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Transportation as an Input to the North Dakota Agricultural Marketing Process

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February 1996

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ABSTRACT

Recent elimination of the Interstate Commerce Commission, pending rail mergers of major carriers, and the recent attempts to set maximum reasonable rate guidelines have indicated the concerns of captive shippers over rates and service. This study has shed some light on the grain marketing practices of N.D. grain elevators and has explained and measured the competitive factors influencing rates, including their role in market dominance determination.

The study shows that carriers' rates are constrained by four factors not under the control of the carrier. These factors include intramodal competition, intermodal competition, geographic competition, and product competition. While the concepts of intermodal competition and intramodal competition have been widely accepted by many, this is not necessarily the case for geographic and product competition. Regions which grow relatively unique crops such as the Upper Great Plains and the Pacific Southwest have higher rail rates as carriers are not constrained by geographic competition in those areas. In addition, shipments of durum and other crops which don't have many substitutes have higher rates as carriers don't realize product competition for these movements.

Finally, the study highlights the importance of efficient and effective rail service for the future of N.D. agriculture. The explanations of current N.D. grain marketing practices and of the factors influencing rail rates should allow for more enlightened decisions regarding policies that may affect the future of N.D. rail service.

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INTRODUCTION

North Dakota's economy relies heavily on its agricultural sector. The state's agricultural sector sells more than a half billion bushels of grain and oilseeds to both domestic and export buyers annually. Compared to most other agricultural commodity sellers in the United States, North Dakota producers attribute a relatively large share of their marketing bill to transportation. Therefore, transportation that is both competitively-priced and reliable is key to the profitability and future viability of North Dakota agriculture.

Because transportation is a necessary input into the agricultural marketing process, it is important to assess its changing role. Prior to the deregulatory trend of the 1980s, transportation was given little consideration as a potential source for achieving a competitive advantage because rates and service were rather inflexible. However, in today's deregulated transporation environment, transporation is at the forefront of agricultural marketing plans. Moreover, success relies heavily on efficient and high quality transportation. Thus, it is important to be proactive in the changing market by encouraging resource investment that will contribute to the success of North Dakota agriculture.

The North Dakota elevator system serves as a gathering network for the thousands of producers across the state. These elevators, in turn, utilize their abilities to competitively access long distance markets through the efficiencies they gain by shipping bulky, relatively low-value grains in large quantities. Although trucks compete with railroads for a limited number of markets, rail remains the dominant mode for marketing grain shipments originating from the state. In fact, between 1983/84 and 1993/94 an average 74 percent of the grain and oilseed shipments originated annually by N.D. elevators were marketed via rail.

The primary reason for the dominance of rail for N.D. grains is that the state's elevators are typically at long distances from barge-loading facilities and terminal markets. As Figure 1 illustrates, trucks cannot compete with rail in long distance markets.

The comparison of dry van, hopper truck[1] and single car rail variable costs for shipping grain illustrates that trucks have lower costs than rail shipments for up to 100 to 130 miles (Figure 1). Typically, beyond this distance trucks must increase backhaul

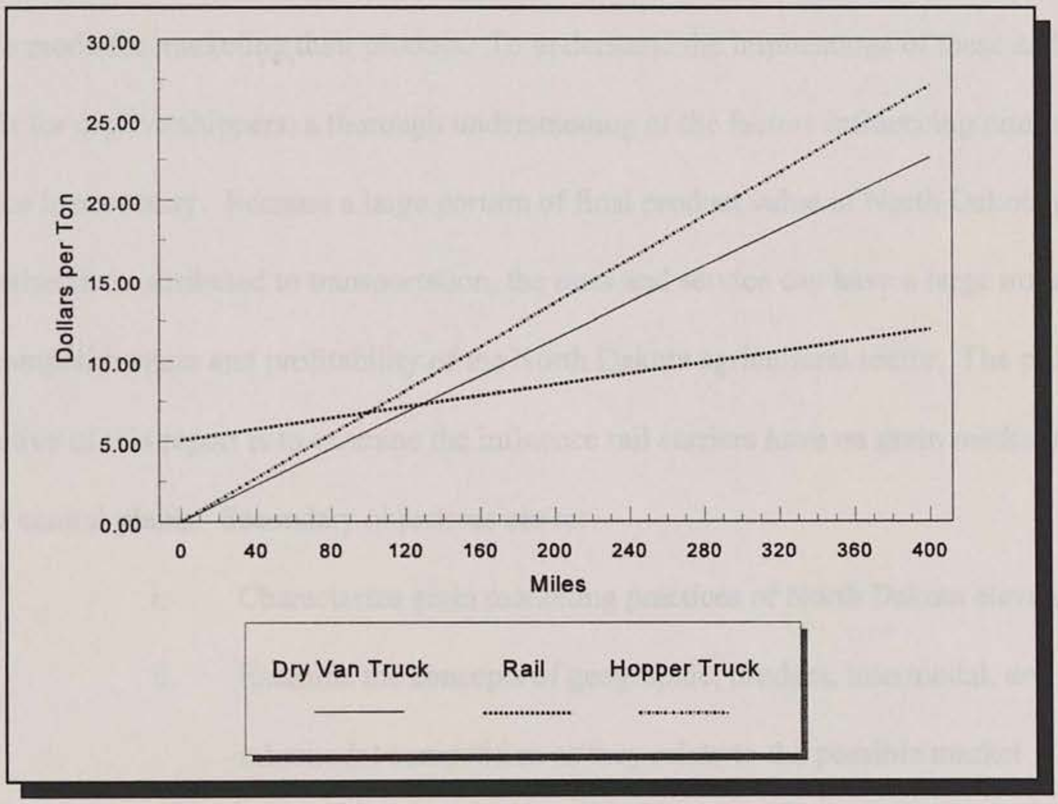

Figure 1. Dry Van and Hopper Truck Costs Compared to Rail Variable Cost

[1] The truck costs are based on the average backhaul activities for the alternative truck types: 85 percent loaded miles for dry van trucks and 60 percent loaded miles for hopper trucks (Jack Faucette Associates).

activities to remain competitive. Although trucks consistently serve about a quarter of the outbound grain market for N.D. elevators, it is evident that railroads have been and will continue to be a vital link in the farm-to-market chain.

Recent legislation to eliminate the Interstate Commerce Commission, the pending mergers of major rail carriers, and the recent attempts to set maximum reasonable rate guidelines for non-coal shipments have identified concerns of captive grain shippers over rates/service. Captive shippers refer to those shippers who are economically dependant on a single mode for marketing their product. To understand the implications of these and other trends for captive shippers, a thorough understanding of the factors influencing rates and service is necessary. Because a large portion of final product value of North Dakota grains and oilseeds is attributed to transportation, the rates and service can have a large impact on the competitiveness and profitability of the North Dakota agricultural sector. The primary objective of this report is to examine the influence rail carriers have on grain marketing in the north central plains. Secondary objectives are to:

i. Characterize grain marketing practices of North Dakota elevators,

ii. Examine the concepts of geographic, product, intermodal, and intramodal competition as they relate to the possible market dominance, in the context of grain transportation, and

iii. Identify potential concerns/opportunities North Dakota elevators face regarding the future of rail.

