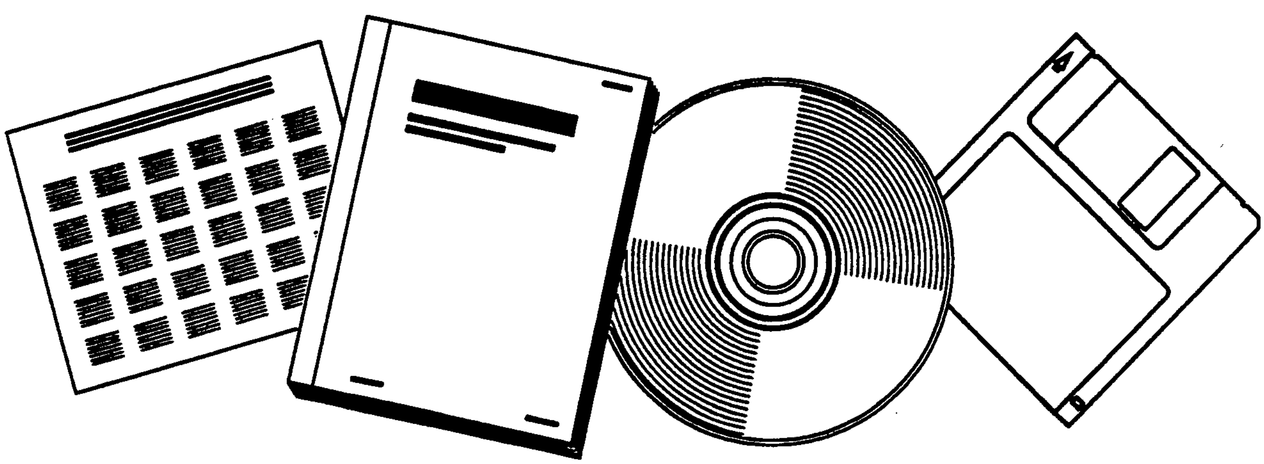
PB98-105505

LONG TERM PROFITABILITY OF GRAIN DEPENDENT SHORT LINE RAILROADS IN THE MIDWEST

JUL 97



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

Report No. K-TRAN:KSU-96-9
Final Report

PB98-105505

LONG TERM PROFITABILITY OF GRAIN DEPENDENT SHORT LINE RAILROADS IN THE MIDWEST

Michael W. Babcock
Marvin Prater
Eugene R. Russell
Kansas State University
Manhattan, Kansas

July 1997

K-TRAN

A COOPERATIVE TRANSPORTATION RESEARCH PROGRAM BETWEEN:
KANSAS DEPARTMENT OF TRANSPORTATION
THE KANSAS STATE UNIVERSITY
THE UNIVERSITY OF KANSAS

LONG TERM PROFITABILITY OF GRAIN DEPENDENT SHORT LINE RAILROADS IN THE MIDWEST

FINAL REPORT

Project No. K-TRAN: KSU-96-9

Prepared for
Bureau of Rail Affairs
Kansas Department of Transportation
and
Mid-America
Transportation Center

by

Michael W. Babcock
Marvin Prater
Department of Economics

Eugene R. Russell
Department of Civil Engineering

Kansas State University
Manhattan, Kansas

July 1997

1. **Report No.** K-TRAN: KSU-96-9	2. PB98-105505	3. **Recipient Catalog No.**
4. **Title and Subtitle** LONG TERM PROFITABILITY OF GRAIN DEPENDENT SHORT LINE RAILROADS IN THE MIDWEST		5. **Report Date** July 1997
		6. **Performing Org. Code**
7. **Author(s)** Michael W. Babcock, Marvin Prater and Eugene R. Russell		8. **Performing Org. Report No.**
9. **Performing Organization Name and Address** Kansas State University, Department of Civil Engineering, Department of Economics, Manhattan, Kansas 66506		10. **Work Unit No. (TRAIS)**
		11. **Contract or Grant No.** C-890
12. **Sponsoring Agency Name and Address** Kansas Department of Transportation, Docking State Office Bldg., Topeka, Kansas 66612		13. **Type of Report and Period Covered** Final Report Oct 1995 to Jul 1997
		14. **Sponsoring Agency Code** 106 RE-0082-01

15. Supplementary Notes

Additional funding was provided by the Mid America Transportation Center.

16. Abstract

In the Midwestern states, short lines are operating many thousands of miles of rural rail branchlines that otherwise might have been abandoned. Abandonment has several potential negative impacts on rural areas in the Great Plains region such as: 1) Lower grain prices received by farmers, 2) Higher transportation costs and lower profits for rail shippers, 3) Loss of market options for shippers, 4) Lost economic development opportunities in rural communities resulting in less diversification of employment, 5) Higher road maintenance and reconstruction costs.

If Short lines are an economically viable alternative to abandonment, then the potential negative effects can be avoided. As Class 1 railroad mileage declines, rural communities, shipper groups, and railroad entrepreneurs may ask for assistance in establishing short line railroads. In order to properly evaluate the question of financial assistance for short lines, the state Departments of Transportation (DOTs) need to know if short line railroads offer an economically viable mode of transportation. The objectives of this study are as follows:

1) Develop predictive models of long term profitability of grain-dependent short line railroads in the Midwestern states.
2) Identify the key factors influencing grain-dependent short line profitability by emperical estimation of the models developed in Objective 1.
3) Develop a quantitative profile of a grain-dependent short line that is likely to be profitable in the long term.

Short line profitability (the dependent variable in the analysis) is measured in the following ways: 1) Real Earnings Before Interest and Taxes (REBIT) per mile of track, 2) Real Gross Railway Operating Income (RGROI) per mile of track, 3) Real Operating Cash Flow Before Interest, Income Taxes, and Working Capital Changes (ROCF) per mile of track.

This report will help governmental decision makers allocate aid to those short line railroads which need aid and are most likely to be profitable. Using the equations, one can estimate the profitability of the railroad prior to income taxes, maintenance and interest expenses and non-interest governmental aid.

17. **Key Words** Short line, railroad, grain, midwest, profitability, economic aid, maintenance, economic development, branch line, impact, highway.	18. **Distribution Statement** No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. **Security Classification (of this Report)** Unclassified	20. **Security Classification (of this page)** Unclassified	21. **No. of Pages** 160	22. **Price**

Form DOT F 1700.7 (8-72)

PREFACE

This research project was funded by the Kansas Department of Transportation K-TRAN research program and the Mid-America Transportation Center(MATC). The Kansas Transportation Research and New-Developments (K-TRAN) Research Program is an ongoing, cooperative and comprehensive research program addressing transportation needs of the State of Kansas utilizing academic and research resources from the Kansas Department of Transportation, Kansas State University and the University of Kansas. The projects included in the research program are jointly developed by transportation professionals in KDOT and the universities.

NOTICE

The authors and the State of Kansas do not endorse products or manufacturers. Trade and manufacturers names appear herein solely because they are considered essential to the object of this report.

This information is available in alternative accessible formats. To obtain an alternative format, contact the Kansas Department of Transportation, Office of Public Information, 7th Floor, Docking State Office Building, Topeka, Kansas, 66612-1568 or phone (913)296-3585 (Voice) (TDD).

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the views or the policies of the State of Kansas. This report does not constitute a standard, specification or regulation.

ACKNOWLEDGEMENTS

This research project could not have been completed without the assistance and cooperation of many people. We are indebted to the Kansas Department of Transportation and the Mid-America Transportation Center for funding this project. Victor Eusebio, Mokhtee Ahmed, and John Rosacker were the KDOT monitors, and they managed the project in a professional manner. Special thanks also go to Dr. Mark McNulty, Dr. Bernt M. Bratsberg, Dr. Abdolamir Tavakkol, Dr. Aruna N. Michie, Robert E. Jackson, and the late Dr. Jarvin Emerson of Kansas State University who provided assistance with the formulation and estimation of the models in this study.

In addition, this project could not have been completed without the cooperation and help of the participating railroads and state Departments of Transportation officials.

TABLE OF CONTENTS

CHAPTER 4
DATA

CHAPTER 5
EMPIRICAL RESULTS

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

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. This national trend has also occurred in the Midwestern states. Since 1989, six short lines, operating 1457 miles of track, have been created in Kansas. Short lines now operate 2306 miles of track in Kansas, which is one-third of the total rail system in Kansas.

In the Midwestern states, 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 in the Great Plains region 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. Currently the DOTs of Midwestern states do not have this information. Accordingly, the objectives of the study are as follows:

1. Develop predictive models of long-term profitability of grain-dependent short line railroads in the Midwestern states.

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.

With regard to Objective 1, short line profitability (the dependent variable in the analysis) is measured in the following three ways:

Real Earnings Before Interest and Taxes (REBIT) per mile of rail track
Real Gross Railway Operating Income (RGROI) per mile of rail track
Real Operating Cash Flow Before Interest, Income Taxes, and Working Capital Changes (ROCF) per mile of rail track

Each of the above dependent variables are analyzed three ways: without adjustment, adjusted for maintenance of way (MOW) expenditures, and adjusted for both MOW and non-interest government aid.

The explanatory variables for the profitability measures in the predictive models of short line railroad profitability include the following:

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.
LAGGRP - number of railroad firms owned by a parent firm, lagged one year.

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.
LAGOWN - percentage of track owned by the railroad firm, lagged one year.
LAGTOP3 - percentage of the railroad's total traffic in the top three Standard Industrial Classification (SIC) codes, lagged one year.
LAGTOP32 - LAGTOP3-squared.
LAGGRAN - percentage of the railroad's total traffic which is grain, lagged one year.
LAGGRAN2- LAGGRAN-squared.
LAGPOH - percentage of the railroad's total traffic which is overhead traffic, lagged one year.
LAGDENS - number of carloads per mile of main-line track, lagged one year.
LGROTEXM- total real operating expense per mile minus real maintenance of way (MOW) expense per mile, lagged one year.
LAGRHAUL- ratio of the railroad's length of haul to gross main-line miles operated, lagged one year.
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 LAGGRP 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, and 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, most 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 railcars 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 LAGOWN is positive. Short lines which own their track incur depreciation and interest costs, but the latter does not affect the profitability measures used in this study. Railroads which lease their track incur leasing costs, which include both depreciation and interest costs, and higher leasing costs reduce the profitability measures employed in the analysis. Thus, since operating expenses under ownership of track are lower than operating expenses under lease, one would expect the sign of LAGOWN to be positive since profitability would be higher for short lines that own their track.

The theoretically expected signs of LAGTOP3 and LAGGRAN are indeterminate. It could be argued that LAGTOP3 and LAGGRAN 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 LAGTOP3 and LAGGRAN 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 LAGTOP32 and LAGGRAN2 are the squared values of the above variables. Both of these are expected to have negative signs since it is expected that LAGTOP3 and LAGGRAN will have maximum values.

The theoretically expected sign of LAGPOH 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 (LAGDENS) in the model may cause LAGPOH to be negative since overhead traffic is included in total traffic, but is priced at a below average level. Thus, the negative sign of LAGPOH may reflect the effects of price discounts on overhead traffic.

The theoretically expected sign of LAGDENS is positive. Since railroads have a high percentage of fixed costs and factor indivisibilities, 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.

The expected sign of LAGRHAUL 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 data to empirically estimate the models of short line profitability is obtained from 34 railroads operating in 17 states in the Midwestern region of the U.S. for the fiscal years 1986 through 1995. The data set 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 data sources include the short lines in the sample which provided balance sheets, income statements, and completed questionnaires. Other major data sources include railroad reports filed at the state DOTs of the 17 Midwestern states and also the publication *Profiles of American Railroads*, published by the Association of American Railroads.

The estimated models are lagged OLS models. The explanatory variables are lagged one year to prevent potential simultaneity bias and to enable the model to predict the values of the dependent variables. The models are estimated with LAGTOP3 as one of the explanatory variables, and the same models are estimated replacing LAGTOP3 with LAGGRAN. Since these two variables are highly correlated, multicollinearity occurs when both variables are in the same equation. A total of 18 regression equations are estimated.

The profitability of a railroad in a given year should be related more to that year's values of the independent variables than to lagged values of those variables. Thus some estimation power may be lost with a lagged (predictive) model. To determine if this is the case, the models are also estimated with contemporaneous (unlagged) independent variables. Predictive fixed-effects panel models are estimated to determine the extent of individual short line railroad effects.

The models with dependent variables adjusted for MOW only and those adjusted for MOW and non-interest government aid have more predictive power and statistical significance than comparable unadjusted models. The adjusted models consistently have higher adjusted R^2s, have more statistically significant variables, and have higher t-statistics for those variables which are significant. Excluding the explanatory variables with indeterminate signs, all the independent variables in the adjusted equations have the theoretically expected sign except ERA2. The models adjusted for MOW only and those adjusted for both MOW and non-interest government aid are relatively equal in explanatory power.

The adjusted R^2s, mean square errors, coefficients, and t-statistics of the predictive (lagged) models are similar to those of the contemporaneous (unlagged) models. Thus the lagged models do not lose any estimation power relative to the unlagged form of the model.

The models using LAGTOP3 as an explanatory variable have nearly the same adjusted R^2s and root mean square errors as those using LAGGRAN. The only differences are that the number of statistically significant variables and the t-statistics in the models using LAGTOP3 are slightly higher than those models using LAGGRAN.

The fixed-effect panel models are rejected since the dummy variables for individual firms are collinear with other explanatory variables, resulting in few of the explanatory variables and firm dummy variables being statistically significant.

Several criteria are employed to determine the key factors for short line profitability. One of these criteria is sensitivity analysis which identifies the explanatory variables that cause the greatest variation in real earnings before interest and taxes adjusted for MOW and non-interest government aid (REBIT2). Other criteria are the size of the elasticities and t-statistics of the explanatory variables.

In the sensitivity analysis, the key variables are LAGDENS, LGROTEXM, GMIL, and LAGTOP3. The elasticities measure the percent change in profitability in response to a 1.0 percent change in the explanatory variables. If the elasticity is > 1.0, it is referred to as elastic; if < 1.0 it is designated as inelastic. The only elastic explanatory variable is LAGDENS; all the others are inelastic. The variables LAGDENS and GMIL are statistically significant at the .01 level in all 18 regression equations. Other variables that are statistically significant at the .01 level for some of the models are LGROTEXM, SHIP, LAGPOH, LAGGRP, CONN, and LAGOWN.

The analysis indicates that the profitability of sample short lines is not very high. A railroad with the mean traffic density (all other values at their mean sample values) is likely to receive a REBIT2 approximately equal to MOW, interest, and income taxes. In addition, sample short lines with less than the mean value of traffic density (LAGDENS) have lass than a 50 percent chance of generating enough REBIT2 to pay MOW, interest, and income taxes (assuming these total $8,000). The analysis of the study also indicates that about 25 percent of the sample short lines have a high probability of requiring government financial assistance in order to continue operating.

Given that some short lines require government assistance to become profitable coupled with the negative consequences of railroad abandonment, we recommend that state governments consider financial assistance programs for short line railroads. For example, state governments could make grants and/or low interest loans available to short line railroads for the purposes of track rehabilitation or for purchasing rural branchlines. Short line railroads need access to low interest loans due to the long term nature of railroad assets. An alternative recommendation is for state governments to guarantee loans to short line railroads. Commercial banks have been reluctant to make loans of the size needed by short lines since most commercial banks have little experience making loans to railroads, the salvage value of the lines are relatively low in relation to the financial exposure of the lending institution, and the Class I railroads have been unable to operate these lines profitably. Loan guarantees will remove much of the uncertainty and risks which prevent local banks from financing short line railroads.

Another recommendation is the creation of a state financed disaster insurance pool which will subsidize the cost of insurance for short line railroads. Due to the relatively low profitability of many short line railroads, they are uninsured for catastrophic losses such as floods and fire. Uninsured short line railroads may be unable to continue service after sustaining major losses since they may be underfinanced and have heavy debt loads which prevent increased borrowing. A state financed disaster insurance pool would prevent this problem.

States should consider assistance for specific maintenance activities. For example, states could assume responsibility for maintaining highway crossings. The costs of maintaining these railroad crossings is particularly onerous on low density railroad lines, affecting the survival probability of some short line railroads.

Another maintenance activity which would result in major savings to short line railroads is for governmental units to mow and clear brush around railroad crossings. Since highway crews already mow along roads, the incremental cost of doing this is virtually zero.

Another recommendation is the creation of a state railcar pool which would lease covered hopper cars from car leasing companies and sublease those railcars on a short term basis to short line railroads. Short line railroads are often limited in the amount of service they can provide due to their inability to obtain railcars. This problem is worse when the short line connects to only one other railroad. Nine of the 34 firms in this study (26 percent) connect to only one other railroad. This system has been employed successfully in the state of Washington.

This study will help governmental decision makers allocate aid to those short line railroads which need aid and are most likely to be profitable. From the regression equations provided, the decision maker can estimate the profitability of the railroad prior to MOW expenses, interest expenses, income taxes, and non-interest government aid. In addition, the decision maker can determine the probabilities for specific levels of profitability.

The models in this study account for over 70 percent of the variation in short line railroad profits. Due to inadequate data, other variables that may affect short line profitability such as managerial effectiveness and intermodal competition were not included in the profitability analysis. Thus, the decision maker will need to couple the results of this study with intuition when allocating aid to short line railroads based on these models.

The benefits of governmental assistance to short line railroads will often exceed the costs of allowing the track to be abandoned. All forms of governmental assistance described in the recommendations can increase the probability of short line survival, but some of the least costly recommendations probably have higher benefit to cost ratios. A good transportation infrastructure, including short line railroads, is a required condition for economic growth. Thus, selective assistance to those short line railroads needing help and having a reasonable probability of success will help preserve the rail infrastructure which is required to maintain the economic health and tax base of rural areas.

CHAPTER 1
INTRODUCTION

1.1 General problem statement

Agriculture is a major part of the economy in the central United States. Since this region of the country is distant from domestic and foreign areas of food consumption, low cost and efficient rail transportation is needed for the continued economic viability of agriculture in the central United States. The recent abandonment of many rail lines has resulted in the loss of rail service for many rural shippers (Babcock, et al, 1994a).

Abandonment of rail lines could have adverse economic consequences upon smaller communities and sparsely populated rural areas. These consequences include (Babcock, et al, 1994a):

- 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.

The negative effects of abandonment can be avoided if short line railroads are economically viable. Therefore, research is needed to discover the determinants of short line profitability.

The purpose of this study is to develop predictive models of long term profitability for grain dependent short line railroads in the Midwest, identify the factors influencing their profitability, and to develop a quantitative profile of those short line railroads likely to be profitable in the long term. Profitability is defined in the accounting sense of the word. Thus, implicit costs are not deducted from the measures of profitability. A grain dependent railroad is defined as one where agricultural products comprise more than 25 percent of the total carloads hauled, and a short line railroad is defined as a line-haul railroad other than a Class I railroad. Thus, this definition of short line railroads includes both regional and local railroads[1]. The Association of American Railroads (AAR) defines a regional railroad as one which operates 350 or more miles of road and/or earns revenue of at least $40 million. A local railroad is neither a Class I railroad nor a regional railroad and is primarily engaged in providing line-haul freight service rather than switching services.

Many factors caused the post-1970 growth of the short line railroad industry. The first factor was the establishment of Conrail by Congress in 1973 (Federal Railroad Administration (FRA), 1989). The reorganization of the Milwaukee Road and the bankruptcy of the Rock Island led to the formation of several regional and short line railroads. In addition, the financial problems of Class I railroads led to federal deregulation of railroads which began in 1973 with the 3-R Act. Operational subsidies and rehabilitation assistance for light density branch lines were provided by the 3-R Act, the 4-R Act of 1976, and the Local Rail Service Assistance Act of 1978 (Levine et al., 1982). Both the 4-R Act of 1976 and the Staggers Act of 1980 made it easier for Class I

---

1 The Association of American Railroads (AAR) classifies a regional railroad as a Class II railroad and a local railroad as a Class III railroad.

railroads to abandon mileage that was not profitable. There was also legislation that ensured the first right of acquisition to entities willing to operate lines scheduled for abandonment (Due, 1984). During this period, many states enacted assistance programs to assist firms willing to operate lines abandoned by Class I railroads. Beginning in 1986, Class I railroads began to structure the disposal of low density lines in ways that encouraged a continuing relationship between the buyer and seller (Mielke, 1988). These sales were challenged in court by the railroad labor unions as a breach of their labor contracts with Class I railroads. The Supreme Court in the *Pittsburgh and Lake Erie Railroad v. Railway Labor Executives' Association* case, held that labor protection is not required in short line sales (Thoms, Dooley and Tolliver, 1989).

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. These new short lines operate 21,028 miles of rail track (Levine, et al, 1988; AAR, *Profiles of American Railroads*, 1993). By 1993, short line and regional railroads operated 45,400 miles of track in the U.S. which is 27 percent of the national rail network (AAR, *Profiles of American Railroads*, 1993). Since 1989, six line-haul short lines, operating 1457 miles of track, have been created in Kansas. Short lines now operate 2306 miles of track in Kansas, which is one-third of the total rail system in Kansas (Kansas Department of Transportation, 1996).

1.2 Advantages of short line railroads

Short line railroads are able to operate rail lines at a cost lower than that of the previous Class I railroads (Due, 1984). The cost savings come from three main sources: labor, equipment, and maintenance of way costs. Labor costs are lower due to more flexible work rules[2], smaller crews, and lower wages and benefits. Short lines formed since 1970 operate with an average of 0.54 employees per mile of track compared with 1.88 employees for Class I railroads (Dooley, 1991). Dooley also found that the Burlington Northern railroad pays an average hourly wage that is 152 percent to 247 percent higher than that paid by the typical short line railroad. In addition, the average benefit package of Burlington Northern is 35 percent of the annual salary compared to 17 percent for the average short line employee (Dooley, 1991).

Equipment costs are lower since short lines operate smaller locomotives and use less expensive used equipment than Class I railroads. Maintenance of way costs are 20 percent less than those of the former Class I railroads (Dooley, 1990, 1991).

Several studies have noted that short line railroads have been more responsive to the needs of their customers than the former Class I railroads (Due, 1984; Babcock, et al, 1994a, 1994b, 1995). Traffic retention and growth has been impressive on many of the short line railroads (Rockey, 1987). Thus, short line railroads could operate profitably on many of the lower density lines that Class I railroads have abandoned.

---

2 Most short line railroads do not use union labor. Those that use union labor have more flexible and cheaper labor contracts than Class I railroads.

1.3 Barriers to the success of short line railroads

Despite the cost and service advantages of short line railroads, they face numerous barriers to their long term profitability. One of the most serious obstacles is the accumulated deferred maintenance on the lines which they operate. Most of the track acquired by short lines is secondary trackage that has suffered declining traffic levels over a period of years. Thus, the Class I railroad did not maintain this track prior to abandonment or sale. By the time the track is sold, it has had five or more years of deferred maintenance and often is being operated under slow order. This deferred maintenance is inherited by the short line railroad, resulting in expensive rehabilitation of track during the formative years of the short line and/or higher operating costs due to reduced operating speeds (FRA, 1989).

In addition, many of the short line railroads have taken over lines having rail which is too light to handle fully loaded 100 ton hopper cars (Due, 1984). When these lines were originally built, grain was hauled in box cars. Thus, these lines did not need to carry rail cars weighing more than 70 tons. The advent of the modern 100 ton hopper cars made these lines obsolete. Since the traffic on these lines was inadequate to justify the replacement of rail, the Class I railroads either abandoned or sold the lines. Although the replacement of ties is usually feasible for short line railroads, the replacement of rail often is not (Due, 1984). Also, many short lines will not have sufficient funds to repair or replace the deteriorating bridges on their lines (Jones, 1996).

Compounding the problem of track and bridge rehabilitation, many short line firms used much of their equity and debt financing to purchase the line, leaving no source of funds for needed rehabilitation. Thus, short line railroads need a source from which to borrow the necessary funds for rehabilitation. Lacking this funding, some short line railroads have been forced to shut down (FRA, 1989).

