VOLUME 1

DESCRIPTION OF THE U.S. FREIGHT RAILROAD INDUSTRY

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ABBREVIATIONS

3-R Act	Regional Rail Reorganization Act of 1973
4-R Act	Railroad Revitalization and Regulatory Reform Act of 1976
AAR	Association of American Railroads
AFC	Average Fixed Cost
ATC	Average Total Cost
AVC	Average Variable Cost
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
the Board	Surface Transportation Board
BNSF	Burlington Northern Santa Fe
CAPM	Capital Asset Pricing Model
CBO	Congressional Budget Office
CCO	Common Carrier Obligation
CFR or C.F.R.	Code of Federal Regulations
CMP	Constrained Market Pricing
CN	Canadian National
the Commission	Interstate Commerce Commission
CP	Canadian Pacific
CSX	CSX Corporation
CWS	Carload Waybill Sample
DCF	Discounted Cash Flow
DOJ	Department of Justice
DOT	Department of Transportation
FCC	Federal Communications Commission
FDC	Fully Distributed Costing (methodology)
FTC	Federal Trade Commission
GAO	Government Accountability Office
GDP	Gross Domestic Product
ICC	Interstate Commerce Commission (also referred to as “the Commission”)
ICCTA	ICC Termination Act of 1995
KCS	Kansas City Southern
MC	Marginal Cost

MFP	Multi-Factor Productivity
NS	Norfolk Southern
PAF	Productivity Adjustment Factor
PPI	Producer Price Index
R/VC	Revenue to Variable Cost ratio
R-1	Form R-1 data from Class I railroads' Annual Reports filed with the STB
RCAF	Rail Cost Adjustment Factor
RCAF-A	Adjusted RCAF
RCAF-U	Unadjusted RCAF
RPM	Railroad Performance Measures
RPTM	Revenue per Ton-Mile
SAC	Stand-Alone Cost (methodology)
SARR	Stand-Alone Railroad (analysis)
SPLC	Standard Point Location Code
STB	Surface Transportation Board
STCC	Standard Transportation Commodity Code
TFP	Total Factor Productivity
TTX	TTX Company
UP	Union Pacific
URCS	Uniform Rail Costing System
USC or U.S.C.	United States Code
USO	Universal Service Obligation
USDA	U.S. Department of Agriculture

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Chapter 1 Contents

CHAPTER 1
INTRODUCTION AND OVERVIEW OF VOLUME 1

Volume 1 of this report presents general background information about the U.S. freight railroad industry and perspective for the other volumes of our study. In Volume 1, we provide a brief historical overview of the U.S. freight railroad industry, review important economic issues that are common to a number of network industries (including the railroad industry), review the economic literature on the railroad industry, and report on the extensive and diverse input we received from industry stakeholders in the qualitative research phase of our study regarding important issues facing the railroad industry. Chapter 2 presents a brief case study of the U.S. freight railroad industry. Chapter 3 discusses the economics of select network industries, with comparisons to the railroad industry. Chapter 4 presents a review of empirical economic studies of the U.S. railroad industry, with a concentration on pricing, costs, productivity and industry structure in the post-Staggers Act period. Finally, Chapter 5 contains a discussion about current concerns over the performance of the U.S. freight railroad industry, including a report of the input we obtained from industry stakeholders.

1A. OVERVIEW OF THE U.S. FREIGHT RAILROAD INDUSTRY

Setting the stage for our study and providing some perspective, Chapter 2 presents an overview of the U.S. freight railroad industry. In this chapter, we discuss the role and importance of the railroad industry for the U.S. economy, provide a brief regulatory history of the industry, and describe the industry's evolution since the passage of the Staggers Rail Act of 1980.

Since 1980, railroads have captured an increasing share of U.S. freight shipments. Railroad accounted for about 27 percent of the ton-miles of U.S. freight movements in 1980, and the ton-miles share of U.S. freight attributed to railroads increased to about 38 percent by 2005. While railroads play a key role in overall U.S. freight shipments, some commodities are particularly dependent on rail transportation. For example, 70 percent of domestically produced automobiles, 70 percent of coal delivered to power plants, and about 35 percent of the U.S. grain harvest move by rail.

The railroad industry's financial viability has improved since the 1970s. Consolidations in the industry have reduced the number of Class I railroads from the forty that existed around the time of the passage of the

Staggers Act to the current seven, and the number of Class I railroad employees declined from over 450,000 in 1980 to 167,000 in 2007. However, the total number of U.S. railroads has increased from about 490 in the mid-1980s to the current 559. Non-Class I employment has declined in proportion to Class I employment declines. Between 1980 and 2006, tons originated by Class I railroads increased 31 percent, ton-miles increased 93 percent (reflecting increasing average length-of-haul) and freight revenues increased 91 percent. Since the 1980s, the Class I proportion of total industry freight revenue has remained relatively constant in the mid-90 percent range.

While the industry has made great strides over the last thirty years, a number of economic issues currently confront the railroad industry, highlighted by rate increases in recent years after long-term declines following the passage of the Staggers Act. These issues include: whether a sufficient degree of competition exists to ensure that customers receive economically efficient prices and levels of service; whether the industry has sufficient capacity to serve current and anticipated demand; and whether railroads' profits are adequate, insufficient, or excessive. Alternatively, these issues can be framed to ask if the current legislative and regulatory framework under which the industry operates adequately fosters competitive market outcomes, or if changes in laws or regulations are needed to allow improvements in the industry's economic performance.

1B. ECONOMIC CHARACTERISTICS OF NETWORK INDUSTRIES WITH COMPARISONS TO THE RAILROAD INDUSTRY

Many of the economic and policy issues that arise in the railroad industry also arise in other industries with network structures. These issues include the cost structures of firms and pricing approaches to recover the firms' costs, obligations to serve customers, open access of the network to competitive firms, and investment in infrastructure. In Chapter 3, we provide a general description of these key economic features shared by many network industries, and review how the issues related to these economic features have been addressed in three industries with network characteristics that are in one way or another similar to the network characteristics of the railroad industry. The three comparison industries are the trucking industry, the telecommunications industry, and the postal service industry.

The trucking industry is similar to the railroad industry in that it provides freight transportation services between different locations and it uses an infrastructure (i.e., highway) network to provide those services. The telecommunications industry relies on a privately financed communications network to provide the transmission of messages between different locations. The postal service industry relies to some extent on the

highway network to provide services, but its network structure also includes the organizational structure of the United States Postal Service. Under this organizational structure, mail is collected from various origination points, combined with other mail, sorted and transported (sometimes between intermediate points), and ultimately delivered to various destination points.

As is the case with the other network industries we studied, the railroad industry engages in differential pricing, where different customer groups face different levels of price markups over marginal costs. With respect to universal service or common carrier obligations, the railroad industry does not have a universal service obligation like the telecommunications or postal service industries, but it does have a common carrier obligation. However, the railroads' responsibilities under the industry's common carrier obligation are currently being debated in an STB proceeding. Regarding open access, since the railroad industry is not reliant on a publicly funded infrastructure as is the trucking industry there is a lesser degree of open access in the railroad industry. While open access is required to some degree by the STB, it is not as prevalent as open access in the telecommunications industry. On the other hand, access is not restricted by law in the railroad industry, as is the case in the postal service industry. Finally, the railroad industry is also similar to the telecommunications industry in the way that infrastructure improvements are privately financed. Except for the subsidization of service to high cost areas, the telecommunications industry does not rely on public funding or investment incentives for its infrastructure investments.

1C. REVIEW OF ECONOMIC STUDIES OF RAILROAD PRICING, COSTS, PRODUCTIVITY, AND INDUSTRY STRUCTURE

Chapter 4 provides a synopsis of the empirical literature related to railroad pricing, costs, productivity, and industry structure, and emphasizes the literature that has erupted in the last 30 years since partial deregulation. Much of this literature examines the effects of regulation and deregulation on prices, costs, and productivity, and more recently, the effects of mergers in the railroad industry.

Most contributions to the literature appearing over the last two decades find that the effects of railroad deregulation were initially mixed, but subsequently reduced rates. Further, the evidence suggests a phasing in of the effects from deregulation. Many empirical studies during this period find that productivity advances allowed by partial deregulation drive the observed reductions in railroad rates.

Current railroad pricing literature also points strongly to the effects of competition, particularly the effects of waterway transportation, other railroads, and motor carriage, on constraining railroad rates. However, the rate-limiting effects of competition in some markets do not mitigate the

issues of captive shippers in other markets. Indeed, in some markets where railroads are dominant, the issues of monopolistic pricing remain.

This chapter also presents an overview of the econometric analyses of costs and productivity for railroads. These econometric studies consistently provide strong evidence of economies of density, and significant effects from deregulation in terms of increasing productivity.

Over the last 25 years, there has been a major consolidation of Class I railroads. While substantial cost savings may have occurred with some mergers, the bulk of the literature prior to the 1990s indicates very small cost savings resulted from consolidation. Although some railroad mergers during the 1990s gave rise to larger cost savings, the results vary across mergers.

1D. CONCERNS ABOUT THE PERFORMANCE OF THE U.S. FREIGHT RAILROAD INDUSTRY

Among other findings, the 2006 GAO report on the U.S. freight railroad industry noted a reversal of the long-term decline in freight railroad rates. This led to questions regarding the competitiveness of the industry, prompting the GAO to recommend that the STB conduct a study to investigate industry performance. Consequently, the STB commissioned the current study.

Chapter 5 reports on the first phase of our study, a qualitative research phase in which we solicited the views of railroad industry stakeholders on the important economic issues currently facing the U.S. freight railroad industry. In our qualitative research, we found that many respondents were of the opinion that there have been significant changes in the railroad industry during the last three to five years. These changes include:

- Increases in rates
- Changes in contract terms
- Deterioration of service quality
- Increased cost shifting
- Changes in railroads' attitudes toward shippers

Many respondents attributed these changes to the railroads' exercise of market power. However, as noted by other respondents, it is also possible that capacity constraints in the freight railroad industry permeate these changes, and that what is being observed is a "normal" market adjustment process and not the exercise of market power.

Many of the opinions expressed to us represent an inherent tension between the view that railroads are private, profit-maximizing firms operating under competitive conditions versus the view that railroads are

"public utility" firms with market power that need to be regulated. The public utility view also implies an expansive view of the railroads' common carrier obligation, similar to universal service obligations of regulated network industries such as electricity, telecommunications, and the U.S. Postal Service. Furthermore, the public utility view reflects the opinion that railroad investment needs to first consider the best interests of the public, not profit maximization of railroads. Thus, a fundamental unresolved question appears to be: what are the railroad industry's obligations to its various stakeholders?

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CHAPTER 2
OVERVIEW OF THE U.S. RAILROAD INDUSTRY

INTRODUCTION

Setting the stage for our study and providing some perspective, this chapter provides an overview of the U.S. railroad industry. While the industry has made great strides over the last thirty years, a number of issues currently confront the railroad industry. These issues include: whether a sufficient degree of competition exists to ensure that customers receive economically efficient prices and levels of service; whether the industry has sufficient capacity to serve current and anticipated demand; and whether railroads' profits are adequate, insufficient, or excessive. Alternatively, these issues can be framed to ask if the current legislative and regulatory framework under which the industry operates adequately fosters competitive market outcomes, or if changes in laws or regulations are needed to allow improvements in the industry's economic performance. Many of these issues are addressed throughout our report. In this chapter, we discuss the role and importance of the railroad industry for the U.S. economy, provide a brief regulatory history of the industry, and describe the industry's evolution since the passage of the Staggers Rail Act of 1980.

2A. ROLE AND IMPORTANCE OF THE RAILROAD INDUSTRY IN THE U.S. ECONOMY

Railroads are an important part of the U.S. economy. Since 1980, railroads have captured an increasing share of U.S. freight shipments (see Table 2-1). According to data complied by the U.S. Department of Transportation, railroads accounted for about 27 percent of the ton-miles of U.S. freight moved in 1980. By 2005, the share of ton-miles attributed to railroads increased to about 38 percent.[1] In fact, the rate of growth of rail freight has been more than double the rate of growth of total freight (2.5 percent/year vs. 1.2 percent/year).

[1] National Transportation Statistics 2008, U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics.

TABLE 2-1
TON-MILES OF FREIGHT BY MODE[2]

	1980	1985	1990	1995	2000	2005
Total	3,404,015	3,313,968	3,621,943	4,104,235	4,328,642	4,537,921
Air Carrier	4,840	6,710	10,420	12,720	15,810	15,731
Intercity Truck	629,675	716,808	848,779	1,034,041	1,192,825	1,293,326
Rail	932,000	876,209	1,064,408	1,317,010	1,546,319	1,733,777
Domestic Water	921,835	892,971	833,544	807,728	645,799	591,276
Pipeline	915,666	821,270	864,792	932,737	927,889	903,811
Rail Share	27%	26%	29%	32%	36%	38%

Table 2-2 indicates that a wide variety of commodities are transported by railroads.

TABLE 2-2
RAIL SHIPMENTS BY COMMODITY GROUPING, 2007[3]

	Tons Originated		Gross Revenue	
	(thousands)	percent	(millions)	percent
Coal	849,630	43.8%	$11,471	21.0%
Chemicals & allied products	177,612	9.2%	$6,885	12.6%
Farm products	152,242	7.8%	$4,529	8.3%
Non-metallic minerals	137,556	7.1%	$1,527	2.8%
Misc. mixed shipments*	124,531	6.4%	$7,863	14.4%
Food & kindred products	105,457	5.4%	$4,041	7.4%
Metallic ores	59,162	3.1%	$542	1.0%
Metals & products	57,046	2.9%	$2,353	4.3%
Petroleum & coke	56,262	2.9%	$1,797	3.3%
Stone, clay, & glass products	48,115	2.5%	$1,607	2.9%
Waste & scrap materials	48,034	2.5%	$1,276	2.3%
Lumber & wood products	36,152	1.9%	$1,987	3.6%
Pulp, paper, & allied products	35,269	1.8%	$2,100	3.8%
Motor vehicle equipment	31,682	1.6%	$4,016	7.3%
All other commodities	20,989	1.1%	$2,642	4.8%
Total	1,939,738	100.0%	$54,637	100.0%

* The "miscellaneous mixed shipments" category consists primarily of intermodal shipments.

In terms of tons originated, coal represents, by far, the largest proportion of railroad shipments. In 2007, coal represented almost 44 percent of total tons originated. Chemicals, farm products, non-metallic minerals, and miscellaneous mixed shipments are also relatively large categories in

[2] National Transportation Statistics 2008, U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics.

[3] Class I Railroad Statistics, Association of American Railroads, July 17, 2008.

terms of tons originated. Examining the proportion of gross revenues to railroads by commodity group, coal is still the largest category but, reflecting its low-value bulk commodity status, does not stand out as much from the other commodity groups in terms of revenue as it does in terms of tonnage. The miscellaneous mixed shipments category, which consists primarily of intermodal shipments, represented only 6.4 percent of 2007 tons originated but accounted for 14.4 percent of revenues received by railroads.[4] This is a reflection of the high value of intermodal railroad services. Other categories that represent a relatively large proportion of railroad revenues include chemicals, farm products, food, and motor vehicle equipment.

While railroads play a key role in overall U.S. freight shipments, some commodities are particularly dependent on rail transportation. For example, the Association of American Railroads (AAR) reports that 70 percent of domestically produced automobiles,[5] 70 percent of coal delivered to power plants,[6] and about 35 percent of the U.S. grain harvest all move by rail.[7]

2B. REGULATORY HISTORY

Railroads and the economics of regulation share a long history.[8] In this chapter, we provide a brief overview of the development of the railroads in the U.S. and the evolution of regulatory structure as it relates to railroads. A more detailed discussion of railroad legislation and regulation can be found in Chapter 20 and its appendix.

From the beginnings of the U.S. railroad industry in the 1830s, railroads were subject to the obligations imposed by common law on common carriers. As a result, railroads were generally obligated to serve all shippers desiring service, charge reasonable rates, and provide safe transportation for goods and people.

The miles of railroad track expanded dramatically through the remainder of the 1800s, and fairly complete railroad networks had been

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[4] Class I Railroad Statistics, Association of American Railroads, July 17, 2008. As discussed below, not all intermodal shipments are captured by the Miscellaneous Mixed Shipments category.

[5] "The Economic Impact of America's Freight Railroads," Association of American Railroads, August 2008, p. 2. This does not include rail transport of imported autos from ports on both coasts.

[6] "Railroads and Coal," Association of American Railroads, July 2008, p. 3.

[7] "Railroads and Grain," Association of American Railroads, July 2008, p. 5.

[8] For a summary of the role of railroads in the economics of regulation, see William G. Waters (2007), "Evolution of Railroad Economics," in Scott M. Dennis and Wayne K. Talley (eds.), *Research in Transport Economics*, 20, pp. 11-68.

established by the early 1900s. The federal government's role in the development of the railroad network was limited primarily to granting land for rights of way. Formal regulation of railroads in the United States (as opposed to obligations imposed under common law) was initially undertaken at the state level.

The initial pressure for federal regulation of railroads in the U.S. came from several sources. Shippers wanted federal regulation to address concerns about potential abuses of market power by railroads. Railroads wanted some type of federal regulation to supersede regulations by numerous states, and to help stabilize prices and profits. These pressures led to the passage of the Interstate Commerce Act in 1887, establishing the Interstate Commerce Commission. The primary focuses of the Interstate Commerce Act were to provide for fair and just rates, eliminate undue price discrimination, eliminate short haul rates in excess of long haul rates, and require that rates be published. Much of the current debate some 120 years after the passage of the Interstate Commerce Act still revolves around the notions of what are fair and just rates, and what constitutes undue price discrimination.

Initially the power of the Interstate Commerce Commission (ICC) to set railroad rates was constrained by court decisions against the ICC. However, additional legislation in 1903 (the Elkins Act), 1906 (the Hepburn Act), and 1920 (the Mann-Elkins Act) enhanced the ability of the ICC to set railroad rates, with the goals of providing financial stability to the railroads and preventing abuses of market power.

Concerns about financial weakness in the railroad industry resulted in the passage of the Transportation Act of 1920. This act increased the powers of the ICC to help maintain adequate rates of return and stabilize the financially weak railroads. Powers granted to the ICC under this act included the powers to control entry, regulate construction and abandonment, and prescribe minimum and maximum rates. A fund was also established to assist weaker railroads.

In the 1930s, railroads began to face financial pressures from two directions. First, the depression of the 1930s decreased the overall level of demand for transportation services provided by railroads. Second, railroads faced increasing competition from trucks and water carriers. In 1935, the Motor Carriers Act brought the trucking sector under the regulatory control of the ICC. The Transportation Act of 1940 brought water transportation under the regulatory control of the ICC. This act included as a statement of national policy the objective to "provide for fair and impartial regulation of all modes of transportation … to recognize and preserve the inherent advantages of each.…"[9]

[9] Transportation Act of 1940, Pub. L. No. 76-785, § 1, 54 Stat. 898, 899 (1940).

During the 1950s, railroads continued to experience financial difficulties. As a result, the historical approach to railroad regulation came under question. President Eisenhower appointed the Weeks Committee to address transportation issues, and the report of the Weeks Committee in 1955 appeared to set the stage for deregulation. In its preamble, the report promoted concepts such as a "…free enterprise system of dynamic competition…" to "encourage and promote full competition between modes of transportation…" and to "reduce economic regulation of the transportation system to the minimum consistent with public interest…"[10]

Three years after the release of the Weeks Committee report, the Transportation Act of 1958 was passed. This act incorporated only a few of the recommendations of the Weeks Committee. Although there was a series of court cases and ICC decisions through the mid-1960s, the regulatory practices in the transportation industry had not been substantially changed by either the report of the Weeks Committee or the Transportation Act of 1958.

By 1973, several large railroads in the Northeastern U.S faced bankruptcy. Concerns about this issue led to the passage of the Regional Rail Reorganization Act of 1973 (the 3-R Act). The 3-R Act resulted in reorganizing the Northeastern railroads under federal control, the formation of Conrail, and the abandonment of about 3000 miles of track.

Continued financial problems for railroads outside the Northeast U.S. resulted in the passage of the Railroad Revitalization and Regulatory Reform Act of 1976 (the 4-R Act). The 4-R Act allowed railroads more latitude regarding the setting of rates. In particular, it set the stage for the deregulation of rates by allowing railroads freedom to set rates for traffic where there was competition.

The next major event in the deregulation of the railroad industry was the passage of the Staggers Rail Act in 1980. The Staggers Act provided railroads with a high level of freedom in setting rates, gave railroads the right to negotiate private rate contracts with shippers, and decreased the difficulty for railroads in abandoning unprofitable rail lines. Under the Staggers Act, shippers could appeal for rate relief if the challenged railroad's ratio of revenue to variable cost (R/VC) was found to exceed 180 percent and the railroad did not face competition from other railroads or other transportation modes for the contested movement.

The Staggers Act was followed by the ICC Termination Act of 1995. This act abolished the ICC and assigned the regulatory authority for railroads to the Surface Transportation Board (STB). The STB maintains a focus on promoting a regulatory structure that:

[10] Presidential Advisory Committee on Transport Policy and Organization, *Revision of Federal Transportation Policy*, U.S. Government Printing Office, Washington, D.C., 1955, p. 8.