The primary sources of data for this study are the North Dakota Public Service Commission grain movement database and the I.C.C. Waybill Sample. The grain movement database consists of a collection of monthly reports from each of the elevators in North Dakota. In these reports elevators specify mode, destination, and volume for shipments of grains and oilseeds they originate. These data provide unbiased information about activities of elevators in the state, including truck/rail decisions and actual marketing volumes.

This report is comprised of four sections. Section two provides a description of the N.D. country elevator network and the rail system. The third section includes a discussion of forms of competition that influence North Dakota grain rail transportation rates and presents a model of rail rates. The project conclusions are summarized in the final section.

N.D. Rail Carriers

About 75 percent of the grain originated by North Dakota elevators is marketed via rail. The North Dakota rail system is operated by two Class I and two regional railroads (Figure 2). The Burlington Northern (BN) operates a majority of the system with about 2,300 miles of track, serving 225 elevators across the state. The Canadian Pacific Rail System (CP) controls more than 900 miles of track, reaching just under 100 elevators in the northern, central and eastern regions of the state. These Class I railroads handled 63percent

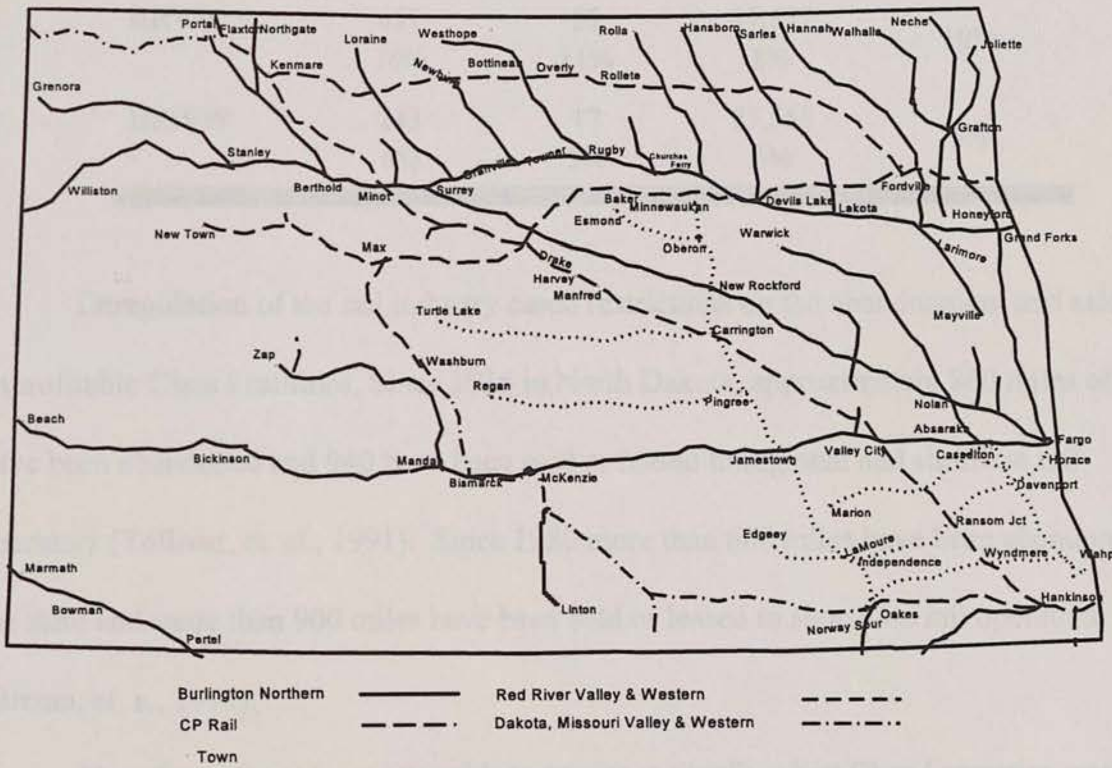

Figure 2. N.D. Rail System Map

of the grain and oilseeds orginating from the state in 1993-94 (Table 1). BN is the largest single carrier of North Dakota grains and oilseeds, with market share averaging 38 percent over the past four years. The CP is second in market share, handling about 22 percent of the North Dakota grain and oilseeds orginations between 1990-91 and 1993-94.

Table 1. N.D. Track Miles, Elevators Served, and Market Share for Grain & Oilseed Origination by Railroad, 1994

	Track Miles	Elevators Served	Grain Handled (000 Bushels)	Avg. Market Share (1990-1994)
BN	2,327 56%	225 46%	212,427 41%	39%
CP	916 22%	98 20%	113,326 22%	22%
RRVW	657 16%	55 11%	39,577 8%	10%
DMVW	243 6%	17 3%	25,556 5%	5%

Deregulation of the rail industry eased restrictions on the abandonment and sale of unprofitable Class I raillines. Since 1936 in North Dakota, approximately 860 miles of track have been abandoned and 940 have been sold or leased to regional and shortline rail operators (Tolliver, et. al., 1991). Since 1980 more than 660 miles have been abandoned in the state and more than 900 miles have been sold or leased to short-line rail operators (Bitzan, et. a., 1995).

Short-line railrooads are often able to operate at a profit, wheat Class I operation was previously unprofitable as short-lines realize labor savings, reduced maintenance-of-way costs, and lower capital costs in comparison to Class I railroads. Previous studies have found short-line service to be better than that provided by Class I railroads in many cases, as the small grain shipper comprises a much larger share of the short-line's total customer base. Two short-line railroads have formed in the state since 1980.

The Red River Valley & Western (RRVW), a regional railroad affiliated with BN, acquired about 650 miles of track in the central and southeastern regions of North Dakota in the mid-1980s and is the primary rail carrier for 55 elevators. A second regional railroad, the Dakota, Missouri Valley & Western (DMVW), affiliated with CP, was formed in the early 1990s. The DMVW operates 243 miles of track and serves 17 elevators in the southern and central reaches of the state (Table 2). The RRVW and DMVW handled 10 percent and 5 percent, respectively, of North Dakota grain and oilseed shipments between 1990-91 and 1993-94.

