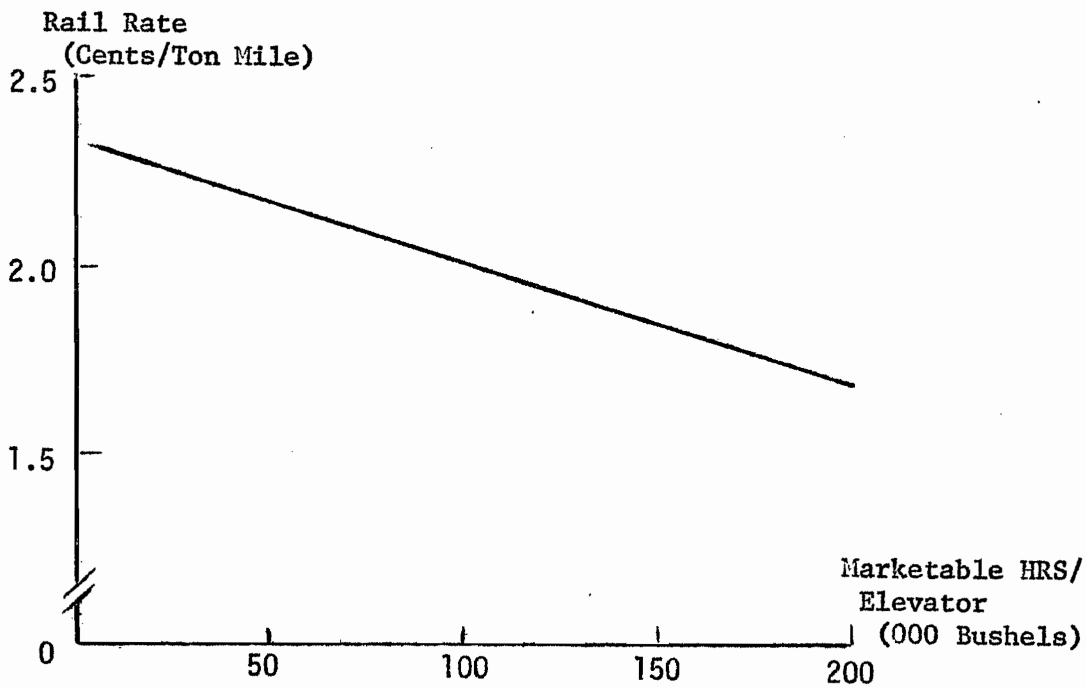

Figure 7. Demand Curve for Rail Transportation of HRS Wheat to the Minneapolis-St. Paul Market, Minnesota, 1967

The direct relationship between Y and X_3 indicated that an increase in marketable HRS/elevator would result in an increase in quantity of HRS shipped by rail/elevator for the specific years 1965, 1966, and 1967. The data suggest that rails would increase the average quantity handled/elevator as the average marketable HRS/elevator increases over the years 1965-1967 (Table 4).

Price Elasticity of Demand for Rail Transportation of HRS Wheat - Minnesota, 1965-1967

Price elasticites of demand for rail transportation calculated from the 1966 shipments indicated that a one percent price decrease in rail rates would be associated with a 5.4 to 6.5 percent gain in quantity shipped by rail/elevator on the average (Table 5) indicating that rails could increase revenues and producers would benefit in terms of reduced transportation costs. A loss of 6.5 to 9.8 percent in rail volume/elevator on the average would be the result of a one percent rate increase. The increase in rail rates would result in a decrease in revenues for railroads and an increase in transportation costs for producers.

Price elasticities for the 1967 data indicated that the demand for transportation was becoming more elastic; i.e., shippers were becoming more responsive to rail rate changes. In 1967 a one percent price (rate) decrease would result in a 6.4 to 7.8 percent increase in volume shipped by rail/elevator on the average, versus a 5.4 to 6.6 percent in 1966. A one percent increase in price in 1967 would result in a loss of 7.8 to 12.6 percent in volume shipped by rail/elevator on the average, versus a 6.5 to 9.8 percent loss in 1966.

The high valued price elasticities (more elastic) in 1967, as compared to 1966, could have been caused by the changing relationship

TABLE 5. ESTIMATED PRICE ELASTICITY OF DEMAND FOR RAIL TRANSPORTATION OF HARD RED SPRING WHEAT TO THE MINNEAPOLIS-ST. PAUL MARKET FROM SAMPLED MINNESOTA, NORTH DAKOTA, AND SOUTH DAKOTA ELEVATORS, 1966 AND 1967[a]

Elasticity[b]	Price	Minnesota 1966	Minnesota 1967	Three-State Area (N.D., Minn. & S.D.) 1966	Three-State Area (N.D., Minn. & S.D.) 1967
Point Elasticity	1% Increase	6.62	7.84	2.27	1.90
	1% Decrease	6.62	7.84	2.27	1.90
Arc Elasticity	1% Increase	6.55	7.84	2.29	1.90
	1% Decrease	6.55	7.84	2.29	1.90
Average Arc Elasticity (1)	1% Increase	9.832	12.62	2.58	2.09
	1% Decrease	6.215	7.46	2.17	1.81
Average Arc Elasticity (2)	1% Increase	8.154	9.89	2.48	2.03
	1% Decrease	5.467	6.48	2.11	1.78
Range of Elasticities	1% Increase	6.5-9.8	7.8-12.6	2.3-2.6	1.9-2.1
	1% Decrease	5.4-6.6	6.4-7.8	2.1-2.3	1.8-1.9

[a]See Appendix A for computational procedures and explanations.

[b]Elasticities were calculated about the means of the rail rates.

between rail and truck rates, the supply of rail cars and trucks, and the marketable HRS/elevator. This does not imply that other factors did not cause the change in price elasticities.

The interaction of the truck rates, supply of rail cars and trucks, and the marketable HRS/elevator caused a shift in the demand curve for rail transportation (Figures 6-7).

The change in Minnesota rail rates (.08 cents/ton mile increase from 1965 to 1967 versus a .07 cents/ton mile increase in truck rate in the same period) caused a movement along the demand curve for rail transportation. The end result of the shift in the demand curve for rail transportation was a more elastic demand for 1967.

The fact that average quantity of HRS shipped by rail/elevator continued to increase from 1965-1967 (average marketable HRS/elevator increased by 12.0 percent and average quantity shipped by rail/elevator increased by 25.0 percent) and rail rates increased at a greater absolute amount than motor carriers indicates that Minnesota elevator managers' decisions on selection of alternative modes were based on factors other than the relative level of rail freight rates. This outcome would discourage railroad rate analysts from decreasing rail rates.

Price elasticities of demand were not estimated for 1965 due to the statistical insignificance of the price-quantity relationship that existed.

South Dakota HRS, 1965-1967

An increase in the marketable HRS/elevator would be associated with an increase in quantity of HRS/elevator shipped by rail for the specific years 1965, 1966, and 1967. The data suggest that an increase in average marketable HRS/elevator would result in a decreasing trend over time (1965-1967) in average quantity shipped by rail/elevator (Table 4).

