SHOULD SHORLTINE RAILROADS UPGRADE THEIR SYSTEMS TO HANDLE HEAVY AXLE LOAD CARS? A KANSAS CASE STUDY

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Abstract

Motivated by lower cost per ton-mile, U.S. Class I railroads have been replacing 263,000-pound GVW (gross vehicle weight) covered hopper cars (primarily used to haul grain) capable of handling 100 tons with 286,000-pound GVW cars that can handle 111 tons. Since the quality of track on shortline railroads is generally less than that of Class I railroads, it is likely that increasing use of heavy axle load (HAL) cars will have a greater impact on shortlines. If light density rail lines are not upgraded to handle HAL cars, the percentage of the grain car fleet that can move on shortlines will decline, possibly threatening the long-term viability of these railroads. If shortline railroads are abandoned it could have negative consequences for U.S. rural communities.

The objectives are to document the shift from 263,000-pound rail cars to 286,000-pound cars by Class I railroads, and to measure the number of route miles and bridges that will require upgrading to handle the HAL rail cars (for a sample of Kansas shortlines). Other objectives include estimation of which branchlines are likely to be upgraded and which will likely be abandoned based on rate of return on investment analysis. The study also measured the road damage cost to state highways if upgrading to handle HAL cars does not occur and shortlines (or parts of shortlines) are abandoned.

Analysis revealed that the total cost to upgrade 1,583 miles of mainline track and 1,352 bridges of five Kansas shortline railroads was estimated to be $308.7 million. None of the shortlines in the analysis can earn an adequate rate of return on upgrading track and bridge investment: given their current traffic densities and other characteristics. If the shortline railroads in the study are abandoned, the annual road damage costs in Kansas will increase by over $58 million.

INTRODUCTION

Following deregulation of the U.S. railroad industry in 1980 with the passage of the Staggers Rail Act, U.S. Class I railroads adopted a cost reduction strategy to restore profitability to the industry. Part of the strategy was sale or lease of low traffic density branchlines to shortline railroads.[1] The result was tremendous growth in the number of U.S. shortlines created. In the 1980-89 period 227 shortlines were created, and in the 1990-2001 era an additional 229 railroads (AAR, *Profiles of American Railroads*, various issues). In 2002, nearly 30% of U.S. track miles were controlled by shortlines (Association of American Railroads, 2003, p. 3).[2]

U.S. Class I railroads have been replacing 263,000-pound GVW (gross vehicle weight) covered hopper cars capable of handling 100 tons with 286,000-pound GVW cars that can handle 111 tons. The number of 263,000-pound and 286,000-pound covered hopper cars of the Union Pacific (UP) and Burlington Northern Santa Fe (BNSF) railroads as of mid-year for the 1999-2003 period is displayed in Table 1. The combined total covered hopper car fleet of the two railroads fell from 72,607 cars in 1999 to 60,614 cars in 2003, a 16.5% decline. The percentage of the combined fleet accounted for by 263,000-pound cars fell from 75.3% (1999) to 63.0% (2003) while the corresponding figures for 286,000-pound cars were 24.7% (1999) and 37.0% (2003). By the year 2010, UP expects that 286,000-pound cars will account for 60% of their grain car fleet, while BNSF expects these cars to amount to half of their grain car fleet.

The motivation for the switch in car size is the decrease in railroad cost per ton-mile. Using larger rail cars results in a reduction in Class I railroad car and locomotive ownership costs, labor costs, fuel costs, and car and locomotive maintenance costs, as well as an increase in rail system capacity. According to a study by Kenneth Casavant and Denver Tolliver titled *Impacts of Heavy Axle Loads on Light Density Lines in the State of Washington* (2001, App. A, p. 20), Class I railroad operating costs per ton-mile of 286,000-pound cars are nearly 9% less than that of 263,000-pound cars.

Table 2 contains data comparing wheat rates per ton for 268,000-pound and 286,000-pound rail cars. The comparison is for wheat shipped from Wichita, Hutchinson, Salina, and Kansas City, Kansas to the Texas Gulf including Houston, Galveston, and Beaumont, Texas. The rates in Table 2 are based on November 2003 BNSF rates for cars shipped in 52 to 109 car trains and for cars shipped in 110 to 120 car trains. In all cases the rates for the 286,000-pound car are 1.9 to 2.0% less than the rates for the 268,000-pound car. Thus, 286,000-pound cars are profitable for Class I railroads because the decline in cost per ton is greater than the decrease in revenue per ton.

The 286,000-pound rail car has the potential to worsen four problem areas of many shortline railroads. These are light rail (rail weighing 90 pounds per yard or less), thin ballast sections (less than one foot of ballast under ties), deferred tie maintenance, and old bridges. According to a study by Resor et al. (2000) titled *An Estimation of the Investment in Track and Structures Needed to Handle 286,000-Pound Rail Cars on Short Line Railroads* (2000), 90 pound per yard rail *may* perform satisfactorily under 286,000-pound carloads provided the line has good tie maintenance, good ballast, and the train is operated at slow speed (between 10 and 25 mph). However, deferred maintenance and/or higher speed train operations will increase rail deflection to unacceptable levels. Deflection is the up and down movement of the track under repeated wheel loads and is the primary source of track deterioration. The Resor et al. (2000) study concluded that 90 pound rail is marginal for operating speeds of 25 miles per hour or less, for 286,000-pound cars, even at the lightest traffic densities.

