The barge and rail freight market for export-bound grain movement from midwest to Mexican Gulf: an econometric analysis

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Abstract

An econometric model of the barge and rail freight market is developed so that factors which influence barge and rail rates for export-bound grain from Midwest to Mexican Gulf can be better understood. Three-stage least squares method is used to estimate the system of four equations that constitute the model. A number of identified factors turned out to be significant in determining grains rail and barge transportation rates. Given the interactive nature of supply and demand processes it is difficult to pinpoint a single most important factor. Yet it is clear that a substitute nature of the two transportation modes in addition to direct price-quantity relationship determine most of the transportation rates. © 2000 Elsevier Science Ltd. All rights reserved.

1. Introduction

The United States is one of the largest producers of grain and oilseeds in the world, with corn, soybeans, and wheat the most commonly grown crops. In terms of world output, the US is the leading producer of the of the first two commodities and is surpassed only by China in the production of wheat. In 1994, a combined total of 388.3 million metric tons of these three crops were harvested in the US (FAO Production Yearbook, 1995). 1

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1 The US has retained its leading role as world’s leading producer and exporter in more recent years. The numbers from 1994 are chosen because the period analyzed in the paper is 01:1986-11:1995.
In addition to satisfying its own needs, the US exports a large amount of grain in order to meet foreign demand. Approximately 4.3 million metric tons of soybeans, 32.1 million metric tons of wheat, and 35.9 million metric tons of corn were exported in 1994 (FAO Trade Yearbook, 1995). Asia (especially Japan, South Korea, and Taiwan) and the European Community are the primary purchasers of US grain. Shipments are carried by ocean freight from several locations in the US, originating from the Gulf of Mexico, Pacific Northwest, Great Lakes, or Atlantic Coast. Grain is transported to these locations by either rail, truck, or barge. The export port at which the grain arrives depends on the transportation rate to each location, ocean freight rates, and the cash commodity price at the port and interior points. Changes in these variables cause shippers to divert movements to other destinations and thus alter the flow of grain.

Export-bound movements of corn and soybeans are usually sent to the Gulf due to its geographic position relative to the Midwestern grain producing region. Barge transportation is popular because the majority of the two crops are grown in the central portion of the country, and shippers exploit the proximity of the Mississippi River. Barge service is relatively inexpensive compared to rail for long hauls to the Gulf.

The amount of barge usage is determined by the actions of buyers and sellers in a market situation in which both parties use relevant information to establish an equilibrium rate and level of service. Following the Staggers Rail Act of 1980, which resulted in the deregulation of rail rates and which brought to an end the practice of publishing rates by rail company, bilateral negotiations between rail companies and shippers determined rail rates. There are several reasons for wanting to accurately identify the factors which influence the supply of, and demand for, barge and rail service and to better understand how these determinants affect rates. From the perspective of shippers and receivers, transportation charges comprise a large portion of their costs. Uncertainty about changing rates make it difficult to decide when to ship grain and to maximize revenue. Understanding the driving forces behind the rates would enable shipping and receiving firms to plan a more effective strategy by better gauging supply and measuring demand variables. Barge and rail firms would also benefit from this knowledge because they might be able to provide more adequate service at peak times, and reduce costs when demand was not as strong.

Grain transportation rate structures have been studied using a variety of methods, ranging from descriptive analysis to mathematical programming and econometric modeling. Traditionally, this has been an area of great interest to economists because of changes in the regulation of rail and barge transportation systems. A comprehensive review of major work in this area during the 1970s and early 1980s can be found in Hauser (1985, 1986) or Price (1996). A number of econometric analyses on grain transportation rates have appeared in the literature during the past 15 years; e.g., Koo and Uhm (1984); Viscencio-Brambila and Fuller (1987) and Wilson et al. (1988). MacDonald (1987, 1989) attempted to gauge the level of inter-rail competition. Thompson et al. (1990) used the ratio of rate-to-variable costs as a measure of intermodal competition, and attempted to define its determinants for export-bound corn and wheat shipments before and after the passage of the Staggers Rail Act of 1980. Fuller et al. (1990) estimated the effects of contract disclosure on rail rates for wheat shipments in the Central and Southern Plains States. McMullen et al. (1989) investigated the impact of grain contracts on rail rates for wheat shipments from the Pacific Northwest. Koo et al. (1993) chose grain and oilseed shipments from North Dakota to the Pacific Northwest by rail to analyze pricing in captive markets. Finally, some recent work in the area emphasized the importance of the issue for US agriculture (Fruin, 1995; Fruin and Halbach,
1995). It should be noted that most of the past work has dealt with rail transportation, most likely due to a lack of data related to barge transportation.