South Dakota rail rates on HRS from 1965-1967 increased by .5 percent (1.99 to 2.00 cents/ton mile). South Dakota truck rates on HRS in the same period increased by 2.2 percent (1.80 to 1.83 cents/ton mile).

Although the truck rates were increasing at a greater relative rate than rail rates, South Dakota elevator managers were shipping less HRS by rail/elevator on the average over the three-year period (Table 4). Apparently the advantages of shipping HRS by rail to Minneapolis-St. Paul were being offset by the lower truck rate or the HRS was being shipped to non-Minneapolis-St. Paul markets by either mode of transportation.[12]

Three-State Area HRS, (N.D., Minn. & S.D.), 1965-1967

The inverse relationship between Y and X_1 indicated that an across the board decrease in rail rates would result in an increase in quantity of HRS shipped by rail/elevator for the specific years 1966 and 1967 (Figures 8-9). For example, in 1966 had the rail rates been decreased (across the board) by .25 cents/ton mile, the quantity shipped by rail/elevator would have increased by approximately 37.5 thousand bushels per elevator.

An across the board increase in truck rates would be associated with an increase in volume shipped by rail/elevator for the specific years 1966 and 1967. The relationship between rail and truck rates for 1966 and 1967 to the quantity of HRS shipped by rail/elevator indicated that rails and trucks were good substitutes.

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[12]Price elasticites of demand for rail transportation were not estimated due to the statistical insignificance of the price-quantity relationship that existed from 1965-1967.

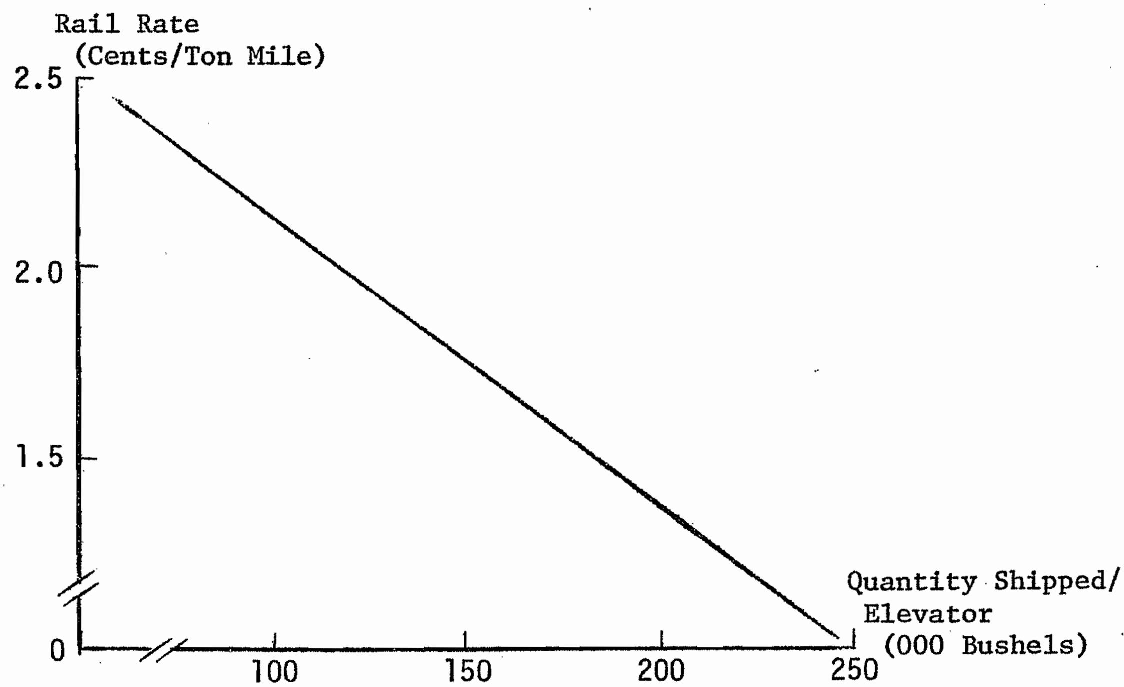

Figure 8. Demand Curve for Rail Transportation of HRS Wheat to the Minneapolis-St. Paul Market, Three-State Area, 1966

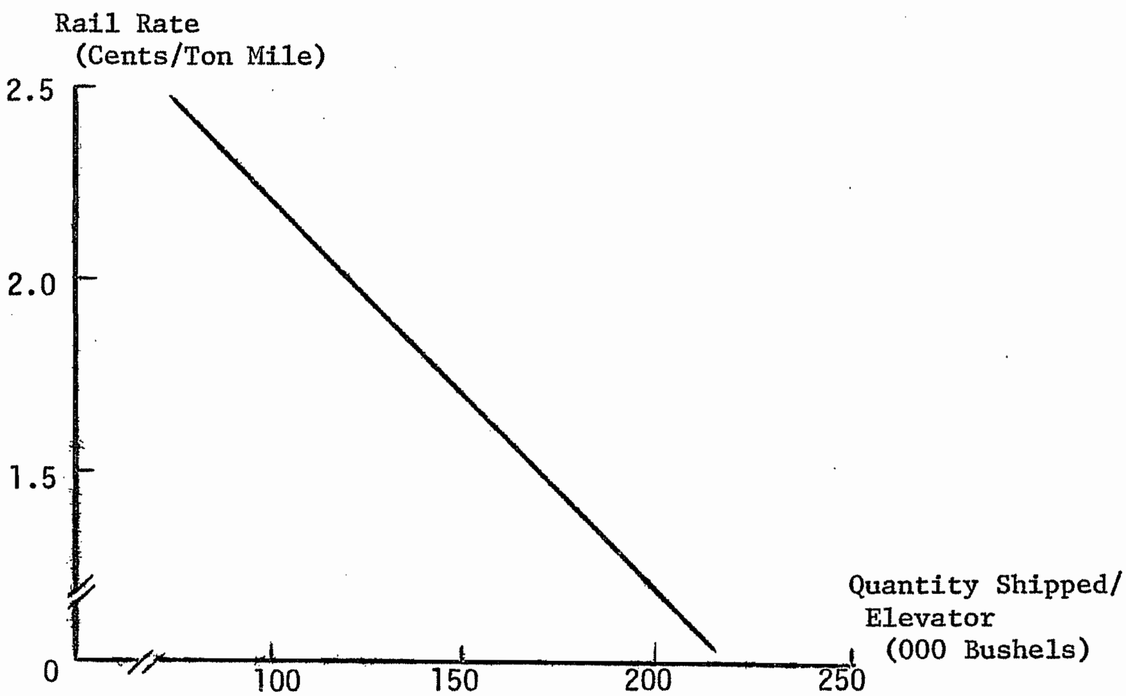

Figure 9. Demand Curve for Rail Transportation of HRS Wheat to the Minneapolis-St. Paul Market, Three-State Area, 1967

The positive relationship between Y and X_1 indicated that an increase in marketable HRS/elevator would be associated with an increase in quantity shipped by rail/elevator for the specific year 1965, 1966 or 1967. The data suggest that quantity shipped by rail/elevator over the three year period would remain relatively stable as marketable HRS/elevator increased or decreased (Table 4).

