Railroad Infrastructure Investment and the Outlook for Coal and Grain Transportation Markets

A White Paper Prepared for
Federal Railroad Administration
Washington, DC

by

Transportation Strategic Planning and Program Development Office
John A. Volpe National Transportation Systems Center
Cambridge, MA

Please send comments to:

John Hopkins
Volpe Center/DTS-24
Cambridge, MA 02142

hopkins@volpe.dot.gov
(617-494-3455

Railroad Infrastructure Investment and the Outlook for Coal and Grain Transportation Markets

Executive Summary

Rail Industry Trends

Subsequent to the deregulation legislation of the early late 1970's and early 1980's, railroads have consolidated the industry, introduced improved and innovative technologies, and adopted more-efficient operations that have resulted in quite dramatic improvements in productivity. Examples are graphed in Figure E-1. As a result, traffic grew at a substantially greater rate after 1980 than in the previous decades, as seen in Figure E-2. Revenue ton-miles for Class I companies increased by 87% even while the system shrank in terms of track mileage (by 39%) and number of employees (by 57%) in the twenty years from 1982 to 2001.

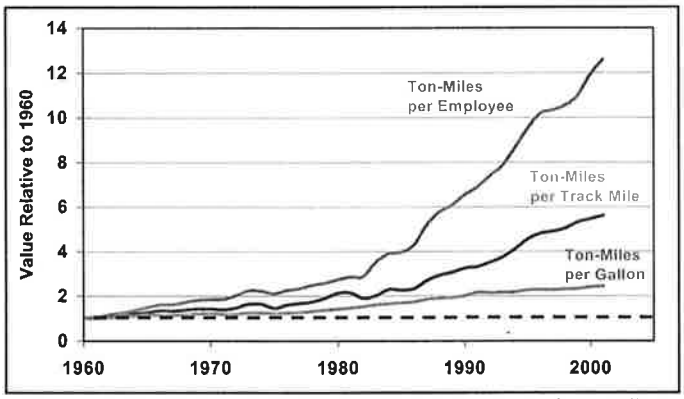

Figure E-1. Railroad Productivity Improvements (Ton-Miles per Employee, Track Mile, and Gallon of Fuel)1960-2001.

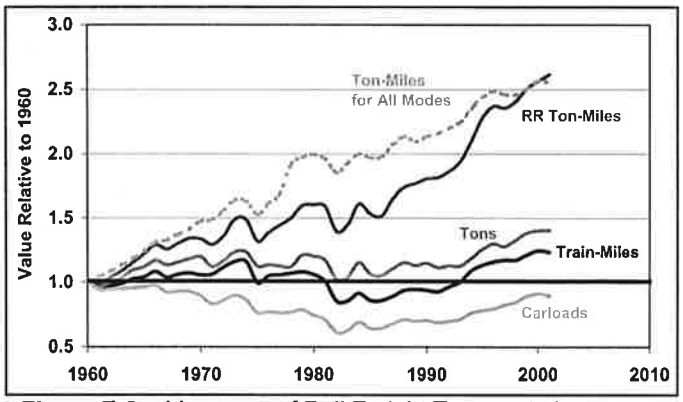

Figure E-2. Measures of Rail Freight Transportation Operations, 1960-2001.

The productivity gains produced much lower expenses. However, the primary beneficiaries so far have been shippers. In a newly competitive marketplace, reduced costs were reflected in lower rates. Revenue per thousand ton-miles, measured in inflation-adjusted dollars, dropped almost as much as expenses: from approximately $75 in 1960 to $50 in 1982, and to $21 in 2001. (Revenue per ton-mile for other modes stayed relatively constant during this period.) These trends, and the continuing small difference between revenues and expenses, are illustrated in Figure E-3. As a result, while railroad constant-dollar operating expenses dropped by 33% in the face of a near doubling of ton-mileage, total revenues also decreased by 24%.

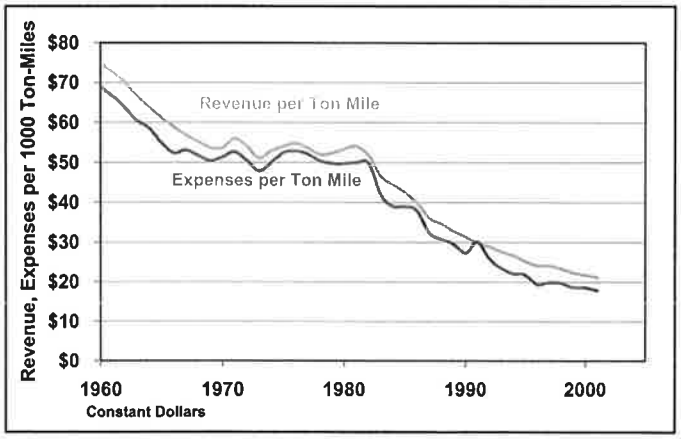

Figure E-3. Class I Railroad Operating Revenues and Expenses, 1960-2001 (Constant 1996 Dollars).

The result, indicated in Figure E-4, was to raise industry return on net investment from the devastating 2% to 4% range of the 1960's and 1970's to around 8% by the late 1990's. While welcome, this remains well below the roughly 12% cost of capital (calculated by the Surface Transportation Board). The railroad industry is extremely infrastructure-intensive. Capital expenditures have long exceeded 10% of operating revenue, and have been in the range of 15% to 20% ($5 billion to $6 billion annually) during the late 1990's.

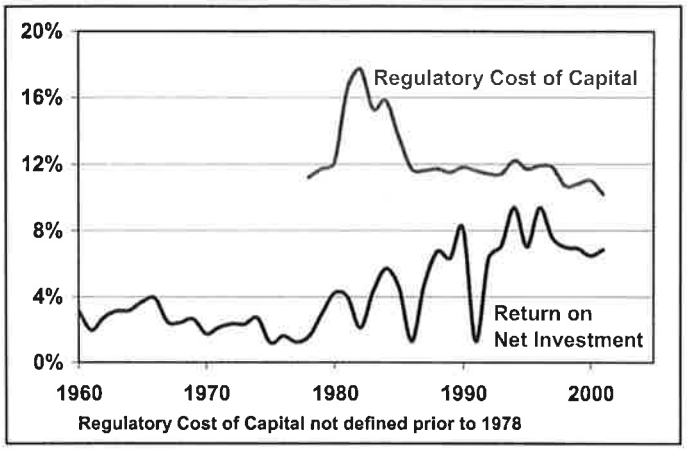

Figure E-4. Class I Railroad Return on Net Investment Compared to Cost of Capital, 1960-2001.

Even with continued gains in efficiency, particularly through more complete integration of information and other technologies into all aspects of railroad operations, it is not clear that the large gap between the STB-defined level of "revenue adequacy" and real revenues can be eliminated. This paper specifically considers the outlook for coal and grain transportation, two important bulk commodity groups in which revenue per ton is relatively low.

Coal Transportation

Overall, transport of coal is one of the most stable markets served by railroads. Coal has fueled approximately half of US power generation since 1950. Rail has always played a major role in the transportation of this low-value and time-insensitive bulk commodity. Indeed, movement of coal currently represents about 44% of all Class I rail tonnage, and 22% of revenue, divided relatively equally among the four major railroads.

The major change now occurring in coal production and transportation is the shift from mines in the eastern and central portions of the company to the rich resources in the west. This trend is due to environmental concerns and the characteristic of western coal that it is generally much lower in sulfur than other sources. For several decades rail has carried more than 60% of coal tonnage, and more than 90% on a ton-mile basis.

The US Department of Energy publishes an annual 25-year energy outlook document based on extensive research, analysis, and computer modeling. Their forecast (Figure E-5) shows a continuing steady trend toward dependence on western coal throughout the period as total production increases by approximately one-third—a growth rate of about 2% annually. Use of coal for power generation is seen as dropping only slightly, from 54% in 2001 down to 48% in 2025.

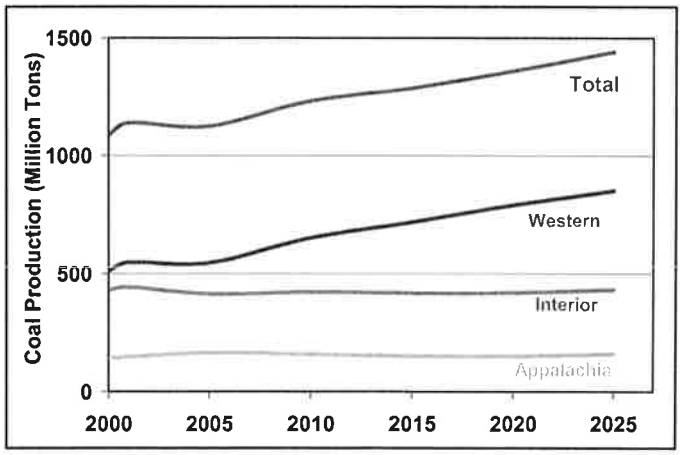

Figure E-5. DOE Forecast of Coal Production, 2000-2025.

Virtually all of the increased production will come from the western coalfields, with eastern and central sources remaining constant. Since there is no real competitor for rail transport of western coal, tonnage should increase in step with coal production; the longer length of haul will generate substantially greater increases in ton-miles and associated revenues for the western railroads (BNSF and UP). However, the potential impact on railroad financial health is likely to be modest, since transportation represents a large fraction of the delivered price of coal, since railroads compete for this business, and the utilities are already outspoken in questioning the fairness of rail rates. This constraint is already apparent. As the share of coal produced by western mines grew during the 1990's, tonnage increased by approximately 50%, but revenue declined by 10%.

Grain Transportation Trends and Outlook

Grain transportation (primarily corn, wheat, and soybeans) accounts for approximately 8% of rail tonnage and revenues. Demand is volatile on both short and long time scales. Domestic use of grain is rising relatively slowly. Global markets are expanding, but so is competition from other countries, particularly Brazil and Argentina. Production is geographically dispersed to a degree that impedes collection into the large quantities needed for efficient rail transportation, particularly after two decades of track abandonment and sale to local railroads. In addition, trends in grain markets, including a shift to off-farm feedlots and location of processing facilities, have increased the demand for the shorter-distance and smaller-quantity transport that is more suited to trucks.

The cumulative effect of these trends has been a substantial shift from rail to truck transport for grain traffic, with rail now down to about a 30% share. Rail tonnage has changed little during the last two decades, and revenues (in constant dollars) are down by 40%. Department of Agriculture forecasts suggest only a slow growth in the overall market, with few changes that are likely to affect the trend away from rail. The market segment mostly likely to favor rail is grain exports to Mexico. These have been growing rapidly, primarily transported by barge to Gulf Coast ports for transshipment. However, as the Mexican rail system becomes increasingly able to provide acceptable service, rail transportation could become attractive. This is a significant market: Mexico already receives more than 10% of US grain exports, and the trend is strongly upward. However, the overall outlook for rail transport of grain does not suggest growth in either tonnage or revenue. Even with growth, revenue is under strong pressure from shippers who feel that rates are too high, and who are actively seeking regulatory relief.

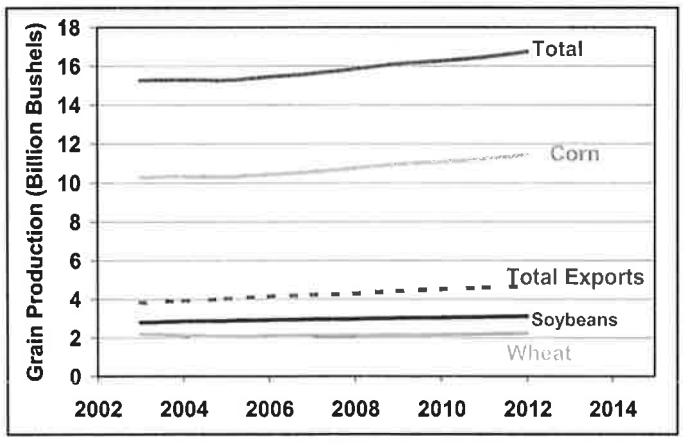

Figure E-7. USDA Forecast Grain Production and Exports, 2003-2012.

Table of Contents

Railroad Infrastructure Investment and the Outlook for Coal and Grain Transportation Markets

1. Introduction

The railroad industry has historically been able to achieve only a low rate of return at best, constraining its ability to make the infrastructure and equipment investments necessary to sustain healthy growth and support a high level of improvements in efficiency and service characteristics. Although the industry as a whole has dramatically increased its productivity and efficiency since partial deregulation in the early 1980's, the benefits have been reflected more in lower costs for its customers than in increased railroad profits. Rate of return on investment has increased significantly since 1980, but this highly capital-intensive industry remains in a "revenue inadequate" condition, with its return still lagging the cost of capital. This threatens future growth and raises concerns that railroads could, in the long term, find it a severe challenge to provide the quantity and level of service required if the nation's steadily increasing freight transportation needs are to be met.

In order to provide insight into factors affecting the industry's future ability to meet that challenge, this paper provides background information concerning current and recent trends in freight transportation generally, and in rail freight operations and performance in particular. It then explores the long-term outlook for coal and grain transportation requirements—two commodities historically of special importance to railroads.

This paper draws on a wide range of industry and government publications and data. In some cases it is useful to combine statistics from multiple sources, which could reflect different definitions, time frames, or original sources. The charts and tables herein are provided only to illuminate trends and provide perspective; in general, they should not be taken as either official or necessarily precise. In virtually all cases, economic measures are expressed in constant (inflation adjusted) dollars, based on the 1996 Gross Domestic Product (GDP) deflator.

2. Background - Recent Trends and the Current Environment for Rail Transportation

Overview

Freight transportation, and particularly rail freight, is in many ways relatively stable activities. Demand is driven largely by changing levels of national economic activity and by population; neither typically changes dramatically in growth rate from decade to decade. Major commodities carried by railroads, such as grain and coal, are linked to other sectors of the economy that also tend not to show sharp changes when viewed over a span of years. On the supply side, the infrastructure-intensive nature of railroading limits the rate at which capacity can be increased and improved technology and service offerings can be implemented. Change is more likely to arise through variations in the relevant commodity markets, as well as shifts among shippers in their transportation needs and preferences.

The following discussion provides a concise summary of freight transportation and rail industry trends over the period 1960-2001 to form a starting point for assessing the likelihood and nature of potential changes in the future. Data is drawn largely from publications of the Association of American Railroads (AAR)[1], supplemented by other resources where appropriate[2]. Although likely to be familiar to many readers, this material is included here to provide an explicit foundation for considering future rail industry infrastructure investment capabilities in the light of anticipated trends in coal and grain markets and transportation.

Freight Transportation Trends

Figure 1 presents a view of the patterns in standard domestic freight indicators (tons carried, revenue ton-miles, total revenue, revenue per ton-mile). All modes—rail, truck, air, pipeline, and maritime (inland and coastal) are included. While transportation services have increased by a factor of approximately 2½ since 1960, the competitive nature of the industry is reflected in virtually flat constant-dollar revenue per ton-mile. The impact on the transportation sector of the economic challenges and disruption of the oil shocks of the 1970's, followed by a substantial degree of transportation deregulation, are clearly visible in these curves. Figure 2 indicates that ton-miles have risen at approximately 2/3 the rate increase of Gross Domestic Product (GDP), but about 1½ times the population growth rate. As a result, tons and ton-miles have increased very slowly on a per-capita basis since 1960, and have actually declined when referenced to GDP.

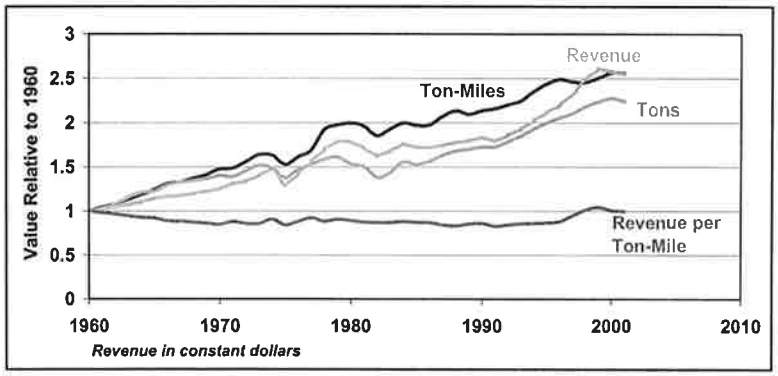

Figure 1. US Freight Transportation Measures, 1960-2000; All Modes; Indexed to Values in 1960.

[1] Current and past issues of the annual *Railroad Facts*, as well as other publications.

[2] Primarily *Transportation in America,* 18th and 19th editions, Eno Transportation Foundation, 2001 (18th edition) and 2002 (19th edition), and *National Transportation Statistics,* published annually by the DOT Bureau of Transportation Statistics.

Given that these data represent the aggregation of an extremely wide range of commodities and transport modes, generalizations must be made with care. However, tonnage and ton-miles do show a substantial degree of consistency in growth from year to year, and transportation industry revenues for the have shown strong growth throughout the last decade. Indeed, as shown in Figure 3, which shows average annual growth rates for the period 1990-2000, overall transportation revenue has grown slightly faster than GDP. Tonnage carried is seen to have increased at a significantly greater rate than total ton-miles, reflecting a continuing increase in shorter movements, largely due to the growing role of trucks.

The changes seen in the mode-share charts of Figures 4-6 are the cumulative result of many specific shifts, but to a large degree they represent the significant growth of trucking, somewhat slower growth for rail, little change for oil pipelines, and a slight decline in maritime. Figure 4, in particular, shows the steady drop in rail share of total tonnage and a marked increase for trucks. However, both rail and truck shares of total ton-miles (Figure 5) increased from 1980 to 2000, primarily at the expense of maritime shipping.

For the rail sector, the steady decline in freight revenue (Figure 6), while maintaining and increasing ton-miles, is a measure of the marked productivity gains achieved by the industry over the last four decades. However, it also indicates the degree to which those gains have been realized primarily in the form of lower costs for shippers, rather than as increased revenue for railroads. Figure 6 also indicates the emergence of aviation as an important and growing part of freight transportation. Figure 7, drawn

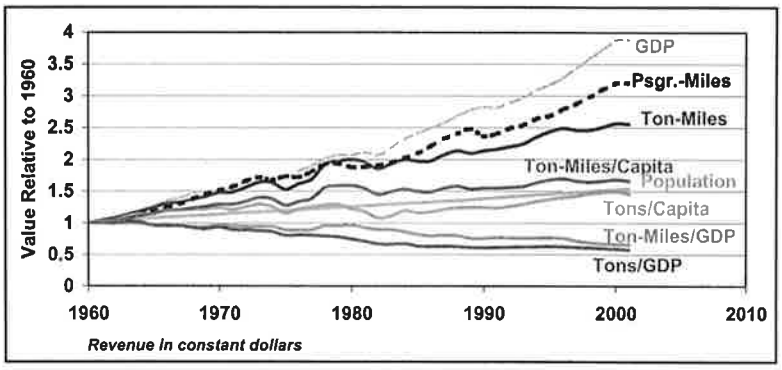

Figure 2. US Passenger-Miles and Various GDP- and Population-Related Freight Transportation Measures, 1960-2000; All Modes; Indexed to Values in 1960.

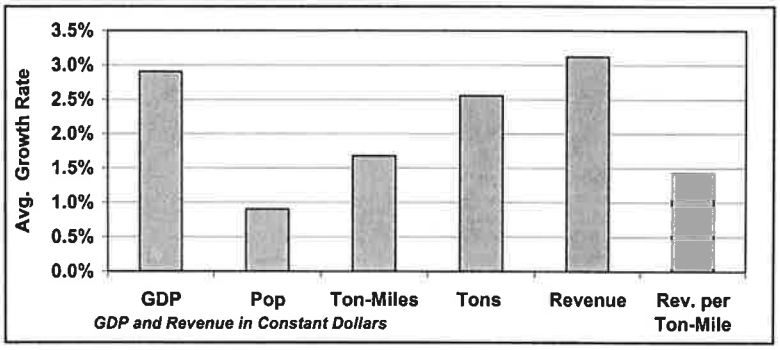

Figure 3. Freight-Related Average Annual Growth Rates During the Period 1990-2000, All Modes.

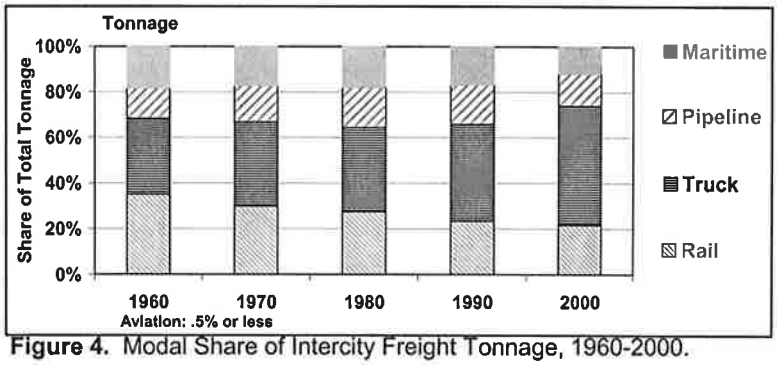

Figure 4. Modal Share of Intercity Freight Tonnage, 1960-2000.