The objective of this study is to develop an econometric model of the barge and rail freight market so that factors which influence barge and rail rates for export-bound grain from Midwest to Mexican Gulf points can be better understood. The factors which influence the supply of and demand for barge and rail service are identified, and a four-equation simultaneous system (i.e., two pairs of supply and demand equations) is developed. After gathering historical data on the variables, the model is tested and the results are compared with initial expectations to help determine if the model accurately depicts the barge and rail industries. This study covers the time period (01:1986-11:1995) in which concentration processes dominated railroad industry (mergers, purchases, acquisitions) after policy makers tried to deregulate the rail rates (Staggers Rail Act or SRA). All previous studies covered period prior to the SRA or pre- and post-SRA period combined. This study covers the post-SRA era only and it is the first one that covers a time period long enough to make statistically valid inferences. Also, this is the first study that looks at bimodal competition for transporting the export-bound grains after the deregulation of the railroads.

2. Data

Historical barge freight data was obtained from the US Army Corps of Engineers’ statistics on waterborne commerce and was provided by the Agricultural Marketing Service, an agency of the US Department of Agriculture. The information noted the volume of grain, feed products, and fertilizer shipments (all in metric tons) from 1980 to 1995. Tonnage was aggregated by month and commodity, as well as by shipping and receiving region. Unmilled grain movements were denoted for barley and rye, corn (maize, not including sweet corn), oats, wheat (including spelt and meslin), sorghum, and soybeans. There were also several classifications of feed products and fertilizers. However, they were not relevant to the objective of the study. Point of origin and destination were grouped into 18 regions and covered all domestic waterway systems. Only corn, soybean, and wheat shipments from the Illinois River to the Gulf region were used.

Spot barge rates for grain shipments along the Illinois River to the Gulf were obtained from the weekly newsletter entitled ‘‘Merchandisers Fact Sheet”, published by MID-CO Commodities between 1982 and May of 1995. Barge rates are expressed as percent of tariff. The weekly figures given in the newsletter were averaged on a monthly basis. This same publication also provided nearby barge rates for shipments originating at midpoints along the Mississippi River. These rates were quoted for a particular day as opposed to a weekly average. Loadings were expected to take place within thirty days, and the rate applied to all loading points along the river. However, the series was not continuous because portions of the Mississippi were impassible due to river freezing. Since the non-navigability along these sections was an annual occurrence, rates were not published from December to February. As a result, the Illinois River rates were used as a proxy for the Mississippi River during these months. This substitution was thought to be acceptable because changes in barge rates along the Illinois River would reflect the same fluctuations which

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\[1\text{ MID-CO Commodities is a subsidiary of GROWMARK.}\]
were felt throughout the entire Mississippi River system. Also, there were no barge rates quoted between July and August of 1987, whereupon estimates were generated.

Export data was obtained from Grain and Feed Market News, a publication of the US Department of Agriculture. The three variables of interest were the Pacific Northwest-Gulf corn price spread, total exports (in tons) from the Gulf, and total exports (in tons) from the Pacific Northwest, including British Columbia.  

The price spread variable was represented by corn rather than the other crops because a significant quantity of corn moved through ports in both regions. The offers were for deliveries at a port elevator, and shipment was to occur within 30 days. The spread between the two cash prices were computed by subtracting the Gulf price from that of Pacific Northwest. We believe that using the price spread is more appropriate than using the Gulf price because shippers may decide to postpone their shipments (or selling their grains) if the Gulf price is relatively low compared to the Pacific Northwest price and vice versa. The export variables represent exports of wheat, corn, and soybeans from the respective ports to the rest of the world. All export data were reported as weekly shipments, and were subsequently averaged on a monthly basis. These monthly export figures begin in January 1986 and extend through November 1995.

