U.S. GRAIN RAIL MARKET INDICATORS

Kimberly Vachal
Upper Great Plains Transportation Institute

John Bitzan
Department of Management, Marketing and Finance

North Dakota State University
Fargo, North Dakota

Funding for this research is provided by the U.S. Department of Agriculture's Transportation Services Branch. The Upper Great Plains Transportation Institute is solely responsible for the content of the report.

ABSTRACT

Secondary rail market prices for guaranteed grain service provide insight regarding U.S. rail service available to grain shippers. This analysis investigates alternative market information that may enhance indicators offered to gauge current and expected rail grain service levels. Regression analysis is used to assess the relevance and relationships of alternative rail grain service measures and market parameters. Findings add to the current knowledge base used for interpreting market parameters as indicators in current and expected rail grain service. Given the derived demand nature of transport, the relevance of demand variables such as manufacturing orders and outstanding grain sales is not surprising. In addition, more specific rail capacity measures such as average grain train speed and system dwell time also offer valuable rail grain service information. Although relationships are largely expected, the analysis offers new insight regarding the relative value of alternative secondary data sources as indicators in current and future rail grain service.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Public institutions play an important role in offering shippers and carriers information that can be used to manage risk and make rational market decisions regarding grain sales and purchases. The transparency that the U.S. Department of Agriculture (USDA) introduces into the grain market comes from an array of information such as production, export sales, and market prices. Within the USDA, the Transportation Services Branch (TSB) offers a specialized focus, concentrating on the grain market supply chain functions. These functions cover modal volume activities, inland modal pricing trends, market flow patterns, and international ocean shipping markets. The information provided by TSB allows practitioners and policymakers to make more effective supply chain decisions regarding capital investment, risk management, and institutional parameters.

One important component of the grain supply chain information offered by TSB is related to rail service. U.S. grain producers use rail to ship to both domestic and export markets. Given the fixed capacity of the U.S. inland waterway system, the lack of proximity of many grain shippers to this system, and the lack of efficiency associated with transporting bulky commodities long distances by truck, rail is an important transportation option for many U.S. grain shippers. In fact, approximately one-third of U.S. grain is originated via rail (USDA, 2004).

Just as local and global grain market conditions are uncertain when many grain participants must make decisions regarding investment, marketing, and purchasing decisions, so too are transportation conditions, including rail market conditions. This uncertainty regarding rail service adds another element of risk for market participants. Given the prominent role of rail in agriculture, transparency regarding rail grain service is critical in risk management for U.S. grain marketing, considering both near-term transportation planning and longer-range investment decisions for the U.S. grain industry and domestic and foreign customers.

The ability and inclination of railroads to provide service to grain shippers throughout the year and during seasonal peaks, such as during harvest, is a function of many internal business and external market decision factors. The goal of this research is to enhance the rail grain market indicators published by TSB. Existing relevant quantitative data items will be identified and tested to assess relevance in understanding and measuring rail grain service. The indicators may include rail activity, service levels, and market trends, as the factors are reflective and or indicative of the rail grain market situation. Because transportation is a derived demand, gaining a better understanding of the relationship between rail service and other market factors may provide valuable insight for planning, investment, and risk management. The analysis will enhance the understanding of current market conditions and improve the ability to offer leading indicators that signal rail grain service trends in future months.

This analysis is presented in six sections. First, general information establishes a context for the rail service indicator project. In the second section, current and potential data sources are identified and described. A market overview offered in section three sets the context for interpreting results. The fourth section describes the methodology employed in the investigation, with empirical results presented in the following section. The final section summarizes findings and the offers suggestions for future research.

BACKGROUND

The 2003-04 crop year was generally successful for U.S. producers. U.S. coarse grain and oilseed exports were 12 percent above the 2002-03 total (USDA, 2004a). U.S. railroads were an important factor in this success, moving an estimated 30 million tons to U.S. ports. Rail grain volume was approximately 20 percent higher than the previous three-year average, accounting for nearly one-third of all U.S. grain export volume in 2003-04. In addition, more than three-quarters of the rail volume increase was delivered to the Pacific Northwest (PNW) export region. Considering the overall volume increase and added distance associated with the PNW market share increase—about 300 miles, or 30 percent, further than the average distances for shipments to the Gulf port region—it is estimated that the 2003-04 grain shipments required capacity that was 25 percent higher than the average for the previous three years (USDA, 2004a; Surface Transportation Board, 2003).

Throughout much of the 2003-04 crop year, railroad service was characterized by shippers as unreliable and uneconomical. Market forces, including a good U.S. crop, a relatively small European crop, a weaker U.S. dollar, and most-favored nation status for China, were compounded by rail industry issues including overall rail traffic increases and rail labor shortages attributed to changes in railroad retirement policies. These factors created a fall and winter rail shipping season that was laden with service problems (Athavaley. 2004; Dininny, 2004; Hare, 2003; Kilman, 2003; McLaughlin, 2004; Gallagher, 2003). Unreliability was associated both with delays in service, as well as a lack of communication between producers, shippers, and rail carriers regarding the current status of the grain system service and plans for service level recovery. These service uncertainties led to many problems for shippers and producers, including elevators acting as storage terminals rather than transfer terminals, an inability for producers and elevators to deliver to financially attractive export markets, and premiums paid for guaranteed rail service that didn't materialize.