- Helps promote revenue adequacy (i.e., that the return on capital invested in railroads is at least as great as that earned on capital invested in other industries)
- Allows flexibility in setting of rail rates in response to differing circumstances
- Protects shippers from the exercise of market power by railroads.[11]

2C. EVOLUTION OF THE POST-STAGGERS ACT RAILROAD INDUSTRY

In 2006, there were 559 railroads in the United States, dominated by the seven Class I railroads. According to the AAR, Class I railroads are defined as those with revenues of at least $346.8 million in 2006.[12] Among the other railroad classes in 2006, there were 33 regional railroads, 323 local linehaul railroads, and 196 switching and terminal railroads.[13] In 2007, the AAR reported there was a total of 140,695 miles of road operated (excluding trackage rights) by railroads in the U.S. The majority of this mileage (94,874 miles, or 67 percent) was operated by the seven Class I railroads. Revenues are even more concentrated in the Class I railroads. The AAR reports that for 2007, freight railroads generated about $56.8 billion of gross revenue and about 93 percent ($52.9 billion) was attributed to Class I railroads. In 2007, freight railroads were reported to have nearly 187,000 employees. Nearly 90 percent of these employees worked for Class I railroads.[14] While this provides a brief current snapshot of the industry, it is worth noting that a number of dramatic and important changes have occurred in the railroad industry since the passage of the Staggers Act. Below, we provide a brief description of the industry's post-Staggers' evolution, including discussions on industry structure, freight traffic, and industry performance.

Industry Structure

Consolidations in the railroad industry have reduced the number of Class I railroads from about forty around the time of the passage of the

[11] See Chapter 20 and its appendix for a discussion of the STB's responsibilities.

[12] "Overview of America's Freight Railroads," Association of American Railroads, September 2008, p. 1.

[13] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 24, p. 10. Regional railroads are linehaul railroads with at least 350 miles and/or revenue of between $40 million and the Class I threshold. Local linehaul railroads operate less than 350 miles and earn less than $40 million per year. Switching and terminal railroads primarily provide switching and terminal services for linehaul carriers. See "Overview of America's Freight Railroads," Association of American Railroads, September 2008, pp. 1-2.

[14] "Overview of America's Freight Railroads," Association of American Railroads, September 2008, p. 2.

Staggers Act to the current seven,[15] and the number of Class I railroad employees declined from over 450,000 in 1980 to 167,000 in 2007.[16] While the number of Class I railroads has declined, the total number of railroads in total has increased from about 490 in the mid-1980s to the current 559.[17] Non-Class I employment has declined in proportion to Class I employment declines as the percent of industry employment by non-Class I railroads has remained at approximately 10 percent over time.

Regional and shortline railroads own and/or operate an increasing proportion of the nation's railroad infrastructure. Overall, both total miles of road owned and miles of road operated by various railroads have fallen between 1987 and 2006. However, both measures have fallen more sharply for Class I railroads than for all railroads in the U.S. Table 2-3 shows that, between 1987 and 2006, miles of track operated declined by 18.9 percent for Class I railroads but increased for all other U.S. railroads. Similarly, miles of track owned declined by 26.8 percent for Class I railroads versus a much smaller decline for regional railroads and increases for other U.S. railroads over this period.[18]

TABLE 2-3
CHANGES IN MILES OF TRACK OPERATED AND OWNED BY U.S. RAILROADS
1987-2006

	Class I	Regional	Linehaul	Switching and Terminal	Total
Miles Operated	-18.9%	30.5%	62.6%	88.1%	-5.9%
Miles Owned	-26.8%	-7.7%	23.4%	29.9%	-20.9%

The data in Table 2-3 indicate that both the proportions of total miles owned and operated by Class I railroads have declined. The proportions of total industry miles owned and miles operated by Class I railroads have fallen by about ten percentage points from over 80 percent of the industry total in the 1980s to about 77 percent (owned) and 70

[15] "The Effects of Rail Mergers on the Number of Class I Railroads and Shipper Captivity," Association of American Railroads, August 2008, p. 1.

[16] "Class I Railroad Statistics, 2007," Association of American Railroads; "Railroad Ten-Year Trends," Association of American Railroads, Vol. 7, p. 10.

[17] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 7, p. 10; and "Class I Railroad Statistics, 2007," Association of American Railroads.

[18] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 24, p. 10; "Class I Railroad Statistics, 2007," Association of American Railroads; and "Railroad Ten-Year Trends," American Association of Railroads, Vol. 7, p. 10. The reported values do not include data for Canadian railroads with U.S. operations.

percent (operated) today, as the number of smaller railroads has increased significantly over this period. As Figure 2-1 shows, the decline has recently been greater for the proportion of miles operated, reflecting spinoffs of Class I-owned trackage to other operators.

FIGURE 2-1
CLASS I PROPORTION OF U.S. RAILROAD MILES OF TRACK OWNED AND OPERATED
1987-2006

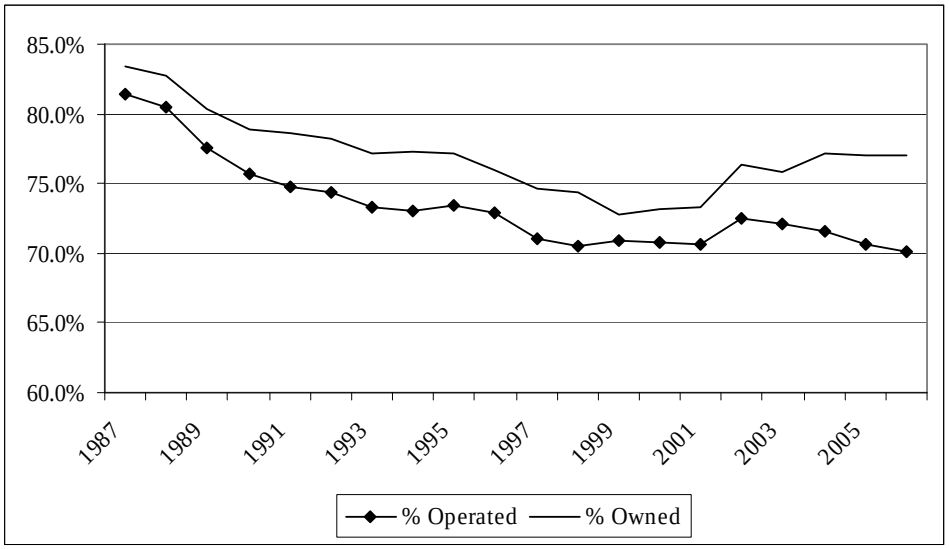
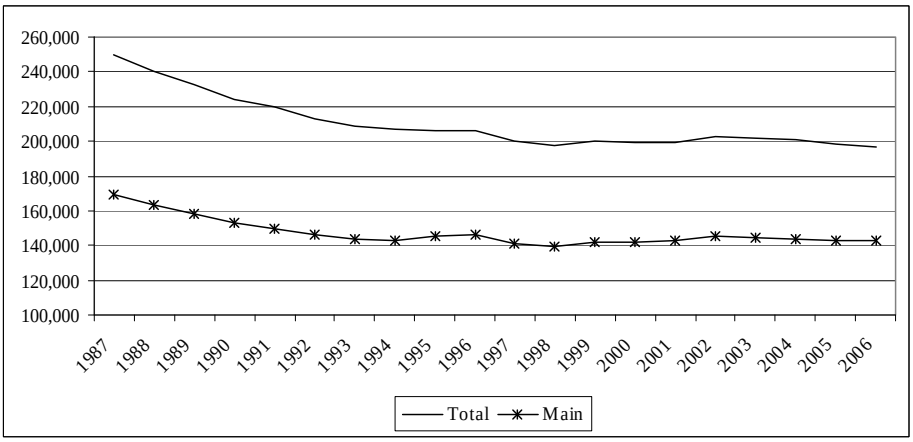


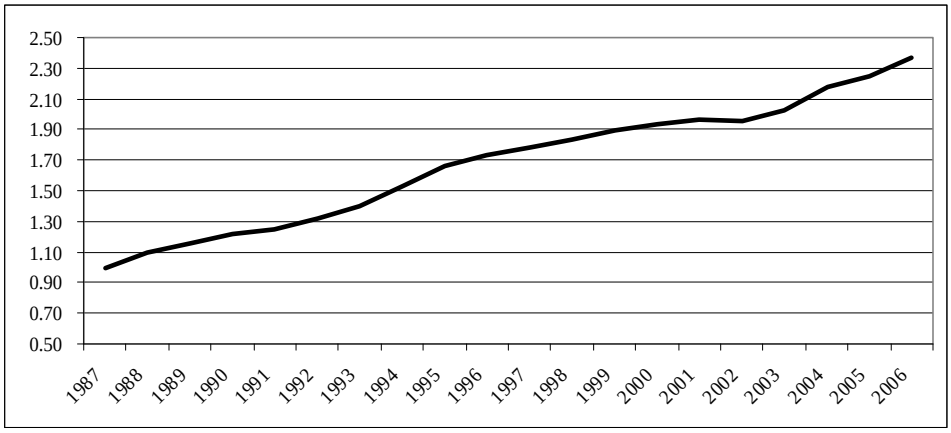
Figure 2-2 charts the 1987-2006 Class I data for total and mainline miles (including second and other mainline miles) of track. It can be seen that there were declines in both total and mainline miles until the mid-1990s, and both series have been relatively flat since then.

FIGURE 2-2
CLASS I MILES OF TRACK
1987-2006



While total Class I miles of track have declined, usage of that track has intensified as revenue ton-miles have grown continuously over the study time period. Between 1987 and 1999, Class I net ton-miles grew by 51.5 percent, compared to a 19.9 percent decline in total track miles. Between 1999 and 2006, Class I net ton-miles grew by 23.1 percent, compared to a 1.7 percent decline in total track miles.[19] The increasingly intensive use of Class I track miles is illustrated in Figure 2-3, which charts the Class I ratio of net ton-miles to total track miles.

FIGURE 2-3
CLASS I RATIO OF NET TON-MILES TO TOTAL TRACK MILES
1987-2006



A key to accommodating ever-increasing traffic on fewer miles of track lies in the technological advancements that have occurred in the railroad industry. Pivotal technological breakthroughs include a number of computer-related applications such as centralized traffic control (CTC) and the automation of waybills. A number of critical advancements relate to equipment technology—e.g., AC traction, distributed power, aluminum cars with higher capacity, containerization and double-stack cars, and end-of-train devices—and way and structures—e.g., continuous welded rail, concrete ties, and integrated maintenance of way machines.[20] Key developments that currently are taking hold in the industry or are on the horizon include electronically controlled pneumatic (ECP) brakes, positive train control (PTC), remote control on the main line, digital inspection technologies, electrification, and applications of nanotechnology.[21]

[19] Net ton-mile data are from R-1 Annual Reports, Schedule 755, Line 114, Column B.

[20] Recent discussions of technological advances in the railroad industry can be found in "6 High-Tech Advances," *Trains*, Vol. 68, No. 11, November 2008; and generally *Progressive Railroading*, Vol. 51, No. 6, June 2008.

[21] See "6 High-Tech Advances," *Trains*, Vol. 68, No. 11, November 2008.

In some cases, these technological advancements have been augmented by additions to second and other mainline miles of track. Table 2-4 reports R-1 annual report information on mainline miles of track for the Class I industry between 1987 and 2006, and for individual Class I railroads from 1999 through 2006 (after the conclusion of major merger activity and the dissolution of Conrail).[22]

TABLE 2-4[23]
CHANGES IN CLASS I MILES OF MAINLINE TRACK
1987-2006

	Main Track (Road)	Second and Other Main	Total Main
1987-1999	-17.9%	-4.0%	-16.1%
1999-2006	-1.1%	6.6%	0.1%
Individual Railroads, 1999-2006			
BNSF	-4.1%	6.2%	-2.8%
CP	0.2%	0.0%	0.2%
CSX	-9.6%	0.0%	-7.8%
KCS	15.2%	25.0%	15.3%
NS	-3.0%	-0.1%	-2.4%
UP	-3.0%	18.5%	-0.1%

While there was an across-the-board reduction in total mainline miles of track between 1987 and 1999, the more-recent 1999-2006 period has witnessed an increase in second and other mainline miles of track, driven by increases in multiple mainline trackage by Western railroads (BNSF, KCS, and UP). Much of this increase in multiple mainline trackage, particularly for BNSF and UP, has occurred on coal routes out of the Powder River Basin area and on intermodal corridors. It has recently been reported, "The coal line reached a milestone on May 14, 2008, when 21 miles of fourth main track went into service over the 1 percent grades of Logan Hill. BNSF claims it's the world's longest stretch of four-track main line exclusively for freight."[24]

[22] The data for CN contained a number of irregularities and therefore CN is not included in Table 2-4.

[23] R-1 Annual Reports, Schedule 700, Line 57.

[24] "Wyoming Coal Line Expansion," *Trains*, Vol. 68, No. 11, November 2008.

Freight Railroad Traffic

Between 1980 and 2006, tons originated by Class I railroads increased 31 percent, ton-miles increased 93 percent (reflecting increasing average length-of-haul), and freight revenues increased 91 percent.[25] The Class I proportion of total industry freight revenue has remained relatively constant, in the mid-90 percent range, since the 1980s.

Table 2-5 shows that in the 1980s average annual growth in tons originated by Class I railroads was slightly negative, freight revenue was relatively flat, and ton-miles grew modestly. The 1990s saw increased growth for all three measures, with average annual growth in ton-miles almost double that of both tons originated and freight revenue. Between 2000 and 2006, average annual growth in tons originated and ton-miles was similar to their respective increases in the 1990s. However, average annual growth in freight revenue increased dramatically in the 2000-2006 period.

TABLE 2-5[26]
AVERAGE ANNUAL GROWTH IN CLASS I TRAFFIC AND REVENUE
1980-2006

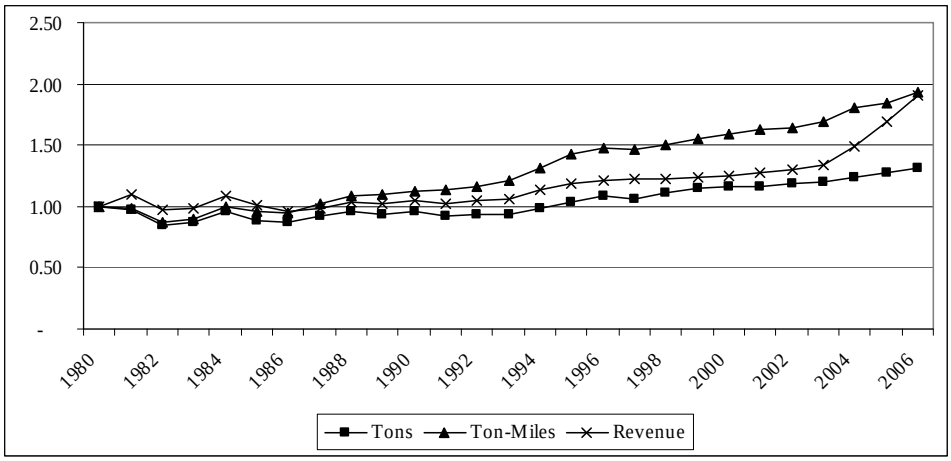
	Tons Originated	Ton-Miles	Freight Revenue
1980-1990	-0.5%	1.2%	0.4%
1990-2000	2.0%	3.6%	1.9%
2000-2006	2.0%	3.2%	7.2%

The trends in these traffic statistics are portrayed in Figure 2-4. It can be seen that tons originated and revenues were relatively flat-to-declining until the mid-1990s, while ton-miles has increased steadily throughout most of the period. As noted above, Class I freight revenues have increased substantially in the last few years.

[25] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 24, p. 43; "Railroad Ten-Year Trends," American Association of Railroads, Vol. 17, p. 43; and "Railroad Ten-Year Trends," American Association of Railroads, Vol. 7, p. 58.

[26] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 24, p. 12; "Railroad Ten-Year Trends," American Association of Railroads, Vol. 17, p. 12; and "Railroad Ten-Year Trends," American Association of Railroads, Vol. 7, p. 22.

FIGURE 2-4
CLASS I FREIGHT TRAFFIC, 1980-2006
1980 = 1.00



To examine the composition of freight railroad traffic over time, Table 2-6 provides the proportion of Class I tonnage by major commodity group in 1980, 1990, 2000, and 2006, while Table 2-7 provides the proportion of Class I revenues by major commodity group for these years. Table 2-6 shows that coal's proportion of Class I tonnage increased between 1980 and 2006. Other significant categories reflect a change in the mix of freight railroad traffic as, for example, the proportions of tonnage for farm products, metallic ores, and non-metallic minerals has declined, while the proportion for chemical tonnage has increased. Another category that has experienced an increase in its proportion of tonnage over time is the miscellaneous mixed shipments category. The growth in this category, which is composed almost entirely of intermodal shipments, reflects the growing importance of intermodal traffic to railroads. However, since intermodal services are not found exclusively in the miscellaneous mixed shipments category, the growth in intermodal services is somewhat masked in Table 2-6.

In Table 2-7, it can be seen that the proportion of Class I revenues accounted for by coal has increased somewhat between 1980 and 2006, but not by as much as the increase in its proportion of tonnage noted above. Other significant revenue categories include farm product and food products, whose proportions of revenues have declined since 1980, while the proportion of Class I revenues from chemical shipments has increased slightly. The increase in the proportion of revenues from miscellaneous mixed shipments again reflects the growth in intermodal shipments, and the more significant increase in its share of total revenue (compared to its increase in tonnage) reflects the growth in high-valued intermodal services.

TABLE 2-6[27]
PROPORTION OF CLASS I TONNAGE BY MAJOR COMMODITY GROUP

	1980	1990	2000	2006
Farm products	10.5%	10.3%	7.8%	7.6%
Metallic ores	7.1%	3.3%	1.8%	3.1%
Coal	35.0%	40.7%	43.6%	43.6%
Nonmetallic minerals	8.4%	7.7%	7.2%	7.2%
Food and kindred products	6.2%	5.7%	5.4%	5.4%
Lumber and wood products	5.7%	3.7%	2.8%	2.2%
Pulp, paper, allied products	2.8%	2.3%	2.1%	1.9%
Chemicals, allied products	7.3%	8.9%	8.9%	8.5%
Petroleum and coal products	2.6%	2.8%	2.4%	2.9%
Stone, clay, and glass products	3.6%	3.1%	2.8%	2.7%
Primary metal products	3.5%	2.6%	3.4%	3.1%
Transportation equipment	1.6%	1.6%	2.4%	1.8%
Waste and scrap materials	2.3%	2.0%	2.3%	2.5%
Misc. Mixed Shipments*		4.1%	5.8%	6.4%
All Other Commodities**		1.2%	1.2%	1.1%

*Misc. Mixed Shipments category is almost all intermodal.

**All Other Commodities category contains a high percentage of intermodal.

TABLE 2-7[28]
PROPORTION OF CLASS I REVENUE BY MAJOR COMMODITY GROUP

	1980	1990	2000	2006
Farm products	10.4%	8.1%	7.4%	8.0%
Metallic ores	2.2%	1.4%	0.9%	1.0%
Coal	18.4%	23.9%	21.5%	20.6%
Nonmetallic minerals	3.5%	3.0%	2.7%	2.8%
Food and kindred products	10.5%	7.3%	6.7%	7.1%
Lumber and wood products	5.7%	4.7%	4.2%	4.4%
Pulp, paper, allied products	6.1%	5.0%	4.2%	4.0%
Chemicals, allied products	10.9%	13.2%	12.8%	11.5%
Petroleum and coal products	3.2%	3.1%	2.8%	3.3%
Stone, clay, and glass products	3.8%	3.1%	3.1%	3.2%
Primary metal products	4.9%	3.3%	3.8%	4.1%
Transportation equipment	7.1%	10.4%	10.6%	8.0%
Waste and scrap materials	1.9%	1.7%	1.9%	2.3%
Misc. Mixed Shipments*		9.2%	13.6%	14.8%
All Other Commodities**		2.7%	4.1%	5.0%

*Misc. Mixed Shipments category is almost all intermodal.

**All Other Commodities category contains a high percentage of intermodal.

[27] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 24, p. 45; "Railroad Ten-Year Trends," American Association of Railroads, Vol. 17, p. 45; and "Railroad Ten-Year Trends," American Association of Railroads, Vol. 7, p. 47.

[28] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 24, p. 47; "Railroad Ten-Year Trends," American Association of Railroads, Vol. 17, p. 47; and "Railroad Ten-Year Trends," American Association of Railroads, Vol. 7, p. 49.

Since intermodal services are not found exclusively in the miscellaneous mixed shipment category, the growth in this category is somewhat masked in Table 2-7 as it was in Table 2-6. Table 2-8 shows the growth in intermodal railroad traffic from 1990 through 2006, with significant growth in containers driving the increases.

