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**Deregulation and Innovation
in Railroad Shipping of
Agricultural Commodities: 1972-1995**

Wesley W. Wilson and William W. Wilson

Acknowledgments

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Abstract

This paper describes the important changes that occurred in the U.S. grain handling and transportation system in the period following deregulation in 1980. This system has evolved and will continue to do so in response to technological and institutional changes, competitive pressures, and a changed regulatory regime. The effect has been to induce investments throughout the system ultimately to improve the efficiency. Some of the important rail innovations include the use of rate discounts to induce more efficient movements from origins first, and more recently at destinations. In addition, each railroad has adopted car allocation systems comprising several mechanisms, giving shippers logistical choices which have also facilitated more efficient allocation of cars among shippers. Finally, a number of important implications for the Canadian industry are identified as it evolves through its forthcoming changes.

Key Words: transportation, grain, logistics

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Deregulation and Innovation in Railroad Shipping of Agricultural Commodities: 1972-1995

Wesley W. Wilson and William W. Wilson*

1. Introduction

A major institutional change occurred in grain transportation in 1980 when the regulatory regime changed toward lesser regulations over rates. While these changes have been noteworthy, the process of adapting to lesser regulation in grain is particularly interesting. At least in concept, deregulation had the effect of inducing innovations in rail operations, improving productivity and reducing costs. Through competitive pressures these were ultimately transferred to shippers in the form of reduced rates.

Since deregulation, rate increases have been a major concern for shippers but most have been unfounded. In the case of grain shipping, there has been recent concerns expressed to the Surface Transportation Board (STB) to propose some form of reregulation. In general, grain shippers have become concerned about problems with competitive access, service deficiencies and railroad performance, problems with product and geographic competition in rate reasonableness cases, and the prospective effects of rail mergers (National Grain and Feed Association, 1997 and 1998). A major issue emerging in the United States relates to the interpretation of *common carriage* (which in Canada has been referred to as *service obligations*).¹ In the STB reauthorization debate there has been opportunity to convey these concerns.

There have been a growing number of studies examining rate levels under partial deregulation of several U.S. industries² and some specifically focused on rail.³ Winston compares the effects of deregulation on a number of industries, including airlines, motor carriers, railroads, banking and natural gas. The common thread across these industries is that deregulation resulted in 1) improvements in industry efficiencies in numerous dimensions, resulting in cost reductions, and 2) rates and prices have declined (in the case of railroads, he cites that average rates per ton mile have declined more than 50 percent in real terms). In addition, he notes that “industries are likely to behave quite similarly when it comes to adjusting to deregulation, and that their

*Wesley W. Wilson is Professor in the Department of Economics at the University of Oregon, and William W. Wilson is Professor in the Department of Agricultural Economics, North Dakota State University, Fargo.

¹To emphasize, common carriage in the United States is alleged to not be meaningful under its current interpretation (NGFA, 1998).

²See Winston (1998) recent summary.

³The now compelling body of literature suggests that rate levels have generally fallen. The primary factor underlying falling rates has been the reduction of costs. Specifically, as discussed in some detail in MacDonald and Cavallusso (1996), deregulation offered a number of pricing innovations that allowed more economic consolidated shipments with longer lengths of haul. In addition to pricing innovations, partial deregulation provided for easier abandonment/sales of unprofitable lines and easier guidelines under which mergers occur. The cost effects of these are large and are described in Berndt *et al.* (1993), Velluro *et al.* (1992) and Wilson (1997).

adjustment, while time-consuming, will raise consumer welfare, significantly at first, and increasingly over time.” (p. 108).

At an aggregate level, several studies have indicated that as a result of deregulation, cost savings have accrued and rail rates have fallen in real terms. Wilson (1997, p. 23) found that “the effects of deregulation on costs and productivity gains are tremendous with costs in 1989 estimated to be 40 percent lower under partial deregulation than they would be under a regulated regime.” In a related study focused on rail pricing, Wilson (1994, p. 20) found that though there were some initial increases in rates following deregulation (1980), by 1988 “deregulation produced lower prices in most commodity classifications and did not increase prices in other classifications, suggesting those advances in productivity have dominated any adverse market power effects.”

Other studies including Boyer (1987), McFarland (1989), Barnekov and Klieh (1990) and MacDonald and Cavalluzzo (1996) have each examined the aggregate (all movements-all commodities) rate level over time and across regulatory regimes. They offer a mix of conclusions including a modest increase in the rate level, no effect, and substantial rate declines under partial deregulation. Burton (1993) and Wilson (1994) each examine rate levels for different aggregated commodity movements. Generally, these studies suggest small initial (both positive and negative) effects of partial deregulation with larger negative effects over time. This latter finding seems to apply to all commodities, although there are important differences across the commodity shipped. There are also a variety of other studies that are commodity-specific. Atkinson and Kekvliet (1986) find rents associated with coal movements have increased to railroads under partial deregulation. Friedlaender (1992) calculated markups which suggested that regulation was effective in constraining rates in some coal markets but not in others, affecting firms and commodities asymmetrically. She also suggests that it was likely that market power of railroads increased in markets pertaining to the transportation of manufactured and agricultural commodities.

Earlier studies by MacDonald (1989) and Fuller et. al. analyzed the effects of the Staggers Rail Act on grain shipping and though using different methods concluded that the effect of deregulation was to reduce rail rates. These were generally static analyses and did not capture the effects of technological changes. In addition, neither of these used methods consistent with the recent advances in industrial organization about modeling supply relations.

In this study we specifically address the effects of deregulation on grain shipping. In particular we model the five individual commodities (barley, corn, wheat, sorghum and soybeans) that dominate rail shipments of farm products. These commodities generally are served by different railroads, have different demand structures and costs. Our results suggest that all five commodities have common patterns but differ in the adjustment to partial deregulation.

Regulation over grain shipping rates has emerged as an important issue in Canada. To summarize, in Canada grains are treated separately from other commodities which are regulated under the Canadian Transport Agency (CTA). Specifically, a separate set of regulations exists for grains for movement within the prairies. Changes were made in 1996 which increased rail shipping costs paid directly by shippers (previously, the total cost was comparable, but a portion

was paid directly by the government of Canada to the railroads). It is important that the new higher rail rates (specifically, that portion paid by the shipper) are still substantially less than comparable rates in the United States (Fulton and Gray). The underlying legislation provides the formula for rate determination and describes its application. These rates are frozen to the year 1999 at which time they become subject to the CTA conditionally upon the results of an efficiency review. This is a much different regulatory regime for rate levels and service than exists on other commodities shipped by rail in Canada, and than grains shipped in eastern Canada. For those commodities, the CTA governs a regulatory regime that is more similar to that in the United States.⁴ Baylis, Brooks, Fulton and Gray analyzed prospective changes in rail rates on grain under deregulation and concluded that rail rates would increase and price discrimination by route and commodity value would emerge. However, this was strictly a static analysis and did not allow for rail productivity changes and cost efficiencies which over time could translate into lower rates.

The purpose of this paper is to analyze the effects of rail deregulation on rail productivity, costs and rates in the case of U.S. grain. Section 2 below describes salient features of the Staggers Rail Act (SRA) which gave rise to a less regulated environment, in contrast to the previous regulatory regime. Section 3 and 4 present the conceptual and empirical models, respectively. We use an econometric model of rate and cost behavior. The model was applied to aggregate grain shipments for individual commodities during the period 1972 to 1995. Results are described in Section 5. Of particular interest, these results show that there have been tremendous productivity gains concurrent with deregulation relative to if regulation had been retained.

2. Background

Prior to deregulation, rail shipping options were limited primarily to single car movements with generic service options. Since then a number of innovations have increased the number of shipment size options, as well as service options. Typically, these innovations are viewed as options from a shipper perspective, but are reflective of movement efficiencies from a carrier view. As a result, these innovations typically reflect price differentials approximately equal to rail cost differences. This section briefly describes some of the salient features of the Staggers Rail Act (SRA) and how they have been adopted in the agricultural (grain) shipping sector.⁵

⁴However, concerns about changing the regulatory regime in Canada are often addressed with reference to the deregulation process that ensued in the United States. Specifically, Fulton and Gray infer that rail rates in Canada under deregulation could increase to levels similar to those in the United States.

⁵Greater detail on material presented in both the subsections below are contained in Wilson (1998).

2.1 Staggers Rail Act (SRA)

Many of the changes that occurred in the U.S. grain marketing system were concurrent with the Staggers Rail Act (SRA) of 1980.⁶ The SRA also introduced important changes in the regulatory regime regarding overall rate levels. A number of these have had important effects on the grain shipping and handling industry. Each is discussed below along with, where appropriate, the pre-SRA institutional environment.

Rate Regulation: Captive Shippers, Market Dominance and the SRA. Prior to the mid 1970's rates were regulated under the Interstate Commerce Act. Beginning with the Railroad Revitalization and Regulatory Reform Act of 1976 (4R) an evolution began toward greater rate flexibility and less rigid regulation, while providing a mechanism for protection of shippers.

The SRA imposes two tests that must be met before the ICC and now the STB⁷ would have jurisdiction to regulate rate levels. The first is the revenue to variable cost ratio (R/VC) threshold.⁸ Specifically, if the R/VC ratio is less than the threshold, the ICC would not have jurisdiction to regulate rates in that movement. If R/VC exceeds the threshold, the STB may have jurisdiction. However, the shipper is not necessarily captive if the ratio exceeds the threshold. The second test is that of market dominance. If the carrier is found to be market dominant in a particular movement, the shipper is defined as captive and the STB would have jurisdiction over rate regulation.

Rate Changes Were Liberalized. Prior to 1980, rate changes required a 90-day notice for increases and there were fairly liberal procedures to challenge proposed changes. The net effect was that rates were rigid and changes were introduced only infrequently. Proposed changes were typically subject to a very long notice about the rate increase. As a result shippers had little risk related to rate changes. The SRA changed the dynamics of rate changes. Specifically, rate increases (decreases) required a 20(1) day notice. The effect was to allow greater flexibility for railroads to respond to market conditions, but also increased the exposure to increases in rail rates for shippers.

In addition, rate bureaus played an extensive role in approval of rate and service changes until 1980, and post 1980 the role of the rate bureaus was diminished to that of a tariff publisher. Thus, the combined effect was that rates could change more quickly in response to both market and competitive conditions.

⁶Technically, the 4R Act of 1976 preceded the SRA and set the stage for some of the changes embedded in the latter.

⁷These roles and functions have since been replaced by the Surface Transportation Board (STB).

⁸In 1984 that threshold was 1.80, but now it depends on whether the railroad is earning an adequate return.