The profits of short line railroads may vary more than the profits of Class I railroads. This higher risk would be expected due to less shipper, commodity and geographical diversification. Since short line railroads serve a smaller geographic area, they would have more relative exposure to catastrophic events[3], and, since they depend on fewer customers, would be more affected by the closure of a shipper firm.

Short line railroads are often heavily dependent upon one or two major commodities for most of their traffic (Dooley, 1990). Should production of the major commodity be seasonal and/or have large variations in annual production, the profits of the railroad would be highly variable. Thus, grain dependent short line railroads would be expected to have a much higher risk than railroads having a more diversified commodity base or those hauling commodities with more stable production.

Another challenge faced by short line railroads is their dependence upon Class I railroads for freight cars and market access (Dooley, 1990). In cases where the short line connects to only one railroad, the Class I railroad has the stronger bargaining position, resulting in revenue splits that favor the Class I railroad and high switching charges. When short line railroads connect to only one Class I railroad, they are often heavily dependent upon that railroad for rail cars. In addition, the short line firm must avoid

---

3 Catastrophic events include items such as floods, fires, and derailments.

doing anything which may provoke the larger railroad to withhold cooperation or overhead traffic.

1.4 Financial assistance needs of short line railroads

Past governmental assistance to short line railroads has included grants to purchase or rehabilitate track, purchase of track which is then leased to rail firms, low-interest loans, government guarantees of loans, disaster relief, operating subsidies, and provision of materials and labor to help maintain the track. While government continues to be active and supportive of short line railroads, funds available from public sources have been greatly reduced (Rockey 1987). Currently, the most prominent need of most short line railroad firms is adequate financing to rehabilitate the track. The federal government is unlikely to underwrite the expected needs of short line railroads since the Local Rail Freight Assistance (LRFA) program is capable of funding only a small fraction of the industry's expected growth.

Local and regional banks have been reluctant to fund short line railroad firms due to their lack of experience with the railroad industry. Most Class I rail firms and short line holding companies borrow funds from banks specializing in railroad loans, but these banks have a minimum loan amount that exceeds the needs of most small independently-owned short line railroads. The high cost of interest on many of these loans is more than short line railroads can afford and most of the loans are of too short duration in relation to the duration of the projects financed. Thus, the individual states will be forced to choose between abandonment and providing financial assistance to short line railroads.

1.5 Benefits received by government from profitable short line railroads

Governmental units would gain three major benefits if short line railroads were profitable. The first benefit is the reduction of heavy motor carrier traffic on highways and secondary roads. Studies have indicated motor carrier traffic greatly increases the costs of maintaining these roads and the damage done by large truck traffic greatly exceeds the taxes paid by those trucks (Babcock, et. al., 1994).

The second benefit is the retention of a viable and healthy tax base in rural areas. Agriculture and agribusiness are a major part of the Central Plains economy. Since the Great Plains is geographically remote from major domestic and foreign food consumption centers, the economic viability of Great Plains agriculture depends on efficient, low cost rail transportation.

The third benefit is the socially desirable goal of encouraging transportation modes which are most fuel efficient and contribute the least to pollution and other environmental problems. Rail transportation is much more fuel efficient than motor freight and contributes much less to air pollution.

1.6 Objectives of this research project

Given the scarcity of public funds, coupled with the precedent of short line assistance in Midwest states, the Departments of Transportation (DOTs) of Midwest states need quantitative information to help allocate scarce funds to the short lines that have the best chance of long term profitability. The DOTs do not have this information.

The major objectives of this study are to:

- Develop predictive models of long-term profitability for grain dependent short line railroads in Midwestern states.
- Identify the key factors influencing profitability by empirical estimation of the models.
- Develop a quantitative profile of a grain-dependent short line railroad that is likely to be profitable in the long term.

1.7 Expected benefits of this study

This study will aid governmental units in evaluating the probabilities that short lines applying for governmental aid will succeed. The research will help identify railroads which have low probabilities of profitability, thus preventing agencies from funding losing causes. The research will also help identify those railroads which should be profitable without governmental aid, preventing the waste of tax monies on those firms not needing assistance. Lastly, this study will provide a quantitative model which will aid governmental agencies in allocating tax monies among short line railroads.

Operators of short line railroads and lending institutions serving short line railroads will receive residual benefits from this study. Since short line railroads have limited amounts of industry cost and profitability data, this study will aid them in estimating the Net Present Value (NPV) of a prospective purchase. In addition, railroad firms can use the data from this study to evaluate the effectiveness of their management by comparing their own financial results with that predicted by the model.

Banks and other lending institutions will benefit since this study will provide needed industry data which will help them to better determine the credit worthiness of individual short line railroads. Increased availability of financial data for short line railroads will help remove the reluctance of smaller banks to make loans to short line railroads.

1.8 Comparison of this study to previous short line railroad research

Much of the past work on the profitability of short line railroads has little quantitative or financial base. Wolfe (1988, 1989a, 1989b) compared the financial and operating statistics of surviving short line railroads to those which failed, but did not develop a quantitative model to predict short line profitability.

Prior studies have not been able to predict future profitability of short lines since they employ current values of independent variables. This study will use ordinary least square regression (OLS) techniques to predict future profitability of short line railroads. This will be done by regressing the prior year's values of the independent variables upon the current year's measure of profitability. Thus, this study will allow one to use current data to predict future profitability.

Another problem of prior studies is their failure to remove inter-firm differences prior to analysis, thus making it difficult to compare the profitability of different firms. For example, if the firms in the study have large differences in their income tax rates, the use of earnings before interest and taxes as the profitability variable will give better comparability between firms than the use of other profitability measures. In addition, removing inter-firm differences before statistical analysis will result in much lower mean square errors. Other common inter-firm differences that affect profitability, which are ignored in prior studies, are the relative amounts of governmental aid and the relative levels of track maintenance.

Another difference between this study and prior studies is that the profitability of rail lines is studied over a significant period of time. This allows measurement of trends, and the study of long run profitability. In addition, the effects of unusual years are easier to detect.

CHAPTER 2
LITERATURE REVIEW

This chapter reviews the findings of other railroad studies, which are generally qualitative in nature, regarding factors important to the success and failure of short line railroads. Next, other short line railroad cost and profitability studies, which generally use quantitative methods, are reviewed.

2.1 Studies identifying factors important to the success of short line railroads

John Due (1984) summarized the experience of all short lines formed between 1970 and April 1984 and attempted to determine the factors related to their success. The data was gathered from State Departments of Transportation and directly from 122 railroad companies that operated 151 lines.

He identified seven factors required for success: competent, experienced management; shipper support; adequate quality of track at a reasonable price; adequate traffic; access to more than one connecting carrier; adequate capital; and state or local government assistance.

To determine why some rail lines failed, Due surveyed shippers, former employees and regulators having contact with short lines which had failed in the past. The most frequently cited causes of failure were inadequate traffic, physical problems, management problems, lack of shipper support, lack of capital, and lack of fair rate division. Specific occurrences leading to failure included:

1) A sharp decline in traffic from the shutdown of a major shipper or a shift in business practices.

2) Increased truck competition, particularly of a backhaul nature.
3) Physical hazards such as fire destroying trestles, washouts, or bridge collapse.
4) Loss of the sole connecting line.
5) Cancellation of joint rates by the connecting carrier or a surcharge imposed by the major carrier on joint traffic.
6) A serious derailment.

Due concludes that many of the short lines are economically viable without subsidies. If this is the case, the sale of these lines by major railroads to local short lines provides a potential net gain to both railroads, as well as the shippers and the communities served.

Due extended his analysis of the short line railroad industry (Due 1987). He concluded that no short line can succeed without adequate traffic since fixed costs cannot be reduced below certain levels. "Adequate" means the railroad originates or terminates 20 to 40 cars annually per mile of line. The minimum traffic required for viability of a short line varies according to the frequency of operation, condition of the track, required speed, rate levels, and short line share of joint rates. Success also depends on management having experience in the rail industry. Other relevant factors include adequate capital, adequate track condition, flexibility in the use of labor, general shipper support, and the cooperation of connecting Class I railroads.

Babcock, et al (1994a, 1994b, 1995a, 1995b) evaluated the economic viability of short line railroads. One goal of the study was to measure shipper evaluation of the railroads' price and service performance. If shippers believe short lines provide competitive service relative to other transportation modes, then it can be assumed short lines have a good chance of success. The shippers were divided into two groups: grain and non-grain. They evaluated the price-service performance of the short line railroads serving them in three ways: independent of other transportation modes, compared with motor carriers, and compared with their previous Class I railroads.

Grain and non-grain shippers on both Iowa and Kansas short lines indicated general approval of their short line railroads, rating them as better than their previous Class I railroads. The grain shippers indicated a greater improvement than did the non-grain shippers. After Class I railroads were replaced by short lines, 40.5 % of the shippers indicated they shipped more by rail while 15% shipped less. Both shipper groups indicated that short line railroads had better rates than motor carriers, but rated short lines as worse than motor carriers on service characteristics related to market access, transit time, and frequency of service.

A second goal of the study was to identify the factors which determine the success of short line railroads. This was done by interviewing short line railroad executives, shippers, and Iowa Department of Transportation officials. The factors identified were grouped into six major categories: traffic components, management and labor components, relationships with Class I railroads, financial, track quality, and governmental assistance.

Traffic components included adequate traffic density, non-seasonal traffic, diversified commodity base, and high valued products included in the traffic base. Adequate traffic density was identified as a key factor by all groups. Railroad executives indicated that excessive reliance on seasonal traffic, such as grain, has a negative effect on profitability. Short line shippers emphasized the importance of careful analysis of potential traffic by short line operators before the purchase of the line. Shippers stated that short line railroad operators have a significant advantage over Class I railroads in that they are located much closer to the shippers, and thus are better able to understand the needs of the shippers which leads to increased traffic.

Important factors included in the management and labor components are a management team experienced in the rail industry and the ability to market rail transportation services. The management must be able to balance tight control of operating costs with a level of track maintenance which allows good service to shippers.

The railroad executives stressed the importance of good relationships with Class I railroads. Connections with more than one Class I railroad increases shipper access to additional markets, increases traffic density, provides access to needed rail cars, and promotes the bargaining power of the short line with regard to revenue splits, car hire fees, and switching charges. These executives stressed the importance of securing commitments from Class I railroads prior to purchasing the railroad, while the short line is still in a good bargaining position. These commitments include guaranteed access to Class I overhead traffic, provision of an adequate number of rail cars, and the right of the short line to establish its own prices for local traffic. Since the success of short line railroads depends upon attracting adequate traffic, an opportunity to set prices which are competitive with other modes is critical.

Financial components which aid the success of a short line railroad are a low purchase price or lease payments, and adequate capitalization. All groups interviewed stressed the importance of not paying "too much" for the line. If the purchase price does not reflect conservative estimates of traffic and revenue, the short line may have insufficient cash flow to service the debt, resulting in service quality problems and insolvency. Adequate capitalization allows the short line to purchase the correct number and type of locomotives and to immediately begin rehabilitation of the track. The railroad executives stressed the importance of investing in track rehabilitation so the railroad could provide high quality service which will attract traffic.

The condition of the track is an important determinant of short line success. If the track needs rehabilitation, it is critical to have a source of low interest loans. Railroad executives noted that profitable short lines can become unprofitable should they fail to reinvest the cash flow from the first several years of operation into track maintenance and rehabilitation.

Short line executives and shippers agree that state financial assistance is important to the survival and expansion of the short line railroad industry. Without government loan guarantees, lenders are reluctant to lend money for track rehabilitation. If the railroad would be unable to repay the loan, the salvage value of the track would rarely be enough to pay off the loan.

The factors which influence the profitability of short line railroads are highly interrelated. Although all of these components are not required for a short line railroad to be successful, a successful short line will have a majority of the above components.

The Federal Railroad Administration of the U.S. Department of Transportation (1989) explored the development of small railroads from 1970 through 1988, assessed the current condition of small railroad lines, and estimated the need for rehabilitation on those lines. The statistical data in this report comes mainly from *Profiles of U.S. Railroads*. Additional information was obtained from a Federal Railroad Administration (FRA) survey of 458 independent regional, local, and switching and terminal railroads. The FRA received responses from 358 of these railroads.

The FRA concluded that although most of the newly formed small railroads would be only marginally profitable, most of them would be able to provide service and remain in business. The main factors determining the success of a small railroad are the nature of the traffic available, the competition from trucks and other railroads, and the rates that can be charged.

Common problems facing newly formed short line railroads include overestimating the amount of new traffic that can be attracted; inaccurate figures on existing traffic; and the inability to recover traffic that had shifted to other modes of transportation. In addition, the FRA concluded that some operators paid too much for the lines given potential profit.

Despite these problems, the FRA found that less than 4,000 miles of railroad line operated by small railroads has gone out of service since 1980. This averages less than 2.3 percent per year of the total mileage operated by this sector of the industry.

2.2 Studies of short line railroad cost and profitability

Sidhu, *et al*, (1977) attempted to determine how the volume of traffic and length of haul influence small railroad costs per ton mile and to determine the economic viability of light traffic rail lines. The authors studied two sets of cross sectional data in an attempt to derive the long run cost function of small railroads, assuming that firms have made all feasible long run adjustments.

The first sample consisted of 209 Class II railroads and utilized data for 1968 from ICC published statistics. The second sample consisted of 44 Class II railroads and used 1973 data obtained from ICC reports filed by the lines. No attempt was made to merge the 1968 and 1973 samples or to compare the findings of the two years due to differences in the samples and the data available.

The authors concluded there is evidence of substantial economies of scale relative to traffic density and those economies were far greater for regional railroads than for main lines. They concluded that viability of railroads with traffic between 50,000 and 200,000 ton miles per mile of line is dependent upon which main lines the railroad connects with, length of haul, and ability to minimize costs. Short lines with traffic between 200,000 and 800,000 ton miles per mile of line and below 25 miles in length of haul are almost certain to be viable unless the main line haul is very short. Railroads having more than 800,000 ton miles per mile of line are viable even without a main line connection.

The authors also found that maintenance of way and transportation rail line, the two largest components of cost, are influenced by volume but not by average length of haul. Therefore, overall costs per ton mile are not influenced as much as expected by the length of haul.

The study concludes the economic feasibility of a short line is a function of its traffic density, the length of haul on both the short line and the connecting main lines, and the costs of shipping by an alternate mode.

Hirschey (1979) investigates the relationship between light density line output and costs. He used 1973 costs developed by United States Railroad Association (USRA) for 300 individual branch lines located in 17 Northeastern states and estimated the cost function for 10 U.S. regions. Hirschey uses a model that relates long run incremental cost to various output characteristics for both on-branch and off-branch rail service. These include quantity, distance, bulk, and frequency.

He found significant scale economies for on-branch traffic density with elasticities between 0.24 and 0.32. For off-branch service, the elasticity of traffic density was close to 1.0, indicating no economies of scale. Other cost elasticities with respect to various variables are as follows:

	On-Branch	Off-Branch
Distance	0.24 to 0.47	0.33 to 0.35
Tons per Carload	0.17 to 0.32	0.49 to 0.52
Frequency of Service	0.24 to 0.28	

Tenpao Lee (1984) used the translog and generalized Leontief models to estimate railroad cost behavior. He used the cost data of 34 freight hauling Class I railroads for the years 1980 and 1981.

From both models, Lee concludes the railroad industry has substantial returns to traffic density and average length of haul and small returns to firm size. In addition, Lee concludes the rail industry had excess capacity for 1980 and 1981 traffic levels. From the cost functions, Lee concludes capital inputs may be easily substituted for labor inputs. Labor and capital inputs are not as easily substituted for fuel inputs, though. He identifies labor as the major component of total railroad costs. Since the price elasticities of all inputs were less than 1.0, the quantity used of all inputs was inelastic with regard to input price.

Wolfe (1988) attempted to identify, explore, and quantify the underlying causes of business failure of short line and regional railroads in the United States. A long time frame (1970 - 1987) was chosen to help evaluate the effects on railroad viability of business recessions, energy crises, interest rate fluctuations, and deregulation. In some cases the data went back as far as 1960.

Wolfe's data sources included *Profiles of U.S. Railroads* assembled by the Association of American Railroads (AAR), *American Shortline Railway Guide* by Lewis, studies by Due, and AAR files on railroads that had been identified as failures or had released their codes for reuse. The financial data came from *Moody's Transportation Manual*, the ICC's file of annual railroad reports, and surveys sent to each railroad and its state's Office of Transportation.

Wolfe determined that 136 line haul and 33 switching and terminal railroads had experienced service failures between 1970 and 1987. Wolfe obtained data on more than 70 failed railroads and paired each of them with a successful railroad of similar type, year established, commodities carried, and geographic region. Over 50 financial and demographic characteristics were assembled for each railroad.

Wolfe found that the 1970 to 1987 five year short line failure rate (a measure of how soon a business fails after it is started) of 30 percent is close to the long term historical failure rate of 29 percent for all railroads. During the period between 1980 and 1987, the five year failure rate of short line railroads increased to 42 percent due to several factors including economic conditions. Nevertheless, these failure rates are less than the 56 percent figure experienced by all firms in the economy.

When Wolfe compared the relative failure rates per 10,000 firms for the period 1980 to 1987, he found that local and regional railroads had a failure rate of 3.02 percent, motor carriers had a failure rate of 1.39 percent, and all firms in the economy had a failure rate of 0.93 percent.

From his data, Wolfe identified twelve key factors underlying failures of local and regional railroads:

1) Limited Traffic
2) Economies of Size and Density
3) Single Factor Reliance
4) Traffic Balance
5) High Rehabilitation Costs
6) Loss of Financial Aid
7) Competition
8) Insurance
9) General Economic Conditions
10) Loss of Key Management Personnel
11) Inexperienced Management
12) Realistic Business Planning and Flexible Financial Instruments

Wolfe found that limited traffic was cited as the dominant cause of failure in almost one half of the cases. This low traffic level was found to be caused by a variety of reasons including: depressed demand in primary or secondary industries; the closing of a dominant supplier's plant; no longer a need for railroad service; and excessive optimism of the market potential.

Regarding economies of scale, Wolfe found that relatively small railroads must have relatively large traffic bases in order to be cost competitive. These economies exist when average costs declined due to haul returns (increases in the number of miles of track operated) and due to density returns (increases in the number of revenue ton miles per mile of track).

From the scattergrams of data from successful railroads, Wolfe found that both operating expenses and total costs per ton mile declined significantly as the number of miles of track operated increases. Generally, economies of size in miles of track were nearly exhausted at 75 miles for line haul railroads. However, he also observed that similar economies of scale could be obtained by efficient railroads that operated as few as 20 miles of track. In addition, Wolfe found significant differences when comparing the average length of the line of failed local and regional railroads (31 miles) with that of successful ones (53 miles).

Wolfe also noted that average unit costs tended to be lower when a railroad had more than 250,000 revenue ton miles per mile of track (RTMPMT). However, efficient railroads could achieve the same economies of density with as little as 90,000 revenue ton miles per mile of track. The fact that his results were 50,000 RTMPMT higher than those of Sidhu was attributed to larger capacity freight cars and more fuel efficient locomotives. Wolfe also found a statistically significant difference between the traffic densities of failed local and regional railroads (averaging 253,000 RTMPMT) and the traffic densities of similar successful railroads (averaging 434,000 RTMPMT).

Wolfe states that local and regional railroads often depend on a single shipper, industry, or other railroad for the majority of their business. Thus, the risk of those local and regional railroads failing is tied to a single entity. He notes a statistically significant difference between failed railroads' single commodity concentration ratio of 77 percent and that of successful railroads of 68 percent. In addition, lines that relied on metallic ore or building materials faced more volatility in the number of carloads hauled than those lines that relied on coal and chemical traffic.

Traffic balance also plays an important role in determining a railroad's costs and ultimate viability. According to Wolfe, a balance between cars originated and cars terminated can reduce average unit costs. The successful railroads averaged 2.5 carloads originated to every carload terminated, whereas the failed railroads averaged 3.3 carloads originated to every car terminated.

The second leading cause of failure in Wolfe's study was high rehabilitation costs. In nearly 20 percent of the cases, failure was attributed to substandard track, structures, or equipment. In this situation, poor track often led to poor service, which resulted in decreased traffic.

Since Class I railroads are usually self insured, except for catastrophic losses, insurance cost increases have affected local and regional railroads more than the Class I railroads. In addition, according to Wolfe, local and regional railroads generally have higher premiums since they require smaller deductibles. Even with insurance, one significant accident can place a local or regional railroad at risk.

High interest rates can affect the viability of railroads. In high interest periods, all businesses minimize their inventories by switching to carriers with faster transit times and smaller shipment sizes. This results in a switch from rail to truck.

Wolfe notes that a lack of contingency plans has also affected the viability of local and regional railroads. This became critical in cases where the railroad was heavily dependent on debt and had failed to recognize the effect of business cycles on the production and sale of commodities the railroad depended on.

Wolfe concludes that local and regional railroads have been relatively successful since more than 80 percent remain in business, but feels that it is too soon to be able to assess their long term viability.

Wolfe (1989) tried to determine if certain financial and/or demographic ratios can be employed as a method of assessing the relative viability of local and regional railroads. The study does not consider other important factors such as the economy, the competitive environment, and managerial expertise that also relate to the success of a particular railroad.

Wolfe's conclusions are derived from the same data as his 1988 paper and the methodology is the same as that of the other study. Of the three models Wolfe developed, the best model correlated three variables to railroad success: ratio of operating revenues to total assets, three year compound growth rate of operating revenues, and fixed charge coverage. The best model that Wolfe developed correctly classified the success or failure of railroads up to 96 percent of the time for the final year and about 73 percent of the time in the preceding three years. Thus, Wolfe concludes that his model does not include all the variables that can predict service failures.

From his initial results, Wolfe found debt played a much larger role in the financing of failed local and regional railroads than in the successful railroads. The successful railroads averaged 0.89 debt to equity, 0.43 debt to asset, and 0.58 total liability to asset ratios compared to 1.93, 0.73, and 0.90 respectively for failed local and regional railroads.

Wolfe also noted that the failed railroad was usually smaller in mileage than the typical successful one. For the 18 year data base, the failed railroads were two thirds smaller than the successful railroads and had long run debt to equity ratios that were over twice as high.

In "Long Run Financial and Demographic Differences Between Failed and Successful Local and Regional Railroads," Wolfe gives a more complete description of the ratios and characteristics tested in the earlier studies. The data and methods are the same.

Due to the small size of the railroads tested, Wolfe states that liquidity and cash flow are important in determining railroad viability. Those railroads experiencing cash flow or liquidity problems often need to borrow more money. However, Wolfe found that the degree of leverage among the failed local and regional railroads prevented them from borrowing more money. Of all the liquidity variables, constant dollar cash flow was the best discriminator between successful and failed railroads. This variable was significant at the .01 level for up to nine years prior to failure.

Efficiency variables test the ability of the local and regional railroad's assets to generate income. Wolfe also states that asset turnover can be interpreted as a proxy for returns to density. Wolfe found that successful railroads overall were able to generate 59 cents of revenue for every dollar of total assets and 68 cents for every dollar of fixed assets. This was more than three times that of their failed counterparts.

Failed railroads had negative retained earnings to net investment ratios for as long as 13 years prior to failure. Wolfe states that the inability of failed railroads to maintain cash flow and increase retained earnings reduced their ability to fund capital expenditures.

Wolfe states that the operating ratio is one of the best measures of management's ability to handle a changing environment. While successful railroads generally had operating ratios of less than 75 percent, failed firms often had operating ratios exceeding 100 percent for up to twelve years before failure.

Other factors Wolfe found to be significant were returns to density and dependency on single industries or firms. Wolfe states that the successful railroads were able to take advantage of economies of scale and density. Failed railroads seemed to be unable to generate enough traffic to be competitive. Also, when a railroad was dependent on one or two commodities, that railroad's fortunes were linked to those of its major commodities.

Wolfe concludes reduced traffic, rather than entire plant closings, was usually associated with railroad failure. This loss of traffic results in higher overall average costs which undermine the carrier's competitive position. Failed railroads seemed to be much more susceptible to slight traffic reductions than those railroads which were successful.