Table 2. North Dakota Elevator Industry, 1979 vs. 1994

	1979	1994	Change
Number of Licensed Sites	589	484	-18%
Market Share for the:			
5 Largest Volume Elevators	5%	12%	140%
150 Largest Volume Elevators	57%	81%	42%
Unit Train Facilities	8	112	1300%
Grain Handled, Avg. (bu.)	808,258	1,044,126	29%
Storage Capacity, Avg. (bu.)	244,000	508,300	108%
Sites with Storage Capacity of:			
less than 400,000 bu	89%	56%	-37%
400,001 to 800,000	9%	26%	189%
800,001 +	2%	18%	800%
Own At Least One Truck	14%	22%	57%
Sites with Rail Loadout per Hour of:			
less than 5,000 bu	76%	32%	-58%
5,001 to 10,000	19%	43%	126%
10,001 +	5%	25%	400%

N.D. Elevator Industry Profile

Since peaking at more than 2,000 sites in 1915, the North Dakota elevator system has experienced rationalization of its resources, and today includes 484 licensed elevator sites. On average, each site houses 508,000 bushels of storage and ships more than a million bushels of grain (North Dakota Public Service Commission). Both average storage capacity and grain handled have increased over the past 15 years. In 1979, elevators averaged 29 percent less grain handled per site and about half the storage capacity. The large increase in average storage capacity may be attributed to the onset of the unit train loading facility. In 1979, only eight sites in North Dakota, just over 1 percent of the elevator population, were equipped to load unit train (Casavant & Griffin, 1983). This compares to about 112 elevators, or 23 percent of the population, today.

Of the 484 sites licensed in 1993-94, 425 of elevators submitted North Dakota Public Service Commission grain movement reports, totaling shipments of more than 500 million bushels of grain to destinations beyond the N.D. elevator system during the 1993-94 crop year.[2] These 425 elevators provide the base for characterizing the types of competition that influence the profitablity of marketing N.D. grains and oilseeds.

Because the nature of the grain industry favors large shipment originators, an important distinction to be made among elevators is their access to rail service. About 10 percent of the elevators in North Dakota are limited to truck shipments because they are located where rail lines have been abandoned. Among the elevators with access to rail, track space for cars ranges from three to 100 cars. Four segments of the elevator population (based on track space) are defined for this report:

[2] The difference between the 484 licensed sites and the 425 elevators that submitted reports to the North Dakota Public Service Commision are facililities such as processors, merged sites permitted to combine reporting information, and sites that did not ship grain or oilseeds beyond the N.D. elevator system.

No-Rail:	No Access to Rail Service
Single-Car:	Track Space for one to 24 Cars
Multicar:	Track Space for 25 to 49 Cars, and
Unit-Train:	Track Space for 50 Cars or More.

A concentration of elevators exists in the single-car group, as these 211 elevators account for nearly half of the elevator population in North Dakota. While the single-car group comprises a large portion (46 percent) of the state's elevator population, this group of elevators originated on 14 percent, or 72,775 thousand bushels, of grain and oilseeds in 1993-94 (Table 3). Multicar loaders, that are able to load 25 to 49 cars, accounted for 20 percent of the elevator population and 22 percent of the shipments.

The number of elevators with the ability to load unit trains has increased dramatically over the past decade. In 1984 only 28 elevators were equipped to load unit trains. By 1993-94, 112 elevators, or nearly a quarter of all the elevators in the state could load unit trains. The importance of the unit train sites is evident. Although they comprised only 24 percent of the sites, they accounted for 63 percent of the grain and oilseed handled and housed 45 percent of the licensed storage capacity in 1993-94.

Table 3. North Dakota Elevator System, 1993-94

	Number of Sites	Grain Handled (000 Bushels)	Storage Capacity (000 Bushels)
No Rail	45	7,223	13,259
	10%	1%	5%
Single Car	211	72,775	65,496
	46%	14%	26%
Multi Car	91	113,222	59,963
	20%	22%	24%
Unit Train	112	322,133	111,760
	24%	63%	45%
Total	**459**	**515,357**	**250,478**

The elevator system is the primary source of North Dakota grain and oilseed origination. Therefore, in discussing the competitive forces that influence transportation rate, it is important to understand how elevators operate within the system. Modal shipments and turnover ratios provide information about the marketing choices and operational efficiency of elevators. Modal alternatives for North Dakota elevators are limited to truck and rail. Although the elevator system is fairly consistent in hiring trucks to haul a quarter of their grains and oilseed originations, the trucking activities vary substantially across commodities and elevators. Beyond the simple rail/truck modal split, the decision to use single car, multi-car or unit train shipments can be identified to examine the differing choices within the rail mode.

As Table 4 shows, the amounts shipped under various rail-car size blocks and under trucking are fairly similiar overall, but there are substantial differences for each elevator group. For the single-car elevators there is a relatively even split between single car shipments and truck. In the multicar elevator group single car shipments are most common, but trucking and multicar shipments comprise a large portion of the total. For unit train shippers, 50+ car shipments comprise the largest portion of total shipments, with multicar and single-car shipments closely following.

Table 4 illustrates that the proportion of shipments made by truck declines steadily from the single-car to the unit train elevators, with single-car elevators shipping 57 percent of their bushels by truck compared to 13 percent for unit train loaders. Although a large segment of the elevator population depends on truck rates, rail rates are of primary interest as they are used in marketing a vast majority of the N.D. elevator shipments.

Table 4. Mode for Shipments, Elevators Segmented by Track Space, 1993-94

	-Mode for Shipments - (000 Bushels)				
Elevator Group	**1-24 Cars**	**25-49 Cars**	**50 Cars+**	**Truck**	**All Modes**
No Rail				7,224 100%	7,224
Single Car	30,563 42%	447 1%	191 0%	41,575 57%	72,776
Multi Car	47,120 42%	29,739 26%	1,676 1%	34,689 31%	113,224
Unit Train	67,940 21%	89,308 28%	123,912 38%	40,984 13%	322,144
Total	145,623 28%	119,494 23%	125,779 24%	124,472 24%	515,368

Rate advantages associated with shipping grain in larger lots provide incentive for shippers to continue to originate larger shipments. Railroads encourage elevators to use unit-trains by establishing rates[3] that include a 13 cent discount from single-car shipments and a five cent discount from multicar shipments relative to unit-train shipments. These rate spreads have been a major factor in elevator decisions to invest in upgrading their facitilities to handle unit trains.

As the share of N.D. elevators that operate or have access to unit train facilities have increased, the marketing patterns for commodities have been modified. Consider the four modes used for marketing N.D. grains and oilseeds: truck, single-car, multicar, and unit train. Figure 3 shows the changes in modal shares since 1987. While truck share has varied little over the past seven years, there has been considerable adjustment within the rail modes.

The single car alternative has lost market share to both multi-car and unit-train alternatives. In 1987-88, single car shipments were used in marketing 41 percent of North Dakota's grain and oilseeds. By 1993-94 single car use had declined 24 percent and was employed for less than one-third of the grain and oilseed shipments (Vachal, et al. 1994).

