ANALYSIS OF RAIL RATES FOR WHEAT RAIL TRANSPORTATION IN MONTANA; COMPARING RATES IN A CAPTIVE MARKET TO ONE WITH MORE INTRAMODAL COMPETITION

by

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ABSTRACT

Today's rail industry is the outcome of years of regulatory and technological change. Since the passage of the Staggers Rail Act of 1980 the industry has seen consolidation through mergers and acquisitions.

The rail industry in Montana has a rich rail history that includes the completion of a northern east-west route over 100 years ago that provided a commerce route from the interior of the US heartland to the ocean ports in the Pacific Northwest. In those hundred years the rail traffic across Montana has seen dramatic change. In the past, those routes have provided access for Montana freight; today those routes primarily serve the needs of consumers and industries far beyond Montana.

While the state's economy is primarily agricultural, the largest user of rail transportation is the energy industry. This leaves the agriculture industry with a lower priority for access, providing a quandary for rail service for the grain industry in the state.

In a state where more than eight national and regional rail carriers once operated, Montana is now only serviced by a small handful, one of which operates over 80% of the rail miles within its borders. Furthermore that carrier provides service through those regions that are almost strictly agricultural, needing the greatest access to the most cost effective means of transportation for the bulk movement of grain.

The objectives of this thesis are to develop a model to measure railroad costs and competition; determine the principal cost determinants and measure

intramodal competition by comparing the rates in a captive market (Montana) to one with more intramodal competition (Kansas).

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CHAPTER 1: INTRODUCTION

Railroads are important for shipping agricultural commodities from producing regions to the domestic processing locations and export ports. These shipments typically involve large scale movements of a bulk commodity over long distances, markets in which railroads have a cost advantage relative to other modes. This is the situation in Montana where 70% of the Montana wheat crop is shipped by rail to Portland and Seattle for export.

Railroads were the most heavily regulated transportation mode prior the passage of the Staggers Rail Act in 1980. Deregulation gave the railroads a great deal of pricing flexibility that was previously unavailable. Prices could be set as low as variable cost and as high as 180% of variable cost without Interstate Commerce Commission (ICC) jurisdiction or review. The Staggers Act set time limits for ICC decisions regarding abandonments and mergers. Thus Class I railroads were able to quickly abandon or sell branchlines that lost money. Mergers reduced the number of Class I railroads from 40 in 1980 to seven today.

Deregulation led to railroad pricing innovations. The introduction of unit trains (also called shuttle trains) rewarded shippers for large volume movements. Unit trains typically involve shipments of one commodity in a 100-110 car train between a single origin and destination. The train stays together as a unit which means cars and locomotives of a unit train aren’t periodically assigned to other movements. Unit trains significantly reduce railroad costs per ton-mile and thus rail prices are relatively low for unit train service.

In some locations deregulation created the necessity to improve efficiency and service since railroads faced intramodal competition that did not exist prior to 1980. This competition led to lower rail prices. For example, Babcock et al. (1985) found that export wheat rates from many Kansas origins increased an average of 64% in the four years prior to 1980 and then fell 34% in the four years after 1980 as a result of intramodal competition (trucks and water carriers are non-competitive modes for these shipments). MacDonald (1989) also found that intermodal competition from barges has strong effects on rail rates. The farther the shipper is from competing water transportation, the higher railroad grain rates rise. For example, wheat shippers located 400 miles from water competition paid rates 40% greater than shippers 100 miles from water competition. MacDonald (1989) also found that intramodal competition has a major impact on rail grain rates; he found that moving from a monopoly to a duopoly in a corn market reduced rates by 18%, and moving further to a triopoly reduced rates another 11%.

Some of the trends previously discussed have occurred in Montana. Prior to 1970, Montana was serviced by six Class I railroads. The trend towards consolidation and mergers generating significant impacts began in 1970. The largest of those consolidations was the Great Northern and the Northern Pacific merging to become part of the Burlington Northern (BN) line. Two other Class I railroads were also part of that merger, bringing a total of four Montana Class I railroads to the BN entity. This merger allowed the BN to operate both the northern and southern east-west railroads in the state. At the time the only other Class I railroad left with an east-west line to compete with BN was the Chicago, Milwaukee, St. Paul and Pacific Railroad (Milwaukee Road or MILW), however the company was in poor financial condition. While the State of Montana made an attempt to purchase the MILW in 1980, it ultimately was unable to and the properties that were not sold to BN and Union Pacific (UP) were abandoned. Table 1.1 reflects the railroads in Montana in 2008.

Montana is a captive market for railroad shipment of wheat. The degree of intermodal competition is limited due to the great distances to barge loading facilities and export ports. Montana's nearest barge loading facility is Lewiston, Idaho, located over 400 miles from major Montana wheat growing areas. Thus, limits on rail rates due to barge competition are likely to be negligible. Further, the great distances from Montana origins to Pacific Northwest ports suggest that railroads have a substantial cost advantage over trucks in transporting Montana's wheat.