Walter and McNair (1990) calculated the financial ratios for twelve of the short line railroads in Iowa, and used those ratios as inputs to viability and bankruptcy models.

The authors used 1986 data for 14 Class II and Class III railroads in Iowa reported to the Iowa Department of Transportation. The railroads were rated according to their performance compared to that of viable railroads for traffic density, cash flows, debt to asset ratio, operating ratio, and earnings as a percent of total assets.

The study found that only the Iowa Interstate Railroad had traffic density in the highest category, those having more than 800,000 ton miles per mile. Five of the short lines had traffic between 200,000 and 800,000 ton miles per mile, but exceeded the length of haul guideline of 25 miles. This meant that these lines would need additional revenue to maintain their track. Three railroads had traffic less than 50,000 ton miles per mile and thus were not likely to survive.

When comparing the averages of the other four viability measures along with the density of traffic, the Cedar Rapids and Iowa City and the Dakota and Iowa railroads were better than the averages for successful railroads for all measures. The Appanoose County, the Chicago, Central & Pacific, the Iowa Interstate, and the Iowa Northern railroads were all weaker than the averages of successful railroads in four or more viability categories.

When using Altman's Z Model, a discriminant analysis, the study found that the Cedar Rapids & Iowa City, the Keokuk Junction, and the Dakota & Iowa railroads appeared to be the strongest. The Iowa Terminal and the Burlington Junction lines were rated as strong and the Cedar Valley score was in the mid-range of that needed to be viable. The remaining railroads were rated weak by this model.

Dooley (1991) measured the economies of size and density that are available to short line railroads. He examined the theoretical framework of cost for the short line railroad industry in order to develop theoretically consistent estimates of short line costs using a short line simulation costing model.

The method of the study is development of a short line simulation costing model relying primarily on data in *Profiles of U.S. Railroads* published by the Association of American Railroads.

The principal conclusions of the study are as follows:

1. Fixed costs dominate the cost structure of short line railroads.

2. Increases in traffic density offer substantial opportunities for lowering short line average costs. For example, an increase in traffic density from 20 to 30 cars per mile lowers average total cost per car by 30 percent.

3. Economies of size are less significant for short lines. For example, increasing the size of the network from 56 to 129 miles decreased average total cost per car by only 7 percent.

4. Thus, the concern with new short lines should be with traffic density, not the size of the network.

Grimm and Sapienza (1993) investigated the extent to which economic and demographic variables are responsible for variations in performance among short line railroads. In addition they studied the extent that managerial actions and characteristics explain variations in the performance of short line railroads. They surveyed 285 short line railroads and used ordinary least squares (OLS) regression to test their hypotheses.

Grimm and Sapienza found that traffic density, the percentage of traffic originated, economic conditions, size of the railroad, and an aggressive management philosophy were positively related to firm performance. Dependence upon a particular shipper or commodity and the degree of financial leverage were negatively related to firm performance. In addition, they found short line performance increases with the number of business courses taken by railroad CEOs, but declines after a certain number of courses.

Eusebio (1993) developed a procedure to identify and measure factors related to the survival of Class I railroad-owned light density branch lines in Kansas. He fitted a parametric regression model to Kansas duration data to determine risk factors that influence the survival of branch lines. The statistically significant determinants of Kansas rail line survival are:

1) Level of local traffic which is positively related to longer survival.
2) Degree of truck competition which is negatively related to survival.
3) Level of track maintenance which is positively related to survival.
4) Potential shipper opposition to abandonment which is positively related to survival.
5) Level of track investment which is positively related to survival.

Eusebio concludes the types of commodities that move on a branchline, competition from other railroad companies or from other lines of the same railroad, the presence of overhead traffic on the line, and overall railroad company profits are not significant determinants of branchline survival. That the type of commodity does not determine branchline survival is possibly due to the dominance of grain in the commodity mix.

2.3 Summary of factors found to be most important to short line railroad profitability

Prior studies agree that adequate traffic density is a key requirement for the profitability of short line railroads, but differ considerably regarding the minimum traffic necessary. Factors which affect the minimum required traffic density include revenue splits, length of haul, and condition of the track. Under ideal conditions, Due considers 20 carloads per mile as the minimum required traffic for short line profitability. Other studies indicate those short line railroads having traffic densities of 40 to 80 carloads per mile often require assistance.

Several studies agree economies of scale exist relative to the length of the railroad. There are disagreements regarding the size of these economies and the lengths of line to which they apply. Wolfe indicated these economies were important up to 75 miles.

Other factors exhibiting positive effects on profitability include longer length of haul, adequate investment in track rehabilitation, experienced management, and adequate growth rate of revenues. Factors having negative effects on profitability are the concentration of traffic in one or two commodities, heavy amounts of debt, poor economic conditions, and high levels of truck competition. Factors such as cash flows and earnings to assets, which are listed as predictors of success, are measurements of rather than causes of profitability.

CHAPTER 3
THE MODELS

3.1 Rationale of the model as related to finance theory

Net Present Value analysis is widely used by firms evaluating an investment. The Net Present Value of an investment is the time discounted value of all expected cash flows derived from àn investment[4]. When a firm has unlimited funds available, the firm will invest only in projects where the Net Present Value is greater than zero. Net Present Value expressed in mathematical form is:

$$NPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + r_f)^t} \tag{3.1}$$

where:
NPV = net present value of an investment.
CF_t = expected cash flows in year t resulting from the initial investment.
r_f = the firm's required rate of return (Weighted Average Cost of Capital[5]).
T = the number of years the investment will generate cash flows.

Two major problems associated with Net Present Value analysis are that funds available to a firm are limited and firms are unable to accurately predict cash flows[6]. When firms have limited funds available to invest, they use a profitability index to choose the projects which will maximize firm value. In this case, projects are approved in order of decreasing profitability indices until the available funds are exhausted. The Profitability Index is derived from Net Present Value analysis.

---

[4]The initial investment is entered as a negative amount at time zero.
[5]The weighted average cost of capital is the weighted average of the cost of debt capital and the cost of equity capital. Equity capital requires a higher return since it is subject to more risk.
[6]The choice of the required rate of return is a third problem which will be discussed in a later paragraph. The required rate of return will greatly affect the NPV of the project.

The mathematical formula for the Profitability Index is:

$$PI = \frac{PV}{I_0} \tag{3.2}$$

where:
PI = profitability index
PV= present value of cash flows subsequent to initial investment
I_0 = initial investment in the project.

The second problem of using Net Present Value analysis is the inability of the firm to accurately forecast future cash flows. As these estimates move further into the future, the potential for error increases due to the firm's inability to predict the future. The effect of these errors is further compounded by the firm's choice of the required rate of return for the investment.

The time discounted value of expected cash flows for a project is approximately equal to the time discounted values of expected profits from the investment. These time discounted values of expected profits are equal to the time discounted values of expected operating revenues less the time discounted values of expected expenses. The cash flows derived from an investment are difficult to predict since they rely on uncertain estimates of both sales and expenses. The mathematical formula for expected profits is shown below:

$$NPV \approx \sum_{t=0}^{T} \frac{NP_t}{(1+r_f)^t} = \sum_{t=0}^{T} \frac{Rev_t}{(1+r_f)^t} - \sum_{t=0}^{T} \frac{Exp_t}{(1+r_f)^t} \tag{3.3}$$

Where:
NPV, T, and r_f are as described above.
NP_t = net profits in year t resulting from the investment.
Rev_t = revenue in year t resulting from the investment.
Exp_t = expenses in year t resulting from the investment.

Firms purchasing railroad lines are likely to use Net Present Value to evaluate the potential profits of rail lines. Net Present Value implies the importance of the price paid for the railroad, factors affecting both revenue and expenses, and the choice of the required rate of return.

When purchasing a railroad, the level of initial investment will affect both the Net Present Value and the Profitability Index. If a firm pays too much for the railroad, the Net Present Value of the investment will be negative and the Profitability Index will be decreased. This occurred often during the 1970s when firms were overly optimistic regarding a railroad's potential profitability.

Expected operating revenues are affected by expected carloads and the expected freight rates per carload. The estimation of operating revenues is complicated by the fact that the level of traffic is inversely related to the freight rates. In addition, the expected carloads and rates per carload will be affected by the level of service which the railroad can offer, production of the major commodities hauled[7], stability of the major industries served, potential to serve new customers, and the prices of competing transportation modes. The level of service the railroad can provide will depend on the condition of the track and the frequency of service. Note that of the above factors, the rail firm can affect only the level of service provided and the freight rates.

Expected expenses will be affected by track condition, managerial ability, amount of traffic, commodities hauled, and length of the line. Track in poor condition will increase

7 Agricultural commodities are noted for large changes in the quantity produced.

the costs of operating the line due to increased time required to haul commodities, increased maintenance required to keep the track operable, and increased derailment costs. Short line railroads require management that has the ability to keep costs low and carloads high. The amount of traffic on the railroad is a key ingredient to its profitability since railroads are typically an industry having potential excess capacity.

Since the track on most branch lines is in poor condition due to deferred maintenance, firms purchasing rail lines will often consider several different levels of track rehabilitation and maintenance before investing in a railroad. Each level of track rehabilitation and maintenance will provide a different level of customer service, leading to different revenues and expenses. This process will lead to several different Net Present Value figures for the purchase of the same railroad.

The required rate of return for the purchase of a railroad will depend upon the market rates of return, the ratio of equity capital to debt capital which is used to finance the railroad, the risk of operating that particular railroad, and the risk of the firm owning the railroad. Equity capital requires a higher rate of return than debt capital due to the higher risk associated with equity financing. As the variability of a railroad's profit increases, its risk increases, resulting in a higher required rate of return. High variability of a railroad's profits is sometimes caused by high variability of the amount of traffic on the railroad.

The covariance of the particular railroad's profits with that of the parent firm also affects the required rate of return. If a particular railroad lowers the variability of the parent firm's profits, then a lower rate of return may be used in the Net Present Value analysis.

Governmental decision makers are investing public funds when providing aid to short line railroads. Since those investments should be evaluated the same way a business evaluates investments, the profitability models in this study are related to Net Present Value theory.

Thus, the profitability measures chosen for this study are related to Net Present Value theory. Real operating cash flows before taxes, interest, and working capital changes (ROCF) relate directly to equation 3.1. Real earnings before interest and taxes (REBIT) and real gross railway operating income (RGROI) are more closely related to equation 3.3. In addition, many of the independent variables chosen in this study relate directly to those factors affecting revenues and expenses in equation 3.3.

3.2 Ordinary least squares (OLS) model

The major objectives of the model are to predict profitability of short line railroads and to accurately estimate the coefficients of the independent variables. If the model errors are independent and identically distributed, OLS is the most efficient linear estimator for achieving the objectives of the model. However, if heteroskedasticity and/or autocorrelation are present in the errors, OLS will not estimate the coefficients and standard errors of the independent variables as accurately as other models. The model for which OLS is appropriate is:

$$Y_{it} = \alpha + \sum_k \beta_k X_{itk} + \varepsilon_{it} \tag{3.4}$$

Where:
Y_{it} = the profitability of a firm in year t.
α = 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 $N(0,\sigma_\epsilon^2)$.

3.3 Panel models

If autocorrelation and/or heteroskedasticity are present in the errors, panel methods may be more suited to achieve model objectives. In the random effects panel model, it is assumed that all independent variable coefficients are the same over cross-sectional units (firms) and time, but the error term varies over time and cross-sectional units. The variations between individual firms and years are assumed to be random and thus are placed in the error term. The random effects panel model is represented by the following form[8]:

$$Y_{it} = \alpha + \sum_k \beta_k X_{itk} + \nu_{it} \tag{3.5}$$

Where:
Y_{it} = the profitability of firm i in year t.
α = the intercept term which is the same for all firms.
β_k = the effects of the independent variable k on profitability.
X_{itk} = the value of independent variable k for firm i and year t.
υ_{it} = $\rho_i + \gamma_t + \varepsilon_{it}$; the error term of the model consisting of three components.

8 Random effects models are also called error component models since the error term has components due to the firm, year, and random error.

$\rho_i =$ the random error due to the effects of different firms, $\rho_i \sim$ iid $N(0,\sigma_\rho^2)$.

$\gamma_t =$ the random error due to the effects of different years, $\gamma_t \sim$ iid $N(0,\sigma_\gamma^2)$.

$\varepsilon_{it} =$ the random error not due to firm or year effects, $\varepsilon_{it} \sim$ iid $N(0,\sigma_\varepsilon^2)$.

An alternative panel model specification is the fixed effects model. In this model, it is assumed that the slope coefficients are the same for all firms but the intercept varies over individual firms, and that the variations between firms are constant and non-random. The fixed effects model is of the following form:

$$Y_{it} = \alpha_i + \sum_k \beta_k X_{itk} + \varepsilon_{it} \tag{3.6}$$

Where:

$Y_{it} =$ the profitability of firm i in year t.

$\alpha_i =$ the intercept term for firm i.

$\beta_k =$ the effects of the independent variable k on profitability.

$X_{itk} =$ the value of independent variable k for firm i and year t.

$\varepsilon_{it} =$ the random error of the estimate, $\varepsilon_{it} \sim$ iid $N(0,\sigma_\varepsilon^2)$.

The models represented by equations (3.4), (3.5), and (3.6) are the ones estimated in this study.

3.4 Explanation of income statement components

This section will explain the various components of income statements as related to rail firms using the sample income statement shown in Table 3.1. Following this is a discussion of the profitability measures chosen and why other commonly used profitability measures were not chosen.

Operating revenues include all income generated by the firm's major operations. For rail firms, this includes all revenues from freight hauling, switching, demurrage, car hire, car repair, car storage, weighing, lease of track and sidings, and passengers. It does not include gain or loss from the sale of equipment or track.

Table 3.1
Sample Income Statement Format[9]

Operating Revenues		$$$
Operating Expenses		- $$$
Operating Income **		$$$
Other Income		+ $$$
Other Expenses		- $$$
Earnings Before Interest & Taxes *		$$$
Interest Paid		- $$$
Earnings Before Taxes & Unusual Items		$$$
Income Taxes		- $$$
Unusual Items	+/-	$$$
Extraordinary Items	+/-	$$$
Net Income ***		$$$

Operating expenses include all expenses generated by the firm's major operations, except for interest and income taxes. These expenses are usually grouped into five categories: maintenance of way, transportation, equipment maintenance, general and administrative, and derailments. These expenses include all depreciation and lease payments.

9 * used for Earnings Before Interest and Taxes
** used for Gross Railway Operating Income
*** used for Cash flows from operations.

Other income is non-operating income. This income comes from incidental transactions or from operations that are peripheral to the firm's main business. Other income includes gains or losses from the sale of assets, interest or dividend income, incidental rents, salvage income, and income from investments or subsidiary companies. For some of the railroads in the sample, other income was quite large. Since this is non-operating income, it does not reflect the underlying profitability of the railroad.

Other expenses are non-operating expenses and were seldom incurred by the railroads in the sample. Usually, when other expenses were present, they were entered as a negative amount in other income. Other expenses would include items such as losses on the sale of investments and losses from subsidiaries.

Interest expense is actually a part of other expenses, but is considered a separate category since it is a fixed charge which the firm must pay for borrowing money. The amount of interest expense is determined by the firm's choice of financing. If the firm is self-financed, it still must earn a reasonable rate of return on the investment or the ownership will dissolve the firm and invest the money elsewhere. Thus, in self-financed firms, the cost of capital is actually included in the net profit of the firm rather than shown as an expense.

The cost of leased track and equipment is included in the operating expenses of the firm, rather than in interest expense. Since the lease payments include the cost of capital, leasing assets results in the transfer of costs from interest expenses to operating costs[10]. Thus, interest expense is very low, or may not exist, for firms which are self-financed or which lease their track and equipment. Interest expense may be quite high for firms which are heavily debt-financed and own their track and equipment. Since the amount of interest expense for a firm is heavily influenced by how a firm is financed and by its choice of ownership or lease, this study will compare before interest measures of profitability.

Income taxes include deferred taxes as well as state and federal income taxes actually paid. Deferred taxes occur due to differences between the rates of depreciation allowed for tax purposes and the rates which are used in a firm's own internal accounting system. Accumulated deferred taxes, a liability account in the balance sheet, increase when the depreciation allowed for taxes exceeds that recorded in the firm's accounting system and decrease when the reverse occurs[11]. In the sample of firms used for this study, there is a wide range of income tax rates. Thus, the measures of profitability used in this study are before income tax.

Unusual items are those events which are typical of business activities, but are either unusual or infrequent. This category will include write-downs of receivables and inventories, adjustment of accrued contract prices, changes in the estimated lives of equipment, settlements of lawsuits, and gains or losses from the sale of discontinued operations.

---

10 Lease payments also include the costs of replacing the equipment and sometimes include maintenance costs on the equipment.

11 Accumulated deferred taxes increase during the early years of an asset's life and are used up in the later years of the asset's life. Thus during the later years of an asset's life, the firm is paying taxes that were deferred earlier.

Extraordinary items are major items that are both unusual and infrequent. Extraordinary items are shown net of income taxes and include gains or losses resulting from casualties, gains from the extinguishment of debt, and adjustments due to accounting changes.

3.5 Description of profitability measures

Profitability of railroads in this study will be measured in three ways: earnings before interest and taxes (EBIT), gross railway operating income (GROI), and operating cash flows before interest, income taxes, and working capital changes (OCF). No one measure of profitability is the best. Earnings before interest and taxes come from the income statement, but do not adjust for interfirm differences caused by leasing rather than ownership[12] nor reflect actual cash flows[13]. Operating cash flow measures of profitability are closest to Net Present Value theory, but have high variability due to shifts between short-term and long-term financing. Gross railway operating income attempts to adjust for interfirm differences caused by the choice of leasing or ownership, but does not show actual cash flows.

All measures of profitability will be measured in 1992 dollars and will be adjusted to reflect dollar amounts before interest and income taxes. In order to better compare

---

12 Lease payments are included in operating expenses, thus affecting earnings before interest and taxes. Firms which own their own equipment and/or track often pay interest on the debt incurred, but interest is not included in earnings before interest and taxes.

13 Depreciation expense is a non-cash expense which is included in operating expenses. Since depreciation and other accounting practices can be manipulated within the guidelines of generally accepted accounting principles to increase a firm's net income, the income statement measures of profitability can be distorted.

railroads having different track mileage, the profitability measures will be in real dollars per mainline mile of track.

3.51 Real earnings before interest and taxes per mile (REBIT, REBIT1, & REBIT2)

Earnings before interest and taxes (EBIT) is shown in the sixth line of the sample income statement. The major advantage of EBIT is that it does not include the effects of most non-operating items upon profitability. EBIT does not include the effects of interest expense, income taxes, extraordinary income, nor unusual income. Inclusion of those non-operating items can significantly increase interfirm differences in profitability, resulting in a distortion of the statistical analysis.

EBIT has several disadvantages as a measure of profitability other than those mentioned above. The first disadvantage is it includes other income and expense items which are peripheral to the major operations of the firm. In addition, it includes depreciation, maintenance of way, and equipment maintenance expenses which can vary according to accounting procedures, condition of the assets, whether the assets are leased or owned, and management discretion. Depreciation also varies between firms due to differences in original cost, is not measured in terms of real dollars, nor does it reflect the current cost of replacing assets used[14].

---

14 An asset purchased in 1970 will have cost much less than the same asset purchased in 1990. Thus, the depreciation on the asset purchased in 1990 will be much higher than on the asset purchased in 1970, even though the assets are the same otherwise. Since the replacement cost has increased, the depreciation on the asset purchased in 1970 will not be adequate to replace the asset at today's price.

Regressions are performed using REBIT, REBIT1, and REBIT2. REBIT is the real EBIT per mile (1992 dollars) for each fiscal year. REBIT1 is REBIT adjusted to remove maintenance of way (MOW) costs, making it a before MOW measure of profitability. REBIT2 is adjusted to remove both MOW costs and the benefits of non-interest government aid. Thus, REBIT2 is a before-interest and before-government aid measure of profitability.

3.52 Real gross railway operating income per mile (RGROI, RGROI1, and RGROI2)

Gross railway operating income (GROI) is an adaptation of net rail operating income (NROI) as defined by the American Association of Railroads (See Table 3.2). NROI is meant to provide a way of comparing operating results of firms which own their own track and equipment with those which lease. NROI adjusts the railway income of a firm to remove the impacts of ownership costs[15]. Thus, NROI reflects the income, excluding ownership costs, which is produced by the operations of the railroad. As such, NROI is used by federal and state regulatory agencies as a measure of revenue adequacy.

The first disadvantage of using NROI is that it is an after-income-tax measure of profitability. The income tax rates of the firms in the sample range from zero to normal corporate rates. The reasons why some railroad firms pay no income taxes will be discussed under the section on adjustments to the profitability measures. The effects of

---

15 Since lease payments, but not debt payments, are included in operating expenses, railroads which own their own track and equipment will have higher operating ratios, operating incomes, and EBIT than those firms which lease.

different interfirm income tax rates on the measures of profitability are immense since income taxes can be up to 36 percent of net income.

Table 3.2
Net Railway Operating Income

Operating Income	$$$
(from line 3 of the sample income statement in Table 3.1)	
Income taxes	- $$$
Deferred income taxes	- $$$
Income from lease of road	- $$$
Income from lease of equipment	- $$$
Rent paid for lease of road	+ $$$
Rent paid for lease of equipment	+ $$$
Net Railway Operating Income	$$$

Another disadvantage of NROI is that it does not include car hire income nor car hire costs. Some short line railroads have arrangements in which the connecting Class I railroad will provide railcars, when available, at no charge. When this is not the case, a short line railroad has the choice of either purchasing railcars, leasing railcars, or paying car hire fees. A lease involves a fixed commitment over a period of time, whereas car hire occurs when and as railcars are needed. When a short line railroad purchases or leases railcars, they will often lease them or make them available to other railroads under car hire agreements. Both lease costs and car hire costs are a part of the railroad's operating expenses, but interest costs due to railcar purchases are not included in operating costs.

When dealing with Class I railroads, the omission of car hire costs and car hire income is not a major problem when comparing the profitability of railroads. However, since car hire costs are a major operating expense for many short line railroads, and car hire is a substitute for leasing railcars, the failure to include car hire costs and car hire income in NROI is a substantial source of error when comparing the profitability of short line railroads.

Given the above disadvantages of NROI, a variable is created called gross railway operating income (GROI)(see Table 3.3). GROI eliminates the problem created by different interfirm income tax rates since it is a before-income-tax measure of profitability. GROI also includes car hire income and car hire costs, which eliminates the arbitrary distinction which NROI makes between car leasing and car hire.

Both GROI and NROI make a distinction between trackage rights fees and track leases. Trackage rights fees allow limited access over specific sections of track, whereas track leases give unlimited use of the track involved. In addition, trackage rights fees have no provision to transfer ownership of the track, whereas track leases often have a clause allowing the lessee to purchase the track at a specific future time and price.

Table 3.3
Gross Railway Operating Income

Operating Income (from line 3 of the sample income statement in Table 3.1)	$$$
Income from lease of road	- $$$
Income from lease of equipment	- $$$
Car Hire Income	- $$$
Rent paid for lease of road	+ $$$
Rent paid for lease of equipment	+ $$$
Car Hire Costs	+ $$$
Gross Railway Operating Income	$$$

The other advantage of GROI is that it does not include other income, other expense, extraordinary income, unusual income, nor interest expense. Thus, the analysis of profitability is not distorted by non-operating items. Thus, GROI gives a good indication of the underlying profitability of a rail firm while removing most of the interfirm differences which are due to owning rather than leasing assets.

A disadvantage of using GROI is that it includes depreciation and track maintenance expenses which vary widely among rail firms. In addition, the data needed to compute GROI is not available from many of the rail firms.

Regressions were performed using RGROI, RGROI1, and RGROI2. RGROI is the real GROI per mile (1992 dollars) for each fiscal year. RGROI1 is RGROI adjusted to remove maintenance of way (MOW) costs, making it a before MOW measure of profitability. RGROI2 is adjusted to remove both MOW costs and non-interest government aid. Thus, RGROI2 is a before-interest and before-government aid measure of profitability.

