Economics of Coal Transportation: Implications for Railroad and Shipper Strategies

CURTIS M. GRIMM, KENT A. PHILLIPS, and LESLIE J. SELZER

ABSTRACT

The importance of coal to the railroad industry is explored in this paper. By drawing from Interstate Commerce Commission waybill sample and quarterly commodity statistics it is shown that coal accounts for more than 20 percent of total railroad revenues while individual railroads' coal-derived revenues ranged from less than 1 percent to 67 percent in 1983. Coal is also instrumental in achieving economies of density. Using the FRA network model, it is shown that traffic densities on lines over which coal moves far exceed those on lines that handle no coal traffic. Finally, implications for shipper and railroad strategies, including shippers' actions to limit coal rates and railroads' investment and disinvestment policies, are explored.

In 1973 the Oil Producing and Exporting Countries (OPEC) formed a cartel and substantially reduced oil supplies to the industralized countries of the West. Although the original motive for the curtailment of oil supplies was political in nature, the ultimate result of the OPEC alliance was a sharp increase in the price of oil and the end of the era of "cheap" energy. The United States, heavily dependent on foreign oil, responded to the escalation of oil prices by tapping its own huge supplies of coal. In addition, the 1973 oil embargo and subsequent energy legislation of 1974 and 1975, which requires that new electric generating plants be designed to burn coal unless exempted on environmental grounds, substantially increased the demand for coal and the ancillary need for transportation by rail.

Dependence on coal as a fuel source is expected to grow in the foreseeable future. In a 1983 study, the Department of Energy (1,p.24) reported that it expects total U.S. coal consumption to increase by 42 percent between 1985 and 1995. Continued reliance on coal is attributable to the high cost and perceived dangers of nuclear power--the only recognized broad-based alternative for generating electricity. In addition, despite recent declines in the price of oil, the uncertainty of future prices and supplies as well as legislation discouraging its use renders oil a weak competitor to coal.

The sharp rise in demand for coal has brought forth an extensive literature on coal transportation systems. Several studies, including those by the Maritime Transportation Research Board (2), Desai and Anderson (3), and Elmes (4), have examined the adequacy of existing coal transportation systems. Other authors have explored the impact coal has had on rail transportation. Heller (5) and Beier (6) have examined the complex interaction between rail transportation of coal and the rate structure for this commodity.

The importance of transporting coal to railroads and utilities is brought into sharp focus by the recent efforts of the Interstate Commerce Commission (ICC) to develop a maximum rate methodology for coal. The public record in Ex Parte No. 347 (sub-1) (7) is replete with data that point to the importance of coal to consumers of energy and to the railroads as a source of revenues and traffic densities. Groups such as the National Coal Association, Edison Electric Institute, Consumer Federation of America, and the Association of American Railroads have documented the dominance of coal as an energy source. Similarly, they all recognize the economic significance of coal to the railroad industry. After 7 years of experimenting with varying cost-base maximum rate formulas, the ICC adopted a flexible maximum rate guideline called constrained market pricing (CMP) in Ex Parte No. 347 (sub-1). CMP requires consideration of both supply and demand in determining the reasonableness of rates. The approach places four constraints on coal rates. First, railroad earnings can generally not exceed a competitive return (revenue adequacy). Second, railroads must be efficient; the cost of inefficiencies is deducted from a carrier's revenue need to ensure that revenue adequacy is based on an efficient operation. Third, rates cannot exceed those of an efficient competitor [the stand-alone cost (SAC) test], and finally, disruptive rate increases are to be phased in so as to prevent economic dislocations.

Despite the intense scrutiny of railroad coal transport, there remain several unanswered questions about the relationship among economies of density, the cost of transporting coal, and the overall importance of coal to the financial health of the railroad industry. The importance of coal to the railroad industry is examined here. The more traditional demand aspects of coal are reviewed, and the supply aspects of coal transportation are quantified. In the second section the importance of coal demand to railroads in terms of the revenues it provides is demonstrated. In the third section coal is viewed from the supply side. Relying on both aggregate industry data and specific carrier data, it is shown that coal is largely responsible for economies of density for railroads. The close link between coal and economies of density has important policy implications for railroad management and for shippers applying the SAC test. These implications are explored in the fourth section of the paper.

C.M. Grimm, College of Business and Management, University of Maryland, College Park, Md. 20742. K.A. Phillips and L.J. Selzer, Interstate Commerce Commission, Constitution Avenue and 12th Street, N.W., Washington, D.C. 20423.