Price Elasticity of Demand for Rail Transportation of HRS Wheat - Three-State Area (N.D., Minn. & S.D.), 1965-1967

Price elasticity of demand for rail transportation for 1966 indicated that a one percent price decrease in rail rates would result in a gain of 2.1 to 2.3 percent in volume shipped of HRS by rail/elevator on the average (Table 5). A loss of 2.3 to 2.6 percent in quantity shipped by rail/elevator would have been the result of a one percent price increase.

In 1967 the price elasticities became less elastic; i.e., shippers became less responsive to price (rail rate) changes. A one percent price decrease in 1967 would result in a gain of 1.8 to 1.9 percent in quantity shipped by rail/elevator.

An increase of one percent in price would be associated with a 1.9 to 2.1 percent loss in quantity shipped of HRS by rail/elevator.

The lower valued price elasticities (less elastic) in 1967, as compared to 1966, could have been caused by the change in marketable HRS/elevator, rail and truck rates, and the supply of rail cars and trucks. This does not imply that other factors were not influencing the change in price elasticities.

The interaction of the truck rates, marketable HRS/elevator, and the supply of rail cars and trucks caused a shift in the demand curve for rail transportation (Figures 8-9). The change in the three-state area rail rates (4.0 percent increase versus a 2.9 percent increase in truck rates during the period 1965-1967) caused a movement along the demand curve for rail transportation. The result of the shift in the demand curve for rail transportation was a less elastic demand for 1967.

Price elasticities of demand for rail transportation were not estimated due to the statistical insignificance of the price-quantity relationship that existed in 1965.

INSTITUTIONAL FACTORS AFFECTING GRAIN SHIPMENTS

Factors considered exogenous[13] to the statistical models are discussed in this section. Regression techniques applied to the data indicated that factors other than price may have a strong influence on the choice of model in shipping grain.

Rail-Truck Supply - 1965, 1966, and 1967

Elevator managers were asked to estimate the supply of rail cars and trucks available to them for the years 1965, 1966, and 1967 (Table 6). The supply of rail cars and trucks definitely affects the movement of grain to the market.

North Dakota elevator managers indicated a less than adequate to adequate supply for both rail cars and trucks. The supply of trucks was slightly better than rail cars. Minnesota elevators estimated a less than adequate supply of rail cars while the supply of trucks was estimated as being adequate. South Dakota elevators appear to have been in a better position than North Dakota and Minnesota elevators as both rail cars and trucks were in adequate supply. In the aggregate majority of

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[13] The term exogenous pertains to outside influences which may or may not affect the alternative selection of modes of transportation.

TABLE 6. ELEVATOR MANAGERS ESTIMATIONS OF RAIL-TRUCK SUPPLY FROM SAMPLED NORTH DAKOTA, MINNESOTA, AND SOUTH DAKOTA ELEVATORS, 1965, 1966, AND 1967

	North Dakota						Minnesota					
	1965		1966		1967		1965		1966		1967	
Supply[a]	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck
	(Percent of Total)											
5	11	5	9	5	9	5						
4	2	15	--	7	2	10		7				
3	39	44	41	51	37	43	39	57	33	57	28	50
2	41	34	39	32	41	37	61	36	61	43	61	50
1	7	2	11	5	11	5			6		11	
N	44	41	44	41	44	41	18	14	18	14	18	14

- continued -

TABLE 6. ELEVATOR MANAGERS ESTIMATIONS OF RAIL-TRUCK SUPPLY FROM SAMPLED NORTH DAKOTA, MINNESOTA, AND SOUTH DAKOTA ELEVATORS, 1965, 1966, AND 1967 (continued)

	South Dakota						Total					
	1965		1966		1967		1965		1966		1967	
Supply[a]	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck
	(Percent of Total)											
5							7	3	5	3	5	3
4	8	9					3	12	--	5	1	6
3	58	73	75	73	69	75	41	52	45	56	40	51
2	34	18	25	27	23	25	45	31	42	33	43	37
1					8		4	2	8	3	11	3
N	12	11	12	11	13	12	74	66	74	66	75	67

[a]5 = abundant supply; 4 = more than adequate; 3 = adequate supply; 2 = less than adequate; 1 = critical shortage; and N = number of observations.

elevator managers believed that the supply of rail cars were adequate to less than adequate. The supply of trucks was estimated to have been adequate. Only four percent of the elevator managers reported critical shortages of rail cars in 1965 while 10.6 percent reported critical shortages in 1967. Those reporting critical shortages of trucks in the same period increased from 2.0 to 3.0 percent.

Advantages and Disadvantages of Shipping Grain by Rail and Truck Transportation

Several institutional factors were listed from which elevator managers were to indicate whether or not the factor was an advantage, disadvantage or undecided as affecting their choice of transport mode. The institutional factors were selected on the basis of the impact that the factors could have on grain shipments by rail or truck.

Advantages of Rail Transportation

Three major advantages of rail transportation were indicated by 70 percent or more of the elevator managers (Table 7). The advantage reported most frequently was the number of markets available (85.5 percent). The second most frequently reported advantage was the availability of large volume shipments per car (76 percent). The third most frequently reported advantage was the availability of weights and grades (72 percent). Approximately 50.0 percent of elevator managers indicated that the transit privileges were an advantage to shipping grain by rail. All elevators do not have transit privileges; elevator managers must apply for the privilege.

TABLE 7. ADVANTAGES AND DISADVANTAGES OF SHIPPING GRAIN BY RAIL, REPORTED BY COUNTRY ELEVATOR MANAGERS, NORTH DAKOTA, MINNESOTA, AND SOUTH DAKOTA 1969[a]

Selections	Choice		
	Advantage	Disadvantage	Undecided
	(Percent of Total)		
No. of markets available	85.5	1.3	13.2
Cost of handling rail cars	32.9	31.6	35.5
Service features; reliable, faster service	18.4	47.4	34.2
Level of freight rates	19.7	47.4	32.9
Vol. of shipments, per car	76.4	11.8	11.8
Weights and grades, availability	72.4	2.6	25.0
Condition of rail cars	10.5	68.4	21.1
Availability of cars	25.0	44.7	30.3
Availability of transit privileges	51.3	7.9	40.8
Other	--	--	--

[a]Seventy-six elevator managers reported.

Disadvantages of Rail Transportation

Sixty-eight percent of the elevator managers indicated that the condition of rail cars was the most frequently encountered disadvantage (Table 7). The level of freight rates and service features (in reliability and slower service) was the second most frequently reported disadvantage (47.0 percent).