3.53 Real operating cash flows per mile (ROCF, ROCF1, ROCF2)[16]

The Statement of Cash Flows (see Table 3.4) is divided into three major portions. The first portion, called cash flows from operations, consists of cash flows derived from the major business operations of the firm. A firm is not able to remain in business for long unless it generates positive cash flows from operations.

---

16 These are operating cash flows before income taxes, interest, and working capital changes. To obtain this, total income taxes and interest paid were added to the subtotal of operating cash flows before working capital changes (see Tables 3.4 and 3.5).

Table 3.4
Sample Statement of Cash Flows

Net Income/Loss (from the sample income statement)	$$$
Depreciation and Amortization	+ $$$
Other Adjustments (from Extraordinary or Unusual income)	+/-$$$
Net gain (-)/loss (+) on sale of Assets	+/-$$$
Working capital changes	+/-$$$
Cash Flows from Operations	$$$
Cash Flows from Investments	+ $$$
Cash Flows from Financing Activities	± $$$
Total Cash Flows	$$$

The second portion, called cash flows from investments, consists of cash flows derived from the investment activities of the firm. These cash flows come from the purchase and sale of assets and from investment income. If a firm obtains positive cash flows by continually selling off its assets or failing to reinvest in assets, it will reduce future profitability. If a firm continually earns higher returns from its investment portfolio, management will soon sell off operating assets in favor of purchasing other investments.

The third portion, called cash flows from financing, consists of cash flows due to either paying off or obtaining additional long-term loans, sale of stock, and payment of dividends. A firm can continually obtain cash from borrowing, but soon the firm will run out of credit or lenders will demand higher interest rates to compensate for higher risk. A firm can continually get cash flow from selling stock, but eventually prior investors will complain about the value of their stock being diluted. Also, if the firm is not earning adequate returns on its investment, the price of the stock plummets.

Thus, positive cash flows from operations is the most important part of the statement of cash flows when comparing the profitability of firms. Operating cash flows comes much closer to Net Present Value Theory than other profitability measures since it deals with actual cash flows rather than with accounting profits. Another advantage of operating cash flows is that it eliminates the distortions caused by depreciation, which is present in the other measures of profitability.

There are two disadvantages to using operating cash flows as a measure of profitability. The first of these is that it includes track maintenance which can vary widely among railroad firms. The second is that operating cash flow includes income and expenses which do not come from the firm's main operations, and thus may not always be a totally accurate reflection of the firm's underlying profitability. These items include other expense and other income. The effects of unusual income and extraordinary income have been deleted from operating cash flows in the other adjustments line of the sample Statement of Cash Flows (see Table 3.4).

There are other disadvantages to using the standard measure of operating cash flow when comparing the profitability of rail firms. The first of these is the wide variability in working capital changes, mainly from year to year within the same firm. One reason these variations occur may be due to the purchase or operation of more track. Thus, as the size of the firm increases, a larger amount of working capital is required by the firm. Another reason these variations in working capital occur is due to shifts between short-term and long-term financing.

Another disadvantage is that the standard measure of operating cash flow is an after-tax measure of profitability. As we discussed earlier, the income tax rate of the firms in this study varies widely. Unless one uses a before-tax measure of profitability, the true underlying profitability will be distorted.

The third disadvantage is that interest paid is technically a part of the cash flows from financing rather than cash flows from operations. Thus interest paid should be added to operating cash flows and subtracted from cash flows from financing. When interest paid is added back into the standard measure of operating cash flows, it allows better interfirm comparisons of profitability between firms having different debt structures. However, one gets a better interfirm comparison of profitability between those firms leasing and those buying assets when operating cash flows are not adjusted for the interest paid[17].

In order to remove the effects of these wide swings in working capital, to obtain before income tax measures of profitability, and to obtain before interest measures of profitability, a subtotal of operating cash flow is chosen which is before working capital changes (see Table 3.5).

---

17 This is due to the fact that operating cash flows begin with net income from the income statement. The amount of lease payments are roughly equal to the interest on debt from the asset purchase plus the depreciation of the asset. Since interest expense and depreciation are both included in the calculation of net income, the net income of those firms leasing and those firms owning their own assets should be roughly equal.

Regressions are performed using ROCF, ROCF1, and ROCF2. ROCF is the real operating cash flow (before taxes and interest) per mile for each fiscal year. ROCF1 is ROCF adjusted to remove maintenance of way (MOW) costs, making it a before MOW measure of profitability. ROCF2 is adjusted to remove both MOW costs and non-interest government aid. Thus, ROCF2 is a before-interest and before-government aid measure of profitability.

Table 3.5
Sample Statement of Cash Flows
(modified)

Net Income/Loss (from the sample income statement)	$$$
Depreciation and Amortization	+ $$$
Other Adjustments	+/-$$$
Net gain (-)/loss (+) on sale of Assets	+/-$$$
Subtotal	$$$
Total Income Taxes	+ $$$
Interest paid by the firm	+ $$$
Operating Cash Flows from Operations (before taxes, interest, and working capital changes) (This is the dependent variable used in this study.)	$$$
Working capital changes	+/-$$$
Cash Flows from Operations	$$$
Cash Flows from Investments	+ $$$
Cash Flows from Financing Activities	+ $$$
Total Cash Flows	$$$

3.6 Commonly used measures of profitability not used in this study

Net profit (income) is the most commonly used measure of profitability. This variable is not chosen since it is much harder to obtain comparability between different firms since it includes unusual and extraordinary income, income taxes, and interest. This lack of comparability may result in lower R^2s and higher mean square errors of the estimates.

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 variations 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.

3.7 Description of the independent variables

Many independent variables were considered for inclusion in the models, but only those actually used will be discussed. These variables were carefully chosen to minimize multicollinearity among the independent variables and to remove endogeneity. Also, since we are trying to predict profitability, we use independent variables which were lagged one year wherever appropriate.

An attempt is made to specify the proper relationship between the independent variable and the dependent variable. When variables may have a quadratic relationship to the profitability measure, models are estimated including squared terms of those variables. If the squared terms do not improve the model, they are discarded. When variables may have an exponential relationship to the profitability measure, a logarithmic form of the variable is substituted in the model. If the model is not improved by the log specification, the linear specification of the independent variable is used in the model.

3.71 Firm characteristic variables

3.711 Era of the firm (ERA1 and ERA2).

Three firm characteristic variables are used in the models. The first of these are dummy variables which relate to the age of the firm. The age of the firm can affect profitability of the railroad in many ways. One would expect a positive relationship between age of the railroad and profitability due to the greater amount of experience in the railroad business, lower depreciation costs, and a higher number of marketing relationships[18].

Dummy variables are used to identify the era in which the firm was established since a discontinuous relationship is expected between age and profitability rather than a linear or quadratic relationship. ERA1 includes those railroads started before 1970 and ERA2 includes railroads established between 1970 and 1987. The default includes only those railroads established since 1987. Due to the higher prices paid for track in the

---

18 Older firms may have most of their track and equipment fully depreciated, thus having lower depreciation costs. In addition, older firms will have purchased equipment when it was less expensive, thereby contributing to lower depreciation costs. However, due to optimism, those firms starting between 1970 and 1987 probably paid more for their track than those firms starting since 1987. Thus, the effects of age on depreciation costs may be indeterminate.

1970-87 era, one would expect the profits for ERA2 firms to be lower than those firms started after 1987.

3.712 Number of rail firms owned by the parent firm (GRP and LAGGRP).

In recent years, there has been a trend for existing short line railroads to purchase other short line railroads, thus forming a group of rail firms. These rail groups benefit from many economies which are not available to independent railroads. These economies derive mainly from their ability to share labor, equipment, technology and management resources. In addition, these rail groups benefit from the ability to diversify their risks. Thus, one would expect the profitability measures to be positively related to the number of railroads in the group. One would also expect the incremental benefits due to being part of a rail group to decline as the number of rail firms in the group increases.

Profitability could be negatively related to the number of rail firms in the group since many marginal railroads can be successful only when they are a part of a rail group. Thus, due to the process of selection, marginal railroads are either purchased by a rail group or abandoned. In addition, most of the railroads in rail groups pay a management fee to the parent firm. If this management fee is more than the railroad's share of central management expenses, profits have been transferred from the individual rail firm to the parent firm. Thus, the expected signs of GRP and LAGGRP (GRP lagged one year) are indeterminate.

3.713 Railroad owned by a shipper or shipper group (SHIP).

This is a dummy variable which takes a value of 1 for those firms owned and managed by a shipper or shipper group. If the railroad is owned by a shipper or shipper group, but managed by a professional rail management firm, the variable is given a value of 0.

An inverse relationship is expected between profitability and ownership by shippers. A railroad is often owned by shippers if it has marginal traffic density resulting in low profit potential. Since no other firm is willing to purchase the line and the railroad is needed by the shipper, the shipper buys the railroad. Since operating the railroad is secondary to the shipper's primary business, it often is operated without professional railroad management and sales of the railroad's services are not pursued as aggressively.

3.72 Line characteristic variables

3.721 Number of connections to other railroad firms (CONN)

The number of connections to other railroads should be positively related to profitability since it reflects the relative bargaining power of the short line railroad with other railroads. Those railroads having only one connection have no market power to obtain railcars, fair rate splits, or to open new markets. The marginal benefit of having more connections probably decreases rapidly once a railroad has more than two connections. The number of connections is positively correlated to the number of main line miles of track. The sample contains 8 short lines with 1 connection, 18 with 2 to 5 connections, and 8 with more than 6 connections.

3.722 Gross miles of mainline track operated by the railroad (GMIL)

The total miles of mainline track includes those operated under trackage rights, but does not include switching, second-main, nor yard track. Based on Wolfe's study, one would expect a positive relationship between GMIL and profitability up to 75 miles of track. GMIL reflects the economies due to the mileage of the railroad. This variable is also used to convert other variables to per-mile variables in order to gain homogeneity between firms.

3.723 Percentage of track owned by the railroad firm (OWN and LAGOWN)

The percentage of track which is owned by the railroad will affect the firm's level of debt. Although interest costs are not included in any of the dependent variables, an increased level of debt will increase the risk of the firm and increase the interest rate of the firm. In addition, ownership of the track will generally increase the depreciation expense of the firm, but leasing costs include both depreciation and interest expenses[19].

The effects of this variable upon the profitability measures is expected to be positive since depreciation expenses are usually less than lease expenses. Although, many short line railroads have leases which are much less than the cost of ownership due to Class I railroads trying to develop feeder relationships with short line railroads, the effects of the entire sample should still outweigh the exceptions.

19 This assumes that the track, and the rehabilitation on the track, has not been fully depreciated.

3.73 Commodity characteristic variables

3.731 Percentage of the total traffic in the top three Standard Industrial Classification (SIC) codes (TOP3, TOP32, LAGTOP3, and LAGTOP32)

This is a measure of the diversity of the traffic on the railroad. As the traffic on a railroad becomes more diverse (TOP3 is lower), seasonal and cyclical variations in traffic are decreased, which leads to more efficiency and less risk to the railroad's profitability. On the other hand, too diverse a traffic mix will eliminate economies due to handling larger amounts of the same commodity. Thus, one would expect TOP3 to be positively related to profitability, reaching a maximum at a certain level. TOP32 and LAGTOP32 are the squared values of TOP3 and LAGTOP3 and are expected to have negative signs, which is consistent with TOP3 and LAGTOP3 having maximums.

3.732 Percentage of the total traffic which is grain (GRAN, GRAN2, LAGGRAN, and LAGGRAN2).

Grain has a lower freight rate than many other commodities hauled by railroads and is much more seasonal. GRAN could have a positive relationship to profitability, though, due to economies of handling since it is usually hauled in larger volumes. Thus, one is uncertain whether GRAN will be positively or negatively correlated with profitability. One could expect a positive correlation with a maximum at a certain level, since the presence of any traffic is better than no traffic at all. GRAN2 and LAGGRAN2 are squared values of GRAN and LAGGRAN and are expected to have negative signs, which is consistent with GRAN and LAGGRAN having maximums.

The percentage of grain hauled will be highly correlated with TOP3. Thus, the estimated models will use one or the other of these variables in order to minimize the effects of multicollinearity.

3.74 Traffic characteristic variables

3.741 Percentage of total traffic which is overhead traffic (POH and LAGPOH)

Overhead traffic is received from a connecting railroad at one location on the line and returned to that same railroad at another location on the line. The connecting railroad has considerable bargaining power regarding the revenue split with the short line since it usually has the option of hauling the carloads a longer distance on its own line. Also, since the railroad industry has relatively high fixed costs and low variable costs, the short line railroad is usually willing to haul these carloads for a price slightly above their variable cost. Although any revenue received above variable costs should increase profitability, the presence of traffic density in the model may cause POH to be negative. Since overhead traffic is included in total traffic, most of which is hauled at a higher price, a negative coefficient would reflect the effects of the discounted price of overhead traffic. Thus, one would expect a negative sign for the percentage of overhead traffic.

3.742 Ratio of the length of haul to gross main line miles operated (RHAUL and LAGRHAUL).

The further the short line railroad hauls the freight, the more revenue they receive for the haul. Since the length of haul is highly correlated with GMIL, the ratio of the length of the haul to gross miles operated (RHAUL) is used in the models. One would expect the profitability measures to be positively related to RHAUL.

3.743 Number of carloads per mile of mainline track (DENSITY, DENS2, LAGDENS, and LAGDENS2).

Since railroads have a high percentage of fixed costs and factor indivisibilities, an increase in traffic density will reduce costs per carload and increase profitability. Thus, the expected sign of traffic density is positive. DENS2 and LAGDENS2 are the values of DENSITY and LAGDENS squared and the signs are expected to be negative. DENS2 and LAGDENS2 are used to determine whether the benefit of increased traffic density has diminishing returns or is linear in nature.

3.75 Management effectiveness variables

3.751 Real other expense per mile (ROTEXPMI and LGROTEXM)

Real other expense per mile is real operating expense with real maintenance of way (MOW) expenses removed. MOW expenses are removed since their amount is discretionary. Many prior studies have noted that a key ingredient for the success of short line railroads is the ability to control expenses. This variable attempts to measure this ability to control expenses. Density of traffic greatly increases ROTEXPMI. Thus, since DENSITY and ROTEXPMI are correlated, it will be difficult to separate the effects of each. Nevertheless, one would expect a negative sign for ROTEXPMI. LGROTEXM is ROTEXPMI lagged one year.

3.76 Real non-interest government aid per mile (RAIDNMI)

Real non-interest government aid per mile is that portion of government aid which is not due to decreased interest expenses. RAIDNMI occurs when short lines are given noncash assistance for track maintenance or non-repayable grants for purchase of the line, track rehabilitation, or disaster assistance. The expected sign of the coefficient for RAIDNMI could be either positive or negative. Since governmental units give aid to railroads that are less profitable, some would argue that the sign should be negative. Others argue that government aid should be considered a benefit to the railroad and thus the sign should be positive. The expected signs of the independent variables are summarized in Table 3.6.

Table 3.6
Expected Signs of the Independent Variables

Independent Variable	Expected Sign
ERA1	+
ERA2	-
GRP	+ or -
LAGGRP	+ or -
SHIP	-
CONN	+
GMIL	+
OWN	+
LAGOWN	+
TOP3	+ or -
LAGTOP3	+ or -
TOP32	-
LAGTOP32	-
GRAN	+ or -
LAGGRAN	+ or -
GRAN2	-
LAGGRAN2	-
POH	-
LAGPOH	-
RHAUL	+
LAGRHAUL	+
DENSITY	+
LAGDENS	+
DENS2	-
LAGDENS2	-
ROTEXPMI	-
LGROTEXM	-
RAIDNMI	+ or -

CHAPTER 4
DATA

This chapter contains a discussion of the general characteristics of the data and the sources of the data employed to estimate the models discussed in the previous chapter. Since the profitability measures have been adjusted to remove interfirm differences which may distort the statistical analysis, the chapter will contain a brief discussion of the nature of the adjustments to the data.

4.1 General characteristics of the data

This study uses 196 annual observations obtained from 34 railroad firms operating in 17 states in the Midwestern region of the United States for the fiscal years 1986 through 1995. The data set is unbalanced since some railroads did not begin operations until after 1986 and other railroads discontinued operations prior to 1995. The number of years data for each railroad varies from 2 to 10 years.

If a firm discontinued operations and was later purchased by another rail firm, the data was handled as though it were a new firm. If a firm was sold without a discontinuance in either operations or the data, the data was handled as though it was the same firm.

The data set contains missing data since some railroads were unable, and sometimes unwilling, to supply all the data requested. Since the regressions drop those observations with missing values, the number of observations for each regression will vary. In addition, this study does not use data for partial years of operation since, due to seasonal variations, one cannot reliably convert partial year data to complete year data. For firms using a fiscal year different from a calendar year, the year end date was used to assign the data to a year. For instance, if a fiscal year ended April 30, 1992, the data was included in the year 1992 although most of the year's business was conducted in 1991.

4.2 Data sources

Most of the firms in this study are privately owned and thus reluctant to share proprietary financial and operating information. In order to obtain the data for the 34 railroads used in this study, more than 100 railroads were contacted by letter and by phone. Those firms participating in the study completed questionnaires and submitted balance sheets and income statements for the relevant years. Samples of the questionnaires are included in Appendix A.

Although financial and other information on publicly held firms is readily available, the data is aggregated for the entire firm, making it useless for analyzing individual railroads. Most states require only limited information on reports filed by short line railroads. Even those reports which had more extensive information often lacked key financial and/or operating data needed for this study. Some states which have the information required for this study are prevented by state law from releasing the data. Even so, the data we received from some state Departments of Transportation was invaluable for the completion of this study. A summary of the data is included in Appendix B.

4.21 Data sources of the dependent variables

Since the dependent variables are derived from financial statement data, most of the data was obtained directly from the participating firms. In a few cases, the data was available from reports filed with a state Department of Transportation. All of the data was converted to 1992 dollars using the Implicit Gross National Product Deflator in the *1996 Economic Report of the President.*

Earnings before interest and taxes (EBIT) was the easiest variable to obtain and came directly from the income statement of the firm. If the income statement of the firm was not available, many of the state reports had enough information to calculate EBIT. The only information required was operating revenues, operating expenses, and other income/expenses.

The data needed to calculate gross railway operating income (GROI) was not as readily available since many firms were unable to provide data on lease/car hire costs and revenues. In addition, most of the reports made to state Departments of Transportation did not include the needed data, particularly car hire revenues/expenses, or alternatively the data was incorrectly submitted. Thus, when this data was missing or there were serious doubts about the accuracy of the data, GROI was not calculated.

Operating cash flows (OCF) were also difficult to obtain for some firms. If a firm was unable to provide a statement of cash flows, estimated statements of cash flows were developed from the balance sheets and income statements of the firm. When making adjustments to obtain before tax and before interest figures, the information was usually obtained from the statement of cash flows rather than from the income statement. When possible, actual interest paid is distinguished from interest expense[20].

Data regarding maintenance of way expenses (MOW) were usually obtained from the income statement of the participating firms. Since the format of the income statements varied widely and the items included in MOW often varied, this data was somewhat difficult to obtain. In order to reflect only what the railroad was actually spending on MOW, any track depreciation included in MOW expenses was removed. An attempt was made to standardize what was included in MOW expenses. In some cases MOW expenses were obtained from reports made to state Departments of Transportation. MOW expenses do not include track rehabilitation investments which are added to the fixed asset accounts in the balance sheet and expensed as depreciation in the income statement over several years.

Government aid data was obtained from both participating firms and state Departments of Transportation. In most cases, state Departments of Transportation were able to give more details regarding the terms of the aid and the timing of the government aid payments. Due to the wide range of terms and types of aid, this information was critical in calculating the amount of government aid for each year. To obtain consistency between loans and grants as to the annual value of the aid, the benefits of government aid were apportioned over the useful life of the assets obtained. Moody's BAA Corporate

---

20 Since the statement of cash flows deals with actual cash flows, actual interest paid is the correct figure to use in making adjustments. Interest expense does not reflect changes in the balance sheet account of Interest Payable.

Bond interest rate, the interest rate government aid benefits are based on, is obtained from *Citibase.*

4.22 Data sources of the independent variables

Data regarding the age of the railroad was usually obtained from the questionnaire returned by the railroad, but some reports made to state Departments of Transportation also had this information. The date on which the railroad actually began operations is used as the relevant date. The eras chosen reflect periods which had significant differences in the number of short line railroads started and the relationship between short line railroads and connecting Class I railroads.

The number of railroads owned by the same company usually came from the questionnaire, but sometimes was obtained from 10K reports of the parent firm, which are publicly available. When a parent firm added a railroad during the year, the number of firms in the group was adjusted to reflect the portion of the year the new railroad was a part of the firm. For instance, if the fiscal year ended December 31 and a new railroad was purchased April 1, the purchase of that railroad added 0.75 to the number of railroads in the group.

Information regarding ownership by a shipper or shipper group was usually obtained from the questionnaire returned by the firm. In some instances, this information was obtained from state Departments of Transportation or *Profiles of American Railroads*, published by the Association of American Railroads.

The number of connecting railroads was obtained from the same sources as shipper group and included all connecting railroads. In some cases, some of the connecting railroads were owned by the same parent company.

The number of mainline miles of track and the ownership of the track were also obtained from the returned questionnaires, reports made to state Departments of Transportation, and *Profiles of American Railroads*. Mainline miles of track do not include second-main, yard, or switching track, but does include track operated under trackage rights.

Data for the commodities hauled, the composition of the traffic, the number of carloads hauled, and the length of haul was also obtained from the questionnaires, reports submitted to state Departments of Transportation, and *Profiles of American Railroads*. Usually, the data came from the questionnaires or the short line railroad reports made to the respective states. The reports made to the respective states did not always include traffic hauled outside the state, but most of these reports were quite complete. Data from *Profiles of American Railroads* seemed to differ considerably from that of the other two sources. Thus, the data from *Profiles of American Railroads* was used only when there was no other alternative.

Density of traffic is calculated by dividing the total number of carloads hauled by the gross miles of mainline track operated. The ratio of the length of haul to the length of the line is calculated since the length of haul is highly correlated with the length of the line, which would lead to inefficient estimates of the coefficients.

The amount of other expenses is calculated by subtracting MOW expenses from operating expenses. The data was obtained from the financial statements of the firms. This data was then adjusted to 1992 dollars and divided by the number of mainline track miles operated.

4.3 Adjustment of the profitability measures

When substantial interfirm differences in profitability measures are caused by accounting and other interfirm differences which do not reflect economic causes, the researcher has to choose between three alternate ways of handling these differences. The first way is to make adjustments to the profitability measures to remove the effects of these differences. A second way is to include the factors causing these differences as independent variables in the model. The third way is to ignore them.

It is unrealistic to remove all interfirm differences prior to statistical analysis since they are infinite in number and the data needed to make these adjustments is often not available. Also, some interfirm differences will have differing effects on the profitability measures depending upon the root cause for the interfirm difference. Thus, one must concentrate on those differences which make the largest impact on the results and make adjustments only after careful consideration. Although it is unrealistic to remove all these differences, this study differs from prior studies of short line profitability due to the number of adjustments made to the dependent variables and in the choice of dependent variables.

Models with adjustments to the dependent variable for each specific factor are compared with models including the same specific factors as independent variables. In most cases, the best statistical results are obtained by adjusting the dependent variables. These results will be discussed in the following chapter.

4.31 Adjustments of economic data

The Gross Domestic Product (GDP) implicit deflator is used to remove the effects of inflation from the dependent variables that are expressed in dollar terms. All dollar amounts are expressed in 1992 dollars. In addition, since there were interfirm differences in the choice of year-end dates, those effects are removed by using a simple interpolation of the GDP implicit deflator.