Because of the concerns expressed by producers and shippers during the 2003-04 crop year, the TSB is seeking to enhance the market indicator information it provides regarding rail grain service. A better understanding of current indicators and assessment of potential new indicators are both considered. The indicators are a means to communicate trends and shifts that have market implications for shippers, producers, and buyers, along with institutional inferences for policymakers.

DATA SOURCES

Data sources considered for this analysis cover a broad spectrum of factors that may potentially impact the service grain shippers receive from rail carriers. Some of these factors are contained within the grain market, while others are related to overarching trends in the economy. The broad brush approach is selected to gain insight into the commonly recognized rail grain market information sources and to identify and better understand other sources of information.

The data sources are grouped into three types. Type I includes data commonly used by industry and institutions in monitoring the rail grain market situation. These data sources include current rail grain market prices, rail grain shipments, grain fleet speed and dwell times, and hopper car supply for Class I rail carriers. Type II data include non-rail specific grain data that impact rail grain markets. These data consider the derived nature of rail grain demand, and include information on U.S. grain production, stocks, and export sales. A final data group, Type III, is formed by factors that may be influential or indicative of service levels in the overall rail market. These factors include overall rail fleet speed and dwell times, durable and manufactured goods orders, and total rail shipments.

The first element of Type I data, rail grain market prices, is commonly comprised of two components. The first is the published rail tariff rate that establishes the price for non-guaranteed service and fulfills the common carrier obligation. These rates establish the longer-term rail service price trends. Tariff price responses to changes in the market are limited by institutional factors, such as 30-day notice requirement for any rate increases. The second component of rail grain market price is a premium to or discount from the tariff rate for guaranteed service. Shippers can secure service guarantees from the railroad directly or through a third party. The three sources for accessing these guarantees are railroad-shipper contractual agreements, railroad auctions, and secondary markets administered by brokers or other agents. The premium paid or discount received for invoking these service guarantees results in a service price that may be above, below, or equal to the applicable tariff service price. Information regarding contractual agreements is confidential to parties involved in the agreement, so it is not a potential price information source. The railroad auctions and secondary markets do offer public information sources for rail service prices. Railroad auctions are held on a weekly or monthly basis. The railroads typically have a price floor to prohibit pricing below tariff rate levels. The secondary rail market is a liquid exchange, with bid and offer prices typically posted each weekday. The discounts (negative prices) in the secondary market are generally associated with railroad guaranteed service cancellation penalties.

Other Type I data elements include rail service capacity parameters such as grain cars online, average train speed for grain trains, and average terminal dwell time for grain trains. These data items are reported by Class I railroads via the American Association of Railroads (AAR). The current Railroad Performance Measures (RPM) and definitions are included in the electronic report (American Association of Railroads, 2004). These measures have been published on a weekly basis since January 1999.

Type II data elements, which are related to rail grain demand, include grain production, stocks, and export information. These are published periodically by the USDA and private industry sources. The Type II data elements regarding overall rail service include average train speed for all trains, average terminal dwell time for all trains, and freight cars online. These data are also reported via the AAR by the Class I railroads.

Finally, Type III data related to the overall demand for rail service include durable goods orders, overall manufactured goods orders, and the total ton-miles of freight carried by each Class I railroad. Durable and overall manufactured goods orders are available from the U.S. Department of Commerce in monthly reports. Class I ton-miles are available from the Surface Transportation Board (STB) in quarterly industry reports.

Each of the data items listed above are considered in the spectrum of potential rail service indicators. The publication frequency, reporting consistency, publisher reliability, and relationships among data are all considered. The analysis of the data, as potential rail service indicators, is presented following a brief market description.

MARKET DESCRIPTION

U.S. farmers produce more than 15 billion bushels of grain and oilseeds each year. This production is dominated by three commodities, corn, soybeans, and wheat, that account for more than 90 percent of annual production. Corn production comprised 62 percent of average annual U.S. grain and oilseed

volumes between 1999 and 2003. Soybeans and wheat accounted for 17 and 14 percent of average U.S. grain production, respectively, over the five-year period.

Top-producing states for these commodities are located primarily in the north and central plains region. Iowa and Illinois are leaders in both corn and soybean production volumes, with Iowa leading in corn and Illinois in soybeans. Nebraska and Minnesota complete the list of the top three corn and soybean producing states, respectively. Kansas, North Dakota, and Oklahoma are the largest volume-producing states for wheat.

As this production leaves the farm gate, it enters a supply chain bound for domestic and foreign customers. Domestic consumption is more dependent on truck transportation, based on USDA modal market analysis (USDA, 2003). Within the commodities, a much larger portion of corn is distributed domestically in comparison to wheat and soybeans (Figure 1). The modal shares are affected by factors such as reliability, price, distance, and volume.