Advantages of Truck Transportation

The major advantage of truck transportation indicated by elevator managers was the relief furnished by trucks during boxcar shortages (Table 8). Service features (reliability and faster service) ranked as the second most frequently reported advantage (70.1 percent). Condition of trucks and the level of truck freight rates were ranked almost equal as the third most frequently reported advantage.

TABLE 8. ADVANTAGES AND DISADVANTAGES OF SHIPPING GRAIN BY TRUCK REPORTED BY COUNTRY ELEVATOR MANAGERS, NORTH DAKOTA, MINNESOTA, AND SOUTH DAKOTA, 1969[a]

Selections	Choice		
	Advantage	Disadvantage	Undecided
	(Percent of Total)		
Furnish relief during boxcar shortage	83.1	3.9	13.0
Availability of trucks	49.4	26.0	24.6
Level of freight rates	61.0	15.6	23.4
No. of markets available	16.9	50.6	32.5
Lack of weights and grades	11.7	53.2	35.1
Unavailability of transit privileges	18.2	44.2	37.6
Cost of handling trucks	41.6	25.9	32.5
Condition of trucks	62.3	5.2	32.5
Service features; reliable, faster service	70.1	3.9	26.0
Vol. of shipments per truck	6.5	54.5	39.0
Other	--	--	--

[a]Seventy-seven elevator managers reported.

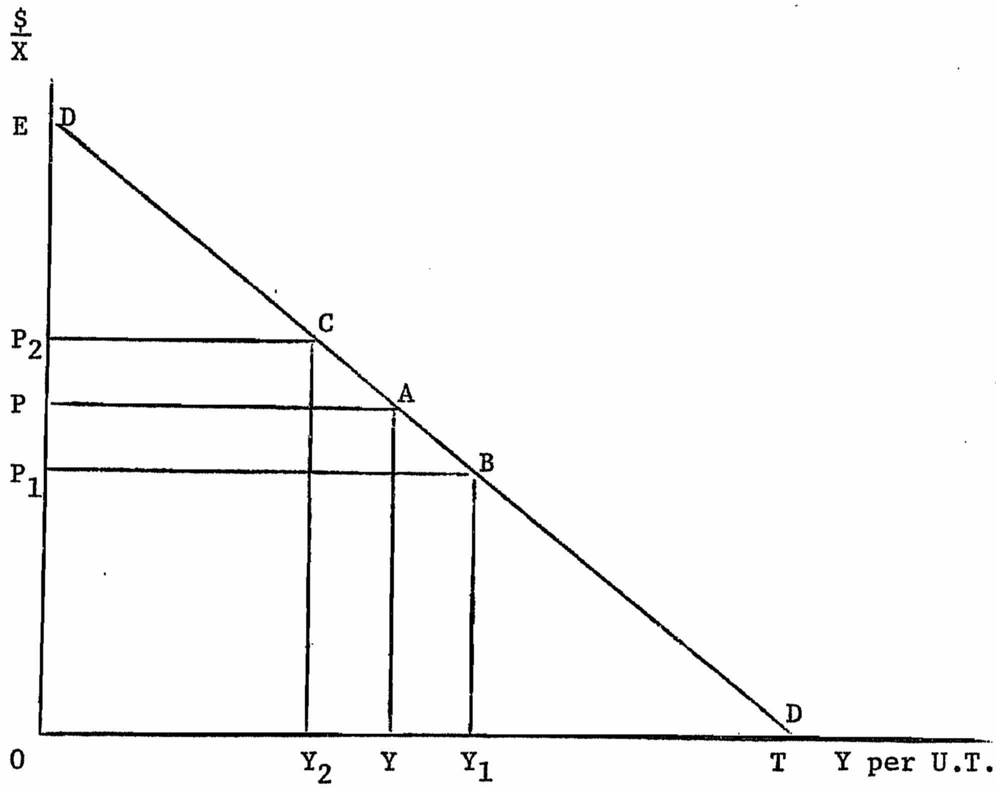
Disadvantages of Truck Transportation

Three disadvantages of truck transportation were indicated by 50.0 to 54.0 percent of the elevator managers (Table 8). Low volume of shipments per truck was the major disadvantage (54.0 percent). The lack of weights and grades was reported as the second major disadvantage. The number of markets available was reported as the third most frequently reported disadvantage.

Appendix A

COMPUTATIONS OF PRICE ELASTICITIES AND EXPLANATIONS

There are two basic types of elasticity, one is arc elasticity and the other point elasticity. Elasticity computed between two separate points, A and B, on the demand curve is called arc elasticity. Point elasticity is more precise than arc elasticity. When the points between



HYPOTHETICAL LINEAR DEMAND CURVE

which arc elasticity is measured are moved closer together, the points merge into a single point. Hence, point elasticity is simply arc elasticity when the distance between the two points is zero. To measure point elasticity at point A, the basic elasticity formula is used.

$$\text{Point Elasticity} = -\frac{\frac{\Delta Y}{Y}}{\frac{\Delta P}{P}} = -\frac{\Delta Y}{Y} \times \frac{P}{\Delta P} = -\frac{\Delta Y}{\Delta P} \times \frac{P}{Y}$$

Where Y = quantity, P = price, and Δ = change in

On the demand curve, from point A, the slope of the demand curve is identified by $\Delta P/\Delta Y$. Geometrically, the slope of the demand curve is YA/YT. Therefore, $\Delta P/\Delta Y$ = YA/YT, or inverting both fractions $\Delta Y/\Delta P$ = YT/YA. Price at point A is YA and quantity of that point is OY. Thus, at point A:

$$\text{Point Elasticity} = \frac{YT}{YA} \times \frac{YA}{OY} = \frac{YT}{OY}$$

To compute the arc elasticity between points A and B and then A and C, the same basic elasticity formula is used:

$$\text{Arc Elasticity} = -\frac{\frac{\Delta Y}{Y}}{\frac{\Delta P}{P}}$$

The percentage changes in quantity and price are different, depending upon the price and quantity. For example, if elasticity is measured from points A to B, the percentage change in price and quantity (price increase) is different from the percentage change in quantity and price (price decrease) from points A to B. Henceforth, resulting in different values of the elasticity coefficient. The difference between arc and point elasticity is that arc elasticity is measured between points. Therefore, arc elasticity is an approximation.

Average arc elasticity strikes an average between the points measured on the demand curve (arc elasticity does not). The two average arc elasticity functions utilized in this analysis may be expressed mathematically as:

$$\text{Average Arc Elasticity (1)} = -\frac{\frac{\Delta Y}{Y}}{\frac{\Delta P}{P_1}}$$

Where Y = Lower of the two quantities
P_1 = Lower of the two prices

$$\text{Average Arc Elasticity (2)} = \frac{Y_1-Y_2}{Y_1+Y_2} \div \frac{P_1-P_2}{P_1+P_2}$$

Where Y_1 = initial quantity
Y_2 = new quantity
P_1 = initial price
P_2 = new price

The difference between the two average arc elasticity equations is that the first average arc elasticity (1) equation takes into account only the lowest quantity and price attained, whereas the second average arc elasticity (2) equation takes into account the initial price and quantity and the new price and quantity.