TABLE 2-8[29]
INTERMODAL TRAILER AND CONTAINER TRAFFIC
NUMBER OF UNITS

	Trailers	Containers	Total
1990	3,451,953	2,754,829	6,206,782
1991	3,201,560	3,044,574	6,246,134
1992	3,264,597	3,363,244	6,627,841
1993	3,464,126	3,692,502	7,156,628
1994	3,752,502	4,375,726	8,128,228
1995	3,678,503	5,417,198	9,095,701
1996	3,446,672	5,869,474	9,316,146
1997	3,586,030	6,409,738	9,995,768
1998	3,457,578	6,669,495	10,127,073
1999	3,407,428	7,157,818	10,565,246
2000	3,093,180	7,879,507	10,972,687
2001	2,794,484	7,956,610	10,751,094
2002	2,755,765	8,611,566	11,367,331
2003	2,842,833	9,267,253	12,110,086
2004	3,077,456	10,075,231	13,152,687
2005	3,091,170	10,845,109	13,936,279
2006	2,988,459	11,650,740	14,639,199

The AAR reports that intermodal traffic increased from 3 million trailers and containers in 1980 to their present-day levels. Furthermore, intermodal's share of rail revenue has increased to 22 percent, overtaking coal as the Class I railroad's largest source of revenues.[30]

Industry Performance

By nearly all measures, the performance of the railroad industry has improved dramatically since the passage of the Staggers Act. The financial situation for the railroad industry has improved and the railroad industry's share of intercity freight movements has increased since 1980. The 2006 GAO report notes that "[t]here is widespread consensus that the freight rail industry had benefited from the Staggers Rail Act," and that "[f]reight railroads' improved financial health is illustrated by a general

[29] "Railroad Ten-Year Trends," American Association of Railroads, Vol. 24, p. 62; "Railroad Ten-Year Trends," American Association of Railroads, Vol. 17, p. 62.

[30] "Rail Intermodal Transportation," Association of American Railroads, June 2008, p. 1.

increase in return on investment since 1980, ..."[31] As discussed above, data from the Department of Transportation indicate that the railroad industry's share of ton-miles of intercity freight movements increased from about 26 percent in 1985 to about 38 percent in 2005.[32] In a broader perspective, the increase in the railroads' share of intercity freight is viewed as providing some relief for a congested road system and as a "green" mode of moving freight.[33]

The AAR reports that from 1980 to 2007 overall railroad productivity increased by 163 percent as compared to about 15 percent for a comparable period prior to the passage of the Staggers Act.[34] This enhanced productivity allowed a reduction in railroad rates even in the face of increased input costs.[35]

The trend in reduced rates is particularly strong for the period from 1985 through about 2000. However, the reduction in rates was not experienced for all commodities or all routes. Since the early 2000s, rates have begun to go up, creating questions about the exercise of market power in the increasingly concentrated railroad industry.[36]

CONCLUSION

Despite all the apparent benefits of deregulation, some timeless questions remain. From the beginning, a major purpose of regulating railroad rates was to provide protection to shippers from the exercise of market power by the railroads. The observation of recent price increases and concerns on the part of some shippers about rate levels and quality of service raise critical issues for policy makers.

Some might claim that the current trends in the railroad industry are a result of the fact that the easiest sources of productivity gains have been captured and increases in traffic have caused capacity constraints. If these claims are true then current conditions could be characterized as the

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[31] GAO Report to Congressional Requesters, "Freight Railroads Industry Health Has Improved, but Concerns about Competition and Capacity Should Be Addressed," October 2006, p. 9. We also discuss the industry's financial performance in Chapter 8.

[32] National Transportation Statistics 2008, U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics.

[33] For example, see "Overview of America's Freight Railroads," Association of American Railroads, September 2008, p. 7.

[34] "Freight Railroads: A Historical Perspective," Association for American Railroads, August 2008, p. 4.

[35] See Chapter 8 for a discussion of railroad input prices and productivity.

[36] For example, see GAO Report to Congressional Requesters, "Freight Railroads Industry Health Has Improved, but Concerns about Competition and Capacity Should Be Addressed," October 2006, pp. 11-15.

functioning of competitive markets. On the other hand, some claim that because of consolidation and mergers as well as the lack of effective competition, railroads seize the opportunity when it presents itself to exercise market power. To a large extent, the rest of this report can be viewed as an exploration of the current situation, an economic perspective on the exercise of market power, and a qualitative and empirical analysis of these issues.

The positive developments in the railroad industry since the passage of the Staggers Act and concerns over whether the industry has become too concentrated to the determinant of the customers it serves are highlighted in the following passage from the 2006 GAO report:

> The changes that have occurred in the railroad industry since the enactment of the Staggers Rail Act are widely viewed as positive. The railroad industry's financial health improved substantially as it cut costs, boosted productivity, and right-sized its networks. Rail rates generally declined between 1985 and 2000 but increased slightly from 2001 through 2004. Likewise, rail rates have declined since 1985 for certain commodity groups and routes despite some increases since 2001, but rates have not declined uniformly, and some commodities are paying significantly higher rates than others. For example, from 1985 through 2004, coal rates declined 35 percent while grain rates increased 9 percent. Concerns about competition and captivity in the industry remain because traffic is concentrated in fewer railroads. It is difficult to determine precisely how many shippers are captive to one railroad. Nevertheless, our analysis indicates that the extent of potential captivity appears to be dropping, but that the percentage of all industry traffic running at rates substantially over the statutory threshold for rate relief—traffic traveling at rates over 180 percent R/VC—has increased. Furthermore, some areas with access to only one Class I railroad have higher percentages of traffic traveling at rates that exceed the statutory threshold for rate relief. This situation may reflect reasonable economic practices by the railroads in an environment of excess demand, or it may represent an abuse of market power.[37]

[37] GAO Report to Congressional Requesters, "Freight Railroads Industry Health Has Improved, but Concerns about Competition and Capacity Should Be Addressed," October 2006, p. 9.

Chapter 3 Contents

CHAPTER 3
ECONOMIC CHARACTERISTICS OF NETWORK INDUSTRIES WITH COMPARISONS TO THE RAILROAD INDUSTRY

INTRODUCTION

Many of the economic and policy issues that arise in the railroad industry also arise in other industries with network structures. These issues include firms' cost structures and pricing approaches to recover those costs, obligations to serve customers, open access of the network to competitive firms, and investment in infrastructure. In this chapter we provide a general description of these key economic features shared by many network industries, and review how the issues related to these economic features have been addressed in three industries with network characteristics that are in one way or another similar to the network characteristics of the railroad industry.

The three industries we use for comparisons of network characteristics are the telecommunications industry, the postal service industry, and the trucking industry. The telecommunications industry relies on a privately financed communications network to provide the transmission of messages between different locations. The postal service industry relies to some extent on the highway network to provide service, but its network structure is also derived from the organizational structure of the United States Postal Service. Under this organizational structure, mail is collected from various points, combined with other mail, sorted and transported to various postal facilities, and then delivered at various points. The trucking industry is similar to the railroad industry in that it provides freight transportation services between different locations, and it uses an infrastructure (i.e., highway) network to provide those services.

In our review of these three industries with networks, we address the following economic characteristics and related policy questions that are central to these network industries and have implications for the railroad industry. First, what are the regulatory and/or policy approaches with respect to rates and terms of service? Second, is there a common carrier or universal service obligation, and does it institute a system of cross-subsidies? Third, is there open access or other encouragement of competitive entry? And finally, what are the implications for infrastructure investment? Before addressing these issues, we provide an overview of the important economic characteristics of network industries that give rise to these issues.

3A. IMPORTANT ECONOMIC CHARACTERISTICS OF NETWORK INDUSTRIES

The term "network industry" has been applied to a wide range of activities, including transportation, communications, computer software, and banking. The term traditionally referred to public utilities and transportation industries. However, in recent years, "network industries" increasingly refers to computer-related collections of activities such as the Internet. Oz Shy notes that most transportation industries are network industries. The characteristic that he finds significant in transportation industries is the fact that they have significant network economies, which means that it is cost effective to connect different locations by a common network.[1]

Many network industries exhibit significant economies of scale or density in production.[2] Economies of scale and density arise when the average cost of serving customers decreases as the volume of business increases over the network.[3] Economies of density imply that it is more cost effective for fewer, larger suppliers to provide service in a particular area, rather than having numerous suppliers with smaller shares of the business. One issue that arises in industries with economies of density is financial viability. While marginal cost pricing maximizes economic efficiency, it is not feasible in industries with economies of density. When economies of density are present, marginal cost pricing does not produce enough revenue to cover a firm's total cost, and alternative pricing or funding mechanisms must be found.

Another important characteristic of network industries is the presence of consumption and production externalities. Consumption externalities arise when the value of a particular product or service increases in value to a customer when other customers are also using that service. A typical example of a network industry with consumption externalities is the telecommunications industry. The value of being connected to a telecommunications network increases as others are also connected to that network, allowing for wider communications possibilities. Production externalities result when the actions of one service provider have an impact on the costs of other providers. Network congestion is an example of a negative production externality. Likewise, "wear and tear" and damage to commonly used infrastructure may have costs that are borne by firms beyond the party inflicting the damage. On

[1] Oz Shy, *The Economics of Network Industries*, Cambridge Press, Cambridge, U.K., 2001, p. 215.

[2] Oz Shy, *The Economics of Network Industries*, Cambridge Press, Cambridge, U.K., 2001, p. 1.

[3] The railroad industry and our three comparison industries do not have significant economies of scale so we limit our discussion here to economies of density.

the other hand, research and development and the resulting technological advances, to the extent the advances are shared by the entire industry, represent positive externalities. Likewise, investment in common infrastructure may provide benefits to parties beyond those funding the investment.

Externalities represent a classic example of a market failure.[4] In the presence of negative externalities, unfettered market forces lead to over-consumption or over-production as the social cost exceeds the private cost perceived by the decision maker. In contrast, positive externalities result in under-consumption, under-production, or under-investment as there is an incentive to "free-ride" and let others incur the cost. In the case of shared infrastructure, positive externalities can result in a failure to invest adequately (from a societal perspective) in infrastructure maintenance, improvement, and expansion.

3B. COST STRUCTURE AND PRICING IN NETWORK INDUSTRIES

Background

The cost structure of a number of network industries is such that prices must exceed the firms' marginal costs so that firms are able to recover their total costs. Key issues include: (1) how are prices set to recover total costs and (2) whether price regulation is necessary to achieve the desired pricing structure. Price regulation can range from rate-of-return regulation, where prices are determined through regulatory proceedings, to more flexible forms of regulation, such as price-cap regulation or regulatory backstops.

A variety of pricing structures have emerged in network industries to address the issue of financial viability when marginal cost pricing does not produce sufficient revenues to cover costs. Unregulated firms with economies of density typically will use one of three pricing variants. The first variant is to set varying price margins for different customers, based on their elasticities of demand (i.e., responsiveness to price changes). Customers with the more inelastic demands pay larger price markups, while the rates for customers with the more elastic demand include smaller price markups. The second variant is non-linear pricing, which can manifest itself in volume discounts of different types. The third variant is two-part pricing, where customers are charged both an access fee and a usage fee, which is a uniform price per unit for the quantity of goods or service received.

[4] See Francis Bator, "The Anatomy of Market Failure," *The Quarterly Journal of Economics*, Vol. 72:3, 1958, pp. 351-379.

Regulatory agencies have also relied to some extent on these pricing variants when setting rates for regulated firms. Nonlinear prices and two-part tariffs are prevalent in a variety of regulated industries. One approach that has been employed is Ramsey pricing. Under Ramsey pricing, price margins over marginal cost are based on the price elasiticities of demand for different customer groups, with the restriction that prices are just high enough so that the regulated firm will not receive monopoly profits. In the telecommunications and electric utility industries, it is common for customers to pay a monthly connection or access charge and also pay for their usage of the network. From an economic policy perspective, non-linear prices and two-part tariffs are designed to achieve outcomes that are similar to marginal cost pricing outcomes, yet maintain the solvency of the regulated firm.

In addition to these three pricing alternatives, regulatory agencies have often developed administrative rules for "distributing costs" to different customer classes and then basing rates on those distributed costs. One widespread approach is to use some sort of activity-based analysis to first allocate "directly attributable" costs to customer classes. These directly attributable costs are the costs that the activity-based analysis determines can be clearly assigned to one customer class over another. The remaining non-attributable costs are then distributed to customer classes based on a specified allocation rule. Different allocation rules have been used in different settings, producing different allocations of non-attributable costs.

Distributed cost mechanisms generally depart from economically efficient outcomes, in some cases quite significantly. In extreme cases, distributed costs can actually hurt customer classes that the regulator was intending to help. For example, if in order to prevent price inelastic customers from being subjected to high prices, the regulator enforces uniform pricing across customer classes, customer classes with elastic demands will likely curtail their consumption or even leave the network. Since the resulting lost sales (output) will reduce company revenue more than company cost, prices will need to be raised on the remaining customers, i.e., the customers with inelastic demand.

In some instances, governments and regulatory agencies have determined that the best way to maintain the financial solvency of the firm with economies of density is to subsidize its operation. (For example, private urban bus systems are regularly subsidized by the government.) This allows the firm to keep its prices closer to marginal cost, leading to increased output. If the required subsidy level is large enough, government ownership might be the preferred alternative to government subsidies (with the financial losses of the now public firm being implicitly subsidized by the government).

Cost Structure and Pricing in the Telecommunications Industry

A number of econometric studies, starting with Caves and Christensen in 1988, have found significant economies of density in the telecommunications (telecom) industry.[5] This Caves and Christensen study analyzed the pre-1984 Bell System, prior to its divestiture into the long-distance carrier, AT&T, and the original seven local exchange Bell Operating Companies (BOCs). Subsequent studies of the post-divestiture local exchange carrier industry also found the existence of economies of density.[6] Thus, pricing above marginal cost is necessary to generate sufficient revenue to cover total costs for telecom firms.

Over time, the rate structure in the telecommunications industry has evolved as the degree of competition in the industry has increased. As discussed below, the telecom industry has long had a universal service obligation, which has historically been implemented by maximizing the percentage of households subscribing to telephone services. Traditionally, to achieve this mandate, a complex system of cross-subsidies was developed prior to the divestiture of the Bell System in 1984 in order to keep residential rates "affordable." Cross-subsidies existed between services and between geographic areas. For example, business customers tended to subsidize residential customers, and urban areas (mostly low-cost) tended to subsidize rural areas (mostly high-cost).[7] After divestiture, emerging competition, new technologies, and legislative and regulatory initiatives made this system of universal service cross-subsidies unsustainable, and an impediment to effective competition. In particular, high-margin services, which provided funding for universal service, were subject to increasing competition. The system of cross-subsidies supporting universal services was overhauled under the Telecommunications Act of 1996 (Telecom Act).[8]

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[5] Douglas W. Caves and Laurits R. Christensen, "The Importance of Scale, Capacity Utilization, and Density in Explaining Interindustry Differences in Productivity Growth," *The Logistics and Transportation Review*, Vol. 24:1, 1988, pp. 3-32.

[6] For example, see Bell Communications Research, "Econometric Estimation of the Marginal Operating Cost of Interstate Access," Special Report SR-FAD-000552, 1987; Richard Shin and John Ying, "Unnatural Monopolies in Local Telephone," *Rand Journal of Economics*, Vol. 23:2, 1992, pp. 171-183; and John Ying and Richard Shin, "Costly Gains to Breaking Up: LECs and the Baby Bells," *Review of Economics and Statistics*, Vol. 75:2, 1993, pp. 357-361.

[7] The funding of universal service programs and the economic distortions involved in the system of cross-subsidies prior to the Telecom Act are described in "Preparation for Addressing Universal Service Issues: A Review of Current Interstate Support Mechanisms," Common Carrier Bureau, Federal Communications Commission, February 23, 1996.

[8] Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996).

Various forms of regulation have been used to regulate non-competitive segments of the telecom industry. At the federal level, the Federal Communications Commission (FCC) recognized in the 1980s the superiority of incentive regulation over traditional rate-of-return regulation. Consistent with its stated preference for competitive markets, the FCC stated that incentive regulation could more accurately replicate the dynamics of a competitive market.[9] When segments of the telecom industry exhibited sufficient competitive features, they have often been deregulated. For example, after divestiture AT&T went through a transitional period of price-cap regulation until it was eventually deregulated in the mid-1990s. At the state level, regulatory commissions followed the lead of the FCC and moved in the direction of more flexible price regulation. In 1985, all 50 states used rate-of-return regulation to regulate telecommunications prices at the intrastate level. By 2002, the number of states using rate-of-return regulation had dropped to eight, and price-cap regulation was implemented in 38 states.[10]

As competition evolved over time and the industry has become less regulated, telecom pricing has become more aligned with Ramsey pricing principles as margins on more competitive service have declined. Among services that are still regulated, it has also been recognized that varying degrees of competitive pressure exist and there is a need for pricing flexibility for these services.[11]

Cost Structure and Pricing in the Postal Industry

Due to its network structure, the United States Postal Service has economies of density, particularly in the delivery of letters and parcels.[12] Once the Postal Service establishes a delivery route, the average cost of delivering letters and parcels decreases as volume increases. For this reason, pricing each piece of mail at its marginal cost would not produce

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[9] Federal Communications Commission, I*n the Matter of Policy and Rules Concerning Rates for Dominant Carriers, Report and Order and Second Further Notice of Proposed Rulemaking*, CC Docket No. 87-313, FCC 89-91, March 16, 1989, para. 36.

[10] Ross C. Hemphill, Mark E. Meitzen, and Philip E. Schoech, "Incentive Regulation in Network Industries: Experience and Prospects in U.S. Telecommunication, Electricity, and Natural Gas Industries," *Review of Network Economics*, Vol. 2:4, 2003, p. 321.

[11] For example, see Timothy J. Tardiff and William E. Taylor, "Aligning Price Regulation with Telecommunications Competition," *Review of Network Economics*, Vol. 2:4, 2003, pp. 338-354.

[12] D. Christensen, L. Christensen, C. Guy, and D. O'Hara, "U.S. Postal Service Productivity: Measurement and Performance," in *Regulation and Nature of Postal and Delivery Services*, M. A. Crew and P. R. Kleindorfer, eds., Kluwer Academic Publishers, Boston, 1993, pp. 237-260; and B. Roy, "Technico-Economic Analysis of the Costs of Outside Work in Postal Delivery," in *Emerging Competition in Postal and Delivery Services*, M. A. Crew and P. R. Kleindorfer, eds., Kluwer Academic Publishers, Boston, 1999, pp. 101-122.

enough revenue for the Postal Service to remain solvent. The Postal Service faces direct competition from the courier and express delivery industry for the delivery of parcels and expedited mail, while it has a protected monopoly for other delivery services. However, even those services protected by law from direct competition have indirect competition from other communications and transportation industries.

Postal Service rates are regulated by the Postal Regulatory Commission. Up until 2007, postal rates were determined by lengthy regulatory proceedings. Rates for each class and subclass of mail were determined based on an analysis of the revenue requirement and the cost of providing each service. The cost analysis was based on a marginal cost framework, which recognized that marginal cost pricing would not meet the revenue requirement. Consequently, price markups were set for each mail subclass using Ramsey pricing principles. Since 2007, the Postal Service has operated under price-cap regulation.[13] Services that do not face a high degree of competition are regulated by a price cap. The price cap sets a ceiling on rates and is adjusted annually based on changes in the Consumer Price Index. Services that face a high degree of competition are not subject to a price ceiling, but there are price floors which establish the minimum allowed price levels for these services.

Cost Structure and Pricing in the Trucking Industry

A key feature of the trucking industry's cost structure is that much of its network infrastructure (i.e., the highway system) is publicly owned and maintained. While trucking firms make contributions to infrastructure investments and maintenance through taxes and licensing fees, these taxes and fees are similar across competing carriers, and in the case of fuel taxes are perceived as a component of marginal cost. Consequently, the burden on pricing to achieve financial viability is less onerous than in other network industries where infrastructure is owned and maintained by the firm(s) in the industry. This discussion ignores the issue of cost recovery for the publicly provided network, as well as the issues of efficient marginal pricing of the use of the publicly owned network.

Trucking was largely deregulated as a result of the Motor Carrier Reform Act of 1980, although intrastate rates were not deregulated until 1994. Pricing flexibility allowed more efficient use of trucking capacity. The removal of entry and exit barriers allowed the industry to reduce excess capacity and adapt to more efficient network configurations. As a result, the trucking industry has improved load factors, reduced the amount of empty backhaul, and reduced labor costs.

[13] Postal Accountability and Enhancement Act, Pub. L. No. 109-435, 120 Stat. 3198 (2006).

These changes resulted in consolidation in the less-than-truckload (LTL) sector but an increase in the number of firms in the truckload sector.[14] Despite the consolidation, competition in the less-than-truckload sector has intensified as a result of the growth of lower-cost carriers and the loss of market share to other small shipment carriers (e.g., Federal Express and United Parcel Service). Overall, competition within the trucking industry and greater competition from railroads have caused decreased profits in the trucking industry since the passage of the Motor Carrier Reform Act.

3C. COMMON CARRIER AND UNIVERSAL SERVICE OBLIGATIONS

Background

Obligations to serve customers can take two forms. The first is a common carrier obligation (CCO), where, typically, the regulated firms must post tariffs and provide service under their posted terms to all potential customers. The second form is a universal service obligation (USO), where the regulated firms must provide a specified minimal level of service to all customer groups, at similar prices.

Common carrier and universal service obligations are often tied to the consumption externalities mentioned above. When consumption externalities exist, groups of customers might not be served, but for common carrier or universal service obligations. This potential loss of service has a welfare impact not only on those directly affected by the loss of service, but also on other customers who are served by the network. Universal service and common carrier obligations can also arise from equity considerations, where the availability of service is considered a fairness issue.