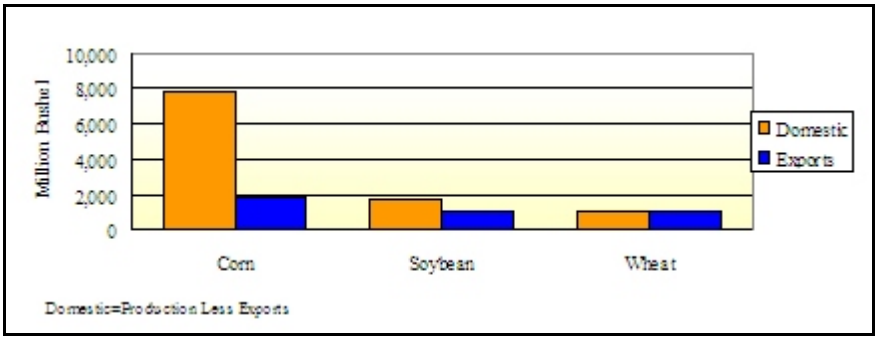

Figure 1. Destination for U.S. Grain Production, by Domestic and Export Markets (Source: USDA, 2003)

A large portion of U.S. grains are consumed domestically (Figure 1). Domestic demand is considered to be rather stable compared to export demand. For example, the domestic market effects of a new 0.5 million metric ton corn ethanol plant are rather insignificant on a national scale compared to a large reduction in corn export volumes by a major competitor. For instance, China, which exported an average 14.5 million metric tons of corn in 2002 and 2003, supplied only 2.32 million metric tons of corn exports in 2004. Dynamics associated with export demand include overall volume fluctuations and temporal dispersion, as well as the distribution among ports.

Trucks are the dominant transportation mode in the domestic supply of corn and soybeans, as well as in the overall market for these commodities (Table 1). By comparison, wheat is more dependent on rail than the other two commodities, as approximately 54 percent of domestic and export movements traveled by rail between 1999 and 2003. Rail accounted for only 30 and 22 percent of corn and soybean tonnage in these years, respectively. These facts may be important to consider in understanding rail service implications and identifying leading indicators for rail grain service.

Table 1. Estimated Distribution of Corn, Soybean, and Wheat Shipments by Mode and Market, 1999 to 2003

	Domestic[1]			Exports			Total		
	Rail	Barge	Truck	Rail	Barge	Truck	Rail	Barge	Truck
Corn	25%	2%	54%	5%	13%	1%	30%	15%	55%
Soybean	11%	2%	49%	11%	24%	3%	22%	26%	52%
Wheat	25%	1%	27%	29%	17%	1%	54%	18%	28%

[1]Domestic shipments is equal to total production less exports for this illustration.

Source: Modal Shares from *Transportation of U.S. Grains*, USDA, 2003; Production data from National Agricultural Statistics Service, 2004; Export data from *Grain and Feed Summary and Statistics*, USDA, 2004a.

Specific to the export market supply chain channels, Table 2 illustrates a shift from traditional barge-delivery export markets at the Louisiana Gulf to the Pacific Northwest and Texas Gulf during 2003, compared to the previous three years. While total exports are lower in 2003 than the average for the previous three-year period, exports to the PNW and Texas Gulf increased by 8 percent. On the other hand, exports to the Mississippi Gulf—the traditional barge delivery export market—decreased by 8 percent from the previous three-year average.

Table 2. U.S. Grain Exports by Port Region

	Exports		
Port Region	Avg. 2000-02	2003	Change
	1,000 Bushels		
PNW	699,893	763,109	9%
Texas Gulf	288,624	305,680	6%
Mississippi (LA) Gulf	2,407,367	2,215,687	-8%
Lakes	197,105	141,626	-28%
East	59,050	32,603	-45%
Interior	176,086	185,117	5%
Total	3,828,125	3,643,822	-5%

Source: U.S. Department of Agriculture, *Grain and Feed Summary and Statistics*.

A shift in grain export markets can have a major impact on the demand for modal service, as was apparent from the rail surge in 2003. Figure 2 shows the rail carloads delivered to U.S. ports from 1998-2000 and from 2001-2003. As the figure shows, the PNW and Texas Gulf are the largest rail export regions, by far. Thus, even though these ports export less volume than the Mississippi Gulf (Figure 3), any increase in export volumes from the Texas Gulf and the PNW has a major impact on the demand for rail service. The dispersion of the three grains among these ports, including all modes, is presented in Figure 3

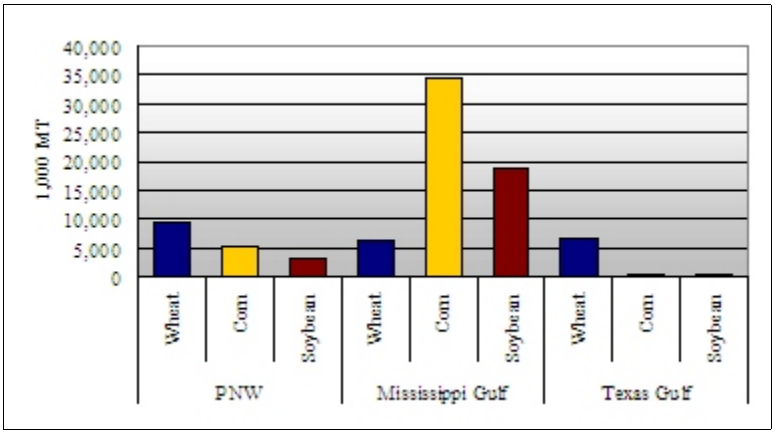

Figure 2. Port Region Grain Exports, Average Commodity Composition 2001 to 2003
(Source: USDA, 2004a)

(USDA, 2004a). Barge-delivered corn and soybean exports dominate exports in the Mississippi Gulf region, while rail-delivered wheat export shipments originated primarily though the Texas Gulf. Wheat is the largest grain commodity export for the Pacific Northwest, although measurable volumes of both corn and soybeans are reported.