Appendix B

APPENDIX TABLE 1. REGRESSION ANALYSIS FOR HARD RED SPRING WHEAT SHIPMENTS TO THE DULUTH-SUPERIOR MARKET FROM SAMPLED NORTH DAKOTA AND MINNESOTA ELEVATORS, 1965, 1966, AND 1967[a]

Equation	a Value	b_1 (Rail Rates)	b_2 (Truck Rates)	b_3 (Marketable HRS)	Coefficient of Determination	Observed F Value	Level of Significance
(1) N.D. - 1965	307.590	-123.804 (65.714)		.111 (.056)	.2285	7.405	.01
(2) N.D. - 1966	35.813			.268 (.056)	.3002	23.160	.001
(3) N.D. - 1967	200.252	- 72.754 (49.993)		.145 (.051)	.2619	9.580	.01
(4) Minn. - 1965	20.965			.463 (.111)	.4626	17.218	.001
(5) Minn. - 1966	968.169	-457.046 (289.674)		.326 (.106)	.4327	7.244	.01
(6) Minn. - 1967	182.794		-73.001 (40.989)	.288 (.116)	.4475	7.695	.01
(7) Two-State Area (N.D. - Minn.) - 1965	254.566	- 97.089 (61.344)		.153 (.051)	.2201	10.298	.001
(8) Two-State Area (N.D. - Minn.) - 1966	38.813			.277 (.048)	.3026	33.417	.001
(9) Two-State Area (N.D. - Minn.) - 1967	181.291		-75.424 (34.453)	.192 (.043)	.2918	15.864	.001

[a]The values in brackets represent the standard error.

APPENDIX TABLE 2. REGRESSION ANALYSIS FOR HARD RED SPRING WHEAT SHIPMENTS TO THE MINNEAPOLIS-ST. PAUL MARKET, FROM SAMPLED NORTH DAKOTA, MINNESOTA, AND SOUTH DAKOTA ELEVATORS, 1965, 1966, AND 1967[a]

Equation	a Value	b_1 (Rail Rates)	b_2 (Truck Rates)	b_3 (Marketable HRS)	Coefficient of Determination	Observed F Value	Level of Significance
(10) N.D. - 1965	-45.838			.651 (.048)	.7789	186.653	.001
(11) N.D. - 1966	-42.730			.621 (.047)	.7539	171.512	.001
(12) N.D. - 1967	-47.626			.652 (.055)	.7214	142.440	.001
(13) Minn. - 1965	-321.367		159.053 (93.225)	.584 (.175)	.4612	5.579	.01
(14) Minn. - 1966	50.085	-284.492 (143.376)	214.282 (94.554)	.694 (.159)	.6482	7,370	.01
(15) Minn. - 1967	178.922	-306.389 (116.021)	216.512 (76.407)	.688 (.106)	.8076	16.792	.001
(16) S.D. - 1965	4.690			.779 (.023)	.9850	1118.850	.001
(17) S.D. - 1966	8.617			.741 (.017)	.9902	1809.460	.001
(18) S.D. - 1967	-2.512			.730 (.026)	.9766	793.841	.001
(19) Three State Area (N.D., Minn. & S.D.) - 1965	-31.652			.644 (.038)	.7652	286.817	.001
(20) Three-State Area (N.D., Minn. & S.D.) - 1966	-71.421	-133.062 (63.398)	176.593 (64.783)	.652 (.038)	.7783	105.303	.001
(21) Three-State Area (N.D., Minn. & S.D.) - 1967	-102.429	-101.205 (59.905)	157.123 (62.032)	.663 (.041)	.7559	92.902	.001

[a]The values in brackets represent the standard error.

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HIGHLIGHTS

This study was undertaken to gain insights into the price elasticities of demand for rail transportation of hard red spring wheat from North Dakota, South Dakota, and Minnesota. The specific objectives of this study were (1) to identify the demand functions for rail transportation of hard red spring wheat for the years 1965, 1966, and 1967 and (2) to measure the price elasticity of demand for rail transportation of hard red spring wheat for the years 1965, 1966, and 1967.

Estimated price elasticities of demand for rail transportation of hard red spring wheat were found to be elastic whenever a significant price-quantity relationship existed. Price elasticities of demand for the three-state area varied around 2.2 percent, with shippers (elevator managers) nearer the markets of Duluth-Superior and Minneapolis-St. Paul responding more to changes in rail rates. This indicates that a decrease in rail rates would increase revenues for the railroads and result in possible savings to producers of hard red spring wheat in terms of reduced transportation costs.

In spite of the elastic demand for rail transportation of hard red spring wheat, the rail rates continued to increase (in most instances, the rail rate increases were greater than truck rate increases) over the three-year period. In view of the increasing rail rates and elastic demands, the railroads' share of the markets remained relatively stable (decreasing to a small degree at the Duluth-Superior market). This indicates that elevator managers were basing their decision on alternative modes or factors (transit privilege, volume of shipment/rail car versus truck, etc.) other than the level of freight rates observed, therefore, discouraging rail rate decreases.

Elevator managers reported that the demand for transportation capacity was fulfilled better by the motor carrier industry than by the railroad industry.

The disadvantages and advantages of shipping grain by rail must offset the disadvantages and advantages of shipping grain by truck, otherwise the motor carriers would be making greater inroads into the Duluth-Superior and Minneapolis-St. Paul markets for hard red spring wheat.

AN ANALYSIS OF THE ELASTICITY OF DEMAND FOR RAIL TRANSPORTATION OF HARD RED SPRING WHEAT

Donald W. Berger and David C. Nelson*

INTRODUCTION

Transportation is vital to the marketing of grain products in North Dakota, Minnesota, and South Dakota. Grain produced at one point has little value unless it is moved to a place where grain is needed or demanded. Movement through space creates value. Space is relevant only in terms of the time and cost of overcoming it. Therefore, transportation costs become an important element in the market value of a product such as grain. The cost of transportation makes up a relatively large part of the value of a commodity if the commodity is: (1) bulky, (2) requires special services or (3) moves a considerable distance. In most cases the transportation of grain possesses all three characteristics. Consequently transportation cost's proportion of the market value of grain is high.

Transportation costs to the two principle first markets (Duluth-Superior and Minneapolis-St. Paul) for North Dakota hard red spring wheat ranged from 10 to 21 percent of market price on November 21, 1969.[1]

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*Berger was formerly Assistant in Agricultural Economics and Nelson is Associate Professor of Agricultural Economics and Director of the Upper Great Plains Transportation Institute, North Dakota State University, Fargo, North Dakota.