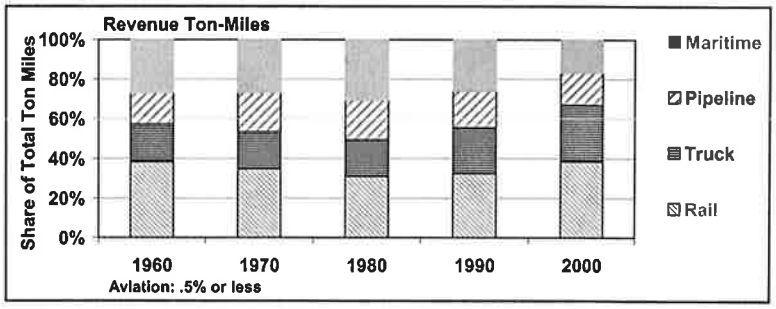

Figure 5. Modal Share of Intercity Freight Revenue Ton Miles, 1960-2000.

with a logarithmic vertical scale to facilitate display of a wide range of values, emphasizes this point by showing the continuing decrease in railroad revenue per ton-mile—which has dropped at a greater rate than for any other means of transportation.

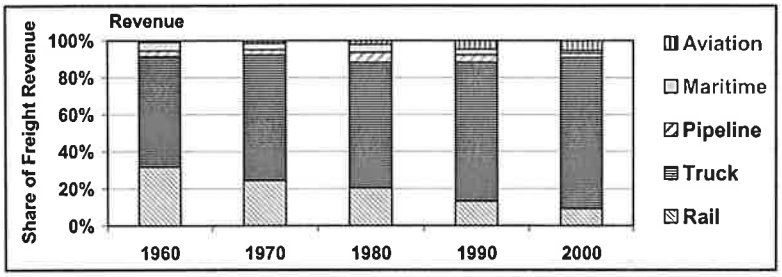

Figure 6. Modal Share of Intercity Freight Revenue, 1960-2000.

Rail Freight Trends

Overview

The above brief discussion of freight transportation trends across all modes has already suggested much of the rail story as well. Over the last four decades railroads have carried a steadily declining share of total tonnage, which itself is growing at only half the rate for GDP. However, by virtue of the much longer average length of haul for rail, particularly compared to trucks, railroads deliver more revenue ton-miles of transport services than any other mode.

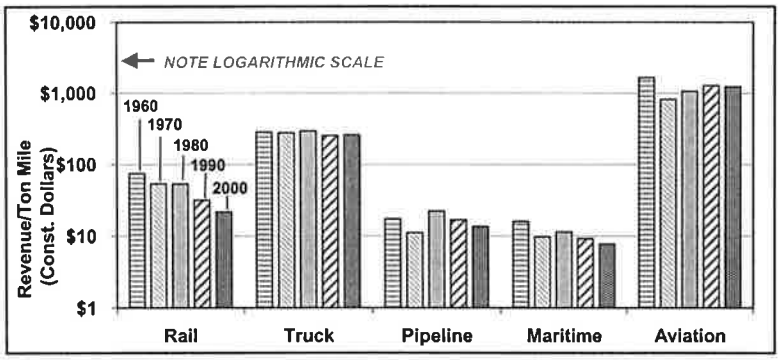

Figure 7. Intercity Freight Revenue per Ton Mile for Each Mode, 1960-2000 (constant dollars; logarithmic vertical axis).

Rail ton-miles are thus growing more rapidly than the total for all modes in the aggregate, and for 1990-2000 slightly exceeded the growth rate for truck ton-miles. On the other hand, the dramatic reduction in railroad costs (indexed for inflation), particularly since deregulation, has been reflected in generally lower (constant-dollar) revenues, a measure of average shipping charges. Overall rail revenues and revenue per ton-mile have shown significant declines. Figure 8 indicates average annual growth rates of these indicators for all modes collectively, and for rail alone, over the last decade.

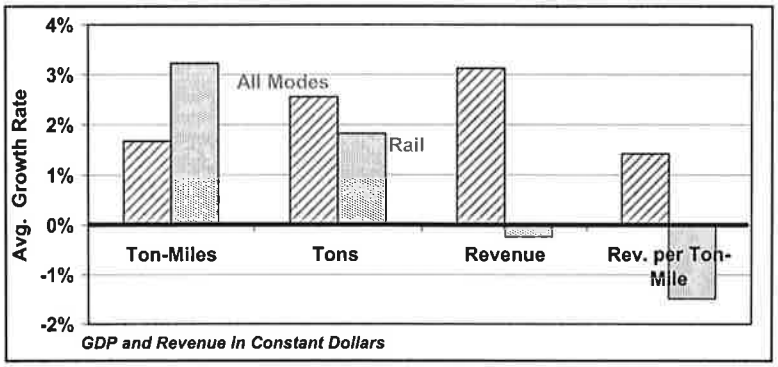

Figure 8. Freight-Related Average Annual Growth Rates During the Period 1990-2000, All Modes and Rail.

The material which follows is generally drawn from statistics for Class I railroads, and is therefore somewhat affected by the creation or expansion of many small local and regional railroads, particularly with respect to number of carloads originated. However, the message of the overall trends is not significantly affected by this limitation.

Operations

Specific long-term trends (1960-2001) for rail freight operations are presented in Figure 9. Railroad ton-miles, which had been below the overall freight growth rate through the 1960's and 1970's, have risen more steeply than the overall rate since deregulation in the early 1980's.

Tonnage and train-miles, however, have grown relatively slowly. The trend for carloads reflects a shifting balance between the increases in average freight car capacity and the rising quantities to be transported. Figure 10 provides the same information, but focuses on the trend in the last decade (1992-2001).

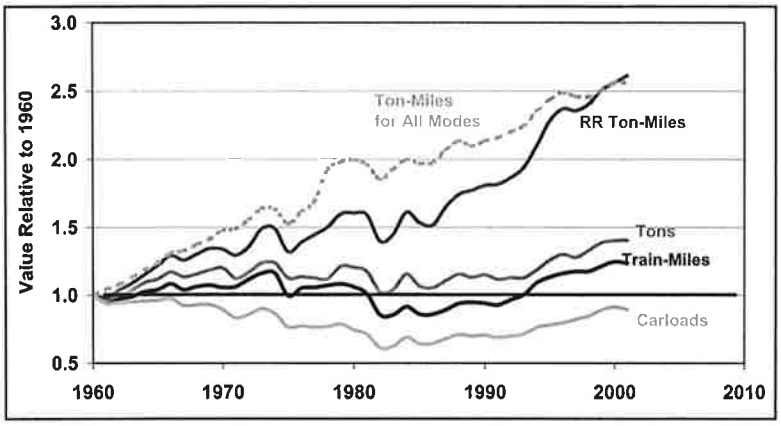

Figure 9. Rail Freight Operations, 1960-2001, Indexed to Value in 1960.

A major contributor to the relatively rapid rate of increase in railroad ton-miles is the steadily growing average length of haul (Figure 11), which in part arises from the transfer of short-haul lines to local and regional railroads. While no firm conclusions can be drawn, the trend appears to have slowed during the late 1990's, having risen by less than 2% during the six years from 1995 to 2001.

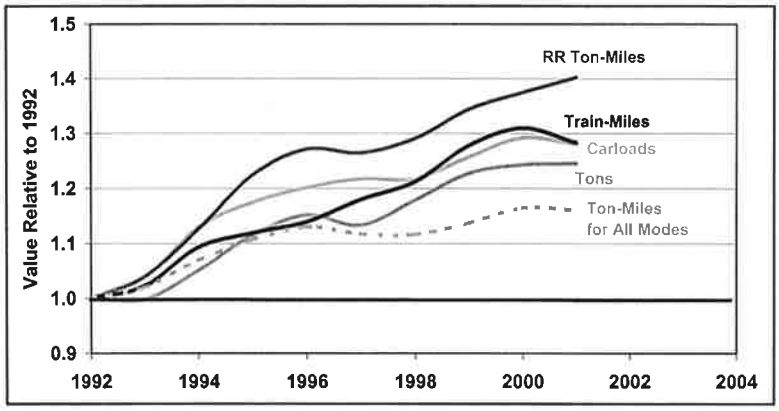

Figure 10. Rail Freight Operations, 1992-2001, Indexed to Value in 1992

Productivity

As has been highly evident in recent years, railroads have made marked progress in raising the efficiency of their operations, particularly in improving the productivity with which they utilize their workforce, infrastructure, and rolling stock. Six major factors contributing to that achievement are described below.

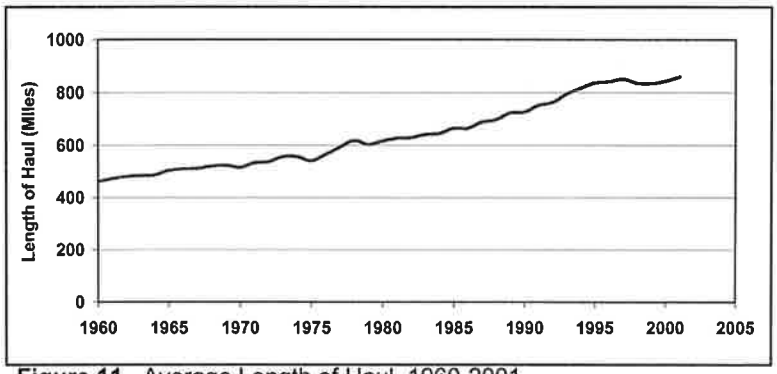

Figure 11. Average Length of Haul, 1960-2001.

Employees: While rail freight operational measures have changed at a fairly modest rate in recent decades, productivity—stimulated and enabled by deregulation in the early 1980's and subsequent industry consolidation—has increased dramatically. The number of railroad employees has been dropping steadily since World War II; from a level of almost 1.7 million in 1944, it had diminished to 237,000 by 2001 for all railroads, and to 162,000 for Class I companies. The trend line in Figure 12 indicates that the rate of shrinkage was actually larger prior to deregulation—a period when the industry was under particularly severe financial pressure—and is now slowing as it approaches a presumably irreducible minimum. Combined with the relatively rapid rise in ton-miles since 1980 (recall Figure 9), the result is that a key measure of productivity, ton-miles per employee, has shown its greatest

growth since then, more than quadrupling in the period 1982-2001—an annual growth rate of 7.7%.

Trackage: Class I railroads have similarly delivered steadily rising ton miles while reducing their miles of road and of track (Figure 13), eliminating approximately 50% of both since 1960. Traffic density, defined as revenue ton-miles per mile of track owned, more than quintupled since 1960, averaging an annual increase of more than 5%. The AAR's *2001Railroad Facts* notes, "A higher figure indicates greater utilization efficiency, but can also signal the risk of congestion." (This number does not include commuter and intercity traffic that also operate on track owned by freight railroads.)

Equipment: Major changes have been occurring in the freight car fleet. As the fleet has gotten smaller, its ownership has shifted substantially from Class I railroads to shippers and car companies. Figure 14 shows the major trends. From 1980 until 2000, while ton-miles increased by over 60%, the total car fleet has dropped by one-fifth, and the number of cars owned by Class I railroads is down by more than 50%. A modest but steady trend toward higher-capacity cars, coupled with longer length of haul, has enabled the railroads to achieve a substantial growth in annual ton-miles per car, which more than doubled from 1960 to 1980, and again by 2000. The gradual rise in annual loads per car also reflects improved operational efficiency.

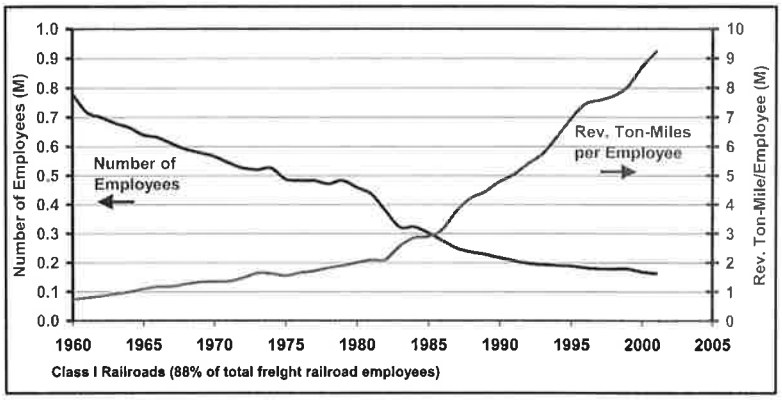

Figure 12. Trends in Class I Railroad Workforce and Revenue Ton Miles per Employee, 1960, 2001.

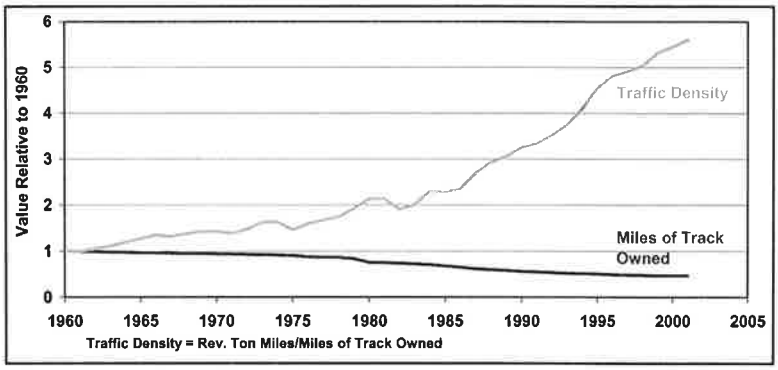

Figure 13. Miles of Track Owned and Revenue Ton Miles per Mile of Track Owned, Class I Railroads, 1960-2001.

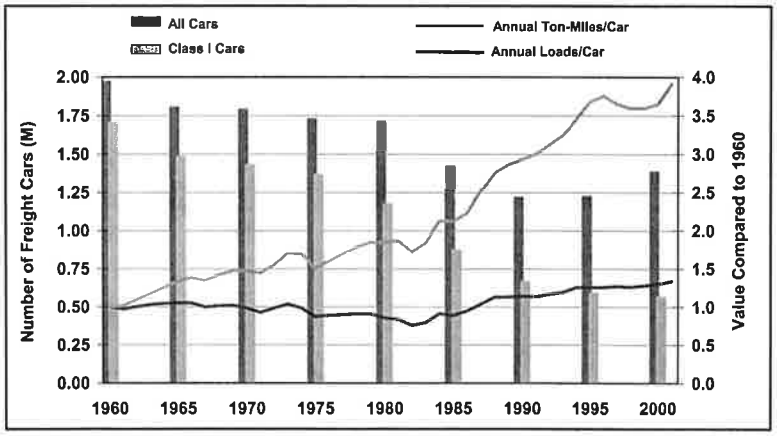

Figure 14. Freight Car Inventory and Productivity, 1960-2001. Annual Revenue Ton Miles per Car and Loads per Car are Indexed to the 1960 Value.

Fuel Efficiency: Diesel fuel is a significant cost of railroad operations, and is also related to meeting air quality objectives. Since the cost of fuel is largely outside a railroad's power to control, reduction of consumption is also important in limiting corporate vulnerability to what can be a volatile market. Motivation for achieving greater fuel efficiency was greatly strengthened by the oil shocks in the 1970's. The result, shown in Figure 15, is that total diesel

fuel consumption in 2000 was only slightly higher than in 1960. This was possible due largely to locomotive efficiency improvements that more than doubled revenue ton-miles per gallon. The trend line in the figure suggests that some continuing improvement is to be expected, particularly through the continued replacement of older locomotives.

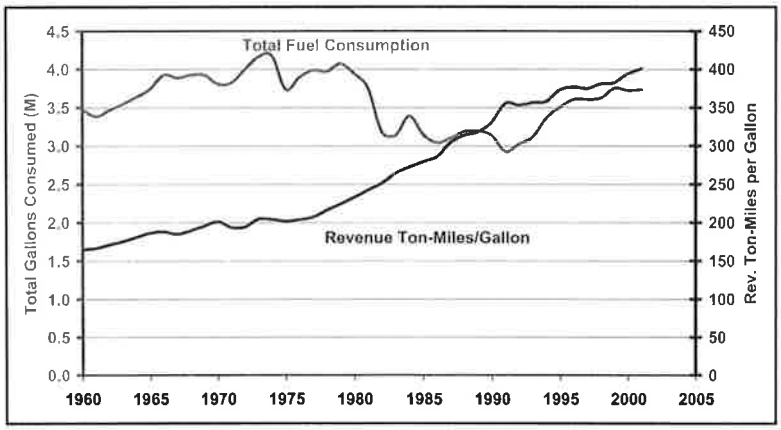

Figure15. Rail Freight Fuel Consumption and Revenue Ton Miles per Gallon, 1960-2001

Technology Investments: A steady infusion of new technologies, coupled to major facility and equipment improvements, has contributed significantly to productivity and safety, and has enabled the advances described above. Examples include sophisticated computer-controlled classification yards, more-efficient locomotives, double-stack intermodal cars, car identification devices, and a wide range of inspection technologies. Operational efficiency is increasingly dependent on effective system-wide information and communication systems for traffic control and management, particularly when integrated into maintenance, engineering, and other functions.

Industry Consolidation: Although the process has sometimes been lengthy and painful, consolidation has enabled a significant rationalization of the rail network. The more than 20 Class I railroads at the time of the Staggers Act[3] have shrunk to seven, with the four largest earning 90% of total revenues. Both end-to-end mergers, which eliminate the need to interchange traffic among railroads, and combination of parallel routes for improved track utilization, have been critical in enabling railroads to compete effectively with other modes and with each other. This consolidation has been central to obtaining full benefits from modern information technology and systems.

Financial Performance

As a result of these and other improvements, inflation-adjusted railroad operating expenses have dropped by almost two-thirds—from 49.7 cents per ton-mile in 1980 to 17.8 cents in 2001. The literal bottom line for operations growth and productivity improvements is achievement of financial performance that will enable a level of investment that sustains the railroad and improves its ability to serve its customers. However, the impressive productivity gains described above have had limited success in this respect. Competitive forces, largely from trucking and among railroads, have resulted in comparable reductions in rates, so that revenues have dropped almost as much as expenses. However, the steady reduction of costs has enabled the railroads to remain reasonably competitive in most markets, and to increase business in some. As indicated in Figure 16, expenses have been reduced or held constant during that time in all major categories.

[3] AAR states that "After accounting for changes in definition, operational integration of commonly-owned railroads that occurred prior to legal integration, and other factors, approximately 22 Class I railroads in 1980 were merged to form the seven existing Class I railroads."

Figure 17 shows the operating revenue and expenses, in both constant and current-year dollars, since 1960. The excess of revenue over expenses has increased, but not dramatically, and, in real terms, total revenues have declined (along with expenses) by about one-third. Revenues per ton-mile are a reasonable proxy for overall levels of rail shipping rates (though not necessarily applicable to specific situations). As can be seen in Figure 18, on a ton-mile basis, both revenues and expenses have dropped even more rapidly. Their difference (relative to ton-miles) has fluctuated, but has stayed within the same range since the late 1960's.

The result of the continuing close match between revenue and costs is clear in Figure 19, which presents the return on net investment (ROI) achieved by the Class I railroads, compared to the cost of capital. As defined by the Surface Transportation Board (STB), ROI is calculated as the ratio of net railway operating income to average net investment in railroad property. The figure confirms that the ROI has improved substantially recent years, but it remains well below the STB's "regulatory cost of capital." "Revenue Adequacy," as defined by STB, is achieved only when ROI reaches or exceeds the cost of capital. As indicated, after narrowing through the 1980's, a 3% to 4% gap has remained since the early 1990's. While this represents a distinct improvement from the situation of 20 or even 10 years ago, it reflects a continuing shortfall in investment capability that, if not overcome, will handicap railroads in responding to new challenges and future opportunities.