Data on rail movements was provided by the Agricultural Marketing Service, Transportation and Marketing Division. The variables of interest were rail rates ($/ton-mile), tonnage shipped, and the origin and destination points. The data source for these variables is the annual Carload Waybill Sample for 1981–1995. The annual Waybill Sample contains shipment data from a stratified sample of rail waybill submitted by freight railroads to the Interstate Commerce Commission (ICC). Each year’s data set contains over 100,000 observations, which were sorted by month, commodity type, origin and destination point. The commodities of interest were wheat, corn, and soybeans. The origin point of interest was the Midwestern state of Illinois. The selected destination points were the Gulf States. From this subset of the Waybill data, the rail rate and tonnage time series Illinois (IL) to Gulf (GU) were generated.

The time coverage of each variable series was not equal, requiring that some of the observations be discarded. As a result, the set of usable observations was limited to January 1986–November 1995.

3. The model

The model consists of two pairs of demand and supply equations. The first pair represents the barge industry. In particular, the demand and supply equations for barges transporting corn, wheat, and soybeans from IL to GU are considered. The second pair represents the rail demand and supply equations for the same commodities and regions (i.e., origin and destination). Note that in addition to these demand and supply equations, each market or demand–supply pair is accompanied by an equilibrium condition equation which equates demand and supply. However, the equations that are estimated econometrically are the two sets of demand and supply equations.

3 Notice that the exports from the Pacific Northwest were used only as one of the instruments in estimation procedure and were not a part of the model.
The demand side of the model involves determining those factors which affect barge or rail usage. The most obvious factors are barge and rail rates, with the law of demand implying that there exists an inverse relationship between rates and the demand for barge or rail services, *ceteris paribus*.

Exogenous factors or variables that shift the demand curves are the competing transportation modes themselves. For instance, the rail and truck industry compete with the barge industry for a share of the grain transportation market. Rail is more competitive than the truck industry due to realized economies of distance. As trip length increases, the rail rate per ton-mile decreases because fixed costs are spread out over greater mileage. It is assumed that as rail rates decrease, grain merchandisers will substitute the cheaper rail transportation for barge service. As a result, less grain is carried by barge, and the demand for barges shifts to the left, thereby reducing barge rates at each level of service.

Export-related variables are also extremely influential in determining barge and rail rates since they represent a measure of foreign demand. The impact of higher export levels depends on the point of origin of ocean freight shipments. For instance, increased movements from the Gulf raise the level of barge and rail demand and shift these curves to the right because more grain is transported down the Mississippi River and by rail to Gulf.

Seasonality also plays a role in determining demand. For example, grain shipments (and therefore barge and rail demand) increase during the harvest season and decrease thereafter. As a result, demand and rates go up and then fall back down again after production is complete. Some argue that export volume exhibits seasonal patterns; however, even if this is true, the rate effects caused by these fluctuations are captured by the export variables.

In the case of supply, barge and rail rates are also determined by the level of usage. According to economic theory, there is a direct relationship between the two variables. That is, as rates increase, the quantity of barges and rail cars supplied will rise.

Other determinants are operational costs, opportunity costs associated with shipping other commodities (e.g., coal, chemicals, and fertilizers), and seasonal effects due to weather and the demand for other commodities. Higher total costs reduce supply and raise rates for each level of service provided because they make it relatively more expensive to supply the same level of service. However, the extent to which barge and rail firms are able to raise rates depends on the degree of intra- and inter-modal competition. A highly competitive environment will significantly limit rate increases and may not allow them to rise at all.

Seasonal effects are expressed through natural occurrences such as floods, droughts, and freezes that limit barge transportation, and through high demand for other commodities such as coal, chemicals, and fertilizers which use both barge and rail services.

Lagged dependent variables are used as independent variables in both demand and supply equations. This is done because the entire previous path of the barge and rail rate and quantity variables and disturbances, not just their current values, determines the current value of the dependent variables. The quantity of grain transported is related to past decisions on whether all of the contracted grain was transported during previous month or not. These delays may happen due to some weather related problem or unavailability of rail cars or barges at the time. Also, in cases of both rail and barge rates the argument about price rigidity, i.e., prices do not adjust instantaneously to exogenous shocks, is valid. Finally, the expectations on rates and quantities that involved parties may have play a role as well.
The simultaneous system of four equations is shown in Table 1. Eqs. (1) and (3) represent the demand for barge transportation of grains and rail transportation of grains from IL to GU. Eqs. (2) and (4) represent the corresponding supply equations.