IMPORTANCE OF COAL

Gross and Net Revenue Contribution

By virtually every measure coal is the most important commodity transported by the railroad industry. When viewed from the perspective of an individual carrier, its importance to the major rail systems is even more striking.

Tables 1-3 give data from ICC Form QCS, Quarterly Report on Commodity Statistics, for all major commodity groups for the years 1978 through 1984. As can be seen in Table 1, coal is the leading revenue source in each year followed by (in 1984) chemicals, transportation equipment, farm products, and food and kindred products. More important, coal shows the greatest growth in revenues of all commodities. In 1978 coal accounted for 13.8 percent of total railroad revenues; by 1984 this percentage had grown to 23.3 percent. This growth is even more dramatically shown through comparisons with other major rail commodities. Taking the next major revenue producer as an illustration, in 1978 coal revenues were 123 percent of chemical revenues; by 1984 coal revenues were 207 percent of chemical revenues. Finally, comparison of Table 1 with Tables 2 and 3 further emphasizes the significance of coal as a revenue producer. The data in these tables indicate that coal volumes (as measured by cars and tons originated) increased through 1981, declined somewhat in 1982 and 1983, then increased dramatically in 1984. Revenues continued to rise throughout this period, with the exception of 1983. If revenue per car and revenue per ton are calculated from the tables, average coal rates have increased for all years with the exception of revenue per ton in 1983. Revenues for many other commodities, on the other hand, followed the pattern of tons and carloads and declined in 1982 and 1983.

The importance of coal varies sharply by railroad. This is illustrated by Table 4, which gives the number of coal cars as a percentage of total cars for 1982. Coal cars represented more than 50 percent of movements for six railroads: Bessemer and Lake Erie, Chesapeake and Ohio, Clinchfield, Norfolk and Western, Pittsburgh and Lake Erie, and Western Maryland. In addition, coal represented 33 to 50 percent of traffic for five railroads: Baltimore & Ohio; Burlington Northern; Denver & Rio Grande; Elgin, Joliet & Eastern, and Louisville & Nashville. On the other hand, coal represented less than 10 percent of carloads for nine railroads: Boston & Maine; Delaware & Hudson; Duluth, Missabe & Iron Range; Florida East Coast; Grand Trunk Western; Soo; Southern Pacific; St. Louis Southwestern; and Western Pacific.

Another perspective on coal's importance as a commodity can be obtained from costed waybill data. The waybill is a stratified sample of railroad movements [for a further description of the data collected and statistical properties of the ICC waybill sample, see Fine and Owen (8)]. Because the waybill contains specific information on the characteristics of each movement, it is possible to develop estimates of movement costs that can be compared with recorded revenue information. The costs used for the purposes of this study are variable costs based on the Rail Form A (RFA) methodology (9) with standard adjustments for multiple-car and trainload movements. These adjustments include reduction of switching costs by 50 and 75 percent for multiple-car and trainload, respectively; reduction of station clerical cost by 25 percent for both types of movements; reduction of variable freight train car costs by 25 and 50 percent, respectively; elimination of inter- and intra-train switching for trainload movements; reduction of interchange switching costs by 50 percent for trainload movements; and elimination of way train costs for trainload movements. There is no adjustment for density, which, as discussed later, is also an important determinant of cost levels.

Tables 5-7 focus on the differential between revenues and variable costs. This differential is termed net revenue contribution. The present analysis will use two measures of rail output, car-miles and ton-miles, in evaluating net contribution. These tables provide revenues, costs, and contribution on a car-mile basis and total contribution on a commodity basis. They indicate that coal ranks ninth in average revenue per car-mile for commodities generating at least 1 percent of total car-miles. This suggests that coal rates are not disproportionate compared with those of other commodities. On the other hand, these tables also indicate that the cost of transporting coal is among the lowest of all commodities. The primary cost efficiencies recognized in the analysis are those associated with multiple-car and unit-train operations. In addition, a significant amount of coal moves in privately owned equipment, which relieves the railroads of the associated costs of car ownership. Because of these low costs, the contribution per car-mile for coal is among the highest of all commodities. Because the purpose here is to compare RFA costs across different commodities, inaccuracies in the method, which is invariant across commodities, will not affect the results. Moreover, the importance of coal's total net revenue contribution is robust with respect to subsequent changes in estimated costs.