The increasing size of grain carrying rail cars has important implications for the economic viability of shortline railroads in agricultural regions, especially in the corn and wheat growing states of the U.S. Midwest. In most cases, grain is the principal commodity of shortlines serving these areas. As the 286,000-pound car replaces the 263,000-pound car for transporting grain, shortlines may have to upgrade their tracks and bridges to handle the increased weight of the larger rail car. Also these railroads face higher costs to operate and maintain their tracks and bridges as more heavy axle load (HAL) cars move on their lines. If grain carrying shortlines are unable to absorb the increased costs of the HAL cars, the percentage of the grain car fleet that can move on shortlines will decline, and shortline grain shippers will have no alternative but to truck their grain to terminal markets or distant Class I railroad facilities. Thus shortlines will lose market share in their principal commodity, threatening the long term viability of these railroads.

If universal adoption of the 286,000-pound covered hopper car, coupled with the higher track maintenance costs of HAL cars, leads to abandonment of shortline railroads, it could have several negative consequences for rural communities in agricultural regions including the following:

- Lower grain prices received by farmers[3]
- Higher transportation costs and lower profits for rail shippers
- Reduction of market options for shippers
- Lost economic development opportunities for rural communities
- Loss of local tax base needed to fund basic government services
- Potential increases in highway traffic accidents due to increased truck traffic
- Increased road damage costs on county roads and state highways
- Increased energy use and pollutant emissions

Given the potential impact of increasing use of HAL rail cars on shortline abandonment and the resulting negative effects on rural communities, the objectives of the research were as follows:

Objective 1 – Document the shift from the 263,000-pound (C6-100 ton) rail car to the 286,000-pound car (C6X-111 ton) by Class I railroads.

Objective 2 – For a sample of shortline railroads, measure the number of route miles and bridges that will require upgrading and rehabilitation to handle the 286,000-pound rail car.

Objective 3 – Estimate which branchlines are likely to be upgraded and which will likely be abandoned based on rate of return on investment analysis.

Objective 4 – Measure the road damage cost to state highways if upgrading to handle HAL cars does not occur and shortlines (or parts of shortlines) are abandoned.

The analysis is applied to Kansas in order to empirically estimate the models that are employed to analyze the research problem. However, as noted above, the potential impact of increasing use of HAL cars is a general problem for all U.S. agricultural regions. Thus, the paper can be viewed as a guide to researchers in other U.S. states concerned with the same research question.

LITERATURE REVIEW

Resor et al. (2000) conducted a study on the effects of 286,000-pound rail cars on the U.S. shortline and regional railroad system. The objectives of the study were to estimate the amount of shortline and regional railroad trackage which met minimum standards for use of heavy axle load rail cars, and to estimate the investment in components required to bring the entire shortline and regional railroad system up to minimum standard.

Resor et al. (2000) developed a survey of track conditions and characteristics for the U.S. shortline and regional railroad industry. A questionnaire was sent to all American Shortline and Regional Railroad Association members, and 46 railroads responded. Other information used in the study was obtained directly from RailAmerica which operates 27 U.S. shortline railroads.

The authors used proprietary engineering models to determine minimum track standards required for 286,000-pound rail cars. The interaction between components is important in track analysis, so minimum standards reflect combinations of components. The study also estimated track component replacements which would be necessary to bring track up to minimum standards.

Track analysis in the study was carried out with logic tables, in which each track component is rated on performance under heavy axle loads. Logic tables are matrices which give component suitability ratings based on multiple characteristics. For example, the rail matrices give ratings based on the weight of rail, operating speed, and traffic density. The rail tie matrices use the number of good ties per 30 foot rail length, operating speed, and traffic density to provide ratings.

The study found that the U.S. 50,000 mile shortline and regional railroad system would need 10,000 miles of new rail and 20 million ties to bring the entire system up to minimum standard. The total cost to upgrade the system to handle HAL cars was estimated at $6.86 billion. The authors pointed out that an upgrading program spread out over 10 years would require 1000 miles of rail and two million ties per year.

The Casavant and Tolliver (2001) study was designed to provide information on the potential impact of 286,000-pound rail cars on light-density track and shortline railroads in the state of Washington. The study assessed the likelihood of heavier rail cars being used, and it examined the condition of track in the state. The track information was obtained from questionnaires and telephone surveys of major shippers and shortlines. The study included technical analysis using railroad track models, and it was determined, similar to Resor et. al (2000), that 90 pounds per yard rail may perform marginally at slow train speed if there is good tie and ballast support. The authors concluded that 480 miles of track would need to be upgraded to handle the heavier axle loads at a cost of between $250,000 and $300,000 per mile, with the total cost ranging from $117 to $140 million.

Bitzan and Tolliver (2001) contains a discussion of the economics of heavy covered hopper cars. The authors performed simulations of heavy axle load cars to determine what track weight would be unable to handle HAL cars. Engineering equations were used to simulate track performance for light-rail and for heavier rail. The authors found any track of less than 90 pounds per yard to be inadequate for HAL car traffic.

