Grain Transportation in the Great Plains Region in a Post-Rationalization Environment:

Volume I

Railroad Rationalization: Efficiency Gains and Impacts in Grain Producing Regions

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INTRODUCTION

Much of America's rural economy is based on agricultural production. According to the Census of Agriculture, there were more than 1.9 million farms in the United States in 1997. These farms produced and sold products valued at $196,865 million.[1] More than 300 million acres of crop land were harvested in 1997.

The distribution of farm products is a major source of transportation demand in rural areas. Grain and oilseed movements are especially critical in the Great Plains region. Most grains and other field crops are delivered from farms to elevators, processing plants, or intermediate storage facilities. Grain elevators are key links in the farm-to-market distribution chain. These facilities receive grains and oilseeds from farmers, which they merchandise and ship to final markets by rail, truck, and barge.

During the last 150 years, the technology of farm-to-market transportation has evolved from a horse-and-wagon system to a vast network of rural highways, commercial vehicles, and transfer and storage facilities. Many changes in transportation and marketing practices have occurred throughout the years. Many of these changes have been external to the farm. Nevertheless, they have affected farmers' delivery practices and altered farm-to-market trucking patterns.

Railroad rationalization is one such example. Railroads have downsized their networks through line closures and abandonment of unprofitable branch lines. This long-term restructuring process has concentrated traffic on mainline routes and lowered the railroads' cost structure. Long-distance unit train movements of grain to export locations and domestic processors offer great efficiencies. However, states such as Iowa, South Dakota and Minnesota have lost more than 40 percent of their rail network since 1965 (Table 1). Fewer elevators exist today. Thus, farmers are facing longer delivery trips than ever before.

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[1] U.S. Census Bureau, *Statistical Abstract of the United States: 1999*, page 676.

Table 1.
Railroad Rationalization: 1965-1995, Data for Selected States

State	Miles of Rail Line: 1965	Miles of Rail Line: 1995	Percent of Rail Miles Abandoned
Iowa	8,369	4,246	-49.27%
Illinois	10,956	7,708	-29.65%
Kansas	7,988	5,621	-29.63%
Missouri	6,412	4,152	-35.25%
Minnesota	8,001	4,784	-40.21%
Montana	4,939	3,282	-33.55%
Nebraska	5,553	3,578	-35.57%
North Dakota	5,195	4,147	-20.17%
South Dakota	3,905	2,121	-45.69%

Source: American Association of Railroads

Most of the railroad network in the Great Plains region was built before 1910. The original network was very dense, with branch lines spaced relatively close to each other. The objective was to allow farmers to deliver grain to elevators by horse-and-wagon and return home during daylight hours. For many years, grain continued to move relatively short distances from farms to nearby country elevators. In 1980, a typical farm truck trip in North Dakota covered only 12 miles.

Today, fewer elevators exist in the Great Plains region. Many of the smaller elevators have become "satellites." They are used primarily for the assembly and storage of grain that is reshipped to a mainline subterminal at a later date. It is usual for farmers on the periphery of a trade area to truck up to 50 miles to reach a unit-train subterminal located on a railroad mainline. Many of the highways that link farms and satellite elevators with mainline subterminals are minor rural arterial or collector roads. Many of these roads are subject to seasonal load limits in spring, resulting in circuitous truck routes and less efficient delivery patterns.

The general theme of this study is *grain transportation in a post-rationalization environment*. The theme does not imply that rationalization has completely run its course. Further consolidation of grain elevators may occur in response to industry economics, shuttle- train rate incentives, use of heavier rail cars, or other market factors. Systemwide deployment of heavier 111-ton rail cars may impact the viability of branch lines and short-line networks built with light rail. For example, many of the branch lines and regional railroad lines in North Dakota are built with rail weighing 90 pounds per yard or less.

PROJECT OBJECTIVES AND OVERVIEW

The main objectives of this project are to describe: (1) the general trends and effects of railroad rationalization on grain transportation, (2) farm-to-market transportation characteristics in the Great Plains region, and (3) grain elevator characteristic and transportation demand. The findings of this study are presented in three volumes. Volume one provides an overview of the project. In addition, it describes rationalization and its effects. Volume 2 continues this theme, focusing on farm-to-market grain movements in the Great Plains region, where farmers deliver grain long distances to a limited number of large shuttle train elevators or mainline subterminals. Volume 2 provides information about the types of trucks owned and leased by farmers and how these trucks are utilized. Specifically, it describes: (1) the proportions of grain delivered to elevators, processing plants, and feed lots; (2) the proportions of grain moved directly to off-farm locations during harvest; (3) the proportions of grain stored on-farm after harvest; (4) average farm-to-market trip distances and average trip distances on paved and unpaved roads; (5) longest farm-to-market trip distances; (6) the types and average numbers of trucks owned and leased by farmers in 2000; (7) the projected types and numbers of trucks owned and leased by farmers in 2005; and (8) average empty and loaded truck weights.

Volume 3 of this study continues the theme by describing the transportation and marketing characteristics of Great Plains elevators. It provides important new information about elevator procurement practices and outbound elevator-to-market shipments. As described in Volume 3, one-quarter of the Great Plains elevators that responded to a transportation survey have no direct rail access. Approximately 12 percent of the grain handled by these facilities is drawn from distances of 30 to 44 miles. Moreover, 16 percent of the bushels handled by these elevators are drawn from distances of greater than 45 miles.

RAILROAD RATIONALIZATION: BACKGROUND AND TRENDS

Rationalization has been going on for more than 50 years. In 1920, there were 1,117 railroads in the United States, including 186 Class I carriers. In contrast, only 9 Class I carriers existed at the end of 1999. The number has since dwindled to 8 (Figure 1).