Table 1.1: Railroads Operating in Montana, 2008

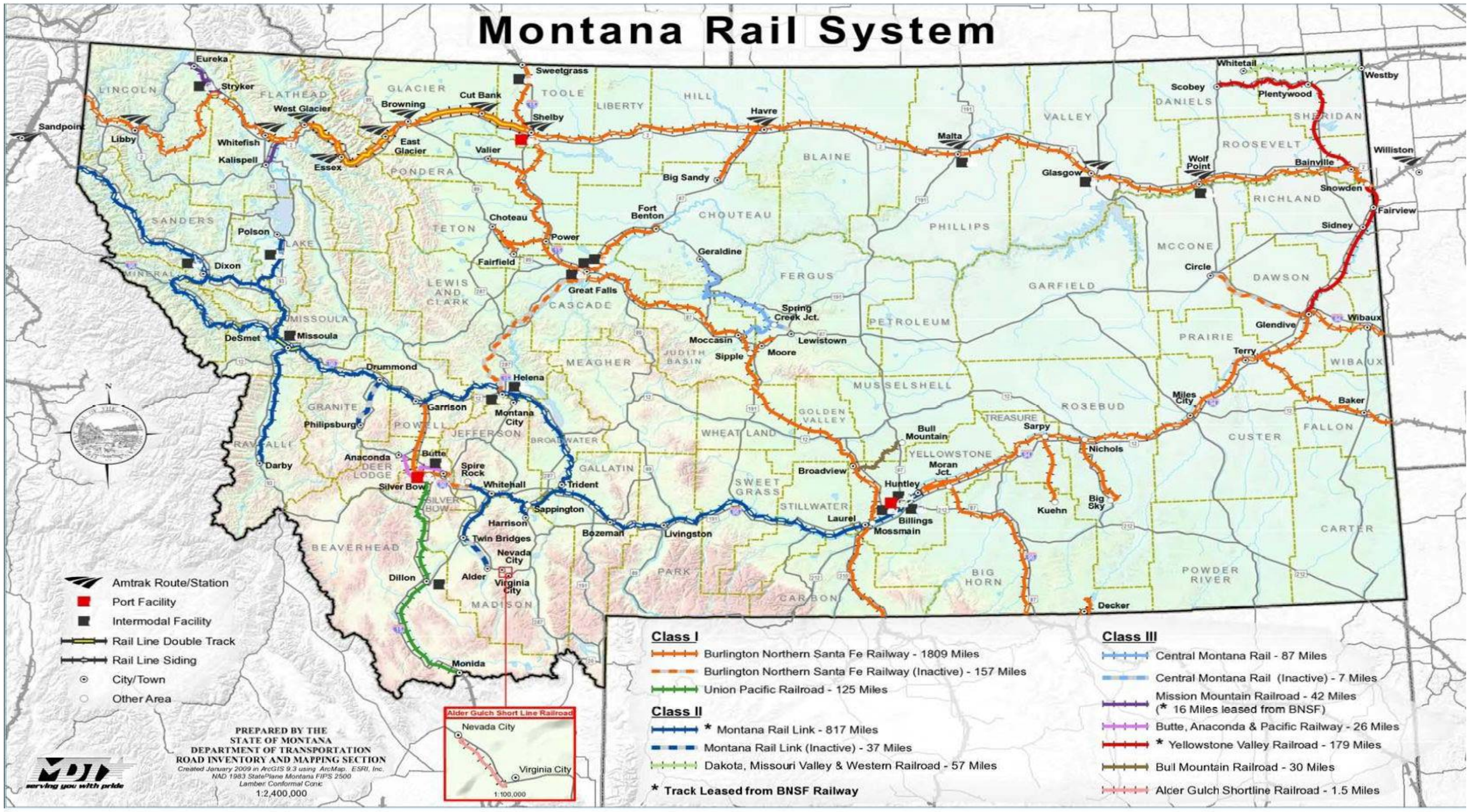
	Railroad	Mileage	Employees
Class I			
	Burlington and Santa Fe Railway Company	2135	2,236
	Union Pacific	125	N/A
Class II Regional	Montana Rail Link	812	942
	Dakota Missouri Valley and Western Railroad, Inc.	57	4
Local Railroads			
	Central Montana Rail, Inc.	87	6
	Montana Western Railway Co	59	16
	Rarus Railway Company	69	13

Source: Montana Department of Transportation

Intramodal competition is also limited in Montana. BNSF operates on 2,135 miles of track, while the only other Class I railroad in the state, UP, operates 125 miles of track. Regional operators include Montana Rail Link (MRL) and Dakota, Missouri Valley and Western Railroad, Inc. (DMVWR). The regional classification for DMVWR is misleading as the railroad only operates 57 miles of track in Montana. While MRL operates a large amount of track (812 miles), it serves as a bridge carrier for BNSF and consequently does not provide intramodal competition. MRL operates and maintains the track, however BNSF still owns the mainline. MRL must obtain permission from BNSF to perform interchange with any other railroad and origins on the MRL line are treated as BNSF origins. Furthermore, BNSF has agreed to provide a given level of bridge traffic on the line, tying much of MRL traffic and financial health to that of BNSF. DMVWR is affiliated with the Canadian Pacific Railroad (CP) and ties into CP lines in central North Dakota. Other short lines include Central Montana Rail, Inc. (87 miles), Montana Western Rail Co. (59 miles), and Rarus Railway Company (69 miles). However each links to one or the other Class I railroads, thus not providing competition. Figure 1 reflects the railroads operating in Montana in 2008.