Bitzan and Tolliver (2003) provided insights into specific areas where abandonment was likely to occur. Abandonment was treated as the result of inability to handle 286,000-pound rail cars and insufficient returns from investment in track upgrades. The study modeled a railroad's decision to upgrade as an investment decision. A firm will invest in a project as long as the internal rate of return to the project exceeds the return available from alternative investments. The investment decision approach to line upgrading was a unique aspect of this report, and is used in this study.

The study reported important findings. The authors concluded that railroads were unlikely to upgrade shortline track with traffic of less than 200 cars per mile. However, the study also discussed alternatives to abandonment of these lines. Longer-term financing mechanisms may allow shortlines to upgrade track with traffic density of 150 cars per mile. Increased revenue splits with Class I railroads, and partial subsidies in the amount of avoided highway damage could also provide greater incentives to upgrade track.

Martens (1999) examined the effects of 286,000-pound rail cars on U.S. shortline and regional railroads. To gather information on track condition, he developed a 16 question survey which was sent to 88 railroads, and 39 (44%) were returned. The questionnaire requested information on the amount of track miles likely to be closed or upgraded due to use of HAL cars. It also requested effects of HAL cars on train speed and how shippers would be affected. In addition, Martens analyzed the impacts of rail line abandonments attributable to use of HAL rail cars.

The study found that 38% of the U.S. shortline rail system was incapable of handling 286,000-pound rail cars even at the slowest operating speeds. It was also determined that the average track upgrading cost for lines which would otherwise be abandoned due to increased use of HAL cars would be $118,662 per mile.

The Iowa Department of Transportation (2002) study was motivated by the state's recognition of the need to assess the potential magnitude of rail line abandonment due to increasing use of HAL cars. An important aspect of the study was the physical inspection of 97% of the shortline track in Iowa. Track information such as weight and general condition was recorded during the inspection. Data was collected on the number of good ties per 39 foot rail length, and depth and condition of ballast. Logic tables from the Resor et al. (2000) study were used to evaluate track components, and necessary upgrading costs were calculated using material and labor costs from railroads.

Short-term and long-term upgrade requirements were estimated . The minimum short-term cost reflected immediate needs utilizing 'marginal' rail, and upgrading ties and ballast to an 'OK' status according to track analysis logic tables. The minimum short-term upgrade cost was estimated at $117,000 per mile or a total of $297 million for the state. The study also determined a long-term cost of $154,000 per mile or $390 million for the state assuming rail was upgraded to an acceptable level along with ties and ballast.

Each of the studies which estimate track upgrading costs have produced different estimates, from a minimum of $117,000 per mile to a maximum of $516,000. This wide range reflects the difference between a minimum short run cost and the cost of complete replacement of track and track components. The different estimates are also due to the different assumptions, objectives, and methodologies of the various studies.

METHODOLOGY

Although it may be possible for shortlines to operate at lower speeds or to not load the 286,000-pound cars to full capacity, these actions do not appear to be long term solutions for adjusting to an eventual industry switch to the larger cars. Lower rates per bushel paid by shippers for loading the larger rail cars will likely make fully loaded 286,000-pound cars operating at normal speed the predominant mode of operation in the future. Thus, shortlines face a choice of abandonment or upgrading their lines to handle 286,000-pound hopper cars. The process employed by railroads to make this decision is described below, and is based on Bitzan and Tolliver (2003).

The shortline's decision for upgrading the railroad to accommodate HAL cars is the same as that of any other business considering an investment in new plant or equipment. It is well known that a firm will make these investments if the internal rate of return from the investment is greater than the rate of return on alternative investments, so long as the firm is able to obtain the required capital for the investment. For a shortline this means that it will invest in upgrading the rail line if the rate of return to upgrading exceeds the rate of return the shortline could receive from investing in other rail lines or property. The internal rate of return for a shortline investment in upgrading can be calculated by solving for ρ (the internal rate of return) in equation (1).

$$(1) \qquad C_u = \sum_{i=0}^{N} \frac{R_i}{(1+\rho)^i}$$

where
C_u – Upgrading cost
N – Number of years over which the upgrade is expected to generate benefits
R_i – Incremental profits in year i resulting from the upgrade
ρ - Internal rate of return

Based on equation (1) the five factors influencing the decision of shortlines to upgrade their lines to handle 286,000-pound cars are as follows:

- Number of years over which the rail line upgrade is expected to yield benefits
- Incremental traffic expected as a result of the upgrade
- Incremental revenues and costs attributable to the incremental traffic from the upgrade
- Service improvements resulting from the upgrade that raise revenues
- The upgrading cost

Useful Life of the Upgrade

Although railroad assets (rail line, bridges, and track components) have long physical lives, railroads consider a relatively short time frame when evaluating the potential benefits of a rail investment (Bitzan and Tolliver, 2003). This is due to uncertainty of future traffic levels and the difficulty of transferring railroad assets within a railroad system. Future traffic is uncertain since the railroad's ability to maintain current traffic depends on the competitiveness of the businesses located on the rail line and the decisions by these businesses to remain at their current locations. Also, if a railroad loses traffic the physical facilities used to upgrade the line can seldom be productively used on another part of the railroad's system or by another railroad. The inability to easily move or liquidate railroad assets increases the risks to banks in providing loans with long repayment periods.