Contribution on a ton-mile basis yields sharply different results. Tables 8-10 give revenues, costs, volumes, net contribution per ton-mile, and total contribution for the years 1981, 1982, and 1983. Of those commodities generating at least 1 percent of total ton-miles, coal yields the lowest average revenues per ton-mile. It also ranks last in every year in terms of average cost per ton-mile. As a consequence, contribution per ton-mile is close to the median.

When looking at revenue contribution it is important to consider volume as well as contribution per ton-mile. Coal ranks first in ton-miles transported. When ton-miles are multiplied by the contribution per ton-mile, coal yields the largest total revenue contribution of all commodities. It is noteworthy that coal's total revenue contribution grew by 29 percent from 1981 to 1982 and remained at approximately 1982 levels in 1983. Thus, despite coal's low average revenue per ton-mile, its importance to the railroads is apparent when viewed in the context of the heavy loadings per car, low cost per ton-mile, and large volumes transported.

In sum, coal is the most important commodity transported by the rail industry. Even in the economic downturn of 1982, coal's overall revenue rose 5 percent from 1981 levels, and cars and tons originated decreased 3 and 1 percent, respectively. In 1983 revenues returned to approximately 1981 levels, and cars and tons dropped by 9 and 6 percent, respectively, from 1981 levels. A more striking picture is presented by looking at total revenue contribution. This figure rose 29 percent from 1981 to 1982, and car-miles and ton-miles increased 9 to 11 percent. Data for 1983 show total contribution declined by 1 percent from 1982 to 1983, and car-miles and ton-miles decreased 5 and 3 percent, respectively. When these figures are contrasted with the decreased revenues and total revenue contribution for most other commodities, it becomes clear that coal is the most important source of revenues for the railroads.

TABLE 1 Yearly Statistics on Revenues by Major Commodity Group for All Class I U.S. Railroads

Commodity	1978 Total Revenues ($000s)	1978 Percentage of Total	1979 Total Revenues ($000s)	1979 Percentage of Total	1980 Total Revenues ($000s)	1980 Percentage of Total
Farm products	1,523,576	7.98	1,946,182	8.67	2,717,673	10.57
Forest products	14,925	0.08	16,486	0.07	14,707	0.06
Fresh fish or other marine products	1,474	0.01	1,394	0.01	1,284	0.00
Metallic ores	532,370	2.79	594,938	2.65	569,577	2.22
Coal	2,642,691	13.84	3,664,103	16.33	4,696,443	18.27
Crude petroleum, natural gas, and gasoline	16,940	0.09	15,129	0.07	17,394	0.07
Nonmetallic minerals	649,593	3.40	752,112	3.35	877,482	3.41
Ordinance or accessories	26,025	0.14	31,727	0.14	30,281	0.12
Food and kindred products	1,995,069	10.45	2,252,435	10.04	2,673,527	10.40
Tobacco products	19,002	0.10	22,604	0.10	24,107	0.09
Textile mill products	41,368	0.22	37,154	0.17	30,262	0.12
Apparel–finished textile products	7,844	0.04	9,353	0.04	8,803	0.03
Lumber and wood (except furniture)	1,341,751	7.03	1,417,743	6.32	1,414,572	5.50
Furniture and fixtures	96,745	0.51	99,952	0.45	92,223	0.36
Pulp, paper, and allied products	1,117,114	5.85	1,281,428	5.71	1,486,123	5.78
Printed matter	11,849	0.06	11,414	0.05	9,819	0.04
Chemicals	2,142,938	11.22	2,512,767	11.20	2,737,306	10.65
Petroleum or coal products	657,087	3.44	782,345	3.49	831,268	3.23
Rubber and miscellaneous plastics	132,694	0.69	151,144	0.67	141,130	0.55
Leather or leather products	2,175	0.01	2,633	0.01	2,513	0.01
Stone, clay, and glass products	775,918	4.06	875,833	3.90	881,152	3.43
Primary metal products	1,026,099	5.37	1,201,169	5.35	1,253,352	4.88
Fabricated metal products	103,712	0.54	105,701	0.47	101,778	0.40
Machinery except electrical	150,780	0.79	159,433	0.71	167,624	0.65
Other 36 categories	169,293	0.89	178,437	0.80	165,691	0.64
Transportation equipment	1,957,049	10.25	2,055,258	9.16	1,813,842	7.06
Instruments or photographic goods	2,972	0.02	3,684	0.02	3,173	0.01
Miscellaneous products of manufacturing	17,723	0.09	19,368	0.09	18,393	0.07
Waste or scrap materials	396,561	2.08	439,426	1.96	477,893	1.86
Miscellaneous freight shipments	37,800	0.20	47,022	0.21	48,343	0.19
Containers returned empty	52,460	0.27	58,848	0.26	47,916	0.19
Freight forwarder traffic	225,762	1.18	233,005	1.04	205,612	0.80
Shipper association traffic	406,510	2.13	501,656	2.24	520,804	2.03
Miscellaneous mixed shipments except forward	798,344	4.18	958,952	4.27	1,159,212	4.51
Less than carload traffic	23,222	0.12	23,649	0.11	14,590	0.06
Total	19,094,209	100.00	22,440,836	100.00	25,703,391	100.00