Eastern Railroads:
CN North America
    Grand Trunk Western Railroad Co.
    Illinois Central Railroad Co.
CSX Transportation
Consolidated Rail Corporation
Norfolk Southern Corporation
Western Railroads:
Burlington Northern- Santa Fe Railroad Co.
CP Rail System
    Soo Line Railroad Co.
Kansas City Southern Railway Co.
Union Pacific

Figure 1. Class I Freight Railroads in the United States-2000

The Baltimore & Ohio opened the first (22-mile) section of general transportation railroad in Maryland in 1830. Almost all of the 30,000 miles of rail line constructed before 1860 terminated east of the Mississippi River. However, approximately 147,000 miles of railroad were built between 1870 and 1910, including much of the Midwestern and Western networks. Railroad mileage in the United States peaked around 1930.
As Table 2 shows, the Class I system (as measured in miles of road owned) shrank by 55% between 1929 and 1999. However, not all of these route miles were abandoned. Much of the approximately 50,000 route miles operated by local and regional railroads consist of track sold to them by Class I carriers. Nevertheless, as the difference suggests, a significant part of the national rail network has been physically abandoned since 1929.

Table 2. Miles of Road and Track Owned by Class I Carriers (Source: AAR, 2000		
Year	**Miles of Road**	**Miles of Track**
1929	229,530	381,417
1944	215,493	355,880
1955	211,459	350,217
1960	217,552	358,520
1970	206,265	366,332
1975	191,520	310,941
1980	164,822	270,623
1985	145,764	242,320
1990	119,758	200,074
1999	**99,430**	**168,979**

This trend is reinforced by Table 3, which shows the current miles of railroad in the United States by type of carrier. As Table 3 shows, total railroad route miles have declined from approximately 230,00 in 1929 to 171,000 today. As Table 3 also suggests, most of the route miles, rail assets, and revenues are attributable to Class I railroads.

The Association of American Railroads (AAR) defines regional railroads as those having revenues of at least $40 million per year (but less than the Class I threshold), or operating at least 350 miles of line. Local railroads are defined as those which fall below the regional thresholds of annual revenues or route miles. In 1999, 546 local and regional carriers provided consolidation and distribution services over low-density branch lines and industry side tracks. The average regional railroad operated 610 miles of road while the average local railroad operated only 56 miles of rail line. In comparison, the average Class I railroad operates more than 13,000 route miles.

Railroad	Number	Miles Operated	Year-End Employees	Freight Revenue ($000)
Class I	9	120,986	177,557	$32,680,081
Regional	36	21,250	11,372	$1,764,646
Local	510	28,422	12,454	$1,448,508
Total	555	170,658	201,383	$35,893,235

Table 3. Summary of U.S. Railroad Industry Characteristics As of 1999 (Source: AAR, 2000)

As Table 4 illustrates, substantial growth in traffic density has occurred in the Class I railroad industry over time. In 1929, the average traffic density (as measured in revenue ton-miles per mile of road) was 1.95 million. In comparison, Class I railroad traffic density in 1999 was 14.42 million. Class I traffic density increased by nearly 150 between 1980 and 1998. This increase in traffic density has allowed Class I carriers to take advantage of economies of size or scale. In particular, the concentration of traffic on mainline routes has resulted in significant economies through the use of high fixed-cost roadway and track investments, which in turn, has lead to a decline in average fixed cost per ton-mile.

Table 4 Class I Railroad Revenue Traffic Density Trend (Source: AAR, 2000)

Year	Million Revenue Ton-Miles	Miles of Road	Million Rev. Ton-Miles per Mile
1929	447,322	229,530	1.95
1944	737,246	215,493	3.42
1955	623,615	211,459	2.95
1960	572,309	217,552	2.63
1970	764,809	206,265	3.71
1975	754,252	191,520	3.94
1980	918,958	164,822	5.58
1985	876,984	145,764	6.02
1990	1,033,969	119,758	8.63
1999	**1,433,461**	**99,430**	**14.42**

Relationship Between Rationalization and Grain Transportation

Changes in the railroad and grain elevator industries have impacted grain logistics in rural and agricultural areas. These impacts have included a change in transportation costs, a change in the amount and pattern of heavy truck traffic, and other secondary economic impacts resulting from transportation cost changes.

Railroad restructuring has resulted in changes in transportation costs to rural shippers for many reasons. Line abandonment has caused some freight to shift from rail to truck, resulting in increased transportation costs for some rural shippers. These costs include the additional cost of trucking commodities from stations on abandoned branch lines to railroad mainlines and the transfer or "double-handling" cost at mainline facilities. In the case of grain, transfer costs include re-elevation and temporary storage costs which can amount to 5 to 10 cents a bushel. On the other hand, improved railroad efficiency as a result of unit train operations, rationalization, and other technological improvements have resulted in decreased transportation costs for some shippers. Thus, the impacts of rail restructuring on grain transportation costs are not uniform across shippers and regions.

In many cases, rationalization may have resulted indirectly from lower unit-train rates and wider rate spreads between mainline and branch-line elevators. Farmers deliver grain primarily in response to net farm prices. The net farm price is equal to the elevator's bid price minus the farmer's trucking or delivery cost. A mainline elevator that ships in unit-train quantities can bid a higher price for grain than a branch-line elevator that ships primarily in single-car lots. When the price premium offered by a unit-train elevator is greater than the incremental trucking cost, it is more profitable for farmers to deliver to the mainline elevator. In essence, the lower unit-train rates which the grain industry wanted have resulted in greater rate spreads between mainline and branch-line stations and contributed to rationalization. When farmers began bypassing branch-line elevators and delivering grain directly to mainline subterminals, the traffic on many branch lines began to disappear. As a result of declining traffic densities, many branch lines become unprofitable and were abandoned.

Scope of Rail Abandonment

The pace of rail-line abandonment has accelerated since the passage of the Staggers Rail Act of 1980. Carriers have abandoned unprofitable light-density branch lines in an effort to reduce overall system expenses and to increase rail profitability. This section of the report assesses the magnitude of rail abandonment in the United States.

Table 5 shows the number of railroad miles where abandonment was applied for, granted, and actually abandoned between 1980 and 1992. As the table shows, railroads filed for abandonment on nearly 43,000 route miles between 1980 and 1992. This amount represents nearly 23 percent of the U.S. total road mileage operated by Class I and II railroads at the end of 1979. Of the amount requested, more than 37,000 miles were approved for abandonment, which is 87 percent of that requested. More than 33,000 miles have actually been abandoned, representing approximately 18 percent of the U.S. total road mileage operated by Class I and II railroads at the end of 1979. The difference between miles of railroad granted for abandonment and that actually abandoned of more than 4,500 miles represents mileage still in use.