In addition to production and exports, it is important to understand rail activity in the grain market in identifying potential parameters and interpreting findings. The rail industry is largely defined by seven

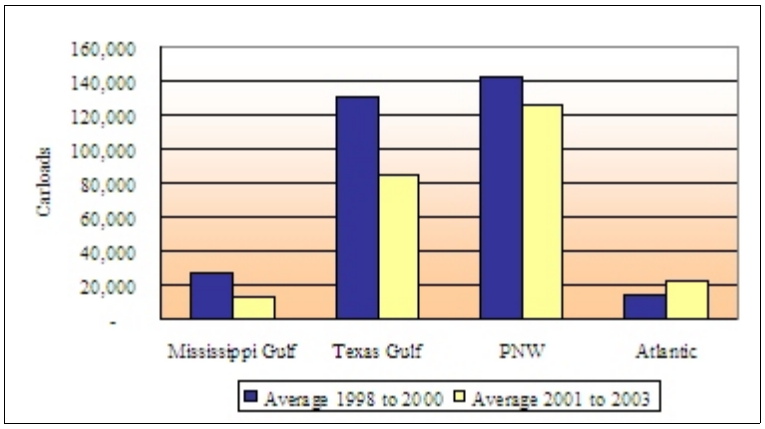

Figure 3. Rail Grain Deliveries to Port, 1998 to 2003
(Source: USDA, 2004b)

Class I railroads that handle about 93 percent of total annual farm product ton-miles and terminate nearly all grain rail export deliveries (Bitzan, et al., 2003). Among these railroads, the Burlington Northern Santa Fe (BNSF) and Union Pacific (UP) dominate U.S. rail grain originations by handling 70 percent of carload originations (Figure 4). The BNSF originated the largest volume between 2001 and 2003, accounting for approximately 38 percent of U.S. rail grain carload originations (USDA, 2004b).

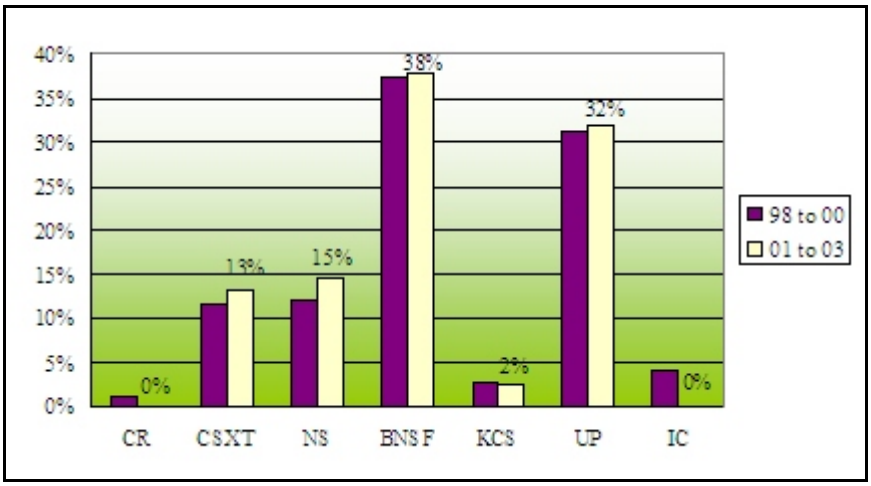

Figure 4. Average Annual U.S. Grain Originations Among Class I Carriers, 1998 to 2000 and 2001 to 2003
(Source: USDA, 2004b)

Basic facts regarding grain production, modal distribution, and market dispersion have been presented in this section. These underlying market characteristics and trends offer important insight for assessing rail grain service. The information is used in selecting and interpreting the analysis of data items as rail service indicators.

RAIL SERVICE MEASURES

A variety of measures might indicate the positive or negative trends in rail service for U.S. grain shippers. The TSB currently reports secondary rail market prices as a rail service indicator. Rail service may also, however, manifest itself in transit times, yard dwell times, and other market measures. These service measures may offer alternatives to the secondary rail market price as a rail grain service indicator. While these data exist in some form, more verification is needed on the tendency for these proxies to move together, and the relationships among market parameters. If proxies move together in a predictable fashion, one or more proxies may be used to assess the availability of rail service in times when preferred rail service data is unavailable. Related market factors may also provide important information regarding rail grain service.

The premium or discount paid for guaranteed railroad grain service in the secondary market has been identified as the best available measure of rail grain service based on discussions with industry experts. This premium/discount is directly determined by the supply of and demand for railroad service. When the rail system is capacity constrained, shippers pay more for guaranteed service. In times of slack, or

excess capacity, such guaranteed service will sell at a discount. Thus, the rail grain premium should generally be higher when the system is constrained and service is poor, and lower when the system has excess capacity and service is good.

To the extent that premiums/discounts paid for guaranteed service are good measures of rail grain service, they offer an additional advantage in that they may serve as a predictor of future rail grain service. Specifically, because bids are placed on service guarantees for up to six months into the future, they may serve as a predictor of rail grain service availability. Reliable data regarding secondary rail market prices, however, are often unavailable for more than three months into the future as the market is usually not well-defined. Thus, more information on how factors influencing the supply and demand for rail grain service influence secondary rail market prices may provide information on likely future rail capacity changes in the absence of secondary rail price data, and may provide increased lead time in predicting rail service problems when significant events or trends are identified. For example, if we know how an increase in export sales affects rail service, holding other factors constant, we might be able to infer the impact on future rail service based on grain export forecasts or sales announcements. The following analysis examines alternative rail service measures, along with their relationships to demand and supply fundamentals.

