Importance of Financial Variables on Efficiency of Class I Railroads in the United States

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Importance of Financial Variables on Efficiency Measures of Class I Railroads in the United States

Abstract

This study evaluates the consequences of financial variables on the efficiency of Class I railroads in the United States for the period 1996-2006. A panel stochastic frontier analysis is used to simultaneously estimate the stochastic frontier model and financial ratio model with output and efficiency measures as endogenous variables. Results show the average efficiency measures was 83 percent across six major class I railroads. The Burlington Northern-Santa Fe was most efficient and Norfolk Southern the least efficient for the period, 1996-2006.

Objectives

The purpose of this paper is to examine the importance of financial variables on the efficiency of Class I Railroads in the United States in a panel stochastic frontier analysis framework. Specific objectives are as follows:

1) Estimate the efficiency of Class I Railroads in the United States
2) Examine the role of financial variables affecting the efficiency of Class I Railroads

Background

Managers and owners of agribusiness firms in the United States depend on the transportation system to move much of their agricultural and food production to destination points in the domestic and export markets. The development over the years of a highly efficient and effective network of highways, railways, waterways, inter-modal facilities, ports and terminals has enabled agribusiness firm managers in the United States to serve their customers at the lowest possible cost without lowering the quality

of services and products. This continued provision of quality services and products allows agribusiness firms in the United States to be economically viable and successful in an ever increasingly globally competitive market.

One of the major participants in the United States transportation system is rail carriers, especially in the grain market. However, significant changes in modal share of rail carriers in the grain market have occurred, particularly between them and truck carriers. Based on the most recent data available, the total railroad modal shares of grain decreased from 48% in 1978 to 35 % in 2004 while truck shares increased from 30% in 1978 to 48% in 2004 (USDA, 2006). Railroads have been, and are still, very instrumental in developing many of the areas specializing in grain, although a competing mode—trucks —has taken over an increased share of that movement; railroads continue to transport large volumes of grain to long distant markets.

The modal shares of grain transport provide information on the changes in the competitiveness and relative efficiencies of railroads in meeting the transportation needs of agribusiness firms in the United States. Therefore, the major rail carriers in the United States need to become more efficient to enhance their economic performance in serving agribusiness firms in the grain industry. If the major rail carriers do not respond by becoming more efficient they may continue to lose modal shares to truck carriers especially in the grain industry. Thus, the efficiency of railroads is vital to their survival and success in the movement of grain and other agricultural and food products from production areas to destination points where they are increasingly being challenged by truck carriers to meet the transportation needs of agribusiness firms. How efficient are

the major railroad firms in the United States and what can be done to improve the current level of efficiency? This is the central question addressed in this paper.

The analysis of efficiency of the Class I Railroads in the United States provides insight into the economic performance of the carriers. The results also provide information that will be useful to policy makers for assessing the effects of public policies on the development of the transportation network that serve the grain and other agricultural industries in the United States. The results of this study provide a guideline to compare the efficiency of Class I railroads as a group and individually. For managers and owners of railroad firms, they will be able to identify areas of weakness and strengths from these guidelines to improve the frequency of making good decisions.

The railroad industry's cost structure in the short run (a period in which both plant and capacity remain constant) consists of a large proportion of indirect cost rather than variable costs. This situation exists because the railroads, along with pipelines, are the only modes that own and maintain their own network and terminals (Coyle et al 1982). In addition, the vehicles used by railroads-locomotives and rail cars-are usually provided by the carriers through ownership or leasing, although a large number of freight cars are supplied by users, for which the railroads pay users a fee based on mileage traveled-a variable cost (Harper, 1982). Three of the major cost elements borne by the railroad industry are total ways and structures, total train operations, and total yard operations.

Review of Literature

The purpose of this section is to provide information on various methods, analyses, and industries that were used for the formulating the model used in this analysis. These studies are discussed below.