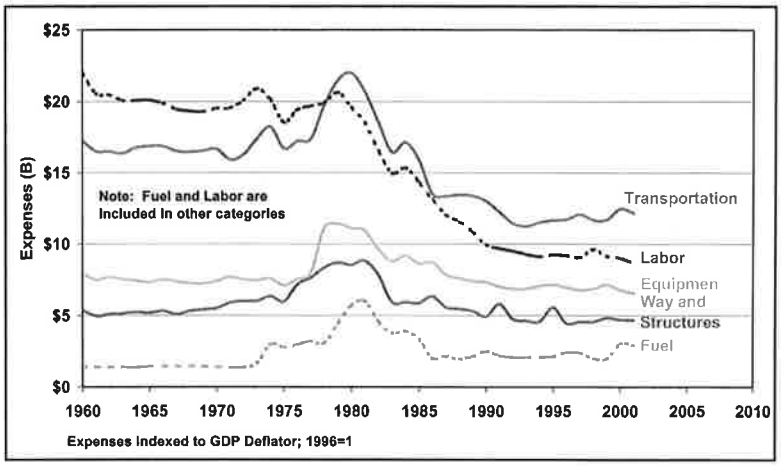

Figure 16. Components of Railroad Expenses in Constant Dollars, 1960-2001. (Note that fuel and labor costs are components of the other categories.)

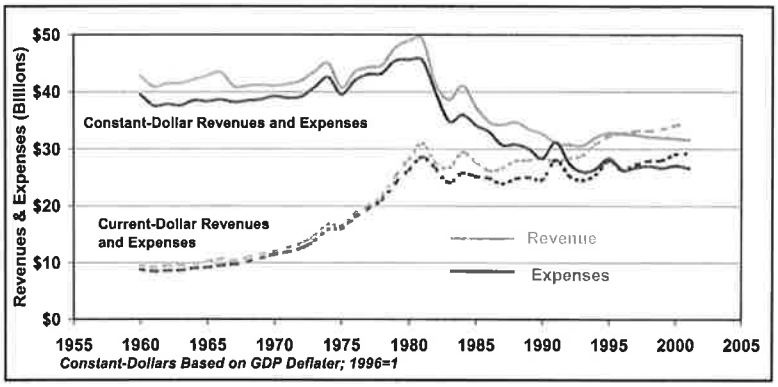

Figure17. Class I Railroad Revenues and Expenses in Current-Year and Constant Dollars, 1960-2001.

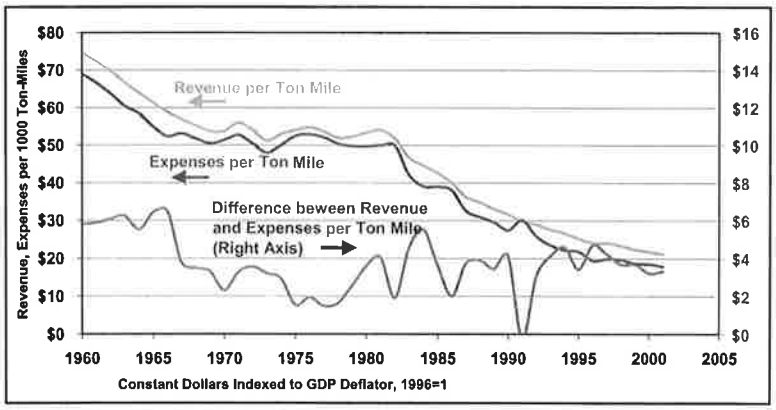

Figure 18. Operating Revenues and Expenses per 1000 Ton Miles, and Their Difference, in Constant Dollars, 1960-2001.

Investment

This shortfall is of particular concern for an industry as infrastructure-intensive as railroads. Figure 20 illustrates the degree to which rail capital expenditures, expressed as a fraction of operating revenues, have historically been substantially greater than for other US industries. In 2000, capital expenditures of Class I railroads were 17.8% of revenue. The comparable figure for all manufacturing was 3.7%, and 10.2% for electric utilities, which are also infrastructure-intensive. The long-term trend in capital expenditures has been relatively constant since 1960, averaging about $5 B in constant 1996 dollars. However, as shown in Figure 21, it has been highly variable in the short term. Figure 21 also illustrates the degree to which those expenditures are influenced by operating income.

Although the magnitude of capital expenditures has been fairly stable, there has been a major change in how that investment is divided between structures (roadway) and equipment[4]. As seen in Figure 22, a substantial shift from equipment to structures occurred at the time of deregulation. The drop in equipment investment is consistent with the sharp reduction in the number of freight cars owned by Class I railroads, seen previously in Figure 14. However, it is noteworthy that capital expenditures for structures increased at the same time that miles of track and roadway were aggressively being sold, taken up, or abandoned. Structures have received approximately three-quarters of investment dollars since deregulation, with the constant-dollar level of structures

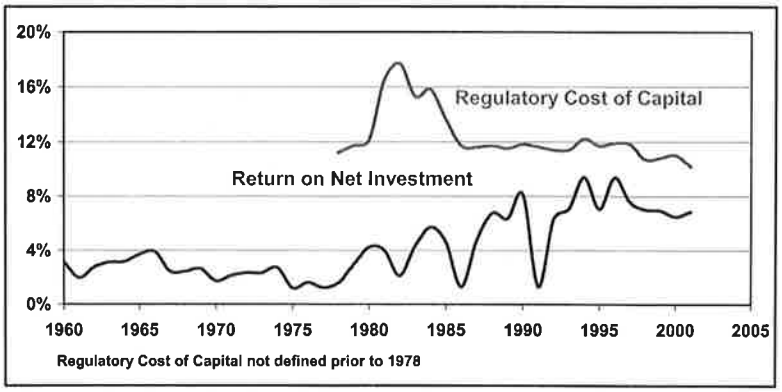

Figure 19. Class I Railroad Return on Net Investment (ROI) and Cost of Capital, 1960-2001.

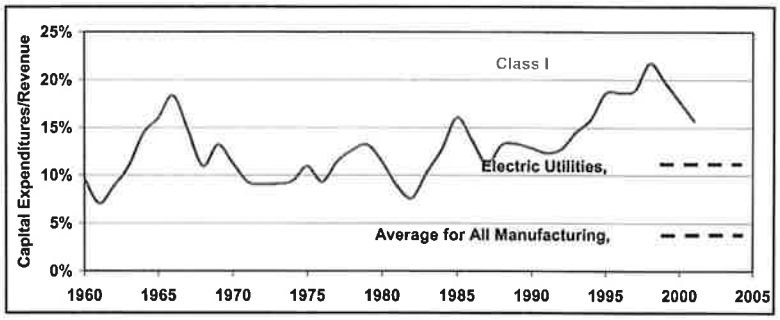

Figure 20. Capital Expenditures of Class I Railroads as a Percentage of Operating Revenue, 1960-2001.

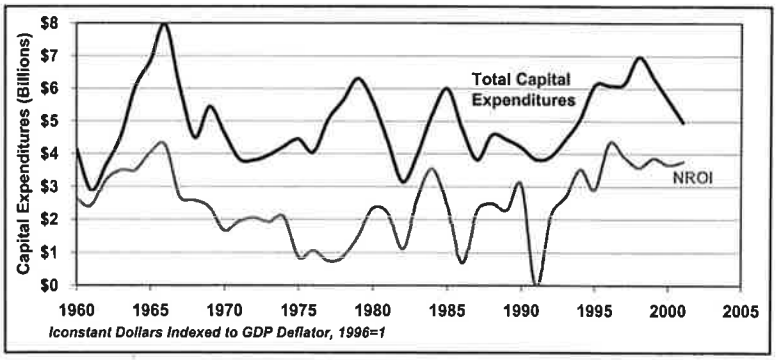

Figure 21. Class I Railroad Capital Expenditures and Net Railway Operating Income, 1960-2000 (Constant Dollars).

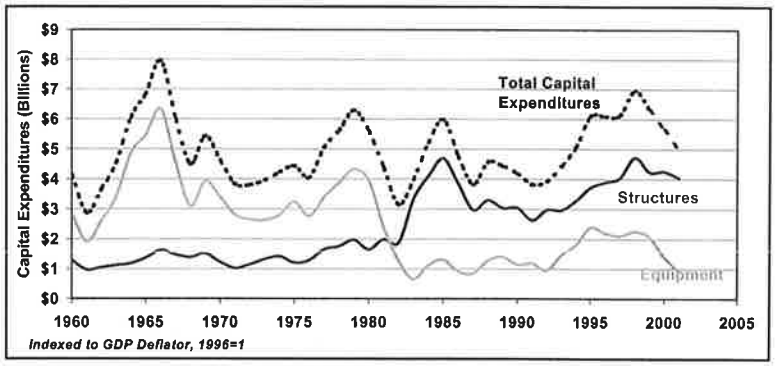

Figure 22. Class I Railroad Structures, Equipment, and Total Capital Expenditures, 1960-2001, in Constant Dollars.

[4] "Structures" includes facilities such as terminal, track, bridges, and classification yards; "equipment" primarily implies freight cars and locomotives.

expenditures more than tripling between 1982 and 2001 (Figure 23).

Commodity-Specific Trends

With some important exceptions, rail transportation of freight is most competitive for bulk commodities characterized by high tonnage and relatively low value per ton, and for which shippers are not highly time-sensitive. Figure 24 shows the rail share in 1998 for tonnage for each of the standard commodity groupings carried by railroads. Not surprisingly, rail market dominance is by far the largest for coal (70% by tonnage, and greater than 90% in terms of ton miles). Metallic ores also make a strong showing, with a 50% share. Other commodities for which the rail share is greater than average include chemicals, paper, motor vehicles, and waste and scrap materials.

Figure 25 presents the average rail tonnage and revenue for each commodity group in the period 1999-2001, and again underlines the importance of the coal market to railroads. Focusing on commodities of greatest future relevance, Figure 26 presents the same information condensed into six major groups plus "All Other." The six represent approximately three-quarters of total revenues and of total tonnage. Figure 27 highlights the importance of coal, chemicals, motor vehicles, and intermodal transport as a source of revenue, and Figure 28 shows the wide variation in revenue per ton for the major commodities. Intermodal transportation and motor vehicles stand out by strongly by this measure.

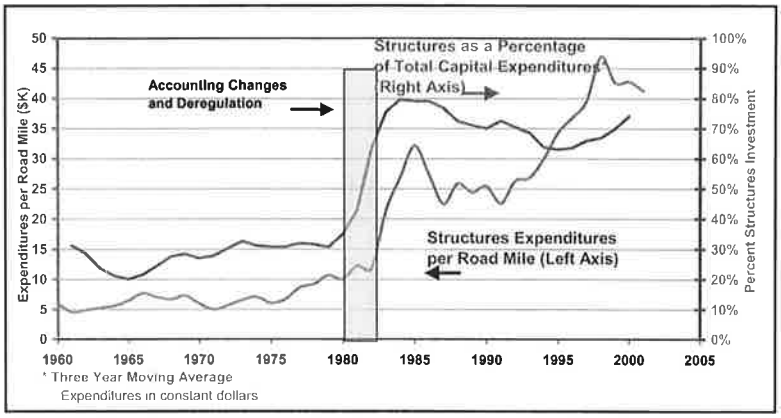

Figure 23. Class I Railroad Capital Expenditures of Structures per Mile of Road Owned in Constant Dollars and a Percentage of Total Capital Expenditures, 1960-2001.

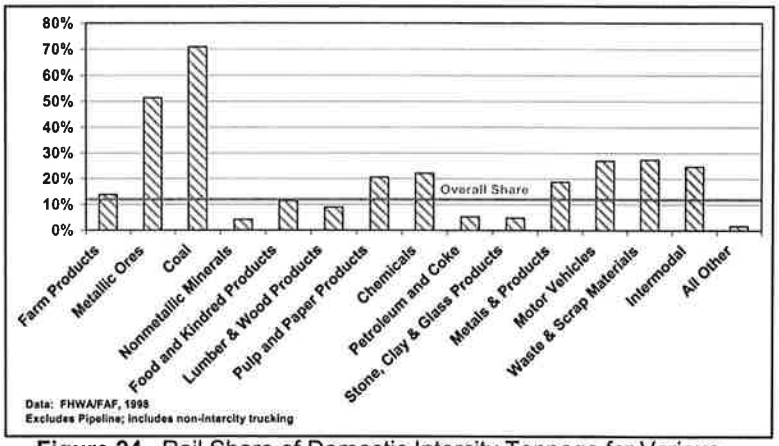

Figure 24. Rail Share of Domestic Intercity Tonnage for Various Commodities, 1998.

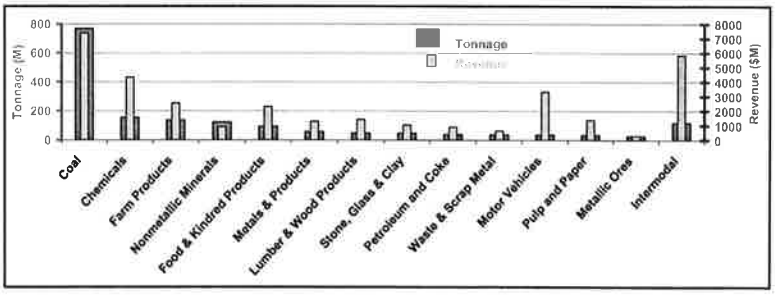

Figure 25. Average Tonnage and Revenue for Rail Commodities for the Period 1999-2001.

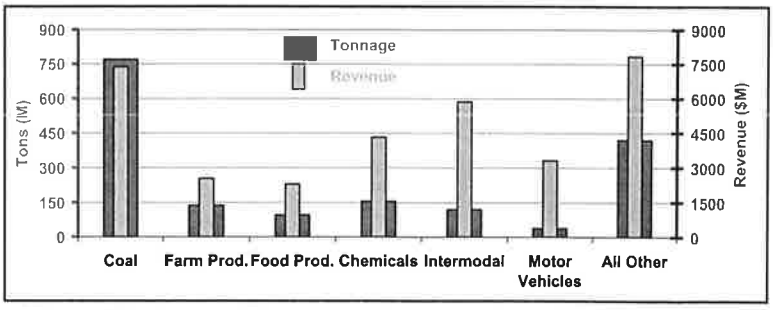

Figure 26. Average Tonnage and Revenue for Selected Commodities for the Period 1999-2001.

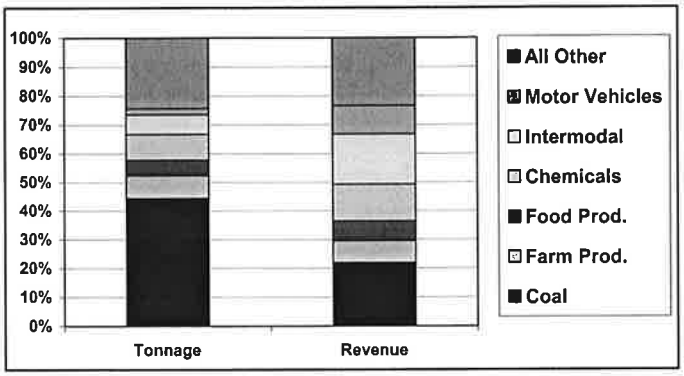

Figure 27. Relative Contribution of Selected Commodities to Rail Tonnage and Revenue: Totals for 1999-2001

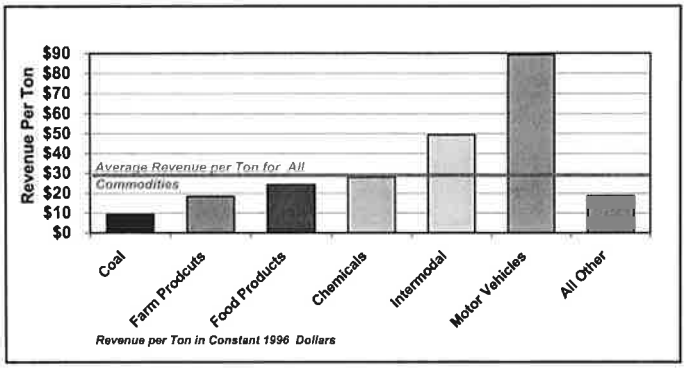

Figure 28. Revenue per Ton for Selected Commodities; Average Value for 1999-2001

To provide a perspective from which to consider the future, the tonnage and revenue data for each year since deregulation are plotted in Figures 29 and 30, indexed to their average values for the transition period of 1981-83. Coal and chemicals show relatively modest growth in tonnage (substantially less than the near-doubling in GDP over that period), while food products show a very low growth rate, and farm products (predominantly grain) have been basically flat in tonnage for twenty years.

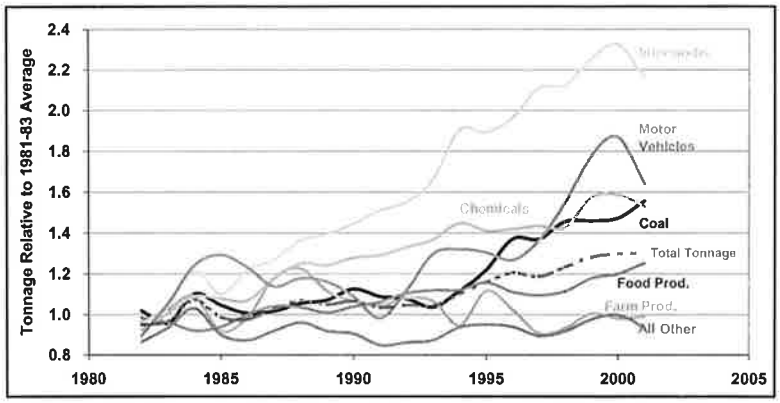

Figure 29. Tonnage Trends for Selected Commodities Indexed to Average Value for 1981-83.

The revenue trend (Figure 30) reflects the previously noted general reduction in indexed rail revenues, and particularly highlights the financially beneficial role of motor vehicle and intermodal traffic. Figure 31 highlights those commodities making the greatest contribution to recent increases in tonnage and revenue; it shows the 1992-2001 percentage change for each group. [Note that the chart shows both measures *relative to the total increase for all rail freight* (26% for tonnage, 1% for constant-dollar revenue), which is subtracted off.] Transport of motor vehicles dominates in terms of tonnage, having increased 41% more than total freight, while intermodal shows the greatest relative revenue increase (30%).

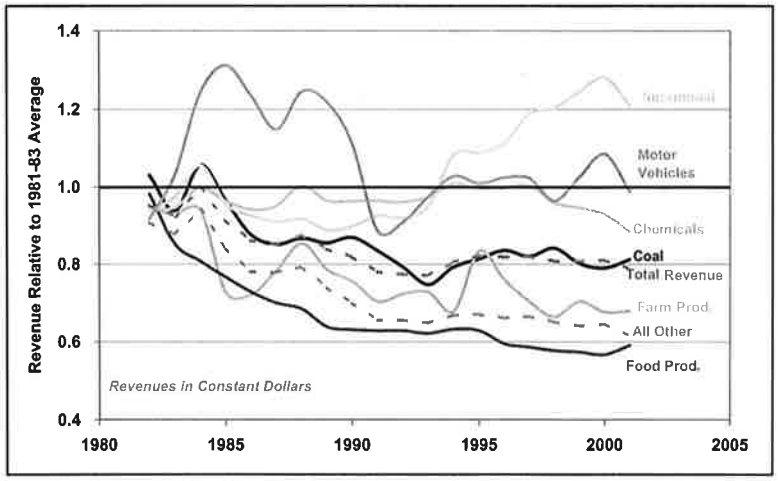

Figure 30. Revenue Trends for Selected Commodities Indexed to Average Value for 1981-83.

The rapid growth of intermodal traffic is captured in Figure 32, in which it is graphed for the period 1960-2001. Separate data for trailers and containers, which exists only for years after 1988, clearly shows the impact of the increasingly global marketplace and the rise of containerization. In 2002, trailers comprised approximately 21% of intermodal moves, a

decrease of 2.8% from 2001. At the same time, moves for both domestic containers (25% of total moves) and international containers (54%) grew by a dramatic 8.5%, in spite of a difficult economic environment.

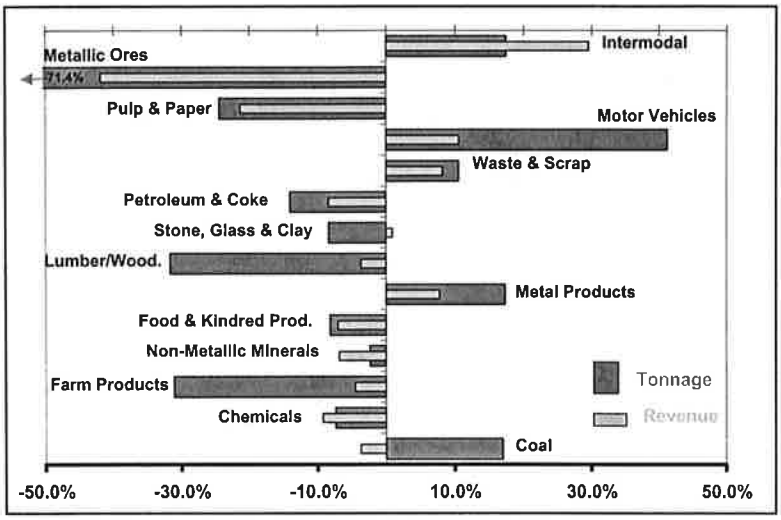

Figure 31. Revenue and Tonnage Growth in Specific Commodities Relative to Overall Rail Freight Growth, 1992-2001.