The table also highlights the timing of 1980-1992 abandonment filings. As the table shows, nearly 70 percent of the miles abandoned between 1980 and 1992 were filed for abandonment before the end of 1985. This is not surprising, as the new freedoms provided by the Staggers Rail Act allowed railroads to abandon rail lines that had been unprofitable for a long time.

Table 5. Railroad Abandonment by Filing Date (Miles of Road)

Year of Filing	Miles Requested	Miles Granted	Miles Actually Abandoned	Percent of 1980 Class I and II Miles Abandoned
1979 & 1980	9,387	8,128	6,916	3.7
1981	5,235	4,496	4,092	2.2
1982	2,303	2,052	1,883	1.0
1983	3,927	3,327	3,134	1.7
1984	5,163	4,778	4,106	2.2
1985	3,271	2,906	2,724	1.5
1986	2,446	2,051	1,867	1.0
1987	2,308	2,201	1,828	1.0
1988	3,009	2,610	2,032	1.1
1989	1,714	1,380	1,289	0.7
1990	1,835	1,683	1,457	0.8
1991	1,927	1,844	1,609	0.9
1992[2]	326	261	261	0.1
1979-1992	42,849	37,716	33,197	17.7

Further insight into the scope of abandonments can be gained by examining Table 6. Of the 14 states having more than 20 percent of their 1979 rail miles abandoned, nine are heavily agricultural in nature. These states include Illinois, Iowa, Minnesota, Missouri, Montana, Nebraska, Ohio, South Dakota, and Washington.

[2]This includes filings between January 1 and March 27, 1992.

Table 6. Railroad Abandonment By State: 1980-1992					
State	**Miles of Class I and II Road at the End of 1979**	**Total Miles of Road Requested for Abandonment**	**Total Miles Granted**	**Total Miles Actually Abandoned**	**Percent of Class I and II Road Abandoned**
AL	4,497	1,100.0	1,055.8	876.6	19.5
AR	2,749	357.1	291.7	275.6	10.0
AZ	1,865	239.7	105.9	105.9	5.7
CA	6,977	922.1	602.8	516.7	7.4
CO	3,413	167.6	143.2	143.2	4.2
CT	664	59.7	58.4	58.4	8.8
DC	52	5.7	5.7	5.7	11.0
DE	269	27.9	21.2	21.2	7.9
FL	3,698	1,000.5	994.2	963.8	26.1
GA	5,471	747.6	725.1	710.2	13.0
IA	5,805	2,693.0	2,506.0	2,204.1	38.0
ID	2,567	572.5	504.7	504.7	19.7
IL	11,167	3,376.3	3,025.4	2,773.4	24.8
IN	5,896	1,438.5	1,250.6	1,072.5	18.2
KS	6,699	1,054.3	1,019.2	836.6	12.5
KY	3,572	795.9	766.7	649.7	18.2
LA	3,452	736.3	684.3	616.3	17.9
MA	1,462	280.6	214.6	213.1	14.6
MD	1,054	126.3	94.4	84.6	8.0
ME	1,727	311.2	311.2	225.5	13.1
MI	4,411	1,569.1	1,316.3	1,233.7	28.0
MN	6,983	1,814.1	1,647.6	1,423.9	20.4
MO	5,902	1,364.0	1,314.9	1,204.5	20.4
MS	3,161	725.6	715.1	576.9	18.3
MT	4,660	1,492.5	1,373.0	1,373.0	29.5

State	Miles of Class I and II Road at the End of 1979	Total Miles of Road Requested for Abandonment	Total Miles Granted	Total Miles Actually Abandoned	Percent of Class I and II Road Abandoned
NC	3,640	770.9	758.4	624.2	17.2
ND	5,121	818.1	688.0	666.2	13.0
NE	4,903	1,266.6	1,154.9	1,133.5	23.1
NH	617	326.0	215.9	207.6	33.7
NJ	1,576	489.7	406.7	312.5	19.8
NM	1,964	12.6	12.6	12.6	0.6
NV	1,564	299.4	267.4	85.5	5.5
NY	4,582	838.8	636.9	606.3	13.2
OH	7,320	1,988.2	1,850.1	1,499.2	20.5
OK	3,860	972.5	941.2	763.4	19.8
OR	2,957	408.5	387.3	287.2	9.7
PA	7,248	1,940.8	1,739.0	1,532.3	21.2
RI	143	25.3	25.3	25.3	17.7
SC	2,772	503.5	489.2	447.1	16.1
SD	2,829	1,939.4	1,397.6	754.1	26.7
TN	3,136	721.0	648.0	570.5	18.2
TX	13,304	1,558.2	1,282.9	1,148.6	8.6
UT	1,659	218.9	218.9	218.9	13.2
VA	3,511	483.9	483.9	446.4	12.7
VT	384	60.6	59.2	59.2	15.4
WA	5,340	1,661.3	1,282.4	1,126.5	21.1
WI	5,653	1,456.5	1,121.8	1,112.8	19.7
WV	3,513	858.3	815.2	801.9	22.8
WY	1,985	251.8	85.5	85.5	4.3

Table 6. Railroad Abandonment By State: 1980-1992

Potential Impacts of Rail-Line Abandonment on Highways

The impact of rail-line abandonment on highway budgets varies with the traffic levels on branch lines and the characteristics of highways in the post-abandonment routes. However, some generalizations can be made.

The Federal Highway Administration (FHWA) recently published the results of a detailed highway cost allocation study. As part of the study, FHWA developed a set of marginal cost factors for travel by various types of vehicles on principal highways. Table 7 presents a partial list of marginal cost factors attributable to automobiles and heavy trucks when traveling over interstate highways. Although these are national values, they illustrate the general congestion, pavement, and safety effects of heavy truck travel.