Atkinson, et al, 2003 derived and estimated an input shadow distance system comprising the dual shadow input distance function and the price equations derived from the shadow cost minimization problem. Estimated shadow quantities provide direct estimates of the effect of allocative inefficiency on input usage. In this approach, one can easily calculate firm-and time varying technical inefficiency by decomposing the residuals. The authors also computed returns to scale and the cost savings obtained by eliminating both types of inefficiency. The authors illustrated this approach by using a panel of U.S. railroads. Results reveal that the average firm inefficiency over all periods is about 42%, with substantial variation from the least to the most efficient firm, which was the Denver, Rio Grande, and Western Railroad, with an average efficiency score of 0.95.

Adkins et al, 2002 used panel data to estimate a stochastic production frontier and the sources of inefficiency for a broad set of countries. A maximum-likelihood procedure was used to estimate the parameters for the stochastic production frontier and the determinants of inefficiency simultaneously. Results show that institutions that promote greater economic freedom in turn promote efficiency.

A paper by Desli et al, 2002 introduced technical efficiency via the intercept that evolved over time as an AR (1) process in a stochastic frontier (SF) framework in a panel

data framework. The authors described the features of the model. First, the model was dynamic in nature. Second, the model can separate technical inefficiency from fixed firm-specific effects which are not part of inefficiency. Third, the model allows one to estimate technical change separate from change in technical efficiency.

The purpose of a paper by Baltagi et al, 1995, was to develop a methodology for obtaining econometrically estimates of firm-specific technical change and contrasts those estimates with a multilateral total factor productivity index. Based on a panel data set of airlines, two measures were contrasted in a variety of ways. Results reveal that improvements in fuel efficiency and load factor have played major roles with hubbing and competition playing smaller roles in explaining efficiency improvements.

A dissertation by Lopez, 2006, contributed to the understanding of productivity growth in dairy production in three Southern Cone countries: Argentina, Chile, and Uruguay. Results reveal that the average technical efficiency estimates from the preferred country specific stochastic production frontier models are 87.0%, 84.9%, and 81.1% for Argentina, Chile, and Uruguay, respectively; however, these technical efficiency measures could not be compared directly with each other. Thus, the author developed the meta-frontier. In this case, the technical efficiency averages were substantially lower and took on the following values: Argentina 72.8%; Chile 65.8%; and Uruguay 73.4%.

Affuso et al, 2002, investigated how efficiency of 25 train operating companies has evolved over the period since privatization using data envelopment analysis (DEA) and corrected ordinary least squares (COLS). Results reveal that privatization has been

associated with a significant improvement in average and whole industry train operating companies' efficiency. This improvement in efficiency was largely driven by the large rise in output over the period and the impressive reduction in real operating costs.

Friebel et al, 2005 estimated a "right-to-manage model to identify the effect of product market strategies and mergers on the employment and earnings of workers of U.S. Class 1 railroads. Results reveal that the majority of employee groups have benefited in terms of compensation from market deregulation. Low-skilled workers, both blue and white collar, have been the main losers following deregulation, in terms of employment. The model developed by the authors has a good fit, except for high-skilled white collars and executives, which indicates relevance of other types of personnel practices, for instance incentive contracts.

A study by Coelli and Perelman, 2000, had two principal objectives. The first objective was to measure and compare the performance of European railways. The second objective was to illustrate the usefulness of econometric distance functions in the analysis of production in muli-output industries, where behavioral assumptions such as cost minimization or profit maximization, are unlikely to be applicable. The authors, using annual data on 17 railways companies during 1988-1993, multi-output distance functions were estimated using corrected ordinary least squares (COLS). The resulting technical efficiency estimates range from 0.980 for the Netherlands to 0.784 for Italy, with a mean of 0.863.

Davis and Wilson, 2002, developed and estimated compensation effects of deregulation on Class 1 railroads in the United States. By using firm level data, the

authors were able to identify effects of partial deregulation, an accompanying and massive consolidation movement, and changes in firm operating and network characteristics. Estimates suggest that mergers contributed 5 to 15 percent, partial deregulation contributed about 20 percent; and changes in firm operating and network characteristics contributed 4 to 5 percent to the overall increase in wages.