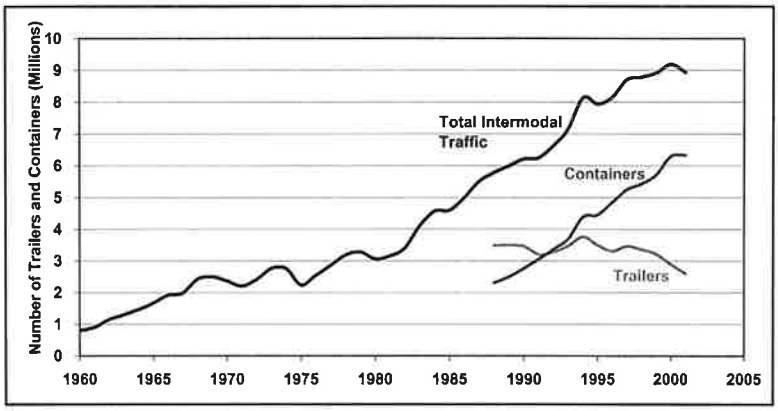

Figure 32. Growth in Container (COFC) and Trailer (TOFC) Loadings, 1960-2001.

The Role of Small Railroads[5]

This paper is focused on the future capital investment environment for Class I railroads. However, the growth and vitality of the national freight rail transportation system will also depend on the condition and capabilities of the hundreds of small regional, local, and terminal railroads that play an important role in the overall system. They, too, face serious challenges in meeting investment needs, often with much more limited resources. These railroads took over much of the trackage eliminated by the Class I companies since deregulation. The importance of their role goes beyond the statistics of their operation. For many shippers, they provide access to the rail system, and enable continued service to many customers and communities. Their services thus also benefit the Class I railroads, since otherwise many shipments would likely be diverted to other modes.

Non-Class I railroads operate over about 30,000 miles of their own lines in the US, and receive 8 percent of total rail revenues—more than $3 billion—while originating 16 percent of carloads. The mix of commodities carried by small railroads is similar to that of Class I companies. Measured in carloads, their leading traffic is in coal (17%, compared to 25 % for Class I), farm products, metallic ores, paper products, lumber, and chemicals. Investment is a major issue for many of these carriers, particular with respect to the need to upgrade infrastructure to handle the 286,000-pound cars now coming into wide use. The total investment required has been estimated as high as $7 billion.

[5] The year 2000 definition of a Class I railroad was operating revenues exceeding $261.9 million. Regional railroads are defined as those which operate more than 350 miles of road and have revenues between $261.9 million and $40 million; there were 35 in 2000. Local railroads are line haul companies below the Regional thresholds, as well as Switching and Terminal railroads; in 2000 there were 517.

3. The Freight Transportation Outlook - Baseline Forecasts

The primary resource used here to for assess likely levels of growth in rail freight transportation is the major study recently published by the American Association of State Highway and Transportation Officials (AASHTO)[6]. This report, prepared by well-qualified consultants using extensive proprietary and DOT databases[7], forecasts freight transportation growth through 2020. It assumes a fixed total 2020 demand, with allocation among modes determined by alternative levels of rail infrastructure investment. The discussion that follows is based on the AASHTO base case, which postulates freight-rail investments sufficient only to enable railroads to maintain current market share of relevant commodities. Revenue ton-miles are expected to increase at an average rate of 2.1% for all modes taken together, and 1.9% for rail. Figure 33 shows the growth rate for revenue ton-miles forecast for each transport mode. The AASHTO forecast for tonnage is very similar to that for ton-miles, with the exception of water transport, which is forecast to show a substantially larger rate for tonnage (1.7%) than for ton-miles (.7%).

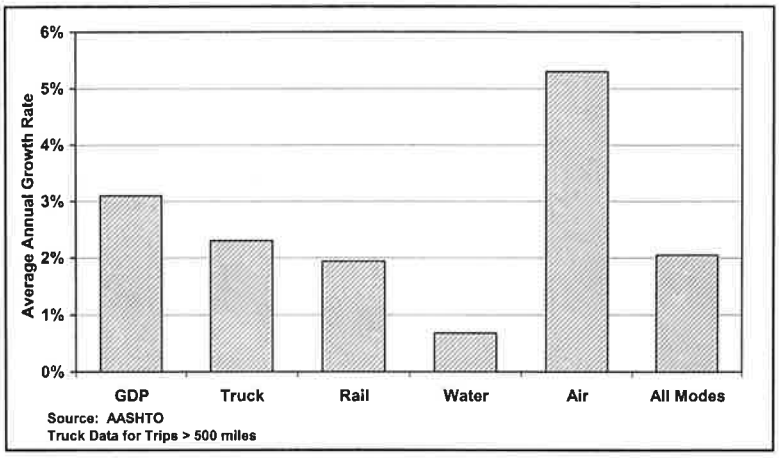

Figure 33. Forecast Changes in Freight Tonnage, Revenue, and Market Share for Each Mode, 1998-2020. *(AASHTO)*

The 3.1% growth rate for real GDP also shown in Figure 33 is an extrapolation from Office of Management and Budget and other estimates that extend only to 2014. (Real GDP grew at a 3.2% rate for 1980-2000. The latest FAA *Aviation Forecast* uses a very similar growth rate anticipated for the global economy.) Recent history and the current clouded global and domestic economic outlook emphasize the inherent uncertainty of economic forecasts. However, as long-term averages to be used for a baseline, these appear to be reasonable. Also, a primary purpose of estimates such as these is to assess when the transportation system in general, or a specific component, is likely to experience a major shortfall of meeting the needs of users. In that sense, the real uncertainty lies not in the level of demand in 2020, but rather whether that level will be reached in 2019, 2021, or some other year.

The AASHTO forecasts explicitly assume that rail system capacity will be adequate to this level of traffic but no more, and, implicitly, that other modes will also be able to provide desired services. Should congestion, environmental, or other factors begin to constrain capacity, increase costs, or degrade service, a new equilibrium will be generated, presumably at lower levels of traffic and possibly somewhat different modal shares. Indeed, the central theme of the *Freight Rail Bottom-Line Report* is that greater investment is needed in rail infrastructure as an alternative to the far greater expenditures otherwise likely to be needed for highway infrastructure as truck and other road traffic grows.

---

[6] *Freight-Rail Bottom Line Report*, AASHTO, January 2003.

[7] Data and analysis developed in the DOT Freight Analysis Framework Project.

Another highly relevant document is *US Freight Transportation Forecast...to 2014*, just published by the American Trucking Association, and prepared by Global Insight Inc., a major participant in the AASHTO *Bottom Line* study. Not surprisingly, for the period 2003-2014 it sees the same total freight growth rates of 2.1%, with 1.9% for rail. Within that, those sectors having a projected growth rate of less than 2% are mining and agriculture; overall, bulk commodity tonnage is expected to grow at 1.6% compared to general commodities at 3.1%.

As part of its Freight Analysis Framework (FAF) program, the Federal Highway Administration (FHWA) has developed a database that forecasts commodity flows in 2010 and 2020, as well as providing data for 1998. (This was one of the resources used in the AASHTO study.) Forecast results for total and rail tonnage, and rail share, are shown in Figure 34. Also plotted in that figure is an estimate of the changes in constant-dollar operating revenue, using 2001 data for revenue per ton. This approach is admittedly highly simplistic,

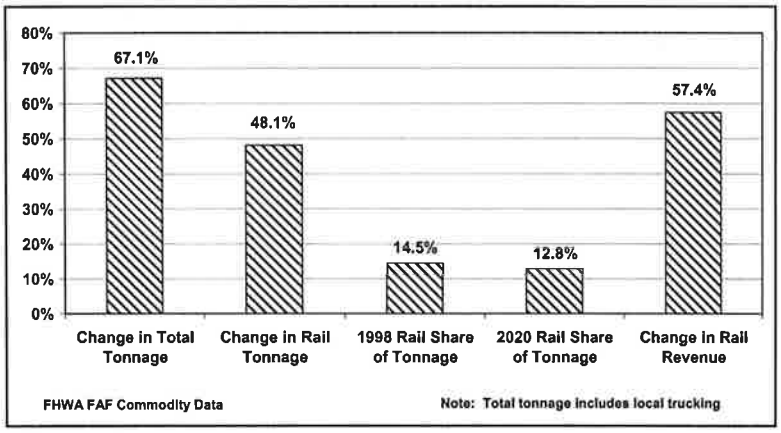

Figure 34. Forecast Changes in Freight Tonnage, Revenue, and Market Share, 1998-2020.

but it offers a rough sense of how constant-dollar revenues might be expected to change. The FAF data allows calculation of forecast growth rates in rail tonnage for selected commodity groupings, as plotted in Figure 35.

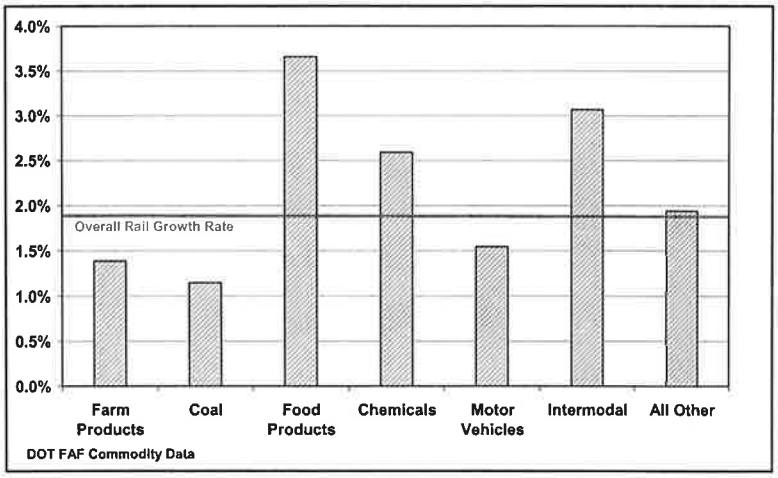

Figure 35. Forecast Average Annual Growth in Rail Tonnage for Selected Commodities, 1998-2020.

The same data were used for determination of future rail share by commodity, shown previously in Figure 24 for 1998. The forecast shares for 2020 are very little different, in part as a result of the basic assumptions in the model. Only three commodities show a 2020 change in modal share of greater than 1%: farm products (increasing from 13.8% to 15.5%), motor vehicles (decreasing from 27% to 25.6%), and waste and scrap materials (increasing from 27.4% to 28.8%).

4. Rail Freight Outlook: Transportation of Coal

Railroads and Coal

In several ways the transport of coal is the primary business of US railroads. As indicated in Section 1, rail tonnage has risen considerably since the early 1990's, while constant-dollar revenue has declined (Figure 36). Averaged over 1999-2001, coal represented 44.4% of Class I railroad tonnage, 21.8% of operating revenue, and 25.8% of carloads (Figure 37). Coal ranked first among rail commodities in tonnage and revenue, and just behind intermodal shipments in carloads. This market is shared fairly evenly; coal represents 40% or more of the tonnage and carloads for each of the four large Class I railroads, and greater than 20% of their freight revenues. Thus, although coal yields less revenue per ton than most other commodities, it is a key force in shaping the future outlook for the industry.

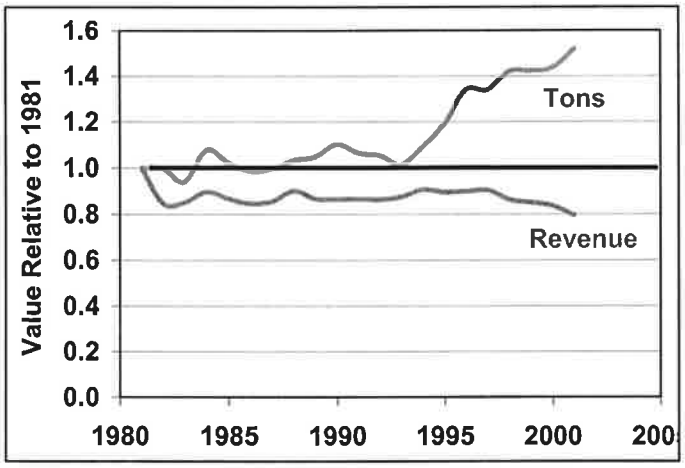

Figure 36. Tonnage and Revenue Trends for Rail Transportation of Coal, 1981-2001. *(AAR)*

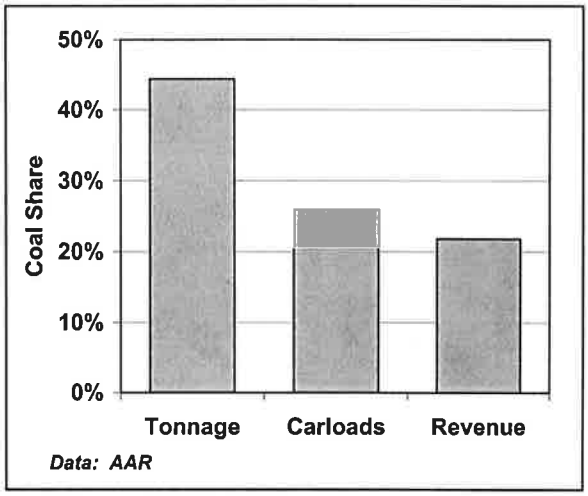

Figure 37. Average Share of Rail Tonnage, Carloads, and Revenue due to Coal Transportation, 1999-2001.

Industry Overview and Characteristics

The coal story is more straightforward than is the case for most other commodities. Almost all of the nation's coal consumption (1.1 billion tons in 2001) is for generation of electricity—91% in 2001. Three percent is used for coke necessary for making iron and steel, and 6% serves other industrial purposes. Less than 1% goes to commercial and residential customers. The growth rate for electric power consumption has long been determined largely by GDP growth. Since 1980 the two have been closely matched, as indicated in Figure 38, which shows five-year trailing averages for electric power generation and GDP growth rates.

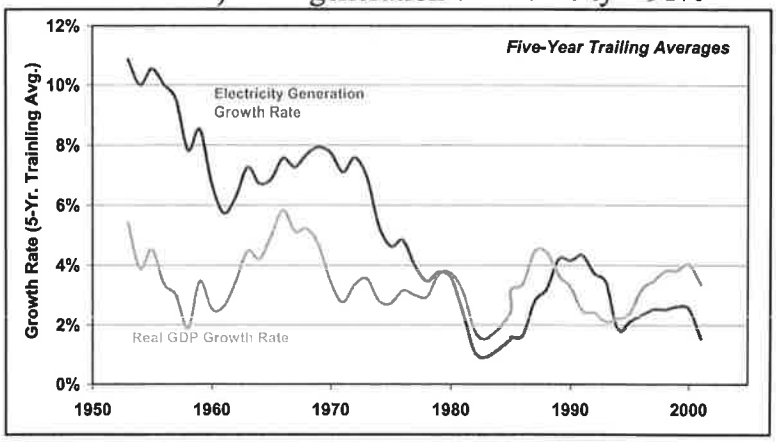

Figure 38. GDP and Electric Power Generation Growth Rates, 1950-2000, Five-year Trailing Average.

Coal is the source of more than half of the nation's electricity, compared to 20% for nuclear and 18% for natural gas (Figure 39). Coal-fired power plants have played an extremely stable role. Since 1950 coal has fueled an average of 51% of total electric power generation, with a low of 44% and a high of 57%. During the last decade coal's share has been between 51% and 53%. Rail transportation of coal has been similarly constant. Exports play a small and declining role in the coal story, dropping from 10.9% in 1991 to 4.3% in 2001.

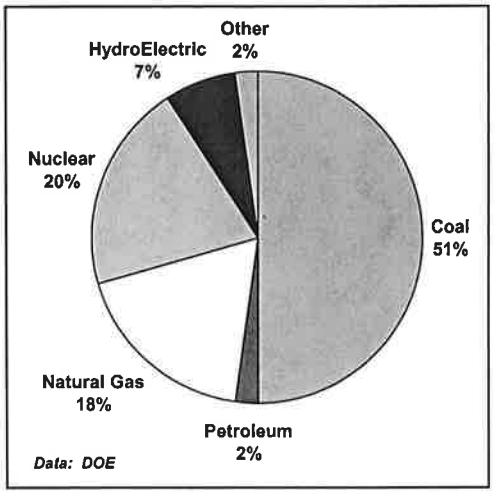

Figure 39. Energy Sources for US Electric Power Generation, 2001.

In some ways, the recent changes in the coal industry have mirrored those of the railroads. During the 1990s it experienced a high degree of consolidation, leading to fewer and larger mines. The industry is also structurally concentrated; just six companies produce half of the coal, and the largest 20 provide 75%. Just as for the rail sector, significant infrastructure investment has led to greater efficiency, resulting in increased production at substantially reduced real prices.

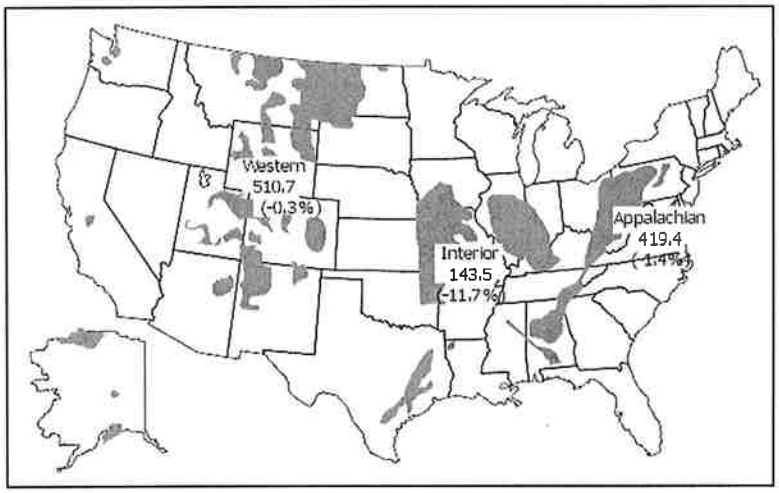

Figure 40. Major Coal Production Regions, Showing Tons Produced in 2000 and Percentage Change from 1999.

Coal is mined primarily in three areas, shown in Figure 40: Appalachian (primarily Pennsylvania, Virginia, West Virginia, Ohio, and eastern Kentucky), *Interior* principally Illinois, Indiana, Texas, and western Kentucky), and *Western* (Wyoming, Montana, Colorado, Utah, North Dakota, New, Mexico, and Arizona). Coal mining is quite localized. In 2002 sixteen states produced more 98% of the nation's coal; Wyoming, West Virginia, and Kentucky alone provided 59%. Adding Texas and Pennsylvania accounts for 70% of the total. Wyoming alone contributes about one third, largely from 15 mines in the Powder River Basin, located in northeast Wyoming and southeast Montana.

The Western region, which produced 7% of US coal in 1970, rose to 38% by 1990 and now yields about 50%, principally because the environmental value of its low-sulfur composition more than compensates for its relatively low heat content and greater distance from consumers. Also, the Powder River coal is surface mined, yielding a substantially lower price at the mine mouth than is the case for Eastern Coal, much of which requires underground mining. The trend toward Western coal clear in Figure 41.

Given the relatively low value of coal (approximately $25 per ton, about $10 of which is the cost of transportation) and its bulk nature, it is not surprising that imports and exports are relatively modest. In the past, exports have reached as much as 10% of total production, but in recent

years have declined to less than 5%. (Exports, primarily for metallurgical uses and steam production, have been significant commodities for Eastern railroads.) Imports are much smaller, seldom exceeding 1% of domestic production. Trends in coal production, use, and transport are graphed for the period 1980-2001 in Figure 42.

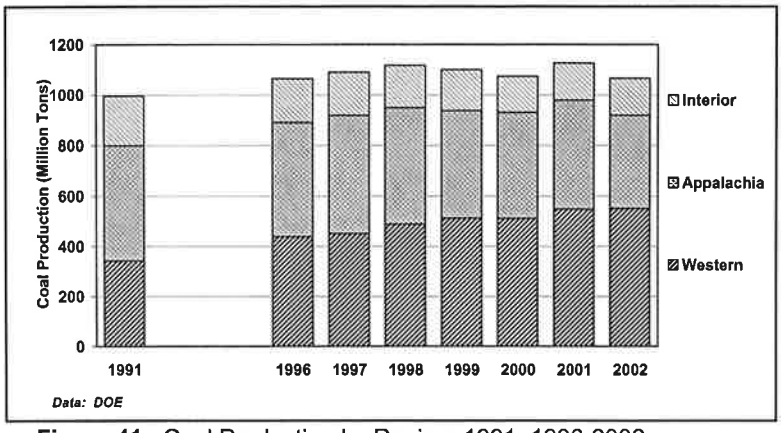

Figure 41. Coal Production by Region; 1991, 1996-2002.