The appropriate time horizon to consider the benefits of upgrading the rail line depends on the risk perceptions of the railroad making the upgrading decision and the banks that are financing the upgrades. According to Bitzan and Tolliver (2003, p. 138), the longest period considered for the benefits of an upgrade by North Dakota shortlines is seven years. In a national survey of bankers specializing in loans to shortline railroads, the bankers stated that the maximum term they would grant on a railroad loan is five to eight years (Bitzan, Tolliver and Benson, 2002). Thus, in modeling shortline railroad upgrading decisions, an eight year time horizon is used. However, shortlines may have access to government loans with longer repayment periods. Thus, 15, 20, and 25 year loans are considered as well.

Incremental Traffic

Incremental traffic as a result of an upgrade investment is the traffic gained compared to a scenario where the railroad line is abandoned. One important factor affecting incremental traffic from an upgrade is the proximity of the shortline to rail competitors. Shippers are likely to move their grain by the closest railroad alternative. If a railroad decides not to upgrade a rail line and instead abandons it, the railroad may lose traffic to a nearby rail competitor. If the closest rail line to the line where the upgrading decision is being made is owned by the railroad making the decision, then traffic is likely to be maintained by the railroad if it abandons the line instead of upgrading it. In this case the incremental traffic from the upgrade is zero. Thus, shortlines are more likely to upgrade the line when rail competitors are close by than in cases where they own the nearest alternative line.

Shortline railroads act as feeder lines to the Class I railroads.[4] Although neither the shortlines nor their Class I partners regard each other as competitors, the proximity of a Class I partner to the line being evaluated for upgrading will influence the shortline's investment decision. If the shortline decides not to upgrade and abandons the line, all the traffic that moved on the line will likely divert to the Class I partner. Thus, a shortline facing the decision to upgrade will be equally influenced by the proximity of its line to that of its Class I partner and its competitors.

Another factor affecting incremental traffic from an upgrade decision is the action taken by rival railroads in upgrading their lines. For example, suppose two railroads (A and B) have lines in close proximity and both need to be upgraded. If railroad B upgrades its line, then the incremental traffic for railroad A from an upgrade is only its current traffic on its own line. However, if railroad B abandons its line, the incremental traffic for railroad A is the traffic on its line plus some part of railroad B's traffic.

In modeling the upgrading decision, it is assumed that shortlines estimate the internal rate of return of upgrading based on the assumption that rival railroads will upgrade their lines. This is because railroads are risk averse, and upgrading involves a large immobile investment. Thus, it is unlikely that a shortline would make the investment assuming it would gain traffic from a rival that abandoned its line.

A third factor affecting the amount of incremental traffic resulting from an upgrade is the ability of trucks, or truck-barge combinations, to serve destination markets directly. Even if the branchline's closest rail alternative is another line on the same shortline railroad, the traffic may still be lost to trucks if the railroad decides to abandon the line rather than upgrade it. If trucks are competitive with rail in transporting to final or intermediate destinations, shippers losing rail service may use trucks to transport their traffic to markets. Thus, even if the closest rail alternative to the line in question is on the same shortline railroad, all the traffic on that line should be considered incremental traffic to an upgrade since it may be lost to truck if the line is abandoned instead.

A fourth factor impacting the amount of incremental traffic resulting from an upgrade is the location of shuttle train stations that ship trains of 100 or more rail cars. Since these facilities have lower transport rates, they can offer higher grain prices to farmers and thus take grain away from elevators in close proximity to the shuttle train station. Thus, the incremental traffic from an upgrade will be smaller for a rail line in close proximity to shuttle train stations, but without their own shuttle train facilities.

The fifth variable affecting the amount of incremental traffic from an upgrading investment is service level changes resulting from the upgrade such as higher speeds and more frequent service. However, for the shortline's calculation of internal rate of return on investment in upgrading, the service level change isn't expected to have much impact on incremental traffic. This is because competitor railroads are assumed to upgrade their lines as well, resulting in no service advantage for the shortline that upgrades its line.

Incremental Revenues and Costs

The incremental revenues due to the upgrades are the revenues on incremental traffic for the entire length of haul that the traffic moves on the railroad's system. The incremental costs generated by the upgrade, in addition to the investment cost of the upgrade, are the routine maintenance costs of the line and the transportation cost of the incremental traffic for the entire movement on the shortline's system. However, the operating cost per ton-mile will be lower due to the ability to ship grain in 286,000-pound rail cars after the upgrade. Using HAL cars results in a reduction in car and locomotive ownership costs, labor costs, fuel costs, and car and locomotive maintenance costs (Kalay and Guins, 1998).