The multicar option is a common shipment size for domestic and specialty export shipments. This mode accounted for about 20 percent of the shipments between 1987-88 and 1991-92. Unit-train use steadily increased between 1987-88 and 1991-92, but was limited by crop quality concerns in 1992-93 and 1993-94 due to poor weather conditions. Figure 3 shows that the large gap that once existed between single-car and unit train modal share has been virtually eliminated.

[3] BN & CP Published Tariff rate comparison single, multi and unit train shipments of wheat to Minneapolis orginating from Minot, Valley City and Devils Lake. May 1995.

In addition to elevator capabilities and rate spreads, marketing choices also may be influenced by the nature of the market for commodities handled by an elevator. For instance, the prominence of export business in the HRS wheat market is more likely to elicit unit car shipments, while local crushing plants that are a relatively strong market for sunflowers make truck shipments economical (Table 5). Moreover, some markets pay a premium to receive smaller shipments because of storage, distance, or quality issues. Buyers support a market for smaller rail shipments and truck shipments by paying relatively higher prices to ship/receive a more specialized shipment, ie. a smaller shipment needed to meet specific storage or quality requirements.

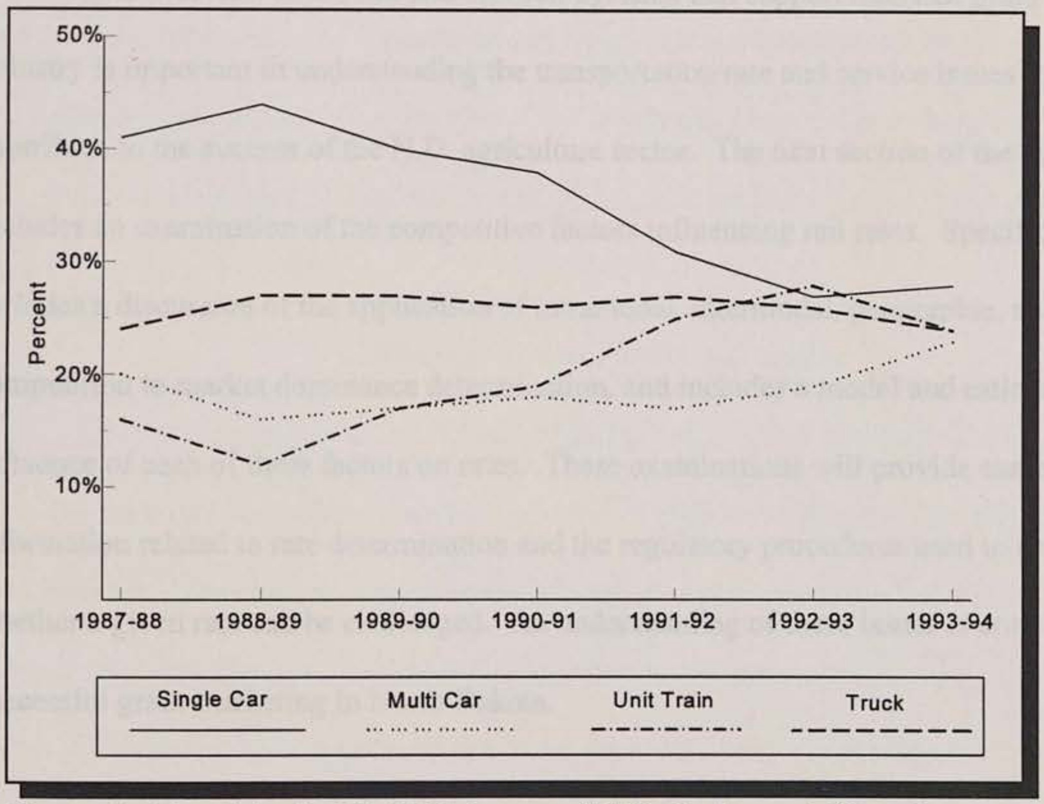

Figure 3. Trends in the Modal Shipment of N.D. Grains and Oilseeds

Table 5. Mode for Shipments of Major Commodities from N.D. Elevators, 1993-94

	Mode for Shipment				
	Single Car (1 to 24 Cars)	**Multi Car** (25 to 49 Cars)	**Unit Train** (50 + Cars)	**Truck**	**Total** (000 Bushels)
HRS Wheat	25%	24%	38%	14%	252,566
Durum	28%	29%	26%	17%	82,921
Barley	34%	28%	5%	32%	109,934
Sunflower	11%	1%	0%	88%	26,017
Oats	67%	9%	0%	24%	11,427
Flaxseed	40%	0%	0%	60%	2,200
Soybeans	42%	24%	23%	10%	9,815
All Grains	28%	23%	24%	24%	515,357

This overview of the rail and elevator systems that support the N.D. grain and oilseed industry is important in understanding the transportation rate and service issues that contribute to the success of the N.D. agriculture sector. The next section of the report includes an examination of the competitive factors influencing rail rates. Specifically, it includes a discussion of the application of intramodal, intermodal, geographic, and product competition to market dominance determination, and includes a model and estimation of the influence of each of these factors on rates. These examinations will provide essential information related to rate determination and the regulatory procedures used to determine whether a given rate can be challenged. An understanding of these issues is critical to successful grain marketing in North Dakota.

Competitive Factors and Rail Rates

In general, there are four types of competition that serve to constrain rail rates. These include:

- intramodal competition
- intermodal competition
- geographic competition
- product competition

Each of these forms of competition affects the supply or demand for railroad transportation services. Intramodal competition results from railroad to railroad competition for a given movement. Intermodal competition increases the elasticity of demand for rail service by providing transportation alternatives to rail. Geographic and product competition act as constraints on a given carrier's pricing by allowing receivers to purchase alternative commodities from alternative locations, and by allowing shippers to transport their products to alternative destinations. This section of the report examines the role these forms of competition play in market dominance, and attempts to measure the influence of each on rates.

Market Dominance and Competition

Prior to the passage of the Railroad Revitalization and Regulatory Reform Act (4-R Act), the Interstate Commerce Commission (ICC) exercised regulatory control over all railroad rates. However, with the passage of the 4-R Act in 1976, the ICC's jurisdiction over railroad rates was limited to situations where market dominance exists.

More than 15 years later, market dominance still is a vital concept in railroad rate regulation. Before a rate can be challenged under the maximum reasonable rate guidelines established by Ex Parte 347,[4] it must first be determined that the ICC has jurisdiction over the movements in question. The brief history of market dominance provided in this section is meant to provide shippers with insight into the roles that competitive factors play in regulatory proceedings, and to highlight factors that are important in influencing rates.