Until recent years, hard red spring wheat has been the primary type of wheat grown in Montana. As reflected in Table 1.2, 2007 spring wheat production was just over 55.2 million bushels, while 2005 and 2006 production was 81.6 and 63.8 million bushels, respectively (NASS). The 2006 and 2007 production is indicative of the impact of multiple years of drought in the region, causing the low total wheat production since 2003. This has forced many customary spring wheat

Figure 1.1: Montana Rail Map, 2008



production areas to rotate to more drought sustainable winter wheat. Hard red spring wheat production is primarily in the north central and northeast areas of the state. These two areas accounted for over 42 million bushels of the 55 million produced in 2007 (NASS). This area, while covering over 2.5 million acres in cropped acres alone, is serviced almost exclusively by BNSF. Hard red spring wheat is not produced in abundant quantities in barge competitive regions of the country, suggesting that rail rates in Montana are unlikely to be constrained by competing traffic in other regions that moves at lower rail rates. In other words, geographic competition is unlikely to be significant for Montana wheat.

Table 1.2: Montana Wheat Production 2003 – 2007

(Thousands of Bushels)

Year	Winter Wheat	Durum Wheat	Other Spring Wheat	Total Wheat
2003	67,340	14,490	60,500	142,330
2004	66,830	17,985	88,350	173,165
2005	94,500	16,380	81,600	192,480
2006	82,560	6,715	63,800	153,075
2007	83,220	11,400	55,200	149,820
Total	394,450	66,970	349,450	810,870
Average 2003-2007	78,890	13,394	69,890	162,174

Source: U.S. Department of Agriculture, National Agricultural Statistics Service
Retrieved June 10, 2008 from http://www.nass.usda.gov/QuickStats

While there have been many studies of railroad pricing of agricultural commodities, few of these have focused on Montana, where the competitive restraints on rail grain prices appear to be minimal. The overall objective of this thesis is to investigate railroad pricing behavior in the shipment of Montana wheat. Specific objectives include the following:

1. Develop a model to measure the impacts of railroad costs and competition on rail rates for Montana wheat.

2. Identify and measure the principal cost determinants of rail prices such as distance, shipment volume, and weight per car.

3. Measure intramodal competition by comparing rail rates in a captive market (Montana) to one with more intramodal competition (Kansas).

1.1 Thesis Statement

Montana has limited intramodal competition for grain shipments across the state and has been called a captive shipper due to the lack of rail competition. By comparing a location with intramodal competition, would the presence of that competition provide reduced shipping rates for wheat transportation in Montana?

1.2 Organization

The document is composed of six chapters and one appendix. Chapter 1 is an introduction to the thesis topic and the organization of the paper. Chapter 2 is a literature review, a summary of selected pertinent publications and their potential application to the thesis. Chapter 3 is a discussion of the theoretical basis of the research. Chapter 4 is a discussion of the research methods and the proposed model to address the thesis problem. Chapter 5 is a discussion of the data methods and the quantitative analysis of the topic. Chapter 6 is a discussion of the findings of the research and its potential application. The attached appendix includes additional reference information that may contribute to understanding of the thesis.

CHAPTER 2: LITERATURE REVIEW

The depth of literature addressing the issue of competition in the railroad transportation industry is significant, providing various degrees of analysis as to the impact of competition within the industry. Much of the analysis investigates the impact of deregulation after the Staggers Rail Act of 1980. A significant amount of the literature is regional in scope and occurred in the decade post-Staggers. Change continues within the railroad industry as both technology and infrastructure advancements have occurred. These factors provide inherent limitations to the findings of prior studies and will continue to do so with any such study as the regional nature of the railroad transportation networks vary. What follows is not a complete survey of the prior research conducted related to railroad competition; however, the works cited provide a foundation and background for the development of a railroad pricing model. Emphasis of this review is on the factors that affect railroad competition on rail grain transportation prices.

The research article often cited in the works below is a piece entitled, “Impact of the Staggers Rail Act on Agriculture: A Kansas Case Study”, Babcock, Sorenson, Chow and Klindworth (1985). One objective of the study was to describe and quantify rail initiatives in the Kansas wheat transportation market following the implementation of the Staggers Act. They found in the four year period of 1981 through 1984 substantial railroad reduction had occurred in the level and arrangement of railroad rates. A pattern of rate changes suggested competition among railroads and between individual railroads and truck-barge combinations. They found that tariff rates to the Gulf of Mexico, in the post-Staggers time frame had been reduced by 34%, compared to a 64% increase in the four years preceding Staggers.

MacDonald (1989) examined Waybill samples as means of quantifying the impact of deregulation on export grain rail shipping rates for wheat, corn and soybeans. Using regression analysis, he found that interrail competition was strongest for corn, and when rail service goes from monopoly to a duopoly, it leads to a rate decline of 18%. Moving further to a triopoly, rates declined at a smaller rate of 11%. He also found that access to water movement impacted rates as rail rates increased as barge competition became less likely. This was most noticeable on the rates associated with the transportation of wheat as wheat origins are typically significantly greater distances from water than that of either corn or soybeans. MacDonald found that shippers who were 400 miles from barge access paid rates 40% more than those 100 miles away. He concluded that concentration measures in all crop reporting areas indicated tight oligopolies and the addition of a competitor makes a difference. Competition from barges has a strong impact.

Chow (1986) examined rail grain rate changes for the Central Plains in the post-Staggers period 1981-1986. He assessed the magnitude of rail rate reductions for domestic and export markets as well as examined the change in patterns of rates among rail firms within different regions of the Central Plains. His analysis indicated an overall reduction in rates for wheat in the five year period after Staggers of 34.5%, with the rate reductions occurring most significantly in the export markets. He found that railroads adopted different strategies for rate-adjustments with some being very consistent in their rate changes over their entire systems, while others had greater rate reductions for some routes and less with others. While rail contracts between carriers and shippers were not available for the analysis, Chow asserted that the contract rates would be significantly lower than the published rates. This would show a greater impact in the rate reductions than the data used for the analysis indicated.