Martens (1999) developed a shortline railroad costing model that can be used to measure the cost reductions resulting from the use of 286,000-pound cars. The model is a spreadsheet based model that employs inputs obtained from interviews with shortline railroad operators. The Martens model accounts for savings in fuel costs, car and locomotive ownership costs, car and locomotive maintenance costs, and labor costs resulting from the shift to larger rail cars. The model is employed to simulate operating costs of shortlines after the upgrading investment. For a detailed description of the model see Bitzan and Tolliver (2001, pp. 63-65).

Service Improvements That Generate Incremental Revenue

As noted above, it is unlikely that major service changes (speed and frequency of service) would result from upgrading the shortline to handle 286,000-pound cars. Instead, the upgrade will allow continued service at current levels. Thus, incremental revenues from service improvements are not considered in internal rate of return calculations for the shortlines in this study. Thus the calculated rates of return are conservative estimates.

DATA AND PROCEDURES

Data Inputs

The five sample Kansas shortline railroads employed to estimate the model are the Cimarron Valley Railroad (CV), the Kansas and Oklahoma Railroad (K&O), the Kyle Railroad, the Nebraska, Kansas, and Colorado Railnet (NKC), and the South Kansas and Oklahoma Railroad (SKOL). Some characteristics of these railroads are displayed in Table 3. They range in size from 254 miles (CV) to 832 miles (K&O). The oldest railroad is the Kyle (1982) and the newest is the K&O (2001).

The required data inputs to calculate internal rates of return for upgrades to handle HAL cars for Kansas shortlines are in Table 4. The mainline miles of road in Table 4 include Kansas mileage and mileage in bordering states for the Kyle, Cimarron Valley, Nebraska, Kansas and Colorado Railnet, and the South Kansas and Oklahoma Railroad. The length of haul data in

Tables 3 and 4

Table 4 was obtained from *Profiles of U.S. Railroads* published by the Association of American Railroads. There was a great deal of annual variation in the length of haul data. In most cases the most recent available year's estimate was used or an average of more recent years' data.

Total carloads are the 2001-2003 averages for the K&O, Kyle, and SKOL railroads. Total carloads for the NKC is the 2002-2003 average. These averages are based on data provided by shortline personnel. Total carloads for the CV railroad was suggested by the Kansas Department of Transportation (KDOT). Carloads per mile were obtained by dividing total carloads by mainline miles of road. Upgrade miles data was obtained from questionnaires completed by Kansas shortline railroad personnel. These are the miles the railroad personnel said need to be upgraded to handle 286,000-pound cars. These personnel indicated that for the five shortlines as a group, 70% of their mainline route miles need heavier weight rail, and 86% of their bridges would have to be upgraded to handle HAL cars.[5] The total upgrade costs for tracks and bridges was estimated to be $308.7 million. Tons per car of 111 is the maximum carrying capacity of a 286,000-pound car. The upgrade cost per mile of $207,770 was obtained by averaging the estimates reported in Table 5. The total upgrading cost is obtained for each Kansas shortline by multiplying $207,770 per mile by the number of miles to be upgraded. Other data inputs from the Martens model are in Table 6.

Internal Rate of Return Calculation Procedure

As discussed previously, the internal rate of return for an upgrading investment to handle larger rail cars depends on the incremental annual profits from upgrading the rail line and the upgrading cost.

Incremental annual revenues are obtained by multiplying revenue per carload by the number of cars per mile and by the railroad's mainline miles. The average revenue per car is from American Shortline and Regional Railroad Association (2000) and is $3.03 per ton for 263,000-pound rail cars. It is assumed that the average revenue per ton would remain the same after the shift to larger cars, resulting in a revenue per car of $336 for the larger cars (111 tons per car). The number of cars per mile varies. Incremental revenues (and costs) are calculated for the actual cars per mile of each Kansas shortline as well as assumed traffic densities of 50, 75, 100, 150, and 200 cars per mile.

Incremental annual costs are estimated using a modified version of the Martens (1999) spreadsheet shortline cost model. The model is an economic engineering model that estimates the equipment and transportation costs to carry a given amount of grain in 286,000-pound rail cars.

The incremental profits per year resulting from the upgrade investment are the estimated incremental revenues minus the incremental equipment, transportation, and maintenance of way costs of Kansas shortline operation. The incremental maintenance of way costs include only those related to routine maintenance such as vegetation control, snow removal, and signal maintenance. Investment types of maintenance of way (tie, rail, and ballast replacement) are not considered since they are included in the upgrading investment.

EMPIRICAL RESULTS

In Tables 7 through 11 the internal rates of return to upgrading the railroad to handle 286,000-pound rail cars are presented for the five Kansas shortlines. For each shortline the internal rate of return is calculated for actual cars per mile and for assumed traffic densities of 50, 75, 100, 150, and 200 cars per mile. For each traffic density (i.e., 50 cars per mile, etc.), the internal rate of return is calculated for four time horizons of 8, 15, 20, and 25 years. For a given shortline, all the rate of return to upgrading calculations are based on the characteristics of that railroad. The four variables that are critical to the rate of return calculations and vary by shortline are average length of haul, carloads per mile, miles of mainline track to be upgraded, and total miles of mainline track. The upgrade cost per mile of $207,770 and tons per car of 111 for the 286,000-pound car are the same for all rate of return calculations. The key data inputs for the rate of return analysis are in Table 4.

