PROCEEDINGS

OF THE 39TH ANNUAL MEETING OF THE

TRANSPORTATION RESEARCH FORUM

Montreal, PQ, Canada
October 16 - 18, 1997

Volume 2

21283 C

DETERMINANTS OF PROFITABILITY OF GRAIN DEPENDENT SHORT LINE RAILROADS

Marvin Prater
Economics Department
Kansas State University
Manhattan, Kansas 66506
913-532-4571

Michael W. Babcock
Professor of Economics
Economics Department
Kansas State University
Manhattan, Kansas 66506
913-532-4571

ABSTRACT

The U.S. short line railroad industry has experienced tremendous growth since railroad deregulation in 1980. Short lines are operating many thousands of miles of rural railroad branchline that would otherwise have been abandoned. If short line railroads are an economically viable alternative to abandonment, then the potential negative effects of abandonment on rural areas can be avoided. Thus the objectives of the study are:

1. Develop models of long term profitability of grain-dependent short line railroads.

2. Identify the key factors influencing grain dependent short line profitability by empirical estimation of the models developed in Objective 1.

3. Develop a quantitative profile of a grain-dependent short line railroad that is likely to be profitable in the long term.

Models of short line railroad profitability are developed using Earnings Before Interest and Taxes (EBIT) as the profitability measure. Explanatory variables in the model include age of the short line, number of connections to other railroads, railroad size, types of traffic, traffic density, and others. The sample to empirically estimate the model includes 34 short lines operating in 17 states in the midwest region of the U.S. for the fiscal years 1986 through 1995. The participating short lines supplied data through questionnaires as well as balance sheets and income statements.

The models of short line profitability are estimated by OLS regression. Nearly all the explanatory variables have the theoretically expected sign and are statistically significant. The equations have a good fit and there is no statistically significant autocorrelation or heteroskedasticity. The key factors influencing EBIT are identified through sensitivity analysis as well as the elasticities and t statistics of the explanatory variables.

The empirical results of the study indicate that the profitability (EBIT) of the grain dependent short lines in the sample is not very high. Results also indicate that about 25 percent of the sample short lines have a high probability of requiring government assistance to continue operating.

INTRODUCTION

The short line railroad industry has experienced tremendous growth since railroad deregulation in 1980. In the United States, 227 short lines were created in the 1980-89 period, operating 21,028 miles of rail track. In the 1989-93 period, another 112 short lines were created, accounting for an additional 13,357 miles of track. By 1995, short line and regional railroads operated 45,400 miles of track in the U.S. which is 27 percent of the national rail network.

Short lines are operating many thousands of miles of rural rail branchline that might otherwise have been abandoned. Abandonment has several potential negative impacts on rural areas such as:

- Lower grain prices received by farmers.
- Higher transportation costs and lower profits for rail shippers.
- Loss of market options for shippers.
- Lost economic development opportunities in rural communities resulting in less diversification of employment.
- Higher road maintenance and reconstruction costs.

Thus, the question of long term economic viability of short lines is important to rural areas. If short lines are an economically viable alternative to abandonment, then the above potential negative effects can be avoided. Also, as Class I railroad mileage continues to decline, rural communities, shipper groups, and railroad entrepreneurs may ask states for assistance in establishing short line railroads. Thus, state Departments of Transportation (DOTs) need to know if short line railroads offer an economically viable mode of transportation in order to properly evaluate the question of financial assistance for short lines.

Several researchers have investigated the economic feasibility of short line railroads. Some studies have estimated short line railroad cost functions (Sidhu, 1977; Dooley, 1991). Others have identified some of the causes of short line success or failure (Due, 1984, 1987;

Wolfe, 1988; Grimm and Sapienza, 1993; and Eusebio, 1993). Some investigators have employed a financial model approach to the question of short line viability (Wolfe, 1989a, 1989b; Walter and McNair, 1990; and USDOT, 1993). Dooley and Rodriquez (1988), ICC and USDOT (1989), USDOT (1989), and Babcock, Prater, Morrill, and Russell (1994 and 1995) addressed the problem by comparing the prices and service of short line railroads to that of the predecessor Class I railroad and to motor carriers. Fitzsimmons (1991) and Eusebio (1993) examined the impact of intramodal and intermodal competition on short lines. Babcock, Prater, and Morrill (1994) identified a qualitative profile of a profitable short line railroad based on personal interviews of short line railroad executives, shippers located on short lines, and public officials.

While these studies made important contributions to our understanding of short line railroad profitability, no study has specified and empirically estimated a model of short line railroad profitability. Accordingly the objectives of this paper are as follows:

1. Develop models of long-term profitability of grain-dependent short line railroads.[1]

2. Identify the key factors influencing grain-dependent short line profitability by empirical estimation of the models developed in Objective 1.

3. Develop a quantitative profile of a grain-dependent short line railroad that is likely to be profitable in the long term.

THE MODEL

The general form of the model is as follows:

$$Y_{it} = \alpha + \sum_{k} \beta_k X_{itk} + \varepsilon_{it}$$

Where:
Y_{it} = the profitability of a firm in year t.
$\propto$ = the intercept term which is the same for all firms.
β_k = the effect of the independent variable k upon profitability.
X_{itk} = the value of the independent variable k for firm i and year t.
ε_{it} = the error term, $\varepsilon_{it} \sim$ iid $N(0, \sigma_\varepsilon^2)$.