[1]Computed as follows: North Dakota price for HRS wheat, ordinary protein at the Minneapolis market = \$1.71/bu.; freight rates ranged from \$.17½/bu. (Fargo) to \$.36/bu. (Belfield) (10% and 21% respectively) to Minneapolis, Minnesota. United States Department of Agriculture, <u>Grain Market News</u>, Grain Division, Consumer and Marketing Service, Vol. 52, No. 47, Minneapolis, Minnesota, November 21, 1969.

In 1968 each of the three states ranked in the top four in production of hard red spring wheat.[2] The population of the three-state area is approximately 3.0 percent of the total United States population. Thus, the region is a surplus producer of HRS wheat and transporation changes that affect the interregional competitive position of grain production and processing are of major importance to the three-state area producers.

In past years research in transportation economics focused mainly on supply. Despite the almost universal adoption of demand oriented pricing ("charging what the traffic will bear") by transportation industries and regulatory bodies, analysis of demand for transportation received relatively little attention. What may appear as an insignificant change in price may actually have a significant impact upon the marketing system for the specific product and for the other products. If carriers had some insight into the reactions of shippers to rate changes, carriers, shippers and society as a whole would benefit. That is, decisions concerning adjustments in freight rates could be made from informed knowledge of the potential results of those adjustments.

Purpose and Objectives

This study was undertaken to gain insights into the price elasticity of demand for rail transportation. Price elasticity of

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[2]Heltemes, C. J. and Fred R. Taylor, North Dakota Crop and Livestock Statistics - Annual Summary for 1968, Revisions for 1967, Statistics No. 19, Statistical Reporting Service, United States Department of Agriculture and Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, May, 1969, p. 3.

demand for rail transportation is the responsiveness of shippers in adjusting their utilization of rail transportation to changes in rail rates.[3] For example, if the shippers (elevator manager) are quite responsive to rail rate changes, a decrease in rail rates may actually increase revenues for the railroads. This decrease might also result in savings to the producer in terms of reduced rail rates. Conversely, an increase in rail rates may actually reduce revenues for the railroads and might increase expenditures for producers. In these situations the elasticity of demand for rail transportation is said to be elastic. On the other hand, if shippers are not responsive to rail rate changes, a decrease in rail rates may actually decrease revenues for the railroads. This decrease may result in a savings to the producer in terms of reduced rail rates. Conversely, an increase in rail rates may actually increase revenues for the railroads, but result in an increase in expenditures for the producer. In these situations where the shippers are not responsive to rail rate changes, the elasticity of demand for railroad transportation is said to be inelastic.

The specific objectives of this study are:

1. To identify demand functions for railroad transportation of hard red spring wheat.

2. To measure the price elasticity of demand for railroad transportation of hard red spring wheat.

Geographic Area

Originally the states of North Dakota, Minnesota, South Dakota and Montana (Figure 1) were used for the analysis; but Montana was

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[3]See Appendix Table 1 for the equations used to calculate the coefficients of elasticity.

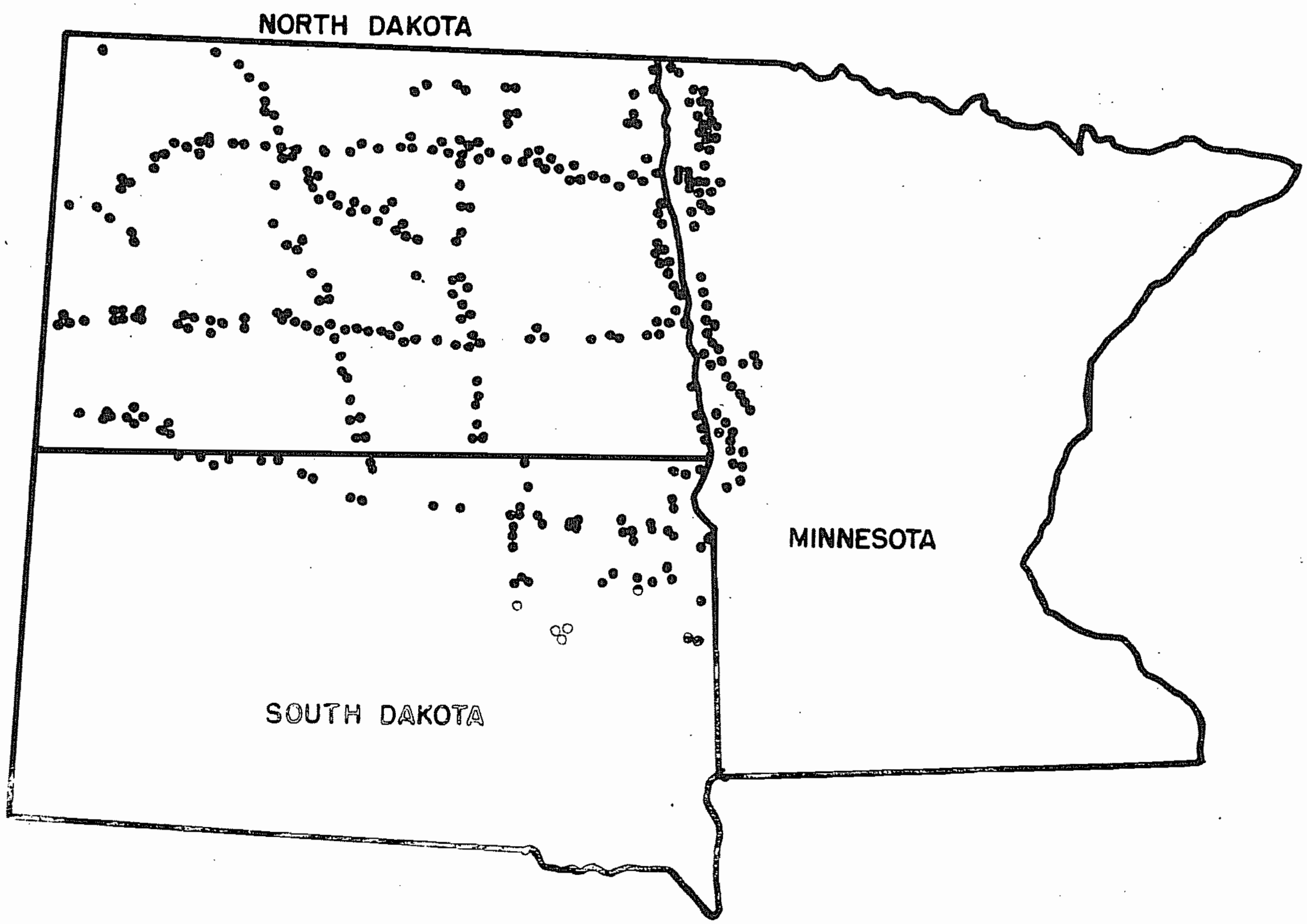

Figure 1. Designation of Sample Area and Location of Country Grain Elevators for Demand Analysis of Rail Transportation, 1969

excluded from the study due to poor response to mailed questionnaires (Table 1). The entire state of North Dakota was used for the analysis, while seven counties in Minnesota and 16 counties in South Dakota were included. Counties were selected on the basis of hard red spring wheat production.