For each shortline, the internal rate of return is calculated for the average actual traffic density (cars per mile) for various time periods over which the upgrade is expected to yield benefits (i.e., 8 to 25 years). This is referred to hereafter as time horizon. In addition, internal rates of return are calculated for other traffic densities (50 to 200 cars per mile) for the same time horizons. The internal rates of return for the alternative traffic densities are hypothetical rates of return assuming a railroad with the same characteristics (i.e., average length of haul, carloads per mile, miles of mainline track upgraded, total miles of mainline track) as each of the five Kansas shortlines. These data reveal what the internal rate of return would be for the Kansas shortline if it were able to increase its traffic up to a maximum of 200 carloads per mile.

As expected, the internal rates of return to upgrading increase as traffic density and time horizon increase. For example, a hypothetical railroad with the Cimarron Valley Railroad's characteristics could obtain a rate of return greater than 10% for all traffic densities of 100 or more cars per mile and a time horizon of 8 years or more (Table 7). If 75 cars per mile is assumed, the hypothetical CV could obtain a rate of return of more than 10% for time horizons of 15 years or more. A hypothetical railroad with the Kansas and Oklahoma Railroad's characteristics receives a rate of return to upgrading of 10% or more for traffic densities of 150 and 200 cars per mile and time horizons of 15 years or more (Table 8). Similar patterns are evident for the other shortlines as well.

As noted above, Bitzan and Tolliver (2003) found that banks specializing in railroad loans generally will not lend money for more than eight years. If this is the case, a hypothetical railroad with the Cimarron Valley's characteristics would have to achieve a traffic density of 100 or more cars per mile to obtain a rate of return to upgrading greater than 10% (Table 7). For hypothetical railroads with the characteristics of the Kyle and NKC railroads a traffic density of 150 or more cars per mile is necessary to obtain a rate of return greater than 10% (Tables 9 and 10). Hypothetical railroads with the characteristics of the Kansas and Oklahoma (Table 8) and South Kansas and Oklahoma (Table 11) railroads are unable to obtain a rate of return greater than 10% for any traffic density examined in the study (i.e., up to 200 cars per mile) assuming a loan length of eight years.

The most significant result of the internal rate of return analysis is that the rate of return to upgrading is negative (or slightly positive in a few cases) for all the hypothetical Kansas shortlines when their actual average traffic density and other characteristics are assumed. This result occurs for all time horizons examined in the study.

IMPACTS OF UPGRADING DECISIONS ON KANSAS HIGHWAYS

In Babcock et al. (2003), the road damage costs were calculated of abandoning four of the five Kansas shortlines in this study. The report concluded that if only the rail miles in

Kansas of the four shortlines were abandoned, the annual road damage costs would be as follows:[6]

Kansas and Oklahoma Railroad	$30.6 million
Kyle Railroad	$15.8 million
Cimarron Valley Railroad	$8.5 million
Nebraska, Kansas, and Colorado Railnet	$2.9 million
Total	$57.8 million

If the 272 Kansas miles of the South Kansas and Oklahoma Railroad were also abandoned, the annual Kansas road damage cost of $57.8 million would be even higher. In addition, the five Kansas shortlines have 587 miles of rail line in the bordering states of Nebraska, Colorado, and Oklahoma. Thus if the five Kansas shortlines conclude that the rate of return to upgrading does not justify the investment, and subsequently abandon the railroads, annual road damage costs in Kansas will rise by over $58 million, with millions of dollars in additional road damage costs in Nebraska, Colorado, and Oklahoma.

CONCLUSION

The rate of return analysis indicated that none of the shortlines can earn an adequate rate of return on upgrading track and bridge investment with their current traffic densities and other characteristics. The cost to upgrade 1,583 miles of track and 1,352 bridges of the five Kansas shortlines was estimated to be $308.7 million, a sum the shortlines are unlikely to be able to obtain in the private capital market, given the negative rates of return associated with their current traffic densities.

State and Federal government financial assistance (i.e., loans with long repayment periods at low interest rates, and loan guarantees) to shortline railroads would be an efficient use of resources if shortline rail transportation results in external benefits. This is the case because the market always underallocates resources to markets with external benefits. This study found that shortline external benefits can be substantial since Kansas shortlines generate a minimum of $58 million a year in avoided road damage costs for the state of Kansas alone. Other potential external benefits of shortline transport are highway safety benefits (due to the reduced number of large trucks on the highway system) and environmental benefits due to lower energy production and consumption emissions.

Bitzan and Tolliver (2003) calculated estimates of internal rate of return to upgrading for a hypothetical Class I rail branchline. They found that the rate of return was 11.9% for a traffic density of 40 cars per mile and soared to 47.2% for the 75 cars per mile scenario. This result is primarily due to the much greater average length of haul (over 1000 miles) of Class I railroads relative to shortlines. As indicated above, most shortlines feed traffic to Class I railroads who deliver the freight to final markets. If the shortline abandons its system due to inadequate returns to upgrading, the partner Class I railroad could lose to a competitor all the traffic and profit it obtains by transporting the freight fed to it by the partner shortline. In this case the Class I railroad may be willing to increase the revenue paid to its shortline partner in order to maintain traffic that is profitable to the Class I. If this occurs the smaller traffic densities needed to justify upgrading a Class I branchline also may apply to partner shortlines. Thus Class I railroads could increase the amount paid per car to shortlines to facilitate shortline upgrading if it financially benefits both railroads.