Adam and Anderson (1985) examined the effect of the Staggers Act on the level of country elevator bid prices and if there was indeed an increase in bid prices since Staggers passage. Using econometric models with corn and soybean elevator bid prices in Nebraska, they found that both corn and soybean bid prices were increased. However the impact on soybeans was higher at a level up to 14 cents per bushel. The impact on corn appeared to be offset by competing elevator bids. However, the study also identified the buildup of capacity for the transport of corn and the decline in the export market at the time, both exigent circumstances such that the rail rate reduction was not seen in the increase of bid prices for corn. The capacity build up during the time frame reflected the growth of unit train activity. In 1977, there were only eight elevators in Nebraska with unit train handling capabilities. By 1982 the growth in unit train handling facilities combined with the decline in export markets provided over 200% of the capacity necessary to move corn to the West Coast ports.

Kwon, Babcock, and Sorenson (1994) studied the impacts of Staggers in the latter half of the 1980s as most prior studies investigated the impact immediately post-Staggers. They investigated whether railroads have the ability to practice differential pricing in a highly competitive and unregulated market as well as sought to measure the determinants of rail differential pricing specific to the transportation of Kansas wheat. Through the development of two econometric models, one for intra Kansas shipments and one for export movements, to account for the average car size differences (10 cars for intra Kansas and 20 for export); they found that differential pricing was practiced by railroads in both cases. They also found substantial differences in determining the factors affecting rate-to-variable cost ratios (R/VC) for intra Kansas wheat movements versus that of export Kansas wheat movements.

They observed that R/VC ratios increased steadily through the period of 1986 to 1989, however, they hypothesized it could have been the result of export demand diminishing over the time frame. They also found that the disclosure of previously confidential contracts reduced the incentive to negotiate contracts and subsequently the published tariff rate was used by railroads and shippers. They found that even though R/VC increased over the time frame, it may not have had a negative consequence as a railroad received a 125.8 R/VC (at that time) and was more likely to be able to provide adequate service and replace capital, versus that of a railroad unable to cover its variable cost. Finally, they indicated geographic competition is likely to constrain increases in R/VC rates for railroads within Kansas for wheat as at some point increased R/VC railroad ratios will induce diversion of Kansas wheat from Texas Gulf ports to other markets. This is also likely the case for non-Kansas origins.

Fuller et al (1987) conducted a study to measure the impact of deregulation on export-grain rates using a procedure that attempted to correct for shortcomings of earlier research studies. The specified procedure controls for impact of events which may be coincident with deregulation and, in addition, circumvents the problem associated with inaccessible rate information included in the confidential contracts. The procedure is applied to major export –grain transportation corridors linking the central and south Plains and Corn Belt Regions with their respective port areas.

The Fuller et al. study identified five regions that included the states of Kansas, Iowa and Indiana as well as the Texas Panhandle and a portion of Illinois. Kansas and The Texas Panhandle represented surplus producers of hard red winter wheat, representing half of the U.S.'s annual wheat production and about 63% of wheat exports. Those regions rely heavily on rail for export transportation, with 90% of western Kansas wheat transported on rail and 75% of northeast Kansas and the Texas Panhandle wheat shipped by rail.

The effects of deregulation on export-grain railroad price structures were identified with the analysis focusing on the price spread between port and associated hinterland region. In general the adopted procedure involves the estimation of regression equations which include hinterland's farm-to-port price spread (m) as the dependent variable and independent variables which control shifts in demand and supply schedules; region and two dummies; a time trend ; and a dummy and an interaction term to isolate changes in rates that may have resulted from the 1980 Staggers deregulation.

Fuller et al. found deregulation to have had a significant effect on rail transportation corridors linking the Plains states of Kansas and Texas with Gulf ports and a relatively modest impact on the corridor linking Indiana with East Cost ports. Kansas and Texas corridors had estimated real rate declines of $.37 and $.31 per bushel during the 1981-1985 period. In the Indiana corridor, deregulation is estimated to have decreased rates by $.08 per bushel. Additional analysis indicated that the effect of deregulation in state subregions may have differed from the estimated state wide effect.

The Iowa and Illinois regression models show deregulation to have had little sustained statistically significant effect on rates in the regions linked with the Gulf Ports. In contrast to the findings in the Plains, barge rates have an extremely important effect on corridor price spreads. In the Illinois and Iowa models a dollar decline in rates served to reduce the price spread by $.51 and $.73 per bushel while the impact for Indiana was $.38 per bushel. To the analyst it seemed that much of the decline in Corn Belt price spreads during the post-Staggers era can be attributed to declining barge rates, not to a reduction in rail rates.

Koo, Tolliver and Bitzan (1993) investigated railroad pricing behavior in North Dakota, a seemingly captive railroad shipping market focusing on the rail transportation characteristics of the Upper Great Plains region. They argued that the region had unique railroad transportation characteristics when compared to other regions of the United States. These characteristics included limited intermodal competition due to great distances to barge loading facilities and large distances to major markets of consumption, processing and export. They developed an econometric model applying data related to car weight, distance, intramodal competition, intermodal competition and variables associated with three respective crops, and the season of the year. Their research found that distance, volume and weight per car all have significant negative effects on rates; intramodal and intermodal competition had significant effects on rail rates suggesting that the two Class I railroads in the state at the time were competing with each other and with barge and truck movements from North Dakota.