Contracts. Shipments under private contract were an important feature of the service environment during the 1980s. In addition, some of the evolving contract terms likely influenced the pricing and car allocation practices that subsequently evolved.

Contract rates were widely used in the United States in the first years following the SRA. The SRA explicitly encouraged carriers and shippers to enter into confidential contracts for grain shipments subject to informational disclosure.⁹ Shippers could challenge contract rates on grounds of competitive harm or impairment of common carrier obligation. In addition, the SRA allowed agricultural shippers to challenge contract rates on grounds of the carrier's refusal to offer similar terms to them (which would constitute unreasonable discrimination). The legal processes to intervene required that the complainant must first prove they would prevail and that the dispute could not be resolved otherwise.

Railroads were restricted in the portion of capacity allocated to contract carriage. In general, a carrier could allocate no more than 40 percent of its own fleet (for a particular car type) to service under contracts. However, the restriction was more specific for large agricultural shippers (i.e., those originating more than 1,000 cars per year). A railroad could allocate no more than 40 percent of the average annual number of rail-owned and private cars supplied to the shipper during the previous three years.

Premium Rates for Premium Service. One of the important features of the SRA was a clause to allow railroads to charge premium rates for premium service. Specifically, Congress stated that "rail carriers shall be permitted to establish tariffs containing premium charges for special services not provided in any tariff otherwise applicable to the movement" (Section 10734 of Title 49, United States Code). As a result of this provision, railroads actively pursued market-driven allocation mechanisms, in addition to addressing shippers' complaints of car availability and to foster productivity gains. This eventually proved to be important because it is one of the clauses that facilitated development of more elaborate guaranteed forward shipping mechanisms and service competition (see below).

Rate Bureaus. Prior to the SRA, rail rates were set by individual railroads subject to approval by the relevant rate bureau. This provided an explicit mechanism for railways to communicate about rate levels and relationships. However, carriers were allowed to initiate independent actions. One of the crucial aspects of the SRA was that the rate bureaus were essentially eliminated, thereby limiting the ability of the railways to communicate about rate changes.

Branch Line Abandonment. The Staggers Rail Act created liberalized procedures for branch line abandonment. As a result of this process, branch line abandonment was expedited beginning in 1980. In the period since 1980, nearly 20 percent of the rail lines were abandoned in the region including the upper Midwestern states. In addition, portions of the rail line were converted to short line railroads and operated independently of the Class I carriers.

⁹Summary information about contract terms were filed by the carrier with the ICC. This information was fairly general and was publicly disseminated including information about railroad, commodity, general origins and destinations, number of cars, type of movement, base tariff rate, any special features and the minimum annual volume.

This escalation of track abandonment is merely an extension of longer-term trends. Since the early 1900's, the Class I railroad network in the United States has been shrinking, while the overall traffic base has remained relatively constant.¹⁰ Concentration of traffic on fewer miles of road, in conjunction with longer hauls, greater car capacity, and other gains in operational efficiency has had a profound effect on railroad productivity. Net ton-miles per train hour (a single-factor measure of productivity) increased by 519 percent during this period.

2.2 Innovations under deregulation: Rail Incentive Mechanisms

The evolution of rail incentive mechanisms has been crucial to the changes that have occurred in the grain handling and transportation industry. Rate differentials implied in these mechanisms reflect economies of rail operations, and therefore reflect productivity gains, which are ultimately passed on in the form of rate discounts. In the process these rate discounts provide incentives to induce more efficient grain handling and shipping practices.

The grain rate structure has evolved to include trainload, single and multiple-origin rates, as well as programs to enhance efficiencies in the total movement --commonly called origin-destination efficiency programs. These are important features that affect rate spreads, providing differentiation and incentives among rail service levels. Rate differentials are captured in: 1) origin efficiency or trainload rates; 2) origin-destination efficiency programs; 3) per-car rates; and 4) rates and requirements for shipments in higher-cube (286,000 lb) covered hopper cars.¹¹ One of the important areas of competition since 1987 has been the evolution of car allocation and service options. These have changed radically during the past few years and have had important implications for the grain handling and shipping industries, as well as rail productivity.¹²

3. DATA SOURCES AND BEHAVIOR

An empirical model is described in the following section and estimated to analyze factors affecting the temporal behavior of rail rates for grain, and the effects of deregulation in particular. In this section we describe the data, both sources as well as trends over time. The model was applied to five selected agricultural commodities including barley, corn, sorghum, soy beans and wheat. These commodities account for 90 percent of all agricultural ton miles and 83 percent of all agricultural tons moved during the sample period. In each case we model aggregate rates for the individual commodities.

¹⁰In 1929, major U.S. railroads originated 1.339 billion tons of freight with 229,530 miles of road. In 1992, Class I carriers originated approximately the same tonnage (1.339 billion tons of freight) with only 113,056 miles of road. Over the same period, the traffic density of the Class I railroad network (as measured in revenue ton-miles per mile) increased from 1.95 million to 9.436 million, while the average length of haul increased from 334 to 762 miles.

¹¹See Wilson (October 1998) for a detailed description of the evolution of each of these mechanisms and applications in the United States.

¹²Wilson (October 1998) provides a detailed description of the evolution of car allocation systems in the United States. Wilson and Priewe analyze the implications of these mechanisms on grain trading strategies using stochastic dynamic simulation, and Wilson and Dahl analyze bidding strategies and implications of these mechanisms.

3.1 Data Sources

Our principal source of data is the public use waybill data set. Until the early 1980s these data were taken from the U.S Department of Transportation, Federal Railway Administration (1972-1984), *Carload Waybill Statistics TD-1 Report*. The variable of particular interest is the average rate per ton-mile for all movements of each commodity. These are Standard Transportation Commodity Code Level 5 rates. From 1985 through 1995, the rates were generated from the Public Use Waybill data.¹³ Each is described in this section.

Data included rail rates, quantities and average movement characteristics. Data were also taken from *Railroad Facts* (American Association of Railroads, Railroad Facts, Various Years) including total ton miles, miles of track and road, net ton miles per hour. Data on grain production (in 1000 tons) and prices (in \$/ton) were taken from USDA *Agricultural Statistics*. Finally, data were taken from the Department of Commerce on producer price index (Producer price index for finished goods (base=1982)) and the GNP price deflator (GNP price deflator (base=1992)). The model was estimated with various deflators including the producer price index for finished goods, the GNP price deflator, and the AAR's combined index for labor, fuel, and material and supplies input prices.¹⁴

3.2 Behavior of Variables Across Commodities and Over Time

Prior to reporting and interpreting the results of the econometric model, the behavior of selected variables is shown and described.

Rail Rates (Figures 3.1-3.4). In nominal terms, average rates (in \$/ton mile) showed an upward trend during the period prior to deregulation, reaching a peak in 1980. During the regulated period there were institutional and competitive practices that facilitated continual increases in nominal rates. In the period immediately following the SRA, rail rates decreased substantially, followed by more moderate nominal rate reductions.

Rates also increased in real terms in the period from 1973 through 1980. In the period following 1980, real rates for all commodities decreased. Again, the rate of decrease was fairly dramatic in the period immediately following 1980. On average, most rates fell by 52 percent (ranging from 40-71 percent) in real terms in the period from 1980 to 1995.

For comparison a similar set of rates from Great Falls, Montana to Portland and from Boyle, North Dakota to Minneapolis are shown in Figures 3.3 and 3.4.¹⁵ While the data described above are aggregate across all movements, these rates are from specific movements. These rates include the effect of the introduction of various forms of unit shipment incentives etc., and are the prevailing rate for the movement. In these markets, rates also decreased in the period post deregulation. Specifically, in real terms rates fell by 28 percent in Montana from 1980 to 1995, and by 33 percent for the North Dakota to Minneapolis movement.

¹³The authors acknowledge the assistance of Mark Burton for helping generate the data.

¹⁴We examined different deflators and experimented with different nominal versions of the model with the deflator represented on the righthand side. The results we report are quite robust to different treatments.

¹⁵Such data were not available for the period prior to 1980 and therefore it was not possible to conduct similar econometric analysis as in this study. For illustration the deflator used here was the same as that used in the econometric analysis and in Figure 3.2.