Further, all profitability measures which are expressed in real dollars are converted to real dollars per mile of mainline track operated by the railroad firm. This removes a potential source of heteroskedasticity which is caused by different sized firms in the sample. In addition, when this adjustment is made on the appropriate independent variables, as well as on the dependent variables, much of the correlation between the independent variables is removed. High levels of correlation among the independent variables results in multicollinearity which makes it difficult to estimate the statistical effects of individual independent variables.

4.32 Adjustments to the dependent variables to remove the effects of differences in interfirm income tax rates

The income tax rates for the firms in the sample vary from zero to 36 percent of income before taxes. There are four major reasons for these differences in income tax rates. The first reason is that sometimes the parent firm pays the income taxes for the subsidiary railroad. In this case the amount of income taxes which are due to the railroad's operations are not available to the researcher. A second reason is that some of the railroads in the sample carried losses from prior years forward, thus eliminating or reducing taxes in profitable years. A third reason is that some railroad firms are organized as a tax-free cooperative. The last reason is that some firms are organized as S corporations or as partnerships. Thus, the tax liability is paid by the individual investors.

To remove the effects of these differences, before-tax measures of profitability are used. If the profitability measure was not already a before-tax measure, it is converted to a before-tax measure. Earnings before interest and taxes (EBIT) is a before-tax measure of profitability, but both net rail operating income (NROI) and operating cash flow (OCF) are after-tax measures of profitability. Thus, both NROI and OCF are adjusted to obtain before-tax measures of profitability.

4.33 Adjustments to the dependent variables to remove the effects of interfirm differences in the amount of interest paid

Interest expenses varied widely among the firms in the sample due to three reasons. The first reason is that some firms operated debt free, while other firms had relatively high amounts of debt. This would result in interfirm distortions of after-interest profitability measures. Both GROI and EBIT are before-interest measures of profitability, and thus would not be affected by the debt structure of the firm. Operating cash flow, however, is an after-interest profitability measure. Thus, to remove differences caused by different debt structures, interest paid should be added back to the operating cash flow.

A second reason is the debt for some short line firms in the sample is carried by the parent firm, which paid the interest without directly charging it to the railroad. Thus, the railroad itself appears to have no interest expense, though it may have been included in the management fees paid to the parent firm. If interest expenses are included in the management fees charged to the railroad firm, before-interest measures of profitability, such as EBIT and GROI, are distorted since this would cause interest expenses to be included in operating expenses. After interest measures of profitability would not be affected. If the interest expenses are not included in management fees, or if the railroad is not charged management fees, then only the after-interest measures of profitability would be distorted[21].

The third reason is some firms in the sample leased track and/or equipment whereas other firms owned those assets. If those firms owning their own assets were debt free, then both before-interest and after-interest measures of profitability would be

---

21 The distortion would be caused by the exclusion of interest expenses from the income statement of the railroad.

distorted[22]. When the debt structure of the firms is similar, the before-interest measures of profitability are distorted since those firms leasing assets would have interest expenses included in their lease payments, which are operating expenses. Thus, before-interest profitability measures, such as EBIT and GROI, would be distorted. However, after-interest profitability measures, such as OCF, would not be distorted by differences in the ownership of assets.

Thus, the fundamental difficulty with adjustments to remove interfirm differences in interest paid is the conflicting effects upon the profitability measures. If the root cause of interfirm differences in profitability is due to debt structure, then before-interest measures of profitability will give better interfirm comparability. However, if the root cause is due to differences in the ownership of assets, after-interest measures of profitability will give better interfirm comparability.

Since both of these root causes are present in the sample, it is difficult to determine the best measures of profitability. For railroads which are owned by other firms, the relevant question is which level of debt to use: that of the subsidiary railroad or that of the parent firm. Since many of the railroads owned by other firms have negative equity, it would probably be more accurate to use the debt level of the parent firm, but this is often not available. Thus, the before-interest measures of profitability are emphasized by this study.

---

22 The before-interest measures of profitability would be distorted due to differences between owning and leasing. The after-interest measures of profitability would be distorted due to differences in the debt structure of the firms.

4.34 Adjustments to remove the effects of interfirm differences in the amount of maintenance of way expenses (MOW)

Maintenance of way (MOW) costs include all expenses associated with maintaining track, including track repair, weed control, snow removal, and depreciation on equipment used to maintain the track. MOW expenses are different from that spent on rail rehabilitation since MOW expenses are expensed in the year they occur, whereas rail rehabilitation is an investment which is depreciated over several years.

Depreciation on the track itself is usually not included in MOW expenses. If a railroad included track depreciation in MOW, it is removed in order to maintain consistency between firms. MOW expenses should measure what a firm is actually spending on maintaining the track. Since depreciation is a non-cash expense, it does not reflect any maintenance activity on the part of the railroad. If depreciation is included in MOW, a firm could have large MOW expenses while doing no maintenance of the track.

MOW expenses are discretionary since management often has the choice of doing the needed maintenance immediately or deferring it to a future year. This decision is usually based on a Net Present Value analysis of each maintenance project. A decision to proceed with a maintenance project will depend on the availability of funds, expected cash flows of the project and of the entire firm, and the cost of capital assigned to the project.

In addition, MOW expenses will vary widely among rail firms due to reasons other than management discretion. Track in good condition, high debt level of the firm, and increased riskiness of the traffic base all result in lower MOW expenses. Increased profitability of the railroad, traffic density, potential to increase traffic, availability of government aid, number of bridges, longer bridges, and the total mainline miles of track tend to increase MOW expenses.

Therefore, models are estimated in which the profitability measures are adjusted for MOW expenses and these are compared to similar models where MOW expenses are included as independent variables[23]. The profitability measures are adjusted by subtracting the MOW expenses from the operating expenses of the firm, thus also eliminating MOW expenses from the profitability measures.

4.35 Adjustments to remove the effects of interfirm differences in government aid received

The amount of government aid received by the railroads in this study varied from none to substantial amounts. These differences in the amount of government aid create substantial potential for error in predicting the profitability of railroads. To make adjustments to the profitability measures, an annual value is placed on the government aid received by each railroad. Next, this government aid is divided into interest and non-interest components and converted into 1992 dollars[24]. Those profitability measures which are before-interest measures are adjusted only for the non-interest portion of the government aid, while those profitability measures which are after-interest measures are adjusted by the total amount of government aid. The goal of this adjustment is to obtain

---

23 The profitability measures were thus converted to before MOW expense measures.

24 Interest benefits are those derived from reduced interest costs.

profitability measures of railroads prior to their receipt of government aid. Since this adjustment is much more complex than the other adjustments to the profitability measures, these adjustments are necessarily more subjective.

The type of governmental aid given to the railroads varied widely among the firms in the study. Some aid was in the form of grants, whereas other aid was in the form of low-interest government-guaranteed loans[25]. In some instances, governmental units purchased the track and leased it to the railroad. One state provided materials and/or labor for the maintenance of state-owned track leased to the railroads.

In addition, the terms of the government aid varied greatly among railroads in the study. Grant and loan aid often required the track to be maintained at specific levels of serviceability. Loan aid given to railroads varied as to the term-length of the loan, whether payments were fixed or variable, deferrals, and the percentage of matching funds the railroad or shippers are required to invest[26]. Lease agreements varied as to whether the ownership was transferred to the railroad at the end of the lease, the railroad had renewal options, payments were fixed or variable, and who has responsibility for maintenance of the track.

Government aid was granted to help railroads purchase the line, help rehabilitate or maintain the track, and provide disaster relief. Government aid to help build or replace sidings, which were not owned by the railroad, is not included in the calculation of

---

25 In this study, grants are defined as aid which is not repaid by the recipient.

26 Deferral periods can refer to interest-free periods and/or to deferral on when payments begin.

government aid. In addition, aid for rehabilitation or maintenance varied greatly as to the amount and type of track maintenance.

In this study, it is assumed that government aid allows railroads to purchase assets they otherwise are not able to purchase. This government aid can help railroads in three ways: by making purchases cheaper, by making debt and/or equity capital available which otherwise would not have been available, and by lowering the interest rate[27]. Some low density railroads would not have been able to remain in business without this aid. Other railroads would have been unable to obtain the financing required to purchase the track and/or would have been unable to invest enough to rehabilitate the track to maintain adequate service levels.

This study measures only the primary benefits from government aid, which is defined as the dollar amount the aid reduces the costs of the railroad in obtaining an asset. The reduction in these costs can be a result of interest savings and/or the original cost of the asset. This measurement excludes reductions in operating costs of the railroad and societal benefits such as reduction in highway maintenance costs or more efficient use of fuel and labor.

The measurement of the value of government aid requires a system which provides comparability and consistency, primarily between the various types of aid. The primary issues are the temporal distribution of the aid and the proper interest rate to assign. In order to obtain comparability between grants and loans, the benefits of the aid

---

27 Lower interest rates allow firms to have a lower weighted average cost of capital. The effect of this lower cost of capital is to increase the Net Present Value of a project. Thus, projects are now feasible which otherwise would not have been.

are distributed over the estimated lifetime of the assets or improvements (see Table 4.1). Thus, unlike the other adjustments which are assigned to the year in which they occurred, the annual value of government aid usually extended far beyond the initial year in which the aid was received.

Table 4.1
Temporal Distribution of Government Aid Benefits

Grant aid for:	
Purchase of the line	25 years
Rehabilitation of track:	
When replace rail or install new ties	25 years
When do not know if rail replaced or age of ties	15 years
Flood-relief or disaster grants	1 year
Loan aid:	The term-length of the loan.
Lease aid:	
If ownership transfers at end of lease:	The initial term-length of the lease.
If lease renewable:	The entire period in which the track is leased by the railroad.
Non-monetary aid:	
Materials and/or labor	5 years.

The proper interest rate depends on whether the aid provides debt capital or equity capital. If the percentage of the firm's investment in the project approximated the percentage of the firm's equity to assets, then the aid is considered to provide only debt capital. Moody's BAA Corporate Bond rate of interest at the time of the aid is used for the cost of debt capital. In this case, the value of the interest benefit portion of the aid is the difference between the cost of debt capital and the interest rate paid for the aid. Since pre-tax measures of profitability are used, the tax benefits of interest are not removed from the cost of the loan.

If the firm did not contribute funds to the project that approximated the firm's equity to assets ratio, then the aid is deemed to provide both debt and equity capital. Since equity capital requires a greater return, a weighted average cost of capital (WACC) is calculated based on Moody's BAA Corporate Bond Rate and the equity to asset ratio of the firm at the time of the acquisition of the loan or grant. As the firm's equity to asset ratio declined, the WACC increased to reflect the additional risk of the firm (see Table 4.2). The difference between the WACC calculated for the project and the interest rate on the aid is the interest portion of the aid benefit.

Table 4.2
Differential Value of Equity Capital to Debt Capital

Equity to Asset ratio of the firm	Premium charged over Moody's BAA Corporate Rate
Greater than 65%	3%
Between 35% and 65%	4%
Less than 35%	5%

Since all the profitability measures used in this study are before-interest measures, the profitability measures are adjusted only for non-interest government aid.

CHAPTER 5
EMPIRICAL RESULTS

This chapter will discuss the results of regressions using real earnings before interest and taxes per mile (REBIT), real gross railway operating income per mile (RGROI), and real operating cash flows per mile before interest, taxes and working capital changes (ROCF) as the dependent variables. Each of the dependent variables are analyzed three ways: without adjustments, adjusted for maintenance of way expenditures (MOW), and adjusted for both MOW and non-interest government aid.

The estimated models are fit with the independent variables lagged one year to prevent potential simultaneity bias and to enable the model to predict the values of the dependent variables. The models are fit by OLS. The standard errors of the estimates are computed in the usual way and also using the Huber/White/Sandwich robust estimator of variance to check for heteroskedasticity. The Durbin-Watson statistic is used to test for serial correlation. Predictive fixed-effects panel models are estimated to determine the extent of the firm effects.

The models are estimated using the lagged percentage of total carloads that are in the top three Standard Industrial Codes (LAGTOP3) as one of the explanatory variables. The same models are then estimated replacing LAGTOP3 with the lagged percentage of total carloads that are grain (LAGGRAN). Since LAGTOP3 and LAGGRAN are highly correlated, multicollinearity occurs when both variables are in the same equation.

5.1 Real Earnings before taxes and interest (REBIT)

5.11 Predictive (lagged) model using LAGTOP3 (REBIT)

The estimated regressions for REBIT1 (before MOW) and REBIT2 (before MOW and non-interest government aid) are displayed in columns 2 and 3 of Table 5.1. The adjusted R^2s of the two models are 0.70 and 0.73 respectively, much better than that of the unadjusted model (0.59). This indicates that the model is improved by adjusting the dependent variable for the effects of MOW and non-interest government aid. The Durbin-Watson statistics of 2.17 for REBIT1 and 2.05 for REBIT2 indicate that serial correlation is not a major problem with the adjusted models. In addition, the parameters and standard errors obtained by robust standard error estimation do not vary greatly from those of the OLS models, indicating that heteroskedasticity is not a problem with the REBIT models. Since the parameter estimates of REBIT1 and REBIT2 are similar, the following discussion of the empirical results is applicable to both models.

The sign of the coefficient for those short-line railroads formed prior to 1970 (ERA1) is positive as expected. This probably reflects their experience in the railroad business, higher number of established marketing relationships, and lower depreciation costs on their assets. The variable is statistically significant at the .05 level.

Firms which were established between 1970 and 1987 (ERA2) are expected to have a negative coefficient due to higher prices paid for track before 1987. Instead, these firms had a positive coefficient. This indicates that the higher prices paid for lines between 1970 and 1987 may not be as large a factor affecting profitability as previously thought. The variable is statistically significant at the .05 level.

Table 5.1
Real Earnings Before Interest and Taxes per Mile (REBIT)
Predictive (Lagged) Model Using LAGTOP3

Explanatory Variable	REBIT (Unadjusted)	REBIT1 (Before MOW)	REBIT2 (Before MOW & Aid)
Era1	3159.54 (1.579)	4510.14 (2.001)**	4856.12 (2.162)**
Era2	1858.04 (1.404)	3233.61 (2.298)**	2748.00 (2.016)**
Laggrp	-184.15 (-1.907)*	-304.90 (-2.956)***	-333.68 (-3.299)***
Ship	-3820.96 (-2.784)***	-5077.93 (-3.438)***	-5381.70 (-3.677)***
Conn	226.63 (2.671)***	247.26 (2.658)***	232.38 (2.509)**
Gmil	9.87 (4.404)***	10.65 (4.372)***	11.25 (4.685)***
Lagown	44.19 (3.149)***	32.13 (2.120)**	32.41 (2.132)**
Lagtop3	674.15 (2.037)**	1204.75 (3.409)***	1155.70 (3.278)***
Lagtop32	-4.06 (-1.848)*	-7.48 (-3.172)***	-7.23 (-3.067)***
Lagpoh	-104.77 (-2.696)***	-134.75 (-3.185)***	-139.96 (-3.312)***
Lagdens	77.46 (3.795)***	133.21 (8.052)***	137.93 (8.510)***
Lgrotexm	-.2007 (-4.317)***	-.2057 (-4.041)***	-.2054 (-4.023)***
Lagrhaul	4942.62 (2.227)**	5018.24 (2.058)**	4883.67 (1.998)**
Lagrmowm	.2791 (0.922)	--------	--------
Raidnmi	.2509 (0.819)	.5683 (1.750)*	--------
Constant	-33822.11 (-2.808)***	-51984.05 (-4.060)***	-49934.58 (-3.916)***
Number of obs.	137	136	136
Adj. R^2	.5861	.6999	.7284
Root MSE	4027.0	4414.2	4428.1
Durbin-Watson	2.1437	2.1740	2.0521

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

The expected sign of the coefficient for the number of railroads owned by the parent firm (LAGGRP) is indeterminate. This variable could be expected to be positive due to the synergistic benefits between railroads in the group. However, this variable proved to be negative, 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. The variable is statistically significant at the .01 level.

The sign of the coefficient for the dummy variable used to indicate those railroads owned and operated by a shipper group (SHIP) is negative as expected. This may reflect the importance of professional rail management and aggressive marketing of the railroad's services, but could be due to pricing rail services to benefit the shipper firm which owns the railroad. Also, in order to maintain rail service which is important to many of these shippers, the purchase of the rail line was the only option left which would preserve rail service. Thus, since no other firms were willing to purchase them, the profitability of these lines may be inherently low. The variable is statistically significant at the .01 level.

The sign of the coefficient for the number of connecting railroads (CONN) is positive as expected. This relationship of CONN to REBIT1 and REBIT2 does not seem to be quadratic, nor does it seem to have a discontinuous relationship. In addition, the model is not improved by specifying the variable as an exponential relationship (log of CONN). Due to a high correlation with the number of main-line miles operated (GMIL), it is difficult to be certain of the true nature of the relationship though it appears to be linear. Increased bargaining power with Class I railroads regarding revenue splits on joint movements, car hire fees, and switching charges is probably the primary reason the coefficient is positive. The result can also be attributed partly to access to additional railcars and the resulting ability to supply more service. However, the marginal benefit of additional connections should decline as the number of connections increases. Access to more markets and inbound freight origins could be possible reasons for the continued benefit from additional connections. The coefficient is significant at the .01 level in the REBIT1 equation and at the .05 level for REBIT2.

The number of gross miles operated (GMIL) has a positive coefficient as expected. The coefficient should be positive due to economies of scale, increased access to markets, and the increased potential for local traffic which both originates and terminates on the short line railroad. Although Wolfe (1989) had indicated that economies of size were exhausted at 75 miles, our models indicate that these economies of size extend to much longer lines. There does not appear to be a quadratic relationship between GMIL and REBIT, nor does an exponential specification (log of GMIL) of the variable improve the estimation of the model. The variable is statistically significant at the .01 level.

The sign of the coefficient for the percentage of track owned by the railroad firm in the prior year (LAGOWN) is positive as expected. Railroads which own track include depreciation costs as an operating expense and interest expense as a non-operating expense (see Table 5.2 below). Since these interest expenses are not included in REBIT, only part of the cost of ownership affects REBIT. Railroads which lease track include the entire amount of the lease costs, which include both depreciation and interest, in operating expenses. Thus, since operating expenses under ownership are lower than operating expenses under lease, one would expect the coefficient of LAGOWN to be positive since REBIT is higher for firms that own their track. LAGOWN is statistically significant at the .05 level.

Table 5.2
Sample Income Statement Format

Operating Revenues	$$$
Operating Expenses	- $$$
Operating Income	$$$
Other Income	+ $$$
Other Expenses	- $$$
Earnings Before Interest & Taxes (EBIT)	$$$
Interest Expense	- $$$
Earnings Before Taxes	$$$

Prior to discussing the empirical results for LAGTOP3 and LAGTOP3-squared, it is important to discuss a few fundamentals of quadratic relationships. 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 LAGTOP3 and using the regression results in Table

5.1, REBIT1 is maximized (with respect to LAGTOP3) when LAGTOP3 is 80.53 percent (- 1204.75 / (2*-7.48)).

In addition, the quadratic relationship is symmetrical around the optimizing value of the explanatory variable. Thus, if profits are zero when LAGTOP3 is zero and is maximized (with respect to LAGTOP3) when LAGTOP3 is 80.53 percent, then profits will be zero again when LAGTOP3 is 161.06 percent (which is not possible). This can be verified by setting $Y = \beta_1 X + \beta_2 X^2$ equal to 0, whereY is again REBIT1 and X is LAGTOP3. Factoring out X, the equation becomes $X(\beta_1 + \beta_2 X) = 0$. Thus, REBIT1 will be zero when LAGTOP3 is zero and when LAGTOP3 is $-\beta_1 / \beta_2$. Applying the regression results from Table 5.1, REBIT1 is zero when LAGTOP3 is zero and also when LAGTOP3 is 161.06 percent (-1204.75/-7.48).

As the explanatory variable exceeds its maximizing value, profitability of the railroad will decrease as the explanatory variable increases[28]. However, profits (as related only to the explanatory variable) remain positive. In the above example, REBIT1 decreases after LAGTOP3 exceeds 80.53 percent, but REBIT1 remains positive[29]. If the profit-maximizing value of LAGTOP3 had been 45 percent, rather than 80 percent, then REBIT1 would have been negative as the value of LAGTOP3 exceeded 90 percent.

The expected sign for the percentage of traffic concentrated in the top three Standard Industrial Codes (LAGTOP3) is indeterminate. LAGTOP3 has a positive

---

28 The profitability of the railroad decreases since the slope of the profitability function is negative when the explanatory variable exceeds its profit-maximizing value.

29 The positive effects from LAGTOP3 still outweigh the negative effects of LAGTOP3-squared.

coefficient and the coefficient of LAGTOP3-squared is negative. As explained above, the effect of LAGTOP3 on REBIT1 and REBIT2 reaches a maximum when LAGTOP3 is approximately 80 percent. The positive sign for the coefficient of LAGTOP3 indicates that economies due to handling larger amounts of the same commodity outweigh the negative effects of a traffic base focused on a few commodities until the value of LAGTOP3 exceeds 80 percent. Both LAGTOP3 and LAGTOP3-squared are statistically significant at the .01 level.

The lagged percentage of overhead traffic to total traffic (LAGPOH) has a negative coefficient as expected. Since short line railroads do not have as much bargaining power as the connecting Class I railroad regarding revenue splits on joint movements, overhead traffic is often priced slightly above variable costs. Although any revenue received above variable costs should increase REBIT, the presence of LAGDENS in the model may cause LAGPOH to have a negative value since overhead traffic is included in total traffic, but is priced at a below average level. Thus, the negative sign of LAGPOH may reflect the effects of price discounts on overhead traffic. The variable is statistically significant at the .01 level.

The coefficient of lagged density of railcar traffic (LAGDENS) has the expected positive sign. This is due to railroads having relatively high fixed costs and potential excess capacity. Thus, as traffic density increases, average costs decline and profits increase. The relationship does not appear to be quadratic since LAGDENS-squared is not significant. Neither does an exponential specification of the variable improve the model. Thus, it appears that density of carload traffic has a linear relationship to REBIT.

The variable is statistically significant at the .01 level and has the highest t-values of all the variables in the model.

Lagged real other expenses per mile[30] (LGROTEXM) has a negative coefficient as expected. This variable reflects the ability of management to control costs. However, these real other expenses are also greatly affected by density of traffic, the condition of the track, and other factors such as terrain. LGROTEXM is statistically significant at the .01 level.

The ratio of the length of haul to the gross miles operated (LAGRHAUL) has the expected positive coefficient. Railroads tend to have a competitive advantage relative to motor carriers on longer hauls. Thus, the greater the length of haul, the greater the likelihood the railroad will be able to charge a price above their variable costs. In addition, the greater the length of haul, the greater the short line share of revenue from joint movements with other railroads. LAGRHAUL is statistically significant at the .05 level.

The sign of the coefficient for real non-interest government aid per mile (RAIDNMI) is positive although it could have been either positive or negative. Since governmental units give aid to railroads that are less profitable, some would argue that the sign should be negative. Although it is conceivable that government aid could have a negative sign, it is generally considered to be more likely to benefit a firm. The variable is statistically significant at the .10 level.

---

[30] Real operating expenses per mile less real maintenance of way (MOW) costs per mile.

The adjusted R^2 and the degree of statistical significance increase substantially with the adjusted models. This indicates that the model is improved by adjusting the dependent variable for the effects of maintenance of way expenditures and non-interest government aid.

5.12 Predictive (lagged) model using LAGGRAN (REBIT)

These models determine the effects on profitability of the percentage of total traffic that is devoted to grain (LAGGRAN). The ordinary least squares (OLS) regression for REBIT1 (before MOW) has an adjusted R^2 of 0.68 while the regression for REBIT2 (before MOW and non-interest government aid) has an adjusted R^2 of 0.71 (Table 5.3). Thus, these models explain about the same amount of variation in REBIT as those models using LAGTOP3. The root mean square errors (Root MSE) for these models are also about the same. However, the values of the t-statistics are generally lower in the LAGGRAN regressions compared to those regressions using LAGTOP3.

The Durbin-Watson statistic is 1.97 for the REBIT1 regression and 2.11 for REBIT2, indicating that serial correlation is not a problem with these OLS models. In addition, the parameter estimates and standard errors obtained by robust standard errors estimation do not vary greatly from those in the OLS models, indicating that heteroskedasticity is not a problem of the OLS models.