The profitability of short line railroads can be measured in several alternative ways and each of them has advantages and disadvantages. The dependent variable selected for this study is Earnings Before Interest and Taxes (EBIT) which is calculated as follows:

Operating Revenues	$$$
Operating Expenses	-$$$
Operating Income	$$$
Other Income	+$$$
Other Expenses	-$$$
Earnings Before Interest and Taxes	$$$

The objective of the study is to identify and measure the economic determinants of short line railroad profitability. Thus it is necessary to adjust the profitability measure for interfirm differences in profits that are due solely to accounting factors or to unusual, nonrecurring events.[2] The major advantage of using EBIT to measure profit is that it does not include the effects of many non-operating items upon profitability. For example, in the sample short lines examined in this study, income tax rates vary from zero to 36 percent of income before taxes. However, since EBIT is a before-tax measure of profitability, it is unaffected by interfirm variation in tax rates. Also interest expenses varied widely among the short lines in the sample, but since EBIT is a before-interest measure of profits, it is unaffected by interfirm variation in interest expense. EBIT also is unaffected by extraordinary income or by unusual income.

The disadvantage of EBIT is that it is affected by other income which is income from incidental transactions or operations that are peripheral to the firm's main business. For some of the short lines in the sample, other income is quite large. Also EBIT is affected by other expenses which are non-operating expenses such as losses on the sale of investments. However, these expenses were seldom incurred by sample short lines.

EBIT is adjusted to remove the effects of interfirm differences in the amount of maintenance of way (MOW) expenses which include all expenses associated with maintaining track including track repair, weed control, snow removal, and depreciation of equipment used to maintain track. MOW expenses vary widely among short lines due to interfirm differences in debt levels, condition of the track, traffic density, miles of track and other factors. EBIT is adjusted for these differences by subtracting MOW expenses from the operating expenses of the firm.

EBIT is also adjusted to remove the effects of interfirm differences in government aid received which varied among the sample short lines from no aid to substantial amounts. To adjust EBIT, an annual value is placed on the government aid received by each railroad. Next, the government aid is divided into interest and non-interest components where the interest benefits are those derived from reduced interest costs. Since EBIT is a before-interest measure of profitability, it is adjusted only for the non-interest portion of government aid.[3]

The effect of the MOW and government aid adjustments is to create three different versions of the dependent variable, EBIT. The first version (REBIT) is not adjusted for interfirm differences in MOW and government aid. The second version (REBIT1) is EBIT adjusted for interfirm differences in MOW, while the third version (REBIT2) is EBIT adjusted for interfirm differences in MOW and government aid.

The final adjustments are to measure EBIT in real dollars and divide by miles of mainline track in order to better compare the profitability of short lines having different track miles. Also this adjustment reduces the potential for statistical problems such as heteroskedasticity.

An alternative to adjusting REBIT is to use MOW and government aid as independent variables. Accordingly the REBIT model contains these two factors as explanatory variables while the REBIT1 model (adjusted for MOW only) has government aid as an independent variable. In the REBIT model, MOW is lagged one year to eliminate potential simultaneity. That is, one can hypothesize that MOW affects profitability and also that profitability affects funds available for MOW. Also MOW is lagged since it is reasonable to assume that increased MOW in the current period will improve profits in the next period due to improved service and safety.

A large number of potential independent variables thought to affect short line revenues and costs were examined. After substantial statistical testing the following explanatory variables are employed in the model.

ERA1-	a dummy variable equal to 1.0 if the railroad was created before 1970.
ERA2-	a dummy variable equal to 1.0 if the railroad was created between 1970 and 1987.
GRP-	number of railroad firms owned by a parent firm.
SHIP-	a dummy variable equal to 1.0 for railroad firms owned and managed by a shipper or shipper group.
CONN-	the number of connections of a short line to other railroad firms.
GMIL-	gross miles of main-line track operated by the railroad.
OWN-	percentage of track owned by the railroad firm.
TOP3-	percentage of the railroad's total traffic in the top three Standard Industrial Classification (SIC) codes.
TOP32-	TOP3-squared.

GRAN-	percentage of the railroad's total traffic which is grain.
GRAN2-	GRAN-squared.
POH-	percentage of the railroad's total traffic which is overhead traffic.
DENS-	number of carloads per mile of main-line track.
LGROTEXM-	total real operating expense per mile minus real maintenance of way (MOW) expense per mile, lagged one year.
RHAUL-	ratio of the railroad's length of haul to gross main-line miles operated.
RAIDNMI-	real non-interest government aid per mile of track.

The theoretically expected sign for explanatory variable ERA1 is positive. Older, established short lines have characteristics that have a positive effect on profitability such as experience in the railroad business, a higher number of established marketing relationships, and lower depreciation costs on their assets. In contrast, the expected sign of ERA2 is negative due to the higher prices paid for short lines in the 1970-87 period and the resulting negative effect on profitability.

The theoretically expected sign for GRP is indeterminate. It can be argued that the sign should be positive since railroad groups benefit from economies that are not available to independent railroads such as the ability to share labor, equipment, technology, management resources, and to diversify risk. However, it can also be argued that the sign should be negative since marginal railroads may be successful only when they are part of a rail group. Thus, marginal railroads are either purchased by a rail group or abandoned. In addition, many railroads in rail groups pay a management fee to the parent firm. If this fee is more than the individual railroad's share of parent firm expenses, then profits are transferred from the individual short line to the parent firm.

The theoretically expected sign of SHIP is negative. A railroad is often owned by shippers if it has marginal traffic density and low profit potential. Since no other firms are willing to purchase these lines, their profitability may be inherently low. Thus, purchase of the line by shippers is the only option that will preserve rail service. Since operating the railroad is not the shipper's primary business, it may be operated without professional railroad management and the short line's service is not aggressively marketed, producing a negative effect on profits.

The expected sign of CONN is positive since it reflects the bargaining power of the short line relative to Class I railroads with regard to revenue splits on joint movements, car hire fees, and switching charges. As the number of connections to alternative Class I railroads increases, short line revenues increase, costs decrease, and profits rise. The positive sign of CONN could also be partly attributed to access to additional rail cars that accompanies additional connections to Class I railroads, and the resulting ability to supply more service and increase profits.