USOs exist in a number of network industries that provide "essential" services. USOs have been established in these industries because policymakers believe that these essential services would not be provided in sufficient quantities at "affordable" prices, but for the imposition of the USOs. These obligations are designed to insure that a large proportion of the population has access to essential service at reasonable rates and terms. In some instances, USOs are linked with funding mechanisms that help finance the obligation. In other instances (primarily when the firm providing the service does not face substantial competition), the firm is expected to internally cover the costs associated with the USO under its pricing structure. Several industries providing

[14] S. A. Morrison and C. Winston, "Regulatory Reform of U.S. Intercity Transportation," in *Essays in Transportation Economics and Policy: A Handbook in Honor of John R. Meyer*, J. A. Gomez-Ibanez, W. B. Tye and C. Winston eds., Brookings Institution Press, Washington, DC, 1999, pp. 469-492.

essential services have undergone the transformation from regulated, non-competitive market structures to more competitive structures, and they have adapted their universal service mechanisms to these changed market structures.

CCOs typically require the regulated firms to post tariffed rates and terms of service, and to provide service to all customers at those posted rates and terms of service. In some instances, a regulated firm can provide contract rates and terms of service to selected customers as an option to the posted tariffs, but in other instances no deviations from posted rates and terms are allowed. Tariffed rates are usually subject to regulation, although the degree of regulation can be quite different in different circumstances and across industries. In some instances, tariffs are determined by regulatory decision. In others, the regulated firm has flexibility in determining its tariffs, subject to the regulatory agency's general oversight, determining that the posted tariffs are in the public interest.

Obligations in the Telecommunications Industry

Universal service in telecommunications is generally thought of as providing ubiquitous essential services to the population at affordable rates. Universal telephone service has historically been measured as the percentage of households subscribing to telephone service. Policy makers traditionally viewed the availability of "basic" local telephone service at affordable rates as the primary means of promoting as high a percentage of subscribership as possible and, thus, fulfilling the goal of universal telephone service. Prior to the Telecom Act,[15] local exchange carriers were given exclusive franchise areas to serve and, in return, were required to provide service to all customers demanding service within their franchise areas at uniform, "affordable" rates.

The Telecom Act established a universal service framework for a competitive local exchange environment. Under this act, competitors as well as incumbent local exchange carriers are all eligible to receive universal service funding. Thus the Telecom Act introduced potential competition for all customers, including those customers who are costly to serve and/or require a subsidy to serve. This act also updated universal service concepts for the telecom industry as it specified the principles and general definitions of universal service, guidelines for carrier contributions to the universal service fund, and how funds can be used by eligible telecommunications carriers. Under the Telecom Act, the FCC is charged with establishing and periodically reviewing a specific definition of the telecom USO.

[15] Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996).

Obligations in the Postal Industry

The postal service industry (which is solely composed of the United States Postal Service) is distinguished from the courier and express delivery industry in the North American Industrial Classification System by the fact that the postal service industry bears a universal service obligation. This USO requires that the Postal Service provides daily mail delivery and collection service to all addresses in the United States. This mail delivery and collection service is conducted under uniform rates.

Most of the cost of this USO is funded internally through the Postal Service's rate structure, although the Postal Service also receives a relatively small annual appropriation from the federal government. The legal monopoly restrictions in the postal industry are designed to make the internal funding of the USO feasible. Without the monopoly restrictions, private sector couriers could compete on the least expensive delivery routes. This competition would lead to a reduction in the Postal Service's net income, which would affect the Postal Service's ability to fund deliveries in high cost areas. Currently, the Postal Regulatory Commission is conducting a formal review of the Postal Service's USO.[16]

Obligations in the Trucking Industry

After the passage of the Motor Carrier Reform Act (and the subsequent deregulation of intrastate trucking), the trucking industry has not been subject to common carrier or universal service obligations.

3D. Open Access and Competition

Background

Open access occurs when a firm must "unbundle" a particular, composite service into its components and allow competitors to provide some of the component services, if the customer chooses this option. Many network industries are capital-intensive, and capital additions must be made in large increments (i.e., investment is "lumpy"). Furthermore, once the lumpy investment is made, it is costly to remove and sell the capital put in place, or its resale value is small. This means that the investment cost is sunk, once the investment is made. This further means that there is uncertainty surrounding an investment when it will become sunk, and that the amount of capital being used at any one time will not necessarily be at its optimal level, resulting in either an excess or a shortage of capacity.

[16] Postal Regulatory Commission PI2008-3, Report on Universal Service and the Postal Monopoly.

Lumpy investments, sunk costs, and investment uncertainties tend to create restricted access at various points in the network. These points of restricted access are barriers to entry in the industry, since potential new entrants cannot profitably replicate the infrastructure investment of the incumbent firm. As a response, regulatory agencies have required the incumbent firms to provide access to competitors over restricted portions of their network facilities.

Open Access and Competition in the Telecommunications Industry

The promotion of competition has been a long-standing policy goal of federal regulation and most state regulation of the telecommunications industry. The reasoning behind this goal has generally been that competition, or regulation that attempts to produce competitive outcomes, results in greater economic efficiency and consumer welfare. In large part, the policy goal of promoting competition has been driven by the federal government with the U.S. Department of Justice pursuing the divestiture of AT&T in the early 1980s[17] and with the passage of the Telecom Act by Congress.[18]

It has been the case that once a segment of the industry demonstrated that it operates in a competitive market, that segment has typically been deregulated. For example, the interexchange carrier long-distance market, once dominated by AT&T, was deregulated in the mid-1990s. The Telecom Act altered the structure of the local exchange industry by introducing greater degrees of competition (through various means such as resale and unbundling of network elements) into those segments of the industry that had not been traditionally subject to a great deal of competition.[19] Included in the Telecom Act's provisions were requirements that incumbent local exchange carriers provide their services at wholesale rates to retail resellers and lease components of their networks (unbundled network elements or "UNEs") to competitors.[20]

Technology has also led to increased competition in the telecommunications industry. For example, wireless telephony and the provision of services by non-traditional providers such as cable television companies have grown significantly in recent years. These technological

[17] *U.S. v. Am. Tel. & Telegraph Co.*, 522 F. Supp. 131 (D.D.C. 1982).

[18] Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996).

[19] While there was growing competition in high-volume, high-margin segments of LEC markets (primarily for services to business customers), little competition existed in local residential services markets.

[20] These provisions of the Telecom Act have been viewed as methods of promoting the development of facilities-based competition.

developments have allowed competitors to bypass traditional telecommunications networks in providing their services. Thus, access to the incumbent providers' networks is not the impediment to competition that it once was in the telecommunications industry.

Open Access and Competition in the Postal Industry

Although the Postal Service has legal monopolies in the delivery of mail to addresses, there has effectively been an unbundling of upstream services. The Postal Service offers rate discounts to mailers who prepare their mail before entering it into the postal network. This preparation includes pre-sorting the mail, preparing the mail with barcodes so that it can be processed more efficiently when it enters the postal network, and transporting the mail to facilities near the addresses of the recipients. In effect, these discounts allow a large mailer the choice of using the Postal Service or a private firm (including itself) for sortation, barcoding, and transportation services.

The Postal Service's monopoly arises from two legal restrictions. First, there are prohibitions on the types of messages that private couriers can deliver. These prohibitions are known as the Private Express Statutes. Generally, private couriers cannot deliver personal messages, except for express delivery of those messages. The second legal restriction concerns access to the mailbox. Under current law, no one except the Postal Service can use the mailbox for delivering mail. The monopoly protection resulting from these restrictions is used to help fund the cost of the universal service obligation borne by the Postal Service.

Open Access and Competition in the Trucking Industry

As mentioned above, the trucking industry has been completely deregulated since 1994. The public ownership of the highway system and the general availability of that system to competing trucking firms lead to the absence of restricted access and, thus, the need for open-access requirements for the trucking industry. Trucking carriers are not required to, nor prohibited from, accepting shipments from competing enterprises.

3E. IMPLICATIONS FOR INFRASTRUCTURE IMPROVEMENTS

Background

Because many network industries rely on substantial capital investments to maintain their network infrastructure, there are a variety of issues that arise with respect to investment incentives. In instances where investment is undertaken by private firms, issues of open access and competition arise. Furthermore, policy makers must determine whether the investment incentives faced by private firms act to produce socially

desirable amounts of infrastructure improvement. This issue is particularly relevant where there are universal service or common carrier obligations. On the other hand, when the public sector is responsible for infrastructure investment, questions arise concerning the rationing of infrastructure capacity and optimal investment. Without a system of price rationing on the network, rationing is accomplished through congestion. Furthermore, if investment decisions are made through the political process, the outcomes may not be economically efficient.

Infrastructure Investment in the Telecommunications Industry

Infrastructure investment in the telecommunications industry is made by the private sector. Except for subsidization of service in high-cost areas, there is no public subsidization of telecom investment, and little concern has been expressed concerning the level of investment in the industry. As mentioned above, the restricted access issues that can arise with private infrastructure investment are handled through open access requirements.

Infrastructure Investment in the Postal Service Industry

Because the Postal Service industry is very labor-intensive, issues concerning infrastructure investment are not as significant as in the telecommunications industry. However, as a public enterprise, infrastructure investment decisions are subject to close Congressional and public scrutiny. Recent Postal Service efforts to modernize and streamline its network have created considerable argument, and both the Government Accountability Office and the Postal Regulatory Commission have conducted investigations into the Postal Service's network modernization plan.[21]

Infrastructure Investment in the Trucking Industry

As mentioned above, the trucking industry relies on a public highway infrastructure network that is funded through taxes and fees. While the public funding of highway infrastructure prevents the establishment of restricted access that discourage competitive entry, the methods of funding do not ration highway capacity in an economically

[21] Government Accountability Office, "U.S. Postal Service: the Service's Strategy for Realigning its Mail Processing Infrastructure Lacks Clarity, Criteria, and Accountability," GAO-05-261, April 2005; Testimony of John Waller, Director of Office of Accountability and Compliance, on behalf of the Postal Regulatory Commission, before the U.S. House of Representatives Committee on Oversight and Government Reform, Subcommittee on Federal Workforce, Postal Service, and the District of Columbia, July 24, 2008.

efficient way, and public investment decisions can be economically inefficient.

3F. IMPLICATIONS FOR THE RAILROAD INDUSTRY

Railroad Industry Cost Structure and Pricing

As we document in Chapter 9, the railroad industry has economies of density, which implies that pricing freight transportation services at marginal costs is unsustainable. As is the case with the other network industries we studied, the railroad industry engages in differential pricing, where different customer groups face different levels of price markup over marginal costs. Since the passage of the Staggers Act, freight transportation rates have been largely deregulated, as discussed in Chapter 20, with the Surface Transportation Board providing a regulatory backstop for captive shippers. In many respects, the pricing and competitive entry environments for the railroads are similar to those of the telecommunications industry, which has a mix of deregulated prices and prices subject to flexible regulation. In our conversations with some industry participants, questions were raised as to whether price regulation is currently too loose in the railroad industry.

Railroad Industry Common Carrier and Universal Service Obligations

The railroad industry does not have a universal service obligation, but it does have a common carrier obligation. However, the railroads' responsibilities under the industry's common carrier obligation are currently being debated in an STB proceeding.[22] In some of our interviews with shippers, concern has been raised that railroads will decline to provide requested transportation services, or require restrictive terms of service which are costly to the shippers. Some of concerns expressed suggest that these shippers believe that the railroads should have stronger common carrier or universal service obligations. However, as we noted above, funding these obligations is a complex exercise. Internal cross-subsidization of services creates a pricing structure that may be unsustainable as competitive entry cherry picks customers that are providing the subsidy. Alternatively, external funding mechanisms may require more complicated regulatory regimes or government involvement.

[22] STB Ex Parte No. 677, Common Carrier Obligation of Railroads−Transportation of Hazardous Materials, June 4, 2008.

Railroad Industry Open Access and Competition

Since the railroad industry is not reliant on a publicly funded infrastructure as is the trucking industry, there is a lesser degree of open access in the railroad industry. While open access is required to some degree by the STB, it is not as extensive as open access in the telecommunications industry. On the other hand, access is not restricted by law, as in the postal service industry (which is restricted to achieve universal service objectives). One policy issue that is being debated is whether more extensive open access to the railroads' networks should be required.

Implications for Infrastructure Improvements in the Railroad Industry

The railroad industry is also similar to the telecommunications industry in the way that infrastructure improvements are privately financed. Except for the subsidization of service to high cost areas, the telecommunications industry does not rely on public funding or investment incentives for its infrastructure investments. This privately financed infrastructure for the telecom and railroad industries is a distinct difference from the publicly financed highway infrastructure used by the trucking industry. The private financing of the infrastructure requires the railroads to finance lumpy and uncertain costs that become sunk costs once they are made.

CONCLUSION

As we address the policy issues in Chapter 22, it will be helpful to place those issues in the context of the experience of other network industries. New policy proposals will have implications for pricing, access to the network, and funding. The experience of other network industries provides guidance on these issues.

Chapter 4 Contents

CHAPTER 4
REVIEW OF ECONOMIC STUDIES OF RAILROAD PRICING, COSTS, PRODUCTIVITY, AND INDUSTRY STRUCTURE

INTRODUCTION[1]

There is a long history of research in the railroad industry, and many of the same issues that have been examined throughout the history of economics and transportation remain pertinent today.[2] This chapter provides a synopsis of the empirical literature related to railroad pricing, costs, productivity, and industry structure, and emphasizes the literature that has erupted in the last 30 years since partial deregulation.[3]

Much of this literature examines the effects of regulation and deregulation on prices, costs, and productivity, and more recently, the effects of mergers in the industry.[4] Most contributions to the literature appearing over the last two decades find that the effects of deregulation were initially mixed, but subsequently reduced rates. Further, the evidence suggests a phasing in of the effects from deregulation. Many studies during this period find that productivity advances drive the observed reductions in railroad rates. Current railroad pricing literature also points strongly to the effects of competition, particularly the effects of waterways, other railroads, and motor carriage, on constraining railroad rates. However, the rate-limiting effects of competition in some markets

[1] For ease of exposition, we use the ALA short form of footnotes in this chapter that comprises a literature review. We include the full citations in the References section that appears at the end of Volume 1.

[2] Wilson (1962), Pegrum (1963), and Locklin (1972) provide in depth discussions of the research and questions of railroad economics; a recent summary of these sources is found in Waters (2007). Wilson (1962), in particular, describes the common cost allocation debated by Pigou (1912) and Taussig (1913) at the turn of the last century. Textbooks by Wilson (1980), Boyer (1997), and McCarthy (2001) provide relatively recent and ample discussions of transportation and rail networks, while books authored by Keeler (1983); Friedlaender and Spady (1981); and Winston, Corsi, Grimm, and Evans (1990) are central readings to the topics at hand. There have also been a number of relatively recent surveys. These include: Winston (1985, 1993); and Oum, Waters, and Yu (1999), as well as the previously mentioned Waters (2007).

[3] The areas of railroad pricing, costs, productivity, and regulation are vast and detailed. This chapter focuses on only the subset of this literature that is most pertinent to the analysis at hand.

[4] Chapter 20 and its appendix provide, in some detail, the legislative and regulatory history of the U.S. railroad industry.

do not mitigate the issues of captive shippers in other markets. Indeed, in some markets where railroads are dominant, the issues of monopolistic pricing remain. This chapter also provides an overview of the econometric analyses of costs and productivity for railroads. These econometric studies generally use highly aggregated measures of outputs and network variables. They consistently provide strong evidence of economies of density, and strong effects from deregulation in terms of increasing productivity.

In the next section, there is a brief discussion of standard economic models from which the literature on prices, costs, and structure can be discussed and interpreted. This discussion is followed by a description of the dimensions of railroad decision-making. Following the background material, there is a discussion of the empirical work on railroad pricing, costs, productivity, and industry structure.

4A. BACKGROUND

Transportation is a service wherein firms move a good from one location to another over a network.[5] A long-standing perspective is that transportation firms create "place utility" by moving goods from one location with lower value to another location with higher value (Wilson (1962)). This flow concept is, indeed, the cornerstone of the classic work by Samuelson (1952), which connects product markets across space with transportation. In a simple version with only two locations, transportation looms large in the product markets because if rates are too high then there is no flow, and if rates are too low then the two markets become consolidated into a single market. Between these two extremes, transportation occurs at non-zero rates, and demand can be derived from the product markets.

More generally, however, railroads haul goods between a large number of locations, and through arrangements with other railroads and/or modes can reach almost any location. They also haul a wide range of commodities that differ in terms of value, volume, density, perishability, fragility, environmental hazard, etc. Interlining with another railroad or another mode raises issues of pricing the interlined service. Further, not only are there differences among the commodities hauled, there are also dramatic differences across demanders. Such differences are often central to the questions posed in the analysis of pricing, costs, and markets.

In freight markets, the formation of demand is usually modeled as a derived demand wherein the demand for rail is the outcome of a profit-maximizing decision of a firm. Demanders may be either originators (the

[5] The definitions of outputs and markets are central to our analysis. Winston (1985), and Wilson and Burton (2004) discuss this point in some detail.

product transported is an output) or receivers (the product transported is an input). In some cases, a good is shipped and its movement from one location to another is part of a sequence wherein the form of the product remains unchanged (e.g., corn), while in other cases a good is used to produce a different product that is then shipped (e.g., corn is used to produce ethanol). Demanders may also differ significantly in terms of size, capacity, location, the ability to use alternative products, and access to other modes. While these attributes impact the quantity of goods shipped by demanders, they also serve to constrain rail pricing.[6] As discussed in section 4B, most models of rail pricing have only an abbreviated notion of demand variables in their specifications. Yet, such considerations are very important in identifying the constraints on railroad pricing.

The process generating costs over a network is one of producing multiple outputs over that network. An output is defined as the movement of a commodity from one location to another over a network. A railroad may provide this service with a single routing or may have options for alternative routings; it may provide this service itself or it may interline with other railroads and/or modes. The cost minimization process then involves flows over a set of links, perhaps constrained by capacity or differing in terms of capacity. The railroad chooses the link flows and a set of inputs such that a vector of outputs is produced. The cost functions that appear in the literature typically use aggregate output measures, and these output measures used often vary across studies. Some progress has been made in the representation of different outputs, and some progress has been made in accounting for differences in networks, but significant issues remain to be analyzed with innovative research techniques and methodology.

A very important consideration relating to the difficulties in analyzing rail markets is the sheer volume of potentially and likely integrated markets. Specifically, the basic dimensions of rail networks are voluminous. That is, there are a vast array of origins, destinations, routings, and commodities. The 2005 confidential waybill's sample of origins, destinations, and commodities for movements that occurred provides an indication of the magnitude of outputs produced by railroads. In that sample, there are 6564 origin Standard Point Location Codes (SPLCs), 6973 destination SPLCs, and 1037 five-digit Standard Transportation Commodity Codes (STCC5). The waybill is only a sample of movements;[7] the number of actual markets and potential markets is much larger than the number of markets included in the waybill's sample. For example, BNSF lists 5842 active stations on its website, while it has

[6] Recall that demand imposes a constraint on rail pricing.

[7] Wolfe (1986, 1991), Wolfe and Linde (1997), and MacDonald (1987, 1989) amply describe sampling issues.

only 1428 "origin" stations represented in the 2005 waybill sample.[8] By virtually any measure, the number of origin-destination-commodity combinations is extremely large, and this magnitude of outputs substantially affects the approaches used for modeling railroad prices, outputs, costs, and structure. Indeed, most analyses of railroad costs either aggregate outputs over networks in order to study market trends, or focus on a single market or subset of markets and ignore all other actual or potential markets.

4B. RAILROAD PRICING STUDIES

The partial deregulation of railroads in 1980 has led to a number of studies that examine both the effects of partial deregulation as well as the adjustments to partial deregulation. Partial deregulation has given railroads much more flexibility in pricing decisions and dramatically eased the impediments to merger. These changed circumstances have led to a number of studies that examine the effects of competitive forces and mergers on rates, as well as more sophisticated pricing approaches (e.g., foreclosure pricing).

As discussed in Waters (2007) and Wilson (1962), the basic railroad pricing problem has a long history, dating at least to the turn of the last century with the debates between Pigou and Taussig on the allocation of common costs. Sizable amounts of railroad costs are "overhead" and common costs. The allocation of these costs to different movements has long been a cornerstone of rail rates. From a regulatory perspective, if there are overhead costs, joint costs, or economies of scale or density, on average, prices must exceed marginal costs to enable the firm to cover its total costs. One approach to accomplishing this is to set prices for various types of traffic so that the margins between price and marginal costs are inversely rated to the traffic's elasticity of demand. When firms price by this approach subject to the constraint that they earn only a normal profit, the resulting prices are known as Ramsey (1927) prices (Baumol and Bradford (1970)). In our present study, such value-of-service pricing under a regulated regime serves as a starting point for examining the pattern of prices under a partially deregulated environment.

Armed with this background, we now turn our attention in the remainder of this section to several primary areas of interest in the railroad industry. We include below a brief discussion of the railroads' pricing problem as well as summaries of the literature that document changes under partial deregulation, the effects of competition, the impacts of vertical linkages, and the repercussions of mergers.

[8] From the 1997 Central Station Master, there are 5453 stations (SPLCs) listed under the BNSF (777) code, but many other stations are listed separately under BN and ATSF, some of which are active while others are not.