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Endnotes

1. In this study shortlines are classified as Class II and Class III railroads as defined by the Surface Transportation Board. In 2002, Class II railroads were classified as railroads with annual operating revenue of $21.8-$271.9 million and Class III railroads were those with less than $21.8 million of operating revenue (Association of American Railroads 2003, p. 3).
2. The percentage of the rail system operated by shortline railroads is higher in agricultural states. Shortline railroads account for 44% of the Kansas rail system (Babcock et al. 2003, p. 1).
3. Farmers in close proximity to facilities located on rail lines capable of handling 286,000-pound cars will realize higher prices for their grain. The low transport costs of the HAL car allow these facilities to pay higher grain prices.
4. A study of seven Kansas shortlines found that three of them had no local traffic, three others had 1 to 2% local traffic, and the remaining railroad had 21% (Babcock et al., 1994).
5. See Babcock and Sanderson (2004), pp. 38-39.
6. The Babcock et al. (2003) study only measured road impacts generated by loaded truck miles. However, actual user fee revenue (motor fuel taxes) is generated from both empty and loaded miles. If it were assumed that empty miles generated the same user fee revenue as loaded miles ($288,531), net road damage cost would only be reduced from $57.8 million to $57.2 million.

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Table 1

Combined Union Pacific, Burlington Northern Santa Fe Grain Hopper Car Fleet

1999-2003*

Year	263,000-Pound Cars	Percent of Combined Fleet	286,000-Pound Cars	Percent of Combined Fleet	Total Combined Fleet
1999	54,700	75.3%	17,907	24.7%	72,607
2000	50,051	71.2	20,294	28.8	70,345
2001	45,065	66.9	22,294	33.1	67,359
2002	38,079	63.1	22,259	36.9	60,338
2003	38,177	63.0	22,437	37.0	60,614
% △ 1999-2003	-30.2%		25.3%		-16.5%

* Measured as of mid-year

Data supplied by representatives of the Union Pacific and Burlington Northern Santa Fe railroads.

Table 2

Comparison of Wheat Rates Per Ton for 268,000-Pound and 286,000-Pound Rail Cars*

Rates for Cars Shipped in 52 to 109 Car Trains

Origin	Rate for 268,000-Pound Car	Rate for 286,000-Pound Car	Percent Difference
Wichita	$19.70	$19.31	-2.0%
Hutchinson	20.35	19.95	-2.0
Salina	21.00	20.59	-2.0
Kansas City, KS	19.00	18.62	-2.0

Rates for Cars Shipped in 110 to 120 Car Trains

Origin	Rate for 268,000-Pound Car	Rate for 286,000-Pound Car	Percent Difference
Wichita	$18.20	$17.84	-2.0%
Hutchinson	18.85	18.48	-2.0
Salina	19.50	19.12	-1.9
Kansas City, KS	17.50	17.16	-1.9

* Destination is the Texas Gulf including Houston, Galveston, and Beaumont, Texas

Source: Rates calculated from data in BNSF Rate Book 4022 (Item # 46,540 and 46,800) at http://www.bnsf.com, November 2003. Calculations assume 100 tons per 268,000-pound car and 111 tons per 286,000-pound car.

Table 3

Kansas Shortline Railroads

Railroad	Starting Date	Total Miles	Full-Time Employment
Cimarron Valley Railroad	1996	254	18
Kansas and Oklahoma Railroad	2001	832	40
Kyle Railroad	1982	557	110
Nebraska, Kansas, and Colorado Railnet	1996	434	17
South Kansas and Oklahoma Railroad	1990	404	76
Total	--	2,481	261

All the data in the table was obtained from questionnaires completed in the summer of 2003 by representatives of the railroads.

Table 4

Internal Rate of Return Analysis Data Inputs for Kansas Shortlines

			Railroad		
Data Input	SKOL	K&O	Kyle	NKC	CV
Mainline Miles	404	832	557	434	254
Length of Haul	85	128	98	85	59
Carloads Per Mile	98	60	37	58	32
Total Carloads*	39,391	49,519	20,311	24,980	8,000
Upgrade Miles	404	603	211	244	96
Upgrade Cost Per Mile	$207,770	$207,770	$207,770	$207,770	$207,770
Tons Per Car	111	111	111	111	111

Data in the table is based on personal interviews and questionnaires completed by personnel of the five Kansas shortline railroads.

* Total carloads are the 2001-2003 averages for the SKOL, K&O, and Kyle railroads. Total carloads for the NKC is the 2002-2003 average. Total carloads for the CV was suggested by KDOT.