The expected sign of GMIL is positive since an increase in the size of the railroad's network will produce economies of scale, increased access to markets, and increased potential for gains in local traffic. All of these factors have a positive effect on the short line's profit potential.

The theoretically expected sign of OWN is positive. Short lines which own their track incur depreciation and interest costs. Depreciation increases operating expense but interest cost does not affect EBIT. Railroads which lease their track incur leasing costs which include both depreciation and interest costs. Thus higher leasing costs reduces EBIT by increasing operating expenses. Thus, since operating expenses under ownership of track are lower than operating expenses under lease, one would expect the sign of OWN to be positive since EBIT would be higher for short lines that own their track.

The theoretically expected signs of TOP3 and GRAN are indeterminate. It could be argued that TOP3 and GRAN have positive signs if there are significant economies that result from specializing in handling a few commodities in large volumes. Other things equal, this would reduce costs and increase profits. However, it can also be argued that TOP3 and GRAN have negative signs since the railroad's traffic may be seasonal, resulting in reduced efficiency and greater risk to the firm's profitability. Also, grain freight rates are low relative to those of other commodities, producing a negative effect on profits. The variables TOP32 and GRAN2 are the squared values of the above variables. Both of these are expected to have negative signs since it is expected that TOP3 and GRAN will have maximum values.

The theoretically expected sign of POH is negative. Overhead traffic is received from a Class I railroad at one location on a short line and returned to the same Class I railroad at a different location on the short line. The Class I railroad has considerable bargaining power relative to the short line since it usually has the option of hauling the traffic a longer distance on its own network. As a result, the short line usually sets a price for overhead traffic that is slightly above its variable cost. Although any revenue in excess of variable cost will increase profits, the presence of traffic density (DENS) in the model may cause POH to be negative since overhead traffic is included in total traffic, but is priced at a below average level. Thus, the negative sign of POH may reflect the effects of price discounts on overhead traffic.

The theoretically expected sign of DENS is positive. Since railroads have a high percentage of fixed costs and factor indivisibilites, an increase in traffic density will reduce costs per carload and increase profitability.

The expected sign of LGROTEXM is negative. Previous short line studies have found that a key factor for the profitability of short line railroads is the ability of management to control expenses. To the extent that short line management is successful in this endeavor, LGROTEXM will fall and profits will increase. This variable is lagged to eliminate potential simultaneity bias. That is, one can hypothesize that reduced other expenses will increase profitability and also that increased profitability affects funds available for other expenses.

The expected sign of RHAUL is positive. Railroads have a competitive advantage relative to motor carriers on longer distance hauls. Thus, the greater the length of haul, the higher the price that the railroad will be able to charge relative to its variable cost. In addition, the greater the length of haul, the larger the short line's share of revenue from joint movements with other railroads. Thus, the greater the length of haul, the higher the profits of the short line railroad.

The expected sign of RAIDNMI is theoretically indeterminate. One could argue that the sign of this variable is negative since government aid is usually given to less profitable railroads. However, government financial assistance is usually considered to be more likely to benefit a firm and thus increase profitability.

The theoretically expected signs of the independent variables are summarized in Table 1.

The sample to empirically estimate the model of short line profitability includes 34 railroads operating in 17 states in the Midwestern region of the U.S. for the fiscal years 1986

Table 1
Theoretically Expected Signs of the Independent Variables

Independent Variable	Theoretically Expected Sign
ERA 1	+
ERA 2	-
GRP	+ or -
SHIP	-
CONN	+
GMIL	+
OWN	+
TOP3	+ or -
TOP32	-
GRAN	+ or -
GRAN2	-
POH	-
DENS	+
LGROTEXM	-
RHAUL	+
RAIDNMI	+ or -

through 1995. The sample is unbalanced since some of the short lines did not begin operations until after 1986 and other railroads discontinued operations prior to 1995. The number of years data for each railroad in the sample varies from 2 to 10 years. A total of 196 annual observations were obtained.

The principal reason that no previous study of this type has been conducted is that it requires proprietary financial information from short line railroads, which they are naturally reluctant to make available to researchers. However, 34 short line railroads participated in this study by completing questionnaires and submitting balance sheets and income statements for the relevant years. In some states, short lines are required to submit annual reports to state DOTs and these reports contain some of the data required in this study. On occasion we used data from *Profiles of American Railroads* published by the Association of American Railroads.

REBIT is obtained directly from the income statements of the participating short line railroads. If the income statement of the short line was not available, the state reports sometimes had enough information to calculate REBIT. REBIT is converted to 1992 dollars using the Implicit Gross Domestic Product Deflator found in the *1996 Economic Report of the President*.

EMPIRICAL RESULTS

The models are estimated by ordinary least squares (OLS) regression.[4] The standard errors of the estimates are computed in the usual manner and we use the Huber-White-Sandwich robust estimator of variance to detect the potential presence of heteroskedasticity. The models are initially estimated using TOP3 and TOP32 as explanatory variables. The same models are then re-estimated replacing TOP3 and TOP32 with GRAN and GRAN2. Since TOP3 and

GRAN (and TOP32 and GRAN2) are highly correlated, multicollinearity occurs if both variables are in the same equation. Some of the independent variables are calculated on a per mile of track basis in order to reduce potential statistical problems such as multicollinearity and heteroskedasticity.