Thompson, Hauser and Coughlin (1990) also evaluated the competitive pressures on railroad rate-to-variable (R/VC) ratios for export shipments of corn and wheat both pre- and post-Staggers. Through the development of four regression models, two for corn and two for wheat, they found that the corn results were less significant than those for wheat as shipment size for wheat likely reflects the impact of expanded multi-car services post-Staggers. They found that there was a lack of identifiable differences in pre- and post- deregulation pricing which may be attributable to the close correlation between changes in certain operating factors such as shipment size and destination opportunity. Their study concluded that their results did not indicate a clear effect of the Staggers Rail act on rail rate competitiveness.

These works and several others provide a collective review of the impact of the Staggers Rail Act on competition and rail rates as well as some regional considerations when one is examining the factors associated with rail rate competition. Limitations were often identified and those factors should be considered as one conducts further study of the topic. Furthermore, as addressed in the introduction of this review, other factors associated with the rail transportation industry have occurred in the time frame since several of these works were completed, especially in Montana.

CHAPTER 3: THEORY

Examination of the markets that railroads operate in provides a basis for the pricing that exists in the grain transportation sector. The theory to be examined include those areas related to firms that operate in a particular market structure, more specifically a railroad that operates with competition, as a monopoly, and finally; as an oligopoly. The need for railroad reform will briefly be addressed followed by a brief description of each market type and its application to railroad transportation industry. The chapter concludes with an intermodal transportation system theory review.

3.1 Railroad Reform Rationale

This paper has previously discussed many aspects of the Staggers Railroad Act of 1980, typically in terms of impacts after the implementation of the legislation. The implementation of Staggers was seen as a necessary tool to promote the reform necessary for the financial well being of the railroad industry. Through the 1950s widespread financial problems arose and in the late 1960s and early 1970s several railroads in the eastern U.S. filed for bankruptcy. Government intervention in the northeastern railroad network formed the Conrail system after financial collapse of the one of the major eastern carriers. Through the late 1970s bankruptcy was also experienced with the three Midwestern railroads, one of which, the Milwaukee Road, had trackage through Montana.

These railroad failures brought on the political necessity to implement reform with the first major reform act, the Rail Revitalization and Regulatory

Reform (4R) of 1976. The act allowed improved pricing flexibility while easing restrictions for abandonments. The Interstate Commerce Commission (ICC) rather restrictively interpreted the act and important changes did not occur until the ICC composition changed in 1979. This led to the ICC approving four major mergers, accelerated abandonments and the introduction of confidential contract rates. These actions preceded the passage of the Staggers Act in 1980 and in some respects; Staggers validated the reform that ICC had already implemented. These measures were necessary to restore the financial viability of railroads and have contributed to the sustainability of the railroad transportation network within the U.S. today.

3.2 Perfect Competition

Perfect competition in a market will reflect pricing according to the market supply and demand curves. Increases in prices are represented on a supply curve to slope upward to the right resulting in increased industry output. The market demand curve slopes downward and toward the right, as prices increase, demand for the product is reduced. Essentially, the key aspect in a perfectly competitive market is that maximum profit exists at the output where marginal revenue (price) is equal to the output price. (Mansfield 2002). Further, the barriers to entry are very low, requiring only a small investment to enter the industry. There are a very large number of buyers and sellers, and the product is homogeneous. In the railroad industry, perfect competition is likely non-existent as there are a limited number of firms that actually compete. The resources necessary to enter the market discourage entry by others as a significant capital investment is required to build and operate a railroad.

3.3 Monopoly

In a monopoly, the industry consists of one firm; a single seller of the product or service. A monopolist will have considerable control over pricing as there is no additional competitor in the industry. A monopolist in an unregulated market, if it maximizes profit, will price its product and produce the output at a point where marginal revenue is equal to marginal cost and marginal revenue is derived from the demand curve. A monopolist, when free of direct competitor imposed restraints, can set higher prices, and generate higher profits than it would if it were exposed to the competition of a rival firm. Entry to the market is essentially blocked.

Railroads reflect characteristics of a monopoly in a regional perspective throughout the U.S. There are also locations where there is more then one railroad firm that may provide intermodal competition. However, as discussed previously, the industry does experience intermodal competition from other firms within the transportation industry (barge and truck). Furthermore, railroads are subject to government regulation limiting the ability of the industry to act as a true monopolist in those areas that lack firm competition.

3.4 Oligopoly

An oligopoly is an intermediate situation between that of perfect competition and a monopoly where there only a few firms competing in a market. An oligopoly is likely going to have less control over pricing than that of a monopoly, but more than that of a perfectly competitive firm. Barriers to entry are high in oligopoly and they tend to rely heavily on nonprice competition.