Note that the spot barge rates agreed upon on a given day apply to grain shipments which will be loaded within thirty days. Because barge service contracts can be confidential, the actual amount carried is not observed until it arrives and is inspected at the Gulf. As a result, an additional three to four weeks of travel must be accounted for during the interim between loading and inspection. Therefore, there is a one to two month lapse from the time rates are set to when the grain arrives at the Gulf. The number of lags between barge rates and barge shipments in Eqs. (1) and (2) is then set in accord with the two-way Granger causality test results. Similar timing considerations apply to the case of rail rates, although the travel time is not as long as in the case of barges. The number of lags between rail rates, and rail rates and barge rates is in accord with the Granger causality test results.

The export demand variables, GUEX and PWEX, are recorded in the period \( t \), just like the barge and rail quantities supplied. Note that most grain shipments delivered to export ports are promptly loaded on the ocean ships. It is intuitive that barge and rail rates need an adjustment period to respond to changes in export price. The spread variable lag is determined based on results of the Granger causality test (Hauser et al., 1998).

4. Methodology and results

Three-stage least squares (3 SLS) is used to estimate the previously defined system of four equations (Judge et al., 1980; Greene, 1990). After the theoretical considerations are made to
justify the specification of the model, the econometric diagnostic analysis is conducted to confirm the validity of the theoretical arguments (Myers, 1994). Note that the estimation of the model using 3 SLS requires the econometrician to be fairly certain of the model specification because parameter estimates are asymptotically efficient if and only if the model is correctly specified. The Chi-squared statistics (equivalent to the F-test in a single equation estimation) suggest that the model specification is appropriate (Greene, 1990, p. 639). The dynamic homoskedasticity test (ARCH test which is asymptotically distributed as chi-squared with one degree of freedom, Engle, 1982) does not suggest the presence of heteroskedasticity. Finally, the Durbin h-statistic is used in testing for autocorrelation due to the presence of dependent lagged variables in the equations. The standard DW statistic is biased toward rejecting the presence of autocorrelation in such cases and therefore should not be used. The regression results do not provide any evidence of autocorrelation in any of the equations.

The regression results, with the estimated coefficients and corresponding $t$-values, are found in Tables 2 and 3. The results reported in Table 2 include the estimated coefficients of the seasonal variables (quarterly dummies). All seasonal variables are included in the model. Although not all of the seasonal variables were statistically significant, none were excluded from the estimation. Notice that the system is estimated in the log–log form which implies that all estimated coefficients represent elasticities (flexibilities). The results of the model are summarized below.

**Demand equations:**

- The expected inverse relationship between price and quantity is evident in the barge demand equation (1), where the coefficient associated with the quantity variable $ILGB_{t+1}$ is negative and statistically significant. The same relationship is present but is not statistically significant in the rail demand equation (3).

- Rail demand equation (3) is positively influenced by the barge rate, $BRAT_t$. This result implies that as barge rates increase, merchandisers will substitute rail for barge, shifting the demand curve for rail service outward and increasing the rail rate at all levels of service. This coefficient is not statistically significant. However, the substitute relationship between rail and barge transportation is also confirmed in the barge demand equation, where there is a positive, statistically significant relationship between the barge rate and the price of rail service to the GU.

- None of the demand equations are significantly influenced by the level of export shipments from the major ports, nor is there an apparent statistically significant relationship between barge and rail demand and the Pacific Northwest to Gulf corn price spread.

- Lagged dependent variables are statistically significant in both demand equations indicating that previous values and disturbances significantly determine the current values of the dependent variables. An increase in barge and rail rates induces further growth in these variables in subsequent period.

- Seasonality dummy variables are all statistically insignificant.

**Supply equations:**

- The expected positive relationship between price and quantity appears in both supply equations. This relationship, however, is statistically significant in the rail equation only. The coefficients indicate elasticities of a plausible and expected size. Since the same railroad cars may be used for grain transportation in different regions, the supply in the rail equation is more elastic. In other words, railroads may behave in a more opportunistic way than barge shippers.
In both supply equations, the level of export shipments from the destination port is positive but not statistically significant.