Alternative Service Measures

Before exploring the relationship between secondary rail grain prices and factors influencing the demand and supply of grain service, it is useful to explore other potential rail service measures and their relationship to secondary rail market prices. One measure of the quality of rail service available to grain shippers is shipment cycle time. It is defined as the time elapsed between car placement at shipment origin and car release at the destination. This time is affected by many factors including the railroad order response time, transit distance, train speed, load/unload times, and on- and off-line idle time. Unfortunately, system-wide shipment time measures are not published on a regular basis.

A general idea of cycle times may be ascertained by examining the AAR's RPM average train speed and dwell time variables. Train speed is measured as total train miles divided by total hours operated by the railroad. One would expect decreased train speeds to result in poorer quality service and increased total times necessary to deliver commodities to market, holding other factors constant. Average terminal dwell time is the number of days that rail cars are idle at a specific terminal location waiting for customer release, interchange, or train arrival, during the trip from origin to destination. Longer dwell times result in a longer transit time for delivering products to market and are associated with degraded service levels.

Although these proxies do not capture the entire variation in delivery time, each of these is an important component of overall transit time. When train speed decreases or dwell time increases, overall transit time will increase when other factors are held constant. Moreover, when the rail system is capacity constrained, it is likely that each of the components of transit time is affected in a negative way.
The Pearson Product-Moment correlation coefficient and significance measures among average monthly secondary rail market prices,[1] average grain train speeds, average overall train speeds, and average terminal dwell times from January 1999 to April 2004 are presented in Table 3. Average secondary rail

[1]Average secondary rail market prices are the average of bids and offers for guaranteed service for up to six months prior to the delivery period.

market price has a significant negative correlation with both grain train speed and overall train speed (r(67)= -0.56, p=0.0001; and r(67)= -0.36,p=0.0001). As expected, the relationship between grain train speed and secondary rail prices is stronger than that between overall train speed and rail prices. These significant relationships offer evidence that train speed is an acceptable proxy indicator of rail service, compared to price, in the current month. As train speeds decline, an increase in prices is expected.

Table 3. Correlation Among Monthly Rail Service Measures, between January 1999 and April 2004*

Rail Service Measure	Average Secondary Rail Market Price	Average Grain Train Speed	Average Overall Train Speed	Average Terminal Dwell Time
Average Secondary Rail Market Price	1.0000	-0.5639 (0.0001)	-0.3578 (0.0029)	0.4161 (0.0006)
Average Grain Train Speed	-0.5639 (0.0002)	1.000	0.5640 (0.0001)	-0.6583 (0.0001)
Average Overall Train Speed	-0.5003 (0.0001)	0.5640 (0.0001)	1.000	-0.4145 (0.0005)
Average Terminal Dwell Time	0.4161 (0.8749)	-0.6583 (0.0001)	-0.4145 (0.0005)	1.000

p-values are in parentheses

*average terminal dwell time is only available from December 2000-February 2004

Average dwell time also has the anticipated relationship with secondary rail market prices, as a moderate, positive relationship exists between the two measures of rail service (r(67)=.42, p=0.0006). Increasing dwell times are associated with subsequent increases in secondary rail market prices. The positive relationship between average dwell time and the average grain train and overall train speeds should be noted. The strength of these two relationships, with a correlation coefficient of (67)= -0.66, p=0.0001; (r(67)= -0.41, p=.0005), respectively, suggests that grain speed train speeds are tied more closely to dwell time increases and decreases than overall train speeds. The strength of this relationship suggests that as system-wide dwell times are increasing, trends are likely to be detected or eminent in declining grain train speeds. The closer relationship between the grain train and dwell time may be attributed to less time sensitivity of these shipments relative to other railroad cargo such as just-in-time inventory and perishables. These parameter relationships tend to support the idea that a change in either dwell time or train speed is likely to be associated with a change in the other. In addition, based on these simple bivariate correlations, as dwell times increase, grain trains are likely to experience relatively more delay on the rail freight system than other trains.

All of these relationships suggest that the average secondary rail market price is likely to serve as a useful measure of rail grain service. As noted previously, an advantage of secondary rail market prices over other measures is that prices may exist for up to six months in advance of train delivery. The significant relationship with system dwell time and train speeds suggest these measures may be valuable supplements or proxies, in the absence of the secondary rail market prices, as indicators of rail grain service. An understanding of the relationships between current and future secondary rail market prices and market factors will provide additional insight into future rail service availability. The following section explores relationships between various factors influencing the supply and demand for rail grain service and the secondary rail market price service measure.

Rail Service Models

A statistical representation of rail service is developed in the following section to gain insight into market factors. One could model the price of railroad service through a system of structural supply and demand equations. As a next best option, rail price could be specified as a reduced form function of a vector of exogenous supply and demand characteristics. However, we do not pursue either of these approaches because the secondary rail market price is not the full rail price. The secondary rail market price is a shorter-term fluctuation in the longer-term tariff price. This fluctuation is determined by the supply and demand conditions in the rail grain market.

Our approach is to estimate a reduced form equation of the secondary rail market price as a function of rail grain demand factors and factors influencing the supply of rail grain service. Shorter-term grain demand factors are defined as outstanding export grain sales and new export grain sales. Domestic demand is not included as a factor because of a lack of temporal data and its more stable nature. The grain products are limited to the three major commodities in this analysis—corn, wheat, and soybeans. Factors influencing the supply of rail grain service include rail grain equipment availability such as hopper cars online, and economic and industry parameters like manufactured goods orders that may suggest trends in the derived demand for transportation service, and total ton-miles that may potentially impact macro locomotive power and labor availability.