The estimated REBIT equations (with TOP3 and TOP32) are displayed in Table 2. An examination of the table reveals that the $\bar{R}^2$s of REBIT1 and REBIT2 are 0.73 and 0.75 respectively, much better than that of REBIT (0.63). This indicates that the model is improved by adjusting the dependent variable for interfirm differences in MOW and non-interest government aid. The Durbin-Watson statistics of the REBIT, REBIT1, and REBIT2 equations are 2.03, 1.97, and 2.03 respectively, so autocorrelation is not a problem in the estimated equations. In addition, the parameters and standard errors obtained by robust standard error estimation do not vary much from those of the OLS models, indicating that heteroskedasticity is not a problem with the estimated REBIT equations.[5]

With respect to the REBIT equation, all the independent variables with a determinate expected sign have the theoretically expected sign except ERA2. The unexpected positive sign of ERA2 indicates that the higher prices paid for short lines between 1970 and 1987 may not be as great a factor affecting profitability as previously thought. Independent variable GRP has a negative sign indicating that some of the railroads purchased by rail groups may be marginally profitable. The negative coefficient may also be partly attributable to the possible transfer of individual railroad profits to the parent firm in the form of management fees. TOP3 has a positive sign indicating that economies due to handling large amounts of the same commodities

Table 2
Real Earnings Before Interest and Taxes per Mile (REBIT)
TOP3 MODEL

Independent Variable	REBIT (Unadjusted)	REBIT1 (Before MOW)	REBIT2 (Before MOW & Aid)
ERA1	2465.18 (1.28)	2977.24 (1.344)	3136.95 (1.416)
ERA2	1594.00 (1.235)	2574.63 (1.835)*	2128.73 (1.573)
GRP	-133.09 (-1.531)	-251.38 (-2.668)***	-273.32 (-2.955)***
SHIP	-3659.32 (-2.823)***	-4492.07 (-3.127)***	-4628.16 (-3.227)***
CONN	206.63 (2.553)**	187.73 (2.108)**	171.11 (1.943)*
GMIL	10.81 (4.938)***	12.74 (5.291)***	13.38 (5.702)***
OWN	48.73 (3.598)***	36.74 (2.484)**	37.80 (2.556)**
TOP3	512.17 (1.570)	1033.71 (2.971)***	1007.09 (2.896)***
TOP32	-2.6867 (-1.243)	-5.9190 (-2.548)**	-5.7989 (-2.495)**
POH	-88.13 (-2.504)**	-127.75 (-3.326)***	-136.34 (-3.610)***
DENS	78.16 (5.047)***	133.90 (9.330)***	137.47 (9.783)***
RHAUL	4229.80 (1.961)*	3654.84 (1.538)	3334.36 (1.410)
LGROTEXM	-.1882 (-4.032)***	-.1592 (-3.196)***	-.1566 (-3.142)***
LAGRMOWM	.4094 (1.593)	--------	--------
RAIDNMI	.2361 (0.802)	.6268 (1.977)**	-------
CONSTANT	-31473.20 (-2.620)***	-50380.04 (-3.938)***	-49228.94 (-3.853)***
Number of obs.	135	134	134
Adj. R^2	.6289	.7273	.7541
Root MSE	3838.5	4235.9	4242.8
Durbin-Watson	2.0256	1.9734	2.0301

t-value in parentheses
* significant at the .10 level
** significant at the .05 level
*** significant at the .01 level

outweigh the negative effects of a traffic base focused on a few commodities. The sign of RAIDNMI is positive indicating that government aid improves short line profitability.

With regard to statistical significance of the coefficients in the REBIT equation, the variables SHIP, GMIL, OWN, DENS, and LGROTEXM are significant at the .01 level. The variables CONN and POH are significant at the .05 level and RHAUL is significant at the .10 level. The other 7 independent variables are nonsignficant including lagged real maintenance of way expenditures (LAGRMOWM).

The empirical results of the REBIT1 and REBIT2 equations are virtually identical. The only variable in both equations with an unexpected sign is ERA2. The variables that are statistically significant at the .01 level in both equations are GRP, SHIP, GMIL, TOP3, POH, DENS, and LGROTEXM. In both equations, OWN and TOP32 are statistically significant at the .05 level. The variable CONN is statistically significant at the .05 level in the REBIT1 equation and at the .10 level in the REBIT2 equation. The variable ERA2 is statistically significant at the .10 level in the REBIT1 equation but is not significant in the REBIT2 equation. In both equations ERA1 and RHAUL are not significant.

It is interesting to note the quadratic nature of TOP3 and its relationship to short line profitability. When a dependent variable has a quadratic relationship to the explanatory variable, the value of the dependent variable is maximized or minimized at some value of the explanatory variable. This maximizing or minimizing value of the explanatory variable can be found by differentiation. For instance, if $Y=\beta_1 X+\beta_2 X^2$, then $\partial Y/\partial X=\beta_1+2\beta_2 X$. Since $\partial Y/\partial X$ is the slope of the function, Y is maximized or minimized where the slope of the function equals zero. Thus, set $\beta_1+2\beta_2 X=0$, and the Y is optimized when X has a value of $-\beta_1/2\beta_2$. Letting Y be REBIT1 and X be TOP3 and using the regression results in Table 2, REBIT1 is maximized (with respect to TOP3) when TOP3 is 87.3 percent (-1033.71/2(-5.92)). The corresponding values for REBIT and REBIT2 are 95.3 and 86.8 percent respectively.

As TOP3 exceeds its profit maximizing value, profitability of the short line will decline as TOP3 increases. Profitability decreases since the slope of the profitability function is negative when TOP3 exceeds its profit maximizing value. However profits as related only to TOP3 remain positive. Thus REBIT1 decreases after TOP3 exceeds 87.3 percent, but REBIT1 remains positive since the positive effect on profits from TOP3 still outweighs the negative effects of TOP32.

The empirical results in Table 2 indicate that the adjusted models (REBIT1 and REBIT2) do a better job of describing short line profitability than the unadjusted REBIT model. The adjusted models have higher $\overline{R}^2s$, higher t statistics, and more statistically significant variables than the unadjusted model.