The coefficients of ERA1, CONN, GMIL, LAGOWN, LAGDENS, and LAGRHAUL are positive as expected. The coefficients of SHIP, LAGPOH, and LGROTEXM are negative as expected. With regard to variables with theoretically indeterminate signs, LAGGRP is negative while LAGGRAN and RAIDNMI are positive. ERA2 was the only variable which has an unexpected sign.

The expected sign of LAGGRAN is theoretically indeterminant. However, regression results indicate that the effect is positive. Also, the effect of LAGGRAN on REBIT is quadratic since the coefficient for LAGGRAN is positive while that of LAGGRAN-squared is negative. REBIT is maximized (with respect to LAGGRAN) when LAGGRAN is approximately 55 percent, so REBIT declines when LAGGRAN exceeds 55 percent. The positive sign of LAGGRAN indicates that economies of handling grain in larger volumes more than offsets the negative effects on profits of relatively low grain freight rates and the seasonality of grain traffic until the value of LAGGRAN exceeds 55 percent.

In both the REBIT1 and REBIT2 regressions, the coefficients for SHIP, GMIL, LAGPOH, LAGDENS, and LGROTEXM are significant at the .01 level. The variables LAGOWN, LAGGRAN, and LAGRHAUL are significant at the .05 level in both regressions. The coefficients of ERA2, LAGGRP, CONN, and LAGGRAN-squared are significant at the .05 level in the REBIT1 regression. The variables CONN, LAGGRAN-squared, ERA1, and ERA2 are significant at the .10 level in the REBIT2 regression. Thus, the only variables in either regression that are not significant at least at the .10 level are ERA1 and RAIDNMI in the REBIT1 regression.

Table 5.3
Real Earnings Before Interest and Taxes per Mile (REBIT)
Predictive (Lagged) Model Using LAGGRAN

Explanatory Variable	REBIT (Unadjusted)	REBIT1 (Before MOW)	REBIT2 (Before MOW & Aid)
Era1	2974.38 (1.488)	3837.95 (1.637)	4348.48 (1.865)*
Era2	1541.29 (1.170)	3102.11 (2.131)**	2596.71 (1.824)*
Laggrp	-143.29 (-1.543)	-263.55 (-2.568)**	-295.66 (-2.930)***
Ship	-4127.57 (-2.959)***	-6066.86 (-3.905)***	-6529.98 (-4.266)***
Conn	219.52 (2.609)***	201.73 (2.114)**	180.67 (1.904)*
Gmil	8.11 (3.413)***	9.11 (3.394)***	10.03 (3.813)***
Lagown	47.21 (3.353)***	33.99 (2.152)**	33.44 (2.107)**
Laggran	153.93 (2.592)**	176.64 (2.461)**	134.50 (2.024)**
Laggran2	-1.35 (-2.413)**	-1.60 (-2.357)**	-1.21 (-1.916)*
Lagpoh	-107.24 (-2.916)***	-128.522 (-3.012)***	-125.22 (-2.924)***
Lagdens	60.95 (2.995)***	131.33 (7.680)***	139.20 (8.504)***
Lgrotexm	-.1984 (-4.319)***	-.1962 (-3.738)***	-.1915 (-3.636)***
Lagrhaul	5888.85 (2.570)**	6076.98 (2.333)**	5511.26 (2.127)**
Lagrmowm	.4976 (1.715)*	--------	--------
Raidnmi	.0607 (0.188)	.4649 (1.309)	--------
Constant	-9302.665 (-4.034)***	-8296.36 (-3.132)***	-8009.62 (-3.016)***
Number of obs.	137	136	136
Adj. R^2	.5874	.6791	.7084
Root MSE	4020.8	4564.8	4588.5
Durbin-Watson	1.8318	1.9736	2.1101

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

The adjusted R^2 increases substantially in the adjusted models relative to the unadjusted model while the degree of statistical significance is about the same. This indicates that the model is improved by adjusting the dependent variable for the effects of maintenance of way expenditures and non-interest government aid.

5.13 Elasticities (REBIT)

The elasticity of REBIT with respect to the various independent variables is important when evaluating the relative impact of the independent variables 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.

The elasticity of REBIT with respect to a given independent variable is defined as the percentage change in REBIT caused by a 1 percent change in the respective independent variable as shown in Equation 5.1.

$$\varepsilon_{REBIT,VARIABLE} = \frac{Percent\ \Delta\ REBIT}{1.0\ Percent\ \Delta\ INDEPENDENT\ VARIABLE} \tag{5.1}$$

The elasticity of REBIT with respect to a given independent variable is calculated from the coefficient of the independent variable and the mean values of the independent and dependent variables as shown below in Equation 5.2.

$$\varepsilon = \beta_i * \frac{\bar{X}_i}{\overline{REBIT}} \tag{5.2}$$

β_i - Coefficient of the independent variable.
$\bar{X}_i$ - Mean of the independent variable.
$\overline{REBIT}$ - Mean of REBIT

For variables such as LAGTOP3 and LAGGRAN, which are also squared in the regression equation, the elasticity is calculated as shown in Equation 5.3.

$$\varepsilon = (\beta_i + 2\beta_{X_i^2}\bar{X}_i) * \frac{\bar{X}_i}{\overline{REBIT}} \tag{5.3}$$

β_i - Coefficient of the independent variable.
$\beta_{Xi}{}^2$ - Coefficient of the independent variable squared.
$\bar{X}_i$ - Mean of the independent variable.
$\overline{REBIT}$ - Mean of REBIT

Whether the dependent variable is REBIT1 or REBIT2, the elasticities do not vary much (Table 5.4). Neither did the elasticities vary much between those models using LAGTOP3 and those using LAGGRAN.

REBIT was elastic to changes in only one variable, LAGDENS, with the elasticities ranging from 1.398 to 1.779. This indicates that short line profitability is more responsive to traffic density than any other variable in the model.

For REBIT1 and REBIT2, other variables with higher elasticities include LGROTEXM (0.70 to 0.83), GMIL (0.38 to 0.53), LAGRHAUL (0.39 to 0.48) and LAGOWN (0.35 to 0.41). In most cases, the elasticities for unadjusted REBIT are larger than those of REBIT1 and REBIT2.

Table 5.4
Estimated Elasticities of
Real Earnings Before Interest and Taxes per Mile (REBIT)

Explanatory Variable	REBIT (Unadjusted)	REBIT1 (Before MOW)	REBIT2 (Before MOW & Aid)
Laggrp	0.247[1] 0.192[2]	0.201 0.174	0.249 0.221
Conn	0.462 0.447	0.248 0.203	0.264 0.205
Gmil	0.834 0.685	0.443 0.379	0.530 0.472
Lagown	0.974 1.041	0.349 0.369	0.398 0.411
Lagtop3	0.036	0.522	0.702
Laggran	0.303	0.131	0.123
Lagpoh	0.247 0.253	0.157 0.150	0.184 0.165
Lagdens	1.776 1.398	1.505 1.484	1.763 1.779
Lgrotexm	1.454 1.438	0.734 0.700	0.830 0.773
Lagrhaul	0.777 0.926	0.389 0.471	0.428 0.483
Lagrmowm	0.329 0.586	-------- --------	-------- --------
Raidnmi	0.073 0.018	0.081 0.067	-------- --------

1 The upper numbers for each variable were calculated from the regressions using LAGTOP3.
2 The lower numbers for each variable were calculated from the regressions using LAGGRAN.

5.14 Contemporaneous (unlagged) model using TOP3 (REBIT)

The independent variables are lagged to allow the model to predict future REBIT from current values of the independent variables and to eliminate potential simultaneity bias of two independent variables. The profitability of a railroad in a given year should be related more to that year's values of the independent variables than to lagged values of those independent variables. Thus, one would expect to lose some estimating power with a lagged (predictive) model. To determine if this is the case, the models are estimated with unlagged independent variables. The results of this analysis reveal that the predictive model loses very little estimating power relative to the unlagged model since the adjusted R^2s of the two estimations are nearly the same and the root mean square errors are within five percent of each other.

Two independent variables in the model ROTEXPMI (real other expense per mile) and RMOWMI (real MOW per mile) are expected to have a simultaneity bias since the profitability of a railroad can affect those two expenses of the railroad. Since the regression results of the lagged models are similar to the results of the unlagged models, one can conclude there is little simultaneity bias in the contemporaneous model.

5.15 Panel models (REBIT)

In general, the panel models did not add much to the understanding of the determinants of short line railroad profitability. The ordinary least squares models (OLS) are chosen since the tests for serial correlation and heteroskedasticity indicated an absence of these problems in the estimated OLS regressions.

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 were significant and the firm effects were significant for relatively few firms. Thus, the panel models were rejected for estimating REBIT.

5.2 Real Gross railway operating income (RGROI)

5.21 Predictive (lagged) model using LAGTOP3 (RGROI)

The regression equations for real gross railway operating income per mile (RGROI) are displayed in Table 5.5. The regression equations for RGROI1 and RGROI2 have virtually identical adjusted R^2 of 0.82 and 0.83 respectively, which is slightly higher than the 0.77 of the unadjusted equation. The Durbin-Watson statistics for the RGROI1 and RGROI2 regressions are 1.96 and 2.15 respectively, indicating that the equations do not have statistically significant serial correlation. This is also the case for the unadjusted model which has a Durbin-Watson of 2.16. The estimated t-statistics obtained by robust standard errors estimation do no vary much from those of the OLS models in Table 5.5, indicating that heteroskedasticity is not a problem of the RGROI models.

Table 5.5
Real Gross Railway Operating Income per Mile (RGROI)
Predictive (Lagged) Model Using LAGTOP3

Explanatory Variable	RGROI (Unadjusted)	RGROI1 (Before MOW)	RGROI2 (Before MOW & Aid)
Era1	6215.68 (2.440)**	6755.90 (2.486)**	6973.41 (2.547)**
Era2	3922.99 (2.447)**	4675.51 (2.839)***	3991.51 (2.483)**
Laggrp	-277.70 (-3.069)***	-327.57 (-3.464)***	-354.65 (-3.775)***
Ship	-6924.34 (-4.376)***	-7083.78 (-4.196)***	-7381.07 (-4.359)***
Conn	563.03 (4.630)***	575.97 (4.514)***	535.06 (4.238)***
Gmil	13.38 (5.811)***	13.02 (5.356)***	13.89 (5.799)***
Lagown	41.37 (3.073)***	36.15 (2.568)**	34.41 (2.430)**
Lagtop3	713.09 (1.544)	1122.02 (2.332)**	919.54 (1.959)*
Lagtop32	-4.34 (-1.459)	-7.08 (-2.285)**	-5.85 (-1.929)*
Lagpoh	-81.10 (-2.046)**	-102.94 (-2.530)**	-104.32 (-2.542)**
Lagdens	123.07 (5.638)***	139.77 (8.045)***	145.26 (8.445)***
Lgrotexm	-.2521 (-3.572)***	-.2501 (-3.398)***	-.2309 (-3.149)***
Lagrhaul	5671.94 (2.511)**	5723.51 (2.376)**	5497.83 (2.266)**
Lagrmowm	-.4879 (-1.319)	---------- ----------	---------- ----------
Raidnmi	.4026 (1.314)	.4832 (1.539)	---------- ----------
Constant	-35109.54 (-1.973)*	-48488.91 (-2.611)***	-40911.16 (-2.254)**
Number of obs.	110	110	110
Adj. R^2	.7689	.8167	.8346
Root MSE	3601.8	3844.1	3878.2
Durbin-Watson	2.1604	1.9594	2.1534

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

Inspection of the RGROI1 regression in Table 5.5 reveals that excluding the variables with indeterminate signs, all the independent variables except ERA2 have the theoretically expected sign. For discussion of possible reasons for the unexpected sign of this variable, see the REBIT discussion of the predictive model using LAGTOP3. All of the independent variables in the RGROI1 equation are statistically significant (except RAIDNMI) at the .05 level or above, with LAGDENS having the highest t-value.

With regard to theoretically expected signs, the results of the RGROI2 equation are the same as that of RGROI1. The variables LAGTOP3 and LAGTOP3-squared are statistically significant at the .10 level in the RGROI2 equation. All the other explanatory variables are significant at the .05 level or above.

Railroad profitability is maximized (with respect to LAGTOP3) when LAGTOP3 is about 79 percent in both the RGROI1 and RGROI2 regressions. This indicates that RGROI is decreasing when LAGTOP3 exceeds 79 percent, even though RGROI remains positive.

The statistical results for the unadjusted RGROI regression are generally good, but not as good as those of RGROI1 and RGROI2. For example, while the RGROI1 regression has one non-significant variable and the RGROI2 regression has none, the unadjusted regression has four non-significant variables.

5.22 Predictive (lagged) model using LAGGRAN (RGROI)

These models, displayed in Table 5.6, show the effects on RGROI of the percentage of total traffic that is devoted to grain (LAGGRAN). The regression equations for RGROI1 and RGROI2 have virtually identical adjusted R^2 of 0.81 and 0.83 respectively, which is slightly higher than the 0.77 of the unadjusted equation. The adjusted R^2s are nearly identical to those models using LAGTOP3. Durbin-Watson statistics for the RGROI1 and RGROI2 regressions are 1.99 and 2.17 respectively, indicating that the equations do not have statistically significant serial correlation. The estimated t-statistics obtained by robust standard errors estimation do no vary much from those of the OLS models in Table 5.6, indicating that heteroskedasticity is not a problem of the RGROI models.

The RGROI1 regression in Table 5.6 reveals that all the independent variables (excluding those with indeterminate signs) except ERA2 have the theoretically expected sign. The possible reasons for the unexpected sign of this variable are discussed in the REBIT predictive model using LAGTOP3. All of the independent variables in the RGROI1 equation are statistically significant at the .05 level or above, except for LAGGRAN-squared, ERA2, ERA1, and RAIDNMI. LAGGRAN-squared and ERA2 are significant at the .10 level. ERA1 and RAIDNMI are not significant. Again, LAGDENS has the highest t-value.

RGROI1 is maximized (with respect to LAGGRAN) when LAGGRAN is around 57 percent. Thus, RGROI1 is decreasing when LAGGRAN exceeds 57 percent. Note that when LAGGRAN reaches 100 percent, most of the benefits of commodity specialization on RGROI1 have disappeared. However, RGROI1 remains positive throughout the range of possible values for LAGGRAN.

Table 5.6
Real Gross Railway Operating Income per Mile (RGROI)
Predictive (Lagged) Model Using LAGGRAN

Explanatory Variable	RGROI (Unadjusted)	RGROI1 (Before MOW)	RGROI2 (Before MOW & Aid)
Era1	4861.79 (1.925)*	4304.41 (1.590)	4850.31 (1.794)*
Era2	2526.58 (1.492)	3093.42 (1.752)*	2599.16 (1.486)
Laggrp	-271.49 (-3.082)***	-311.48 (-3.350)***	-336.15 (-3.643)***
Ship	-6914.56 (-4.225)***	-7047.18 (-4.003)***	-7446.03 (-4.244)***
Conn	472.24 (3.961)***	444.26 (3.602)***	426.54 (3.449)***
Gmil	12.67 (5.498)***	12.66 (5.201)***	13.51 (5.655)***
Lagown	38.16 (2.890)***	32.41 (2.329)**	31.27 (2.234)**
Laggran	120.37 (1.685)*	151.37 (2.023)**	119.79 (1.652)
Laggran2	-.9376 (-1.427)	-1.3290 (-1.973)*	-1.0044 (-1.558)
Lagpoh	-82.20 (-2.015)**	-101.39 (-2.478)**	-97.14 (-2.363)**
Lagdens	109.60 (5.091)***	127.37 (7.227)***	135.82 (8.046)***
Lgrotexm	-.1774 (-2.481)**	-.1509 (-2.034)**	-.1433 (-1.922)*
Lagrhaul	5003.60 (2.132)**	5133.42 (2.036)**	4622.57 (1.836)*
Lagrmowm	-.4312 (-1.105)	---------- ----------	---------- ----------
Raidnmi	.4321 (1.414)	.5041 (1.574)	---------- ----------
Constant	-8397.59 (-3.300)***	-7688.71 (-2.808)***	-7851.13 (-2.849)***
Number of obs.	110	110	110
Adj. R^2	.7697	.8140	.8327
Root MSE	3595.4	3872.5	3900.6
Durbin-Watson	2.1108	1.9900	2.1682

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

With regard to theoretically expected signs, the results of the RGROI2 equation are the same as that of RGROI1. The variables ERA1, LGROTEXM, and LAGRHAUL are statistically significant at the .10 level in the RGROI2 equation and the variables ERA2, LAGGRAN, and LAGGRAN-squared are not significant. All the other explanatory variables are significant at the .05 level or above. The statistical results for the unadjusted RGROI regression are about the same as those of RGROI1 and RGROI2.

5.23 Elasticities (RGROI)

The elasticities of RGROI to changes in the various independent variables are shown in Table 5.7. Whether the dependent variable was RGROI1 or RGROI2, the calculated elasticities generally did not vary a lot. Neither did the elasticities vary much between those models using LAGTOP3 and those using LAGGRAN. The elasticities of the unadjusted RGROI model were generally higher than those of the adjusted models.

RGROI1 and RGROI2 are elastic to changes in only one variable, LAGDENS, with the elasticities ranging from 1.156 to 1.591. This indicates that short line profitability is more responsive to traffic density than any other variable in the model.

For RGROI1 and RGROI2, variables with higher elasticities include LGROTEXM (0.433 to 0.799), LAGTOP3 (0.590 to 0.685), GMIL (0.423 to 0.560), CONN (0.358 to 0.521) and LAGRHAUL (0.319 to 0.413).

Table 5.7
Estimated Elasticities of
Real Gross Railway Operating Income per Mile (RGROI)

Explanatory Variable	RGROI (Unadjusted)	RGROI1 (Before MOW)	RGROI2 (Before MOW & Aid)
Laggrp	0.276[1]	0.174	0.227
	0.270[2]	0.165	0.215
Conn	0.852	0.464	0.521
	0.715	0.358	0.415
Gmil	0.839	0.435	0.560
	0.795	0.423	0.545
Lagown	0.678	0.315	0.362
	0.625	0.283	0.329
Lagtop3	0.178	0.590	0.685
Laggran	0.318	0.118	0.149
Lagpoh	0.142	0.096	0.118
	0.144	0.095	0.110
Lagdens	2.096	1.268	1.591
	1.867	1.156	1.487
Lgrotexm	1.357	0.717	0.799
	0.955	0.433	0.496
Lagrhaul	0.663	0.356	0.413
	0.585	0.319	0.347
Lagrmowm	0.427	----------	----------
	0.377	----------	----------
Raidnmi	0.087	0.056	----------
	0.093	0.058	----------

1 The upper numbers for each variable were calculated from the regressions using LAGTOP3.
2 The lower numbers for each variable were calculated from the regressions using LAGGRAN.

5.24 Contemporaneous (unlagged) model using TOP3 (RGROI)

The independent variables are lagged to allow the model to predict future RGROI from current values of the independent variables and to eliminate potential simultaneity bias of two independent variables. The profitability of a railroad in a given year should be related more to that year's values of the independent variables than to lagged values of those independent variables. Thus, one would expect to lose some estimating power with a predictive model. To determine if this is the case, the models were estimated with unlagged independent variables. The results of these estimations indicate that although the predictive models have slightly higher adjusted R^2s than the contemporaneous models and the root mean square errors are nearly identical, the significance of the explanatory variables are generally higher in the contemporaneous models.

Two independent variables in the model ROTEXPMI (real other expense per mile) and RMOWMI (real MOW per mile) were expected to have a simultaneity bias since the profitability of a railroad can affect these two railroad expenses. Since the regression results of the model with lagged variables are similar to the results with unlagged variables, one can conclude there is little simultaneity bias in the contemporaneous model.

5.25 Panel models (RGROI)

In general, the panel models did not add much to the understanding of the determinants of short line RGROI. The ordinary least squares models (OLS) were chosen since the tests for serial correlation and heteroskedasticity indicated an absence of these problems in the estimated OLS regressions.

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 were significant and the firm effects were significant for relatively few firms. Thus, the panel models were rejected for estimating RGROI.

5.3 Real Operating cash flows (ROCF)

5.31 Predictive (lagged) model using LAGTOP3 (ROCF)

The regression equations for real operating cash flows per mile before interest, taxes and working capital changes (ROCF) are displayed in Table 5.8. The regression equations for ROCF1 and ROCF2 have adjusted R^2s of 0.71 and 0.74 respectively, which are higher than the 0.61 of the unadjusted equation. The Durbin-Watson statistics for the ROCF1 and ROCF2 regressions are 2.02 and 2.03 respectively, indicating that the equations do not have statistically significant serial correlation. This is also the case for the unadjusted model which has a Durbin-Watson of 1.96. The estimated t-statistics obtained by robust standard errors estimation do no vary much from those of the OLS models in Table 5.8, indicating that heteroskedasticity is not a problem of the ROCF models.

Table 5.8
Real Operating Cash Flow per Mile[1] (ROCF)
Predictive (Lagged) Model Using LAGTOP3

Explanatory Variable	ROCF (Unadjusted)	ROCF1 (Before MOW)	ROCF2 (Before MOW & Aid)
Era1	648.91 (0.265)	4719.18 (1.743)*	4957.41 (1.846)*
Era2	940.91 (0.570)	3704.69 (2.173)**	3465.84 (2.071)**
Laggrp	-174.58 (-1.672)*	-273.60 (-2.386)**	-289.12 (-2.565)**
Ship	-1279.65 (-0.845)	-2741.32 (-1.656)	-2966.25 (-1.823)*
Conn	73.67 (0.809)	110.52 (1.092)	100.87 (1.006)
Gmil	9.81 (4.014)***	10.10 (3.730)***	10.41 (3.892)***
Lagown	62.35 (4.049)***	43.74 (2.619)***	44.16 (2.650)***
Lagtop3	661.25 (1.686)*	1430.28 (3.438)***	1390.43 (3.374)***
Lagtop32	-4.00 (-1.511)	-9.16 (-3.246)***	-8.94 (-3.190)***
Lagpoh	-123.53 (-2.968)***	-156.66 (-3.416)***	-159.49 (-3.495)***
Lagdens	49.30 (2.171)**	114.47 (6.377)***	117.56 (6.731)***
Lgrotexm	-.0400 (-0.797)	-.0524 (-0.940)	-.0520 (-0.934)
Lagrhaul	3888.69 (1.447)	5645.92 (1.896)**	5476.84 (1.847)**
Lagrmowm	.5059 (1.457)	---------- ----------	---------- ----------
Raidnmi	.3077 (0.928)	.7276 (2.060)**	---------- ----------
Constant	-32737.39 (-2.295)**	-59665.79 (-3.978)***	-58103.79 (-3.916)***
Number of obs. Adj. R^2 Root MSE	129 .6119 4274.6	128 .7101 4748.4	128 .7370 4740.0
Durbin-Watson	1.9572	2.0207	2.0345

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

1 Before interest, income taxes, and working capital changes.

Inspection of the ROCF1 regression in Table 5.8 reveals that all the independent variables (excluding those with indeterminate signs) except ERA2 have the theoretically expected sign. For discussion of possible reasons for the unexpected sign of this variable, see the REBIT discussion of the predictive model using LAGTOP3. Variables GMIL, LAGOWN, LAGTOP3, LAGTOP3-squared , LAGPOH, and LAGDENS are statistically significant at the .01 level. Again, LAGDENS has the highest t-statistic. ERA2, LAGGRP, LAGRHAUL, and RAIDNMI are significant at the .05 level, whereas ERA1 is significant at the .10 level. SHIP, CONN, and LGROTEXM are not statistically significant.

With regard to theoretically expected signs, the results of the ROCF2 equation are the same as that of ROCF1. The variables ERA1 and SHIP are statistically significant at the .10 level in the ROCF2 equation. All the other variables except CONN and LGROTEXM are significant at the .05 level or above.