Lagged dependent variables are statistically significant in both supply equations indicating that previous values and disturbances significantly determine the current values of the dependent variables. An increase in shipments of grains by barge and rail induces shippers to further increase supply of barges and rail cars in subsequent period.

The seasonal coefficients vary in sign, and do not indicate a consistent pattern.

Table 2
Estimated results from the simultaneous equation model (with seasonal dummies included)

<table>
<thead>
<tr>
<th>Variables</th>
<th>BRAT, (1)</th>
<th>Dependent variables (Eq. #)</th>
<th>PILG, (3)</th>
<th>ILGT, (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_0$</td>
<td>2.832</td>
<td>(0.644)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_1$</td>
<td>4.158</td>
<td>(0.515)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_2$</td>
<td>1.427</td>
<td>(0.675)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_3$</td>
<td></td>
<td></td>
<td>-5.920</td>
<td>(-1.226)</td>
</tr>
<tr>
<td>BRAT$_t$</td>
<td>0.625</td>
<td></td>
<td>0.104E-01</td>
<td>0.457E-01</td>
</tr>
<tr>
<td>BRAT$_{t-1}$</td>
<td>0.683</td>
<td>(4.038)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ILGB$_{t-1}$</td>
<td>-0.485</td>
<td>(-3.751)</td>
<td>0.638</td>
<td>(3.164)</td>
</tr>
<tr>
<td>PILG$_{t-2}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PILG$_t$</td>
<td>1.335</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PILG$_{t-1}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ILGT$_{t-1}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GUEX$_{t-2}$</td>
<td>-0.162</td>
<td>(-0.450)</td>
<td>0.177</td>
<td>(0.266)</td>
</tr>
<tr>
<td>Spread$_{t-2}$</td>
<td>-0.234</td>
<td>(-1.232)</td>
<td>-0.338E-01</td>
<td>(-0.594)</td>
</tr>
<tr>
<td>Quarter2$_t$</td>
<td>0.158</td>
<td>(0.252)</td>
<td>-0.319E-01</td>
<td>-0.350</td>
</tr>
<tr>
<td>Quarter3$_t$</td>
<td>0.498</td>
<td>(0.429)</td>
<td>-0.848</td>
<td>(-2.104)</td>
</tr>
<tr>
<td>Quarter4$_t$</td>
<td>0.359</td>
<td>(0.821)</td>
<td>-0.172</td>
<td>(-0.466)</td>
</tr>
</tbody>
</table>

- In both supply equations, the level of export shipments from the destination port is positive but not statistically significant.
- Lagged dependent variables are statistically significant in both supply equations indicating that previous values and disturbances significantly determine the current values of the dependent variables. An increase in shipments of grains by barge and rail induces shippers to further increase supply of barges and rail cars in subsequent period.
- The seasonal coefficients vary in sign, and do not indicate a consistent pattern.

Since prices (rail and barge rates) in demand equations were dependent, and the quantities of the grain transported were independent, direct estimates of the own-price elasticities were not possible. Instead, price flexibilities were estimated. The inverse of the price flexibility of demand relative to quantity would approximate the elasticity, setting the lower limit (Tomek and Robinson, 1990). Short run flexibilities are estimated for each of the demand equations. The coefficient associated with the quantity variable in the demand equation represents the short run flexibility of
demand. In the case of barge demand the short run flexibility is \(-0.485\), while in the case of rail demand the short run flexibility is \(-0.924 \times 10^{-1}\). Both values indicate considerable elasticity of demand.

Table 3 summarizes the regression results after the seasonal dummy variables were excluded. Justification for the exclusion was that it was hard to know what exactly these dummies represented. There is a number of unmeasurable factors that have effect on the variables in the model and it is impossible to separate the effects of each individual factor. Yet, this model performed comparably to the model containing seasonal dummies. The results can be summarized as follows:

**Demand equations:**
- As in the model with the seasonal dummies, the expected inverse relationship between price and quantity is evident in the barge demand equation (1), where the coefficient associated with the quantity variable ILGB\(_{t+2}\) is negative and significant. The coefficient associated with the quantity ILGT\(_{t+1}\) variable in Eq. (3) is negative but not statistically significant.
- The IL to GU rail demand equation (3) is positively influenced by the barge rate, BRAT\(_t\). This coefficient is, however, not statistically significant. The substitute relationship is also confirmed in the barge demand equation (1), where there is a positive and significant relationship between the barge rate and the price of rail service to the GU.