Regulatory Oversight[9]

Important legislation that led to the current regime of partial deregulation included the 4-R Act in the mid-1970s, and the Stagger's Rail Act of 1980.[10] These acts changed the regulatory rules under which the reasonableness of rates was established and eased the regulatory impediments to mergers. Following the passage of this legislation, a finding of market dominance was required before a challenged movement could be assessed regarding the reasonableness of its rate. Market dominance was determined through a qualitative evaluation of intramodal, intermodal, product, and geographic competition (see Friedlaender and Spady (1981), Eaton and Center (1985), and Wilson (1996)). Generally, market dominance is a slippery principle that was loosely applied. Indeed, in most markets the availability of other modes, products, or sources led to findings that the challenged movements were not market dominant and thus the reasonableness of rates was not assessed in most cases. Wilson (1996) frames the legislated market dominance factors in terms of demand alternatives for shippers, and points to three pricing outcomes that could result : (1) the monopoly price (market dominant), (2) a constrained monopoly price (constrained market dominance), and (3) marginal cost pricing.[11]

Given that partial deregulation granted railroads with some degree of pricing flexibility, and given that rates had been set under regulation for over 100 years as well as the fact that most origin-destination-commodity movements are served by a single railroad, it seemed logical to infer that rates should generally increase as the maximum rate regulations were eased. However, deregulation has been a heralded success in terms of decreasing the rate levels. Much of the reduction in rates is due to the tremendous cost savings afforded through partial deregulation, productivity gains, mergers, traffic shifts, the abandonment and sale of unprofitable lines, and new pricing innovations that have occurred.

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[9] Chapter 20 and its appendix provide a review of railroad legislation and regulation, and discusses the Surface Transportation Board's current regulatory responsibilities.

[10] See Chapter 20 and its appendix for a summary of these acts.

[11] In Wilson's model, railroads only provide the movement if their offering dominates that of other modes, products, and locations. If so, then railroad prices are captured as $(r - mc)/r = (\lambda - 1)/\varepsilon$ where r represents the rate of the movement, mc represents the marginal cost of the movement, λ represents the inverse of market dominance, and ε represents the demand elasticity. The market dominance parameter (λ) varies between 0 and 1. When the market dominance parameter equals zero monopoly prices result, and when it equals 1 competitive marginal cost pricing results. A market dominance value between 0 and 1 means that the monopoly price is marked down to reflect competitive constraints on railroad pricing (e.g., other railroads or modes), with values closer to 1 indicating greater competitive pressures.

Economic Framework

Almost all studies of railroad rates can be or have been rationalized from a markup pricing equation of the form, p = mc + markup (price equals marginal cost plus a markup). This simple equation forms the basis of an econometric model, which is a specific application of Bresnahan's (1989) New Empirical Industrial Organization (NEIO) model. In the NEIO model, prices and outputs are the result of an equilibrium process identified by a representation of demand, cost, and pricing. This model is given by the following set of equations:

$$\text{Demand:} \quad Q = Q(P, X^D)$$

$$\text{Cost:} \quad C_i = C(Q_i, X^C)$$

$$\text{Pricing:} \quad P = MC(Q_i, X^C) - \frac{\partial P(Q, X^D)}{\partial Q} Q_i \theta$$

where for this purpose, the error structures are omitted and there is a minimum of notation. This model, when properly specified, describes market equilibrium. The pricing model is indexed by a parameter (or function), θ, that enters multiplicatively with the slope of the inverse demand function $\left(\frac{\partial P(Q, X^D)}{\partial Q} \right)$. When θ equals zero, marginal cost prices result (i.e., $P = MC(Q_i, X^C)$); when θ is not equal to zero, the parameter indexes the departure of price from marginal cost.

The NEIO model can be framed to capture pricing in a variety of circumstances, including a regulated regime and a monopolistic regime, and it is useful in interpreting some of the empirical research that has evolved over the last 25 years. A number of studies that have their specifications generally grounding in the pricing relationship shown above examined railroad rates before and after partial deregulation of the industry.

Studies Addressing the Effects of Partial Deregulation

Boyer (1987) notes that average revenues per ton-mile (ton-mile weighted averages of the rates charged) fell by 20 percent from 1970 to 1984. He estimates real rail rates from 1970 to1984, as a function of the regulatory regime and freight train weight in a first specification, and with a trend added in a second specification. These specifications do not yield statistically important effects from partial deregulation. In both specifications, the freight train weight (which captures changes in the structure of traffic) was the only statistically important variable.

Barnekov and Kleit (1990) criticize Boyer's early work on a variety of specification issues. They hold that deregulation was not immediate but was phased in over time. Accordingly, they use the number of "contract" rates in their study years, relative to the number of contract rates in 1987, as a proxy for the phase-in of deregulation. Barnekov and Kleit find that deregulation had a negative and statistically significant impact on rates.

McFarland (1989) estimates average revenue deflated by the AAR's index of input prices as a function of traffic density, average length of haul, the share of traffic that is bulk, and a time trend to capture technological change. Markups are assumed to result from changes in demand and the regulatory regime. Using system data from 1969 to 1987, he finds that deregulation had two effects. One effect suggests higher rates as a result of partial deregulation, but this impact is offset by the other effect of technological change. Regardless of specification, McFarland found the combined effects of deregulation on rail rates were not statistically different from zero.

Burton (1993) provides a highly disaggregated study of rail rates for 17 different commodities. In this study, he uses waybill statistics from 1973 to 1987 (excluding 1975), which are then pooled to form quarterly time series. The explanatory variables include a wide variety of variables used to capture competition, commodity characteristics, overall economic activity, shipment characteristics, route characteristics, factor prices, and productivity. Burton specifies phases in deregulation through the use of the dummy variable from 1981 to 1983. His results lead to his conclusion that "…shippers of nearly all commodities have, to some degree, benefited from lower rates as a consequence of railroad deregulation" (p. 433).

Wilson (1994) examines aggregate rail rates across 34 different commodity groups from 1972 to 1988. The data represent waybill aggregations taken from the DOT's TD-1 reports. This model explains rail rates in terms of a technological trend, average length of haul, average load, density, and a variable to represent aggregate economic conditions. Wilson finds mixed effects on rates initially after partial deregulation, and then almost exclusively negative effects later in the time period. Further, he finds that commodities that travel long distances and have large loads generally experienced initial rate increases that dissipated and became negative later in the study period.

Wilson and Wilson (2001) provide an examination of rail rates for major agricultural commodities moved by rail. These five commodities, barley, corn, sorghum, wheat, and soybeans, account for over 90 percent of all agricultural movements. The authors use waybill aggregates from the DOT's TD-1 reports for their analysis. The explanatory variables include commodity ton-miles, commodity prices, average length of haul, and a non-linear specification of deregulation that allows the effects to phase in over time. In all specifications, the authors find that commodity

prices have positive effects on rates (indicating value of service pricing), and length of haul has a strong negative effect. In terms of the impact from the regulatory regime, these results point to large negative effects on rates from partial deregulation, which dissipate with time. Wilson and Wilson also found that the effects of deregulation on rates was initially small for all commodities, but became larger through time at a decreasing rate.

Studies Addressing the Effects of Competition

In addition to the studies mentioned above that examine rail rates and partial deregulation, there is also a host of studies that examine the effects of competition on rail rates. Analyses of the effects of water competition, truck competition, and intramodal competition on rail rates are included among these studies.

In a central paper, MacDonald (1987) uses the 1983 waybill sample data to examine the rail rates for corn, wheat, and soybeans. He frames his model in terms of a standard markup model (the pricing relation in the NEIO structure). His determinants include cost variables such as distance, tonnage, and volume of the shipment, as well as measures of water and rail competition, as the markup variables. MacDonald finds that tonnage, distance, and volume of the shipments are each negatively related to rates. He also finds that competitiveness variables affect rates. In particular, increased intramodal competition (the reciprocal of the Herfindahl index)[12] is negatively related to rates, while rates increase with distance to waterways. The latter effect suggests growing market dominance as the distance from waterways increases.

MacDonald (1989) applies a similar specification to examine the effects of rail deregulation on grain transportation. In this later study, he uses data from a longer time period (1981-1985) and also examines asymmetric effects over geographic regions. He obtains similar results on the cost and competition determinants as in his earlier study. But, he also separately estimates regional differences in rate trends. In this analysis, he finds that rail rates in the Great Plains were declining through time. MacDonald concludes that, in this region, the Stagger's Rail Act was successful in introducing inter-rail competition.

Burton (1993) is discussed above in the context of rail deregulation. In addition, however, his study also indicates the importance

[12] The Herfindahl Index (H), also known as the Herfindahl-Hirschman Index or HHI, is a measure of industry concentration. The value of the Herfindahl Index is the sum of the squares of the market shares of all firms in an industry. Larger values of H indicate greater market concentration for the industry. The formula for this index can be expressed as: $H = \sum s_i^2$, where s_i is the market share of firm i and the summation includes all firms in the industry. Thus, the higher the value of the reciprocal of the Herfindahl Index, the lower is the measure of industry concentration and, presumably, the greater the degree of competitive behavior in the industry.

of competitive factors. He concludes that under partial deregulation, rates are much more sensitive to the presence of other rail carriers than before deregulation. In addition, he also finds strong effects from water competition, albeit that partial deregulation dampened the effect for all but coal movements.

In contrast to the majority of empirical work in this area, Wilson, Wilson, and Koo (1988) develop and estimate a structural model of railroad pricing, where railroads compete with motor carriers. Their model consists of differentiated demands for rail and truck services, a truck supply function, and a railroad pricing relation. The railroad pricing relation is based on the notion that railroads are price leaders and trucks are followers. The authors estimate their model using monthly data from 1973 to 1983. The authors find that after partial deregulation, rates were less influenced by costs and more influenced by competitive conditions.

Dennis (2000) estimates a model based on the NEIO structure. In his model, he derives the demand for transportation from a long-run shipper cost function. He appends the system with the costs of providing rail services and a markup term (defined as $1/(1+\varepsilon_i)$) where *i* refers to a shipper *i*. If shipper *i*'s traffic is subject to maximum rate regulation, then the markup is exogenously determined. Dennis uses waybill data from 1982-1996 and a variety of other data sources. He finds significant changes in rail rates over the study time period and identifies the sources of these changes. Dennis concludes that while other factors are important, the primary source of rate reductions emanates from productivity enhancements.

Schmidt (2001) also examines rail rates in the context of the NEIO structure. He bases his model in a dominant-firm leadership context, following the approach of Wilson et al. (1988). Schmidt uses cross-sectional, city-pair rate aggregates for different commodities in 1992 to examine the effects of the number of firms serving markets. He finds that rates increase as the number of firms serving the market falls. He also finds that interline shipments are much more costly than single-line shipments, from which he concludes that mergers may be desirable even if they exacerbate market power.

Studies Addressing Captive Shipper Issues

From the literature discussed above, it is clear that there are important sources of potential competition in the rail industry. However, there are also a number of studies that analyze the problems facing captive shippers and more complex pricing calculus that result from the connectivity of transportation modes and foreclosure issues.

Captive shippers have long been a concern in the railroad industry. Indeed, the generally accepted historical interpretation is that protection of the captive shipper was the motivation for the Interstate Commerce Act of

1887. More recently, the regulatory implementation of the market dominance concept is a very important development in the economic view of captivity. (Garrod and Miklius (1987) and Wilson (1996)). Theoretically, market dominance links directly to the presence of market power. As noted by Wilson (1996), market dominance is framed in terms of monopoly pricing, constrained pricing, and marginal cost pricing. In regulatory practice, market dominance is established by ratios of revenue to variable cost as well as a consideration of the presence of competitive pressures. These factors can be linked directly to the theoretical concept of market dominance (Wilson (1996)).

Many coal shippers, particularly in the West, are often thought of as captive shippers. Studies by Garrod and Miklius (1987) and by Atkinson and Kerkvliet (1986) examine the market for coal shipments. Garrod and Miklius (1987) find that railroads are able to capture about 25 percent of the rent in the coal market.[13] These authors maintain that if coal shippers were captive, railroads should be able to capture 100 percent of the rent. Atkinson and Kerkvliet (1986) similarly find that railroads and coal companies each capture approximately 23 percent of the potential rent, while state and purchasing utilities capture about 7 percent and 47 percent, respectively. They also find that since deregulation, the share of potential rent captured by railroads has increased.

While not an empirical work, the recent paper by Anderson and Wilson (2008) integrates many relevant themes. The authors develop a model of railroad pricing over (geographic) space. In this model, the railroads serve shippers that have dominant options. Shippers are distributed over space and the dominant options vary. For locations close to waterways, railroads are not market dominant, and, in fact, are dominated by water transportation. For locations further from the water, railroads are dominant but constrained in pricing. For locations still further from the water, railroads are the dominant transportation mode and unfettered by the existence of competition on the waterways, but they may be constrained by the opportunity costs of shippers. The Anderson and Wilson model is also very comparable to that of Wilson (1996).

In addition to the existence of captive shippers, the vertical linkages in movements over a network also give rise to market power issues. Indeed, virtually all railroad outputs can be seen from a vertical perspective with each link between origin and destination representing a vertical stage of producing transportation output. In this regard, railroads may be vertically integrated and able to complete the production of a shipment from origin to final destination. However, it is commonly the case that in the complete production of a shipment, an individual railroad may face competition on at least one leg of the network. As mentioned

[13] The term "rent" in this context generally refers to the difference between price received for an output and the variable costs of producing that output.

above, interlining can be very expensive. When this is the case, then the integrated railroad may be able to price the leg(s) on which it faces competition to vertically exclude or foreclose its rival(s). Grimm, Winston, and Evans (1992) examine this type of pricing in the case where the rival is another railroad. They find that the existence of interline railroad rivals on shippers' economic welfare is "substantial and statistically reliable." Burton and Wilson (2006) also examine the issue of vertical linkages, but with respect to barges. In their study, Burton and Wilson compare econometrically estimated rates on a monopoly leg in a vertical movement where shippers have access to barge transportation, with estimated rates for comparable movements without the vertical linkage (i.e., no access to barge transportation). Their hypothesis is that shipping rates should be lower in the markets with vertical linkages (i.e., shippers have access to barge transportation) than in the markets without vertical linkages. Their results support their hypothesis and suggest that the shipping price differentials range from 6 to 24 percent in the markets with vertical linkages.

4C. RAILROAD COSTS, PRODUCTIVITY, AND INDUSTRY STRUCTURE[14]

This section provides a brief discussion of the empirical literature on rail costs, productivity, and industry structure. The overriding purpose of most of this literature is to statistically estimate the levels of scale and density economies, the costs of individual movements, the level of productivity, and the effects of mergers and deregulation. The discussion is presented in chronological order as many innovations in economic techniques have occurred over time.

Pre-1970 Studies

As noted by Waters (2007), the statistical estimation of cost relationships dates back to the early part of the last century with works by Lorenz (1916) and Clark (1923), which examined cost and output relationships. Since the early 1950s, there has been a wide range of studies that estimate production and cost functions, beginning with the classic articles by Borts (1952, 1954, and 1960) and Klein (1953). The modern literature in this field begins in the late 1970s with research by Friedlaender (1971) and Keeler (1974). Friedlaender (1971) estimates short- and long-run cost functions for railroads, and then infers from her estimated results that there was substantial excess capacity in the industry during the time frame analyzed. In Friedlaender's model of long-run costs,

[14] See Jara-Diaz (1982), Waters and Woodland (1984), Oum and Waters (1996), Brauetigam (1999), and Waters (2007) for excellent discussions of this literature.

freight and passenger miles are taken as outputs and the cost function is estimated with a cross-section of data from 88 railroads in order to capture long-run scale effects. To estimate short-run costs, she uses quarterly data for 33 railroads with no major changes in miles of road (no major changes in networks) during the study time period. She finds that there was tremendous over-capacity in the industry for the period studied.

Keeler (1974) uses a Cobb-Douglas production function to model railroads. His model includes gross ton-miles of freight and passenger service as output measures. As he notes, "….more output variables would be desirable, but some simplification is necessary to make estimation feasible…" (p. 202). Keeler estimates a short-run cost function, treating miles of track as a fixed "input," and then solves the production envelope for the long-run function. His results point to substantial economies of density, but constant returns to scale. These findings indicate substantial excess capacity.

Late 1970s through 1980s

The late 1970s ushered in a host of innovations in the empirical analysis of railroad costs. Harris (1977) examines economies of density and scale, and discusses a variety of measurement issues. He finds significant economies of density, and notes that his results are sensitive to model specifications. In particular, he holds that gross ton-miles or car-miles are both inappropriate measures of output. He states, "[T]he real output of a railroad is the freight it carries, not the weight of the engines or cars" (p. 557).

The late 1970s and early 1980s marked a significant change in the estimation methodology for railroad cost functions. Brown, Caves, and Christensen (1979); Caves, Christensen, and Swanson (1980, 1981); and Friedlaender and Spady (1981) estimate railroad costs using translog cost functions.[15] The advantage of a translog function is that costs can be used to estimate the properties of a technology without the functional form placing *a priori* restrictions on the technology. Brown et al. (1979) estimate a variety of functional forms and compare them with the translog form. In their specification, they use freight and passenger services as outputs in a long-run railroad cost function where all factors of production are optimized. They find that there are substantial economies of scale in the railroad industry. In their book, Friedlaender and Spady (1981) also estimate a translog function. In their specification, they measure output as

[15] "Translog" function has become the commonly used term for "transcendental logarithmic" function. The translog function is a second-order approximation to an unspecified technology, and thus called a flexible form. When second-order terms are eliminated, the translog function collapses to the Cobb-Douglas functional form. See Christensen, Jorgenson, and Lau (1971 and 1973) for the theoretical development of the translog function.

freight revenue ton-miles and passenger miles (the latter is adjusted hedonically for service quality). Friedlaender and Spady make a very important distinction between the size of the network, proxied by route-miles, and the capital invested in the network. The former is properly a measure of network size, while the latter is a measure of capital. They find increasing returns to density, but decreasing returns to firm size.

Caves, Christensen, and Swanson (1980, 1981) estimate technology with a translog function, and link total factor productivity with the cost function's time derivative. Their results suggest substantially different productivity growth than what is found in index-procedure studies, and sensitivity to restrictions on the technology variable. Caves and his co-authors also evaluate scale economies by source of change. In particular, they find modest scale economies when increases in output are driven by increases in the average length of haul, but constant returns when the sources of output increase are either increases in tonnage or passengers.

In the mid-1980s, there were at least three published studies discussing the issue of unobserved firm effects. Brauetigam, Daughety, and Turnquist (1982, 1984) estimate a short-run and a long-run cost function with time series data from a single firm. Under those conditions, unobserved firm heterogeneity is not an issue. They use loaded car miles and average distance as explanatory variables, and introduce service speed to capture output. In both of their studies, they find strong economies of density for railroads.

Caves, Christensen, Tretheway, and Windle (1985) estimate a cost function over an extended period with controls for fixed effects in order to capture unobserved heterogeneity, one source of which is the difference in effects from different networks. In this work, Caves et al. reconcile previous results suggesting economies of density and mixed evidence on returns to scale. In this 1985 study, the authors find substantial increasing returns to density, and modest or constant returns to scale. The sensitivity of scale return estimates to the inclusion of fixed effects is a major finding of this study, which remains the accepted wisdom in today's literature.

Barbera, Grimm, Phillips, and Selzer (1987); and Lee and Baumel (1987) published studies in the late 1980s using limited data that were likely affected by the partial deregulation of the railroad industry. Barbera et al. used four years of data covering the time period during which the railroad industry transitioned from a regulated to a partially regulated industry. The results of their 1987 study indicate increasing returns to density and modest returns to scale. During the time period of this study, there was a change in the accounting basis from betterment to depreciation-based accounting. These two accounting systems rest on the measurement of capital expenses. Barbera et al. find that the current replacement cost of capital is very important in their model. Lee and Baumel (1987) use two years of data and estimate a variable cost function.

They find only slight economies of density, which is a distinctly different finding from the previous works reported in the literature.

1990s to Present

Since the early 1990s, there have been several studies that estimate cost functions in order to assess the effects of partial deregulation on costs, productivity, and mergers. In separate studies, Vellturo, Berndt, Friedlaender, Chiang, and Showalter (1992); Berndt, Friedlaender, Chiang, and Vellturo (1993); and Friedlaender, Berndt, Chiang, Showalter, and Vellturo (1993) use total ton-miles as the output measure, while including a variety of other variables to capture differences across firms. The models reported in these three papers also include fixed effects to capture unobserved (network) effects across firms. In these models, a new fixed effect was introduced each time a merger occurred. These studies find increasing returns to density and slightly increasing returns to firm size. The primary findings from this research are that cost declines in the early 1980s were dominated by the effects of deregulation, and only nine percent of the decline in costs came from mergers and consolidations.

Wilson (1997) estimates a translog function with data from 1978 to1989 in order to evaluate the cost savings and productivity from partial deregulation. He uses revenue ton-miles as the output variable, but includes a variety of variables to capture the differences in railroad networks and outputs. These include the ratio of revenue to gross ton-miles, the speed rating of tracks, the percent of traffic that is unit train traffic, the percent of traffic that is interlined traffic, and the average length of haul. He finds near constant returns to scale and significant density economies. He also reports results based on the methods of Caves, Christensen, and Swanson (1980, 1981), and finds that productivity levels were low prior to partial deregulation, and that partial deregulation had sizable positive effects on productivity that dissipated through time.

Ivaldi and McCullough (2001) estimate a cost function defined in terms of "operational outputs" and infrastructure service. They include several measures of output to differentiate car-miles for different types of operational outputs (bulk, and high-value and low-value equipment), while infrastructure service is captured by a measure of replacement ties. They find substantial returns to density as well as cost complementarities between different outputs. More specifically, they find cost complementarities between operational outputs, but not between operational outputs and infrastructure service. This finding suggests that vertical integration of these outputs does not provide any cost savings, which implies that an open-access network could be feasible.