Table 3 contains the empirical results of the models when TOP3 and TOP32 are replaced with GRAN and GRAN2. The $\overline{R}^2$ of REBIT is 0.63 compared to 0.71 for REBIT1 and 0.74 for REBIT2. Thus these models explain about the same amount of variation in REBIT as the models using TOP3 and TOP32. The root mean square errors for these models are also about the same.

The Durbin-Watson statistics for the REBIT, REBIT1, and REBIT2 equations are 1.95, 2.09, and 1.93 respectively, indicating that autocorrelation is not a problem with these OLS equations. In addition, the parameter estimates and standard errors obtained by robust standard errors estimation do not vary greatly from those of the OLS models, indicating that heteroskedasticity is not a problem of the OLS equations.

Table 3
Real Earnings Before Interest and Taxes per Mile (REBIT)
GRAN MODEL

Independent Variable	REBIT (Unadjusted)	REBIT1 (Before MOW)	REBIT2 (Before MOW & Aid)
ERA1	3309.35 (1.761)*	3542.58 (1.623)	3831.8 (1.746)*
ERA2	1357.15 (1.049)	2449.01 (1.709)*	1856.71 (1.323)
GRP	-145.59 (-1.721)*	-269.49 (-2.900)***	-299.00 (-3.245)***
SHIP	-4159.06 (-3.267)***	-5531.47 (-3.877)***	-5837.59 (-4.089)***
CONN	221.38 (2.729)***	187.78 (2.063)**	155.68 (1.731)*
GMIL	9.01 (3.930)***	10.48 (4.072)***	11.63 (4.642)***
OWN	48.71 (3.580)***	35.47 (2.347)**	36.54 (2.399)**
GRAN	165.88 (2.753)***	252.30 (3.523)***	207.08 (3.077)***
GRAN2	-1.4433 (-2.628)***	-2.2612 (-3.455)***	-1.8404 (-3.001)***
POH	-104.47 (-3.157)***	-145.73 (-3.875)***	-149.40 (-3.946)***
DENS	66.38 (4.391)***	127.05 (8.879)***	133.96 (9.661)***
RHAUL	6433.64 (2.922)***	6535.10 (2.643)***	5544.40 (2.285)**
LGROTEXM	-.2240 (-5.030)***	-.1996 (-4.046)***	-.1879 (-3.813)***
LAGRMOWM	.5444 (2.208)**	---------	---------
RAIDNMI	.0637 (.207)	.4014 (1.168)	---------
CONSTANT	-10158.76 (-4.394)***	-9849.37 (-3.722)***	-9528.30 (-3.579)***
Number of obs.	135	134	134
Adj. R^2	.6256	.7149	.7394
Root MSE	3855.7	4331.5	4368.0
Durbin-Watson	1.9482	2.0861	1.9267

t-value of the coefficients are in parentheses
* significant at the .10 level
** significant at the .05 level
*** significant at the .01 level

Examination of Table 3 reveals that with regard to the REBIT equation the only variable with an unexpected sign is ERA2. With regard to the variables with a theoretically indeterminate sign, GRP has a negative sign while both GRAN and RAIDMI have positive signs. There is a large difference in the number of statistically significant variables compared to that of the TOP3 equation (Table 2). Ten of the independent variables in the GRAN (Table 3) equation are statistically significant at the .01 level compared to only five in the TOP3 equation. Only two independent variables are not statistically significant in the GRAN equation (Table 3) compared to seven in the TOP3 equation (Table 2). Also the variable, lagged real maintenance of way (LAGRMOWM), is statistically significant at the .05 level in the GRAN equation and not statistically significant in the TOP3 equation.

The empirical results of the REBIT1 and REBIT2 equations in Table 3 are nearly identical to each other and to the empirical results for these two equations in Table 2. The only variable with an unexpected sign is ERA2 and among the variables with a theoretically indeterminate sign, GRP has a negative sign while GRAN and RAIDMI have positive signs. In both the REBIT1 and REBIT2 equations, a large majority of the independent variables are statistically significant at the .01 level. Only two explanatory variables are not statistically significant in the REBIT1 equation and only ERA2 is not significant in the REBIT2 equation.

GRAN has a quadratic relationship to short line railroad profitability. REBIT1 is maximized (with respect to GRAN) when GRAN is 55.8 percent. The corresponding values for REBIT and REBIT2 are 57.6 and 56.3 percent respectively. As GRAN exceeds these profit maximizing values, short line profitability (with respect to GRAN only) will decrease.

Unlike the TOP3 equations, the empirical results of the adjusted models (REBIT1 and REBIT2) are not substantially different than those of the unadjusted model (REBIT). The $\overline{R}^2s$ of REBIT1 and REBIT2 are higher than REBIT, but the number of statistically significant variables and the level of the t statistics is similar in all three equations.

Table 4 contains the elasticities (calculated at the mean) for the various independent variables. The top row of numbers for each variable are the elasticities pertaining to the models using TOP3 as an independent variable and the bottom row of numbers are the elasticities for the models using GRAN. The elasticity of REBIT with respect to the various independent variables is important in evaluating the relative impact of the independent variable on REBIT. In general, changes in those independent variables having larger elasticities will produce larger changes in REBIT than changes in those independent variables having lower elasticities.

An examination of Table 4 reveals that the elasticities of the REBIT model are higher than those of the REBIT1 and REBIT2 models for several variables including CONN, OWN, TOP3, RHAUL, and LGROTEXM. With the exception of DENS, the elasticities of the independent variables for the REBIT1 and REBIT2 models are similar for both the TOP3 and GRAN versions of the model. The variable with the highest elasticities is DENS with the elasticity ranging from a low of 1.492 to a high of 1.863. With the exception of DENS, no independent variable has an elastic coefficient (i.e. >1.0) with respect to REBIT1 and REBIT2. However for the unadjusted REBIT model, several independent variables have elastic coefficients including OWN, TOP3, DENS, RHAUL [GRAN version], and LGROTEXM. In general, the high elasticities of DENS for all versions of the models indicate that short line profitability is more responsive to traffic density than any other variable in the model.