Market Dominance

In the 4-R Act, congress directed the ICC to establish market dominance rules within 240 days of the effective date of the act.[5] After the proposed rules were introduced by the ICC, the Association of American Railroads (AAR), the Department of Justice, and the Department of Transportation proposed the consideration of product substitution and geographic competition in deciding market dominance. These terms were briefly defined by the ICC as follows: "product substitution refers to the shipper's or receiver's option to use commodities which are interchangeable for the commodity named in the issue tariff; geographic competition is shipper use of alternative destinations or sources for the products to which the rate applies."[6]

The ICC established rules which included four presumptions of market dominance. Market dominance was presumed to exist when the carrier had been involved in rate bureau agreements, owned a 70 percent share of the market,[7] or had rates that exceeded variable

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[4] Ex Parte No. 347 (Sub-No. 1) establishes rate guidelines for coal traffic, while Ex Parte No. 347 (Sub-No. 2) establishes rate guidelines for non-coal traffic.

[5] Eaton and Center (1985).

[6] ICC, Ex Parte No. 320.

[7] Defined as the market for transportation of the specific commodity between the specific origin and destination

costs by 80 percent or more. Market dominance also could exist if a shipper had made a substantial investment in rail-related facilities. However, the initial rules established by the ICC rejected the consideration of geographic and product competition, citing the need for a quick determination of market dominance:

> *It is true that the forms of competition which the railroads, Justice, and DOT have discussed, such as product substitution and geographic competition, could have an impact upon the ability of rail carriers to raise their rates. Nevertheless, determining whether these factors have a significant impact in a particular case would require lengthy antitrust-type litigation,...*[8]

In January of 1980, the ICC deviated from these rules in a rate reasonableness case, Incentive Rates on Coal - Axial, CO, to Coleto Creek, TX, Docket No. 37226.[9] The ICC rejected the contention by the Central Power & Light Company that the railroads in question had market dominance. The ICC's basis for rejecting the presence of market dominance relied partially on the concepts of geographic and product competition. "Competition from competing carriers, alternative product competition and geographic source competition are each shown to be present and cannot be ignored as providing effective competition."[10] However, this decision was struck down by the courts in Central Power & Light Co. v. United States, 634 F.2d 137 (5th Cir. 1980).[11]

Finally, with the passage of the Staggers Act in 1980, the ICC changed its market dominance guidelines in Ex Parte No. 320 (Sub-No. 2). The Commission abandoned the four

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[8] ICC, Ex Parte No. 320.

[9] Eaton and Center (1985).

[10] ICC, Docket No. 37226.

[11] Eaton and Center (1985).

presumptions of market dominance and replaced them with general guidelines. This new policy provided the ICC with greater flexibility in deciding market dominance, as it no longer relied on specific threshold percentages in determining market dominance. As stated by the ICC in Ex Parte 320 (Sub-No. 2), "flexibility is necessary because of substantial differences among cases that preclude simple universally applicable rules." The ICC stated that the new guidelines would consider intermodal competition, intramodal competition, geographic competition, and product competition in deciding market dominance. The Commission defined geographic and product competition as follows: "Geographic competition is a restraint on rail pricing stemming from a shipper's or receiver's ability to get the product to which the rate applies from another source, or ship it to another destination... Product competition occurs when a receiver or shipper can use a substitute(s) for the product covered by the rail rate."[12] These definitions implicitly assume that a carrier other than the one in question exists at the alternative source or destination.

The guidelines introduced in Ex Parte No. 320 (Sub-No. 2) still remain in place today. However, they have been subject to considerable criticism, particularly the use of geographic and product competition. The use of these concepts in market dominance determination was first criticized by shippers in response to the ICC's proposed revisions of the market dominance rules.[13] Shippers based their objections on the old market dominance rules. In addition, the ICC's use of these concepts has been criticized heavily by the courts and

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[12] Ex Parte No. 320 (Sub-No. 2).

[13] Ex Parte No. 320 (Sub-No. 2).

lawyers.[14] Eaton and Center (1985) criticize the ICC's use of geographic and product competition for two basic reasons: (1) the use of these concepts is not consistent with traditional antitrust law, and (2) the ICC relies on the concept of "potential competition," meaning that product or geographic competition for a movement can be present even when the shipper or receiver has not substituted for the commodity in question, or substituted for the origin or destination in question. These criticisms are similar to those asserted by the courts.

The first criticism is somewhat moot, since railroad rate regulation does not have to be consistent with traditional antitrust law to be workable. The second criticism is more germane to this paper. However, it can be addressed empirically. If potential competition acts to constrain the market power of rail carriers, there is no reason why actual substitution has to take place.

This study attempts to empirically measure the limits imposed on railroad pricing resulting from geographic and product competition. In this approach, the measurement of geographic and product competition will not require the actual occurrence of a substitution by shippers. Instead, only the potential for substitution must exist. Thus, any empirical finding consistent with the expected relationships between geographic/product competition and railroad pricing will support the ICC's notion of potential competition.

In this study the two concepts are defined as follows: geographic competition is a force that acts as a constraint on a carrier's market power, and is the result of the same

[14] Eaton and Center (1985).

products being available to a given receiver from different sources where a different carrier connects the receiver with that source[15]; product competition also acts as a constraint on a carrier's market power, and is the result of the receiver's ability to substitute other commodities for the commodity being shipped where the substitute commodities are transported by a different carrier.[16]

Review of Literature

There has been no empirical work performed to date that attempts to explicitly measure geographic and product competition. Nonetheless, there have been several studies which have examined rail rate variations among regions and crops. One of these studies by Thompson, Hauser, and Coughlin (1990), attempted to measure the differences in competitive pressures on railroad revenue/variable cost ratios for export grain shipments before and after the Staggers Rail Act went into effect. The authors found that differences in rail revenue/variable cost ratios existed among crops and regions. However, their empirical model didn't measure geographic and product competition specifically. Since the authors didn't include specific measures of intermodal or intramodal competition that varied by

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[15] The definition of geographic competition used in this study includes only the geographic substitution that the receiver can make. This is slightly different from the ICC's definition which also includes geographic substitution by the shipper. However, the model employed in this study measures intramodal and intermodal competition in relation to all originating shipments from the origin, regardless of the destination. Thus, a shipper's ability to ship to different locations will be captured by these variables.

[16] Product competition is defined to include only the option of the receiver to substitute. This is slightly different than the ICC's definition, as the ICC also included the ability of the shipper to substitute for the commodity in question. However, product substitution by the shipper is unlikely, since this would require a large degree of capital investment and a large learning cost in most cases. The definition used in this study also is consistent with most discussion in this area.

region, the variations in rail revenue to variable cost ratios that they found among regions measured the combined effects of intermodal, intramodal, and geographic competition on rates. Furthermore, product competition was not explicitly shown since the authors used two separate regressions to estimate wheat and corn. The regressions showed higher estimated rates for wheat than corn. However, this comparison did not hold other relevant factors constant (such as the fact that more corn was transported in unit trains). Although the study didn't measure these factors explicitly, it was valuable as it noted regional and product differences in rail rates.