Railroad profitability is maximized (with respect to LAGTOP3) when LAGTOP3 is about 78 percent in both the ROCF1 and ROCF2 regressions. When LAGTOP3 exceeds 78 percent, ROCF decreases, although ROCF remains positive for all possible values of LAGTOP3.

The statistical results for the unadjusted ROCF regression are not as good as those of the ROCF1 and ROCF2 regressions. The ROCF regression has 9 variables which are not statistically significant and 2 variables which are significant at only the .10 level.

5.32 Predictive (lagged) model using LAGGRAN (ROCF)

These models, displayed in Table 5.9, show the effects on ROCF of the percentage of total traffic that is devoted to grain (GRAN). The regression equations for ROCF1 and ROCF2 have adjusted R^2s of 0.69 and 0.72 respectively, which is slightly higher than the 0.62 of the unadjusted equation. The adjusted R^2s are nearly identical to those models using LAGTOP3. Durbin-Watson statistics for the ROCF1 and ROCF2 regressions are 2.05 and 2.24 respectively, indicating that the equations do not have statistically significant serial correlation. The estimated t-statistics obtained by robust standard errors estimation do not vary much from those of the OLS models in Table 5.9, indicating that heteroskedasticity is not a problem of the ROCF models.

The ROCF1 regression in Table 5.9 reveals that all the independent variables (excluding those with indeterminate signs) except ERA2 have the theoretically expected sign. The possible reasons for the unexpected sign of this variable are discussed in the REBIT predictive model using LAGTOP3. The variables GMIL, LAGOWN, LAGPOH, and LAGDENS are statistically significant at the .01 level, with LAGDENS having the largest t-statistic. ERA2, LAGGRAN, LAGGRAN-squared, and LAGRHAUL are statistically significant at the .05 level. Variables which are significant at the .10 level are LAGGRP, SHIP, and RAIDNMI. The variables which are not statistically significant in the ROCF1 regression are ERA1, CONN, and LGROTEXM.

With regard to theoretically expected signs, the results of the ROCF2 equation are the same as that of ROCF1. The variables ERA1, CONN, and LGROTEXM are not statistically significant in the ROCF2 equation. All the other explanatory variables are significant at the .05 level or above.

The profitability of short line railroads is maximized (with respect to LAGGRAN) when LAGRAN is 45 and 43 percent respectively in the regressions for ROCF1 and ROCF2. The values of ROCF1 and ROCF2 are zero (in relation to LAGGRAN only) when LAGGRAN is 89 percent and 87 percent respectively. These are the only regressions for which the profitability function is zero before the explanatory variable reaches 100 percent. This indicates that ROCF1 and ROCF2 decrease after LAGGRAN exceeds 45 and 43 percent, but ROCF1 and ROCF2 remain positive until LAGGRAN reaches 89 percent and 87 percent. The values of ROCF1 and ROCF2, in relation to LAGGRAN only, become negative after LAGGRAN exceeds 89 percent and 87 percent respectively.

The statistical results for the unadjusted ROCF regression are not as good as those of ROCF1 and ROCF2 as seven independent variables are not statistically significant in the unadjusted equation.

5.33 Elasticities (ROCF)

The elasticities of ROCF to changes in the various independent variables are shown in Table 5.10. Whether the dependent variable is ROCF1 or ROCF2, the calculated elasticities generally do not vary a lot. Neither do the elasticities vary much between those models using LAGTOP3 and those using LAGGRAN. The elasticities of the unadjusted ROCF model are generally higher than those of the adjusted models.

Table 5.9
Real Operating Cash Flow per Mile[1] (ROCF) Predictive (Lagged) Model Using LAGGRAN

Explanatory Variable	ROCF (Unadjusted)	ROCF1 (Before MOW)	ROCF2 (Before MOW & Aid)
Era1	280.56 (0.124)	3001.84 (1.157)	3310.28 (1.287)
Era2	1187.27 (0.717)	4351.05 (2.457)**	4020.28 (2.321)**
Laggrp	-143.49 (-1.414)	-219.35 (-1.900)*	-241.15 (-2.136)**
Ship	-1076.10 (-0.719)	-3294.79 (-1.949)*	-3609.78 (-2.183)**
Conn	52.67 (0.591)	37.09 (0.362)	23.10 (0.228)
Gmil	8.88 (3.454)***	9.48 (3.225)***	10.04 (3.498)***
Lagown	67.31 (4.428)***	51.27 (2.985)***	51.10 (2.978)***
Laggran	150.18 (2.338)**	175.07 (2.231)**	148.09 (2.037)**
Laggran2	-1.58 (-2.548)**	-1.96 (-2.590)**	-1.71 (-2.424)**
Lagpoh	-146.84 (-3.731)***	-165.78 (-3.591)***	-164.05 (-3.559)***
Lagdens	36.65 (1.613)	118.02 (6.403)***	123.00 (6.989)***
Lgrotexm	-.0591 (-1.204)	-.0638 (-1.119)	-.0605 (-1.065)
Lagrhaul	5796.34 (2.181)**	7123.72 (2.351)**	6682.49 (2.236)**
Lagrmowm	.6759 (2.057)**	---------- ----------	---------- ----------
Raidnmi	.1540 (0.449)	.6512 (1.712)*	---------- ----------
Constant	-8533.54 (-3.226)***	-8939.74 (-2.923)***	-8710.29 (-2.859)***
Number of obs.	129	128	128
Adj. R^2	.6166	.6948	.7226
Root MSE	4248.8	4871.8	4868.4
Durbin-Watson	2.3812	2.0476	2.2362

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

[1] Before interest, income taxes, and working capital changes.

Table 5.10
Estimated Elasticities of
Real Operating Cash Flow per Mile[1] (ROCF)

Explanatory Variable	ROCF (Unadjusted)	ROCF1 (Before MOW)	ROCF2 (Before MOW & Aid)
Laggrp	0.119[2]	0.122	0.139
	0.098[3]	0.098	0.116
Conn	0.077	0.075	0.074
	0.055	0.025	0.017
Gmil	0.423	0.284	0.316
	0.383	0.267	0.305
Lagown	0.701	0.321	0.350
	0.757	0.377	0.406
Lagtop3	0.047	0.828	0.924
Laggran	0.059	0.110	0.128
Lagpoh	0.149	0.123	0.136
	0.177	0.130	0.139
Lagdens	0.577	0.874	0.970
	0.429	0.902	1.015
Lgrotexm	0.148	0.127	0.136
	0.219	0.154	0.158
Lagrhaul	0.312	0.296	0.310
	0.465	0.373	0.378
Lagrmowm	0.304	----------	----------
	0.406	----------	----------
Raidnmi	0.046	0.070	----------
	0.023	0.063	----------

---

1 Before interest, income taxes, and working capital changes.
2 The upper numbers of each variable were calculated from the regressions using LAGTOP3.
3 The lower numbers of each variable were calculated from the regressions using LAGGRAN.

ROCF1 and ROCF2 are not elastic to changes in any variable. The elasticity of ROCF1 and ROCF2 to LAGDENS ranged from 0.874 to 1.015. These are the only regressions in which LAGDENS is not elastic for all specifications of the model.

For ROCF1 and ROCF2, variables with higher elasticities include LAGTOP3 (.828 to .924), LAGOWN (0.321 to .406), LAGRHAUL (0.296 to 0.378), GMIL (0.267 to 0.316).

5.34 Contemporaneous (unlagged) model using TOP3 (ROCF)

The independent variables are lagged to allow the model to predict future ROCF from current values of the independent variables and to eliminate potential simultaneity bias of two independent variables. The profitability of a railroad in a given year should be related more to that year's values of the independent variables than to lagged values of those independent variables. Thus, one would expect to lose some estimating power with a predictive model. To determine if this is the case, the models were estimated with unlagged independent variables. The adjusted R^2s for the contemporaneous models are slightly higher than the lagged models for ROCF. In addition, the root mean square errors for the contemporaneous models are approximately 10 percent lower than those of the lagged models. The significance of the explanatory variables are also generally higher in the contemporaneous models. Thus, the lagged ROCF models lose some of their predictive power relative to the unlagged models.

Two independent variables in the model ROTEXPMI (real other expense per mile) and RMOWMI (real MOW per mile) are expected to have a simultaneity bias since the profitability of a railroad can affect these two railroad expenses. Since the regression results of the adjusted models with lagged variables are similar to the results with unlagged variables, one can conclude there is little simultaneity bias in the adjusted contemporaneous models.

5.35 Panel models (ROCF)

In general, the panel models did not add much to the understanding of the determinants of ROCF. The ordinary least squares models (OLS) were chosen since the tests for serial correlation and heteroskedasticity indicated an absence of these problems in the estimated ROCF, OLS regressions.

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 were significant and the firm effects were significant for relatively few firms. Thus, the panel models were rejected for estimating ROCF.

5.4 Sensitivity analysis

The estimated short line profitability equations can be used by state policy makers to develop "rules of thumb" regarding the expected profitability of short line railroads that request state financial assistance. The data in Table 5.11 indicate how this can be accomplished. The table contains the non-dummy variables from the REBIT2, LAGTOP3 regression. The first numbers in the first column of numbers in the table is the REBIT2 of short line railroads assuming a given variable has its minimum sample value with all other variables assuming their sample mean values. All values in the table assume that the firm is 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). 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 $5,155. The second and third numbers listed in the table for each variable are the lower and upper 95 percent confidence interval values. For CONN, these confidence interval values are - $3,524 and $13,834, which means that we are 95 percent sure that REBIT2 is between these two values.

The middle column of numbers in the table contain REBIT2 and 95 percent confidence interval values for each 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 $5,155 to $9,104. The 95 percent confidence interval values are $425 and $17,783.

The third column of numbers in the table displays REBIT2 and 95 percent confidence values for each variable assuming a given variable has its maximum sample value while all other variables have their sample mean value. For example, if the value of

Table 5.11
Sensitivity of REBIT2 to Changes in Specific Variables[1]

Independent Variable	At the variable's Minimum Value	At the variable's Mean Value	At the variable's Maximum Value
CONN	5,155.03[2]	9,104.02	15,527.00
	(3,524.05)[3]	424.94	6,847.93
	13,834.10[4]	17,783.10	24,206.08
GMIL	5,026.28	7,858.46	15,770.03
	(3,652.80)[5]	(820.61)	7,090.95
	13,705.35	16,537.54	24,449.10
LAGOWN	5,627.36	7,858.46	8,868.36
	(3,051.72)	(820.61)	189.28
	14,306.43	16,537.54	17,547.43
LAGTOP3	(1,921.62)	7,858.46	5,021.55
	(10,600.70)	(820.61)	(3,657.53)
	6,757.45	16,537.54	13,700.62
LAGPOH	8,889.97	7,858.46	772.29
	210.89	(820.61)	(7,906.79)
	17,569.04	16,537.54	9,451.36
LAGDENS	(1,392.50)	7,858.46	47,073.34
	(10,071.58)	(820.61)	38,394.27
	7,286.57	16,537.54	55,752.42
LGROTEXM	11,751.07	7,858.46	(3,742.51)
	3,072.00	(820.61)	(12,421.59)
	20,430.15	16,537.54	4,936.56
LAGRHAUL	6,039.78	7,858.46	10,349.13
	(2,639.29)	(820.61)	1,670.06
	14,718.86	16,537.54	19,028.21

1 Each specific 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 indicate negative values.

CONN is increased to its maximum sample value, all other variables assuming their sample mean value, REBIT2 is $15,527.

Thus the data in the table reveals to the policy maker the range of potential short line profitability at the minimum, mean, and maximum sample values of a given variable. In the case of CONN, REBIT2 ranges from a low of $5155 to a high of $15,527. For GMIL, REBIT2 ranges from a low of $5026 to a high of $15,770. The table contains the corresponding values for each non-dummy variable in the REBIT2, LAGTOP3 regression. The same exercise can be performed using any of the other estimated profitability equations.

The differences between the values of REBIT2 at the minimum and maximum sample values of the independent variables range from $48,465.84 ($47,073.34 + $1,392.50) for LAGDENS to $3,241.00 ($8,868.36 - $5,627.36) for LAGOWN. Since the root mean square error of the estimate is $4,428, the 95 percent confidence intervals are $8,679 above and below the mean values of each variable. The independent variables for which the differences between the values of REBIT2 at the minimum and maximum sample values that exceed $8,679 include: CONN, GMIL, LAGTOP3, LAGDENS and LGROTEXM. Thus, these five variables seem to have the most impact on the value of REBIT2 because of their wide variation.

Since the value of LAGDENS has the most impact on the value of REBIT2, the values of REBIT2 are estimated at density levels ranging from 20 railcars/mile to 100 railcars/mile (Table 5.12). The values of the other independent variables are at the sample mean and it is assumed that the railroad is established after 1987, is independent of other railroads, is not owned by shippers and connects to only one other railroad.

Recall, REBIT2 is defined as real earnings before interest and taxes and is adjusted to remove the effects of maintenance of way expenses (MOW) and non-interest government aid. Thus, the profit levels estimated for REBIT2 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. The amount of MOW required to keep the track in its present condition will vary greatly according to the density of traffic, terrain, number and size of bridges, and many other factors. Thus, a railroad with the mean density of traffic in the sample (71.59), and all other 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, the table indicates it takes in excess of 100 carloads/mile to be 95 percent certain of receiving REBIT2 high enough to cover MOW, interest and income taxes.

Using the predictive equations estimated in this paper and data supplied by a prospective railroad firm, state policymakers can determine the expected profitability of the railroad and the confidence intervals of that profitability estimate. For example, the prospective railroad would supply estimates of the independent variables in the various profitability equations, yielding estimates of REBIT, GROI, and OCF. By considering factors specific to the prospective railroad which influence the required amount of MOW, policymakers can estimate the amount of MOW required to keep the track in the

Table 5.12
Sensitivity of REBIT2 to Changes in LAGDENS[1]

Density of Railcar Traffic[2]	Estimated Value of REBIT2	Lower 95% CI of REBIT2	Upper 95% CI of REBIT2
	REBIT2 model using LAGTOP3:		
20	742.65	(7,936.42)	9,421.73
40	3,501.25	(5,177.82)	12,180.33
60	6,259.85	(2,419.22)	14,938.93
71.59[3]	7,858.46	(820.61)	16,537.54
80	9,018.45	339.38	17,697.53
100	11,777.05	3,097.98	20,456.13
	REBIT2 model using GRAN:		
20	750.92	(8,242.54)	9,744.38
40	3,534.92	(5,458.54)	12,528.38
60	6,318.92	(2,674.54)	15,312.38
71.59	7,932.25	(1,061.21)	16,925.71
80	9,102.92	109.46	18,096.38
100	11,886.92	2,893.46	20,880.38

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 railcars per main-line mile of track.

3 This is the mean density of the sample.

condition required by a specific level of railroad service and relate this figure to the estimates of profitability.

Knowing the probability of a railroad's success can help state policymakers decide whether the benefits of aiding a given short line railroad outweigh the costs and risks of providing that aid. Thus, the data in Table 5.13 was developed using a Z-table, the predicted value of REBIT2 from Tables 5.11 and 5.12, and the mean square error of the regression from Table 5.1 for REBIT2, LAGTOP3. The Z-values are calculated using the formula below:

$$Z_{pop} = \frac{specified\ level\ of\ REBIT2\ -\ predicted\ value\ of\ REBIT2}{RMSE}$$

Z_{pop} - the value used to find the probability a railroad will exceed a specified level of REBIT2 from a Z probability distribution table.
RMSE - the root mean square error.

Table 5.13 indicates there is a 29 percent probability that REBIT2 for a rail firm will exceed \$6,000, given a traffic density of 40 railcars per mile in the prior year[31]. Thus, if the expected MOW is \$4,000 and interest expenses are expected to be \$2,000, the firm has a 29 percent probability of having a profit. Railroads with LAGDENS below the mean sample value of 71.6 have relatively low probabilities of being profitable.

Figure 5.1 shows the distribution of the lagged traffic density of the railroads included in this study. Three of the 34 railroads in the sample had traffic densities of less

31 Assuming the railroad connects to only one other railroad, is not shipper owned, is independent of other railroad firms and all other variables at their mean sample values.

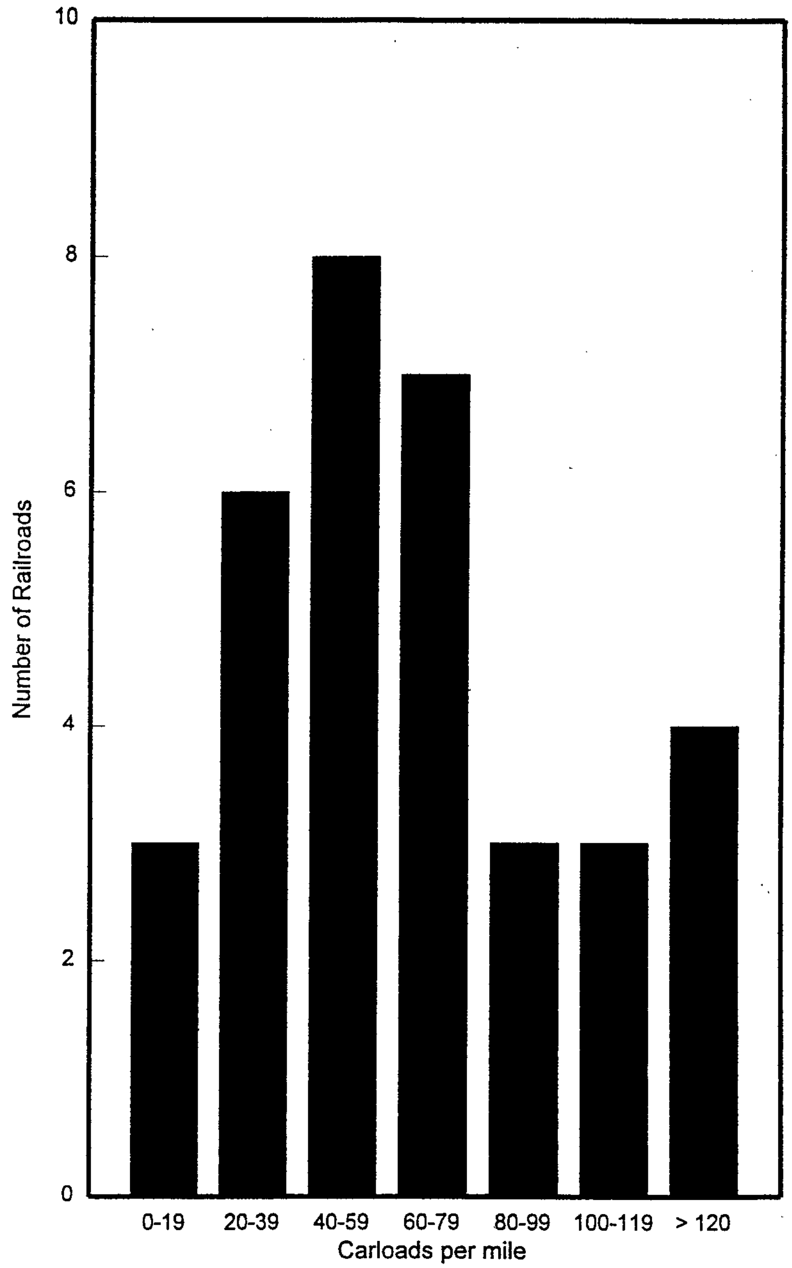
than 20 carloads per mile and six of the railroads in the sample had traffic densities between 20 carloads per mile and 40 carloads per mile. Thus, about 25 percent of the short line railroads in this study have a high probability of requiring governmental financial assistance in order to continue operating.

Table 5.13
Probabilities a Railroad Will Exceed Specified Values of REBIT2 at Specified Values of LAGDENS (Regression Using LAGTOP3).[1]

Value of LAGDENS[2]	Estimated REBIT2	Probability REBIT2 Will be Greater Than: $4,000	$6,000	$8,000
4.51[3]	($1,393)	0.11	0.05	0.02
20	$743	0.23	0.12	0.05
40	$3,501	0.46	0.29	0.15
60	$6,260	0.70	0.52	0.35
71.59[4]	$7,858	0.81	0.66	0.49
80	$9,018	0.87	0.75	0.59
100	$11,777	0.96	0.90	0.80

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, excepting LAGDENS, are at their mean sample values.
2 LAGDENS is measured in carloads per mile.
3 Minimum sample value of LAGDENS.
4 Mean sample value of LAGDENS.

Figure 5.1
Number of Railroads in Each Category of LAGDENS



CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

This study develops quantitative models which can be used to predict the long term profitability of grain dependent short line railroads in the Midwest and identifies the key factors influencing the profitability of those railroads. These models can aid state policymakers in allocating financial assistance among potential short line railroads.

This chapter discusses conclusions regarding the performance of the adjusted models relative to the that of non-adjusted models, the performance of lagged models compared to contemporaneous models, the key factors influencing the profitability of short line railroads, and the sensitivity of short line railroad profitability to those key factors. Since railroads are important to local economies and state governments, this chapter will recommend actions governmental units can take to increase the long-run probability of short line railroad success.

6.1 Conclusions

6.11 Comparison of models

Both the models adjusted for MOW only and those adjusted for MOW and non-interest government aid have more predictive power and statistical significance than comparable unadjusted models. The adjusted models consistently have higher adjusted R^2s, have more statistically significant explanatory variables, and have higher t-statistics for those variables which are significant. Except for the variable ERA2, the signs of all the explanatory variables are as predicted.

Since differences in the adjusted R^2s are small and differences in the statistical significance of the explanatory variables are mixed, the models adjusted for MOW only and those adjusted for both MOW and non-interest government aid are relatively equal in explanatory power. The root mean square errors for the model adjusted for MOW only are nearly the same as those for the model adjusted for both MOW and non-interest government aid.

In addition, the predictive (lagged) models compare well with the contemporaneous models. The adjusted R^2s of the predictive models are nearly equal to those of the contemporaneous models. Usually the difference in mean square error between the two types of models is less than 5 percent. Only those lagged models estimating real operating cash flows per mile (ROCF) had mean square errors 10 percent higher than the contemporaneous models. The coefficient estimates and t-statistics of the predictive models are also similar to those of the contemporaneous models. The contemporaneous models exhibit no evidence of simultaneity bias.

The models using LAGTOP3 as an explanatory variable have nearly the same adjusted R^2s and root mean square errors as those using LAGGRAN. The only differences are that the number of statistically significant variables and the t-statistics in the models using LAGTOP3 are slightly higher than those models using LAGGRAN.

The fixed-effect panel models are rejected since the dummy variables for individual firms are collinear with other explanatory variables, resulting in few of the explanatory variables and firm dummy variables being statistically significant. Since the Durbin-Watson statistics indicate no statistically significant autocorrelation and the robust standard error estimations indicate no heteroskedasticity for the OLS models, the random-effect panel models are not used to estimate short line profitability.

6.12 Key factors influencing profitability

The criteria used to determine the key factors influencing the profitability of short line railroads are the sensitivity analysis of REBIT2, the elasticities, and the t-statistics of the explanatory variables. Although LAGDENS is the most important factor for all three of these criteria, the important variables according to each of these criteria are discussed in the order given above.

6.121 Sensitivity analysis

In the sensitivity analysis of REBIT2, lagged carloads per mile (LAGDENS) is by far the most important variable. For every 10 carloads of traffic per mile, REBIT2 increases by $1379. The difference in REBIT2 between the sample minimum and maximum values of LAGDENS is $48,466, which is more than 3 times that of the next most important variable.

The second most important variable in the sensitivity analysis is lagged real other expenses per mile[32] (LGROTEXM), in which REBIT2 has a difference of $15,494 between the sample minimum and maximum values of LGROTEXM. For each additional $1000 dollars per mile spent on LGROTEXM, REBIT2 decreases by $210.

There is a $10,744 difference in REBIT2 between the sample minimum and maximum values of gross miles of main-line track operated (GMIL). REBIT2 increases by $11.25 for each main-line mile of track operated and by $232.38 for each connecting railroad (CONN).