A study by the National Economic Research Associates, 2000, examined the productivity performance of overseas railways, and considered what conclusions, if any, can be drawn about the scope of Railtrack to improve efficiency over the next control period. The main findings from this study reveal since 1986, US Class 1 railroads have achieved productivity gains in infrastructure provision of 3.3 to 3.9 percent a year. This is in addition to efficiency improvements resulting from increased traffic volumes and network rationalization. The economic consultants believe that this finding provides a suitable benchmark for long run productivity growth in rail infrastructure provision. In addition, Railtrack should be able to realize “catching up” efficiency improvements.

Data and Methods

Data to accomplish the objectives of this study came from the Surface Transportation Board (STB) and the Bureau of Transportation Statistics for Class I Railroads for time period 1996-2006 or 11 years of data. As of 2005, a Class I railroad has an annual operating revenue exceeding $319.3 million. Data include ton-miles as the output variable; while input variables include labor (employment data) and capital (number of company owned locomotives and rail cars). Operating expense variables include (total

ways and structures; total train operations; and total yard operations). Financial variables include debt/asset ratio and current ratio.

The employment data was used to represent labor included (1) Executives, officials, and staff assistants; (2) Professional and administrative; (3) Maintenance of way and structures; (4) Maintenance of equipment and stores; (5) Transportation-other than train and engine; and (6) Transportation-train and engine. The 1996 employment data was not available by individual carriers. Therefore, the 1997 employment data by individual carriers was used to allocate Class 1 railroad totals for the year 1996 to specific individual carriers. Capital data for the years 1996-2004 were not available by individual carriers, therefore the 2005 data was used to allocate Class 1 railroad totals to specific carriers. The industry capital totals were obtained from the Pocket Guide to Transportation published annually by the Bureau of Transportation Statistics.

Financial ratios can be put to many uses. They may be used by a firm operator or business manager in managerial analysis; they also may be used by lending agencies in credit analysis; and they may be used by an investor in investment analysis (Langemeier, 2005). A number of useful ratios have been found to be indicators of firm financial progress and risk-bearing ability. These ratios can be grouped into five categories: (1) Liquidity; (2) Solvency; (3) Profitability; (4) Financial Efficiency; and (5) Repayment Capacity. In this study we used liquidity and solvency ratios.

The liquidity ratios measures the ability of a business to meet financial obligations as they come due in the ordinary course of business, without disrupting the normal operations of the business. In this study the current ratio was used. The current

ratio indicates the extent to which current assets of a firm, if liquidated, would cover current liabilities. The ratio was obtained by dividing total current assets by total current liabilities. Numbers greater than one indicate that the railroad company has enough available cash or liquid assets to service current liabilities. A number less than one means that the company does not have sufficient funds to service current liabilities. Total assets may be very high; however, its current ratio may be less than one due to limited current or liquid assets, Firms generally try to maintain enough liquid assets to cover short-term debts (Allen & Myles, 1989).

Solvency measures the amount of debt and other expense obligations used in the business relative to the amount of owner equity invested in the business. Solvency ratios provide an indication of the business' ability to repay all financial obligations if all assets were sold, as well as indication of the ability to continue operations as a viable business after a financial adversity, such as a drought. In this study we used the debt/asset ratio to measure the solvency of the Class 1 railroads. The debt/asset ratio was obtained by dividing total carrier liabilities by total carrier assets. This ratio expresses what proportion of total assets of the firm is owed to creditors. This ratio will vary from firm to firm and each firm must make its own decision about the optimal level of debt. A low debt/asset ratio does not always mean a company or railroad firm is operating at its most productive level. However, a low ratio may suggest that the railroad company is in a better position to obtain additional funds (Allen & Myles, 1989).

To examine the importance of financial variables on the efficiency of Class I Railroads in the United States, we simultaneously estimated the stochastic frontier

model and financial ratio model with output and efficiency measures as endogenous variables. The basic form of the stochastic efficiency model in the primal approach for a firm i, $i = 1, \ldots\ldots\ldots, I$, can be represented as

(1) $$\begin{aligned} y &= f(x;\beta)\cdot v - u \\ u &= f(Z) \end{aligned}$$

where v representing firm or time specific random error which are assumed to be independent identically (iid) and normally distributed variable with mean zero and variance σ_V^2; u representing the technical efficiency which must be positive hence absolutely normally distributed variable with mean zero and variance σ_U^2; and y , x and β are the output, input and parameter coefficients respectively. The u representing the technical efficiency is used as an endogenous variable to examine the importance of financial variables, Z in the second equation.