Table 4
Elasticities of Real Earnings Before Interest and Taxes per Mile (REBIT)

Independent Variable	REBIT (Unadjusted)	REBIT1 (Before MOW)	REBIT2 (Before MOW & Aid)
GRP	.193[1] .211[2]	.179 .192	.220 .241
CONN	.421 .451	.188 .188	.194 .177
GMIL	.913 .761	.530 .436	.630 .548
OWN	1.071 1.071	.398 .384	.463 .448
TOP3	1.725	.629	.613
GRAN	.360	.219	.217
POH	.214 .254	.153 .175	.185 .203
DENS	1.863 1.582	1.572 1.492	1.826 1.780
RHAUL	.660 1.003	.281 .502	.290 .482
LGROTEXM	1.364 1.623	.568 .712	.633 .759
LAGRMOWM	.482 .642	-------- --------	-------- --------
RAIDNMI	.069 .019	.090 .057	-------- --------

1 The upper row of numbers for each variable are calculated from the models using TOP3.

2 The lower row of numbers for each variable are calculated from the models using GRAN.

SENSITIVITY ANALYSIS

The estimated short line profitability equations can be used to develop "rules of thumb" regarding the expected profitability of short line railroads. The data in Table 5 indicates how this can be accomplished. The table contains the non-dummy variables from the REBIT2, TOP3 regression (see last column of Table 2). The top numbers in the first column of numbers in Table 5 is the REBIT2 of short line railroads assuming a given independent variable has its minimum sample value with all other variables assuming their sample mean values.[6] For example, if CONN has its minimum sample value of 1.0 and the other variables have their mean sample value, short line REBIT2 is $4453. The second and third numbers listed in Table 5 for each independent variable are the lower and upper 95 percent confidence interval values. For CONN, these confidence interval values are -$3863 and $12,769, which means that we are 95 percent sure that REBIT2 is between these two values.

The middle column of numbers in Table 5 contain REBIT2 and 95 confidence interval values for each independent variable assuming all the variables have values equal to their sample means. For example, if the value of CONN increases to its mean sample value (6.36), all other variables assuming their mean sample values, REBIT2 will increase from $4453 to $8635. The 95 percent confidence interval values are $319 and $16,951.

The third column of numbers in Table 5 displays REBIT2 and 95 percent confidence interval values for each independent variable assuming a given variable has its maximum sample value while all other independent variables have their sample mean value. For example, if the value of CONN is increased to its maximum sample value, all other variables assuming their sample mean value, REBIT2 is $13,365.

Table 5
Sensitivity of REBIT2 to Changes in Independent Variables[1]
TOP3 MODEL

Independent Variable	At the Variable's Minimum Value	At the Variable's Mean Value	At the Variable's Maximum Value
CONN	4,452.90[2]	8,635.28	13,364.76
	(3,862.99)[3]	319.39	5,048.87
	12,768.79[4]	16,951.16	21,680.65
GMIL	4,349.71	7,718.13	17,127.61
	(3,966.18)[5]	(597.76)	8,811.72
	12,665.60	16,034.02	25,443.50
OWN	5,124.03	7,718.13	8,904.03
	(3,191.86)	(597.76)	588.14
	13,439.91	16,034.02	17,219.91
TOP3	(3,350.93)	7,718.13	6,786.36
	(11,666.82)	(597.76)	(1,529.52)
	4,964.96	16,034.02	15,102.25
POH	8,754.17	7,718.13	846.45
	438.29	(597.76)	(7,469.43)
	17,070.06	16,034.02	9,162.34
DENS	(1,889.93)	7,718.13	46,414.28
	(10,205.81)	(597.76)	38,098.39
	6,425.96	16,034.02	54,730.17
LGROTEXM	10,685.91	7,718.13	(1,126.63)
	2,370.02	(597.76)	(9,442.52)
	19,001.80	16,034.02	7,189.26
RHAUL	6,494.42	7,718.13	9,428.65
	(1,821.47)	(597.76)	1,112.77
	14,810.30	16,034.02	17,744.54

1 Each independent variable is evaluated at its minimum, mean and maximum values while holding all other variables at their mean values.

2 The top number for each variable is the estimated REBIT2.

3 The middle number for each variable is the lower 95 percent confidence interval value of REBIT2.

4 The bottom number for each variable is the upper 95 percent confidence interval value of REBIT2.

5 Numbers in parentheses are negative values.

Thus the data in Table 5 reveals the range of potential short line profitability at the minimum, mean, and maximum sample values of a given variable. The same exercise can be performed using any of the other profitability equations in Table 2 and 3.

Examination of Table 5 reveals that DENS has wider variation of REBIT2 than any other independent variable, ranging from a low of -$1890 (minimum sample value of DENS) to a high of $46,414 (maximum sample value of DENS). Given this variation and the high elasticity of DENS, it is clear that DENS has a greater impact on REBIT2 than any other variable.

Table 6 contains values of REBIT2 estimated at various values of DENS ranging from 20 carloads per mile to 100 carloads per mile. The values of the other independent variables are set at their sample means. Recall, REBIT2 is defined as real earnings before interest and taxes and is adjusted to remove the interfirm differences in maintenance of way expenses (MOW) and non-interest government aid. Thus, the profit levels estimated for REBIT2 in Table 6 would be reduced by track maintenance, interest, and income taxes.