Figure 3.1 Nominal Rates by Commodity

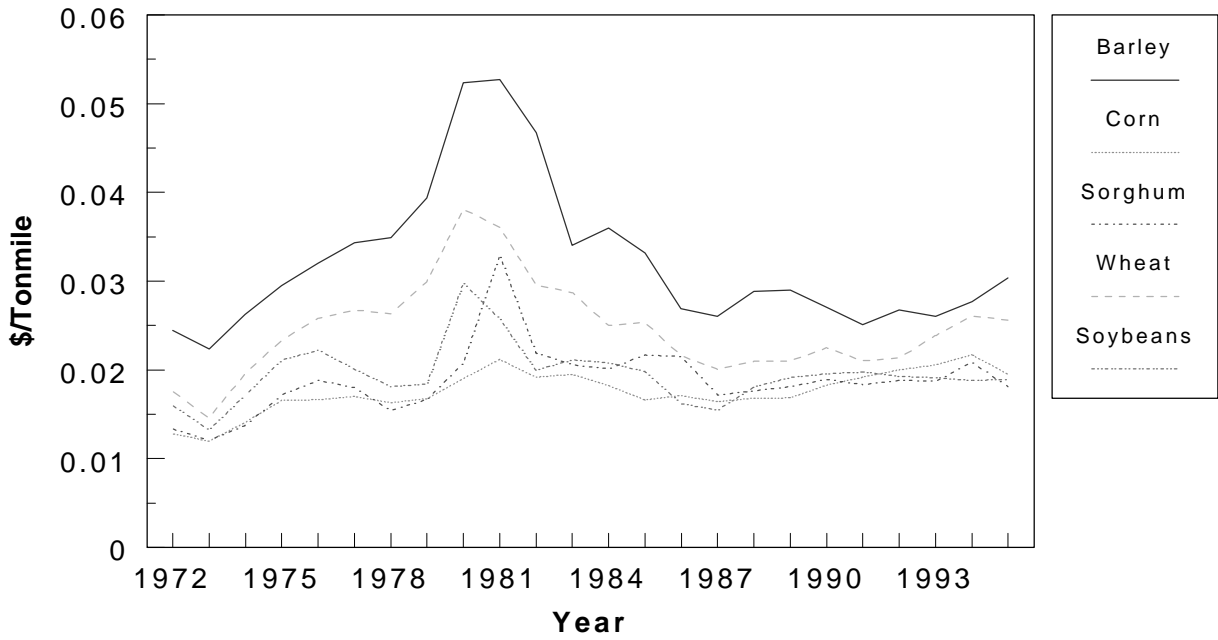


Figure 3.2 Real Rates by Commodity

Real Rates by Commodity

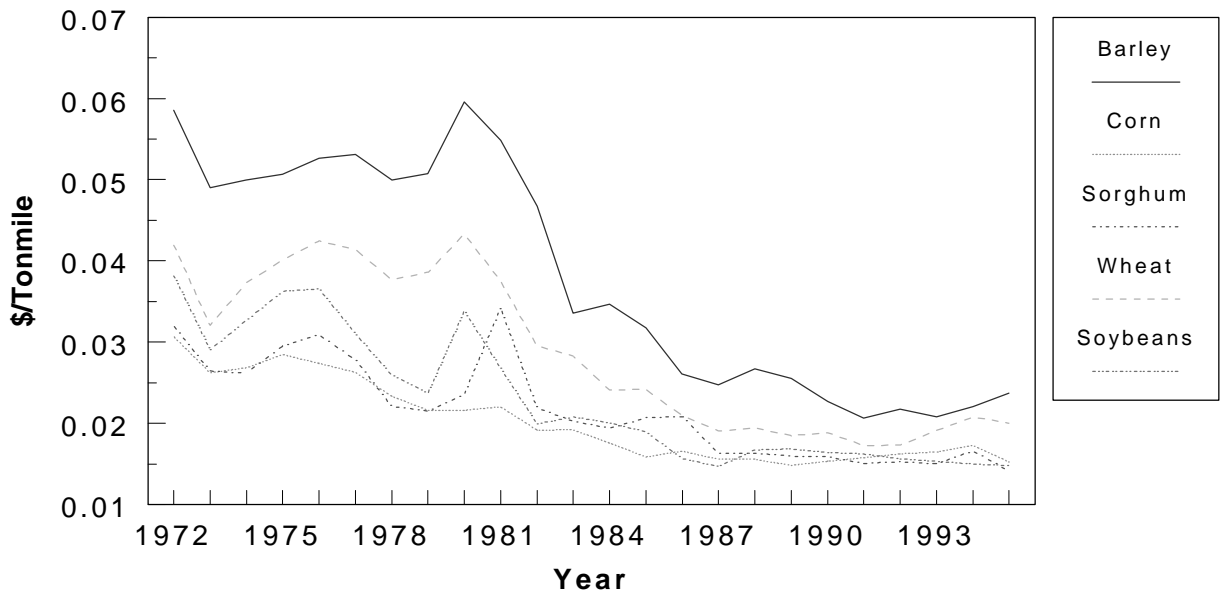


Figure 3.3 Great Falls, Montana 52 Car PNW Wheat Rates

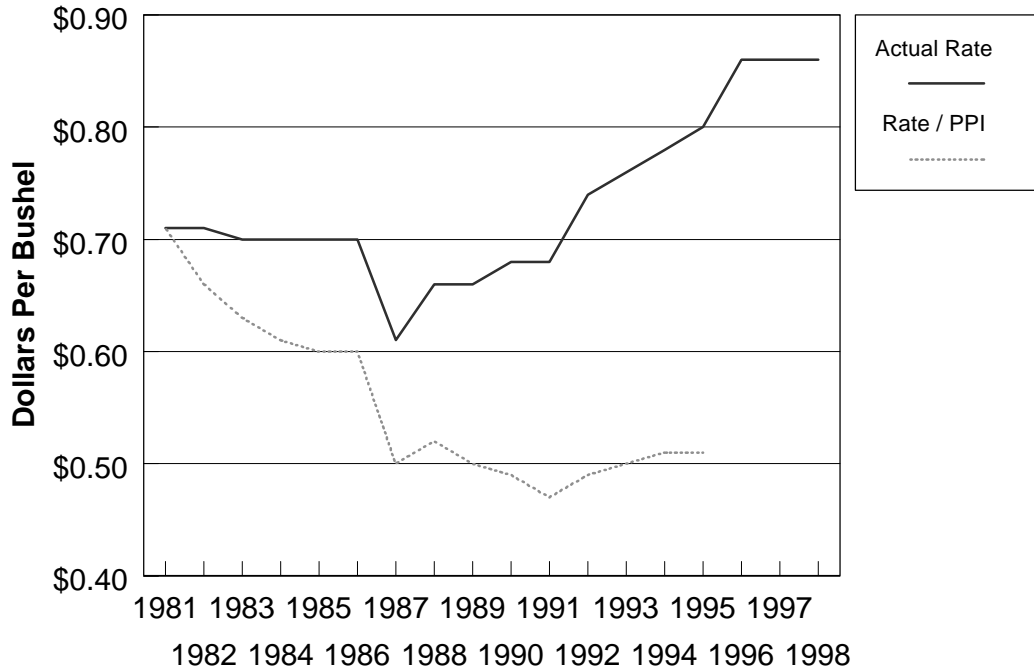
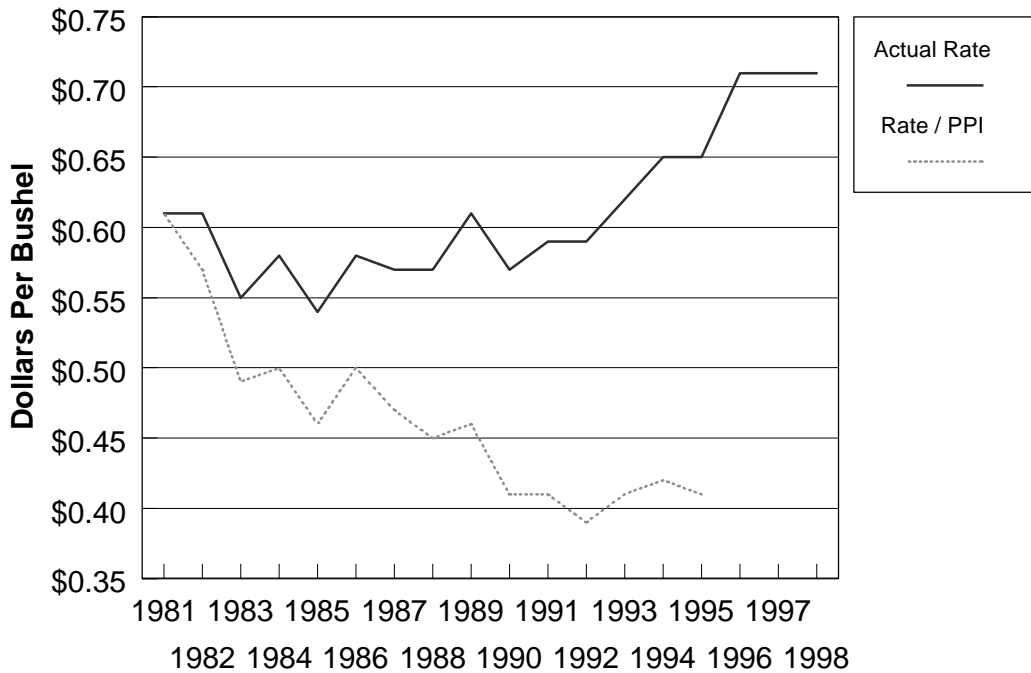


Figure 3.4 Boyle, North Dakota 52 Car MPLS Wheat Rates



Operating Characteristics and Input Prices (Figures 3.5-3.10). Data on shipping characteristics indicate that there has been an increase in ton miles shipped by rail for each commodity which would affect marginal costs. However, wheat ton miles declined from 1973 through the latter 1970s. Of particular interest, however, is that there has been a distinct change in movement characteristics. Both the average length of haul, and the average load per car have increased. In the period following 1980 there was a tendency for railroad shipments to be concentrated on longer hauls. In addition, and particularly important from a productivity perspective, both the volume shipped per car and the cars per train have increased. Given the changes in rate setting described above, these would have been expected.

The number of miles operated decreased from 164,882 to 108,264 during the period 1980 to 1995, a decrease of 34 percent. Ton miles per hour increased from about 40 in the 1970s to about 65 in the late 1980s. Factor prices have also changed. While labor has increased, prices of fuel and materials and supplies declined in the period following 1980.

Commodity Characteristics (Figures 3.11-3.13). The price of each commodity shipped is potentially an important variable affecting shipping demand. Increases in the price of the commodity should have an increasing effect on rates. Nominal commodity prices have shown no discernable trend. However, on a real term basis, grain commodity prices have been declining since 1974, though the rate of decline slowed in the early 1990s, and in fact increased between 1994 and 1995.