Coal Consumption, Transportation, and Economics

Coal consumption is relatively concentrated compared to other commodities; ten states account for about half of all consumption. Very little coal is used in the Northeast, Northwest, and California-Nevada; Texas, Indiana, Ohio, Michigan, and North Dakota are major consumers. No other state uses more than 2% of the national total. This pattern largely reflects differences in the preferred fuel for electricity generation in different areas of the country.

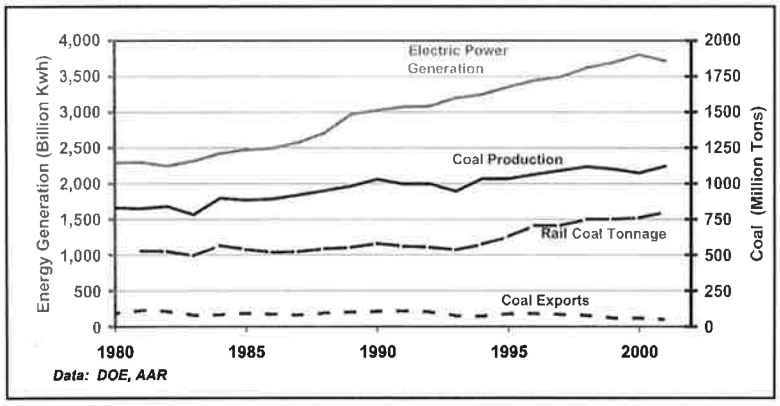

Figure 42. Electric Power Generation, Coal Production and Exports, and Rail Coal Tonnage, 1980-2001.

The relative concentration of sources and users, and the large scale on which coal is produced and consumed, enable highly efficient transportation. Eighty five percent of rail shipments are by unit trains of more than 50 cars, typically traveling directly from loading facility to the final customer. The cars carry an average load of 109 tons of coal. As a result of the high suitability of this traffic to rail transportation, coupled with steadily reduced (constant-dollar) cost and long hauls from the Power River Basin mines, railroads now carry almost 2/3 of domestic coal production, as indicated in Figure 43. The remainder is split relatively evenly among truck (very short-haul), barge, and other means (pipelines, tramways, conveyor belts).

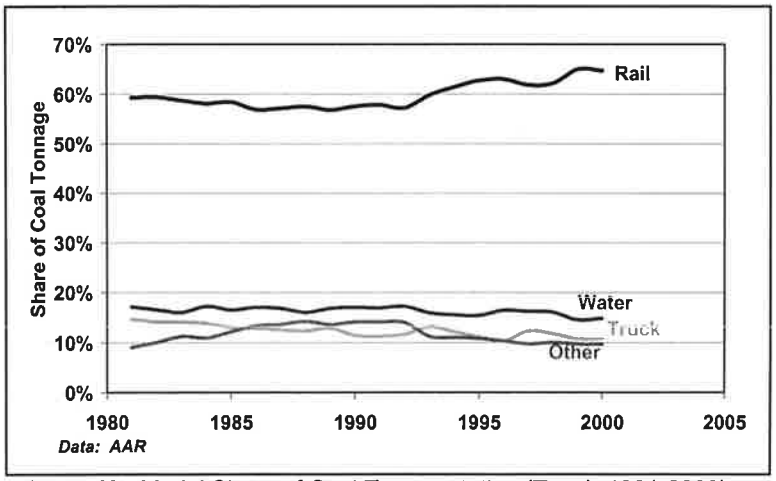

Figure 43. Modal Share of Coal Transportation (Tons), 1981-2000).

The rail share has increased slowly but steadily, at the expense of all three other modes, for the last decade. The average shipment distance is more than 800 miles for rail, 300 miles for barge, and tens of miles for trucking, implying a greater than 90% rail share of ton-miles. The rail length

of haul is increasing, due to the rising percentage of coal coming from the Western region, which is more distant than other regions from the largely Midwestern consumers.

Railroad	Percentage of Tons Originated	Percentage of Total Revenue	Percentage of Total US Rail Coal Tonnage	Percentage of US Total Rail Coal Revenue
BNSF	50.7%	22.5%	29.1%	26.9%
CSX	41.6%	22.4%	22.3%	21.1%
NS	45.7%	23.9%	19.3%	18.9%
UP	40.9%	20.4%	24.8%	29.8%
All Class I Railroads	43.6%	21.5%	100%	100%

Table 1. Percentage of Tons Originated, Revenue, and Share of Total Rail Tonnage for Each of the Four Major Class I Railroads, 2000. *(AAR)*

Coal is currently of approximately equal importance to each of the four major Class I railroads, representing 22% to 25% of their total revenue and 41% to 51% of total tonnage; details are indicated in Table 1. Cumulatively, in 2000 the four originated 95.6% of total coal tonnage and received 96.6% of total revenues. Figures 44 and 45 show the revenue and tonnage trends, respectively, for each railroad.

The result of rising GDP and electric power consumption, an associated increase in coal production, and a growing rail share of the coal transport market and has led to a 44% rise in rail coal tonnage from 1992 to 2001, outpacing most other commodities (shown previously in Figure 31). Due to the larger cars in use, carloads have increased by only 28% in that period. As for most rail freight, constant-dollar revenues have dropped, though by less than 3%. AAR reports that coal revenue per ton-mile in 2000 was 1.61 cents, much lower than for any other major commodity, and 22% lower than in 1991.

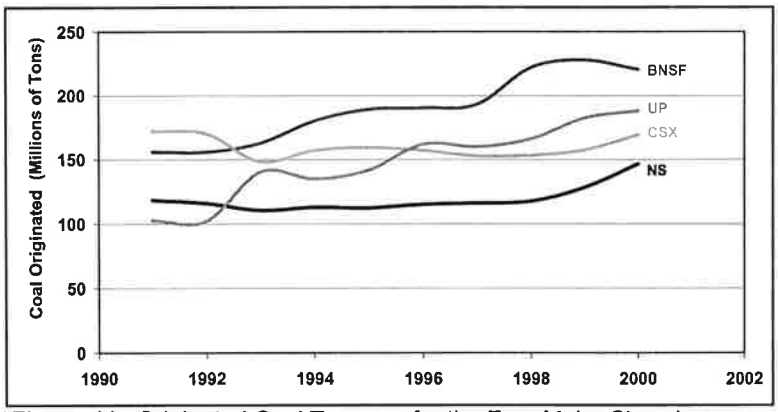

Figure 44. Originated Coal Tonnage for the Four Major Class I Railroads. 1991-2001. (AAR)

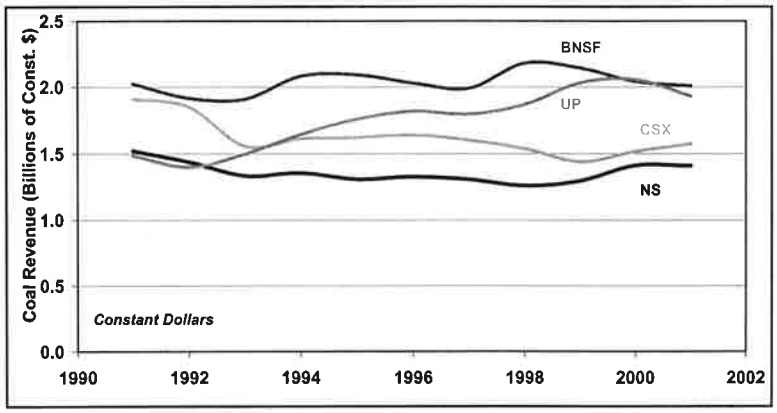

Figure 45. Operating Revenue Derived from Coal Transport for the Four Major Class I Railroads, 1991-2001; constant 1996 Dollars. (AAR)

Railroads have relatively little power to shape the market for coal transportation, which is determined largely by the external trends and forces operating on the electric power industry. Major changes are now occurring in that sector. Utilities, increasingly subject to a competitive marketplace, are highly sensitive to fuel costs. Further, they can find themselves facing lower-cost competitors in other regions, electric power having very low transmission costs. Improved low-cost gas turbine technology, which is particularly suited to supplying peak and intermediate capacity, dominates strongly in the installation of new capacity. The result is a strong constraint on the rates railroads can charge, lest they induce a reduced reliance on coal. This factor reinforces the pressures of

direct competition (many coal routes are served by two or more railroads) and the possibility that a utility might switch to coal from a different region served by another carrier.

Ever since deregulation, some shippers have expressed concerns that competitive pressures in the coal and other transportation markets may be insufficient to assure fair rates. At the request of Congress, the Government Accounting Office (GAO) addressed this topic in 1997 and 2000, as did a subsequent study by the Department of Energy, required under the Energy Policy Act. These reports confirmed that rates had generally decreased since 1990, but have not fully satisfied the feeling of "captive" shippers that rates are higher justified by railroad costs. This remains a contentious topic.

Coal and the Clean Air Act Amendments of 1990

The Clean Air Act Amendments of 1990 (CAAA) have been a major force affecting decisions of the electric power industry, and therefore in shaping the coal marketplace. The stated purpose of Title IV of the CAAA is to "reduce the adverse effects of acid deposition ['acid rain'] through reductions in annual emissions of sulfur dioxide of ten million tons from 1980 emission levels, and ... of nitrogen oxides emissions of approximately two million tons from 1980 emission levels..." Electric power generating companies that go beyond minimum compliance requirements are allowed to sell credits to other generators. As a result, many companies switched from higher-sulfur bituminous coals to low-sulfur sub-bituminous coal from the Western region, particularly the Powder River Basin, and the Central Appalachian region. However, particularly in areas producing high-sulfur coal, some utilities took the alternative approach of controlling emissions by investing in flue gas desulfurization equipment ("scrubbers").

The greater transportation distance associated with the Western coal was a principal reason for a 60% increase in rail ton-miles from 1991 to 2000, along with the associated 29% increase in the rail share of coal tonnage carried and a 21% increase in average length of haul for coal movements. Although the length of haul is much greater for the Western coal, the large scale of the movements, a steadily declining mine-mouth cost, and competitive forces resulted in a low cost differential between high-sulfur and low-sulfur coal. Table 2, based on DOE data for contract coal shipments from 1988 to 1997[8], shows the trend in shipping cost per ton and delivered cost for high- and low-sulfur coal.

Year	Low Sulfur Coal			High Sulfur Coal		
	Avg. distance Shipped (Miles)	Avg. rate ($/ton)	Delivered Price	Avg. distance Shipped (Miles)	Avg. rate Per ton	Delivered Price
1988	994	18.82	37.42	134	6.57	43.80
1997	1037	12.05	23.49	180	5.83	27.12

Table 2. Comparison of Average Distance Shipped, Rate per Ton, and Delivered Price for Contract Shipments of Low- and High-Sulfur Coal. Rate and Price are in constant 1996 Dollars. (DOE)

[8] *Energy Policy Act Transportation Rate Study: Final Report on Coal Transportation*, DOE EIA, 1997.

Outlook

Coal Outlook

The *Annual Energy Outlook,* prepared every year by the Energy Information Administration of the US Department of Energy, is the key source for assessing the outlook for electric power generation and associated demand for mining and transportation of coal[9]. The *Outlook* is based on EIA's sophisticated and comprehensive National Energy Modeling System. *Annual Energy Outlook 2003* (AEO2003), just published, provides projections out to 2025. This document is the primary source for the discussion that follows.

AEO2003 forecasts average annual GDP growth for the period 2001-2025 at 3.0%, with total electricity demand increasing at 1.8%. (The corresponding rates for the 1992-2001 were 2.7% and 1.9%, respectively.) New generation capacity installed in recent years has been almost all natural-gas-fired, with less than 1% using coal. Natural gas plants are less capital-intensive and more efficient than coal, natural gas prices have been relatively low, and coal-fired plants have been less attractive due to the long lead-time for construction and concerns about the environmental impact of coal. Natural gas technologies are most appropriate for supplying peak-period and intermediate capacity, but they are also suitable for base load generation.

This pattern is expected to continue through 2010, after which rising natural gas prices are expected to enable advanced-design clean-coal technologies to become more competitive. Overall, DOE forecasts that approximately 80% of new capacity between 2001 and 2025 will be fueled with natural gas. The rest will primarily be coal, comprising 17% of all capacity added during that period. A small contribution from renewable sources is also expected. No new nuclear capacity is foreseen, although some existing units may be slightly expanded.

However, given the very large existing base of high-utilization coal-fired plants, coal is forecast to remain the dominant fuel for utilities, accounting for 48% of total electricity generation in 2025(compared to 52% in 2001). Environmental pressures will continue to shape the coal market. Low-sulfur Western coal production will increase at a 1.7% annual rate, while output stays virtually level (.1% growth) in the East, for a 1.3% overall growth. The forecast is plotted in Figure 46. The higher sulfur coal will still find a significant market, as scrubbers and other advanced technologies enable post-combustion emission control.

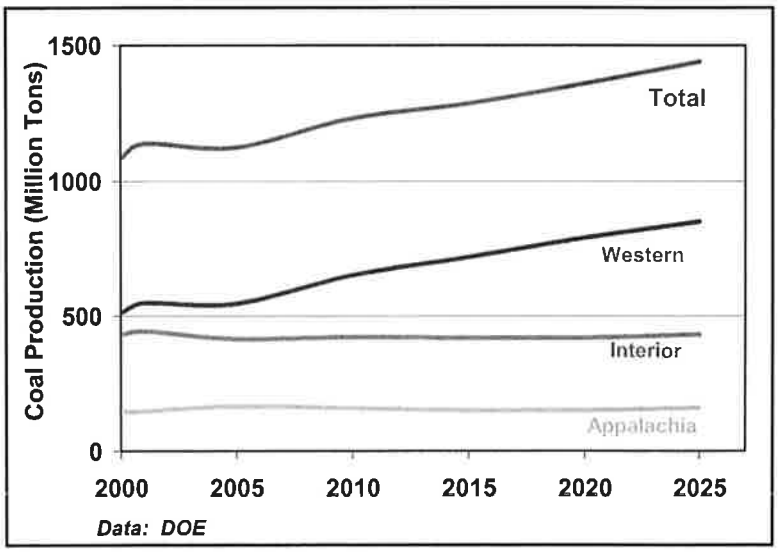

Figure 46. Projected US Coal Production in Specific Regions, 2000-2020. (DOE)

[9] *Annual Energy Outlook 2003 with Projections to 2025, DOE, January 2003.*

This highly competitive market will continue to drive improvements in mine productivity. In addition, the increasingly used Western coal can be mined at lower cost, resulting in an overall average annual decline in the mine mouth constant-dollar price of coal of .8%. As indicated previously in Table 2, transportation costs, particularly for Western coal, can be a large fraction of delivered cost, so there will be continued competitive pressures to constrain them.

Other uses of coal—residential, commercial, industrial, and coke—currently account for about 9% of coal consumption, and are projected to drop to 6.5%. International competition for export coal is expected to intensify, with the US share of this market dropping from 7% down to 3%, and steam coal exports accounting for less than .1% of production. A similar decline is seen for coking coal. Overall, the forecast shows coal exports and imports virtually vanishing.

Rail Transportation Outlook

The expected steady but modest increase in coal usage results in a baseline projection that US coal consumption will increase at an average annual rate of 1.3%, for a total growth 33.6% from 2001 through 2025. However, supply-side changes are anticipated that will somewhat reshape the transportation requirement. No growth is projected for Appalachian coal, 10% for the Interior region, and 66% for Western coal. Since that increase would be accompanied by a steady shift to longer transport distances for Western coal, ton-miles carried could rise at a significantly faster than the 1.3% overall annual rate. However, competitive constraints are likely to make it difficult for railroads to derive significantly increased net revenues from the situation. As noted, the AEO2003 forecasts an average decrease of 1.2% per year in transportation costs.

Within the industry, there could be significant impacts, positive for the Western railroads (BNSF and UP), and neutral or negative for the Eastern roads (NS and CSX). Indeed, this pattern is suggested by the trend in the 1990's, as seen previously in Figures 43 and 44. Given the longer haul and associated higher rate per ton generally found for the Western coal, differential impacts on revenues could be substantially greater than implied merely by the tonnage forecast.

Uncertainties and Issues

The AEO2003 document models two economic scenarios in addition to the baseline case just described: low (2.5%) and high (3.5%) GDP growth. The low-growth case reduces the 2025 coal consumption by 4.6%; high growth increases it by 5.5%. Rail tonnage and revenues would be expected to shift by like amounts.

The above discussion noted the importance of the Clean Air Act Amendments of 1990 in shaping decisions in the coal and electric power industries. The AEO2003 projections are based on current law. Future public policy decisions concerning acid rain, air quality, or climate change could significantly change the picture. The *Annual Energy Outlook* emphasizes the particular uncertainties associated with potential environmental restrictions and deregulation of the US electricity generation industry. AEO2003 also reports results from two commercial analyses, both of which incorporate stiffening SO_2 and other restrictions. Other assumptions embodied in those studies are not stated, but they presumably differ in various respects. Their projections extend only through 2020. One, by Energy Venture Analysis, Inc., finds a value for

coal consumption in 2020 14% lower than the AEO2003 baseline case. The other, from Hill & Associates, projects usage 3.2% higher than AEO2003.

More generally, the outlook for the coal sector could be significantly affected, particularly in the longer term, by the evolution of public policy and legislation with regard to environmental protection and energy production and consumption. In addition to future air quality requirements, national response to concerns of global climate change could at some point have a substantial impact on the power generation and coal industries, including significant changes in the patterns of coal use.

Technology advances, in part driven by environmental pressures, could also affect the coal marketplace. Given the low cost and abundance of US coal, there is much interest in assuring that it remains a usable resource. The Department of Energy has a major Clean Coal R&D program, similar to initiatives in Europe and elsewhere. Serious efforts are currently under way to explore improved means of controlling combustion emissions, alternative coal-based means of generating power, and pre-processing methods that could diminish subsequent combustion emissions. Also, programs to increase the viability and economic competitiveness of nuclear power are currently being pursued. In the longer term, depending on the degree of success achieved and the level of concern with respect to global warming, these programs could have a significant impact on coal consumption, and hence on rail transport of coal.

Although forecast production is up a relatively modest 34%, most of the increase will come from the Western region. Thus, one result will be a steady increase in rail traffic, which has caused safety and environmental concerns in the past,[10] and could e a source of future contention and possible constraints on capacity and efficiency.

[10] An application to the STB by the Dakota, Minnesota & Eastern Railroad to construct new rail lines in Wyoming, South Dakota, and Minnesota received 8500 comments, mostly in opposition, on safety and environmental grounds. The application was approved in January 2002, after an extensive review.

5. Rail Freight Outlook: Transportation of Grain

Railroads and Grain

Grain[11] (here used to include wheat, corn, soybeans, rye, oats, barley, and sorghum) has long been an important commodity for railroads. However, as shown in Figure 47, it has not shared in the general increase in rail freight tonnage since deregulation. It can be seen in Figure 48 that grain represented 7.9% of tons originated and 7.6% of total revenue averaged over the period 1999-2001. However, recent trends have been downward; in 1981 it was 9.6% of tonnage and 8.8% of revenue. Total grain tonnage carried in 2001 was down by 2% from the 1981 value, and by 19% from its 1987 peak. Constant-dollar revenues declined by 40% from 1981 to 2001. Although the revenues reduction arises partly through of higher railroad productivity and associated lower costs, an important additional factor is a reversal in mode share with respect to trucking. In 1981, as estimated by the US Department of Agriculture (USDA), the railroad share of all US grain transportation was 47.9% (by weight), compared to 27.5% for trucks. However, a variety of factors (discussed below) essentially reversed the values for rail and truck by 1998, as rail dropped to 31.1% and trucks rose to 48.4. (During the same period barge transportation declined from 24.6 to 17.2%.) Only a total market rising by 67% minimized the reduction in the grain-related rail freight business.