Two models are defined for this analysis. The first model is defined to estimate the relationship between current secondary rail market price and market parameters. This model is valuable in understanding rail grain service in the current shipping period, and identifying information that may best proxy secondary market prices in measuring rail grain service. The second model is defined to better understand parameters that may be leading indicators for rail grain service. The relationships identified in this model will provide insight for identifying market phenomenon that may signal oncoming rail grain service level changes.

Average monthly secondary rail market price is included as the dependent variable in the rail service model for the current month. A simple average is used because of a lack of information for weighting observations among the bids and offers in the auction months for a bidding period that may begin up to six months in advance of the delivery date in the data set. The model is defined as:

$$PREM_t = \beta_0 + \beta_1 OUTS_t + \beta_2 DWELL_t + \beta_3 GRAINSPEED_t + \beta_4 GCI + \varepsilon_t$$

where,

$PREM_t$ =	the real average premium/discount for guaranteed service during the current month, from January 1999 to April 2004
$OUTS_t$=	the average weekly tons of outstanding U.S. export grain sales during the current month
$DWELL_t$ =	the average Class I railroad dwell time for the current month, weighted by cars online
$GRNSPD_t$ =	the average Class I railroad grain train speed for the current month, weighted by grain cars online
GCI=	grain capacity index

The monthly average of the weekly outstanding grain sales parameter (OUTS) is expected to have a positive relationship with average secondary rail market price. As higher volumes of completed corn, wheat, and soybeans sales remain on the books for future shipment, the market builds expectations regarding the demands that will be placed on the rail industry in repositioning these grain stocks from inland producing regions to coastal export positions. As expected rail service demand increases, the secondary rail market prices rise. Export sales (SALES) for the current month was also considered as a demand variable but, as expected, it did not have a statistically significant relationship with current secondary rail market prices. Typically, the minimum lag between a grain export sale and actual shipment is 30 days.

Regarding rail supply parameters, system dwell time (DWELL), grain train speed (GRNSPD), and a grain capacity index (GCI) are included in the model. Dwell time is expected to be positively related to secondary rail market price. As dwell times increase, the rail market prices rise in reaction to the relatively lower levels of available rail capacity. The price increases signal service constraints and indicate declining rail grain service levels. More specific to the grain sector, grain train speed is also as indicator of rail service. A positive correlation exists between grain train speed and rail service, as measured by the monthly average secondary rail market prices. As grain train speeds increase, capacity is expected to be positively impacted and reflected in lower rail service prices as an indicator of better rail grain service. Grain capacity index is a ratio of current month rail grain capacity to the average rail capacity in 2001. The grain capacity is calculated as individual rail carrier's hopper cars online multiplied times train speed, then divided by the rail carrier's dwell time index. The dwell time index is a ratio of the current month dwell time to the average dwell time during 2001. The grain car capacity index trends are illustrated in Figure 5, with capacity increasing through early 2002, then reversing through mid 2004. The most recent months in the index suggest the grain rail capacity downward trend has reversed.

A second model is developed to assess parameters as leading indicators of rail grain service. To the degree that relationships are identified, these market parameters may offer insight regarding future rail grain service levels. The specific model used to estimate weekly secondary rail market prices is:

Figure 5. Grain Capacity Index for Class I Railroads, January 1999 to September 2004

$$PREM_{it} = \beta_0 + \beta_1 OUTS_{t-1} + \beta_2 SALES_t + \beta_3 ORDERS_t + \beta_4 TMILES_{it} + \beta_5 HOPPER_{it} + \beta_6 UP + \varepsilon_{it}$$

where,

$PREM_{it}$ =	the real premium/discount for guaranteed service on railroad i as bid during the current week for one, two, or three months into the future
$OUTS_{t-1}$=	the total tons of outstanding U.S. export grain sales for the previous week (corn, soybeans, and wheat)
$SALES_t$ =	total tons of U.S. export grain sales for the current week (corn, soybeans, and wheat)
$ORDERS_t$ =	total real dollar value of manufactured goods orders for the current month
$TMILES_{it}$ =	total ton-miles on railroad i for the current quarter
$HOPPER_{it}$ =	total hopper cars on line for railroad i during the current month
UP (=1) =	dummy variable for the Union Pacific Railroad

The total tons of outstanding export grain sales from the previous week and the new export grain sale tons are the total amount of grain that needs to be exported as of this week. Larger amounts of upcoming exports mean more rail traffic, holding other factors constant. Thus, each of these variables is expected to have a positive influence on secondary rail market prices bid for future months.

Manufactured goods orders represent manufactured goods that have been ordered but not yet shipped. To the extent that manufactured goods are shipped by rail or to the extent their shipment on an alternative mode shifts other products to rail, an increase in orders suggests an increase in future rail demand. Thus, ORDERS is expected to have a positive influence on secondary rail market prices bid for future months.

Quarterly ton-miles represent the total ton-miles shipped on the railroad for the current quarter. These ton-miles include grain and manufactured ton-miles as well as other ton-miles. To the extent that the demand for grain shipments and manufactured shipments are controlled by the previous three measures, ton-miles represent all other traffic. Ton-miles are also expected to have a positive influence on secondary rail market prices, as they suggest more overall demand for rail service. While including export sales of other products, such as coal, would be preferable to including ton-miles, such data are not available. Ton-miles for the quarter include future shipments, and thus do not have the predictive power that other variables do, but it is included primarily as a control variable.