Figure 3.5 Tonmiles by Commodity

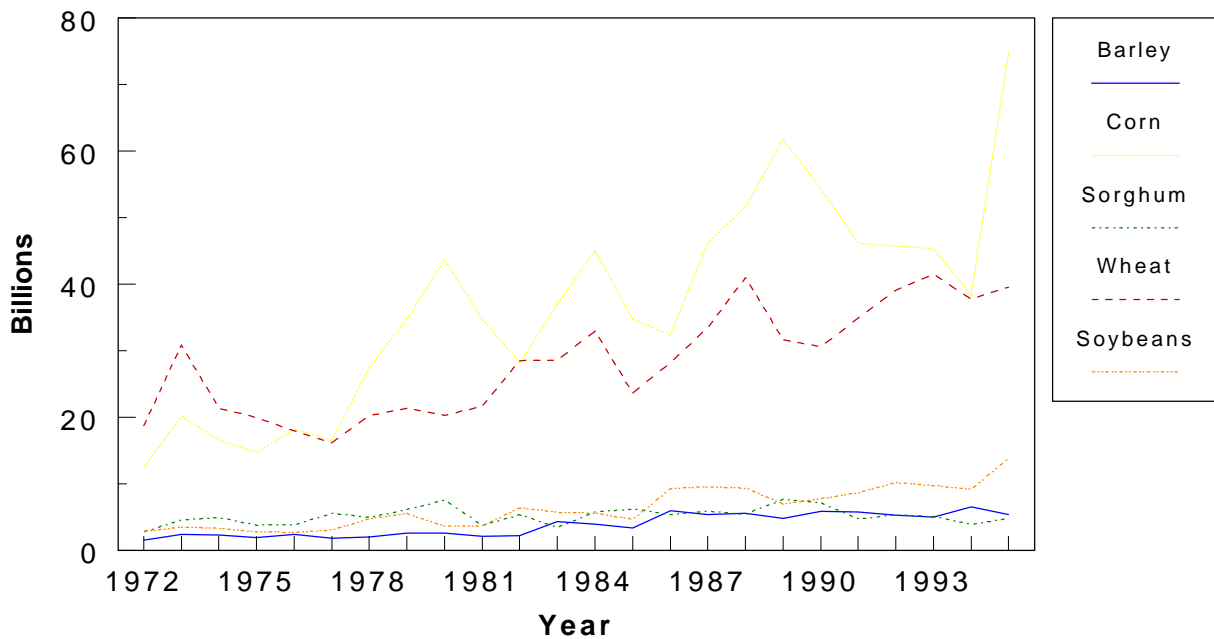


Figure 3.6 Average Length of Haul by Commodity

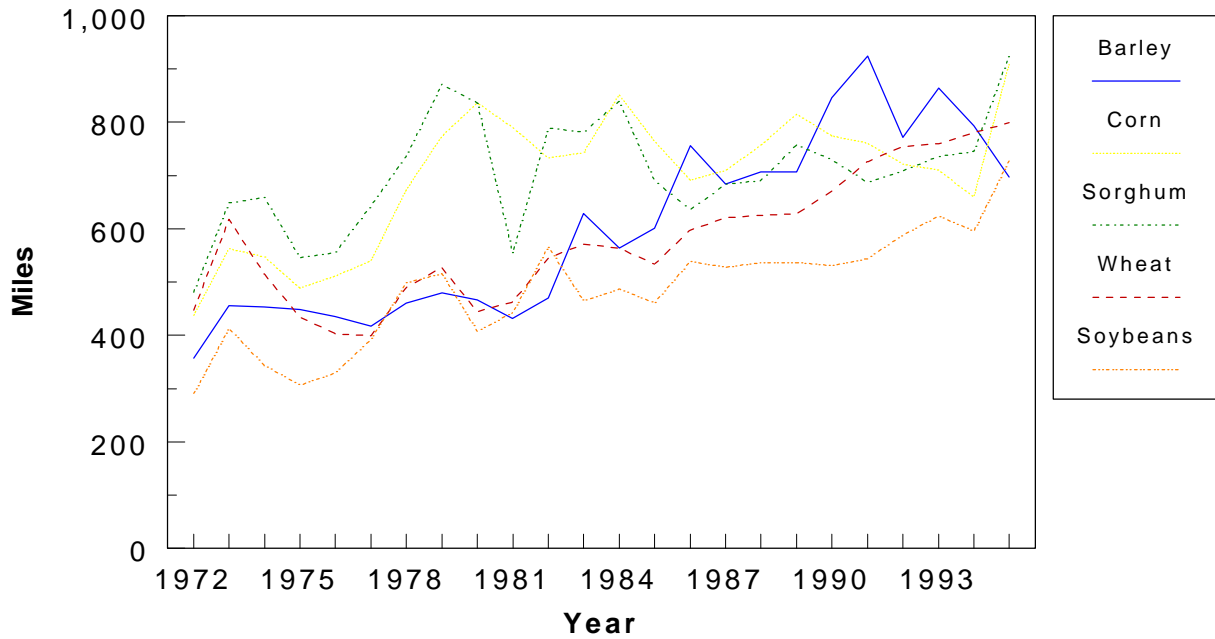


Figure 3.7 Average Load by Commodity

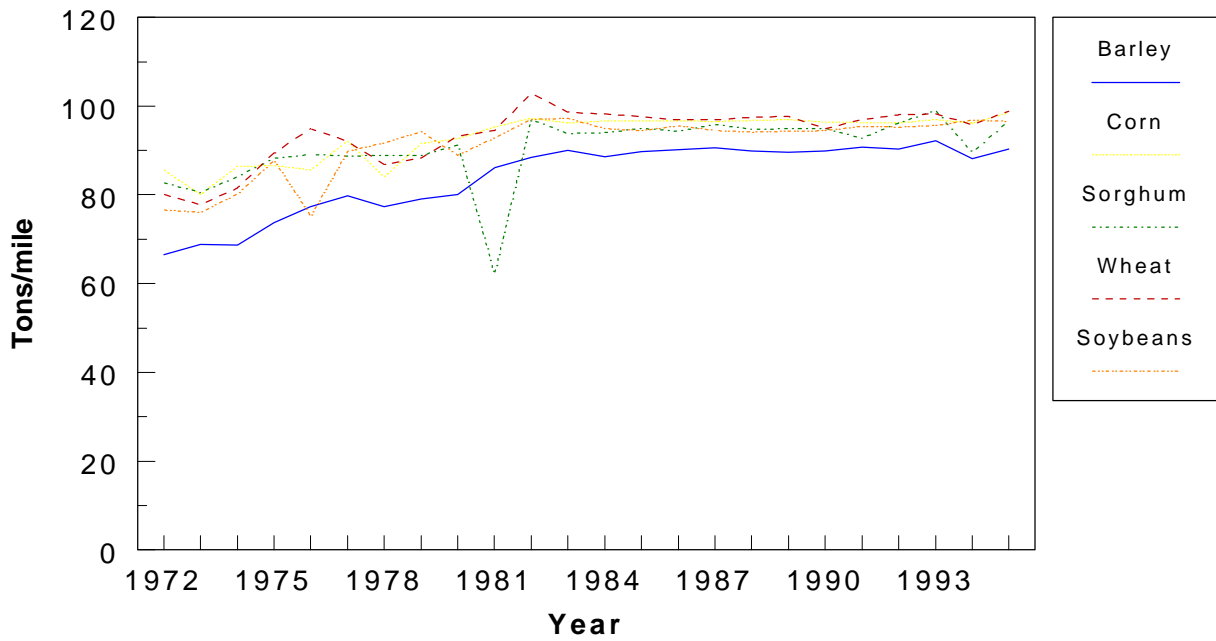


Figure 3.8 Miles of Track and Road

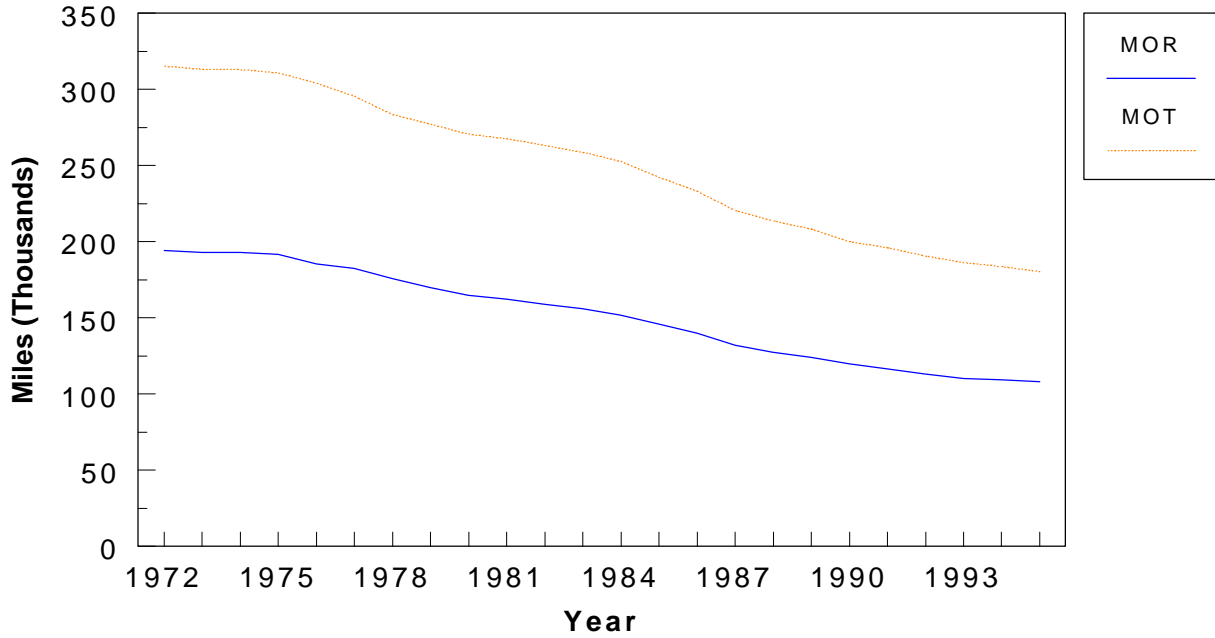


Figure 3.9 Operating Characteristics

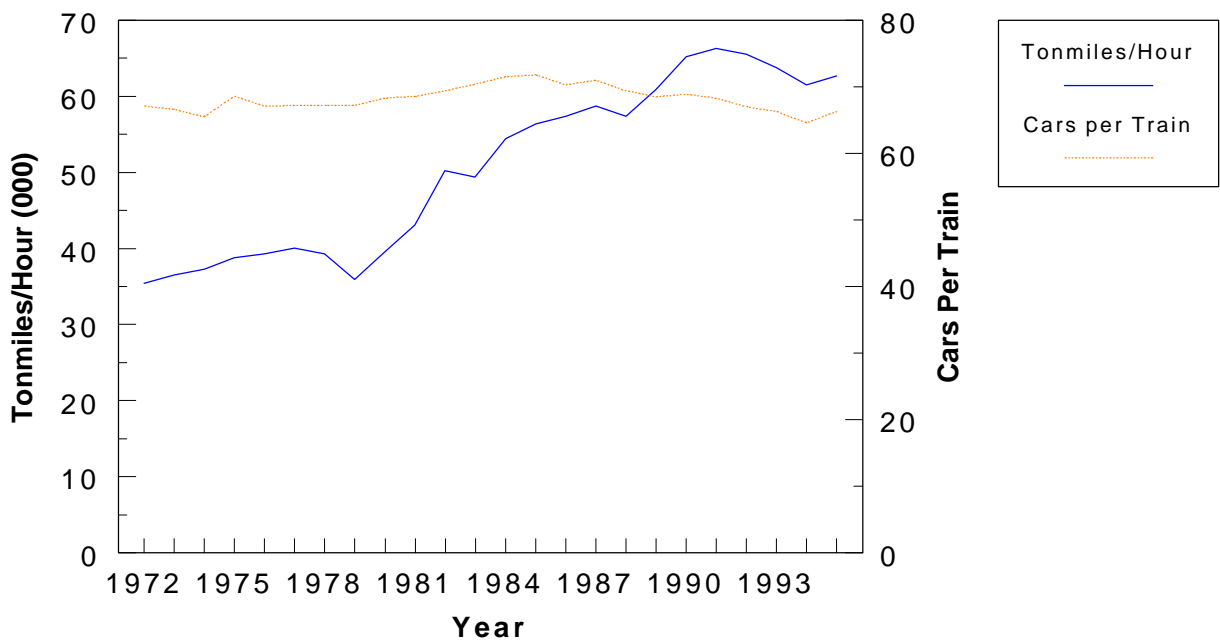


Figure 3.10 Factor Prices

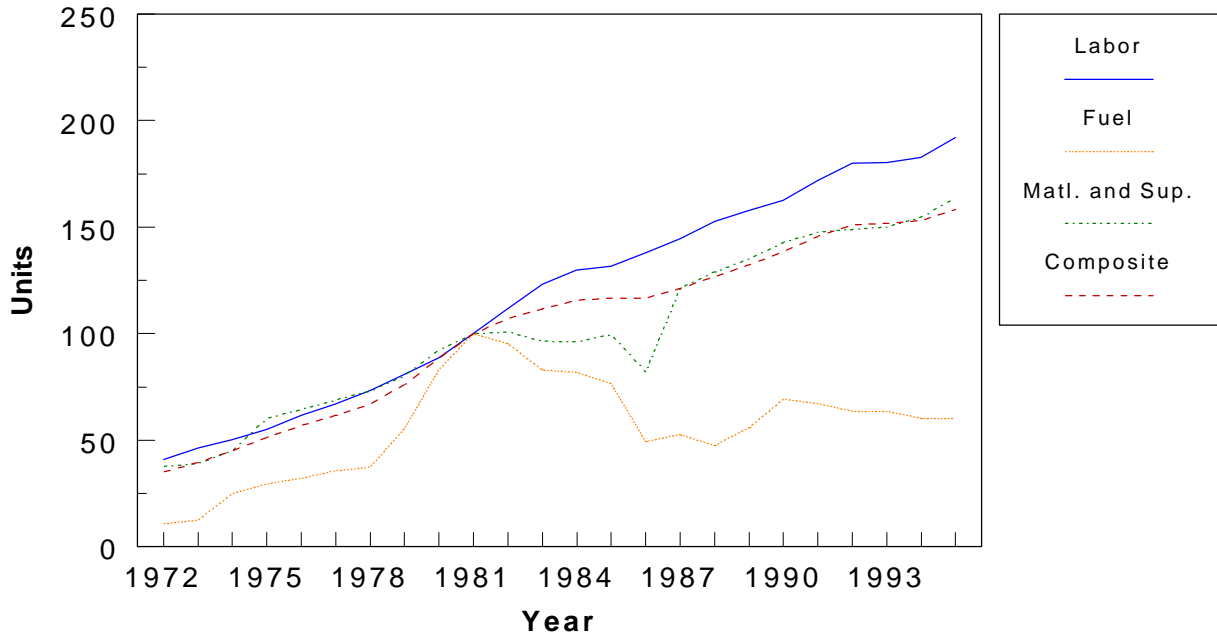


Figure 3.11 Production by Commodity

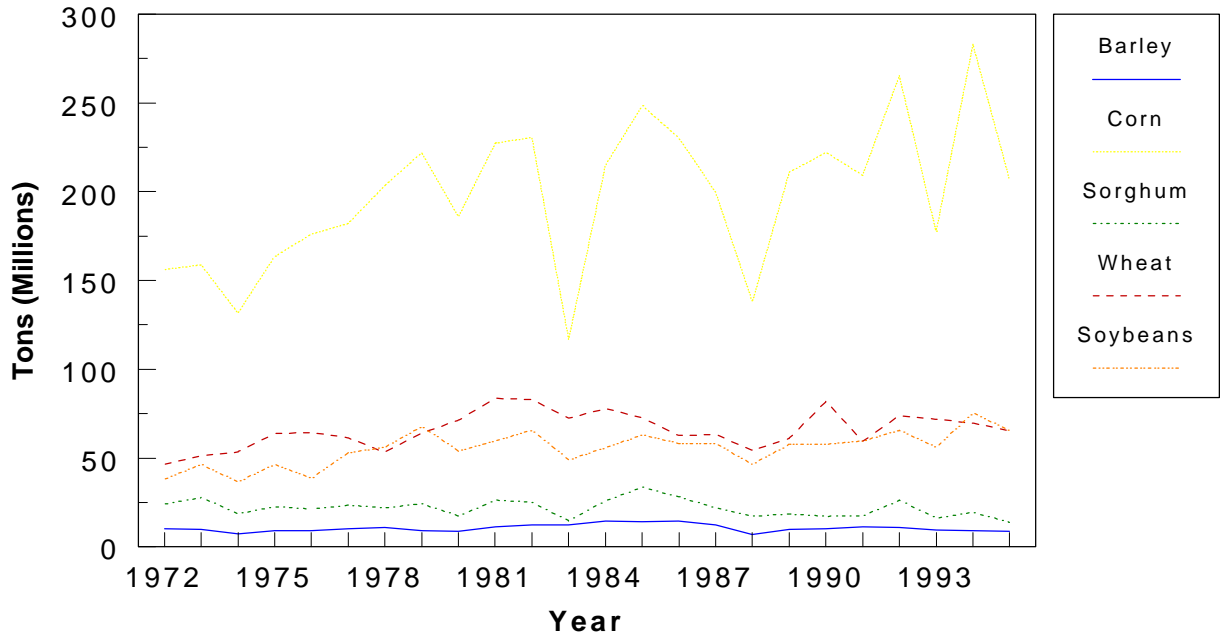


Figure 3.12 Nominal Prices of Commodities

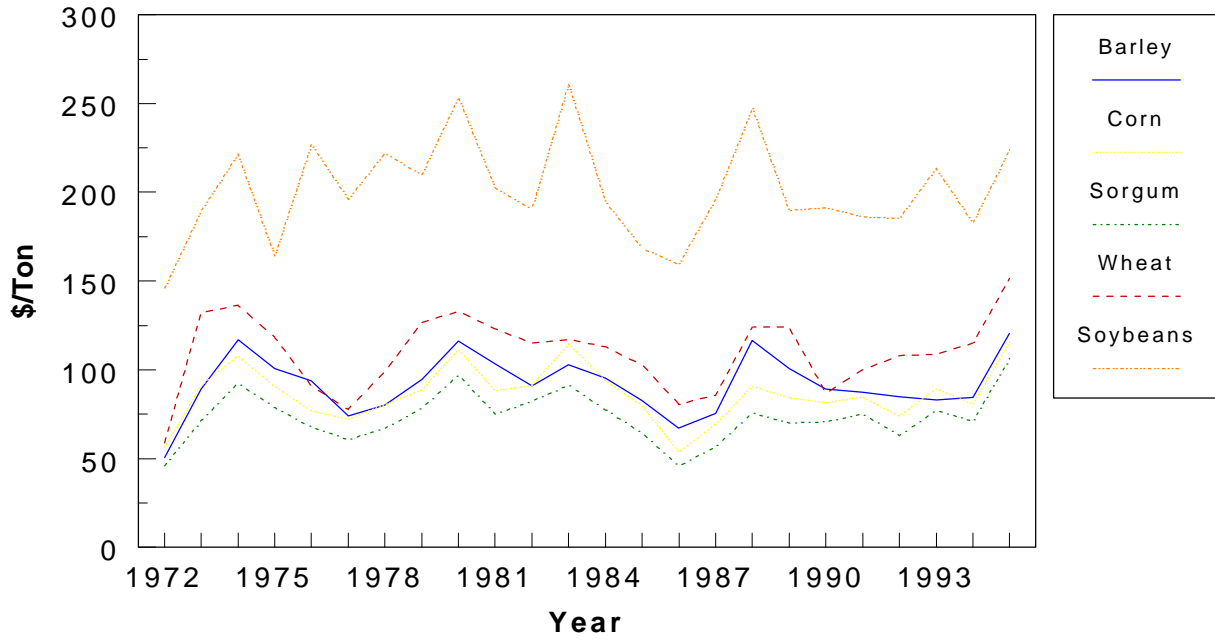
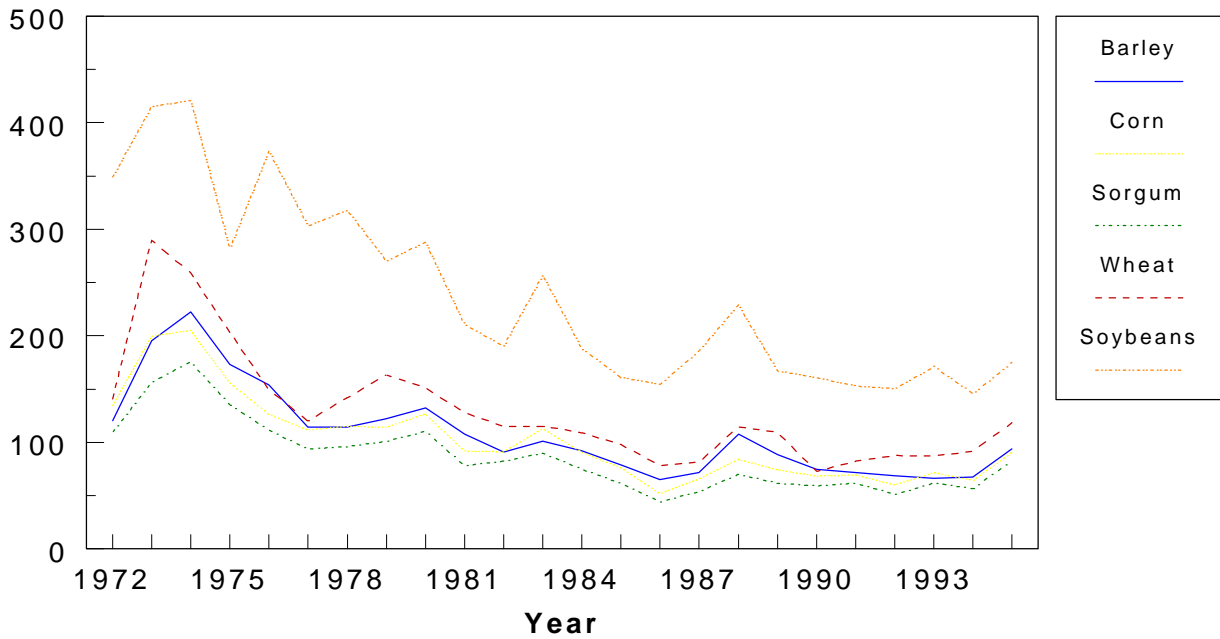


Figure 3.13 Real Commodity Prices



4. Conceptual and Empirical Models

As described in the previous section, there are very clear differences in the demand and cost structures, and the pricing of railroad services. In this section, we describe the framework we used to analyze rate changes from 1972 through 1995 and the impacts of rail deregulation.

4.1 Theoretical Model of Pricing Relationships

Our general framework evolves from four basic factors. These include demand, costs, pricing, and the regulatory regime. We analyze five different agricultural commodities including barley, wheat, corn, soybeans and sorghum. These five agricultural commodities reflect most of the ton miles of farm products shipped. Within these five commodities, corn and wheat shipments dominate.