Table 7. Marginal Pavement, Congestion, and Crash Costs for Illustrative Vehicle Classes: 2000

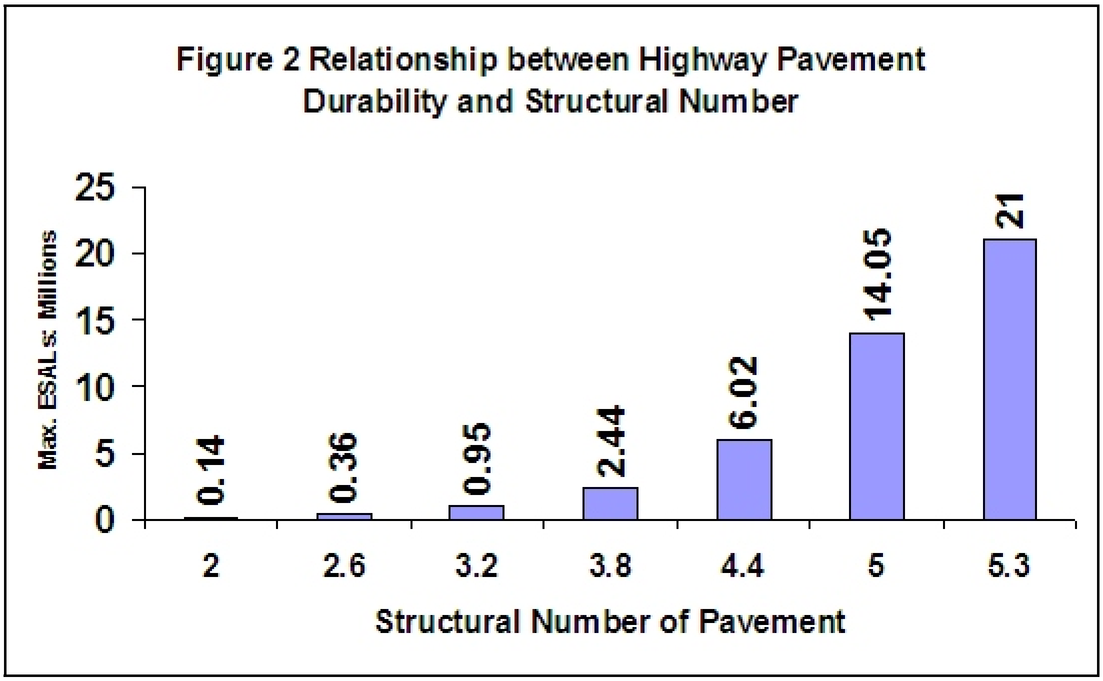
Vehicle Class / Highway Class	Marginal Costs (cents per mile)		
	Pavement	**Congestion**	**Crash**
Autos / Rural Interstate	0	0.78	0.98
Autos / Urban Interstate	0.1	7.70	1.19
60-kip 5-axle Truck / Rural Interstate	3.3	1.88	0.88
60-kip 5-axle Truck / Urban Interstate	10.5	18.39	1.15
80-kip 5-axle Truck / Rural Interstate	12.7	2.23	0.88
80-kip 5-axle Truck / Urban Interstate	40.9	20.06	1.15

Notes: 1 kip equals 1,000 pounds. Costs reflect middle range estimates.
Source: Federal Highway Administration, *1997 Federal Highway Cost Allocation Study*.

According to FHWA, the marginal pavement cost of an 80,000-pound combination truck traveling on a rural interstate highway is 12.7 cents per mile. In comparison, the marginal pavement cost of the same truck is almost 41 cents per mile on urban interstate highways. Marginal congestion costs are approximately 20 cents per mile for an 80,000-pound truck traveling on urban interstate highways, but only 2.23 cents per mile on rural interstate highways.

Abandonment may result in many different types of new truck traffic. The effects of different truck axle configurations are accounted for by converting all axle loads to equivalent single axle loads or ESALs. The ESAL life of a pavement is the cumulative number of equivalent single axle loads that the pavement can accommodate before it is rehabilitated. The ESAL life of a flexible (asphalt) pavement is directly related to its structural number. For example, the maximum service life of a new flexible pavement increases from 140,000 ESALs for a structural number of 2.0 to 21 million ESALs for a structural number of 5.3 (Figure 2).

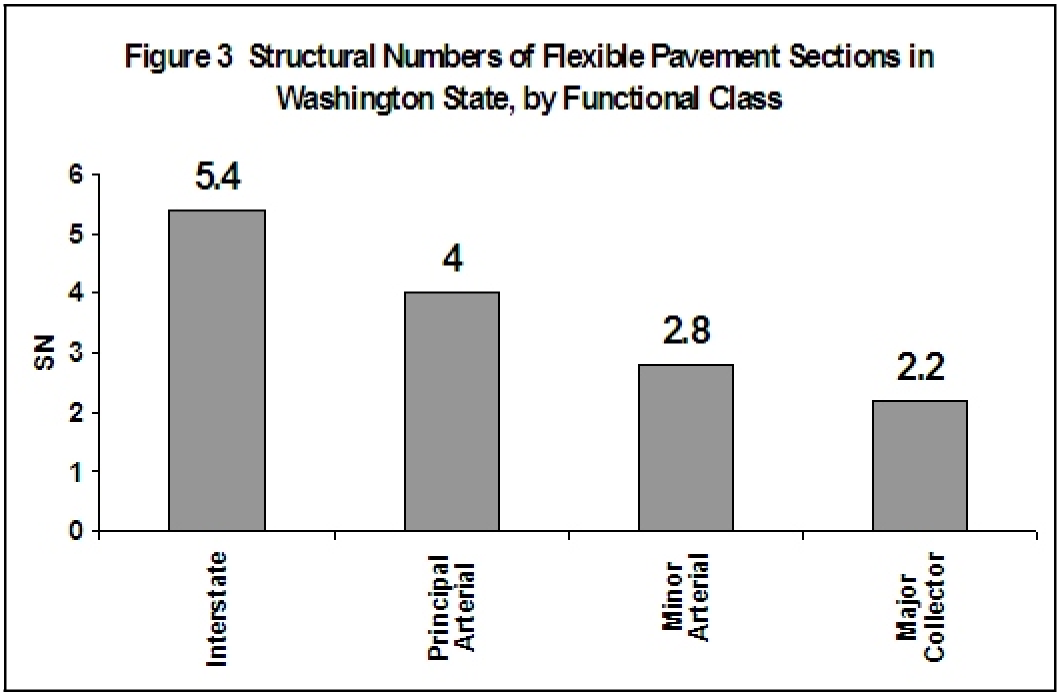
As shown earlier, FHWA found that the marginal pavement cost of an 80,000-pound truck traveling over a