In another study, Ivaldi and McCullough (2007) examine the welfare tradeoffs of mergers. They estimate a multiproduct cost function with a novel treatment of outputs. They use bulk, intermodal, and general

car miles as measures of operational output and replacement ties as a measure of infrastructure output. They find sizeable economies of density, cost complementarities among their output measures, and sizeable (4.1% per year) productivity growth.

In a recent study, Ivaldi and McCollough (2008) estimate a cost function with car-mile measures of bulk and general traffic as their operational output variables, and once again use a measure of replacement ties as the output variable for infrastructure service. They perform subadditivity tests that compare an integrated firm's cost structure versus separation of infrastructure and train service operations. They find in that there are cost complementarities amongst all of the outputs, and that costs are subadditive. That is, the separation of operational and infrastructure outputs would increase costs.

Bitzan (2003) examines the subadditivity of railroad outputs from 1983 to 1997. He specifies output variables for types of train service (way, through, and unit trains) and includes average speed as a service variable. The use of multiple output measures more accurately captures the multi-product nature of railroad outputs. His model also includes a capital stock measure and miles of road as a measure of network size. Bitzan finds that infrastructure and train service operations have strong cost complementarities, and that the separation of operational and track outputs would increase costs.

Bitzan and Keeler (2003, 2007) estimate translog cost functions to examine productivity growth as well as economies of density. In their model, output is represented measures for way, through, and unit train gross ton-miles, adjusted to reflect revenue ton-miles. They also include fixed effects and a variety of other variables to capture differences in the networks and output mixes of firms. They find that the elimination of cabooses and associated crew members has a substantial cost-reducing effect. They also report measures of the economies of density from 1983-2001, using a slightly different specification. In their 2007 study, they conduct a set of simulations to find that deregulation saved about $7-$10 billion per year, and that a primary source of savings came from increased density for rail freight traffic.

Bitzan and Wilson (2007a, 2007b) estimate cost functions first to evaluate the effects of mergers on the railroad industry, and then to consider the effects of a hedonic output treatment. In the merger study (2007a), they use revenue ton-miles as a measure of output, and also include controls for way and through traffic as well as average length of haul. They also include fixed effects as well as variables capturing network size and network investment. As in the bulk of studies in this field, they find significant economies of density. In terms of productivity, they find a reduction in costs of about 3.5 percent per year over the 1984 to 1997 period. This study provides estimates of the cost effects resulting from individual mergers, and the industry cost savings from mergers

during this time period. The estimated impacts of individual mergers on cost are very idiosyncratic and dominated by a few large mergers in the 1990s. Additionally, Bitzan and Wilson estimate that industry consolidation accounts for about $4 billion (1992 dollars) in cost savings. In their hedonic output study (2007b), Bitzan and Wilson estimate costs in terms of two different outputs (unit train output, and way and through output) and find significant differences in costs between these two outputs. Their model also estimates the effects of shipment size and average length of haul, as well as marginal costs for each output type. Overall returns to density are significant and comparable to most previous studies.

CONCLUSION

This chapter provided a synopsis of economic studies of the railroad industry that examine rates, costs, and market structure. In so doing, it also pointed to issues that have been discussed in the literature for almost the entirety of its history dating to the beginning of the last century. These enduring topics include: (a) the definition and measurement of output, (b) the structure and effects of networks, (c) joint and common costs, and (d) the benefits and costs of regulation and deregulation. Generally, the studies that examine rates are based on reduced form models with control variables for costs, demand (in some cases), and markups. Most contributions to the literature appearing over the last two decades find that the effects of deregulation were initially mixed, but subsequently reduced rates. Further, the evidence suggests a phasing in of the effects from deregulation. Many studies in this later period find that productivity advances drive the observed reductions in railroad rates.

Current railroad pricing literature also points strongly to the effects of competition, particularly the effects of waterways, other railroads, and motor carriage, on constraining railroad rates. However, the rate-limiting effects of competition in some markets do not mitigate the issues of captive shippers in other markets. Indeed, in some markets where railroads are dominant, the issues of monopolistic pricing remain.

There is evidence that partial deregulation has given rise to more sophisticated pricing arrangements. Examples of these new pricing arrangements include multi-car rates, contracts, and electronic auctions. While these arrangements were not discussed in the above review, they have become important pricing mechanisms. Finally, some of the studies reviewed in this chapter discuss the development of relatively sophisticated pricing over the networks (e.g., bottleneck pricing with respect to other railroads and modes). The upshot is that pricing was influenced by regulation and real rail prices have fallen since deregulation. Productivity seems to be a very important driver of the fall in rail prices. In addition, recent theoretical research points to the geography of the networks and competitive modes as being very important constraints on railroad pricing. Since these factors vary across commodities and across

U.S. geographical areas, it is very likely that significant pockets of market power exist for the U.S. railroad industry.

This chapter also provided an overview of the econometric analyses of costs and productivity for railroads. These econometric studies generally use highly aggregated measures of outputs and network variables. They consistently provide strong evidence of economies of density, and strong effects from deregulation in terms of increasing productivity. Over the last 25 years or so, there has been a major consolidation of railroads. Some of the studies evaluating the effects of consolidation estimate rather small cost savings, cost savings that are very idiosyncratic, and, in some cases, cost increases resulting from individual mergers. All told, the consolidation movement in the railroad industry generally does not appear to be driven by an attempt to garner dramatic cost savings. While substantial cost savings may occur with some mergers, the bulk of the literature prior to the 1990s indicates very small cost savings resulting from consolidation. Although some mergers during the 1990s gave rise to larger cost savings, the results vary across mergers.

Chapter 5 Contents

CHAPTER 5
CURRENT CONCERNS ABOUT THE PERFORMANCE OF THE U.S. FREIGHT INDUSTRY

INTRODUCTION

Among other findings, the 2006 GAO report on the U.S. freight railroad industry noted a reversal of the long-term decline in freight railroad rates. This led to questions regarding the competitiveness of the industry, prompting the GAO to recommend that the STB conduct a study to investigate industry performance. Consequently, the STB commissioned the current study. The first phase of our study was a qualitative research phase in which we solicited views of railroad industry stakeholders on the important economic issues facing the U.S. freight railroad industry. The purpose of this qualitative research was to obtain railroad industry stakeholders' perceptions about the important issues facing the industry—e.g., competition, rates, capacity, service quality—and to ensure, to the extent possible, that these perspectives were considered in our study.

In this chapter, we first provide a synopsis of the 2006 GAO report, which highlights trends in the railroad industry's performance and questions about that performance. We then provide a description of our qualitative research approach and summarize the findings of the qualitative research phase of our project.

5A. SYNOPSIS OF 2006 GAO REPORT ON U.S. FREIGHT RAILROAD INDUSTRY

The GAO has issued several reports on the U.S. freight railroad industry since the passage of the Staggers Act. This is largely in response to Congressional concern over the appropriate balancing of railroad and shipper interests, and the railroad industry's continued viability and ability to fulfill demands for its services:

> Policymakers continue to believe that the federal government should provide a viable process to protect shippers against unreasonably high rates, as well as address competition issues, while still balancing the interests of both railroads and shippers. Over the past 10 years, significant consolidation has taken place in the freight railroad industry, while

> railroads—particularly Class I railroads—have seen their productivity and financial health improve. Railroad officials worry that any attempt to increase economic regulation will reduce carriers' ability to earn sufficient revenues and limit future infrastructure investment. At the same time, a number of academic and government studies are predicting a significant increase in the demand for freight rail over the next 10 to 15 years.[1]

The 2006 GAO report noted that, after a long-term downward trend in railroad rates since the passage of the Staggers Act, increases began to occur in the early 2000s:

> The changes that have occurred in the railroad industry since the enactment of the Staggers Rail Act are widely viewed as positive, since the financial health of the industry has improved and most rates have declined since 1985. However, concerns about competition and captivity in the industry remain. The freight railroad industry's financial health improved substantially as railroads cut costs through productivity improvements; streamlined and right-sized their rail networks; implemented new technologies; and expanded business into new markets, such as the intermodal market. Between 1985 and 2000, rail rates generally declined, but then increased slightly from 2001 through 2004. Although rates have declined since 1985, they have not done so uniformly, and rates for some commodities are significantly higher than rates for others. Several factors could have contributed to recent rate increases, including broad changes in the domestic and world economy, the emergence of a capacity constrained environment in which demand exceeds supply, and consolidation in the 1990s in the industry leading to changes in competition. Other costs, such as fuel surcharges, have also shifted to shippers, and

[1] Government Accountability Office, Freight Railroads: Industry Health has Improved, but Concerns about Competition and Capacity should be Addressed, October 2006, pp. 1-2.

> STB has not clearly tracked the revenues the railroads have raised from some of these charges.[2]

The question posed by the GAO was whether the observed pattern in railroad rates was the reflection of economic market forces or the "possible abuse of market power" against captive shippers by railroads:

> Some concerns about competition and captivity in the industry remain because traffic is concentrated in fewer railroads. It is difficult to determine precisely how many shippers are captive because available proxy measures can overstate or understate captivity. In addition, STB does not accurately collect railroad revenue data. Nevertheless, our analysis of available measures indicates that the extent of captivity appears to be dropping, but the percentage of industry traffic traveling at rates substantially over the statutory threshold for rate relief has increased. For example, the amount of traffic traveling at rates over 300 percent of the railroad's variable cost increased from 4 percent in 1985 to 6 percent in 2004. Furthermore, some areas with access to one Class I railroad have higher percentages of traffic traveling at rates that exceed the statutory threshold for rate relief. These findings may reflect reasonable economic practices by the railroads in an environment of excess demand, or they may indicate a possible abuse of market power.[3]

Based on these issues, the GAO recommended that the STB conduct a rigorous analysis of the state of U.S. railroad competition:

> We are recommending that STB conduct a rigorous analysis of the state of competition nationwide and, where appropriate, consider the range of actions available to address problems associated with the potential abuse of market power.[4]

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[2] Government Accountability Office, Freight Railroads: Industry Health has Improved, but Concerns about Competition and Capacity should be Addressed, October 2006, p. 3.

[3] Government Accountability Office, Freight Railroads: Industry Health has Improved, but Concerns about Competition and Capacity should be Addressed, October 2006, p. 3.

[4] Government Accountability Office, Freight Railroads: Industry Health has Improved, but Concerns about Competition and Capacity should be Addressed, October 2006, pp. 3-4.

Against this backdrop, the remainder of this chapter reports on the results of the qualitative research phase of our project. In this qualitative phase, we solicited the views of railroad industry stakeholders to get their input on the important economic features and issues relating to the U.S. freight railroad industry.

5B. OVERVIEW OF STAKEHOLDER INPUT PROCESS

Prior to conducting quantitative research, we conducted a qualitative research phase of our project. This qualitative phase primarily consisted of obtaining input from various railroad industry stakeholder groups.[5] The purpose of this qualitative research was to obtain railroad industry stakeholders' perceptions about the important issues facing the industry—e.g., competition, rates, capacity, service quality—and to ensure, to the extent possible, that these perspectives were considered in our study. [6] The requirements for this qualitative research phase were outlined in the STB's Request for Proposal (RFP):

> *The purpose of this task is to conduct in-depth interviews and focus group discussions with shippers, railroad managers, academic experts, consultants, financial analysts, and key Government staff. In particular, attention is to be focused on the importance of competition, capacity, and regulatory policy as drivers of the industry's performance. In conducting these interviews, the Contractor shall include in its inquiries topics not limited to: (1) competition in the U.S. railroad industry both nationally and in selected geographic markets to be identified; (2) competition for grain, coal, chemical, general merchandise (boxcar) and inter-modal movements; and (3) the effects of competition and capacity availability on service quality.*

We conducted our qualitative research in a manner that provided open access to any stakeholder who desired to provide input to us. We accomplished this through two approaches for soliciting input. First, we initiated contact with stakeholders in various targeted groups (see below) and conducted interviews in person and also over the phone. In addition to initiating contact with stakeholders, we designed a system for stakeholders

[5] This phase of the project also involved performing literature searches, reviewing STB proceedings, and researching industry trade publications.

[6] Some of the issues raised by stakeholders were outside the scope of our study, while data limitations prevented us from thoroughly examining other issues. We list some of these other issues in the "Additional Research Considerations" section of this report.

to initiate contact with us. We established a website (www.lrca.com/railroadstudy) to provide a means by which any interested party could reach us. The website featured a forum by which registered users could provide comments and also included a direct e-mail link to us. We conducted interviews with those who approached us via the website and expressed an interest in talking with us.

Our stakeholder-input solicitation began in November 2007. Although this phase of our project was scheduled to end in January-February 2008, we did not want to foreclose the possibility of obtaining additional information through this process. Therefore, we continued to accept input after the scheduled end of this phase of the project from anyone who desired to contact us. In fact, our last interview occurred in late August, 2008. Ultimately, over sixty stakeholder interviews were conducted by our research team.[7] We also made eight presentations about the study to various stakeholder groups.

Interview Protocol

At least two people from our research team were present for each interview in order to ensure that the information obtained from the interviews was complete and accurate. We always included the questions called for in the RFP. The interview format was largely "open-ended" to allow respondents to tell us what is important to them; we did not want to arbitrarily foreclose or restrict information or opinions, or to direct the focus of the interview to a limited set of issues.

Stakeholder Selection

It was not our purpose to determine what percentage of stakeholders held particular opinions. The purpose of our stakeholder interviews was to obtain a broad and balanced range of views regarding the issues we should consider in our empirical research. As discussed above, this was accomplished through our stakeholder solicitation process, which consisted of targeted solicitation of particular stakeholder groups and the establishment of our website for stakeholder input.

We list below the stakeholder groups that participated in and provided input to the qualitative research process in some way—i.e., through interviews, our website forum, e-mail, or conventional mail.[8]

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[7] This tally includes individual meetings with the STB Commissioners and various STB staff members on January 29, 2008. However, this count does not include multiple submissions we received through our website forum, e-mail, or conventional mail.

[8] In addition to participants from the listed categories, we also attempted to contact and interview representatives from two railroad unions (United Transportation Union and Brotherhood of Locomotive Engineers and Trainmen). We were unsuccessful in getting their participation.

- Shipper associations
- Industry consultants
- Academic/research economists
- Financial analysts
- Equipment lessors
- Chemical shippers
- Chemical buyers
- Grain shippers
- Pulp/paperboard shippers
- Western and Eastern coal shippers
- Merchandise shippers
- Auto shippers
- Parcel shippers
- Class I railroads
- Regional/shortline railroads
- Logistics/intermodal companies
- West coast port
- USDA
- GAO
- STB Commissioners and staff

Rail Competition Study Advisory Panel

We also assembled an advisory panel for the following purposes:

- To serve as a sounding board for the qualitative research findings:
  - Are the issues that we have uncovered relevant?
  - Have we missed any critical issues?

- To serve as a sounding board for the specific research questions to be investigated:
  - Are we addressing meaningful questions?
  - Are there other meaningful questions we should investigate?

- To serve as a sounding board for the general methodological approaches to the research questions:
  - Are our proposed methods and uses of data appropriate?
  - Are there other data and methods we should consider?

- To have individual members available for providing our research team with sector/industry/market specific insights.

The advisory panel did not receive or review any preliminary reports regarding the results of this study. Furthermore, participation on

the advisory panel did not imply that the individual or his/her organization agreed with or endorsed the study's approach or findings, nor did it limit the individual's or his/her organization's ability to provide comments directly to the research team or to participate in the online forum at the study's website.

In selecting members for the advisory panel, our goal was to constitute a panel that would be fairly representative of industry stakeholder groups as a whole. To that end, we invited representatives (at the level of chief marketing officer, chief planning officer, or higher) from a number of shipper groups, labor unions, intermodal companies, port operators, railroads of various sizes, the investor community, academics, and government agencies. More information on the advisory panel can be found in the Appendix and on our website.

5C. SUMMARY OF STAKEHOLDER FEEDBACK

This summary is not intended to be comprehensive and, therefore, does not cover everything that was discussed in our interviews. Rather, this summary focuses on the feedback that was most relevant in guiding and informing our empirical research.[9] It is important to note that not all shippers, nor all railroads, held the same opinions—neither is a monolithic entity.

The major topic areas covered by stakeholders include:

- Capacity
- Rates
- Competition
- Service quality
- Captivity
- Cost shifting
- Earnings
- Access to rail networks
- Class II and Class III issues
- Legislative issues
- STB issues

[9] For example, our summary in this report does not include a number of comments that were expressed regarding the motives or attitudes of other stakeholders. It is our assessment that while such comments may reveal something about the interactions between stakeholders, many of these comments were consistent with other information we considered and, thus, did not provide additional independent information for the purposes of informing our research design.

Capacity Issues

A generally held opinion among the stakeholders providing input is that the rail industry has gone from excess capacity to "tighter" capacity in the last few years. Another widely held opinion is that rail capacity investment is lagging demand growth (aside from cyclical or seasonal factors), and that railroads are using rate increases to ration scarce capacity and prioritize traffic on their networks. However, opinions differ regarding why capacity has tightened and the effects of this tightening.

- Some stakeholders are of the opinion that the lag in capacity growth is intentional and used by the railroads so they can raise rates—i.e., it is another aspect of the railroads' exercise of market power. In this regard, some are of the opinion that railroads have been "sitting on their hands" regarding capacity investment until the last few years.
- The lack of investment is also related to aging car fleets and pushing ownership to shippers.
- A contrasting opinion expressed by others is that capacity growth lags demand because of the time involved in the recognition of capacity issues and in the planning and implementation process, and also the significant expense of most railroad investments. In this view, the lags in capacity additions are not the result of the exercise of market power but, these lags are viewed as normal for an industry when faced with investment amounts of this magnitude. Individuals expressing this view observed that the industry has recently made a significant transition to tighter capacity after years of excess capacity where cost cutting and capacity reductions were the primary focus.
- Also adding to the lag, in some cases, is the involvement with the public sector—e.g., obtaining permits and/or funding.

At a more micro level, some shippers hold the opinion that railroads are primarily adding to capacity in certain corridors serving high-margin or high-volume traffic, to the detriment of merchandise corridors.

The public goods aspect of rail capacity is reflected in the opinion that capacity decisions need to start with what is in the best interest of the public, not with how to maximize railroad profits. In a closely related perspective, some hold the opinion that there is a disconnect between rail infrastructure investment and national transportation needs.

Interacting with capacity issues, some stakeholders have questions regarding the railroad industry's prioritizing traffic and refusal to handle traffic, including the following:

- To what extent do railroads prioritize traffic and why? We heard that intermodal shipments have priority over other types of shipments. However, less obviously, shippers of various commodities pointed to other commodities (e.g., coal) as having priority. Is the perceived prioritization due to capacity constraints or the result of railroads deciding they do not have to offer good service to some shippers who lack competitive alternatives?
- Similarly, we heard that railroads refuse to handle some traffic—either through "de-marketing" (e.g., hazardous chemicals) or by not submitting a competing bid against another railroad that is currently carrying the traffic. To what extent are such refusals to handle traffic due to a lack of capacity versus oligopolistic behavior where railroads have allocated markets?

Another aspect of the capacity analysis is the role of non-railroad equipment owners, including shippers and third-party capital providers. Capacity issues relate to the question of whether these markets operate efficiently, supplying the appropriate amount of equipment.

Rates Issues

As one might expect, rate increases are one of the primary complaints of shippers.

- Many shippers view the rate increases as an exercise of market power by the railroads. For example, among shippers that have multiple origins and/or destinations, many said that rates are much higher on lanes where only one rail option is available.
- However, some shippers who had access to more than one railroad said that the advantages of having service from more than one railroad have diminished in recent years, i.e., the competitive behavior of railroads has decreased.
- The effect of competition (or a lack thereof) is illustrated by the example of a captive shipper paying a higher rate compared to the rate of a closely neighboring shipper of the same commodity who had more than one railroad providing service. The captive shipper's higher rate puts it at a competitive disadvantage.
- In a number of instances, the opinion that the railroads are exercising market power was made in the context of the rate not being "fair."

- An example of the exercise of market power noted by a number of coal shippers is the publicly stated goal of some railroads to extract the difference in price between what utilities pay for coal versus natural gas.
- A number of shippers noted that railroads have moved away from confidential contracts with shippers to public tariffs for certain types of shipments. Some shippers state that both Western railroads use almost identical public pricing and appear to be happy with their market share and now refuse to compete. In fact, it has been alleged that such public pricing represents a signaling mechanism through which railroads can fix prices—i.e., such pricing is a deterrent to true competition between railroads. It has been further alleged that the railroads now refuse to participate in private contracts or private contract negotiations.
- While many acknowledged that differential pricing was appropriate, there is still an issue of determining when rates under differential pricing are "too high," with "too high" implying the exercise of market power. Many point to the ratio of revenue to variable cost (R/VC) as a key to determining when rates are "too high."
- Some shippers also recognize that capacity constraints play a part in rate increases and believe railroads have intentionally withheld capacity (or make sure capacity investment lags demand) as a means of increasing rates.
- Some interviewees feel that rates are used to prioritize railroad traffic and that intermodal and coal are the railroads' preferred commodities.
- A frequently mentioned aspect of recent developments in rail rates is the fuel surcharge issue and the associated increases in railroad miscellaneous revenues. For example, it has been asserted that the new STB rules still don't "have it right" and railroad finance people know how to manipulate the system. As another illustration of the claimed inadequacy of the new rules, it has been stated that the wide variation in surcharges "makes no sense."
- From the railroads' point of view, the expiration of legacy contracts allows them to re-price business that was under-priced to more compensatory levels and to cover escalating fuel costs. The railroads have told us that some of these legacy contracts were not profitable from the beginning.
- Commodity-specific rate issues need to be considered. For example, grain shippers told us that, since transportation costs

are an important part of overall grain costs, differences in rates by location can have an effect on the competitiveness of particular shippers in grain markets. (For example, Montana wheat shippers are at a disadvantage because they pay higher transportation costs than Nebraska wheat shippers).