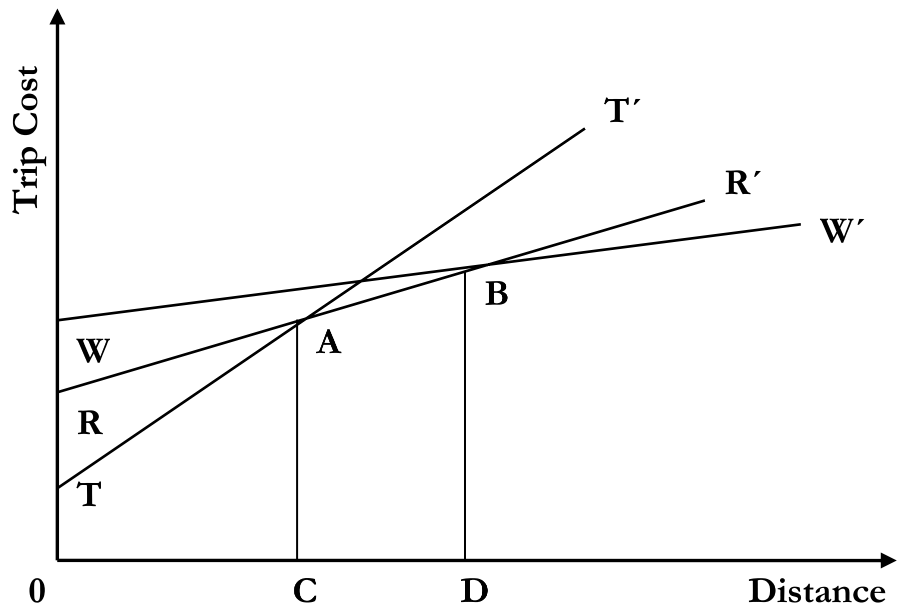
Oligopoly competition most accurately reflects railroads as grain shippers can utilize other modes (barge and truck) in some cases to transport grain to domestic markets.

3.5 Intermodal Transportation System Theory

Grain shippers utilize three modes of transport to ship grain to markets: (1) rail, (2) truck, and (3) water. The least cost mode for a given grain shipment is a function of distance from origin to destination. In Figure 1, hypothetical modal cost curves are constructed for the rail, truck, and water modes between origin i and destination j. The hypothetical cost curve for trucking (T) indicates that trucks have a cost advantage for short hauls because they have insignificant fixed and terminal costs relative to other modes. The cost curve for water shipment (W) shows that water movements have the lowest unit costs with respect to distance but significantly higher fixed or terminal costs than other modes. Thus water has the highest trip costs for short distance movements and the lowest costs for long haul shipments. The railroad cost structure (R) lies between the short haul cost advantage of trucks and the long haul advantage of water shipment.

While the cost curves in Figure 1 are linear to simplify the modal relationships, costs increase at a decreasing rate with distance due to economies of long hauls. Carriers realize economies of long haul primarily because fixed terminal costs are spread over a great number of miles. If the freight rate is determined solely by costs, the transport market will be divided among modes, according to distance, holding all other rate factors constant. Thus in Figure 1, motor carriers will have a cost advantage for distance OC, railroads will have the cost advantage for distance CD, and water will have the advantage for distances greater than OD.

Figure 3.1: Hypothetical Trip Cost Curves for Rail (RR'), Truck (TT'), and Water (WW'), Modes of Transportation for a given Origin/Destination



In addition to cost factors such as distance, competitive factors have an impact on rail rates. Intermodal and intramodal competition constrains rail market power, and in markets where such competition exists, railroads will charge lower rates than in non-competitive markets.

3.6 Theoretical Model

The theoretical model is a variant of the model published in Koo et al (1993). Equilibrium prices of rail transport of agricultural products are determined by demand for and supply of rail service. Demand for a railroad's service (q_d) is a function of the price of the railroad's service (p_1), the price of other railroads' transport service (p_2, p_3...), the prices of other modes of transport (a_1, a_2, ...), and other factors affecting demand for rail transport (S). Thus the demand function is equation (1).

(1) $q_d = f_d(p_1, p_2, p_3\ldots, a_1, a_2, S)$

The supply of a railroad's service is a function of the price of the railroad's service (p_1), cost factors such as distance (d) and shipment volume (v), and other variables that affect the cost of rail service (C). Thus the supply function is equation (2).

(2) $q_s = f_s(p_1, d, v, C\ )$

In equilibrium, $q_d = q_s$, so equations (1) and (2) can be combined to form the equilibrium condition. Thus the equilibrium price equation for railroad (1) is as follows:

(3) $p_1 = f_1(p_2, p_3, \ldots, a_1, a_2, d, v, S, C\ )$

All the variables in equation (3) are as defined above.

If the prices of other railroads (p_2, p_3) are defined as intramodal competition (iac) and the prices of other modes (a_1, a_2...) are defined as intermodal competition (ioc), then equation (3) can be rewritten as follows:

(4) $p_1 = f(iac, ioc, v, S, C)$

The following chapter applies the theoretical model to the empirical model to achieve the objectives of the study.

CHAPTER 4: EMPIRICAL MODEL

The theoretical model from the previous chapter is modified to achieve the objectives of the study. As discussed in Chapter 3, intermodal competition is likely to be minimal for rail shipments of Montana wheat. The great majority of the shipments are long distance movements to Portland, making truck competition ineffective. The average distance to a water port is 522 miles rendering barge competition to be non-existent. The BNSF dominates the rail industry in Montana so intramodal competition is non-existent as well. The empirical model is specified as follows where all continuous variables are specified as natural logarithms so the coefficients are elasticity's.