Methodology and Sources of Data

"The demand for railroad transportation is a derived demand, that is, it exists only insofar as a commodity is worth more at one point than at another."[4] A demand curve describes the relationship between possible alternative prices of the good or service and the quantities of it that consumers will take, other things equal.[5]

The demand functions were developed through the use of accepted statistical techniques.[6] The statistical analysis was applied to rail unloading data of HRS for 1965, 1966, and 1967 at the Minneapolis-St. Paul and Duluth-Superior markets, where grain orginates from country grain elevators. Country elevators were selected by a single criterion, i.e., elevators were to be located on primary highways (Figure 1). By selecting elevators located on primary highways, truck movements of grain are not hindered by spring weight restrictions. Cross-sectional data were gathered as opposed to time-series data because rail freight rates do not normally exhibit sufficient variation over time to provide data on demand responses.

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[4]McCallum, George E., New Techniques in Railroad Ratemaking, Study No. 44, College of Economics and Business, Bureau of Economic and Business Research, Washington State University, 1965, p. 4.

[5]Leftwich, Richard H., The Price System and Resource Allocation, Holt, Rinehart, and Winston, New York, 1966, p. 25.

[6]Multiple Linear Regression was used.

TABLE 1. BREAKDOWN OF RESPONSE TO QUESTIONNAIRE NUMBERS 1, 2, AND 3, BY STATE, 1969

	Questionnaire Number One				Two				Three			
	No. Dak.	Minn.	So. Dak.	Mont.	No. Dak.	Minn.	So. Dak.	Mont.	No. Dak.	Minn.	So. Dak.	Mont.[a]
						(Percent)						
Useable[b]	36.6	37.9	33.3	16.3	61.5	76.0	57.2	77.3	92.3	100.0	100.0	--
Incomplete	5.6	3.0	15.9	25.2	1.3	--	9.5	--	6.4	--	--	--
Out-of Business	2.3	1.5	6.3	2.2	--	--	--	4.5	1.3	--	--	--
Locally Used Seed House Others	.5	7.6	4.8	4.4	--	--	--	--	--	--	--	--
Total Returned	45.0	50.0	60.3	48.1	62.8	76.0	66.7	81.8	100.0	100.0	100.0	--
Total Questionnaires Mailed	213	66	63	135	78	25	21	22	78	25	21	--

[a]Questionnaire number 3 was not mailed to Montana elevators, due to poor response from questionnaire number 1.

[b]Sections of questionnaire may not be useable.

Data required for this study were obtained from two main sources: (1) country grain elevators and (2) Minneapolis Grain Exchange rate books numbers 5, 6, and 7.[7]

Truck rates and quantities of hard red spring wheat shipped by rail and truck were obtained through three mailed questionnaires to grain elevator managers. Additional data were also obtained through these questionnaires.

Rail rates utilized in this study were in effect during the period June 1 through October 31 of each year. Truck rates were assumed to be directly related to rail rates, as certain segments of the states have seasonal adjustments in rail rates. All rail and truck rates were converted from cents per hundredweight to cents per ton mile to avoid intercorrelation.

ANALYSIS OF HARD RED SPRING WHEAT SHIPMENTS

Hard red spring wheat is used mainly in the manufacturing of yeast-leavened products. These include rolls, bread, and sweet goods. There is no differentiation in rail or truck rates according to variations in the quality or use of hard red spring wheat.[8]

Dependent and Independent Variables

The variables used in the following hard red spring wheat analysis are:

Y = Quantity of hard red spring wheat shipped by rail cars from individual country grain elevators to the markets (in bushels per year).

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[7]Minneapolis Grain Exchange, Grain Rate Book, Numbers 5, 6, and 7. Traffic Department, Minneapolis Grain Exchange, Minneapolis, Minnesota, 1965, 1966, and 1967.

[8]Hard red spring wheat will be hereinafter referred to as HRS or wheat (terminology will be interchangeable).

X_1 = Rail rates in cents/ton mile from individual country elevators to the markets.

X_2 = Truck rates in cents/ton mile from individual country elevators to the markets.

X_3 = Marketable hard red spring wheat from individual country elevators (in bushels per year).

<u>Demand for Rail Transportation of Hard Red Spring Wheat</u>

Various combinations of existing variables listed above were tested in fitting a mathematical equation to the demand for rail transportation of hard red spring wheat to the Duluth-Superior and Minneapolis-St. Paul markets. The .10 probability level was the minimum probability level for which the equations would be considered significant. The "best-fitting" equation was the only equation analyzed and presented.

Duluth-Superior Market

Equations 1-9 were analyzed for shipments of hard red spring wheat to the Duluth-Superior market (Appendix Table 1). Hard red spring wheat was not shipped from sampled South Dakota elevators to the Duluth-Superior market and therefore there is no analysis of the South Dakota situation to that market.

<u>North Dakota HRS, 1965-1967</u>

An across the board increase in North Dakota rail rates would be associated with a decrease in quantity shipped by rail/elevator from North Dakota for the specific years 1965 and 1967 (Figures 2-3). For example, in 1965 had the rails increased rates (across the board) by .25 cents/ton mile, the quantity shipped by rail/elevator would decrease by approximately 30.7 thousand bushels. The same rail rate increase in