Pavement Durability Varies as Approximately a 4th-Power Function of Structural Number

rural interstate highway is 12.7 cents per vehicle-mile. However, interstate highways are built with much thicker pavements than the arterial and collector highways used to move grain from satellite elevators to mainline facilities. This relationship is illustrated with data from a recent study in Washington State.[3] The average structural number of flexible interstate highway sections in Washington State is 5.4 (Figure 3). As shown in Figure 2, such highways have an expected ESAL life of more than 21 million. In comparison, the average structural number of minor arterial and collector highways is 2.8 and 2.2, respectively. As shown in Figure 2, the expected service lives of these pavements are 495,000 and 191,000 ESALs, respectively. Although structural relationships among highway classes may vary from state-to-state, the relationships shown in Figure 3 are fairly representative of state highways in rural areas.

[3] Tolliver, Denver. *Benefits of Rail Freight Transportation in Washington*, prepared for the Washington State Department of Transportation, December, 2000.



Less money is required to resurface a mile of arterial or collector highway than to resurface a mile of interstate highway. For example, it costs approximately four times as much to resurface a mile of four-lane rural interstate highway in Washington State as it does to resurface a mile of two-lane minor arterial highway (Figure 4). However, the expected ESAL life of a rural interstate highway section is 48 times greater than that of a minor arterial highway section. This relationship illustrates economies of scale in pavement thickness. The example also suggests why there is a great difference between the marginal pavement cost of truck travel on local arterial and interstate highways.

The Federal Highway Cost Allocation Study doesn't present marginal pavement costs for arterial and collector highways. However, the U.S. DOT Comprehensive Truck Size and Weight Study presents a range of unit costs for different highway classes. Figure 5 illustrates a general relationship among pavement unit costs. The chart shows marginal pavement cost indexes for an 80,000-pound combination five-axle truck traveling over secondary rural highways. These indexes reflect the marginal pavement cost of a combination

Figure 5 Pavement Marginal Cost Indexes for Rural Highways

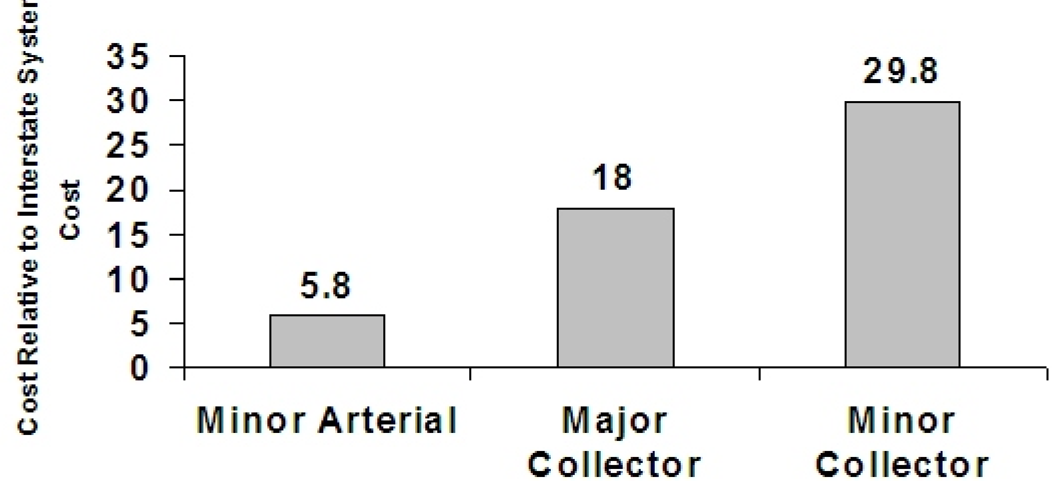
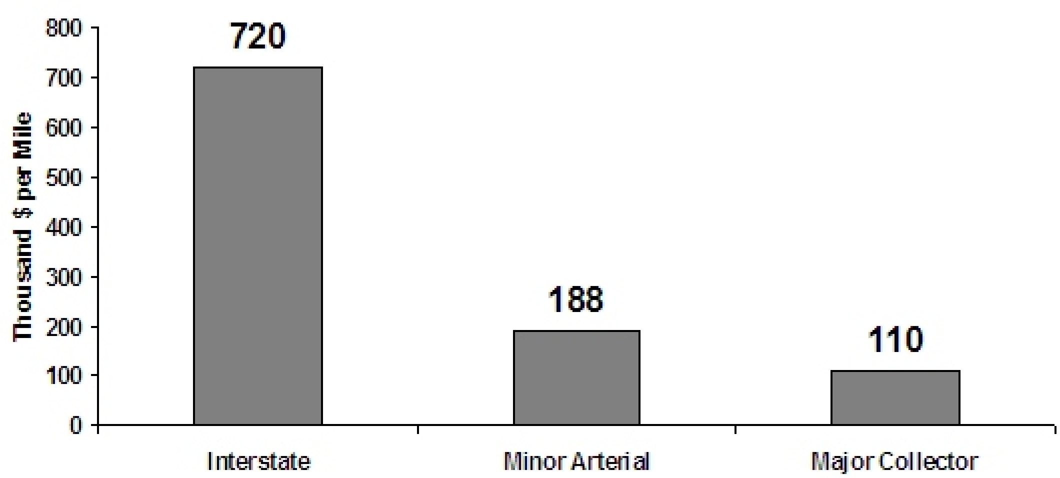


Figure 4 Resurfacing Cost per Mile of Rural Highways in Washington State



truck relative to its cost on a rural interstate highway.[4] The indexes suggest that the marginal pavement cost of an 80,000-pound truck is nearly six times greater on a minor arterial highway than on a rural interstate highway, about 18 times greater on a major collector highway, and about 30 times greater on a minor collector highway.