(1) $CWT = \beta 0 + \beta 1CARWT + \beta 2DIST + \beta 3GVW + \beta 4BARGE + \beta 5DUMMY + \varepsilon i$

CWT - Rail rate in dollars per cwt-mile for the shipment

CARWT - Weight (lbs) of each loaded covered hopper rail car in a shipment

DIST - Distance in rail miles between origins and export port

GVW - Total shipment weight in tons

BARGE - Distance of origin to barge loading facilities

DUMMY - Dummy variable to represent either a Montana or Kansas location, Montana being assigned 1 and Kansas 0

ε - random error term

The dependent variable (CWT) is the rail rate per hundred weight (cwt)-mile and can be obtained by dividing total revenue of the shipment by weight and distance. Calculation is further demonstrated in Table 4.1. Variation in total revenues of the shipment is obtained by varying the number of cars in the train, and variation in distance is obtained by varying the origin of the shipment. The total shipment weight (GVW) is obtained by varying the number of carloads in the train and multiplying by the weight per car (CARWT). The distance variable (DIST) is the distance from various origins in Montana to Portland, Oregon and from various origins in Kansas to Houston, Texas. The distance of the origin to barge loading facilities (BARGE) is the distance from Montana origins to Lewiston, Idaho for the Montana equation, and the distance from Kansas origins to Kansas City, Missouri in the Kansas equation. Variation in weight per car (CARWT) is introduced by assuming various car sizes, i.e., 268,000 pound cars vs. 286,000 pound cars.

Figure 4.1: Method for Calculation for BNSF Rates Per Cwt-Mile

(1) Total Revenue of Shipment = Number of cars in the shipment x rate per car.
(2) Weight of the Shipment = Number of cars in the shipment x weight per car/100.
(3) Divide (1) by (2) to get Revenue per cwt.
(4) Divide (3) by distance of shipment to get Revenue per cwt-mile.
(5) Multiply (4) by 1000 to get into integer form.

The theoretically expected sign of the natural log of the distance variable is negative. A large share of railroad costs are fixed with respect to distance, such as loading and clerical costs, insurance, taxes, interest, and managerial overhead. As these costs are spread over more miles, the costs per mile decrease at a decreasing rate, so the change in the rail rate per cwt-mile falls as distance increases.

The GVW variable reflects (a) the number of cars in the shipment, and (b) the weight per car. Since the empirical model includes the commodity weight per car (CARWT), the volume variable reflects the impact on rail rates of increased cars in the shipment. Because a large share of rail costs are fixed with respect to weight, railroads also realize economies of weight. Thus the change in rail rates per cwt-mile are expected to decrease at a decreasing rate as volume increases. Intermodal competition is measured by highway miles to water ports. Longer distances to water access points reduce the feasibility of truck-barge competition for rail wheat shipments. Thus, the theoretically expected sign of BARGE is positive since the greater the distance to water ports the greater the pricing power of railroads.

Weight per car (CARWT) is expected to have a negative relationship to the change in rail rates per cwt-mile. Because operating costs such as switching costs per car, labor costs, clerical costs, and various other costs are fixed per car, these costs per car decrease as car weight increases. Thus the change in rail rates per cwt-mile fall as car weight rises.

The empirical model is estimated for Montana and Kansas. For Montana, the shipments in the empirical model are from Montana wheat origins to Portland, Oregon for export. For Kansas, the modeled wheat shipments are from Kansas origins to the export ports at Houston. Like Montana, intermodal competition is limited in the Kansas wheat transport market. The distance to Houston makes truck competition non-existent, and historically only negligible amounts of Kansas wheat have been shipped on the Missouri and Arkansas Rivers. However, unlike

Montana, Kansas is served by both the BNSF and UP. The lines of the two railroads are in close physical proximity in many cases, and they have roughly the same number of Kansas track miles (1,260 miles for BNSF and 1,505 miles for UP). Then intramodal competition is introduced by pooling the data of the two states and inserting a dummy variable in the equation for all Montana observations.

CHAPTER 5: DATA AND EMPIRICAL RESULTS

5.1 Data

The model is estimated, using rates published on the BNSF website (www.bnsf.com.) for wheat movements in Montana to Portland and Kansas to Houston. This is believed to be the best data available as it represents accurate shipping charges published by BNSF. The published rates were taken from the website on November 4, 2008 for each respective car type and train size. The BNSF website was further used to gather the rail shipping miles from each origin to the port destination.

Table 5.1: Montana and Kansas Truck Miles from Origins

Truck Mileage to nearest barge facility - Montana origins to Lewiston, ID		
Glendive	786	
Harlem	452	
Collins	410	Average
Pompeys	597	511
Shelby	449	
Carter	413.5	
Rudyard	511	
Grove	467	
Truck Mileage to nearest barge facility - Kansas origins to Kansas City, MO		
Wichita	199	
Wellington	226	
Salina	175	Average
Hutchinson	217	239
Garden City	387.5	
Dodge City	335	
Concordia	223	
Abilene	151	

The model uses eight locations in Kansas and Montana identified in Table 5.1. The table also identifies the distance in miles to the nearest barge location. Other data used for the model included distance in rail miles from points of origin to export in Montana and Kansas respectively. The wheat export destination for all Montana origins was Portland, Oregon; while the wheat export location for all Kansas locations was Houston, Texas.

Table 5.2: Mean and Standard Deviation of Variables

Variables	**CARWT**	**DIST**	**GVW**	**BARGE**	**CWT**
Combined Mean	277000	886.567	11697.923	427.212	1.325
Combined Standard Deviation	9021.713	152.516	5679.549	165.155	0.228
Montana Mean	277000	946.875	11141.556	510.750	1.252
Montana Standard Deviation	9031.414	137.490	5655.667	118.677	0.178
Kansas Mean	277000	750.875	12949.750	239.250	1.487
Kansas Standard Deviation	9071.147	80.649	5575.328	76.233	0.244

Table 5.2 is the mean and the standard deviation of the data series for the variables. The mean and standard deviation is reflected for the combined data series and Montana and Kansas individually. Table 5. reflects the Montana and Kansas locations and the respective rail mileage for each.