Table 5

Shortline Upgrade Cost Per Mile Estimates—Mainline Track

Source of Estimate	Cost Per Mile
Iowa Department of Transportation*	$262,385
Casavant and Tolliver (115 pound rail)*	265,111
Casavant and Tolliver (115 pound rail, net of salvage value)*	205,000
Casavant and Tolliver (132 pound curve-worn rail)*	209,015
Kansas and Oklahoma Railroad (115 pound rail)	210,000
Kyle Railroad (115 pound rail)	138,000
Nebraska, Kansas, and Colorado Railnet (115 pound rail)	106,307
South Kansas and Oklahoma Railroad (115 pound rail)	209,000
Cimarron Valley Railroad	265,109
Mean	$207,770

* See Casavant and Tolliver (2001)

Table 6

Data Inputs of the Martens Model*

Variable	Assumed Value
Average Cars Per Train	26.0
Average Speed (mph)	25.0
Switch Time Per Car (minutes)	9.3
Train Crew Size	2.0
Wages Per Hour (dollars)	$16.00
Payroll Tax (percent)	25%
Fringe Benefits (percent)	20%
Locomotive Replacement Costs (dollars)	$200,000
Locomotive Useful Life (years)	15
Locomotive Salvage Value (dollars)	$50,000
Locomotives Per Train	1
Gallons Per Freight Mile (gallons)	4.77
Cost Per Gallon of Fuel (dollars)	$0.98
Locomotive Cost Per Locomotive Day (dollars)	$120.00
286,000-Pound Car Replacement Cost (dollars)	$63,000
Useful Life of 286,000-Pound Car (years)	35
Salvage Value of 286,000-Pound Car (dollars)	$4,000
Average Car Days Per Car Per Shipment (days)	4.5
Cost Per Car Mile (dollars)	$0.043
Other Transportation Costs Per Train Mile (dollars)	$2.88
Non-Capitalized Maintenance of Way Cost Per Mile (dollars)	$3,000

* Based on discussions with industry personnel

Table 7

Cimarron Valley Railroad Estimated Internal Rate of Return to Upgrading, by Traffic Density and Time Horizon (Percent)

	Time Horizon			
Traffic Density	8 Years	15 Years	20 Years	25 Years
Actual Traffic	-28.3%	-9.7%	-4.9%	-2.3%
50 Cars Per Mile	-13.4	1.0	4.2	5.7
75 Cars Per Mile	0.7	11.5	13.4	14.1
100 Cars Per Mile	13.1	21.1	22.2	22.5
150 Cars Per Mile	38.0	42.1	42.4	42.4
200 Cars Per Mile	68.0	69.8	69.8	69.8

Table 8

Kansas and Oklahoma Railroad Estimated Internal Rate of Return to Upgrading, by Traffic Density and Time Horizon (Percent)

	Time Horizon			
Traffic Density	8 Years	15 Years	20 Years	25 Years
Actual Traffic	-27.7%	-9.3%	-4.6%	-2.0%
50 Cars Per Mile	-31.9	-12.3	-7.1	-4.2
75 Cars Per Mile	-22.1	-5.3	-1.3	0.9
100 Cars Per Mile	-15.1	-0.2	3.1	4.7
150 Cars Per Mile	-3.7	8.2	10.4	11.3
200 Cars Per Mile	6.1	15.6	17.0	17.6

Table 9

Kyle Railroad Estimated Internal Rate of Return to Upgrading, by Traffic Density and Time Horizon (Percent)

	Time Horizon			
Traffic Density	8 Years	15 Years	20 Years	25 Years
Actual Traffic	-28.0%	-9.5%	-4.8%	-2.2%
50 Cars Per Mile	-18.1	-2.4	1.3	3.1
75 Cars Per Mile	-4.9	7.3	9.6	10.6
100 Cars Per Mile	6.0	15.5	17.0	17.5
150 Cars Per Mile	26.6	32.3	32.8	32.9
200 Cars Per Mile	49.1	52.2	52.3	52.3

Table 10

Nebraska, Kansas, and Colorado Railnet Estimated Internal Rate of Return to Upgrading,
by Traffic Density and Time Horizon (Percent)

	Time Horizon			
Traffic Density	8 Years	15 Years	20 Years	25 Years
Actual Traffic	-19.6%	-3.4%	0.4%	2.3%
50 Cars Per Mile	-23.3	-6.1	-1.9	0.3
75 Cars Per Mile	-12.3	1.9	4.9	6.3
100 Cars Per Mile	-3.6	8.3	10.5	11.4
150 Cars Per Mile	11.7	20.0	21.1	21.5
200 Cars Per Mile	26.4	32.1	32.6	32.7

Table 11

South Kansas and Oklahoma Railroad Estimated Internal Rate of Return to Upgrading,
by Traffic Density and Time Horizon (Percent)

	Time Horizon			
Traffic Density	8 Years	15 Years	20 Years	25 Years
Actual Traffic	-16.9%	-1.5%	2.0%	3.7%
50 Cars Per Mile	-31.6	-12.2	-6.9	-4.1
75 Cars Per Mile	-22.9	-5.8	-1.7	0.5
100 Cars Per Mile	-16.3	-1.1	2.3	4.0
150 Cars Per Mile	-5.9	6.5	8.9	10.0
200 Cars Per Mile	3.1	13.3	15.0	15.6