<table>
<thead>
<tr>
<th>Variables</th>
<th>BRAT(_t) (1)</th>
<th>Dependent variables (Eq. #)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ILGB(_{t+2}) (2)</td>
</tr>
<tr>
<td>(x_0)</td>
<td>4.003</td>
<td>(0.938)</td>
</tr>
<tr>
<td>(x_1)</td>
<td></td>
<td>5.938</td>
</tr>
<tr>
<td>(x_2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(x_3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRAT(_{t-1})</td>
<td>0.872</td>
<td>(4.971)</td>
</tr>
<tr>
<td>ILGB(_{t+1})</td>
<td>(-0.541)</td>
<td>((-4.480))</td>
</tr>
<tr>
<td>PILG(_{t+2})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PILG(_t)</td>
<td>1.3544</td>
<td>(2.281)</td>
</tr>
<tr>
<td>PILG(_{t-1})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ILGT(_{t+1})</td>
<td>(-0.141E-01)</td>
<td>((-0.263))</td>
</tr>
<tr>
<td>GUEX(_{t+2})</td>
<td>(-0.256)</td>
<td>((-0.732))</td>
</tr>
<tr>
<td>Spread(_{t-2})</td>
<td>(-0.311)</td>
<td>((-1.764))</td>
</tr>
</tbody>
</table>

• The demand equations are not significantly influenced by any of the export-related variables. Although GUEX and Spread variables have the expected negative sign in both demand equations, only the Spread variable in rail demand equation (3) is marginally statistically significant.
• The calculated short run flexibility for demand for barge service is –0.541, indicating elastic demand.
• The coefficients associated with the lagged dependent variables were significant in both demand equations. The interpretation of these coefficients is similar to their interpretation in the unrestricted model including seasonal dummy variables.

Supply equations:
• As was indicated in the model with the seasonal dummies, the expected positive relationship between price and quantity in the supply equations appears in both barge and rail supply equations. It is statistically significant in the case of the rail supply equation only. The coefficients indicate elasticities of a plausible and expected size. Similarly as in the unrestricted model, since same railroad cars may be used for grain transportation in different regions, the supply in the rail equation is more elastic. In other words, railroads may behave in a more opportunistic way than barge shippers.
• In both supply equations, the level of export shipments from the destination port are positive and statistically insignificant.

Finally, an F-test is conducted in order to compare the unrestricted model, i.e., the model including seasonal dummies, with the restricted model. The calculated F-statistic of 9.75 indicates that jointly dependent seasonal dummies are different from zero at any standard level of significance. Therefore seasonal dummies are jointly significant in this system.

5. Conclusions

The model designed here was in an attempt to answer the question: which factors have major influence on the barge and rail rates for export-bound grain from Midwest to Mexican Gulf exporting ports. It seems, based on the results for demand equations, that these two modes of grain transportation exhibit a strong substitute relationship. That is the relationship that drives demand strongly along with the strong support for the law of demand relationship in these equations. There is a lack of statistically significant relationship between export related variables and transportation rates. The significance of lagged dependent variables indicate the importance of historical transportation rates’ behavior on their current values. It seems that seasonality plays an important but not critical role in the model. It also does not affect the relationship between transportation rates and other variables once seasonal quarterly dummies were dropped.

The export shipments seem to be a factor of minor influence in both supply equations. The level of usage or direct price-quantity relationship appears to be statistically significant only in rail supply equation. Seasonal coefficients do not indicate any clear pattern. Finally, the importance of lagged dependent variables implies that an increase in shipments of grains by barge and rail induces shippers to further increase supply of barges and rail cars in subsequent period.

A number of identified factors turned out to be significant in determining grains rail and barge transportation rates. Given the interactive nature of supply and demand processes it is difficult to pinpoint a single most important factor. Yet it is clear that a substitute nature of the two
transportation modes and direct price-quantity relationship, determine most of the transportation rates.

References