Table 5.3: Montana and Kansas Rail Miles from Origins

Rail mileage Montana Origins to Portland, Oregon		Rail mileage Kansas Origins to Houston, Texas	
Origin	Rail Mileage	Origin	Rail Mileage
Glendive	1245	Wichita	646
Harlem	925	Wellington	631
Collins	839	Salina	775
Pompeys	1054	Hutchinson	702
Shelby	785	Garden City	872
Carter	909	Dodge City	822
Rudyard	849	Concordia	807
Grove	969	Abilene	752

5.2 Empirical Results

Table 5.3 reflects the results of the regression estimated with ordinary least squares. Model outcome has an adjusted R-squared of 0.74 and the standard error of regression is 0.11 with the standard dependent variable at 0.22. Probability factor for each variable is close to zero with CARWT having the highest level of 0.0047. The signs and magnitudes of the statistically significant parameters appear reasonable given the outlined theoretical framework.

Table 5.4: Railroad Rate Regression Equation

Method: Least Squares				
Sample: 208				
Included observations: 208				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.860065	0.253147	7.347764	0
CARWT	2.52E-06	8.82E-07	2.859597	0.0047
DIST	-0.001199	0.000124	-9.644381	0
GVW	-2.28E-05	1.42E-06	-16.10731	0
BARGE	0.000519	0.000142	3.651677	0.0003
DUMMY	-0.182486	0.027907	-6.539061	0
R-squared	0.754499	Mean dependent var		1.324604
Adjusted R-squared	0.748422	S.D. dependent var		0.227749
S.E. of regression	0.114233	Akaike info criterion		-1.472723
Sum squared resid	2.635955	Schwarz criterion		-1.376448
Log likelihood	159.1632	F-statistic		124.1611
Durbin-Watson stat	1.11315	Prob(F-statistic)		0

All the explanatory variables were statistically significant at the .01 level except for CARWT. Independent variables DIST and GVW had the theoretically expected negative sign, while BARGE had the expected positive sign. The expected sign of CARWT is negative, so the positive sign was not expected. However, given the small size of the coefficient, CARWT has minimal impact on the dependent variable.

The most unexpected result was the statistically significant negative sign for the dummy variable, indicating that wheat rail rates are lower in Montana than Kansas. This finding does not agree with previous research with found that rail wheat rates are higher in North Dakota and Montana compared to the other wheat producing areas. The reasons for the observed higher wheat rail rates in Montana are a topic for further research.

CHAPTER 6: CONCLUSION

The objectives of this thesis were to develop a model to measure railroad costs and competition; determine the principal cost determinants and measure intramodal competition by comparing the rates in a captive market (Montana) to one with more intramodal competition (Kansas).

The empirical model reflects key cost components and competition impacts on the rates associated with rail shipments of wheat out of Montana and Kansas. The empirical model regression outcomes reflect a reasonable goodness of fit for the variables established as determinants of cost. The model indicates rates of a captive market like Montana may not be higher then those with more intramodal competition such as Kansas.

Because this finding doesn't agree with previous research, other factors may contribute to the price determinants of rail competition and further study such as a revenue to variable cost assessment may find similar findings of prior research.

REFERENCES

Adam, Brian G. and Dale G Anderson. "Implications of the Staggers Rail Act of 1980 for the Level and Variability fo County Elevator Price Bids." Proceedings of the Transportation Research Forum 26(1), (1985): 357-363.

Babcock, Michael W., L. Orlo Sorenson, Ming H. Chow, and Keith Klindworth. "Impact of Staggers Rail Act on Agriculture: A Kansas Case Study." Proceedings of the Transportation Research Forum 26(1), (1985): 364 -372.

Chow, Ming H. "Interrail Competition in Rail Grain Rates on the Central Plains." Proceedings of the Transportation Research Forum 27(1), (1986): 164 -171.

Fuller, Stephen, David Bessler, James MacDonald, Michael Wohlgenant. "Effects of Deregulation on Export-Grain Rail Rates in the Plains and Corn Belt." Proceedings of the Transportation Research Forum 28(1), (1987): 160 -167.

Koo, Won W., Denver D. Tolliver and John D. Bitzan. "Railroad Pricing in Captive Markets: An Empirical Study of North Dakota." *Logistics and Transportation Review* 29(2), (1993)): 123 -137.

Kwon, Y.W., Michael W. Babcock, Orlo I. Sorenson. "Railroad Differential Pricing in Unregulated Transportation Markets: A Kansas Case Study." The Logistics and Transportation Review 30 (3), (1994): 223 -244.

MacDonald, James M. "Competition and Rail Rates for the Shipment of Corn, Soybeans and Wheat." *Rand Journal of Economics* 18(1), (1987): 151-163.

MacDonald, James M. (1989). *Effects of Railroad Deregulation on Grain Transportation*, U.S. Department of Agriculture, ERS Technical Bulletin No. 1759, Washington D. C.

Mansfield, E. "Managerial Economics: Theory, Applications, and Cases" 5th. Ed. W.W. Norton and Company 2002.

Thompson, S.R., R. J. Hauser and B.A. Coughlin. "The Competitiveness of Rail Rates for Export-Bound Grain." The Logistics and Transportation Review 26(1), (1990): 35-53.