Various studies and state Departments of Transportation have estimated the minimum annual real MOW expenses at between $5,000 and $8,000 per mile of track.[7] Thus, a railroad with the mean density of traffic in the sample (74.41), and all other independent variables at the sample mean, is likely to receive a profit about equal to needed expenditures for MOW, leaving no revenue to pay interest on its debt and income taxes. Also, Table 6 indicates it takes in excess of 100 carloads per mile to be 95 percent certain of receiving REBIT2 high enough to cover MOW, interest and income taxes.

Three of the 34 railroads in the sample of this study had traffic densities of less than 20 carloads per mile and six of the railroads in the sample had traffic densities between 20 and 40

Table 6
Sensitivity of REBIT2 to Changes in DENS[1]

Density of Railcar Traffic[2]	Estimated Value of REBIT2	Lower 95% CI of REBIT2	Upper 95% CI of REBIT2
		REBIT2 Model Using TOP3:	
20	$238.11	-$8,077.78	$8,554.00
40	$2,987.51	-$5,328.38	$11,303.40
60	$5,736.91	-$2,578.98	$14,052.80
74.41[3]	$7,718.13	-$597.76	$16,034.02
80	$8,486.31	$170.42	$16,802.20
100	$11,235.71	$2,919.82	$19,551.60
		REBIT2 Model Using GRAN:	
20	$1,640.50	-$6,920.78	$10,201.78
40	$4,319.70	-$4,241.58	$12,880.98
60	$6,998.90	-$1,562.38	$15,560.18
74.41	$8,929.53	$368.25	$17,490.81
80	$9,678.10	$1,116.82	$18,239.38
100	$12,357.30	$3,796.02	$20,918.58

1 Calculated based on the predictive equation of REBIT2. All values assume the railroad is established after 1987, is independent of other railroads, is not owned by shippers, and connects to only one other railroad firm. It is further assumed that all other independent variables are at the mean values of the sample.

2 Density is measured in rail cars per main-line mile of track.

3 This is the mean density of the sample.

carloads per mile. Thus, about 25 percent of the short line railroads in this study have a high probability of requiring governmental financial assistance in order to continue operating.

CONCLUSION

One of the principal objectives of this paper is to develop models of profitability for grain-dependent short line railroads. This objective is accomplished through the specification of models that explain up to 75 percent of the variation in short line railroad REBIT. These models incorporate explanatory variables which in nearly every case have signs that are in accordance with theoretical expectations.

For the version of the model that contains the variables TOP3 and TOP32, the REBIT1 and REBIT2 equations are superior to the REBIT equation as the former two models have higher $\overline{R}^2$, more statistically significant variables, and higher t statistics. There is virtually no difference in the statistical performance of the REBIT1 and REBIT2 equations. Thus there is very little incremental statistical benefit from adjusting the REBIT1 equation (adjusted for MOW) to obtain REBIT2 (adjusted for MOW and non-interest government aid). Nearly all of the explanatory variables in the REBIT1 and REBIT2 equations are statistically significant.

The statistical performance of the models that include GRAN and GRAN2 is different from the models that contain TOP3 and TOP32. The dramatic change occurs in the statistical results of the REBIT equation. Although there is no change in the $\overline{R}^2$ of the two versions of REBIT, the number of variables that are statistically significant at the .01 level doubles from 5 (TOP3 version) to 10 (GRAN version) and the number of non-significant variables declines from 7 (TOP3 version) to 2 (GRAN version). Although the $\overline{R}^2$ of the REBIT1 and REBIT2 equations is somewhat higher than that of REBIT, the number of statistically significant variables and the level of the t statistics is similar in all three equations. As is the case with the TOP3 version of the model, there is virtually no difference in the statistical performance of the REBIT1 and REBIT2 equations in the GRAN version. The greater majority of the variables in these two equations are statistically significant.

Another important objective of the paper is to identify the key factors influencing grain-dependent short line profitability. This objective is achieved through the sensitivity analysis of REBIT2 (TOP3 version) and the elasticities and t statistics of the explanatory variables. Although DENS is the most important factor by all three of these criteria, the other important variables according to each of these criteria are discussed in the order mentioned above.

In the sensitivity analysis of REBIT2 (TOP3 version), DENS is by far the most important variable. For every 10 carloads of traffic per mile, REBIT2 increases by $1375 (Table 2). The variation in REBIT2 between the sample minimum and maximum values of DENS is $48,304 which is nearly 4 times greater than that of the second most important variable (Table 5). Other variables which have high variation in the sensitivity analysis are GMIL ($12,778), LGROTEXM ($11,813), and TOP3 ($10,137).

The elasticity of REBIT with respect to the various independent variables is another good indicator of the relative important of these variables. The variable with the highest elasticities is DENS with the elasticity ranging from a low of 1.49 to a high of 1.86 (Table 4). With respect to REBIT1 and REBIT2 no other explanatory variable has an elastic coefficient. However with respect to REBIT several variables have elastic coefficients including OWN, TOP3, DENS, RHAUL (GRAN version), and LGROTEXM. In general, the elasticity analysis indicates that REBIT is more responsive to DENS than any other variable in the model.

DENS has the highest t statistic in 5 of the 6 equations in Tables 2 and 3. The variables SHIP, GMIL, DENS, and LGROTEXM are statistically significant at the .01 level in all 6 equations. The variables GRAN, GRAN2, and POH are statistically significant at the .01 level in all 3 equations in Table 3 (GRAN version of the model).

The empirical results of the study indicate that the profitability (REBIT) of the grain-dependent short lines in the sample is not very high. A short line with the mean traffic density (all other variables at their mean values) is likely to receive REBIT2 approximately equal to MOW, interest, and income taxes (i.e. "break even"). The analysis of the paper also indicates that about 25 percent of the sample short lines have a high probability of requiring government assistance to continue operating. This study will help state DOTs to allocate assistance to those short line railroads which need aid and are most likely to be profitable, and thus avoid the negative impacts of abandonment on rural areas.