[4]U.S. Department of Transportation, *1997 Comprehensive Truck Size and Weight Study*, Draft Report, June, 1997, Table VI-6. The index for a particular functional class was computed by dividing the unit payload cost for that class by the unit payload cost for the rural interstate system.

EFFICIENCY GAINS FROM RATIONALIZATION

Branch-line abandonment, unit trains, and larger freight cars have resulted in great efficiency gains in the railroad industry. Many of these efficiency gains have been passed on to shippers in the form of rate savings or increased transportation capacity. These efficiency gains are analyzed in this section of the report.

Class I Railroad Efficiency Measures and Trends

Productivity gains occur when growth in output is proportionately greater than growth in inputs (i.e., the labor, materials, or capital input requirements). Several studies have documented strong productivity growth in the railroad industry, particularly after deregulation. For example, Martland (1999) estimates that productivity improvements from 1965 to 1995 reduced annual railway costs by $25 billion in 1995.[5] Specifically, the shift to unit trains resulted in $7.5 billion in annual savings. Network rationalization and economies of traffic density resulted in $7 billion in annual track cost savings. Improvements in computers and communication technology reduced clerical and mid-management labor costs by $4.7 billion. The use of smaller train crews saved $4.2 billion. And, improved fuel economy saved $1.3 billion.

Several types of productivity measures are possible. In productivity analysis, railroad output is usually measured in revenue ton-miles. Railroad inputs are measured by average employees, annual employee-hours, gallons of fuel, and other factor quantities. Multi-factor productivity accounts for the fact that railroads may substitute labor for capital, and vice-versa.

Although insightful, multi-factor indexes are difficult to derive. In comparison, a single-factor productivity measure compares changes in a factor input such as labor to output without considering potential substitution effects. Single-factor indices convey less information. However, they are easier to compute.

Trends in Class I Employment

Table 8 shows trends in railroad employees and compensation rates. As columns (2) and (3) illustrate, railroad employment has declined dramatically since 1929. Class I and industry trends are very similar, reflecting reductions in train and engine crew and track maintenance workers as a result of line abandonments, general downsizing, and labor efficiency measures implemented by rail management. During the 1980s, rail management negotiated successfully with labor unions to allow two-person crews to operate over most rail lines. However, a reverse trend in railroad compensation is shown in Table 8. In 1999, labor costs comprised 39% of railroad operating expenses and taxes and 35% of railroad operating revenues (AAR, 2000).

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[5] Martland, Carl. D. *Productivity and Prices in the U.S. Rail Industry: Experience from 1965 to 1995 and Prospects for the Future*, in Journal of the Transportation Research Forum, Volume 38, No. 1, 1999.

Table 8. Railroad Employment and Compensation

Year	Thousands of Employees: Industry	Thousands of Employees: Class I	Class I Compensation Per Employee: Per Year	Class I Compensation Per Employee: Per Hour
1929		1,661	$ 1,743	$ 0.67
1960	909	780	6,270	2.66
1970	640	566	10,086	4.14
1980	532	458	24,695	10.21
1985	372	302	34,991	14.30
1990	296	216	39,987	15.83
1999	**255**	**178**	**54,082**	**20.96**

Source: AAR, 2000

Trends in Output and Labor Productivity

As Table 9 illustrates, unadjusted Class I railroad output has been increasing steadily even though the number of Class I carriers has been falling. Furthermore, labor productivity has been increasing at an impressive pace. As Table 9 shows, revenue ton-miles per employee is 25 times greater in 1998 than in 1929, and has increased consistently throughout the period. A large part of the productivity trend can be accounted for by the introduction of new technologies such as the diesel-electric locomotive, large-capacity freight cars, and automated traffic control systems. However, revenue ton-miles per employee have continued to climb in recent years, roughly doubling since 1980. Recent trend lines for railroad labor and multi-factor productivity (as measured by the Bureau of Labor Statistics) are roughly parallel. The implication is that while capital-for-labor substitution has influenced labor productivity, it has not determined its trend over time.

Table 9. Revenue Ton-Miles Per Employee and Employee-Hour			
		Freight Revenue Ton-Miles Per	
Year	Revenue Ton Miles (millions)	Employees (millions)	Employee-Hours
1929	447,322	0.3	108
1960	572,309	0.8	327
1970	764,809	1.4	584
1980	918,958	2.1	863
1990	1,033,969	4.8	1,901
1999	**1,433,461**	**8.1**	**3,139**

Source: AAR, 2000

Rail Fuel Efficiency

Railroads have become much more fuel efficient over time. As Table 10 shows, the gross quantity of fuel consumed is only slightly greater in 1999 than in 1955, in spite of the fact that revenue ton-miles per gallon have more than doubled during the period. Much of the reason lies with locomotive advances such as automated throttle controls and improved engine performance. However, the trend also reflects system and operational changes. The concentration of traffic in mainline corridors has resulted in more through and unit train operations and less way train consolidation service than in the past. Consequently, a greater proportion of locomotive hours occur at more efficient cruising speeds.

Table 10. Revenue Ton-Miles Per Gallon of Fuel Consumed			
Year	Revenue Ton-Miles (millions)	Fuel Consumed in Freight Service (million gallons)	Revenue Ton-Miles per Gallon of Fuel Consumed
1955	623,615	3,384	184
1960	572,309	3,463	165
1970	764,809	3,181	240
1980	918,958	3,904	235
1990	1,033,969	3,115	332
1999	**1,433,461**	**3,715**	**386**

Source: AAR, 2000

Rail-Car Capacity

As Table 11 shows, average freight car capacity has increased steadily over time, from 46.3 tons in 1929 to 91.4 tons in 1999. This growth in car capacity has brought tremendous productivity gains to the railroad industry, as many terminal and train crew expenses are not greatly affected by increases in car size and carrying capacity.