Another study that looked at the effects of deregulation on rail rates for export grain provides a better specification for modeling rail rates (MacDonald, 1989). MacDonald estimated revenue per ton mile using volume, distance, intramodal competition, intermodal competition, and seasonal factors. He found all the factors to be statistically significant in determining rail rates. MacDonald's model presented some very effective tools for examining rail rate variations resulting from intermodal and intramodal competition. For example, MacDonald used the distance from barge-loading facilities to measure intermodal competition, and a Herfindahl-Hirschman Index to measure intramodal competition. In spite of its contributions, MacDonald's model did not attempt to measure the effects of geographic or product competition.

There have been several other studies that examined variations in rail rates using methodologies similar to MacDonald's. However, none of these studies has attempted to empirically measure geographic or product competition.

Model and Data Sources

In this section a conceptual model is presented that will serve as the basis for the specification of a statistical model later in the paper. In this model, the revenue per hundred-weight (CWT) mile generated from a grain shipment is related to movement costs, competitive factors, market demand and separation, and the timing of the shipment. This relationship can be expressed by the general function:[17]

$$Revenue/cwt\text{-}mile = f(distance, shipment size, load factor, intramodal competition, \\ intermodal competition, geographic competition, \\ product competition, export/domestic market, seasonal factors)$$

Each causal variable exhibits an intuitive and important relationship to revenue per cwt-mile. Since carriers generally realize economies of distance, increases in distance will normally have a negative effect on revenue/cwt-mile. Likewise, carriers realize economies of shipment size and weight per car. Thus, increases in the number of cars in a shipment and the average weight per car will normally decrease revenue/cwt-mile. Since competition serves to constrain a carrier's market power, intramodal, intermodal, geographic, and product competition should have negative effects on carrier rates. Export movements will generally have lower rates than similar domestic movements, *ceteris paribus*, as export movements are usually more competitive. Also, rates may vary throughout the year in response to demand and equipment availability. Thus, some seasonal pattern of variation may exist.

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[17] Rates are standardized by weight and short line rail distance (i.e. shortest rail distance between origin and destination). This allows all rates to be compared on an equal basis.

The parameters of the model are estimated using a statistically valid sample of grain movements. This sample is the 1988 waybill sample. The waybill sample is believed to be the best database available for rail movements for several reasons. First, the waybill population encompasses nearly all U.S. rail movements.[18] Second, the data are sampled in a manner that allows a good estimation of the total movements. Each waybill record contains the population of the stratum from which the sample was drawn and the sample stratum count.[19] Third, the data have a low error rate.[20] Finally, the waybill sample is the only railroad commodity flow database in the U.S.

One possible problem with using the waybill sample relates to movements under contract rates that may appear in the sample. Wolfe (1986) suggested that waybill revenues may be overstated due to the use of contracts. This possible overstatement occurs because railroads are only required to approximate rail rates based on what they would be in the absence of a contract.[21] However, it is believed that the 1987 Interstate Commerce Commission decision requiring carriers to begin disclosing contracts will reduce the distortions in the waybill data. This is due to the widespread reduction in contract use

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[18] According to Wolfe (1986) the new standard put in place in 1981 for Waybill sampling required any railroad terminating at least 4,500 carloads during one of the previous three years, or which represented at least 5 percent of the traffic terminated in any state in any one of the previous three years to submit a sample of waybills.

[19] The regression used in this study is weighted by the exact expansion factor calculated from the Waybill. The exact expansion factor is calculated by dividing the population of the strata which the movement is in by the sample strata count in the waybill.

[20] According to Eric Wolfe (1986), the 1984 waybill had an error rate of 1.8 percent, but most of this was due to an error flag placed on records where rail cars weren't registered in the Universal Machine Language Equipment Register. The actual error rate was 0.6 percent.

[21] Wolfe (1986).

resulting from the disclosure rules.[22] Thus, while it is important to be aware of the fact that waybill revenues on contract movements may not accurately reflect the actual revenues in all cases, this factor is not likely to bias the results of the study.

Empirical Model and Estimation Techniques

This study presents a generalized least squares (GLS)[23] estimation of revenue per hundred-weight (cwt) mile for individual grain and oilseed movements, with all continuous variables in natural logarithms. This functional form is appropriate because it allows the coefficients to be interpreted as elasticities. Furthermore, the log-linear functional form permits the estimation of a model that is not linear in variables, but still does not violate the classic assumption of linearity in parameters. By standardizing all revenues by weight and distance,[24] a revenue-to-output measure is obtained (a rate) that allows all revenues to be compared on an equal basis.

The short-line rail distance of a shipment is the shortest railroad distance between an origin and destination. Rail revenue/cwt-mile should decrease at a decreasing rate with increases in short-line distance. This relationship is primarily due to spreading fixed terminal costs over a greater number of line-haul miles. This effect is generally referred to as economies of haul or distance. Because the model is in natural logs, a negative sign on the

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[22] Association of American Railroads. "Grain contracts drop with more disclosure" *On Track*, Vol II No. 7, April 1-15, 1988.

[23] White's heteroskedasticity-consistent estimator of the variance-covariance matrix of the OLS estimator is used, as White's test revealed heteroskedasticity.

[24] Short-line distance, which is defined as the shortest possible rail movement between the origin and destination, is used to standardize rates.

parameter estimate for short-line distance will show that revenue/cwt-mile decreases at a decreasing rate with increases in mileage.

Two factors that are expected to have a negative effect on revenue/cwt-mile are the number of cars in the shipment and the load factor of the shipment. Carriers realize economies of weight, since many common train-mile costs such as locomotive ownership and train crew wages are relatively fixed with respect to weight. Therefore, unit costs per cwt (and associated revenue/cwt mile) decline at a decreasing rate with increased train weight. Because the model is in natural logarithms, negative signs on the number of cars and the load factor would suggest that revenue/cwt-mile decreases at a decreasing rate with increases in the number of cars and the weight per car.

The level of intramodal competition for grain in various supply regions can be measured by two variables: (1) the number of carriers originating grain shipments and (2) the market shares of the largest carriers. Even if there are five railroads in a supply region, if one or two carriers originate the majority of the traffic, then strong effective intramodal competition may not be present.

One measure that captures both of these elements is the Herfindahl-Hirschman Index. This measure, which is used to measure market power, decreases with increasing numbers of carriers and increases with rising inequalities among a given number of carriers. The index will always be between zero and one, with one representing a pure monopoly. The Herfindahl-Hirschman index is calculated as:[25]

$$H = \sum_{i=1}^{n} S_i^2$$

where: H = Herfindahl-Hirschman Index
S = Market Share (in tons) of the total grain moving by rail from the origin state (regardless of destination)

The Herfindahl-Hirschman Index is expected to have a positive effect on revenue/cwt-mile for the reason that less intramodal competition allows more power in pricing.