Transportation demand is a derived demand, and the end use and portion exported of the five different commodities are quite different. We treat demand (Q_{it}^D which is the quantity shipped by rail of product i by year t) as being dependent on the rate for the product shipped (r), the value of the product shipped (P), and various other demand shifters (X^D) and as potentially having different parameters β which may vary over time with the introduction of new transportation services and as the quality of transportation services change.

$$Q_{it}^D = Q^D(r_{it}, P_{it}, X_{it}^D, \beta_{it}) \quad (1)$$

There are a number of complications in modeling of transportation costs. Typically, researchers examining costs use an aggregate measure of transportation output (i.e., ton miles of all products transported) in conjunction with a number of other variables used to capture the heterogeneity of outputs across firms. We follow this general strategy with some added dimensions. Specifically, we follow the bulk of the literature in using the aggregate measure of output [ton miles (Q_t)] as well as that of the commodity shipped Q_{it} along with the variables capturing heterogeneity (X^C). However, we allow for commodity specific effects in the estimation (as discussed below). Thus, our model of costs is

$$C_{it} = C(Q_t, X_{it}^C, \gamma_{it}) \quad (2)$$

In equation (2), γ is a set of parameters applying to each commodity. As we discuss later, γ may vary across time, commodity, regulatory regime, and/or be explained by a set of observables.

Our central purpose is to explain the behavior of rates over time. In explaining the determination of prices, we augment equations (1) and (2) with a pricing relation.¹⁶ The pricing

¹⁶Relevant previous research is described in some detail by Bresnahan (1989). Similar models were applied to model railroad rates in Wilson (1994) and to model truck rates in Ying and Keeler (1991).

relation is indeed the key to our analysis of rates over time and across commodities and regulatory regimes. The pricing relation reflects the marginal revenue-marginal cost condition. In this case, there is a pricing relation for each of the five commodities given by:

$$r_{it} = MC(Q_{it}^C, X_{it}^C, \gamma_{it}) - Q_{it}^{D'}(r_{it}, P_{it}, X_{it}^D, \beta_{it})Q_{it}^D\theta_{it} \quad (3)$$

In equation (3), $MC(\bullet)$ is simply the derivative of the cost equation, while the second term involves the derivative of the demand condition in equation (1). The remaining term, θ , is an index of the departure of rates from marginal costs.

There are a number of important characteristics about θ . If $\theta=0$, then prices are consistent with marginal cost pricing. While such pricing is not expected in railroad markets either under a regulated or a partially deregulated regime, upon identification of θ , it serves as a useful reference point. More importantly, θ is used to model the effects of deregulation. In particular, the index may vary across regulatory regimes as in Wilson (1994) describing rate changes across STCC level 2 codes. In such a model applied to the above, the effects of partial deregulation may be reflected by:

$$\frac{r_{it}^{PD} - r_{it}^R}{r_{it}^R} = \frac{MC_{it}^{PD}/(1 - \theta_{it}^{PD}/\eta_{it})}{MC_{it}^R/(1 - \theta_{it}^R/\eta_{it})} \quad (4)$$

where the superscripts PD and R index partially deregulated and regulated regimes respectively, while η denotes the demand elasticity.

4.2 Estimation

Ideally, estimation would consist of a nonlinear 3SLS approach of equations (1), (2) and (3). However, data and identification requirements for such a procedure are quite substantial. Furthermore, in network industries the number of individual products with different costs and prices makes such a procedure quite difficult in specification, estimation and data.¹⁷ In our case, we focus on the movements of five different commodities aggregated across all origins and destinations.¹⁸ Using equations (1), (2), and (3) our model of rates of individual commodities is:

¹⁷Conceptually, there is a separate demand function for each price in the network, a multi-output cost function allowing for different cost behavior for each of the outputs, and a separate pricing relation for each service. In rail networks, the number of products transported and the number of origin-destination pairs is intractably large.

¹⁸Such a procedure is common in modeling railroad rates. See Boyer (1987), McFarland (1989) and Barnekov and Kliet (1990) each of whom analyze rates aggregated across all dimensions including not only origin-destination but also commodity. Also, Burton (1993) and Wilson (1994) analyze aggregate rates of various commodities. Finally, there are a few studies that focus on relatively disaggregate commodity and geographic

$$r_{it} = r(Q_t, Q_{it}, P_{it}, X_{it}^D, X_{it}^C, t, R_t) + \epsilon_{it} \quad (5)$$

wherein all variables have the definitions described above, t reflects time dependent changes, and R reflects changes in the regulatory regime. We term this a quasi-reduced form in that it represents the equilibrium price as a function of casual variables, some of which may be endogenous and require use of instrumental variable techniques. We treat the endogenetic issue as an empirical issue.

In estimating equation (5), we use a double-log specification in all continuous variables. We treat the manner in which time dependence and changes in the regulatory regime enter as empirical issues, i.e., we treat the alternatives of a discontinuous trend versus the use of time specific dummies as an empirical issue.¹⁹ The exact method we use to estimate equation (5) rests on several issues. First, we examine treatment of various right-hand test variables as exogenous through the use of Hausman (1978) tests. In all cases, we use OLS and instrumental variables to test the hypothesis that the potentially endogenous right-hand side variables do not introduce significant bias by treating them as exogenous. We conduct the test on each of the five commodities separately using the total production of the commodity as an instrument for the ton miles of the product transported. We also examine the endogeneity of total ton miles, average length of haul using various industrial production indices, i.e., coal, transportation equipment, and chemicals which along with agricultural products represent the four most major products transported by railroads.

A second issue relates to the treatment of error terms. Specifically, our data (described below) pertain to five different commodities from 1972-1995. We examine and make appropriate corrections as necessary for serial correlation in the individual errors for each of the five commodities (using Durbin-Watson and Durbin-H statistics as appropriate).

There are a variety of remaining variables which are introduced as demand or cost variables. These include average length of haul, average load, train miles per hour, and miles of road etc.²⁰ Longer lengths of haul require less switching and provide potentially tremendous

levels. See Fuller *et al.* (1988), Wilson *et al.* (1988), MacDonald (1987a; 1989b).

¹⁹ We experimented with a variety of trend treatments as discussed below. In all cases, we employ a broken trend allowing the trending effects to vary before and after partial deregulation. We measure the trend with a value of zero for 1981 allowing the initial effect of Staggers to be interpreted directly. The dummy for Staggers takes a value of zero before 1981 and a value of 1 for 1981 through 1995. In addition, we experiment with different smoothing techniques for the introduction of Staggers. For example, one such technique is to allow the Stagger's effects to begin to be felt in 1978 by defining the dummy weight as .1, as .2 in 1979, as .4 in 1980, as .7 in 1981, as .85 in 1982, and as 1 in 1983. Of course, we examine a variety of weights and compare R-squares to settle in on the weighting procedure. Another approach is to define the break point at different time periods around 1981 (e.g., Staggers =1 for years 1980-1995), etc.

²⁰The percentage of unit train traffic, average shipment size, and/or the percentage of bulk traffic are variables that often appear in rate regressions of the form appearing above. In each case, these variables at the system level have increased over time and increased in particular since partial deregulation. At the individual

savings to railroads; this a variable that almost always appears in rate regressions, and is commonly expected to reduce rates. From the demand side perspective, longer lengths of haul may increase transit times and have an increasing effect on rates. In most previous research, the effect has been negative. We note that the length of haul has been increasing for all commodities and the increase has been greater since partial deregulation, with an increase on average from about 500 miles in 1972 to over 800 miles in 1995 (an increase of over 60 percent). Soybeans tend to be somewhat shorter in haul than the other commodities. There is no clear longest hauled commodity. Indeed it seems that the length of haul has increased faster for some commodities than for others.

Average load (defined as ton miles divided by carmiles) is included to capture costs. While there are differences across commodities and slight increases in the 1970s, the time behavior of average load is relatively constant for most of the time period. While such a variable might be useful in explaining differing rates across commodities, in a commodity-specific regression the effect can be captured in the constant.

It is well accepted that railroads operate more efficiently under partial deregulation. Such efficiencies are manifested in larger firm sizes in terms of output and network size but a reduced system network, higher densities, longer lengths of haul, a different traffic mix (e.g., more bulk movements), faster car turnaround, larger shipment sizes etc. Miles of road (network size) has fallen steadily over the time period (and the correlation with the time trend in all cases is in excess of .99), carmiles per hour have risen steadily over the time period, and railroad now ship a higher proportion of bulk commodities. Identification of each source of cost savings is quite difficult in an aggregate study with 24 observations per commodity. However, such efficiency gains are strongly correlated with the trend, and underlie our findings on the trend.

5. Results

Our purpose in the empirical work is to identify the dynamic behavior of rates across regulatory regimes. To this end there are many issues. The dependent variable in all cases is the rail rate per ton mile for each commodity, appropriately deflated. We explored a variety of deflators and report those based on the index of labor, fuel and materials and supplies combined index.²¹ We estimate a “fully specified” model, with a measure for system ton miles (Q_t), commodity ton miles (Q_{it}), the commodity price (P_{it}), a variety of demand and/or supply shifters including average length of haul (ALH_{it}), average load (AL_{it}), and miles of road (MOR_t), and the

commodity level, such variables are not readily available. These variables are likely captured in the intercepts and in the time trends as discussed below.

²¹We also estimated the model with the producer price index for finished goods and the GNP price deflator. In both of these the results were qualitatively identical and numerically quite comparable. We use the AAR deflated results because of the fact that the equation estimated is based on a markup equation with homogenous of degree one marginal costs. Factoring the changes in the factor price component provides a natural deflator. We further note that placing the deflator as a right-hand side variable in most cases results in a coefficient not statistically different from 1. Finally, in these examinations neither the qualitative nor the numerical results are materially affected.

time (t) and regulatory regime effects (R_t). All continuous variables except for time are measured in logs.

The time and regulatory effects are the key component of the analysis. With respect to the treatment of trends, we experimented with both linear and nonlinear trends, and the results are somewhat tempered by the differences in trend treatment. The results we report here are based on a linear trend through the passage of Staggers (trend=1 for 1972, trend=2 for 1973 etc.) and a nonlinear trend beginning with the passage of Staggers. Specifically, until the passage of Staggers the trend is given by $\alpha_1 t$. If the changes in rates are due primarily to improved technological change, the coefficient should be negative. However, under the regulatory environment technological changes are commonly thought to be quite small. Accordingly the coefficient should not be statistically different from zero. If the changes in rates are due to increased pricing flexibility on the part of railroads with the markups increasing, the coefficient could be positive (if this effect outweighs the technological effect).²²

Post Staggers effects on productivity are based on the conjecture and previous observations (i.e., see Winston, p. 108) and common expectations that the initial effects are quite small and are adopted through time. We estimated different treatments including linear, quadratic, and cubic adjustments. We choose the following based on consistency of results across specifications and across commodities.²³ The trend we chose was a linear trend for the pre-Staggers model and a nonlinear trend for the post-Staggers model defined as

$$trend = \alpha_t t + \alpha_{ts} t / (1 + t) STAG \quad (6)$$

where $STAG$ is a dummy variable equal to 1(0) in the post (pre) Staggers period. This specification has the advantage of allowing the effects of Staggers to have a nonlinear effect with the greatest weight being in the initial time periods following deregulation. Further, the rate of time change due to the trend also allows Staggers to have different initial effects which potentially dissipate over time, reaching an asymptote of $\alpha_t + \alpha_{ts}$.