Empirical Application and Results

Parameter coefficients and the significant variables indicated by bold font are presented in Table 1. Labor variable with a positive sign indicates with more labor- more output- tons per mile are realized. Capital was negative and significant indicating that with less locomotives and railcars less output will be obtained per mile. Total train operations were also positive and significant revealing that with more train operations the industry can increase its output in terms of tons per mile. The variable total yard operations were negative and significant indicating that output will decline with a decrease in yard operations.

Table 1 reports the results of the model that show the effects of the financial variables on the dependent variable ton-miles. Overall results reveal that the variables debt/asset ratio and current ratio did not significantly affect the output of the carriers during the study period.

Average efficiency measures estimated by the stochastic frontier analysis equation are shown in Table 2. Results by years indicate that the average efficiencies of Class 1 railroads ranged from a low of 76 percent in 1996 to a high of 89 percent in 1997. This result indicates that Class 1 railroads increased the efficiency of their operations to meet customer demands during this time. Overall, Class 1 railroads averaged almost 83 percent. These results imply that Class 1 railroads need to do a more efficient job if they are to remain competitive in the transportation market.

The results of average efficiencies of individual Class 1 railroads are shown in Table 3. Results indicate that the Burlington Northern-Santa Fe had the highest average efficiency values of 91 percent while Norfolk Southern had the lowest with a value 76 percent. These results imply that the owners and/or managers of the Burlington Northern-Santa Fe have done a creditable job in keeping the carrier in efficient operational manner during the study period while other carriers need to increase their efficiencies to become more effective competitors in the transportation market.

Summary and Conclusions

The purpose of this paper is to examine the importance of financial variables on the efficiency of Class I Railroads in the United States in a panel stochastic frontier analysis

framework by using panel data for the period 1996-2006. We estimate stochastic frontier production function and financial ratio model with output and efficiency measures as endogenous variables to test the effects of several variables, including but not limited to total ways and structures; total train operations; and total yard operations.

The basic premise underlying this research is that firm operating and financial performance data can be used as representative indicators of the determinants of the efficiency of U.S. Class 1 railroads. Data and information needed to accomplish the objective of this study came from electronic copies of the Surface Transportation Board (STB) and the Bureau of Transportation Statistics for Class I Railroads for time period 1996-2006 or 11 years of data and other secondary sources.

Results from this study indicate that several variables in this study have statistically significant impact on the efficiency measures. For example, the results indicate that labor, capital, and total train operations significantly affected the efficiency of firms during the study period.

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Table 1. Parameter Coefficients of the Production Function

Stochastic Frontier Production Function Equation				
		coefficient	**St. error**	**t-ratio**
	Intercept	11.753	0.579	20.304
	Labor	1.535	0.105	**14.601**
	Capital	-0.958	0.087	**-11.015**
	Total Ways & Structures	0.152	0.110	1.387
	Total Train Operations	0.347	0.099	**3.524**
	Total Yard Operations	-0.317	0.100	**-3.170**
Financial Ratio Equation				
	Intercept	-1.571	0.869	-1.808
	Debt/Asset Ratio	0.416	0.224	1.856
	Current Ratio	0.020	0.054	0.133
		0.020	0.006	**3.548**

Table 2.Average Stochastic Frontier Analysis Efficiencies of Class 1 Railroads, 1996-2006

Year	Average Efficiency Values
1996	0.7608
1997	0.8936
1998	0.8709
1999	0.8509
2000	0.8560
2001	0.8251
2002	0.8366
2003	0.8298
2004	0.8471
2005	0.7706
2006	0.7667
Grand Mean	**0.8280**

Table 3. Average Stochastic Frontier Analysis Efficiency Estimates for Class 1 Railroads, 1996-2006

Name of Railroad	Average SFA Efficiency Values
Burlington Northern-Santa Fe	0.9087
CSX	0.8358
Kansas City Southern	0.8015
Norfolk Southern	0.7610
SOO	0.8306
Union Pacific	0.8307