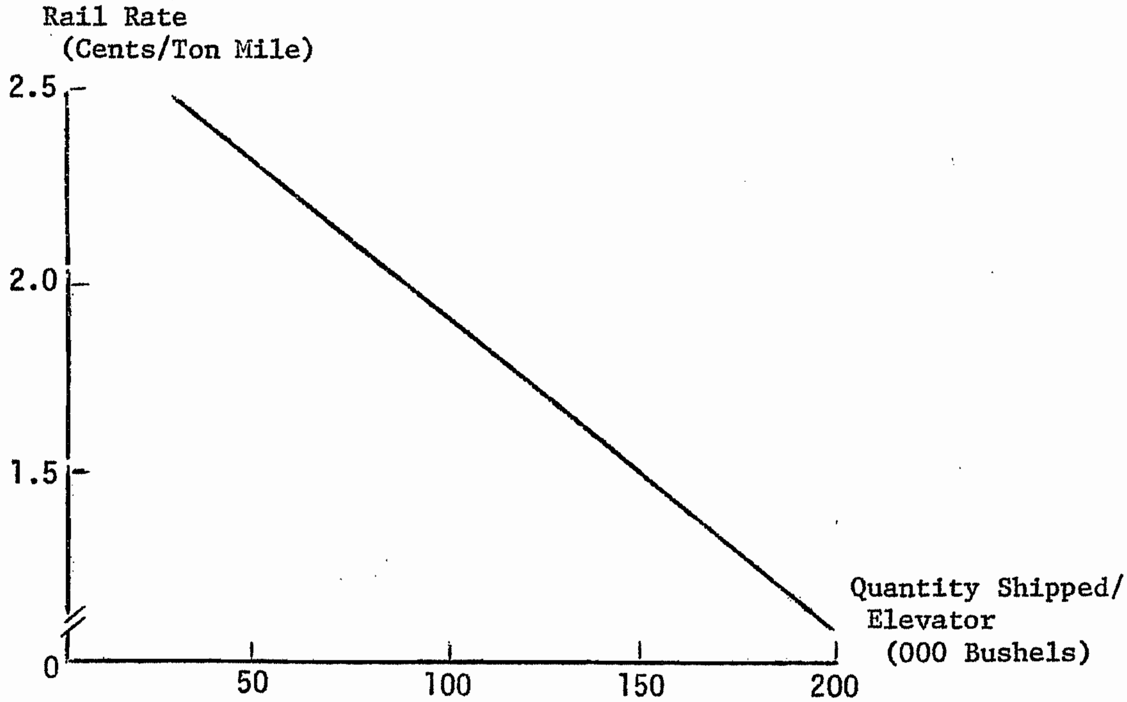

Figure 2. Demand Curve for Rail Transportation of HRS Wheat to the Duluth-Superior Market, North Dakota, 1965

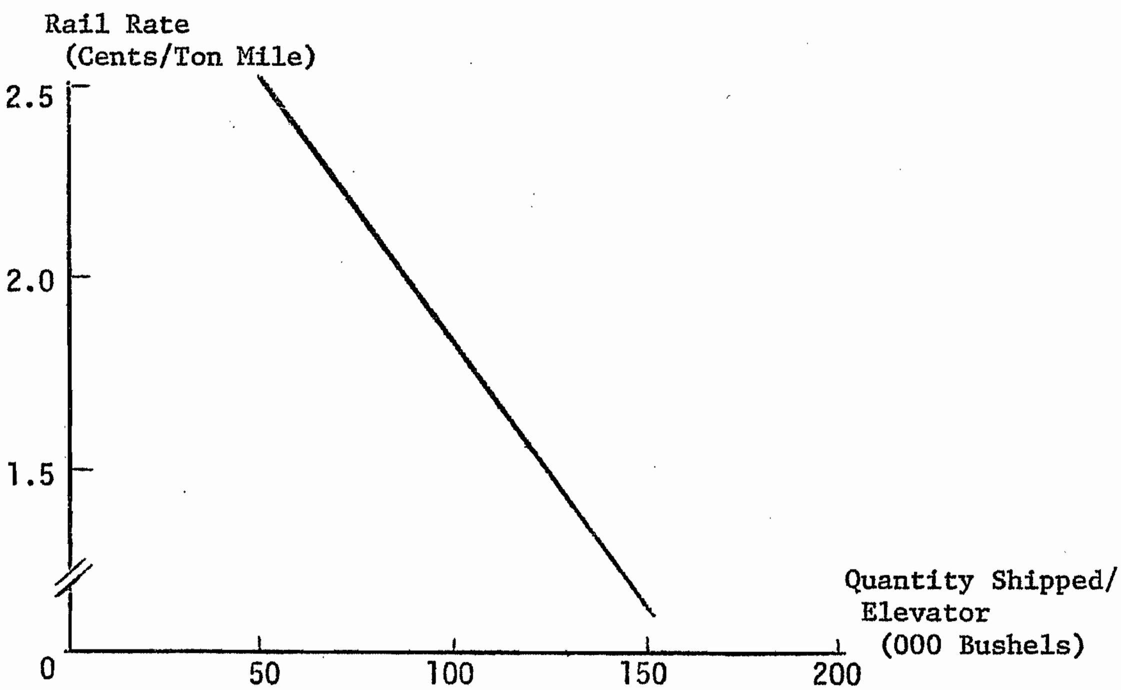

Figure 3. Demand Curve for Rail Transportation of HRS Wheat to the Duluth-Superior Market, North Dakota, 1967

1967 would have resulted in a decrease of approximately 18.1 thousand bushels shipped/elevator by rails. The reason for this difference will be discussed in the price elasticity section.

The direct relationship between Y and X3 indicated that an increase in marketable HRS/elevator would be associated with an increase in quantity shipped by rail/elevator for the specific years 1965, 1966, and 1967. For example, in 1965 an increase of 50 thousand bushels of marketable HRS/elevator would increase rail shipments by approximately 5.5 thousand bushels/elevator.

Price Elasticity of Demand for Rail Transportation of HRS Wheat - North Dakota, 1965-1967

Price elasticities[9] of demand for rail transportation for 1965 indicated that a one percent increase in rail rates would result in a 2.4 to 2.9 percent decrease in the quantity of HRS shipped by rail/elevator on the average other things equal[10] (Table 2). This would also result in increased revenues for railroads and a possible savings to producers because the demand is elastic. The increased volume shipped would more than offset the price decrease, thus increasing total revenues.

A one percent increase in rail rates would result in a 2.9 to 4.2 percent loss in quantity shipped by rail/elevator on the average. Where demand is elastic, a price increase has an opposite affect on total revenues than a price decrease, i.e., total revenues decline.

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[9]Price elasticities were measured about the means (average).

[10]Other things equal means taking the same conditions that existed in this analysis the results would be the same. In other words the truck rate, marketable HRS/elevator and any other factor that would shift the demand curve would have to remain the same or the elasticity coefficients would change. This assumption will hold throughout the HRS analysis.

TABLE 2. ESTIMATED PRICE ELASTICITES OF DEMAND FOR RAIL TRANSPORTATION OF HARD RED SPRING WHEAT TO THE DULUTH-SUPERIOR MARKET FROM SAMPLED NORTH DAKOTA AND MINNESOTA ELEVATORS, 1965, 1966, AND 1967[a]

Elasticity[b]	Price	North Dakota 1965	North Dakota 1967	Minnesota 1966	Two-State Area (N.D. - Minn.) 1965
Point	1% Increase	2.91	1.92	8.14	2.08
Elasticity	1% Decrease	2.91	1.92	8.14	2.08
Arc	1% Increase	2.94	1.92	8.14	2.24
Elasticity	1% Decrease	2.94	1.92	8.14	2.24
Average Arc	1% Increase	4.17	2.12	13.64	2.53
Elasticity (1)	1% Decrease	2.65	1.83	7.75	2.13
Average Arc	1% Increase	3.62	2.06	10.47	2.44
Elasticity (2)	1% Decrease	2.42	1.79	6.60	2.07
Range of	1% Increase	2.9-4.2	1.9-2.1	8.1-13.6	2.1-2.5
Elasticities	1% Decrease	2.4-2.9	1.8-1.9	6.6-8.1	2.1-2.2

[a]See Appendix A for computational procedures and explanations.

[b]Elasticities were calculated about the means of the rail rates.