REFERENCES

Association of American Railroads. *Profiles of American Railroads*. Washington, D.C.: 1994.

Babcock, Michael W., Marvin E. Prater, John Morrill and Eugene R. Russell. "Competitiveness of Short Line Railroads." *Journal of the Transportation Research Forum* 34 (1995): 13-26.

_________, Marvin E. Prater and John Morrill. "A Profile of Short Line Railroad Success." *Transportation Journal* 34 (Fall 1994): 22-31.

_________, Marvin E. Prater, John Morrill and Eugene R. Russell. "Short Line Railroads' Performance." *Transportation Quarterly* 49 (Spring 1995): 73-86.

Dooley, Frank J. "Economies of Size and Density for Short Line Railroads." *MPC Report No. 91-2, Upper Great Plains Transportation Institute*, North Dakota State University, 1991.

Dooley, Frank J. and Julene M. Rodriguez. "Rail Service Levels for Grain Shippers Under Class I and Short Line Ownership." *Journal of the Transportation Research Forum* 29 (1988): 86-93.

Due, John F. "New Railroad Companies Formed to Take Over Abandoned or Spun-Off Lines." *Transportation Journal* 23 (Fall 1994): 30-50.

_________. "Abandonment of Rail Lines and the Smaller Railroad Alternative." *Logistics and Transportation Review* 23 (March 1987): 109-134.

Eusebio, Victor E., Stephen J. Rindom, Ali Abderrezak and John J. Rosacker. "Rail Branch Lines at Risk: An Application of the Exponential Survival Model on Kansas Duration Data." *Journal of the Transportation Research Forum* 33 (1993): 86-96.

Federal Railroad Administration, U.S. Department of Transportation. *Deferred Maintenance and Delayed Capital Improvements on Class II and Class III Railroads: A Report to Congress*. Washington, D.C.: U.S. Government Printing Office, February 1989.

_________. *Small Railroad Investment Goals and Financial Options*. Washington, D.C.: U.S. Government Printing Office, January 1993.

Fitzsimmons, Edward L. "Factors Associated with Intramodal Competition Reported by Small Railroads." *Logistics and Transportation Review* 27 (March 1991): 73-90.

Grimm, Curtis M. and Harry J. Sapienza. "Determinants of Shortline Railroad Performance." *Transportation Journal* 32 (Spring 1993): 5-13.

Office of Transportation Analysis, Interstate Commerce Commission and Federal Railroad Administration, U.S. Department of Transportation. *A Survey of Shipper Satisfaction with Service and Rates of Shortline and Regional Railroads*. Washington, D.C.: U.S. Government Printing Office. August 1989.

Prater, Marvin. *Long Term Profitability of Grain Dependent Short Line Railroads in the Midwest*. Unpublished Ph.D. dissertation, Kansas State University, Manhattan, Kansas, May 1997.

Sidhu, Nancy D., Albert Chaney, and John F. Due. "Cost Functions of Class II Railroads and the Viability of Light Density Railway Lines." *Quarterly Review of Economics and Business* 27 (Autumn 1977): 7-24.

Walter, Clyde K. and Henry J. McNair. "Viability Measures Applied to Iowa Shortline Railroads." *Journal of the Transportation Research Forum* 30 (1990): 275-285.

Wolfe, K. Eric. "The Downside Risk: An Analysis of Local and Regional Railroad Service Failures." *Journal of the Transportation Research Forum* 29 (1988): 124-137.

_________. "Financial and Demographic Conditions Associated with Local and Regional Railroad Service Failures." *Transportation Quarterly* 43 (January 1989): 3-28.

__________. "Long Run Financial and Demographic Differences Between Failed and Successful Local and Regional Railroads." *Transportation Journal* 28 (1989): 13-23.

ENDNOTES

1. A grain-dependent short line railroad is defined as a line haul short line whose grain carloadings are at least 25 percent of total annual carloadings.

2. Net profit (income) is the most commonly cited measure of profitability. We chose not to use net profit because it is much harder to obtain comparability between different firms since net income includes unusual and extraordinary income, income taxes, and interest which vary greatly between firms. Return on assets and return on equity are often used to compare profitability of firms. These variables were not selected since they do not remove tax rate variation between firms and are based on accounting values of the assets which vary quite widely according to the year in which the assets were purchased. In addition, there are substantial differences in the asset base between those firms which own their assets and those firms which lease. Return on equity cannot be used since some firms in the sample show negative equity. Thus, return on equity cannot be calculated for those firms. Also, some of the firms showing negative equity were subsidiaries of rail holding firms which have positive equity. Thus, the negative equity position of the rail firm is misleading.

3. For more details regarding the adjustment of EBIT for interfirm differences in government aid see Prater (1997: 73-77).

4. Fixed effects models were estimated to ascertain the effects on profitability due to individual firm differences. Unfortunately, the firm dummy variables are collinear with the other independent variables. Thus, very few of the independent variables are significant and the firm effects are significant for relatively few firms. Thus, fixed effects models are rejected for estimating REBIT. Also since the Durbin-Watson statistics of the estimated equations indicate no statistically significant autocorrelation and the robust standard error estimations indicate no heteroskedasticity for the OLS models, the random effects panel models are not used to estimate REBIT.

5. The only exception is the number of connections CONN, which changes from being statistically significant in the OLS estimation of REBIT1 and REBIT2 to statistically nonsignificant in the robust standard errors estimation.

6. The assumptions regarding the variables not in Table 5 are that the firm was established after 1987, is independent of other railroads, is not owned by shippers, and connects to only one other railroad firm (except when CONN is varied).

7. The amount of MOW required to keep the track in its present condition will vary greatly depending on the density of traffic, terrain, number and size of bridges, and many other factors.