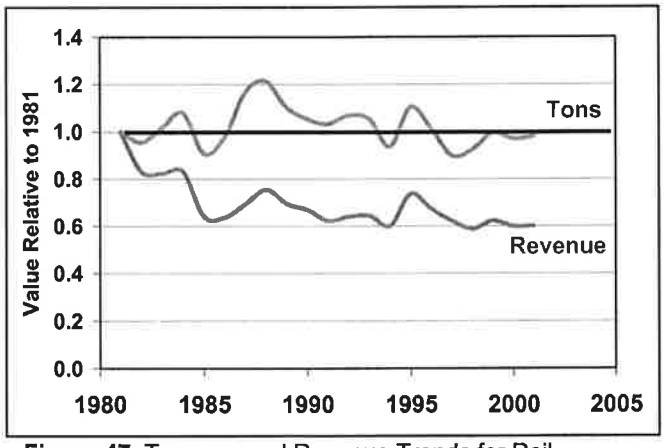

Figure 47. Tonnage and Revenue Trends for Rail Transportation of Grain, 1981-2001. *(AAR)*

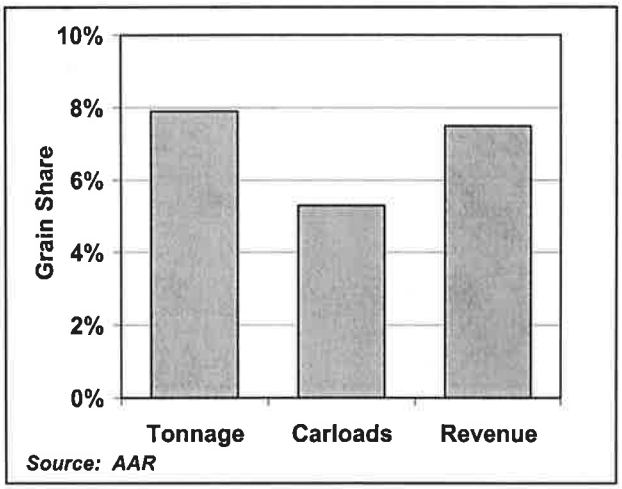

Figure 48. Share of Rail Tonnage, Carloads, and Revenue due to Grain Transportation, 1999-2001.

Characteristics of Grain Production and Markets

The grain transportation business environment is, in many ways, the opposite of that presented by coal. It is highly variable from year to year, and even from week to week. It is has a large export component, and is thereby significantly affected by the strength of the US dollar, global economic conditions, and the competitive strength of other nations. Whereas much of the coal originates at a small number of locations, production of various grains is widely dispersed geographically. Finally, the coal industry structure involves a relatively small number of producers and consumers and a nearly a single purpose to be served. In contrast, the grain

[11] Grain is generally listed in rail statistics as "Farm Products," Standard Transportation Commodity Classification (STCC) code 1. For railroad freight, virtually all shipments so classified refer to grain.

market reflects many and diverse producers, consumers, and uses. There is also a greater potential for geographic changes in production and use; one field crop can be replaced by another, or even by an alternative use of the land. Food processing facilities and feedlots can move far more easily than power plants. Political forces are also stronger for grain, in terms of the unpredictability and potential impact of farm legislation and the possible power of shippers to affect railroad rates though regulatory channels.

Grain crops can be consumed domestically, exported, or stored for future sale and use. Overall, exports have remained at a relatively constant level (averaged over several years) in recent decades, while domestic use has increased at a modest rate. Approximately one-quarter of total US grain production is exported. Since weather conditions and market forecasts in a given year may fail to match actual demand, storage is an important means of matching supply to demand over a multi-year time span, assuming that storage facilities are adequate.

The grain story is basically that of corn, wheat, and soybeans, which together comprise 93% of US grain production, 92% of rail "farm product" tonnage, and 91% of associated rail revenue. This paper focuses on these crops. In recent years, corn alone made up 61% of the total; wheat, 15%; and soybeans, 20%, as shown in Figure 49. The remainder comprises crops raised primarily as feed grains (oats, barley, rye, and sorghum); and oilseeds other than soybeans. (Soybeans represent approximately 90% of US oilseed crops.) Figure 50 presents the production trends, which have been quite stable for wheat and soybeans since 1985. Corn, on the other hand, has seen substantial variation, driving the swings in overall US grain production.

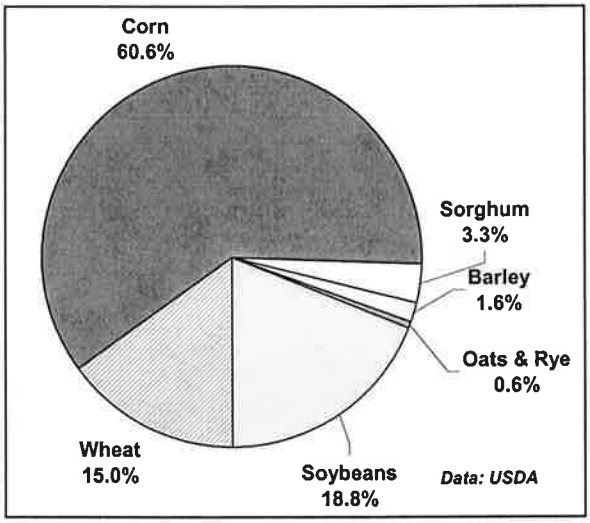

Figure 49. Principle US Grain Crops (Average for 1997-2002).

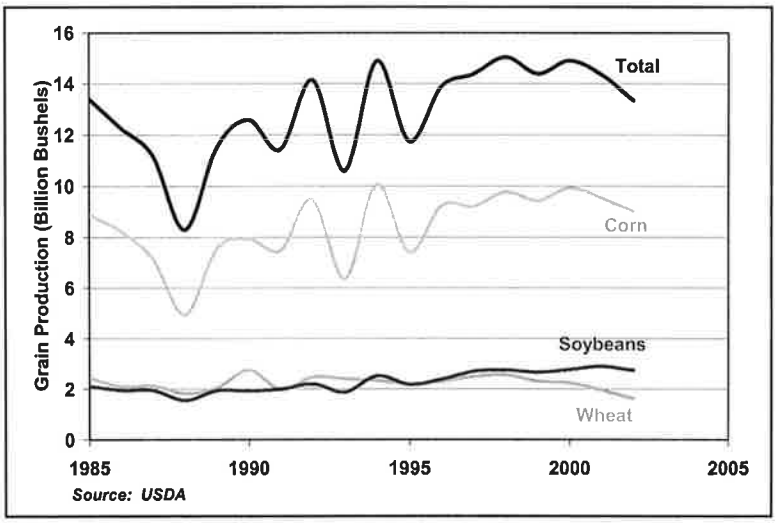

Figure 50. Production of Corn, Wheat, and Soybeans, 1985-2002.

A variety of terms can be used in discussing grains. USDA defines the following categories: (1) All Wheat—the threshed, dry seeds of a cereal cultivated for human consumption in the milled form of flour used for bread, pastries, etc., and used as an animal feed; (2) Mixed Grain--the threshed, dry seeds of any combination of wheat, barley, corn, oats, rye, sorghum grown and harvested in the same field; and (3) Coarse Grains--the total of rye, barley, oats, corn, sorghum, millet, mixed grains. Soybeans are also often included in the "grains" category. They are by far

the dominant US oilseed—seeds or crops grown largely for their oil. Oilseeds include soybean, cottonseed, peanut, rapeseed (canola), sunflowerseed, copra, and palm kernel.

The data presented in the following discussion are subject to some degree of imprecision, due not only to the need to combine various sources and substantial year-to-year variability, but also because some data are characterized in terms of market years, based on the growing season, which generally does not coincide with calendar years, and can vary with the specific grain and part of the world in which it is grown. Also, grain quantities are typically in either bushels or in metric tons (primarily with respect to global statistics); in some cases these data have been combined based on assumed bushel-to-ton ratios.

Corn

Corn production varied sharply in the early 1990's, particularly due to severe weather, averaging around 8 billion bushels per year. Since then, production has been between 9 billion and 10 billion bushels annually. Approximately 60% of corn grown in the US is used as feed for cattle, poultry and hogs, much of it used on the farm where it is grown; corn makes up more than 90% of all feedgrain production. This use increased by 49% between 1978 and 1995, partly due rising poultry production in the Southeast, which doubled during the same period. About 20% of the remaining corn is used for a variety of domestic consumption (corn oil, sweeteners, corn starch, ethanol, etc.), which tripled from 1978-1995. Government programs to support farm income have encouraged development of the high-fructose corn syrup and fuel alcohol markets. The remaining 20% of corn production is exported, with quantities varying with market demand and competitive pressures. The breakdown is shown in Figure 51.

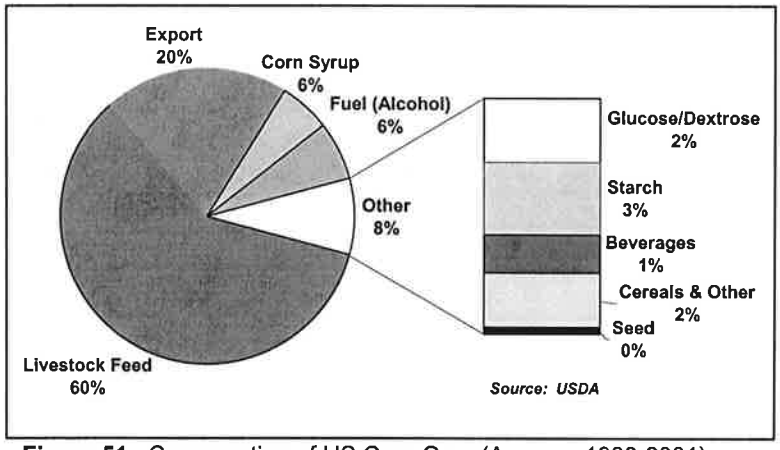

Figure 51. Consumption of US Corn Crop (Average 1998-2001).

Principal corn-growing states, which cumulatively account for 2/3 of US production, are Iowa (18%), Illinois (17%), Nebraska (12%), Minnesota (9%), and Indiana (9%). The trend during the 1990's was for substantial increases in corn acreage west of the Mississippi River, with eastern production rising much less.

Wheat

US wheat production is exceeded only by that of China, the European Union (EU), and, in some years, India. Export and domestic food consumption are the primary uses; a significant amount is also consumed as livestock feed. (Figure 52.) After corn and soybeans, wheat is the nation's

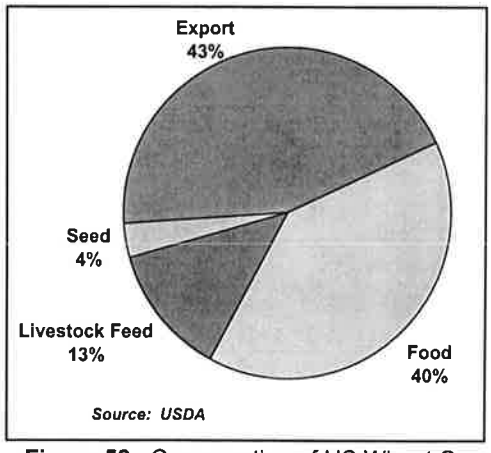

Figure 52. Consumption of US Wheat Crop (Average 1998-2001).

leading field crop. Wheat production, though quite variable on an annual basis, was stable for many years, but dropped by almost one-third between 1998 and 2002. Domestic and global markets remain strong, but foreign price competition has reduced the market value of wheat relative to other crops (particularly corn and soybeans[12]), as have alternatives offered by government programs.

Wheat varieties known as "winter wheat" are sown in the fall, lie dormant through the winter, grow during the spring, and are harvested in early summer. These represent approximately 70% of the total. In the Northern Plains, subject to harsh winters, other varieties ("spring wheat") are planted in the spring for harvest in late summer or fall. Kansas is the leading producer (19.8% of the total), followed by North Dakota (10.9%), Montana (7.3%), Washington (6.9%), and Idaho and Texas (both 5.3%)[13]. (Fourteen other states each contribute between 1% and 5% of the total.)

Soybeans

The US is the leader in production and processing of soybeans, which are the world's largest source of vegetable oil and protein feed. Export of soybeans and soybean products represent 43% of US production, making soybeans the second-ranked crop in export value, exceeded only by corn. The uses of soybeans are indicated in Figure 53. Soybeans represent about 90% of all US oilseed production. Soybeans are planted in late spring and harvested in early fall. They are grown predominantly in the upper Midwest [Iowa (17.8%), Illinois (16.6%), Minnesota (9.3%), Indiana (8.4%), Ohio (6.9%), and Missouri (6.6%)]. Several considerations have significantly increased soybean production in recent years. Development of herbicide-tolerant varieties, narrow-rowed seeding practices and other practices, and rotation of corn and soybean crops, contributed to an increase of 29% during the 1990's.

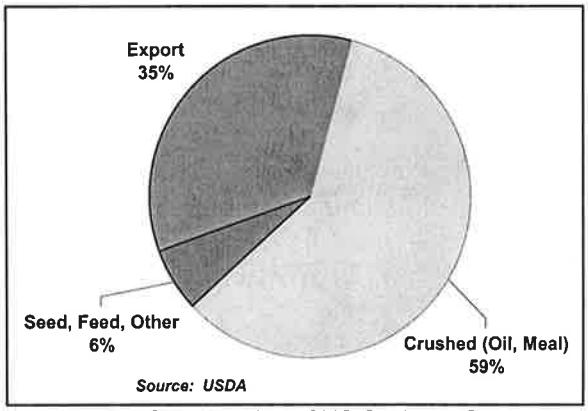

Figure 53. Consumption of US Soybean Crop (Average 1998-2001).

Most of the US soybean crop is crushed, with the oil—about 19% of the bean's weight—being separated from the meal. Soybean meal, which represents 50% to 75% of crop value (depending on current prices) provides 65% of world protein feed supplies; 98% of soybean meal production is used as livestock feed. Soybean oil—less than 20% of the soybean's weight—is also of importance domestically and globally, providing about two-thirds of US use of vegetable oils and animal fats.

Grain Exports

As noted above, export sales are a major aspect of grain production and markets, consuming about one-quarter of total production. Figures 51 – 53, above, indicated the portion of corn,

[12] Genetic improvements in corn and soybeans now offer varieties suitable to traditional wheat-growing regions.
[13] 1997 USDA Census of Agriculture

wheat, and soybean crops exported in recent years. Just as total production can vary substantially with weather and market forces, so do exports. During the period 1985-2001 the fraction of total US corn, wheat, and soybean crops that went abroad ranged from 21% to 37.3%, with the exception of 1988, when it reached 48.2%. More recently (1998-2001), the exports have averaged approximately 27%.

However, percentages can be misleading. Particularly for corn, which is predominantly a feed crop, excess production can be stored for use in the following year. Year-end stocks exceed more than 10% of production in most years, and at times have reached more than 20%. This serves as a balance wheel to compensate for market and weather related variability. This is illustrated in Figure 54, which shows corn production, total consumption (the aggregate of domestic use, exports, and seed, referred to in the grain world as "Disappearance"), and end-of-year stocks.

As a result, exports are actually fairly stable from year to year, even as total production varies. Figure 55 shows total production, domestic use, and exports for the major grain crops for 1985-2001; virtually all of the growth in grain markets has been associated with domestic use. From 1980 to 2000, the portions of grain crops used domestically rose from 67% to 80% for corn, from 34% to 54% for wheat, and from 61% to 64% for soybeans[14]. Figure 56 presents recent export trends for corn, wheat, and soybeans for that period.

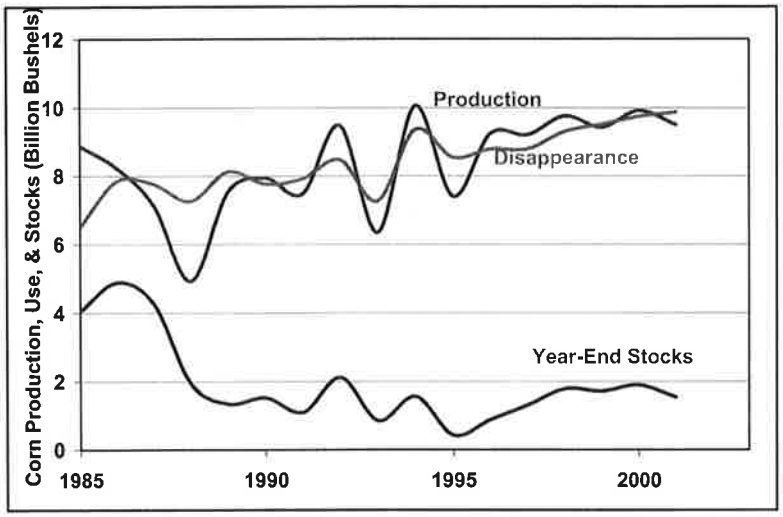

Figure 54. Production, Disappearance, and Year-End Stocks of Corn, 1985-2002.

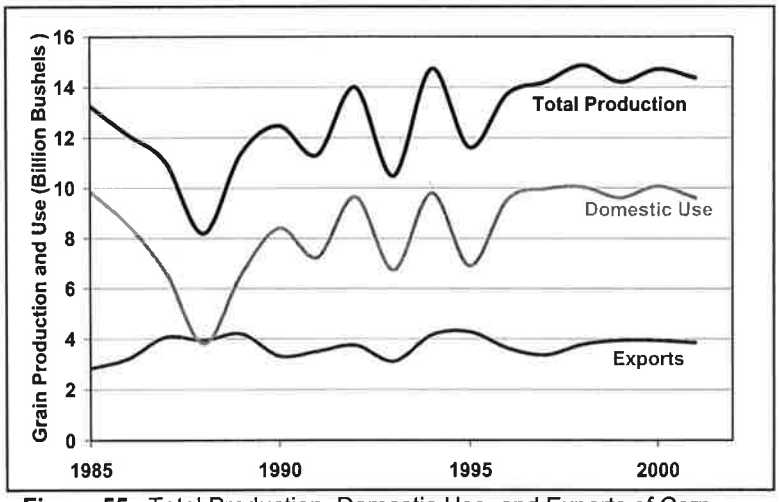

Figure 55. Total Production, Domestic Use, and Exports of Corn, Wheat and Soybeans, 1985-2001.

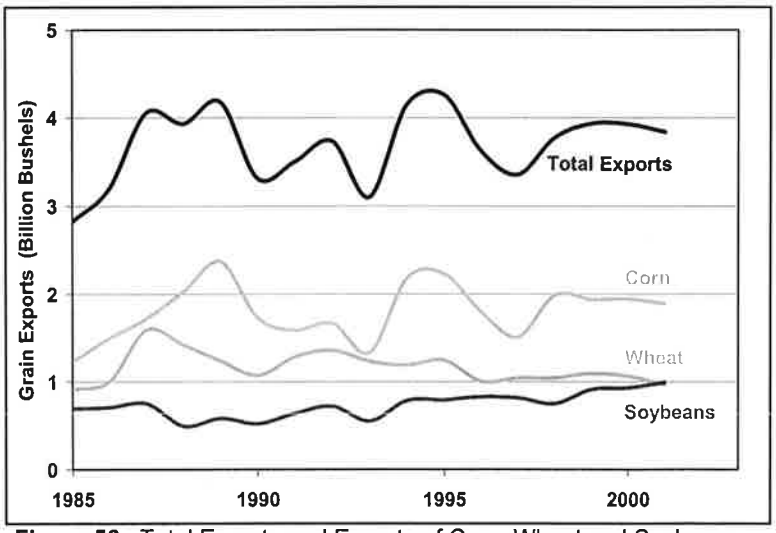

Figure 56. Total Exports and Exports of Corn, Wheat and Soybeans, 1985-2001.

[14] *Long-Term Structural Shifts in Grain, Oilseed, and Animal Industries in the United States*, Chris Hurt and Lee Schrader, USDA, Nov. 2000.

With these levels of export, the United States has long been a major player in the international grain market. As global demand surged in the 1970's, US farmers responded quickly and captured a large share of the market. For corn, in particular, the US has a highly favorable climate not found widely elsewhere. Total grain exports peaked in 1980, and exports have subsequently been constrained by increases in world production and emergence of strong international competition in grain markets. However, the data for bulk grains do not tell the whole story. Increases in export of animal products in part are enabled by domestic use of feed crops, and there has been a growing market for domestically processed soybean meal and oil.

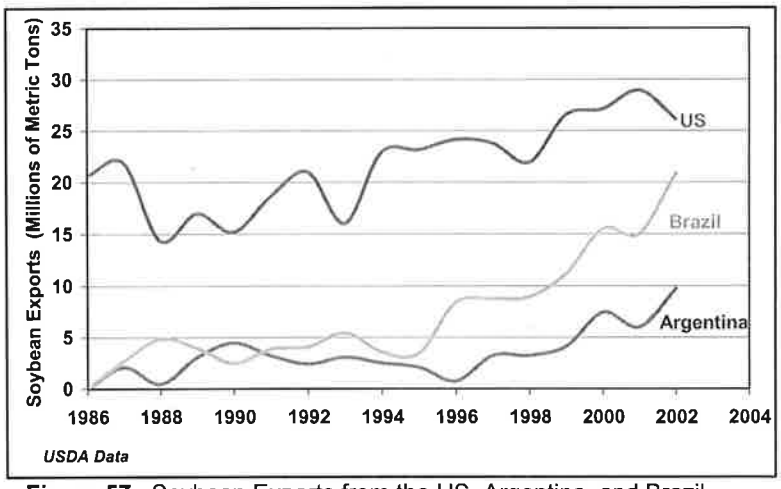

Figure 57. Soybean Exports from the US, Argentina, and Brazil, 1986-2001.