In terms of the timing of the initial effects of Staggers, we examined alternative switching points for the regulatory regime as well as alternative smoothing techniques (e.g., defining the dummy variable with increasing weights such as $STAG=.2$ for 1980, $STAG=.6$ for 1981,

²²Delineating the two effects is quite difficult, requiring the identification of both demand and marginal cost parameters. Our efforts with this limited data set have not been successful.

²³Linear specifications of regulatory adjustments did not provide for a smoothing of regulatory adjustment and yielded negative effects on the trend that were largely statistically significant. In a few cases the negative effects were small in magnitude but not statistically significant, and in a few cases the effect of Staggers on the trend was positive but small and not statistically significant. The quadratic trends performed quite well but have the unfortunate property that rapid initial effects cause the effects of Staggers to reverse the trend (In the cases in which the effect of Staggers reversed the trend, the switching point occurred in the late 1980s. This occurred for some of the commodities and is consistent with increasing markups. To further examine this property we considered both introduced a cubic trend and various switching point models. These considerations were of little success with considerable insignificance in the trend terms (only in one case did the specification yield significant results) and the effects were not materially affected from the preferred specification.

STAG=.9 for 1982, etc.) The qualitative and numerical results are not materially affected, and given our smoothing technique above, we choose the usual STAG dummy variable to capture the change in regulatory regimes.²⁴

We base our discussion of the remainder on a reduced specification reported in Table 1, versus that in Appendix Table A1. Specifically, our inspection of the data suggests that there are significant correlations between miles of road, system ton miles and average load²⁵ and the time and regulatory regime. However, the results are not qualitatively affected by their exclusion. Quantitatively, there is some effect on the results discussed below owing largely to the correlation between these variables and the STAG and trend variables. As reported in the Appendix, these variables are generally not statistically significant for all commodities. Average load is statistically significant in the barley specification. Miles of road is statistically significant only in the sorghum specification. System ton miles is significant only in the sorghum specification. Because of the limited degrees of freedom, the high degree of multicollinearity in these variables with the STAG and trend effects, we exclude them from the results we document in the remainder of this section. We do note, however, that because these variables are correlated with the coefficients of interest their effects are present in the model and at least in part explain the results below.²⁶

In both the full specification (Appendix Table A1) and those reported in Table 1, serial correlation corrections were necessary only for wheat. Consequently, the OLS results are reported with exception of wheat which was estimated using maximum likelihood iterative techniques. The fit in all specifications is extremely high with adjusted R-squares in excess of .96. Further, the statistically significant coefficients are generally consistent with prior expectations.

The results discussed described below are from Table 1. First, commodity ton miles has a negative effect on rates in all specifications. However, these estimates are statistically significant only for wheat and for soybeans. In these two cases, a 1 percent increase in ton miles reduces rates by 25 percent.

²⁴The fit of the models in all cases is so very high that they provide little discrimination between the model. However, the simulated effects of a change in regulatory regime provide support for the usual effects of Staggers. For example, if STAG is defined with 1980 instead of 1981 as the switching point, the initial effects of STAG is almost uniformly positive. If STAG is defined with 1982 as the switching effect the effects are substantially larger than those reported. While the regulatory effects of the smoothed dummy (STAG with varying weights) are quite comparable to those reported, the effects of a change in regulatory regime on the time related effects ($\partial \log(\text{rate}) / \partial t$) have quite large negative effects in 1980 and 1981 and then reverse quickly in 1982. The behavior of the time effects reported later with the usual STAG switch point is much more realistic and vies for the specification reported.

²⁵Average load is simply ton miles divided by the number of carmiles. Such a variable is probably not as useful as shipment size in explaining rate changes. In the data, we attempted to proxy average shipment size with tons divided by the sample size (the number of waybills on which the statistics are based). We did not obtain significant effects and the measure seemed quite noisy.

²⁶When we do not include these variables in the regression, the effect of STAG and the asymptotic adjustment to STAG is larger than when we control for these variables. The differences range from four percent to 24 percent in magnitude.

Table 1. Regression Results by Commodity

	Commodity				
	Barley	Corn	Sorghum	Wheat	Soybeans
Constant	-2.08*	-3.83*	-2.51	.41	-.68
Commodity	-.11	-.06	-.04	-.25*	-.25*
Commodity	.11*	.24*	.17*	.06	.24*
Avg. Length	-.61*	-.66*	-.86*	-.43*	-.54*
SRA	10.96*	9.18 *	13.88 *	10.39*	6.01*
TT	.01	-.02	0.01	.01	.02
SRA-T	-12.17*	-10.21*	-15.29*	-11.59*	-6.8*
Adj. R ²	.99	.98	.96	.98	.98

Values in () is the t-statistic and * indicates significance at the 10% level

Second, the commodity price has a positive effect in all specifications which is statistically significant for all commodities except for wheat. For the statistically significant effects, a 1 percent increase in the price of the commodity increases the rate per ton mile by .11 percent for barley, .24 percent for corn, .17 percent for sorghum, and .24 percent for soybeans. The significance of this variable is important in that it represents a demand shift and illustrates that rates are sensitive to changes in demand and are not fueled entirely by cost changes. Furthermore, such a finding is not common in previous empirical work.

Third, average length of haul has a universally negative and statistically significant effect on rates. A one percent increase in ALH reduces rates by .61 percent for barley, .66 percent for corn, .86 percent for sorghum, .43 percent for wheat, and .54 percent for soybeans. This result is not unlike most previous research. Virtually, all empirical specifications include average length of haul and its inclusion is based on cost considerations. Traffic movements have quasi-fixed factors associated with them (e.g., loading) and longer lengths of haul allow these quasi-fixed factors to be spread over greater distances. The magnitude of the coefficients suggests that these changes are an important source of rate reductions under Staggers. In particular, from 1981 to 1995, ALH increased about 62 percent for barley, 15 percent for corn, 67 percent for sorghum, 73 percent for wheat, and 65 percent for soybeans. The effects of these through the econometric results translate into a 38 percent reduction in barley rates, a 10 percent reduction in corn rates, a 58 percent reduction in sorghum rates, a 31 percent reduction in wheat rates, and a 35 percent reduction in soybean rates.

The remaining results pertain to the dynamic effects of rate changes and regulatory regime effects. We included a linear trend to capture the effects of technological progress, and the possibility of increasing markups over time (Figure 4.1). The results are consistent across specifications. Prior to partial deregulation, there is no evidence of a trend. In all cases, the coefficient on the linear trend is small in magnitude and statistically insignificant in all specifications, providing strong evidence against significant technological progress in the 1970s.²⁷ The interaction of Staggers with the nonlinear trend is, in contrast, statistically significant in all specifications (at the 10 percent level) and is negative, suggesting that the annual percent change in rates from deregulation is negative and statistically significant.

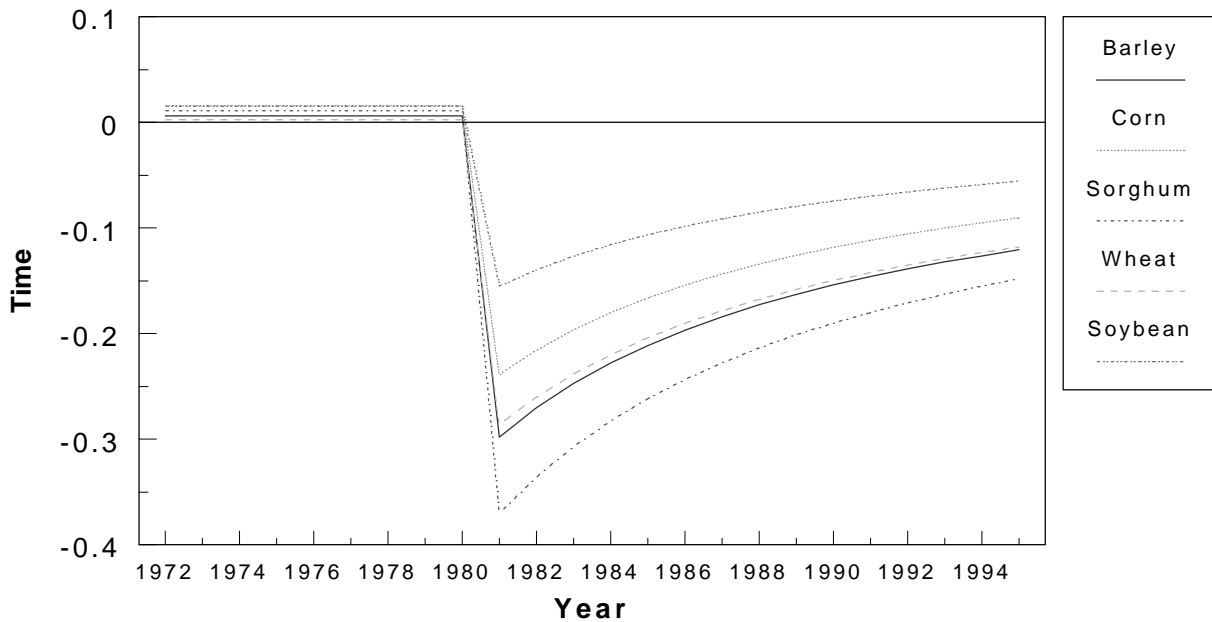
To examine the time pattern of rates with respect to the trend before and after partial deregulation, we plot $\partial \log(r)/\partial t$ in Figure 4.1 for each commodity (Table A-1 in the Appendix contains the estimated effects). In all cases there were very minimal and insignificant trends in the time rate of change in rates prior to partial deregulation. With the passage of Staggers in late 1980, there were very significant effects which dissipate with time for all commodities.