Hopper cars online partially represent the availability of grain-carrying equipment on the railroad's system. To the extent that hopper cars online serve as a proxy for the ability to get grain service, we would expect more equipment availability to have a negative influence on prices for future months.

These models estimate secondary rail market prices for guaranteed service for the BNSF and UP railroads from January 1999 through April 2004. The following section presents empirical results.

Empirical Results

The results of the current month secondary rail price model are presented in Table 4. The explanatory power of the model is acceptable with an R-squared of 0.61, and parameters having the expected relationship with the dependent rail service variable. The average BNSF and UP monthly secondary rail guaranteed service prices ranged from a low of -$149 to a high of $231 during the January 1999 to April 2004 study period. Based on the range of these bids and offers, average weekly rail prices in the OLS estimation ranged from -$47 to $86.00 with an average price of -$2.81 per car.

Outstanding export sales of grain for the current month, including corn, soybean, and wheat sales that have been reported but not shipped, is the most influential parameter in the rail service estimation. Reported average monthly export sales one standard deviation of 3.6 million tons above the 16.9 million ton mean is associated with a $14.82 increase in the secondary rail market price, with other parameters held constant at their mean values. This amount is about a five-fold increase over the average estimated rail market price.

Table 4. OLS Estimation of Current Rail Service, as Measured by Monthly Secondary Rail Market Prices

Parameter	Coefficient Estimate	Standard Error
$Intercept_t$	233.62766	147.03025
$GRNSPD_t$	-9.74889*	4.34718
$DWELL_t$	3.23874**	1.19613
$OUTS_t$	0.00000409**	0.0000007
GCI_t	-199.7751**	77.0315
	R^2 = 0.6108	
	F = 24.44	
	N=66	

*Significant at the 1 percent level; **Significant at the 5 percent level

The two grain-specific supply-side parameters, the grain train speed and grain capacity index, are also significant factors in the rail grain service estimation. The relative influence of each is found to be smaller than for the outstanding export sales demand variable. Grain train speed one standard deviation below the mean is associated with a $7.91 increase in secondary rail market prices, holding other factors constant. A decreased grain capacity index of one standard deviation is accompanied by a $6.81 increase in the rail price, with other factors held at their mean.

The final supply parameter is the system dwell time. An increase in average system dwell time for the month of one standard deviation of 2.82 hours is associated with a $7.40 per car increase in the rail price service measure, holding other variables constant. These estimates indicate that system dwell time has less influence on rail grain service than grain train speed, considering the supply parameters included in this analysis.

The current secondary rail market price model results offer evidence that both demand and supply factors should be considered in discussing current rail grain service. Outstanding export grain sales is identified

as most influential among the model parameters. Fluctuations in outstanding export grain sales are associated with the largest changes in rail service levels, considering distribution of values for this parameter over the study period, relative to other parameters. Supply-side factors, including the grain capacity index, system dwell time, and grain train speed, are each also relevant but less important, respectively, as individual determinants of rail grain service.

Table 5 presents the estimated secondary rail market price model for guaranteed service one, two, and three months into the future. In the rail grain service model results for one month in advance, all independent variables have their expected signs and all but one are significant at conventional levels.

Table 5. OLS Estimation of Rail Grain Services One, Two, and Three Months into the Future, Measured by Weekly Secondary Rail Market Prices

Variable	One Month into the Future	Two Months into the Future	Three Months into the Future
Intercept	-667.1820*	-676.3946*	-659.1044*
	(97.6350)	(71.4252)	(58.9001)
$SALES_t$	0.000003	-0.0000006	-0.000002
	(0.000003)	(0.000002)	(0.000002)
$OUTS_{t-1}$	0.000005*	0.000003*	-0.0000005
	(0.0000007)	(0.0000006)	(0.0000005)
$TMILES_{it}$	0.000004*	0.000004*	0.000004*
	(0.0000005)	(0.0000004)	(0.0000003)
$ORDERS_t$	0.0004**	0.0006*	0.0008*
	(0.0002)	(0.0001)	(0.0001)
$HOPPER_{it}$	-0.1119*	-0.0815*	-0.0716*
	(0.0135)	(0.0114)	(0.0094)
UP	-14.5988*	-11.8676*	-14.3191*
	(5.5841)	(4.3662)	(3.6005)
	Adjusted R^2 = 0.4017	Adjusted R^2 = 0.3814	Adjusted R^2 = 0.3183
	F = 46.66	F = 48.38	F = 36.87
	N=408	N=461	N=461

Standard Errors in parentheses
*Significant at the 1 percent level; **Significant at the 5 percent level

Total outstanding export grain sales from the previous week and new export grain sales both have a positive sign, although new export grain sales are not statistically significant. These findings suggest that some insight into the future of rail service availability may be gained by examining outstanding and new export grain sales. A large amount of grain export sales outstanding and new export sales suggest that rail availability is likely to be tight in one month.

Manufactured goods orders also have an important influence on secondary rail market prices for guaranteed service one month into the future. As expected, the positive and statistically significant

parameter estimate suggests that an increase in orders for manufactured goods will increase prices for guaranteed service in one month.