- A number of grain shippers stated that U.S. grain products are becoming less competitive in international markets because of increasing rail costs.
- Grain shippers also noted that, because transportation costs are netted out of a grain producer's receipts, the producer has no ability to pass higher transportation costs on to others in the chain; the entire burden falls on the grain producer.

Competition among Railroads

An important area of disagreement concerns whether railroads compete with each other or whether they are duopolists who allocate markets and do not compete. Another aspect of this alleged duopolistic behavior includes the greater use of tariffs versus contracts by railroads, which allows price signaling. It was also alleged that railroads limit competition through the use of route closures, restricted switching access, excessive charges for trackage rights, and paper barriers.

Some shippers hold the opinion that it takes more than two railroads to provide effective competition. For example, we heard that even when a shipper has access to two railroads, they cannot get the potential competitor to give them a bid against the incumbent railroad. This refusal-to-bid practice is viewed as an indication that the railroads are allocating markets among themselves. A variant of this view is the opinion expressed by some shippers that railroads don't seem to be hungry for new business. However, an alternative explanation is that such behavior results from a combination of capacity constraints and railroad bureaucracy.

Not only is there disagreement between the obvious parties here—shippers and railroads—but there is also disagreement among shippers on this issue. Some of the possible sources of disagreement between shippers include:

- Commodity—an intermodal shipper said it always had competing railroad options while coal shippers often said that when a competing option is available they are not able to get bids from the potential competitor. A possible question here is whether this practice is the result of anti-competitive behavior by the railroads or the railroads rationing scare capacity by prioritizing traffic—i.e., shippers do not get competing bids because the potential competitor does not have enough capacity

to provide service to these shippers. It may also be that railroads are only willing to compete for higher margin traffic.

- Mobility of shipper—shippers who have the ability to change locations, or ship to or from different locations, are more likely to observe railroads competing than shippers whose locations are fixed. For example, intermodal shippers may be able to truck to different terminals or ships can go to different ports, while an existing electric generating plant has a fixed location. (However, at some point an electric utility may alter its plant dispatch).

Service Quality Issues

Many shippers expressed the theme that service quality has deteriorated while rates have increased. (A caveat to this perception is that service has improved somewhat over the last few years when compared to 2004-05). Many shippers stated that service variability is the most important issue and causes them the most problems.

Much of the problem with service variability was attributed to reduction in rail competition. Moreover, many shippers stated that new contracts rarely include any performance standards or penalties for not meeting standards, so there is an increasing lack of railroad accountability.

Part of the service quality issue was seen as an outcome of deteriorating communications between railroads and shippers. This communication problem appears to have a few dimensions:

- Many shippers said that railroads were increasingly adopting a "take it or leave it" attitude.
- The greater use of internet-based communications versus direct access to railroad personnel.
- Inability of railroad bureaucracies to respond to changing conditions.

Aside from measurement issues, two important aspects of service quality were discussed: additional costs placed on shippers because of service quality problems, and sources of service quality problems.

The additional cost factors, which shippers claimed they incur as a result of railroad service quality problems, include:

- The need to hold additional inventories because of uncertain/variable deliveries. In this regard, some shippers said that consistency of service is more important than speed.

- The need to have larger fleets of railcars to ensure adequate deliveries.
- The need to dedicate shipper personnel and other resources to the monitoring of railroad performance.
- Congestion in ports caused by additional lead time used as a hedge against service variance.

Regarding the sources of service quality problems, the following were mentioned as possible causes or contributing factors:

- Tight capacity and the "fragility" of the railroad network. Shippers expressed the opinion that with the railroad network operating at close to its capacity it does not take much to upset the fluidity of the railroad network.
- Tight capacity is often related to location-specific congestion or "choke points" in rail networks.
- Rail service problems can also be related to congestion points in the wider transportation network—ports, terminals, highways—that are beyond the railroads' control.
- Shipper-caused problems—e.g., slow unloading.
- Railroad management structures that impede the ability to improve service or solve problems despite good intentions. In this regard, we heard that railroads are good at serving "cookie cutter" business but have trouble when conditions deviate from the norm. We also heard that because railroads tend to be very large and dispersed businesses, it can be difficult for a railroad to ensure that decisions made at one level/location are actually carried out at lower levels or distant locations.
- Market-dominant firms can be less concerned with providing good service.
- One shipper stated that one reason rail service has deteriorated is because railroads are forcing routing protocols on shippers under the guise of operating efficiency, but these forced routes offer no better (or even worse) transit times than previously allowed routes.

Captivity Issues

A number of responding shippers defined captivity in terms of their preferred mode of transportation and from the perspective of whether rate differentials between transportation modes were fair. For example, some shippers defined themselves as captive because, although they could

use trucking, this mode was more expensive than and not as efficient as rail, and thus was not the preferred mode of transportation.

Captivity can be defined by rules and regulations that restrict transportation options available to shippers. A prime example here is the transport of hazardous chemicals that can only be performed by rail.

The type of commodity shipped can also determine whether there are intermodal options—e.g., coal. Regarding coal, one shipper contended that the degree of captivity among coal shippers was understated in the 2006 GAO report—merely counting the number of railroads in a geographic area is not sufficient and duopoly behavior of railroads must be evaluated to determine if a shipper actually has competitive options.

Furthermore, there are situations where traffic may be captive at one end of a move but not the other. For example, Powder River Basin coal traveling to an Eastern utility only served by either NS or CSX may have BNSF and UP competing with each other at the origin to get the haul to the interchange point.

Captivity can be affected by a shipper's location for the same commodity as that of another shipper, but originated at a different location "just down the tracks."

Cost Shifting

Cost shifting generally refers to the shifting of expenses, including investment expenses, previously incurred by railroads to shippers or other entities such as equipment lessors. Cost shifting also refers to additional costs incurred by shippers or other entities as a result of changes in railroad operations. Examples of cost shifting are:

- A shift in railcar ownership and associated expenses such as maintenance and insurance from railroads to others (shippers, leasing/finance companies).
- Increased railcar maintenance standards required by railroads, which the railroads argue are necessary to maintain service and capacity.
- Increases in accessorial charges, new charges such as finance charges, "no bill" charges, charges for faxing versus electronic transmission, higher demurrage charges, private car storage charges, and car cleaning charges.
- Deterioration in railroad service causing the increased use of shipper labor to monitor railroad performance.
- Deterioration in railroad service causing the increased use of shipper labor to unload railcars.

- The use of additional trucking to transport haul to more distant terminals, which railroads argue helps lower cost and improve service capacity.
- Increased highway congestion and maintenance because of the increased use of trucking.

Railroad Earnings

Shippers did not generally comment much on railroad earnings; they were more focused on rate issues, as discussed above. On the other hand, railroads and analysts had the following to say about earnings:

- After decades of sub-par earnings, the railroad industry is just now achieving revenue adequacy and this financial environment needs to continue so that railroads can reinvest in their networks. Some shippers have also expressed the opinion that higher rail rates and earnings are more palatable to the extent that railroads increase their investments.
- The real test of revenue adequacy is Wall Street's view of railroads and whether they can attract capital from the investment community.
- There is a link between capacity and earnings in that scarce capacity justifies higher earnings, but should then lead to increased investment.

The earnings of private equipment owners, such as banks and investment companies, are also important for the supply of industry capacity. Given that private equipment owners control a significant portion of the railcar fleet, their investment decisions are very important for the industry, particularly if the capacity crunch predicted by many stakeholders actually materializes. Many private owners are associated with large banks and finance companies that have alternative uses of funds. These entities must determine whether they are attaining sufficient returns on rail investments to merit further investment.

Access to Rail Networks

The "rationalization" or "optimization" of networks by railroads has resulted in reduced access to rail networks (e.g., fewer intermodal facilities and loading sites) and increased costs of access for some shippers. Rationalization or optimization is attributed by some to reduced competition resulting from mergers.

The reduced access to rail networks seems to be a particularly acute issue for small grain shippers who, because of the implementation of

shuttle trains, now have to transport grain by truck to more distant terminals. Other agricultural commodity shippers also noted the access problem. Some commented that the access issue is more important to them than the railroad rate issue.

Many who expressed concerns about access to rail networks also pointed to the common carrier obligation (CCO) of railroads. This issue is particularly significant for shippers of hazardous materials, and concerns about this matter have prompted the STB to open a proceeding to investigate what the common carrier obligation of railroads should be.[10]

Issues Related to Class II and Class III Railroads

Some smaller railroads expressed a number of concerns, including the following:

- Class I railroads "cherry pick" traffic; they are primarily interested in long-haul movements and don't want a lot of the shorter-haul manifest traffic that is profitable for the smaller railroads, resulting in a loss of potential business for smaller railroads.
- The difference in what Class I railroads and smaller railroads view as desirable traffic is related to the capacity issue. To the extent Class I capacity is constrained, the types of carload traffic that smaller railroads can generate will likely suffer. Such consequences are also likely to worsen if Class I investment does not keep pace with demand.
- Pricing by Class I railroads often works to the detriment of smaller railroads. Smaller railroads often find that they are unable to generate or keep business because the prices for the Class I part of the movement are too high. As a result, smaller railroads often lose business to trucks.
- Related to this issue, Class I railroads are more frequently using automated, web-based pricing (usually based only on distance and tonnage) that is often higher than if the smaller railroad interlining with either the Class I or the shipper were able to have discussions with a marketing representative from the Class I railroads. Smaller railroads noted that it is getting harder for them to gain access and talk to Class I marketing representatives.
- Class II and III railroads that interline with Class I railroads often do not have control over service quality (e.g., variability

[10] STB Ex Parte 677, Common Carrier Obligation of Railroads−Transportation of Hazardous Materials, June 4, 2008.

of delivery times) because the Class I railroads ultimately determine the service quality for the entire movement.

- Because many of their networks consist of abandonments of Class I railroads' less well maintained routes, smaller railroads have had to undertake significantly greater investments (proportionately speaking) than Class I railroads.
- There is a difference of opinion, even among smaller railroads, on the paper barrier issue.
  - While many see a need for some type of arrangement when Class I railroads spin-off or "outsource" lighter density lines to smaller railroads, it is viewed by many as an impediment to competition.
  - On the other hand, some see paper barriers as providing a better alternative to the simple abandonment of lines by Class I railroads or continued operation at increasingly higher costs with poorer service. Some feel that without paper barriers it is unlikely that the smaller railroads will be able to acquire lines from the Class I railroads in the near future.
  - Some view the paper barriers as often being a captive shipper issue (because the shipper would still be captive if control of the line in question reverted back to the original Class I owner) that should be resolved through STB captive-shipper processes.
  - Some are of the opinion that paper barrier issues should be resolved through the Rail Industry Working Group (RIWG) and not through legislation.
- Some shippers also opined that some shortline networks are seriously underfunded.

Legislative Proposals

There was mixed support among shippers for the various bills pending before Congress. A number of respondents who supported legislative reforms stated that they believed Canadian rail regulation would work in the U.S. For example, some shippers believe that final-offer arbitration and zone switching would improve competitiveness.

- In support of zone switching, some shippers noted that where reciprocal switching exists in the U.S., they benefit from greater competitive options.

- Other shippers supported reciprocal switching and bottleneck rates as ways of increasing competition.
- While many respondents did not believe that the proposal to remove antitrust exemptions would produce any benefits, others believed that the removal of the exemptions is needed to make the industry more competitive. Those supporting the removal of the antitrust exemptions also thought it is important for the DOJ to have oversight powers in the event of future merger proposals.

Railroads, some shippers, and financial analysts expressed the opinion that the proposed legislative reforms would result in less investment and, thus, exacerbate capacity problems. A few consultants and academics also expressed the view that many of the issues, which the proposed legislative reforms are attempting to resolve, are not effectively addressed because true solutions require a comprehensive, multi-modal view of transportation issues; the issues and solutions are bigger than just rail. Finally, as noted above, there is disagreement on whether more needs to be done on the paper barrier issue.

STB Issues

An opinion expressed by a number of respondents is that the various legislative reforms are not necessary and that the focus should be on making the STB work better. These respondents hold the opinion that, overall, the current system is working well and that the real need is for more effective protections for those shippers who do not have competitive alternatives.

However, other respondents expressed the view that the STB has created a situation where legislative reform is necessary—e.g., "by giving the railroads an unregulated monopoly, the STB has made certain that the only way the situation can be made tolerable is through legislation by Congress."

One of the major criticisms of the STB's procedures focuses on the stand-alone cost (SAC) process for large rate cases, which is viewed as expensive, time-consuming, and one-sided. In addition, a number of shippers commented that changes in the STB's procedures made the SAC process a moving target that added expense and time to the process. In this regard, most shippers who have access to the large rate case process said they would not use it. Some shippers, who believe that the SAC process is one-sided in favor or railroads, reported that railroads use this process in their rate negotiations as leverage.

Other comments relating to the STB include:

- The definition of "effective competition" (based on access to more than one railroad) prohibits STB oversight in cases where railroads are not behaving competitively. Closely related to this point, imposing trackage rights as a condition of merger in "2:1" situations has not successfully resolved anticompetitive situations.
- STB competitive access rules are outdated; they were developed at a time when railroads were more abundant and competed.
- The application of the Staggers Act by the STB has not caught up with "modern times."
- The STB is overly concerned with revenue adequacy issues and does not adequately consider shipper concerns. Additionally, the STB has a very narrow view of its jurisdiction.
    - In this regard, one shipper opined that if the STB charter were to be changed to create a level playing field for both shipper and railroad interests, then revenue adequacy would no longer be a valid measurement.
    - Another concern regarding the STB's revenue adequacy standard was stated as follows:

> The STB acts under the principle that if railroad monopolies were required to operate in free and open markets, they would suddenly begin pricing services at unsustainable levels, generating inadequate infrastructure capital. In reality however, we must presume that railroads, like any business would instead act responsibly and with self control, pricing services at reasonable and sustainable levels, posing little risk to investment capital supply.

- STB procedures (other than the SAC process) have not provided shipper relief.
    - The small rate case procedure has been in place since 1995 but has not been used.
    - Three cases have been recently filed under simplified guidelines, but it is not yet known whether these rules will provide meaningful relief to shippers.

- Several shippers expressed hesitancy in bringing rate cases or complaints before the STB because of possible retribution by railroads.
- The STB needs to be more involved in the oversight of public tariffs.
- The STB is on the side of the railroads. (This is a widespread perception among shippers, many of whom pointed to the career paths of a number of former Commissioners.)

5D. ADDITIONAL RESEARCH CONSIDERATIONS

The comments we received from various stakeholders provided guidance for our empirical research. However, not all stakeholders' concerns could be examined in our study because a number of issues were either beyond the scope of this project or because sufficient data were not available to perform a comprehensive empirical analysis. Below, we discuss a number of such issues that could be the basis of additional research or lead to a dialog on the collection of appropriate and/or sufficient data to allow analysis of the issues. The issues listed do not necessarily comprise an exhaustive compilation of the issues that merit further investigation, but rather reflect concerns that are important to various stakeholders who provided input to us during the current study.

Capacity—Railroad Equipment Markets

These capacity issues relate to the question of whether railroad equipment markets operate efficiently, supplying the appropriate amount of equipment. For example:

- Do deprescription and other car-hire rules need to be examined? One complaint we heard was that even though private car ownership now represents approximately 70% of the nation's railcar fleet, AAR committees that set rules are dominated by the Class I railroads with token representation by private car owners. Some interviewees felt that this practice will cause (or already has caused) private capital to leave the market, resulting in equipment shortages.
- What is the role of TTX in managing the pool of specialized cars such as intermodal cars and automobile cars and does their ownership by the Class I railroads result in a misallocation of resources that favors railroads over shippers.[11] For example,

[11] TTX is the largest rail car provider in the United States. It is jointly owned by a number of railroads, including the seven Class I railroads.

one shipper complained that TTX was not very effective in getting empty cars back to shippers expeditiously because TTX favored railroads' interests over shippers' interests.

Rates—Fuel Surcharges

Although the STB has begun to collect data on fuel surcharges, the data are not sufficient to examine a number of issues related to these surcharges. [12] For example, it was asserted that the new STB rules still don't "have it right" and railroad finance people know how to manipulate the system. As another illustration of the claimed inadequacy of the new rules, it has been stated that the wide variation in surcharges "makes no sense."

Costs of Service Quality Issues

As mentioned above, an important aspect of service quality is the possibility of additional costs placed on shippers because of service quality problems. Some of the costs incurred by shippers because of railroad service quality problems are:

- The need to hold additional inventories because of uncertain/variable deliveries. In this regard, some shippers said that consistency of service is more important than speed.
- The need to have larger fleets of railcars to ensure adequate deliveries.
- The need to dedicate shipper personnel to the monitoring of railroad performance.
- Congestion in ports caused by additional lead time used as a hedge against service variance.

Cost Shifting

Potential research questions related to cost shifting include:

- Are the investment incentives in equipment markets appropriately aligned with the industry's needs? As an example, third-party owners are concerned that deprescription is an issue that needs to be examined.

[12] http://www.stb.dot.gov/econdata.nsf/260029d11703bd498525740100662c49?OpenView&Start=1&Count=300&Collapse=1#1.

- Can we measure the extent of cost shifting? This topic includes not only the amount, but also who is affected. For example, not only have shippers told us about cost shifting, but this phenomenon also appears to be an important factor in the equipment leasing business.
    - What is the net effect of cost shifting on the rail prices paid by shippers? There are a number of related questions here. For example:
        - Is cost shifting associated with any offsetting cost or rate reductions enjoyed by shippers?
        - Do railroad efficiency gains outweigh the amount of cost shifting? If so, are these efficiency gains shared with shippers? For example, private railcar owners claim that railroads require them to incur costs to improve the performance of railcars and that railroads benefit from these required expenditures—e.g., less maintenance, fewer derailments, higher train speeds—without sharing any of the benefits with car owners or shippers.
    - Is cost shifting the result of railroads' prioritizing their investments? For example, we have heard the opinion that railroads would rather invest in rails than cars with their given budgets. Would such a decision on the part of railroads be indicative of anti-competitive behavior?
    - In contrast to the efficiency explanation for cost shifting, we have heard the opinion that cost shifting is an example of railroads' exercising their market power.

Network Access

Potential research questions here include:

- Is reduced access the product of railroad network optimization?
- If so, have there been gains in efficiency?
- Are any efficiency gains reflected in the rates paid by shippers?

- Are any increased shipper costs—e.g., added trucking—offset by lower rail rates?
- Are costs also shifted to the public—e.g., greater highway maintenance?

Critical Evaluation of Rail Demand Growth Projections

There are a number of studies that project a widening gap between the demand for rail services and railroad capacity—e.g., the Cambridge Systematics study commissioned by the AAR. These demand projections provide a basis for projecting investment needs and support for the importance of continued railroad earnings growth.

Because of the important implications of these demand projections, there needs to be a critical evaluation of these projections and rail capacity needs. Supporting this need for a critical evaluation, we have heard in our interviews that the projections of long-term rail demand are overstated by many studies and, thus, the demand-capacity balance may not be as "painful" as these studies predict.

CONCLUSION

Since the passage of the Staggers Act, the GAO has issued a number of reports about the performance of the U.S. freight railroad industry. The GAO has noted that these reports have largely been in response to Congressional concern over the appropriate balancing of railroad and shipper interests, and the railroad industry's continued viability and ability to fulfill demands for its services. The 2006 GAO report noted that, after a long-term downward trend in railroad rates since the passage of the Staggers Act, increases began to occur in the early 2000s. The question posed by the GAO was whether the observed pattern in railroad rates was the reflection of economic market forces or the exercise of market power against captive shippers by railroads.

In our qualitative research, we found that many stakeholders were of the opinion that there have been significant changes in the railroad industry during the last three to five years. These changes include:

- Increases in rates
- Changes in contract terms
- Deterioration of service quality
- Increased cost shifting
- Railroad attitudes toward shippers ("take it or leave it")

Many respondents attributed these changes to the railroads' exercise of market power. However, as noted by other respondents, it is also possible that these changes are related to the capacity constraints described above and that what is being observed is a "normal" market adjustment process—i.e., structural shifts—and not the exercise of market power.

Many of the opinions expressed to us represent an inherent tension between the view that railroads are private, profit-maximizing firms operating under competitive conditions versus the view that railroads are "public utility" firms with market power and they need to be regulated. Moreover, the public utility view also implies an expansive view of the railroads' common carrier obligation, similar to universal service obligations of regulated network industries such as electricity, telecommunications, and the U.S. Postal Service. The public utility view is also reflected in the opinion that railroad investment needs to first consider the best interests of the public, not the profit maximization of railroads. Thus, a fundamental unresolved question appears to be, what are the railroad industry's obligations to its various stakeholders?