Table 11. Average Tons Per Freight Train and Carload

Year	Average Car Capacity (Tons)	Average Car Load (Tons)	Average Train Load (Tons)
1929	46.3	35.4	804
1960	55.4	44.4	1,453
1970	67.1	54.9	1,820
1980	79.4	67.1	2,222
1990	88.2	66.6	2,755
1999	**91.4**	**63.4**	**2,947**

Source: AAR, 2000

Train Size

A trend toward longer trains is evident in Table 12. The average cars per train increased in the Western region from 45.5 cars in 1929 to 72.1 cars per train in 1999. There is a practical limit to train size because of operational and safety factors. However, railroads are capable of moving grain in 100 to 110 car units. Average train size may further increase as Class I railroads phase-down way train consolidation and delivery services.

Car and Train Weights

Larger car capacities have resulted in significant increases in the average load per car and average train size. As Table 11 shows, the average cargo load per car increased from 35.4 tons in 1929 to 63.4 tons in 1999. However, this average may be deceiving, as coal and grain cars typically carry at least 100 tons. As Table 11 also shows, the average net load per train has increased from 804 tons in 1929 to 2,947 tons in 1999. Part of this increase is due to higher car load factors. However, much of it can be attributed to longer trains. For example, a 110-car grain unit train of 286,000-pound cars hauls nearly 12,000 net tons per trip.

Year	East	West
1929	49.1	45.5
1970	71.1	69.0
1980	67.6	68.9
1990	73.8	66.2
1999	**63.5**	**72.1**

Table 12. Average Cars Per Freight Train

Source: AAR, 2000

Revenue Ton-Miles per Carload

As a result of longer hauls, longer and heavier trains, and improved car load factors the average revenue ton-miles per carload has been increasing. As shown in Table 13, the average revenue ton-miles per carload for Western railroads increased from 11,622 in 1929 to 67,599 in 1999. Since revenue ton-miles are the primary railroad output measure, this trend implies greater service per shipment unit (e.g., carload).

Table 13. Revenue Ton-Miles Per Carload

Year	East	West
1929	12,465	11,622
1970	24,092	34,803
1980	30,415	54,740
1990	33,491	64,035
1999	**35,089**	**67,599**

Source: AAR, 2000

Net Ton-Miles per Train-Hour

Net ton-miles per train-hour is a proxy for line-haul efficiency. It reflects both the tons moved and the miles traveled during an average hour of freight train operations. The numerator (revenue ton-miles) is a measure of final output, while the denominator (train-hours) is a work measure that reflects crew, fuel, train supplies, locomotives and other inputs consumed during road train operations. Higher ratios tend to reflect higher train speeds, fewer delays, longer trains, and higher load factors, w,hich imply better fuel, labor and equipment utilization per ton-mile.

As Table 14 shows, the average net ton-miles per train-hour have increased in both the East and West regions. Although the AAR's numbers before 1980 are not directly comparable to those from 1980 onward, a clear trend exists in each period. From 1929 to 1970, net ton-miles per train-hour tripled in the Western region, and increased significantly in both regions between 1980 and 1990. However, net ton-miles per train-hour have declined since 1990 in both regions. There are many possible explanations for this trend. A likely contributing factor is the congestion and transitional car supply problems after several mergers during the 1990s.

Table 14. Net Ton-Miles Per Train-Hour

Year	East	West
1929	10,601	9,568
1960	27,291	29,757
1970	34,335	39,564
1980	31,037	50,335
1990	56,113	71,619
1999	**44,545**	**69,195**

Source: AAR, 1999

Revenue per Ton-Mile

As Figure 6 shows, rail rates per ton-mile (adjusted for inflation) have dropped dramatically since deregulation for three of the principal commodities hauled by railroads in the United States. As the chart shows, average food product revenue per ton-mile decreased by 53 percent from 1982 to 1996. Similarly, coal revenue per ton-mile declined by 54 percent during the same period. Finally, farm products revenue per ton-mile decreased by 42 percent in real terms from 1982 to 1996. The farm products classification includes grains, oilseeds, and other field crops. The decline in farm products revenue per ton-mile implies that much of the efficiency gain from unit trains and system rationalization has been passed on to shippers and producers in the form of lower real freight rates.

Two specific examples are used to illustrate the long-term trend in rail grain rates in the Northern Plains. (1) Multi-car and unit train rates were first introduced in North Dakota in 1979 and 1980. At the time these rates were introduced, the single-car rate for shipping wheat from Minot, N.D., to Portland, OR, was $2.51 per cwt or $1.51 per bushel. Today, the 52-car wheat rate from Minot to Portland, is $4,379 per car for shipments in 286,000-pound cars. This carload rate is equivalent to a rate of $1.18 per bushel. (2) In 1980, the single-car rate for shipping wheat from Devils Lake, N.D., to Portland, OR, was $1.30 per bushel. Today, the single-car rate from Devils Lake to Portland is $1.33 per bushel. In real dollars, this represents a rate decline of more than 50 percent.