Similarly, ton-miles have a positive and significant impact on secondary rail market prices for one month into the future. The positive and significant impacts of ton-miles and manufactured goods orders both suggest a need to look at non-grain data in addition to grain data when examining the likely future availability of rail service for grain shippers. For example, an announced major build-up of coal inventories at power plants will provide information as relevant for assessing the future availability of rail grain service as will an announced major wheat export sale.
Finally, hopper cars online are shown to have a statistically significant negative impact on rail grain prices for guaranteed service in one month. As expected, this proxy for the availability of rail grain equipment suggests that prices will be down when more equipment is available.

Table 5 also includes the estimated secondary rail market price model for expected service levels two months into the future. All independent variables but one have their expected signs, and only the one with the unexpected sign is not significant at conventional levels.

Not surprisingly, our ability to explain secondary rail market prices in two months with this model is not quite as good as our ability to explain prices in one month. In addition to having a slightly lower adjusted R-squared, this model also has an unexpected sign on the current week's export grain sales (though it is not significant). However, all other variables are still significant at conventional levels and have their expected signs. This model is encouraging, as it suggests that one may be able to make a reasonable assessment of rail grain availability in two months using the same data used to assess grain availability in one month.

The estimated model for secondary rail market prices for guaranteed service three months into the future is also presented in Table 5. As the table shows, the model is not as well-equipped to explain secondary rail market prices three months into the future as it is to explain secondary rail market prices one or two months into the future. In this model, outstanding export grain sales and weekly export grain sales have an unexpected sign and are not significant at conventional levels. However, all other variables have their expected signs and are statistically significant. This may provide further support for the idea that non-grain variables are very important measures to examine in assessing the future availability of rail grain service.

SUMMARY AND IMPLICATIONS

This paper has examined publicly available data sources for assessing rail grain service availability. The paper showed strong correlations among secondary rail market prices for guaranteed service, train speed, and train dwell times. These correlations suggest that any of these variables might be used as a reasonable proxy for the availability of rail grain service. However, the added advantage of secondary rail grain prices is that they are available for future time periods. Thus, secondary rail grain prices may provide insight into the likely future availability of rail grain service.

The paper also presented statistical models to explain secondary rail market prices for guaranteed service in the current month, as well as one, two, and three months into the future. The model showed that outstanding grain export sales is a critical factor in discussing current rail grain service, as well as anticipating future service changes. The models also support ideals to present a broader view of the market by supplementing rail grain data with a range of economic and rail industry data. Market parameters including export grain sales, manufactured goods orders, total rail ton-miles, system dwell times, and grain hopper cars online all have an influence on secondary rail market prices.

In estimating the secondary rail market prices for one, two, and three months into the future, the importance of non-grain variables becomes apparent. The non-grain variables are shown to be statistically significant in explaining prices in all three estimations. Moreover, in estimating prices three months into the future, the non-grain variables are still statistically significant, while outstanding and current export grain sales are not significant. This suggests that the current convention of primarily examining grain data only should be reconsidered.

REFERENCES

American Association of Railroads. 2004. *Railroad Performance Measures*. Accessed October 21, 2004, at www.railroadpm.org.

Athavaley, Anjali. 2004. The Little Engine that Couldn't, *Houston Chronicle*, Houston, Texas, Jul. 10: 1.

Bitzan, John, Doug Benson, Tamara VanWechel, and Doug Benson. 2003. The Importance of Short-Line Railroads to Rural and Agricultural America, Upper Great Plains Transportation Institute, North Dakota State University, DP-152.

Dininny, Shannon. 2004. Export of Wheat Held up by Rail Shortage, *Columbian*, Vancouver, Washington: Dec. 5: C.2.

Hare, Mary. 2003. New Crop Transport Service Amounts to Hill of Beans, *The Sun*, Baltimore, Maryland, Nov. 18: 3.B.

Gallagher, John. 2003. *Rail's Crew Cuts*, Traffic World, Nov. 10: p. 1.

Kilman, Scott and Daniel Machalaba. 2003. *Railroad Logjams Threaten Boom in the Farm Belt*, Wall Street Journal, New York: A.1.

Knight, Frank. 1921. *Risk, Uncertainty, and Profit*. Hart, Schaffner & Marx; Houghton Mifflin Company, Boston, MA.

McLaughlin, Tim. 2004. Missing out on the Gravy Train, *St. Louis Post-Dispatch*, St. Louis, MO., Jul. 16: A.1.

Surface Transportation Board. 2002. *U.S. Public Use Waybill Sample: 2002*, U.S. Department of Transportation, Washington, D.C.

U.S. Department of Agriculture, Agricultural Marketing Service, Livestock and Seed Programs, Livestock and Grain Market News. 2004a. *Grain and Feed Summary and Statistics*. Washington D.C., various issues, 2000 to 2004.

U.S. Department of Agriculture, Agricultural Marketing Service, Transportation Services Branch. 2004b. *Grain Transportation Report*, various issues, accessed November 18, 2004, at http://www.ams.usda.gov/tmdtsb/grain/.

U.S. Department of Agriculture, Agricultural Marketing Service, Transportation Services Branch. 2003. *Transportation of U.S. Grains, A Modal Share Analysis 1978 to 2000*, accessed at www.ams.usda.gov/tmd/tsb/Modal_Share.pdf.

U.S. Department of Agriculture, World Agricultural Outlook Board. 2004. *World Agricultural Supply and Demand Estimates*, accessed October 7, 2004, at usda.mannlib.cornell.edu/usda/reports/waobr/wasde-bb/2004/.