There is a $9,857 difference in REBIT2 between the sample minimum of LAGTOP3 (43 percent) and the REBIT2 maximum with respect to LAGTOP3 (79.92 percent). Since the relationship of REBIT2 to LAGTOP3 is a quadratic function, the incremental effect of additional amounts of LAGTOP3 on REBIT2 is negative when LAGTOP3 exceeds 80 percent. As the value of LAGTOP3 increases from its REBIT2 maximizing value, REBIT2 decreases much more rapidly. For instance, when LAGTOP3 is 85 percent, the incremental effect of an additional 1 percent upon REBIT2 is - $73.40. However when LAGTOP3 is 95 percent, the incremental effect of an additional 1 percent upon REBIT2 is - $218.

---

32 Lagged real other expenses per mile is defined as real operating expenses per mile less real MOW expenses per mile.

6.122 Elasticities

The elasticity of the profitability measures with respect to the various explanatory variables is another good indication of the relative importance of variables. REBIT and RGROI are elastic to changes in only one variable, LAGDENS. This indicates that short line profitability, as measured by these two variables, is more responsive to traffic density than to any other variable in the model. The elasticities of REBIT with respect to LAGDENS range from 1.48 to 1.78 and the elasticities of RGROI with respect to LAGDENS range from 1.16 to 1.59.

Other variables with higher elasticities for REBIT include LGROTEXM (0.70 to 0.83), LAGTOP3 (0.52 to 0.70), GMIL (0.37 to 0.53), and LAGRHAUL (0.39 to 0.48). Other variables with higher elasticities for RGROI include LGROTEXM (.43 to .80), LAGTOP3 (.59 to .69), and GMIL (.42 to .56). ROCF is near unitary elasticity with respect to LAGDENS (0.87 to 1.02). Other variables with higher elasticities for ROCF include LAGTOP3 (0.82 to 0.92), LAGOWN (0.32 to 0.41), and LAGRHAUL (0.30 to 0.38).

6.123 Statistical significance

LAGDENS has the highest t-statistics for all model estimations and is significant at the .01 level in all these regressions. The t-statistics of LAGDENS range from 6.38 to 8.51 and the values of the coefficient range from $114 to $145 for each additional carload per mile of main-line track operated.

GMIL is the other explanatory variable which is significant at the 1 percent level for all models estimated and all measures of profitability. The t-statistics of GMIL range from 3.23 to 5.80 and the coefficient values range from $9.11 to $13.89 for every main-line mile operated.

For REBIT1 and REBIT2, the other variables that are significant at the .01 level are LGROTEXM, SHIP, and LAGPOH. The coefficients range from - $0.1915 to - $0.2057 for every dollar of lagged operating expense spent on non-MOW items (LGROTEXM), from - $5078 to - $6530 if the railroad is operated by a shipper (SHIP), and from - $125 to - $140 for each lagged percent of overhead traffic to total traffic (LAGPOH).

The variables which are statistically significant at the .01 level in all the RGROI1 and RGROI2 regressions are LAGGRP, SHIP, and CONN. The coefficients range from - $311 to - $355 for each railroad firm operated by the parent company the prior year (LAGGRP), from - $7047 to - $7446 if the railroad is operated by a shipper (SHIP), and from $427 to $576 for each connecting railroad (CONN).

The variables which are statistically significant at the .01 level in all the ROCF1 and ROCF2 regressions are LAGOWN and LAGPOH. The coefficients range from - $43.74 to - $51.00 for each percent of track operated which the railroad owned the prior year (LAGOWN), and from - $157 to - $166 for each lagged percent of overhead traffic to total traffic (LAGPOH).

6.2 Recommendations

The analysis of this study indicates that the profitability of sample short lines is not very high. A railroad with the mean traffic density (all other values at their mean values) is likely to receive a REBIT2 approximately equal to MOW, interest, and income taxes. In addition, sample short lines with less than the mean value of traffic density have less than a 50 percent chance of generating enough REBIT2 to pay MOW, interest, and income taxes (assuming these total to $8,000). The analysis of the study also indicates that about 25 percent of the sample short lines have a high probability of requiring government financial assistance in order to continue operating.

6.21 Benefits of preserving short line rail service

Prior to discussion of recommendations it is useful to briefly discuss the benefits of preserving short line rail service. When rail lines are abandoned, the increased truck traffic on highways greatly increases the costs of highway maintenance and reconstruction. Babcock, Russell, and Mauler (1995) estimated the costs of abandonment for three former Santa Fe branchlines in south central Kansas, currently operated by the Central Kansas Railway. In this study, the increased costs of highway maintenance due to abandonment are estimated to be $1,004,590 annually, which is a 48 percent increase from pre-abandonment highway maintenance costs. The three branchlines together total 300 hundred miles. Thus, the estimated increase in road maintenance costs per mile of track abandoned for this particular study is $3,349. These costs will vary according to the density of traffic on the rail line to be abandoned, the length of the rail haul which is replaced by motor freight, the type of trucks used for the haul, and the quality of the highways used.

Other costs involved with rail line abandonment include higher freight costs to agricultural producers which result in lower grain prices received by farmers. In the aforementioned study, Babcock, et. al estimate that 40 percent of the shipments would involve a 1 percent to 16 percent increase in transportation costs in the event of rail line abandonment. In general, as the distance from the county elevator to the market increases, the greater the increase in transportation costs.

Other effects of rail line abandonment include the loss of market options for shippers and foreclosed economic development options in rural communities. These effects result in a loss of jobs for the communities involved and a loss of tax base for governmental units.

Railroads are more fuel efficient than motor carriers and contribute less to pollution and other environmental problems. Thus, preservation of short line rail service conserves energy and is environmentally sound.

6.22 Grants and low-interest loans

The first recommendation is that governmental units make grants and/or low-interest loans available to short line railroad firms for the purposes of upgrading track or purchasing lines in order to capture the benefits of rail service preservation noted above. Short line railroads need access to low-interest loans due to the long-term nature of rail investments.

6.23 Loan guarantees

The second recommendation is for governmental units to guarantee loans to short line railroad firms. Since they are more comfortable working with larger railroads, those banks specializing in loans to railroads have minimum loan amounts far in excess of that needed by most short line rail firms. Local commercial banks have been reluctant to make loans of the size needed by most independent rail firms since most local banks have little experience making loans to railroads, the salvage value of the lines are relatively low in relation to the financial exposure of the lending institution, and the Class I railroads have been unable to operate these lines profitably. These loan guarantees will remove much of the uncertainty and risks which prevent local banks from financing short line railroads.

6.24 State financed disaster insurance pool

Another recommendation is the creation of a state or regional financed disaster insurance pool which will subsidize the cost of insurance to short line railroads. Many short lines are uninsured for catastrophic losses due to their relatively low profitability. Uninsured short line railroads may be unable to continue service after sustaining major losses since they are usually underfinanced and have heavy debt loads which prevent increased borrowing. A state financed disaster insurance pool would prevent the loss of rail service due to catastrophic losses.

6.25 Assistance for specific maintenance activities

The next recommendation is governmental assistance for specific maintenance activities. State and local governmental units could assume responsibility for maintaining highway crossings. The costs of maintaining these railroad crossings is particularly onerous on low density railroad lines, affecting the survival probability of some short line railroads.

Another maintenance activity which would result in major savings to short line railroads is for governmental units to mow and clear brush around railroad crossings. Since highway crews already mow along roads, the incremental cost of doing this is virtually zero.

6.26 State covered hopper car pool

A fifth recommendation is the creation of a state pool which would lease covered hopper cars from car leasing companies and sublease those rail cars on a short term basis to short line railroads. Short line railroads are often limited in the amount of service they can provide due to their inability to obtain rail cars. This problem is worse when the short line connects to only one other railroad. Nine of the 34 firms in this study (26 percent) connect to only one other railroad.

Casavant and Mack (1996), report on the success the State of Washington has had with the operation of a 29 grain car pool serving the eastern half of the state. These rail cars produced 423 carloads in 1995. The operating revenues not only cover the operating expenses of the program, but are sufficient to increase the fleet size to 91 cars by the end of the twenty-third year, even if the project had been financed at market interest rates. The total impacts of the program for 1995 were $303,439, of which $8,263 were safety savings, $14,129 were fuel savings, $92,320 were transportation charges saved by agricultural producers, and $188,727 were avoided damages to state and county roads.

6.3 Final thoughts

This study will help governmental decision makers allocate aid to those short line railroads which need aid and are most likely to be profitable. From the regression equations provided, the decision maker can estimate the profitability of the railroad prior to MOW expenses, interest expenses, income taxes, and non-interest government aid. In addition the decision maker can determine the probabilities for specific levels of profitability.

The models in this study account for over 70 percent of the variation in short line railroad profits. Due to inadequate data, other variables that may affect short line profitability such as managerial effectiveness and intermodal competition were not included in the profitability analysis. Thus, the decision maker will need to use some intuition when allocating aid to short line railroads based on these models.

The most important conclusion of this study is that the benefits of governmental assistance to short line railroads will often exceed the costs of allowing the track to be abandoned. All forms of governmental assistance described in the recommendations section can increase the probability of short line survival, but some of the least costly recommendations have higher benefit to cost ratios. A good transportation infrastructure, including railroads, is a required condition for economic growth. Thus, selective assistance to those short line railroads needing help and having a reasonable probability of success will help preserve the rail infrastructure which is required to maintain the economic health and tax base of rural areas.

BIBLIOGRAPHY

Association of American Railroads, *Profiles of American Railroads*, 1993.

Babcock, Michael W., Eugene R. Russell, Marvin E. Prater and John Morrill, *State Short Line Railroads and the Rural Economy.*, Kansas Department of Transportation Report No. KSU-92-2R, June 1994, pp. 1-225.

__________, Marvin E. Prater and John Morrill, "A Profile of Short Line Railroad Success.", Transportation Journal, Vol. 34, No. 1, Fall 1994, pp. 22-31.

__________, Marvin E. Prater, John Morrill and Eugene R. Russell, "Short-Line Railroads' Performance.", Transportation Quarterly, Vol. 49, No. 2, Spring 1995, pp. 73-86.

__________, Marvin E. Prater, John Morrill and Eugene R. Russell, "Competitiveness of Short Line Railroads.", Journal of the Transportation Research Forum, Vol. 34, No. 2, 1995, pp. 13-26.

__________, Eugene R. Russell and Curtis E. Mauler, "Shipper Transportation and Highway Damage Cost Changes Due to Branchline Abandonment: A Kansas Case Study.", Proceedings of the 1995 Conference of the Transportation Congress, Vol. 2, 1995, pp. 1479-1490.

Casavant, Ken and Richard Mack, "The "Grain Train" in Washington State: An Evaluation of Internal and External Benefits.", Washington State University, 1996.

Dooley, Frank J., "The Evolution of the Shortline Railroad Industry." Journal of the Transportation Research Forum, Vol. 31, No. 1, 1990, 180-94.

________________. "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, Vol. 29, No. 1, 1988, 86-93.

Due, John F., "New Railroad Companies Formed to Take Over Abandoned or Spun-Off Lines." Transportation Journal, Fall 1984, 30-50.

__________, "Abandonment of Rail Lines and the Smaller Railroad Alternative.", Logistics and Transportation Review, Vol. 23, No. 1, March 1987, 109-134.

Eusebio, Victor E., Stephen J. Rindom, Ali Abderrezak, and John Jay Rosacker, "Rail Branch Lines at Risk: An Application of the Exponential Survival Model on Kansas Duration Data.", Transportation Research Forum, Vol. 33, No. 1, 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, U. S. Government Printing Office, February 1989.

Fitzsimmons, Edward L., "Factors Associated with Intramodal Competition Reported by Small Railroads." Logistics and Transportation Review, Vol. 27, No. 1, 1988, 73-90.

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

Hirschey, Mark John, "Estimation of Cost Elasticities for Light Density Railroad Freight Service." Land Economics, Vol. 55, No. 3, August 1979, 366-378.

Jones, Mike, Telephone conversation, Texas Department of Transportation, 1996.

Kansas Department of Transportation, Bureau of Rail Affairs, *Kansas Rail Plan*, 1995 Update, June 1996.

Lee, Tenpao, *The Cost Structure of U.S. Railroad Industry, 1980-81.*, Ph.D. dissertation, Department of Economics, Iowa State University, Ames, Iowa, 1984.

Levine, Harvey A., et al., Small Railroads, Chelsae, MI, Association of American Railroads, 1982.

Mielke, Jon H., "Short Line Railroad Creations: Terms of Sale, Impacts on Viability, and Public Policy Implications." Journal of the Transportation Research Forum, Vol. 29, No. 1, 1988, 138-48.

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., August 1989.

Rockey, Craig F., "The Formation of Regional Railroads in the United States." Transportation Journal, Vol. 27, No. 2, Winter 1987, 5-13.

Sidhu, Nancy D., Alberta 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, Vol. 17, Autumn 1977, pp. 7-24.

Thoms, Wm. E., Frank J. Dooley and Denver D. Tolliver, "Rail Spinoffs, Labor Standoffs, and the P&LE.", Transportation Law Journal, Vol. 28, No. 1, 57-83, 1989.

Walter, Clyde Kenneth and Henry J. McNair, "Viability Measures Applied To Iowa Shortline Railroads." Journal of the Transportation Research Forum, Vol. 30, No. 2, 1990, 275-285.

Wolfe, K. Eric, "The Downside Risk: An Analysis of Local and Regional Railroad Service Failures." Journal of the Transportation Research Forum, Vol. 29, No. 1, 1988, 124-137.

Wolfe, K. Eric, "Financial and Demographic Conditions Associated With Local and Regional Railroad Service Failures." Transportation Quarterly, Vol. 43, No. 1, January 1989, 3-28.

Wolfe, K. Eric, "Long-Run Financial and Demographic Differences Between Failed and Successful Local and Regional Railroads." Data Collection, Economics and Finance Department, Association of American Railroads, Washington, D.C.

APPENDIX A

RAILROAD QUESTIONNAIRE

Part A: GENERAL QUESTIONS

1. When did your company buy or lease this line?

2. When did your company begin operating this line?

3. Please list any changes in management and the dates of these changes.

4. If you own the short line, what was the purchase price?

5. If you lease track **from** another party, please list the amount paid for track leases each year.

<u>1986</u> <u>1987</u> <u>1988</u> <u>1989</u> <u>1990</u>

<u>1991</u> <u>1992</u> <u>1993</u> <u>1994</u>

6. If you lease track **to** another party, please list the amount received from the track leases each year.

<u>1986</u> <u>1987</u> <u>1988</u> <u>1989</u> <u>1990</u>

<u>1991</u> <u>1992</u> <u>1993</u> <u>1994</u>

7. Is your firm part of a group of rail firms? If so, what is the name and address of the rail group?

8. List the firms that have been a part of this rail group.

Railroad Name	Purchase Date	Sold Date

9. Is this rail firm unionized? If so, what was the date of unionization and the trades unionized?

10. List the railroads that your firm has connections with?

11. Has your short line received any state or local government assistance (loans, grants, materials)?

Date of Assistance	Original Amount	Interest Rate	Maturity Date	Purpose of Assistance

12. Has your short line received any federal government assistance (loans, grants)?

Date of Assistance	Original Amount	Interest Rate	Maturity Date	Purpose of Assistance

Part B: TRACK

1. Please list the miles of primary main line track operated by your short line for each of the following years:

	1986	1987	1988	1989	1990	____	1992	1993	1994
Owned	__	__	__	__	__	__	__	__	__
Leased from RRs	__	__	__	__	__	__	__	__	__
Leased from govt.	__	__	__	__	__	__	__	__	__
Trackage Rights	__	__	__	__	__	__	__	__	__
Other	__	__	__	__	__	__	__	__	__
Total	__	__	__	__	__	__	__	__	__

2. How many miles of track were under slow order (less than 10 mph) each year?

1986 1987 1988 1989 1990 1991 1992 1993 1994

3. How many dollars did your short line spend on maintenance of way (expensed that year) each year?

1986 1987 1988 1989 1990

1991 1992 1993 1994

4. How many dollars did your short line spend on track rehabilitation (where the expense is spread over several years) each year?

1986 1987 1988 1989 1990

1991 1992 1993 1994

Part C: TRAFFIC

In answering the following questions regarding traffic on your short line, please use the following traffic definitions:

Local -- traffic that **originates and terminates on your railroad.**

Originated -- traffic that **originates on your railroad** and **terminates on another railroad.**

Terminated -- traffic that **originates on another railroad** and **terminates on your railroad.**

Overhead -- traffic handled by your railroad but which **originates and terminates on other railroads.**

1. For each year, please list the number of carloads:

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Local	___	___	___	___	___	___	___	___	___
Originated	___	___	___	___	___	___	___	___	___
Terminated	___	___	___	___	___	___	___	___	___
Overhead	___	___	___	___	___	___	___	___	___
Total Cars	___	___	___	___	___	___	___	___	___

2. List below the SIC codes of the top commodities hauled (including farm products -- SIC 01) and the carloads hauled each year. (See attached list of SIC codes).

SIC code	1986	1987	1988	1989	1990	1991	1992	1993	1994
01	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___
TOFC/COFC	___	___	___	___	___	___	___	___	___

3. How many carloads were switched each year?

1986 1987 1988 1989 1990 1991 1992 1993 1994

4. What was the average length of haul (in miles) each year (this may be estimated)?

1986 1987 1988 1989 1990 1991 1992 1993 1994

Part D: EQUIPMENT

1. How much did your firm **spend on equipment leased** (locomotives and cars) each year?

1986 1987 1988 1989 1990

1991 1992 1993 1994

2. How much did your firm **receive from equipment leased** (locomotives and cars) each year?

1986 1987 1988 1989 1990

1991 1992 1993 1994

3. How much did your firm **spend on car hire** each year?

1986 1987 1988 1989 1990

1991 1992 1993 1994

4. How much did your firm **receive from car hire** each year?

<u>1986</u> <u>1987</u> <u>1988</u> <u>1989</u> <u>1990</u>

<u>1991</u> <u>1992</u> <u>1993</u> <u>1994</u>

5. How much did your firm **spend on the purchase of equipment** each year?

<u>1986</u> <u>1987</u> <u>1988</u> <u>1989</u> <u>1990</u>

<u>1991</u> <u>1992</u> <u>1993</u> <u>1994</u>

6. How much did your firm **receive from the sale of equipment** each year?

<u>1986</u> <u>1987</u> <u>1988</u> <u>1989</u> <u>1990</u>

<u>1991</u> <u>1992</u> <u>1993</u> <u>1994</u>

Part E: FINANCIAL

1. How much depreciation and amortization did your firm have each year?

<u>1986</u> <u>1987</u> <u>1988</u> <u>1989</u> <u>1990</u>

<u>1991</u> <u>1992</u> <u>1993</u> <u>1994</u>

2. Which method of depreciation does your firm use for:

	Internal books	Taxes
Accelerated Cost Recovery	___	___
Straight Line	___	___
Other: ________	___	___

3. What date does your firm use for its year end?

4. <u>If your firm is part of a group and taxes are paid by the parent firm</u>, what is the effective taxe rate of the parent firm for each year?

1986	1987	1988	1989	1990	1991	1992	1993	1994

5. How much was your firm's interest expense each year?

1986	1987	1988	1989	1990	1991	1992	1993	1994

6. Please enclose copies of the following financial statements:

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Balance Sheet	X	X	X	X	X	X	X	X	X	X
Income Statement		X	X	X	X	X	X	X	X	X
Statement of Cash Flows (if available)		X	X	X	X	X	X	X	X	X

APPENDIX B
SUMMARY OF DATA

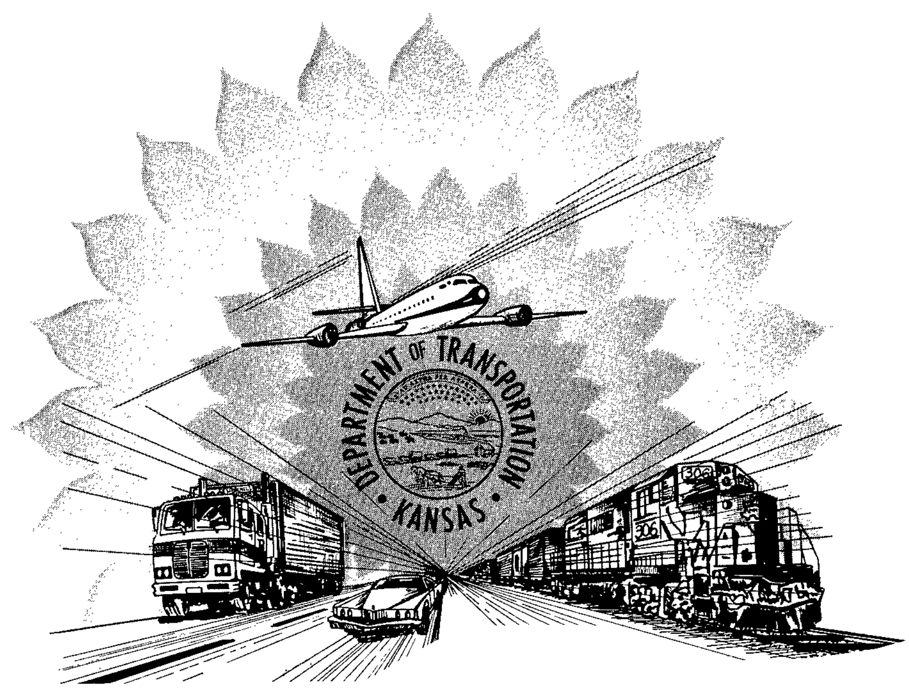
Explanatory Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
age	196	10.745	19.794	0	94
era1	196	.102	.303	0	1
era2	196	.612	.488	0	1
grp	196	4.517	6.055	1	> 6
laggrp	162	4.181	5.624	1	> 6
2<=grp<=5	196	.291	.455	0	1
grp>=6	196	.255	.437	0	1
ship	196	.321	.468	0	1
conn	196	6.362	8.421	1	> 6
conn=1	196	.260	.440	0	1
2<=conn<=5	196	.505	.501	0	1
conn>=6	196	.235	.425	0	1
gmil	196	263.753	273.921	12	> 800
own	196	68.627	39.767	0	100
lagown	162	68.845	39.692	0	100
top3	180	83.278	15.835	43	100
lagtop3	151	83.192	16.112	43	100
gran	180	49.617	32.456	0	100
laggran	151	49.914	32.170	0	100
poh	182	7.599	14.488	0	58
lagpoh	153	7.373	14.179	0	58
density	182	74.412	56.267	4.52	355.91
lagdens	153	71.592	52.358	4.52	355.91
rhaul	186	.487	.213	.12	1
lagrhaul	155	.491	.209	.12	1
rmowmi	183	3643.208	2553.891	204.46	12380.59
lgrmowm	153	3679.437	2542.868	204.46	11321.69
rotexpmi	183	22264.72	18454.63	3536.48	79102.95
lgrotexm	153	22623.02	18933.57	3671.66	79102.95
raidnmi	185	907.207	1424.516	0	8828.24

APPENDIX B
SUMMARY OF DATA

Dependent Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
rebit	196	3122.278	6783.982	-11508.13	40085.52
rebit1	183	6337.861	7639.623	-7937.60	47225.34
rebit2	172	5601.16	8002.794	-10630.21	47024.04
rgroi	143	4203.854	7472.901	-9618.49	33634.90
rgroi1	141	7891.492	8964.544	-8892.27	42479.11
rgroi2	140	6537.794	9004.13	-8892.27	42390.61
rocf	184	6121.301	7873.598	-6620.89	51103.93
rocf1	171	9371.469	8352.436	-2796.62	45827.46
rocf2	161	8674.701	8671.17	-4024.71	45623.60

K - TRAN

KANSAS TRANSPORTATION RESEARCH
AND
NEW - DEVELOPMENTS PROGRAM



A COOPERATIVE TRANSPORTATION RESEARCH PROGRAM BETWEEN:

KANSAS DEPARTMENT OF TRANSPORTATION

THE KANSAS STATE UNIVERSITY

THE UNIVERSITY OF KANSAS

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Technical Information Service
Springfield, VA 22161 (703) 487-4650