To measure the amount of intermodal competition in the region, the distance from barge-loading facilities is used. The closer shippers are to barge-loading facilities, the more likely the chance that truck/barge combinations can effectively compete with railroads.[26] Thus, the distance from barge-loading facilities is expected to have a positive effect on revenue/cwt-mile; i.e. the greater the distance, the more market power a carrier will have, as a result of diminished intermodal competition.

Dummy variables for commodities and regions are used to measure product and geographic competition.[27] Because the concepts of geographic and product competition are

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[25] Scherer (1980).

[26] MacDonald (1989).

[27] Dummy variables are used to measure the effect of qualitative variables. These variables always have a value of either zero or one, with one representing the presence of a certain attribute and zero the absence of it. Dummy variables do not change the slope of a regression line, but change the location of the line (shift the intercept). In this study, dummy variables are used to measure the effect on revenue/cwt-mile of a movement originating in a certain region or hauling a specific

so interrelated it is difficult to empirically separate out the effects of each. In some cases such as this, the inclusion of interaction terms in the model may help isolate the effects of two independent variables. However, interaction terms would not serve to separate the effects of geographic and product competition for two reasons: 1) The Waybill does not separate hard red spring wheat, hard red winter wheat, and soft wheats from each other. The hard wheats are highly substitutable for each other in bread production, but are higher quality and not used as often for feed. Soft wheats on the other hand are lower in quality and generally are sold at a discount from hard wheats, making their use for feed much more widespread. Because these wheats are not separated in the Waybill, these effects cannot be picked up in the commodity dummies. However, substitution effects among varieties of wheat will be reflected in the regional dummies. 2) The separation of geographic and product competitive effects is really a theoretical issue, not an econometric concern. One of the most important characteristics that differentiates regions is the products they produce. The following example illustrates the commonality of the two competitive effects. Overall, durum shipments encounter less competitive pressures than other types of grains. Is this the case because durum doesn't have many substitutes (product competition), or because there aren't many regions which grow durum (geographic competition)? The answer is *durum shipments don't encounter much competitive pressure for both reasons*. From a practical perspective, it is not important to separate out the effects of geographic and product competition, since they work equally to constrain the market power of rail carriers. If one or

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commodity (e.g. the dummy variable for corn takes on a value of one for all corn movements, and zero for all others).

the other exists, then the potential for substitution by shippers is present. The question examined by this study is: Do geographic and product competition act as a restraint on rail rates even where substitution has not actually occurred? In answering this question, it is not necessary to separate the effects of the two variables.

In the empirical model, the commodity and regional dummy variables should be interpreted as reflecting both geographic and product competition. The commodity dummies included in the model are wheat, corn, soybeans, barley, and durum. These dummies should be interpreted in relation to other grains and oilseeds. *A priori*, durum is expected to have the greatest positive effect on revenue/cwt-mile because the majority of durum production is concentrated heavily in one small area of the Upper Great Plains[28], and there are few substitutes for the commodity in the production of pasta. The dummy for barley should also have a positive effect on revenue/cwt-mile. There are few substitutes for barley in the production of beer, and a large share of its production is concentrated in one region. However, some substitutes for barley do exist on the feed side, and its production is not as concentrated as durum, suggesting that the magnitude of its parameter will not be as great as that of durum. Because varieties of wheat cannot be separated from the Waybill data, wheat should have the third highest revenue/cwt-mile. There are few substitutes for hard wheat in bread production, but varieties of hard wheat are grown in more than one geographic region. On the other hand, because the soft wheats are generally lower in quality they often sell at a discount from hard wheats, making them more attractive as feed grains. The greater use of

[28] The Upper Great Plains is defined in this study to include North Dakota, Minnesota, and South Dakota.

soft wheats as feed suggests that there are several substitutes for them, and their production is wide spread. In effect, there are likely contrasting effects on rates from the wheat dummy due to its representation of more than one variety of wheat. Corn and soybeans should have the lowest revenue/cwt-mile, *a priori*. Both corn and soybeans have many substitutes as they are primarily used for feed, and their production is widespread.

Although geographic competition is partially reflected in the commodity dummy variables, geographic effects cannot be captured solely by the commodity dummies. The amount of geographic competition realized for a movement is not only a function of the commodity shipped but of the primary grains produced in the region. Regions whose primary grains also are produced in adequate supply elsewhere are more likely to receive favorable rates on their shipments. If railroads attempt to charge substantially higher rates in these regions they may lose traffic to competing regions, where another carrier can originate the same commodity. Thus, regions for which substantial geographic competition exists should exert negative or downward pressure on revenue/cwt-mile. The regional dummy left out of the model[29] is for the Upper Great Plains; all of the regional dummies are expected to have negative signs, *a priori,* since the Upper Great Plains produces two commodities, durum and barley, which are not produced in adequate supply elsewhere.

The dummy variable for export movements is expected to have a negative effect on revenue/cwt-mile. The export variable is, in some respects, an additional measure of the

[29] To avoid perfect collinearity one dummy must be left out (i.e. if all dummies were included in the model, it would be impossible to separate out the effects that each has on revenue/cwt-mile).

effectiveness of geographic and product competition. Geographic and product competition are likely to be more effective for export movements, since ports tend to be served by many railroads, making movements from many regions possible. Because of the increased options for export movements, geographic, and product competition should be more effective than for domestic movements. The log-linear model of rail grain rates is shown below:

$$
\begin{aligned}
lnREVCTM = {} & \beta_0 + \beta_1 lnSHRT + \beta_2 lnCARS + \beta_3 lnLOAD + \beta_4 lnHERF + \beta_5 lnBDIST + \\
& \beta_6 REG2 + \beta_7 REG3 + \beta_8 REG4 + \beta_9 REG5 + \beta_{10} REG6 + \beta_{11} REG7 + \beta_{12} REG8 + \\
& \beta_{13} REG9 + \beta_{14} REG10 + \beta_{15} BARLEY + \beta_{16} CORN + \beta_{17} DURUM + \beta_{18} SOYBEANS \\
& \beta_{19} WHEAT + \beta_{20} EXP + \beta_{21} Q2 + \beta_{22} Q3 + \beta_{23} Q4 + u
\end{aligned}
$$

where: REVCTM =	revenue/cwt-mile
SHRT =	short-line distance
CARS =	number of cars in the shipment
LOAD =	weight per car in the shipment
HERF =	Herfindahl-Hirschman Index
BDIST =	distance from barge loading facilities
REG1 =	dummy for region (1=N.D., SD, or MN; 0=other states)
REG2 =	dummy for region (1=KS, IA, NE, or MO; 0=other states)
REG3 =	dummy for region (1=WI, IN, IL, MI, or OH; 0=other states)
REG4 =	dummy for region (1=WY, ID, CO, UT, or MT; 0=other states)
REG5 =	dummy for region (1=WA or OR; 0=other states)
REG6 =	dummy for region (1=AZ, NM, CA, or NV; 0=other states)
REG7 =	dummy for region (1=DE, MD, NY, NJ, PA, MA, ME; 0=other states)
REG8 =	dummy for region (1=TX, OK, AR, LA; 0=other states)
REG9 =	dummy for region (1=FL, GA, AL, SC, MS; 0=other states)
REG10 =	dummy for region (1=NC, TN, KY, VA; 0=other states)
BARLEY =	dummy for Barley
CORN =	dummy for Corn
DURUM =	dummy for Durum
SOYBEANS=	dummy for Soybeans
WHEAT =	dummy for Wheat
OTHER =	other grains and oilseeds