The US leads all other nations in the export of corn, wheat, and soybean, representing almost two thirds of total global exports. Table 3 shows the primary grain exporting nations. Brazil and Argentina are becoming increasingly strong competitors in the soybean market, as suggested by Figure 57. There can be significant variability from year to year; Table 3 is based on exports averaged over 1998-2001.

Table 4 lists the major customers for US grains. Japan and Mexico stand out as major buyers of all

Grain-Exporting Countries	Percentage of World Grain Exports	Cumulative Percentage of World Exports
Wheat		
United States	25.0%	25.0%
Canada	14.4%	39.4%
European Union	13.8%	53.2%
Australia	13.8%	67.0%
Argentina	9.7%	76.6%
Corn		
United States	62.7%	62.7%
China	12.9%	75.6%
Argentina	13.5%	89.2%
Soybeans		
United States	49.6%	49.6%
Brazil	27.7%	77.3%
Argentina	12.2%	89.6%

Table 3. Major World Grain Exporters. (USDA data; Averages for 1998-2001.)

Importers of US Grain	Percentage of US Exports	Cumulative Percentage of US Exports
Wheat		
Egypt	13.4%	13.4%
Japan	11.8%	25.2%
Mexico	7.6%	32.8%
Nigeria	5.7%	38.5%
Philippines	6.8%	45.2%
Korea	5.5%	50.7%
Taiwan	3.7%	54.4%
Corn		
Japan	30.4%	30.4%
Mexico	10.9%	41.2%
Taiwan	9.6%	50.9%
Canada	4.9%	55.8%
Egypt	7.6%	63.4%
Soybeans		
China	16.4%	16.4%
Mexico	13.7%	30.0%
Japan	13.7%	43.7%
Taiwan	7.4%	51.1%
Netherlands	8.1%	59.2%

Table 4. Major Importers of US Grains. (USDA Data; Average for 1998-2001)

three crops. Japan has long been a dominant importer of US grains, but the effect of the North American Free Trade Agreement (NAFTA) is clearly evident in grain exports to Mexico (see Figure 58), which have tripled in the last 10 years.

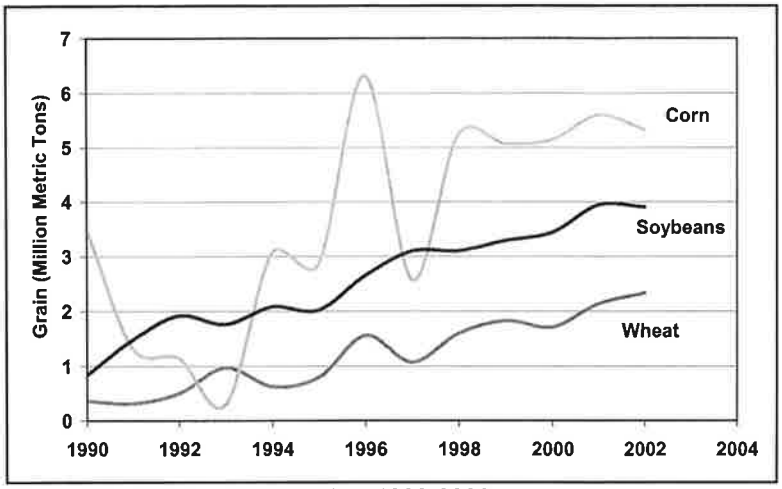

Figure 58. US Exports to Mexico, 1990-2002.

Grain Transportation

Transportation represents a large fraction of the delivered cost of grain and oilseeds, in some cases exceeding 40%. Given the predominantly bulk and low-value nature of agricultural commodities in general and grain in particular, rail is an important mode of transportation in that sector, and for some shippers the only practical choice. Figure 59 indicates the relative significance of each major grain crop for railroads.

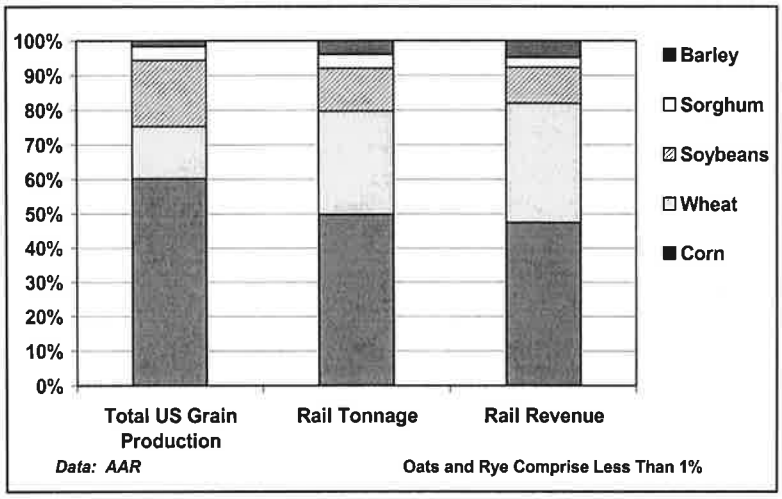

Figure 59. Contribution of Specific Grains to Total US Production, Rail Tonnage, and Real Revenue (Average for 1996-2000). *(AAR)*

The major Class I railroads participate to differing degrees in grain transportation. Tonnage carried ranges from 3.5% to 9.7% of total tons, with a similar range for revenues. BNSF and UP together receive almost 70% of all grain revenues. Grain is of particular importance to the smaller Soo, which derives 20% of its revenues from that commodity. The four major railroads account for 88% of total rail grain revenue. Data for 2000 is contained in Table 5.

Railroad	Percentage of Tons Carried	Percentage of Total Revenue	Percentage of US Total Rail Grain Revenue
BNSF	9.7%	10.6%	41.1
CSX	3.5%	3.5%	10.1
NS	4.9%	3.8%	9.3
UP	7.0%	6.4%	28.3

Table 5. Percentage of Tons of Grain Carried, Gross Revenue, and Share of Total Rail Revenue for Each of the

In recent years, railroads have carried around one-third of total grain and oilseed production, having declined gradually from nearly 50% 20-25 years ago (Figure 60). The drop in the rail share has occurred for all major grains, as indicated in Figure 61.

Shifting export destinations over recent decades—growth in Asia and sharp decline in exports to Europe—have caused a major shift in port activity. As shown in Figure 62, Gulf Coast ports—primarily on the Mississippi River—now handle almost three-quarters of US grain exports, with most of the remainder shipped via Pacific Northwest terminals. Much of this moves down the river by barge for highly efficient

transfer to ocean carriers operating from the Gulf Coast ports. Rail carries most of the remaining export traffic (33%), with only 8% moving by truck.

The most recent detailed information on market shares of rail, truck, and barge is an older USDA study based on data for 1978-1995, supplemented by a later analysis that includes some 1996-1998 statistics[15]. While age limits their current relevance, these resources provide a level of detail not otherwise available. During that period the total tonnage of corn moved doubled, so that each mode increased the amount carried. Within a fairly high level of annual variability, the data show few strong trends. The most noteworthy is a shift from rail to truck dominance in domestic corn transport[16]. Market shares typically differ substantially between domestic and export grains, and within specific market segments; data on the overall split is available only for 1984-1995. Relevant data are summarized in Table 6.

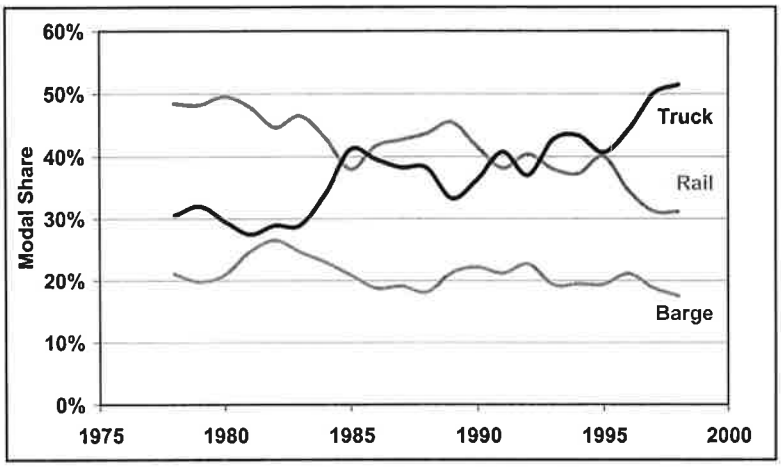

Figure 60. Rail, Truck, and Barge Shares of Total Grain and Oilseed Tonnage, 1975-1998.

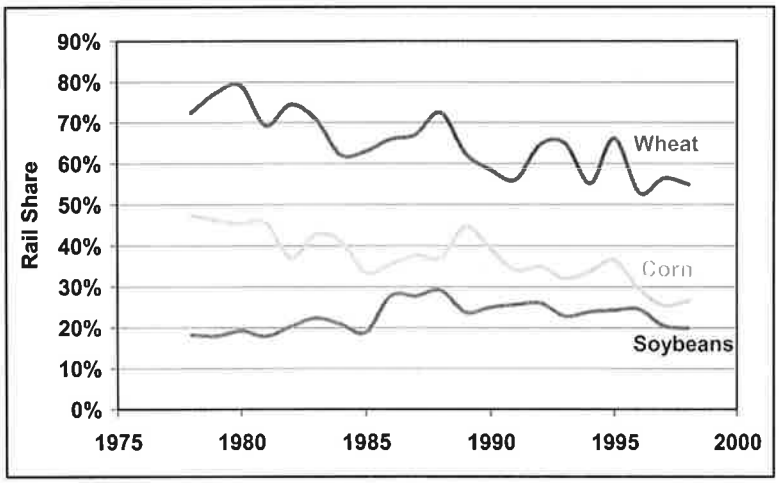

Figure 61. Rail Share of Corn, Wheat, and Soybean Tonnage, 1975-1998.

Corn Transportation

For corn, truck movements (domestic plus export) rose from a value of 27% in 1978 to 45% in 1995, thereby becoming the dominant means of transport for that product, while rail dropped from 47% to 37%. Most of that change was associated with the movement of domestic corn, as the fraction of transported corn devoted to domestic use, rather than export, rose from 38% to 62%. This primarily arose due to greatly increased commercial use of corn in processed products, as noted above. In addition, the period 1978-1995 saw a substantial decrease in on-farm use of feed corn, as fewer livestock were raised on corn-producing farms. The number of feedlots with less than 1000-head capacity dropped

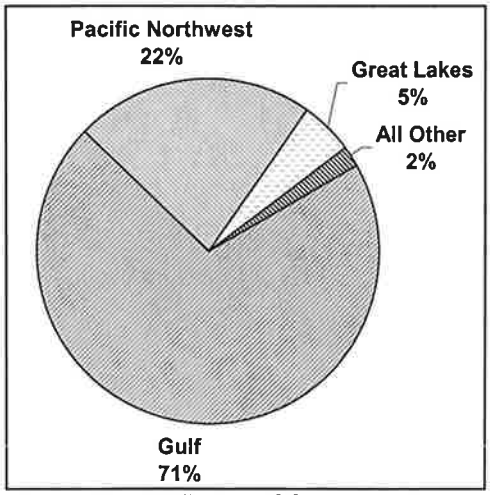

Figure 62. Distribution of Grain and Oilseed Exports by Geographic Region of Port, 2000.

[15] *Transportation of U.S. Grains: A Modal Share Analysis, 1978-1995*, USDA, March, 1998; Supplemented by 1996-1998 data from *Long-Term Trends in Railroad Service and Capacity for US Agriculture*, Marvin Prater and Keith Klindworth, USDA (2000).

[16] All data in that report are in tons transported.

precipitously during this period, leading to a large increase in the amount of grain leaving farms and entering commercial markets. All of these factors tend to be associated with relatively short-haul movements, increasing the truck fraction of transport services. However, substantial quantities of corn go to Southeastern poultry producers, who continue to depend primarily on rail.

	All Grains	Corn	Wheat	Soybeans
Total Crop Movements				
Rail	40.0%	36.5%	66.1%	24.2%
Truck	40.6%	44.8%	15.1%	49.7
Barge	19.4%	18.7%	18.8%	26.1
Domestic Market				
Rail	41.0%	37.9%	76.4%	25.1%
Truck	56.5%	60.4%	20.3%	70.3%
Barge	2.5%	1.8%	3.2%	4.6%
Export Market				
Rail	38.1%	33.2%	57.6%	22.5%
Truck	11.1%	8.3%	10.8%	11.6%
Barge	50.9%	58.4%	31.6%	65.9%

Table 6. Modal Share (tons) for Transportation of Primary Grain Crops. 1995. (Source: USDA)

As a result, the truck share of the domestic corn crop rose from 54% to 60% in 1995, while rail dropped from 41% to 38%; the barge share dropped from 4% to less than 2%. However, barges, due to the efficiency of transfer to large ships, were the dominant carrier of export corn. They accounted for 58% in 1995, having reached as high as 73% in earlier years.

Wheat

Overall, rail dominated in wheat transportation. With only modest year-to-year variation, rail averaged more than 67% over the 1978-1995 period. Barges ranked second, with 23%, while trucks carried 14%. For domestic markets only, rail had a somewhat larger share—71% between 1984 and 1995—while trucks had 26% and barges less than 3%. The truck-barge split was reversed for exported wheat, for which rail typically carried approximately 60%, barges 30%, and trucks 10%.

Soybeans

Trucks carry approximately half of soybean tonnage, with barge and rail splitting the remainder. However, as for corn and wheat, there is a marked difference in the truck and barge share between domestic and export markets, whereas rail varies relatively little between the categories. Domestically, trucks have strong dominance (70%), with barges carrying 5% and rail the remainder; for export, barges move 66% and trucks 12%.

Outlook

Overview

The USDA recently released projections for the agricultural sector though 2012[17]. This document, intended to provide a baseline against which alternative scenarios can be assessed, assumes no major impacts from weather, economic extremes, federal agricultural legislative or

[17] *USDA Agricultural Baseline Projections to 2012*, USDA, February 2003. This section also draws on an earlier report: *Long-Term Structural Shifts in Grain, Oilseed, and Animal Industries in the United States*, Chris Hurt and Lee Schrader, USDA, Nov. 2000.

policy changes, or changes affecting international supply and demand. In addition to making assumptions concerning the US economy, government policies, and the agriculture sector, USDA had to consider production and consumption trends in exporting and importing countries, as well as other factors affecting world trade. USDA assumptions for long-term domestic and global GDP and population growth are shown in Table 7. Although the forecasts reach only through 2012, the trends portrayed could easily continue well beyond that timeframe. Indeed, other less extensive and detailed USDA analyses go out to 2020, with similar findings.

Country or Region	Avg. Annual GDP Growth	Avg. Annual Population Growth
World	3.2%	1.1%
United States	3.4%	1.1%
Western Europe	3.4%	.1%
Eastern Europe	4.0%	-.1%
Russia	3.7%	.2%
Japan	1.5%	-.1%
Asia	6.0%	1.1%
China	7.4%	.6%
Latin America	4.3%	1.1%
Middle East	4.0%	1.9%
Africa	4.2%	1.5%

Table 7. Average Annual GDP and Population Growth for Selected Countries and Regions, 2002-2012. *(USDA baseline projections)*

USDA notes that economic growth in developing countries has a particularly strong impact on the quantity and type of food demanded, as larger numbers of people become able to adopt diets including more meat, dairy products, other higher valued foods. Consumption and imports of food are particularly sensitive to income change in these regions. As a result, most of the increase in world food consumption will take place in developing countries (which will account for more than 97% of the change in total world population), and the increased demand for meat products will drive greater use of grains for feed.

US Grain Forecasts	Corn	Wheat	Soybeans	Combined Total
Total Growth				
Production	19.9%	13.5%	7.8%	16.6%
Domestic Use	9.9%	6.8%	19.6%	11.2%
Exports	42.9%	9.4%	-13.0%	19.5%
Average Annual Growth Rate				
Production	1.8%	1.3%	0.8%	1.5%
Domestic Use	0.9%	0.7%	1.8%	1.1%
Exports	3.6%	0.9%	-1.4%	1.8%

Table 8. Total Growth and Average Annual Growth Rates for Selected Grain Crops, 2002-2012. *(USDA baseline projections)*

US acreage devoted to the major field crops is expected to remain nearly constant over the 2002-2012 period, with slowly increasing crop yields. The forecast assumes strengthened domestic and global economic growth beginning in 2003, leading to increased world consumption, trade, and prices. However, a strong US dollar and rising competition from Brazil, Argentina, and other countries are expected to limit the total market for US exports. Forecast trends for corn, wheat, and soybeans are summarized in Table 8 and are discussed below. The forecasts are also presented graphically in Figure 63 (forecast production levels), Figure 64 (forecast exports), and Figure 65 (average annual percentage increase in production, domestic use, and exports).

Corn Outlook

Reasonably strong growth in domestic corn use is anticipated. Production will increase by about 20%, based almost entirely on greater yield from slightly more planted acreage. Initially, feed consumption will be stable as rising demand associated with increased poultry output is offset by fewer cattle on feed and lower pork production; feed use is then expected to rise slowly as meat

production rises. Corn use for fuel alcohol (ethanol) is expected to increase at approximately 3% for several years, later slowing to 2%. (Federal policy and legislative actions, such as tax credits, have a strong impact in this area.) Recent rapid increases in markets for food and industrial corn products, such as corn syrup and alcoholic beverages, are expected to slow to a rate matching population growth.

Corn exports—more than 60% of the world total—are seen as increasing at a greater rate than global trade as a whole, with the US increasing its market share to more than two-thirds. However, competitors, including Argentina and Eastern European nations, will also be raising their share of that trade.

Wheat Outlook

A slow increase in demand for wheat is forecast. Domestic food use of wheat is seen as growing more slowly than population, due to a consumer trend toward reduced carbohydrate consumption. Feed use is expected to increase from currently low levels, based on a price level that is attractive relative to corn.

Exports are forecast to shrink in the near term, due to recovery from drought conditions in major competitors Canada and Australia, as well as the European Union and new exporters in the Black Sea region. Over the long term, US share of the total wheat export market, currently just under a quarter, is expected to decline with a few years to about 21% and remain at that level.

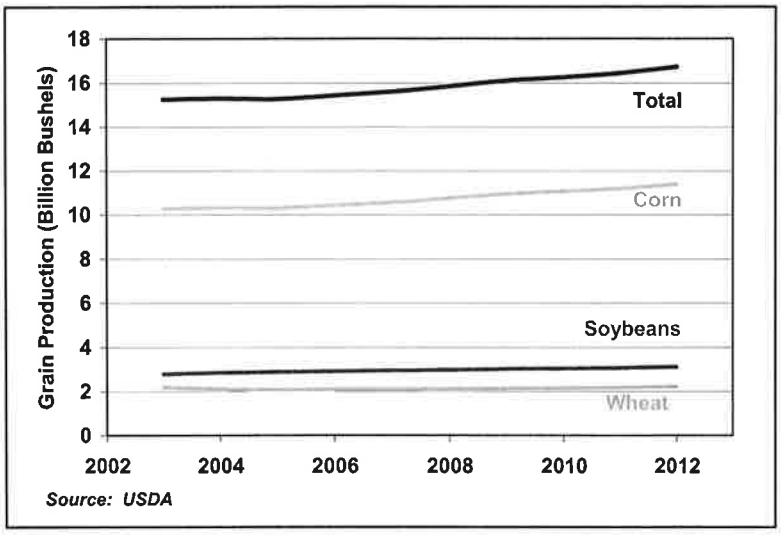

Figure 63. Forecast Production of Selected Grains, 2000-2012.

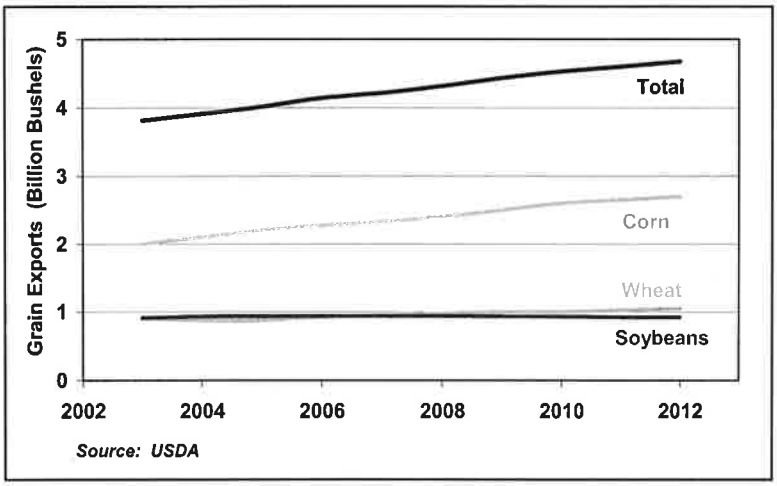

Figure 64. Forecast Exports: Corn, Wheat, Soybeans, and Total, 2003-2012.