APPENDIX 5-A
MEMBERS OF ADVISORY PANEL

Coal Shippers	
Mike Scanlan	PPL Energy Plus, LLC
Jack Reid	Seminole Electric Cooperative
Duane Richards	Western Fuels Association, Inc.
Terry Huval	Lafayette Utility Systems
Grain Shippers	
Scott Frederickson	ADM
Chemical Shippers	
David McGregor	BASF
Cindy Elliot	Dow Chemical
Stuart Agler	ExxonMobil
Non-Metallic Minerals	
Rick Everist, Jr.	L.G. Everist, Inc.
Building Materials	
Wayne Johnson	American Gypsum
Retailers	
Anthony Brooks	Sears Holdings Company
Ken Braunbach	Wal-Mart
Intermodal	
Paul Bergant	JB Hunt
Tom Jensen	UPS
Railroads	
John Lanigan	BNSF
Marcella Szel	Canadian Pacific
Ed Burkhardt	Rail World, Inc.
Daniel Sabin	Iowa Northern Railway Company
Richard Webb	Watco Companies
Peter Gilbertson	Anacostia & Pacific
Investors	
John Larkin	Stifel Nicolaus
Dennis Neumann	The Bank of New York Mellon
Government	
Bruce Blanton	USDA - Agricultural Marketing Service
Ron Jarmin	Department of Commerce
Academics	
Ronald Braeutigam	Northwestern University
William G. Waters II	University of British Columbia
Richard W. Barsness	Lehigh University
Dorsey D. Ellis	Washington University School of Law

VOLUME 1 REFERENCES

"6 High-Tech Advances," *Trains*, 68(11), November 2008.

Simon P. Anderson and Wesley W. Wilson, "Spatial Competition, Pricing, and Market Power in Transportation: A Dominant Firm Model," *Journal of Regional Science*, 48(2), 2008, pp. 367-398.

Association of American Railroads, "Class I Railroad Statistics," July 17, 2008.

Association of American Railroads, "The Economic Impact of America's Freight Railroads," August 2008.

Association of American Railroads, "The Effects of Rail Mergers on the Number of Class I Railroads and Shipper Captivity," August 2008.

Association of American Railroads, "Freight Railroads: A Historical Perspective," August 2008.

Association of American Railroads, "Overview of America's Freight Railroads," September 2008.

Association of American Railroads, "Rail Intermodal Transportation," June 2008.

Association of American Railroads, "Railroad Ten-Year Trends: 1980-1989," Vol. 7.

Association of American Railroads, "Railroad Ten-Year Trends: 1990-1999," Vol. 17.

Association of American Railroads, "Railroad Ten-Year Trends: 1997-2006," Vol. 24.

Association of American Railroads, "Railroads and Coal," July 2008.

Association of American Railroads, "Railroads and Grain," July 2008.

Scott E. Atkinson and Joe Kerkvliet, "Measuring the Multilateral Allocation of Rents: Wyoming Low-Sulfur Coal," *Rand Journal of Economics*, 17(3), 1986, pp. 416-30.

A. Barbera, C. M. Grimm, K. A. Phillips, and L. J. Selzer, "Railroad Cost Structure − Revisited," *Journal of the Transportation Research Forum*, 28(1), 1987, pp. 237-244.

C. C. Barnekov and Andrew N. Kleit, "The Efficiency Effects of Railroad Deregulation in the United States," *International Journal of Transport Economics,* 17(1), 1990, pp. 21-36.

Francis Bator, "The Anatomy of Market Failure," *The Quarterly Journal of Economics*, 72(3), 1958, pp. 351-379.

William J. Baumol and David F. Bradford, "Optimal Departures from Marginal Cost Pricing," *The American Economic Review*, 60(3), 1970, pp. 265-283.

Bell Communications Research, *Econometric Estimation of the Marginal Operating Cost of Interstate Access*, Special Report SR-FAD-000552, 1987.

Ernst R. Berndt, Ann F. Friedlaender, Judy Shaw-Er Wang Chiang, and Christopher A. Vellturo, "Cost Effects of Mergers and Deregulation in the U.S. Rail Industry," *Journal of Productivity Analysis*, 4(1-2), 1993, pp. 127-144.

John D. Bitzan, "Railroad Costs and Competition: The Implications of Introducing Competition to Railroad Networks," *Journal of Transport Economics and Policy,* 37(2), May 2003, pp. 201-225.

John D. Bitzan and Theodore E. Keeler, "Economies of Density and Regulatory Change in the U.S. Railroad Freight Industry," *Journal of Law and Economics,* 50(1), February 2007, pp. 157-179.

John D. Bitzan and Theodore E. Keeler, "Productivity Growth and Some of Its Determinants in the Deregulated U.S. Railroad Industry," *Southern Economic Journal*, 70(2), October 2003, pp. 232-253.

John D. Bitzan and Wesley W. Wilson, "Industry Costs and Consolidation: Efficiency Gains and Mergers in the U.S. Railroad Industry," *Review of Industrial Organization*, 30(2), 2007a, pp. 81-105.

John D. Bitzan and Wesley W. Wilson, "A Hedonic Cost Function Approach to Estimating Railroad Costs," *Research in Transportation Economics*, 20(1), 2007b, pp. 69-95.

George H. Borts, "Production Relations in the Railway Industry," *Econometrica*, 20(1), 1952, pp. 71-79.

George H. Borts, "Increasing Returns in the Railway Industry," *Journal of Political Economy*, 28(1), 1954, pp. 316-33.

George H. Borts, "The Estimation of Rail Cost Functions." *Econometrica*, 28(1), January 1960, pp. 108-31.

Kenneth D. Boyer, "The Cost of Price Regulation: Lessons from Railroad Deregulation," *Rand Journal of Economics,* 18(3), 1987, pp. 408-416.

Kenneth D. Boyer, *Principles of Transportation Economics*, (Reading, MA: Addison-Wesley), 1997.

Ronald R. Braeutigam, "Learning About Transport Costs," in *Essays in Transportation Economics and Policy: A Handbook in Honor of John R. Meyer*, J. A. Gomez-Ibanez, W. B. Tye, and C. Winston, eds., (Washington, DC: Brookings Institution), 1999, pp. 59-98.

Ronald R. Braeutigam, Andrew F. Daughety, and Mark A. Turnquist, "The Estimation of a Hybrid Cost Function for a Railroad Firm," *Review of Economics and Statistics*, 64(3), 1982, pp. 394-404.

Ronald R. Brauetigam, Andrew F. Daughety, and Mark A. Turnquist, "A Firm Specific Analysis of Economies of Density in the Railroad Industry," *The Journal of Industrial Economics*, 33(1), 1984, pp. 3-20.

Timothy F. Bresnahan, "Empirical Studies of Industries with Market Power," in *Handbook of Industrial Organization,* Volume 2, R. Schmalensee and R. D. Willig, eds., (Amsterdam: North Holland), 1989, pp. 1011-1057.

Randall S. Brown, Douglas W. Caves, and Laurits R. Christensen, "Modelling the Structure of Cost and Production for Multiproduct Firms," *Southern Economic Journal*, 46(1), 1979, pp. 256-273.

Mark L. Burton, "Railroad Deregulation, Carrier Behavior, and Shipper Response: A Disaggregated Analysis," *Journal of Regulatory Economics* 5(4), 1993, pp. 417-34.

Mark L. Burton and Wesley W. Wilson, "Network Pricing: Service Differentials, Scale Economies, and Vertical Exclusion in Railroad Markets," *Journal of Transport Economics and Policy*, 40(2), 2006, pp. 255-77.

Douglas W. Caves and Laurits R. Christensen, "The Importance of Scale, Capacity Utilization, and Density in Explaining Interindustry Differences in Productivity Growth," *The Logistics and Transportation Review*, 24(1), 1988, pp. 3-32.

Douglas W. Caves, Laurits R. Christensen, and Joseph A. Swanson, "Productivity Growth, Scale Economies, and Capacity Utilization in U.S. Railroads, 1955-74," *American Economic Review*, 71(5), 1981, pp. 994-1002.

Douglas W. Caves, Laurits R. Christensen, and Joseph A. Swanson, "Productivity in the U.S. Railroads, 1951-74," *Bell Journal of Economics,* 11(1), 1980, pp. 166-181.

Douglas W. Caves, Laurits R. Christensen, Michael W. Tretheway, and Robert J. Windle, "Network Effects and the Measurement of Returns to Scale and Density for U.S. Railroads," in *Analytical Studies in Transport Economics*, A.F. Daugherty, ed., (Cambridge, MA: Cambridge University Press), 1985, pp. 97-120.

Dianne Christensen, Laurits Christensen, Charles Guy, and Donald O'Hara, "U.S. Postal Service Productivity: Measurement and Performance," in *Regulation and Nature of Postal and Delivery Services*, M. A. Crew and P. R. Kleindorfer, eds., (Boston: Kluwer Academic Publishers), 1993, pp. 237-260.

Laurits R. Christensen, Dale W. Jorgenson, and Lawrence J. Lau, "Conjugate Duality and the Transcendental Logarithmic Production Function," *Econometrica*, 39(4), July 1971, pp. 255-256.

Laurits R. Christensen, Dale W. Jorgenson, and Lawrence J. Lau, "Transcendental Logarithmic Production Frontiers," *Review of Economics and Statistics*, 55(1), February 1973, pp. 28-45.

John M. Clark, *Studies in the Economies of Overhead* Costs, (Chicago, IL: University of Chicago Press), 1923.

Scott M. Dennis, "Changes in Railroad Rates since the Staggers Act," *Transportation Research Part E*, 37, 2000, pp. 55-69.

Jade Alice Eaton and Judith A. Center, "A Tale of Two Markets: The ICC's Use of Product and Geographic Competition in the Assessment of Rail Market Dominance," *Transportation Practitioners Journal*, 53(1), 1985, pp. 16-35.

Federal Communications Commission, *In the Matter of Policy and Rules Concerning Rates for Dominant Carriers, Report and Order and Second Further Notice of Proposed Rulemaking*, CC Docket No. 87-313, FCC 89-91, March 16, 1989.

Federal Communications Commission, *Preparation for Addressing Universal Service Issues: A Review of Current Interstate Support Mechanisms*, February 23, 1996.

Ann F. Friedlaender, "The Social Costs of Regulating the Railroads," *American Economic Review*, 61(2), 1971, pp. 226-34.

Ann F. Friedlaender, Ernst R. Berndt, Judy Shaw-Er Wang Chiang, Mark Showalter, and Christopher A. Vellturo, "Rail Costs and Capital

Adjustments in a Quasi-Regulated Environment," *Journal of Transport Economics and Policy*, 27(2), May 1993, pp. 131-152.

Ann F. Friedlaender and Richard H. Spady, *Freight Transport Regulation*, (Cambridge, MA: The MIT Press), 1981.

Government Accountability Office, *Freight Railroads: Industry Health Has Improved, but Concerns about Competition and Capacity Should Be Addressed,* GAO-07-94, October 2006.

Government Accountability Office, *U.S. Postal Service: the Service's Strategy for Realigning its Mail Processing Infrastructure Lacks Clarity, Criteria, and Accountability*, GAO-05-261, April 2005.

P. V. Garrod and W. Miklius, "'Captive Shippers' and the Success of Railroads in Capturing Monopoly Rent," *Journal of Law and Economics*, 30(2), 1987, pp. 423-442.

Curtis M. Grimm, Clifford Winston, and Carol A. Evans, "Foreclosure of Railroad Markets: A Test of Chicago Leverage Theory," *The Journal of Law and Economics*, 35(2), October 1992, pp. 295-310.

Robert G. Harris, "Economies of Traffic Density in the Rail Freight Industry," *Bell Journal of Economics*, 8(2), 1977, pp. 556-564.

Ross C. Hemphill, Mark E. Meitzen, and Philip E. Schoech, "Incentive Regulation in Network Industries: Experience and Prospects in the U.S. Telecommunications, Electricity, and Natural Gas Industries," *Review of Network Economics*, 2(4), 2003, pp. 316-337.

Marc Ivaldi and Gerard J. McCullough, "Density and Integration Effects on Class I U.S. Freight Railroads," *Journal of Regulatory Economics*, 19(2), March 2001, pp. 161-182.

Marc Ivaldi and Gerard J. McCullough, "Railroad Pricing and Revenue-to-Cost Margins in the Post-Staggers Era," in *Railroad Economics*, S. M. Dennis and W. K. Talley, ed., (Amsterdam: Elsevier Science), 2007, pp. 153-178.

Marc Ivaldi and Gerard J. McCullough, "Subadditivity Tests for Network Separation with an Application to U.S. Railroads," *Review of Network Economics,* 7(1), March 2008, pp. 159-171.

Sergio Jara-Diaz, "The Estimation of Transport Cost Functions: A Methodological Review," *Transport Reviews*, 2(3), 1982, pp. 257-78.

Theodore E. Keeler, "Railroad Costs, Returns to Scale, and Excess Capacity," *Review of Economics and Statistics*, 56(2), 1974, pp. 201-208.

Theodore E. Keeler, *Railroads, Freight, and Public Policy*, (Washington, DC: The Brookings Institution), 1983.

L. R. Klein, *Textbook on Econometrics,* (Evanston, Illinois: Row, Peterson and Company), 1953.

Tenpao Lee and C. Phillip Baumel, "The Cost Structure of the U.S. Railroad Industry under Deregulation," *Journal of the Transportation Research Forum*, 28(1), 1987, pp. 245-253.

D. Phillip Locklin, *Economics of Transportation*, (Homewood, IL: Irwin), 1972.

M. O. Lorenz, "Cost and Value of Service in Railroad Ratemaking," *Quarterly Journal of Economics*, 30(2), 1916, pp. 205-232.

James M. MacDonald, "Competition and Rail Rates for the Shipment of Corn, Soybeans, and Wheat," *Rand Journal of Economics*, 18(1), 1987, pp. 151-163.

James M. MacDonald, "Railroad Deregulation, Innovation, and Competition: Effects of the Staggers Act on Grain Transportation," *Journal of Law and Economics*, 32, 1989, pp. 63-96.

Patrick S. McCarthy, *Transportation Economics*, (Oxford: Blackwell), 2001.

Henry McFarland, "The Effects of United States Railroad Deregulation on Shippers, Labor, and Capital," *Journal of Regulatory Economics,* 1, 1989, pp. 259-270.

S. A. Morrison and C. Winston, "Regulatory Reform of U.S. Intercity Transportation," in *Essays in Transportation Economics and Policy: A Handbook in Honor of John R. Meyer*, J. A. Gomez-Ibanez, W. B. Tye and C. Winston, eds., (Washington, DC: Brookings Institution Press), 1999, pp. 469-492.

Tae H. Oum and William G. Waters II, "A Survey of Recent Developments in Transportation Cost Function Research," *Logistics and Transportation Review*, 32(4), 1996, pp. 423-463.

Tae H. Oum, William G. Waters II, and Chunyan Yu, "A Survey of Productivity and Efficiency Measurement in Rail Transport," *Journal of Transport Economics and Policy*, 33(1), 1999, pp. 9-42.

Dudley Pegrum, *Transportation Economics and Public Policy*, (Homewood, IL: Richard D. Irwin), 1963.

A. C. Pigou, *Wealth and Welfare,* (London and New York: MacMillan), 1913.

Postal Accountability and Enhancement Act, Pub. L. No. 109-435, 120 Stat. 3198, (2006).

Postal Regulatory Commission, PI2008-3, Report on Universal Service and the Postal Monopoly, 2008.

Presidential Advisory Committee on Transport Policy and Organization, *Revision of Federal Transportation Policy*, (Washington, DC: U.S. Government Printing Office), 1955.

Progressive Railroading, 51(6), June 2008.

F. P. Ramsey, "A Contribution to the Theory of Taxation," *The Economic Journal*, 37, 1927, pp. 47-61.

B. Roy, "Technico-Economic Analysis of the Costs of Outside Work in Postal Delivery," in *Emerging Competition in Postal and Delivery Services*, M. A. Crew and P. R. Kleindorfer, eds., (Boston: Kluwer Academic Publishers), 1999, pp. 101-122.

Paul A. Samuelson, "Spatial Price Equilibrium and Linear Programming," *The American Economic Review*, 42(3), 1952, pp. 283-303.

Stephen Schmidt, "Market Structure and Market Outcomes in Deregulated Rail Freight Markets," *International Journal of Industrial Economics*, 19(1-2), 2001, pp. 99-131.

Richard Shin and John Ying, "Unnatural Monopolies in Local Telephone," *Rand Journal of Economics*, 23(2), 1992, pp. 171-183.

Oz Shy, *The Economics of Network Industries*, (Cambridge: Cambridge Press), 2001.

Surface Transportation Board, Class I Railroad Annual Report (Form R-1), Reports filed by all Class I railroads, 1987 through 2006.

Surface Transportation Board, Ex Parte No. 677, Common Carrier Obligation of Railroads, Notice, February 22, 2008.

Surface Transportation Board, Ex Parte No. 677, Common Carrier Obligation of Railroads, Decision, April 15, 2008.

Surface Transportation Board, Ex Parte No. 677, Common Carrier Obligation of Railroads–Transportation of Hazardous Materials, Notice of Public Hearing, June 4, 2008.

Surface Transportation Board, Ex Parte No. 677, Common Carrier Obligation of Railroads–Transportation of Hazardous Materials, Notice of Public Hearing, July 16, 2008.

Surface Transportation Board, Quarterly Report of Rail Fuel Surcharges, at http://www.stb.dot.gov/econdata.nsf/260029d11703bd498525740100662c49?OpenView&Start=1&Count=300&Collapse=1#1.

Timothy J. Tardiff and William E. Taylor, "Aligning Price Regulation with Telecommunications Competition," *Review of Network Economics*, 2(4), 2003, pp. 338-354.

F. W. Taussig, "Railway Rates and Joint Cost Once More," *Quarterly Journal of Economics*, 27, 1913, pp. 378-84.

Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56, (1996).

Transportation Act of 1940, Pub. L. No. 76-785, § 1, 54 Stat. 898, 899 (1940).

U.S. Department of Transportation, "National Transportation Statistics," 2008.

U.S. v. Am. Tel. & Telegraph Co., 522 F. Supp. 131 (D.D.C. 1982).

Christopher A. Vellturo, Ernst R. Berndt, Ann F. Friedlaender, Judy Shaw-Er Wang Chiang, and Mark H. Showalter, "Deregulation, Mergers, and Cost Savings in Class I U.S. Railroads, 1974-1986," *Journal of Economics & Management Strategy*, 1(2),1992, pp. 339-369.

John Waller, Director of Office of Accountability and Compliance, on behalf of the Postal Regulatory Commission, before the U.S. House of Representatives Committee on Oversight and Government Reform, Subcommittee on Federal Workforce, Postal Service, and the District of Columbia, July 24, 2008.

William G. Waters, "Evolution of Railroad Economics," in *Research in Transport Economics*, S. M. Dennis and W. K. Talley, eds., 20, 2007, pp. 11-68.

William G. Waters and A. D. Woodland, *Econometric Analysis and Railway Costing*, (Oxford, England: North Oxford Academic Publishing), 1984.

George W. Wilson, *Economic Analysis of Intercity Freight Transportation*, (Bloomington: Indiana University Press), 1980.

George W. Wilson, *Essays on Some Unsettled Question in the Economics of Transportation*, (Bloomington: Foundation for Economic and Business Studies), 1962.

Wesley W. Wilson, "Cost Savings and Productivity in the Railroad Industry," *Journal of Regulatory Economics*, 11(1), 1997, pp. 21-40.

Wesley W. Wilson, "Legislated Market Dominance," *Research in Transportation Economics*, 4(1), 1996, pp. 33-48.

Wesley W. Wilson, "Market-Specific Effects of Rail Deregulation," *Journal of Industrial Economics*, 42(1), 1994, pp. 1-22.

Wesley W. Wilson and Mark L. Burton, "The Economics of Railroad Operations: Resurgence of a Declining Industry," in *Handbook of Transportation Engineering*, Myer Kutz, ed., (New York: McGraw-Hill), 2004.

Wesley W. Wilson and William W. Wilson, "Deregulation, Rate Incentives, and Efficiency in the Railroad Market," in *Research in Transportation Economics*, 6, B. Starr McMullen ed., 2001, pp. 1-24.

William W. Wilson, Wesley W. Wilson, and Won W. Koo, "Model Competition in Grain Transport," *Journal of Transport Economics and Policy*, 22(3), 1988, pp. 319-37.

Clifford Winston, "Conceptual Developments in the Economics of Transportation: An Interpretive Survey," *Journal of Economic Literature*, 31(1), 1985, pp. 1263-1289.

Clifford Winston, "Economic Deregulation: Days of Reckoning for Microeconomists," *Journal of Economic Literature*, 31(3), 1993, pp. 1263-1289.

Clifford Winston, Thomas M. Corsi, Curtis M. Grimm, and Carol A. Evans, *The Economic Effects of Surface Freight Deregulation*, (Washington, DC: The Brookings Institute), 1990.

K. Eric Wolfe, "The Carload Waybill Statistics: A Content Analysis," *Transportation Research Forum – Proceedings*, 27(1), 1986, pp. 244-52.

K. Eric Wolfe, "The Interstate Commerce Commission's Public Use Waybill File: Concerns for Misinterpretation," *Journal of the Transportation Research Forum*, 32(1), 1991, pp. 263-265.

K. Eric Wolfe and W. P. Linde, "The Carload Waybill Statistics: Usefulness for Economic Analysis," *Journal of the Transportation Research Forum*, 36(2), 1997, pp. 26-41.

"Wyoming Coal Line Expansion," *Trains*, 68(11), November 2008.

John Ying and Richard Shin, "Costly Gains to Breaking Up: LECs and the Baby Bells," *Review of Economics and Statistics*, 75(2), 1993, pp. 357-361.