EXP[30] =	dummy for export (1=export; 0=non-export)
Q2 =	second quarter of 1988
Q3 =	third quarter of 1988
Q4 =	fourth quarter of 1988
u =	random error term

Empirical Results

Since White's test revealed heteroskedasticity, this model was estimated using a heteroskedasticity-consistent estimator. Thus, the estimator is efficient (i.e. minimum variance). The results of the log-linear estimation are shown in Table 6.

[30] Movements for which the domestic/export status is unknown are classified as domestic.

Table 6. Estimation of Revenue/Cwt-Mile

Variable	Estimate	t-ratio
Intercept	-1.7800	8.66*
SHRT	-0.5125	75.56*
HERF	0.1298	7.39*
BDIST	0.0450	6.25*
CARS	-0.0638	16.10*
LOAD	-0.3497	7.71*
REG2	-0.1522	9.26*
REG3	-0.0666	3.41*
REG4	-0.0502	2.78*
REG5	-0.1451	3.89*
REG6	0.0062	0.12
REG7	-0.2734	7.33*
REG8	0.0029	0.14
REG9	-0.3930	12.23*
REG10	-0.2378	8.94*
CORN	-0.0343	1.79**
SOY	-0.1655	7.36*
WHEAT	-0.0006	0.03
BAR	0.1217	5.80*
DUR	0.1432	4.14*
EXP	-0.0236	1.30
Q2	0.0552	4.65*
Q3	0.0581	4.31*
Q4	0.0716	5.22*

ADJUSTED R^2 = .7089 F=1321 N=12,658
*significant at the 5% level
**significant at the 10% level
- All continuous variables are in natural logarithms

Overall, the estimated model provides a good explanation of variations in revenue per cwt-mile. As shown in Table 6, over 70 percent of the variation in the dependent variable is explained by the model. More importantly, the estimated model shows that a strong expected relationship exists between the explanatory variables and revenue/cwt-mile. As expected, the natural log of short-line distance has a negative sign and is significant at the 5 percent level. This suggests that as short-line distance increases, carriers pass on some of the economies realized; e.g. revenues per cwt-mile decrease at a decreasing rate with distance. The Herfindahl-Hirschman Index has a positive sign, and also is significant at the 5 percent level, suggesting that intramodal competition has a negative effect on revenue/cwt-mile. The distance from barge-loading facilities has a positive sign and is significant at the 5 percent level, indicating that carriers realize greater revenue/cwt-mile the farther away the traffic is from barge loading facilities. The natural logs of the weight per car and the number of cars in the shipment have negative signs and are significant at the 5 percent level, indicating that revenues per cwt-mile decrease at a decreasing rate with increased weight.

The variables of special interest in this estimation are the regional and commodity dummies. These variables are hypothesized to represent geographic and product competition. In the estimated model, the commodity dummies have the expected signs, and suggest that product and geographic competition have important effects on revenues per cwt-mile. These variables are interpreted in relation to other grains and oilseeds, which is the dummy left out of the model. Durum and barley both have positive signs and are significant at the 5 percent level, suggesting, as expected, there is less product and geographic competition for movements of these commodities. Further, the magnitude of the parameter on durum is highest of all the commodities, reflecting that durum is a highly specialized crop used in the production of pasta which has few substitutes. Furthermore, the majority of durum production is concentrated in the Upper Great Plains. The dummy variables for corn and soybeans have negative signs and are significant at the 10 and 5 percent level, respectively. This is not surprising as there are many substitutes for corn and soybeans, and their production is wide spread throughout the U.S. The only commodity dummy variable with a t-statistic not significantly different from zero is wheat. However, this result is not totally unexpected since the Standard Transportation Commodity Code (STCC) on the waybill does not distinguish between hard and soft wheats. Although the commodity dummy for wheat does not reflect product competition, product and geographic competition are reflected in the regional dummy variables discussed below.

The regional dummies also have the expected signs, suggesting the presence of geographic and product competition. First, all of the regional dummies, except two, have negative signs, suggesting that carriers in most regions experience greater geographic and product competition than those in the Upper Great Plains, where the primary crops are relatively unique to the region. Further, the two regions that don't show a significant difference from the Upper Great Plains in the amount of geographic and product competition show amazing similarities to the Upper Great Plains. Region 6, which includes Arizona, New Mexico, California, and Nevada, has an agricultural base which is heavily concentrated on hard wheat and durum. Region 8, which includes Texas, Oklahoma, Arkansas, and Louisiana, is concentrated heavily on hard wheat (although a significant amount of soft wheat is produced there, as well). The regions which show the greatest amount of regional and product competition are Region 9, Region 7, and Region 10. Regions 9 and 10 concentrate heavily on corn, soybeans, and soft wheat. Region 7 concentrates heavily on corn and soft wheat.

Conclusion

Recent elimination of the Interstate Commerce Commission, pending rail mergers of major carriers, and the recent attempts to set maximum reasonable rate guidelines have indicated the concerns of captive shippers over rates and service. This study has shed some light on the grain marketing practices of N.D. grain elevators and has explained and measured the competitive factors influencing rates, including their role in market dominance determination.

The study shows that carriers' rates are constrained by four factors not under the control of the carrier. These factors include intramodal competition, intermodal competition, geographic competition, and product competition. While the concepts of intermodal competition and intramodal competition have been widely accepted by many, this is not necessarily the case for geographic and product competition. Regions which grow relatively unique crops such as the Upper Great Plains and the Pacific Southwest have higher rail rates as carriers are not constrained by geographic competition in those areas. In addition, shipments of durum and other crops which don't have many substitutes have higher rates as carriers don't realize product competition for these movements.

Finally, the study highlights the importance of efficient and effective rail service for the future of N.D. agriculture. The explanations of current N.D. grain marketing practices and of the factors influencing rail rates should allow for more enlightened decisions regarding policies that may affect the future of N.D. rail service.

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