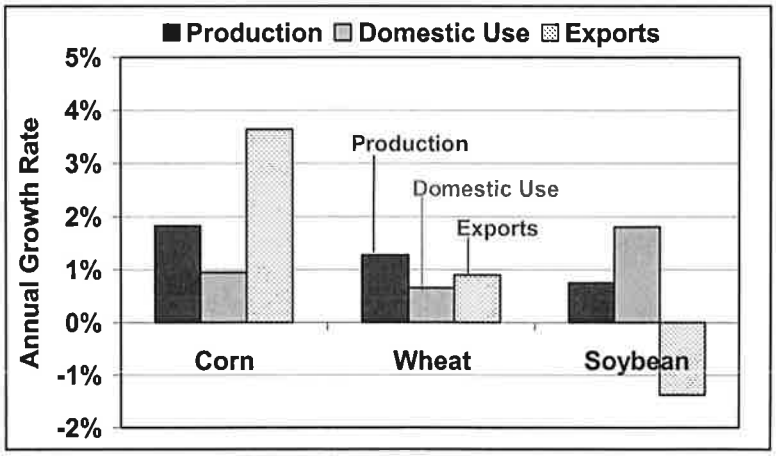

Figure 65. Forecast Average Annual Rates of Increase of Production, Domestic Use, and Exports of Selected Grains, 2000-2012.

Soybean Outlook

An increasing level of demand for feed to support pork and poultry production is expected to drive as steady growth in domestic soybean meal. Income and population is seen as increasing soybean oil demand in North Africa, the Middle East, and the Caribbean, but market growth will slow Europe, Japan, and the US.

Together, the United States, Brazil, and Argentina virtually own the global soybean market, providing almost 90% of all exports; the US alone provides half at present, but is expected to drop to approximately one-third as its exports decline slightly and Brazil's share increases to almost 50%. Demand for soybean meal exports will expand this market, but Brazil and Argentina will absorb most of the increase. US share is forecast to drop from 15% to 12.4%.

Rail Transportation Outlook

As indicated previously in Table 8, total grain production will increase at an estimated 1.8% annually. However, the trend during the 1990's suggests that railroads are likely to capture a declining share of the grain transportation market in coming years, which itself is growing slowly. Although the actual trend may appear somewhat ambiguous, USDA analysis supports that conclusion. An agency paper[18] presented in late 2000 concluded that agricultural traffic is of shrinking interest to the railroads, due to its seasonal nature, cyclical volatility, variability in regional production levels, and its sensitivity to cost. At the same time, in their quest for operating efficiency, the railroads are less and less able to provide the service characteristics sought by shippers.

One of the major factors cited in the USDA paper as contributing to this trend is the steadily rising degree of domestic processing of crops and off-farm feeding. Industrial use of corn, rising commercial sales of high-fructose corn syrup, and a growing market for ethanol as a fuel. Corn previously consumed by livestock on the farm is now transported to commercial feedlots, which often are relatively close to the point of production. Grains that might previously been exported now go to those nearby feedlots and are consumed by livestock to yield exportable meat products. Soybeans are typically processed near the source. Thus, there has been a general trend toward domestic use, often close to the farm, rather than export sales. The net result is transportation requirements that are often better suited to trucks than rail.

Other factors are also at work. Driven by a heightened need for operational efficiency, and diminished regulatory constraints, railroads have abandoned substantial amounts of track, particularly in rural grain-growing regions. They have simultaneously moved toward 100- to 110-car trainload operations, using 286,000-pound railcars and serving only large grain elevators that must draw from wide areas to achieve an efficient volume of business. One consequence of these trends is a steady degradation of the access to rail transportation for many shippers, particularly the smaller operations, and increased cost of access where service is available. While short line and regional railroads have somewhat mitigated these consequences in some cases, and may well increase their role in the future, the net effect is to decrease rail carriage of

[18] *Long-Term Trends in Railroad Service and Capacity for US Agriculture*, M. Prater and K. Klindworth, Conference on Agricultural Challenges of the 21st Century, St. Louis, MO, November 28-29, 2000.

grains. Indeed, there remains an open question as to the ability of small railroads to make the infrastructure investments necessary to handle the larger railcars. In some cases there are also issues relating to their relationship with Class I carriers.

The agricultural community is outspoken in expressing it's feeling that these changes are being accompanied by excessive railroad rates, which further reduce the viability of rail transportation. The charge is vigorously argued by the rail industry, which emphasizes that rates have fallen steadily since deregulation—a point that has been confirmed by GAO. However, deregulation has permitted railroads rate-setting flexibility that enables them to price services based on market forces and the competitive environment ("differential pricing"), rather than meeting the pre-Staggers Act regulatory requirement to charge according to the cost of providing services. The result has been to exacerbate the degree of conflict between the revenue- and efficiency-seeking behavior of railroads and what shippers sometimes see as an unfair and painful degradation of services.

As summarized in the above-referenced USDA paper, "The net results for many agricultural shippers have been fewer shipping options, fewer marketing choices, and increased transportation costs." When this situation is combined with trend toward shorter-haul transportation services, it strongly suggests that the role of railroads in grain transportation could continue to decline for the foreseeable future, particularly if a shrinking market generates further reductions in rail access and encourages trends toward location of grain processing and livestock production closer to the source of the various crops. Only if it proves possible for railroads to increase service quality and access while maintaining or lower rates are they likely to be able to achieve the volume necessary to expand their role in grain transportation, as desired by the growers and by rural communities.

Uncertainties and Issues

The USDA 2012 forecasts are presented merely as a baseline projection of current data and trends. Many unpredictable events and developments could produce significant changes in actual outcomes. Some factors that could produce a somewhat different future than that set forth in the baseline forecast are identified below[19].

Food Production Technology/Biotechnology: Scientific and technological advances are no less present in agriculture than in any other sector. Public attention has particularly been on consumer acceptability of some genetically modified foods and food products, especially in Europe. However, technology innovations are actually affecting all phases of agriculture in a range of ways that, cumulatively, will play an important role in affecting grain production, processing, markets, and transportation in the future.

---

[19] This discussion draws on the previous reference and two other analyses: (1) *Long-Term Structural Shifts in Grain, Oilseed, and Animal Industries in the United States*, Chris Hurt and Lee Schrader, USDA, Nov. 2000; and (2) *U.S. Agriculture & Transportation: Challenges & Opportunities for the 21st Century*, prepared by USDA for the National Summit on Agricultural Transportation Challenges of the 21st Century, St. Louis, MO, Nov. 28-29, 2000.

Farmers now benefit increasingly from many of the technologies, including computers, sophisticated market and yield analysis, telecommunications, and GPS positioning common to throughout the economy. In addition, a particularly visible and sometimes contentious innovation involves advances in biotechnology. Techniques such as selective breeding have long been used to introduce or emphasize traits in plants and animals that improve their suitability to human purposes. In recent years, that type of activity has been broadened to include genetic engineering—the alternation or movement of genes of living cells in order to create, modify, or improve specific traits in animals, plants, and microorganisms. Cumulatively, the array of tools and processes now available for such efforts is generally referred to as agricultural biotechnology. Quite naturally, the initial applications relative to grain production have focused on development of herbicide tolerant and insect resistant strains, particularly for major crops such as corn, cotton, and soybeans. Other traits are also actively being sought.

Resistance to insects, herbicides, and diseases is obviously of great importance to the productivity and economic success of farming. Improvements in other traits, such as frost or drought tolerance, not only support efficient farming, but, if sufficiently marked, can substantially increase the geographic area in which a particular grain can be grown, possibly displacing another less profitable crop. This process is already occurring; soybean production is replacing wheat in some areas. Thus, yields could increase more rapidly than the historical rates assumed in the USDA 2012 projections. More generally, over time there is a significant potential for significant changes in basic characteristics of these field crops: cost, suitable farming regions, food and commercial uses, and global markets. For example, Brazil and Argentina are energetically pursuing the application of yield-raising biotechnology to enlarge growing regions and increase yields. Changes of these types will undoubtedly be reflected in many ways, not least of which will be transportation needs and the preferred modes of transport.

Specific traits can also be engineered to improve the harvested product. Enhanced nutritional content, tailored to particular markets, can be of substantial value for both livestock feed and food products. Characteristics that increase the efficiency of processing are also being developed, such as altered gluten levels in wheat to alter baking quality, or colored cotton.

There are many uncertainties and ramifications associated with the increasing role of these genetically modified crop varieties in an already complex global marketplace. In general these issues go beyond the scope of this paper, and are likely to have only a slowly emerging impact, at most, on rail transportation. However, one consideration is of direct relevance. The essence of agricultural biotechnology is the creation of plants with specific traits or characteristics. From the perspective of consumers desiring that trait, and everyone involved in moving it from farm to final market, there will be a requirement for some form of labeling the product, and for segregating it from similar products not sharing the desired trait. Crop identity will have to be maintained. Similar requirements will arise in cases for which some consumers insist on being able to avoid genetically modified foods in general, as is currently the case in the European Union. Concerns of this nature could be increasingly associated with a generally rising sensitivity to the traceability of food products for safety, security, and personal preference reasons.

A relatively rapid shift in this direction could reduce the degree to which grain represents a true bulk commodity and have significant impacts on the entire grain transportation chain. Several factors, such as smaller total shipment size and higher-value commodities, could enlarge the share of the market captured by trucks. However, the suitability of these products to containerized transport could sustain an important role for rail.

Food Processing: Numerous considerations determine the location of food processing facilities. As economic and other circumstances change, often associated with the forces discussed above, significant—but largely unpredictable—changes are likely to occur in the nature of transportation requirements. For example, the heavy concentration of poultry raising and processing in the Southeast, which is thus a major destination for feedcorn, has been shaped in large part by low labor costs. USDA suggests that the steady reduction that has been achieved in the labor required for this process reduce that consideration. Similarly, freezing, packaging and other technical advances are extending shelf life. Together, the result could be a trend to relocate closer to the source of the feed. For other grain uses, trends toward more ready-to-eat products may tip the balance toward locating processing facilities closer to major population centers. Similar considerations apply to each of the many products for which corn and soybeans are used.

Industry Consolidation and Integration: Starting with poultry in the 1950's and 1960's, agriculture has been moving steadily toward large-scale standardized production. As the ability to control disease has improved, it has become feasible for a relatively small number of producers to maintain large concentrations of food animals. This has tended to produce a parallel concentration among input (feed) suppliers and processors, and to foster integration of production and processing. Feed raised for consumption of livestock on a farm now is often transported to sometimes-distant processing locations. In addition, information technology is now creating the ability to coordinate more closely decisions that link primary grain production, transport, processing, and markets. Concentration and integration of production and processing locations are likely to have continuing significant impacts on transportation requirements, as is particularly visible already in the development of very large grain elevators to support unit train grain shipments. The impacts are difficult to assess in advance. They seem in many cases likely to favor short-distance trucking, but rail opportunities may well emerge if sufficiently high levels of service quality can be achieved.

Global Trade/NAFTA: A large portion of the growth anticipated in grain production is associated with the expectation of a rising export market. For corn, in particular, exports are projected to increase by 43%, representing one-third of the total increase in US grain production. Yet, the volatility and uncertainty of the global grain marketplace is clearly suggested in previous figures and needs little emphasis. The final result each year will be the aggregate product of global economic forces and agricultural policies, as well as specific situations in the major importing and exporting countries.

Mexican grain trade is of special importance, both for overall volumes and in the potential it holds for railroads. Mexico is currently the second largest importer of US grain (see the earlier Table 4), with corn and soybean imports forecast to approximately double by 2012. Most importantly for the topic of this paper, Mexico is readily accessible to US growers by rail. The North American Free Trade Agreement, along with global market forces, has been a significant

factor in creating a large increase in US exports to Mexico in recent years. (Recall Figure 56.) However, beyond uncertainties concerning the future growth of the Mexican economy and level of imports, there remain questions over the degree to which railroads will carry this increasing volume.

Currently, most grains and oilseeds exported to Mexico travel down the Mississippi River to Gulf Coast ports by barge, where they are transferred to ships that deliver them to Veracruz and other Mexican ports. They then move to their final destination by rail. The low cost of barge and ship transport, supported by efficient terminal processes, yield rates estimated to be as much as 10% lower than for rail from origin to destination. However, the privatization of Mexican rail carriers and resulting steady improvements in their efficiency are now making all-rail transport significantly more competitive, particularly for unit trains of 50 cars and up. Trans-border rail traffic is said to have doubled between the early and late 1990's. Potentially, to the degree that Mexican rail carriers can establish operational performance and intermodal terminals and linked trucking services, a significant market could develop for rail transport of containers for trait-specific ("identity-preserved") grains, which are generally not highly time-sensitive.

Environmental Issues/Ethanol: Agriculture is involved in many environmental issues, but perhaps the most relevant to this paper relates to use of ethanol, produced from corn, as a component of motor vehicle fuel. During the 1970's, oil supply disruptions and a desire to remove lead (used to boost octane) from gasoline stimulated oil companies to market "gasohol"—a 10%-90% mix of ethanol and gasoline. Federal and state tax exemptions made ethanol price competitive in this application in the Midwest, where ethanol transportation costs were low. Subsequently, the Clean Air Act Amendments of 1990 required use of oxygenated fuels during winter months in some parts of the country to reduce carbon monoxide emissions; ethanol achieves this, and led to some use outside the Midwest. By 2001 total production was 1.7 billion gallons. However, demand is still sensitive to corn prices.

Ethanol bears a substantial cost burden for transport from the processor to the user. At present, the commercial viability of ethanol is largely dependent on state and Federal tax exemptions, scheduled to expire in 2008. The DOE long-term forecast, which assumes extension of the favorable tax treatment, is for ethanol production to increase to 4 billion gallons by 2025. The outlook for corn could be substantially altered by technology advances being sought (particularly by the Department of Energy) that would enable use of feedstock materials other than corn. For example, corn stover (the cobs, stalks, and leaves remaining after harvest) could become an important source of ethanol. More generally, other research is addressing the use of a wide range of low-cost cellulose-containing biomass, such as other crop residues, forestry waste, grasses, and even municipal wastes.

Depending on the outcome of such research, railroads could be affected in a variety of ways, involving both the movement of feedstocks to processors and the transport of the resulting fuel to other parts of the country. The DOE baseline projection sees the ethanol as shifting from the current 95% corn-based to 85%. However, their analysis for the "high renewables case" sees all of the post-2002 growth as coming from cellulose (non-corn) sources. At present, ethanol consumes more than 6% of corn production, so this topic, while not likely to have a major impact, could be of significance to rail transportation.

Legislation and Treaties: In the US as well as most other countries, there is a long history of government intervention in agricultural markets, often motivated by a variety of national objective and political factors. Examples can include efforts to protect growers from the vicissitudes of weather and global economic forces, as well as actions intended to create a more orderly and effective market environment. In the emerging global economy, issues of trade in agricultural products have proven particularly contentious, due in part to the broad mix of costs and benefits born by various elements of society and the differential impacts among nations.

6. Conclusions

Railroad Investment Trends

A brief paper such as this, limited to two commodity groups, cannot provide a definitive picture of the future capital investment capability of the US railroad industry. However, the long-term trend, even since deregulation, suggests the magnitude of the challenge facing the rail sector. Subsequent to the deregulation legislation of the early late 1970's and early 1980's, railroads have consolidated the industry, introduced improved and innovative technologies, and adopted more-efficient operations that have resulted in quite dramatic improvements in productivity. Revenue ton miles for Class I companies increased by 87% even while the system shrink in terms of track (by 39%) and labor (by 57%) in the twenty years from 1982 to 2001. Constant-dollar revenue per ton-mile dropped from $74.81 in 1960 to $49.86 in 1982 and $21.10 in 2001, while the comparable measure for other modes stayed relatively constant.

However, the primary beneficiaries so far have been shippers. While the total constant-dollar operating expenses dropped by 33%, and ton-miles nearly doubled, real total revenues dropped by 24%. The result was to raise industry return on net investment from the devastating 2% to 4% range of the 1960's and 1970's to around 8% by the late 1990's. While welcome, this remains well below their roughly 12% cost of capital as calculated. Railroading is an extremely infrastructure-intensive industry in which capital expenditures have long exceeded 10% of operating revenue, and have been in the range of 15% to 20% ($5 billion to $6 billion) during the late 1990's.

There are presumably further gains to be made in efficiency, particularly in the integration of information and other technologies into all aspects of railroad operations, and in further adjustments to the industry structural changes of the last two decades. While track mileage and the labor force are unlikely to continue their relatively rapid rate of shrinkage, those basic resources can surely continue to suffice for steadily increasing ton mileage. Nonetheless, the gap between the STB-defined level of "revenue adequacy" and real revenues remains large, and the railroads remain under the threat of some degree of re-regulation, stimulated by concerns—and political efforts—of shippers.

This paper specifically considers the outlook for coal and grain transportation, two important bulk commodity groups in which revenue per ton is inherently low. As discussed below, coal and grain are not seen as likely to eliminate the rail investment shortfall, and may have a limited impact at best. Thus, the outlook for the financial health of the rail industry is likely to depend more on its ability to achieve still higher levels of service quality and responsiveness to customers that increase its attractiveness to transportation markets that involve the higher value and more time sensitive commodities. Steadily rising highway congestion should provide a strong stimulus for shippers to seek alternatives, and trucking companies to enter into collaborations. The traditional markets, such as coal and grain, will be important in maintaining the railroad's financial base, but will not lead the way to adequate revenues.

Coal Transportation Trends and Outlook

Transportation of coal is a notably stable market railroads. The nation's demand for coal, now almost entirely for power generation, has long been highly correlated with GDP, and for the last two decades GDP and electricity generation rates have matched very closely. At the same time, coal has fueled approximately half of US power generation since 1950. As a low-value and time-insensitive bulk commodity, rail has always played a major role in its transportation. Indeed, movement of coal currently represents about 44% of all Class I rail tonnage, and 22% of their revenue, fairly equally divided among the four major railroads.

The major change occurring in coal production and transportation is the shift from mines in the eastern and central portions of the company to the rich resources in the west. This trend is due to environmental concerns and the characteristic of western coal that it is generally much lower in sulfur than other sources. Rail carries more than 60% of coal tonnage, and more than 90% on a ton-mile basis.

The US Department of Energy's 25-year energy outlook forecasts a continuing steady trend toward dependence on western coal throughout the period as total production increases by approximately one-third—a rate of about 2% annually. Use of coal for power generation is seen as dropping only slightly, from 54% in 2001 down to 48% in 2025.

Virtually all of the increased production will come from western coalfields, with eastern and central mines maintaining constant output. Since there is no real competitor for rail transport of western coal, tonnage more rapid increase in step with coal production; the longer length of haul will generate a substantially greater increase in ton-miles and revenues. However, the potential impact on railroad financial health is likely to be modest, since transportation represents a large fraction of the delivered price of coal. Railroads compete with one another for this business, and the utilities are already concerned about the fairness of rail rates. This constraint is already apparent. As the share of coal produced by western mines grew during the 1990's, tonnage increased by approximately 50%, but revenue declined by 10%.

Grain Transportation Trends and Outlook

Grain transportation (primarily corn, wheat, and soybeans) accounts for approximately 8% of rail tonnage and revenues. Demand is volatile on both short and long time scales. Domestic use of grain is rising relatively slowly. Global markets are expanding, but so is competition from other countries, particularly Brazil and Argentina. Production is geographically dispersed to a degree that impedes collection into the large quantities needed for efficient rail transportation, particularly after two decades of track abandonment and sale to local railroads. In addition, trends in grain markets, including a shift to off-farm feedlots and location of processing facilities, have increased the demand for shorter-distance and smaller-quantity transport, more suited to trucks.

The cumulative effect of these trends has been a substantial shift from rail to truck transport for grain traffic, with rail now down to about 30%. Department of Agriculture forecasts suggest only a slow growth in the overall market, with few changes likely to affect the trend away from rail. The market segment mostly likely to favor rail is exports to Mexico. These have been

growing rapidly, primarily transported by barge to Gulf Coast ports for trans-shipment. However, as the Mexican rail system becomes increasingly able to provide acceptable service, rail transportation could become attractive. This is a significant market: Mexico already receives more than 10% of US grain exports, and the trend is strongly upward. However, the overall outlook for rail transport of grain does not suggest growth in either tonnage or revenue. Even with growth, revenue is under strong pressure from shippers who feel that rates are too high, and who are actively seeking regulatory relief.