Specific interpretations of these results vary by commodity. Barley rates increased by .006 percent until 1981. In 1981, the rate of change was about -.3 and has steadily fallen in magnitude with time. In 1995, the rate of change is about -.12 percent per year. Similar patterns are observed for the other commodities. For corn, sorghum, wheat and soybeans, the pre-Staggers trend pointed to percent changes in rates per year of .016, .011, .003, and .015, respectively. The initial effect of partial deregulation on the time rate of change is uniformly negative with a -.24, -.37, -.28, and -.15 rate of change per year (in 1981) for corn, sorghum, wheat, and soybeans. In 1995, again, the effects are smaller in magnitude for all commodities. The 1995 percent change in rates is -.09, -.15, -.12, and -.06 percent per year.

These results provide substantial evidence that the effects of technological change (given little markup changes) were: 1) not prevalent prior to partial deregulation, 2) quite substantial with the passage of Staggers; and 3) have dissipated with time but remain quite strong. It is important that rate changes are attributable to technologically induced cost changes, which through competitive pressures results in rate changes. Thus, cost changes outweigh any possible effects due to changes in markup. We cannot deduce from these results the extent that they are attributable to cost versus mark up effects, but clearly the former must dominate.

²⁷This conclusion is tempered somewhat by the failure to separately identify changes in marginal costs from changes in markups. Such a finding described in the text is also consistent with significant technological progress (reducing rates) along with offsetting increases in the markup term. We conjecture that neither of these are present but note the possibility.

Figure 4.1 Time Rate of Change in Rail Rates: 1972-1995.



The final set of results discussed are the effects of Staggers on rates as represented in the previous section by equation 4. We first note that by construction there are no regulatory effects prior to 1980. In 1981, the effect of partial deregulation involves multiple parameters, is time dependent and is given by:²⁸

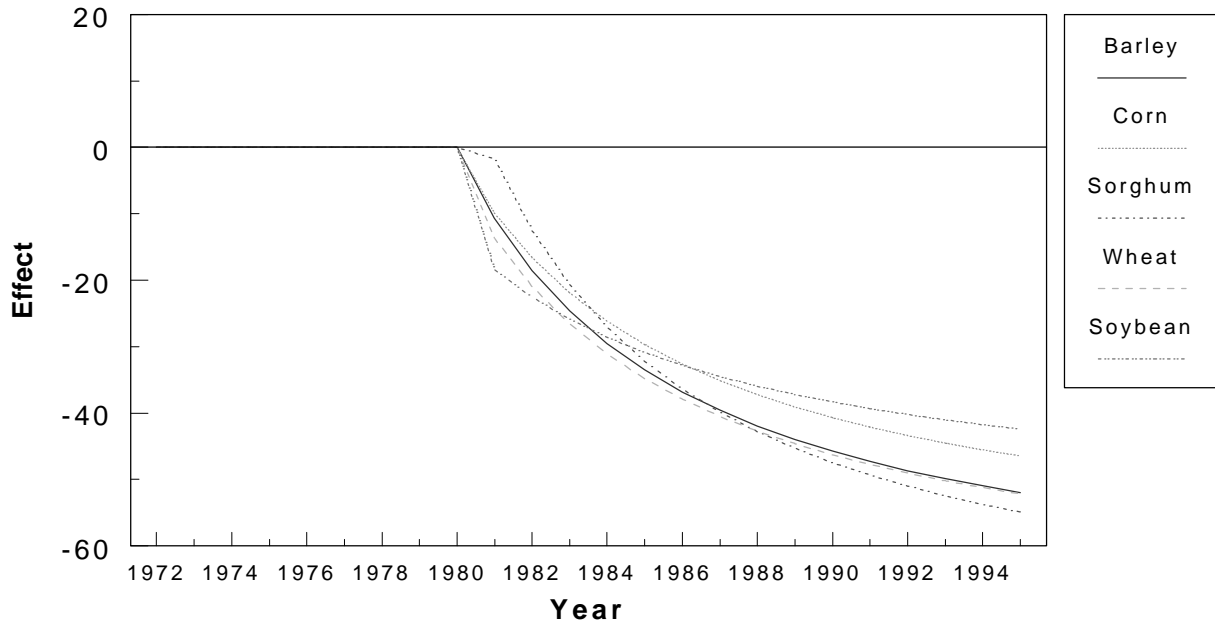
$$\frac{r^{PD} - r^R}{r^R} = [\exp(\alpha_{STAG} + \alpha_{STAGT} \frac{t}{1+t}) - 1] * 100 \quad (7)$$

These results are shown in Figure 4.2. The effects are negative for all commodities in 1981. For barley, corn, sorghum, wheat and soybeans the initial effect (i.e., the 1981 effect) is -10.6, -9.9, -1.8, -13.7, and -18.4, respectively. The initial effects of partial deregulation grew over time but at a decreasing rate. In 1995, the longer term effects are -.52, -.46, -.55, -.52, and -.42 for barley, corn, sorghum, wheat and soybeans, respectively. Both the figures and the estimates are consistent with priors. Most conjecture small initial effects of deregulation but eventually level out to longer term effects. Specifically, by 1990, the decline in rail rates

²⁸As discussed earlier the results reported contain the effects of AL, USTONMILES, and MOR operating through the correlations with the trend and Stagger dummy variable. The effect of not estimating the parameters of these coefficients to separately identify the effect does and should impact the figures reported. Calculating the effects given by the above equation but using the Appendix specification (i.e., washing out the effects of AL, USTONMI, and MOR) yields 1981 and 1995 effects for barley of -4.9 and -64.5 percent, for corn of -2.3 and -46.6, for sorghum of +4.1 and -41.6 percent, for wheat of -13.3 and -55.4 percent, and for soybeans of -15.9 and -50.7 percent. Generally, removing the effects of these three variables from both the initial effects and the long run effects tempers the effects of Staggers operating through both the dummy and the trend variable.

attributable to deregulation was about 20 percent, and by 1995, rail rates were at least 40 percent less than they would have been had deregulation not occurred.

Figure 4.2 Percent Change in Rate Attributable to Deregulation



6. Conclusions

Deregulation of rail rates in grain has had an important effect on the evolution, efficiency and conduct of the grain marketing industry. Several important features of the Staggers Rail Act (SRA) facilitated a change in the conduct of the rail shipping industry. Some of the more important features of the SRA were that the definition of captive shippers and tests were changed, as well as a liberalization in the timing of rate changes, adoption of contracts, a reduced role of rate bureaus, liberalization of rail line abandonment and the ability to introduce premium rates for premium service. These provisions induced selected line abandonment, mergers, development of short line railroads, and the introduction of numerous mechanisms to induce more efficient shipping practices. The purpose of this study was to analyze the extent that observed changes in rail rates can be attributed to productivity changes and cost reductions, and/or to the more liberalized regulatory environment.

The effects of the SRA have been a recent concern to shippers in the United States. Some of the most important concerns are about competitive access, service deficiencies and the prospective effects of mergers. These problems have also been identified in Canada in the case of grain shipping. In that country, rail rates on grain for the vast majority of movements are highly regulated. However, pending the results of an efficiency review (the so called *Esty Commission*), it may be that grain would be subject to the same regulations as all other commodities under the

CTA. Several recent studies have argued, however, that such a regulatory environment would result in higher rates, and an increase in discrimination in Canadian grain shipping.

This study developed an econometric model of shipping rates for grains through time. In particular a model based on demand, costs, a pricing relation and the regulatory regime was specified. It was estimated over the period 1972-1995 to identify the effect of these variables on rail rates. It should be emphasized that the analysis was on a time series of rates aggregated across movements, origins and destinations. This is the most appropriate way to assess the effects of deregulation on rate levels over time.

Review of the data indicates a number of interesting facts. First, there have been both nominal and real reductions in rail rates since 1980. In particular, in the period prior to 1980, rail rates were generally increasing in real terms. However, in the period following the SRA, most rail rates decreased in real terms by 52 percent (ranging from 40-71 percent across commodities). Second, there has been a notable change in operating characteristics. Most important is that in the period following the SRA, there has been an increase in ton miles shipped, both the average length of haul, and average load per car have increased and there has been a decrease in the miles of road operated. These variables affect equilibrium rate levels in several dimensions.

Results from the econometric analysis indicated that rate levels and their change through time are explained by these fundamental demand and cost factors. Several conclusions are drawn. First, commodity ton miles affects rates negatively. Second, commodity prices have a positive impact on rates, reflecting demand conditions. These results indicate that rates are sensitive to demand and not entirely due to cost changes. Third, average length of haul (ALH) is a very important variable affecting rate levels. In all cases this variable was negative and significant. This is noteworthy, since during the post-SRA period, ALH has increased substantially, which resulted in a substantial reduction in rate levels.

The final set of results relates specifically to technical changes induced by the SRA. These results indicated that in general, in the period prior to SRA, productivity changes were nil. However, as a result of the SRA, there was a one-shot large improvement in productivity, and concurrent reduction in rates. This was followed by continued productivity increases and rate reductions in the ensuing years. However, the effects tended to dissipate and by about year 10 following deregulation, most of the benefits had been accrued. The initial effect of deregulation resulted in rate reductions ranging from 2 to 19 percent. However, by 1995, the cumulative effects resulted in rate reductions ranging from -42 to -55 percent relative to the rate level had the regulatory regime been unchanged.

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Appendix

Table A.1 Regression Results by Commodity

	Commodity				
	Barley	Corn	Sorghum	Wheat	Soybeans
Constant	13.24 (1.41)	-758623 (.76)	-42.24* (2.73)	9.57 (.53)	-3.87 (.30)
Commodity Ton Miles	-.04 (.50)	-.11 (.96)	-.04 (.05)	-.17 (1.16)	-.16 (1.23)
Commodity Price	.09 (1.5)	.14* (2.37)	.06 (.62)	.06 (.59)	.09 (.64)
Avg. Length of Haul	-.64* (4.09)	-.64* (2.59)	-1.03* (3.60)	-.63* (2.13)	-.67* (2.78)
SRA	17.54* (6.01)	10.76* (4.05)	10.34* (1.81)	11.71* (1.80)	9.37* (2.26)
TT	.01 (.74)	-.01 (.48)	.03 (1.51)	.01 (.08)	.01 (.12)
SRA-T	-19.35* (6.00)	-11.87* (4.08)	-11.33* (1.83)	-13.04* (1.81)	-10.49* (2.30)
US Ton Mi	-.27 (.89)	.68* (2.89)	1.03 (1.44)	-.07 (.17)	.47 (1.34)
MOR	-.70 (1.18)	-.29 (.47)	-2.14* (2.47)	-.48 (.37)	-.15 (.16)
AL	-1.01* (2.00)	-.09 (.21)	.11 (.19)	-.65 (.94)	-.39 (.77)
Adj. R ²	.99	.98	.98	.98	.98
DW	2.23	2.16	1.91	1.55	1.93

Values in () is the t-statistic and * indicates significance at the 10% level