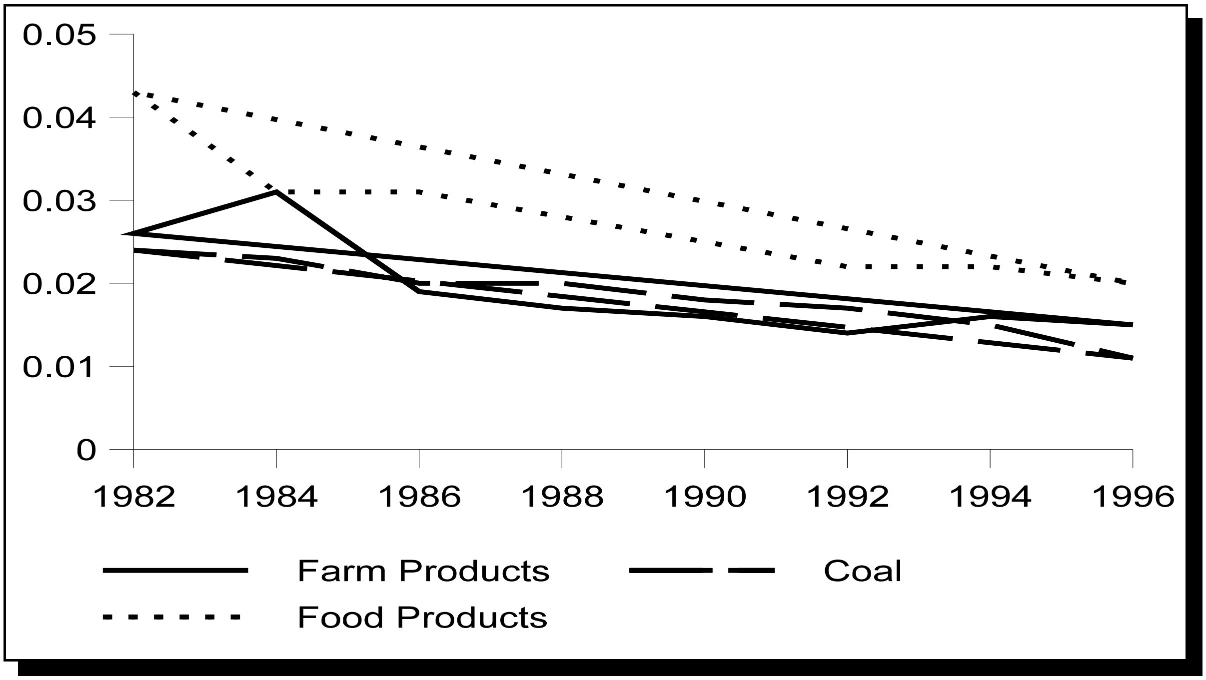

Figure 6. Railroad Revenue per Ton-Mile for Principal Commodities in 1982 Dollars. Source: Surface Transportation Board

Class I Railroad Traffic Density

Table 15 illustrates the substantial growth in traffic density that occurred in the Class I railroad industry over time. In 1929, the average traffic density (as measured in revenue ton-miles per mile of road) was 1.95 million. In comparison, Class I railroad traffic density in 1999 was 14.42 million. Class I traffic density increased by nearly 150 percent between 1980 and 1998. This increase in traffic density has allowed Class I carriers to take advantage of economies of size or scale. In particular, the concentration of traffic on mainline routes has resulted in significant economies of utilization of high fixed-cost roadway and track investments, which in turn, has lead to a decline in average fixed cost per ton-mile.

Table 15. Class I Railroad Revenue Traffic Density Trend

Year	Million Revenue Ton-Miles	Miles of Road	Million Rev. Ton-Miles per Mile
1929	447,322	229,530	1.95
1944	737,246	215,493	3.42
1955	623,615	211,459	2.95
1960	572,309	217,552	2.63
1970	764,809	206,265	3.71
1975	754,252	191,520	3.94
1980	918,958	164,822	5.58
1985	876,984	145,764	6.02
1990	1,033,969	119,758	8.63
1999	**1,433,461**	**99,430**	**14.42**

Source: AAR, 2000

EFFECTS OF RATIONALIZATION ON FARM-TO-MARKET TRIPS

Clearly, railroad rationalization has contributed to great efficiency gains in the railroad industry. Real revenue per ton-mile has declined for farm and food products shipments since 1980, indicating that some grain merchandisers have benefitted from railroad productivity gains. However, branch-line abandonment and concentration within the elevator industry have increased farm-to-market trip distances.

Volume 2 of this report documents the results of a detailed survey of farm operators in the Northern Plains. More than 4,700 wheat and barley producers in North Dakota, Montana, South Dakota and western Minnesota responded to a detailed transportation questionnaire. Some inferences from the farm operator survey are presented in this volume of the report because they are germane to the rationalization issue.

In 1980s, the average farm-to-market trip distance in North Dakota was about 12 miles. In 2000, the average trip distance for wheat movements via semi-trucks in the Northern Plains, as computed from the sample data, was 32 miles: 7 miles on unpaved roads and 25 miles on paved roads. The average loaded semi-truck of barley traveled 44 miles: 6 miles on unpaved roads and 38 miles on paved roads. These results are specific to the sample of wheat and barley producers in the Northern Plains region. However, they illustrate the length of farm truck trips in a post-rationalization setting.

Conclusion

In summary, railroad and grain elevator rationalization have changed farm-to-market transportation in the western United States. Railroad route miles have declined from approximately 230,00 in 1929 to 171,000 today. Over the same period, average railroad traffic density (as measured in revenue ton-miles per mile of road) has increased from 1.95 million to 14.42 million. The concentration of railroad traffic on mainline routes has resulted in significant economies of scale or utilization and lower real freight rates. However, fewer elevators exist today. As a result, farmers are facing longer delivery trips than ever before.

The long-term shift of traffic from rail lines to trucks may have increased highway infrastructure costs in some areas. After a branch line is abandoned, commodities usually are shipped by truck to mainline rail stations, river ports, or final markets. Regardless of the destination, a movement on an arterial or collector highway is usually necessary to arrive at an interstate highway, port, or mainline station where freight can be transferred to rail for a long-haul movement. Although branch-line traffic densities are lower than mainline densities, secondary rural highways are not designed to the same standards as interstate or principal arterial highways. Additional heavy truck traffic on these highways tends to accelerate pavement deterioration and shorten the interval between resurfacing events. The scope and magnitude of these effects will vary with traffic and local conditions. The impact may be greatest for low-type flexible pavements in climatic zones characterized by freeze-thaw cycles. Older farm trucks with single rear axles may result in higher marginal costs per ton-mile than combination trucks.

This report does not place blame for the changes that have occurred. Under federal regulation, only unprofitable branch lines can be abandoned. Railroads make abandonment decisions on the basis of business criteria. Most of their abandonment petitions have been approved by federal regulators. Productivity grains from unit-train operations have allowed railroads to offer lower unit-train rates which have benefitted farmers and the grain industry. Ironically, these lower rates may have been a contributory factor in the decline of many branch lines.

The theme of this study is continued in Volume 2, where a detailed analysis is presented of farm-to-market transportation patterns in the Great Plains region. A detailed analysis of Great Plains elevators is presented in Volume 3.