Source: Interstate Commerce Commission Quarterly Commodity Statistics Reports.

TABLE 2 Yearly Statistics on Tons Originated by Major Commodity Group for All Class I U.S. Railroads

Commodity	1978 Total Tons (000s)	1978 Percentage of Total	1979 Total Tons (000s)	1979 Percentage of Total	1980 Total Tons (000s)	1980 Percentage of Total
Farm products	114,899	9.12	125,917	9.20	151,038	10.30
Forest products	593	0.05	596	0.04	485	0.03
Fresh fish or other marine products	68	0.01	56	0.00	49	0.00
Metallic ores	110,565	8.78	117,688	8.60	103,507	7.06
Coal	354,040	28.11	439,521	32.12	482,603	32.93
Crude petroleum, natural gas, and gasoline	1,650	0.13	1,190	0.09	1,156	0.08
Nonmetallic minerals	118,467	9.41	118,019	8.62	113,900	7.77
Ordinance or accessories	415	0.03	450	0.03	372	0.03
Food and kindred products	85,779	6.81	84,047	6.14	84,428	5.76
Tobacco products	282	0.02	325	0.02	285	0.02
Textile mill products	657	0.05	467	0.03	307	0.02
Apparel–finished textile products	130	0.01	130	0.01	93	0.01
Lumber and wood (except furniture)	79,646	6.32	77,409	5.66	70,802	4.83
Furniture and fixtures	851	0.07	752	0.05	579	0.04
Pulp, paper, and allied products	34,002	2.70	34,480	2.52	34,712	2.37
Printed matter	253	0.02	219	0.02	158	0.01
Chemicals	98,353	7.81	103,314	7.55	100,366	6.85
Petroleum or coal products	41,301	3.28	41,445	3.03	36,937	2.52
Rubber and miscellaneous plastics	2,522	0.20	2,532	0.18	1,992	0.14
Leather or leather products	55	0.00	47	0.00	45	0.00
Stone, clay, and glass products	49,737	3.95	51,087	3.73	44,619	3.04
Primary metal products	57,351	4.55	60,743	4.44	50,543	3.45
Fabricated metal products	2,194	0.17	1,945	0.14	1,841	0.13
Machinery except electrical	2,266	0.18	2,055	0.15	1,942	0.13
Other 36 categories	2,229	0.18	2,101	0.15	1,719	0.12
Transportation equipment	29,498	2.34	27,939	2.04	22,194	1.51
Instruments or photographic goods	46	0.00	48	0.00	34	0.00
Miscellaneous products of manufacturing	207	0.02	212	0.02	179	0.01
Waste or scrap materials	34,670	2.75	35,243	2.58	31,655	2.16
Miscellaneous freight shipments	772	0.06	923	0.07	966	0.07
Containers returned empty	1,302	0.10	1,265	0.09	988	0.07
Freight forwarder traffic	4,037	0.32	3,925	0.29	3,066	0.21
Shipper association traffic	8,423	0.67	9,248	0.68	8,262	0.56
Miscellaneous mixed shipments except forward	22,126	1.76	23,170	1.69	23,786	1.62
Less than carload traffic	549	0.04	450	0.03	258	0.02
Total	1,259,385	100.00	1,368,507	100.00	1,465,704	100.00

Source: Interstate Commerce Commission Quarterly Commodity Statistics Reports.

1981		1982		1983		1984	
Total Revenues ($000s)	Percentage of Total	Total Revenues ($000s)	Percentage of Total	Total Revenues ($000s)	Percentage of Total	Total Revenues ($000s)	Percentage of Total
2,616,539	8.89	2,298,161	8.73	2,371,460	8.90	2,482,893	8.32
17,242	0.06	13,469	0.05	15,253	0.06	18,830	0.06
1,460	0.00	1,110	0.00	895	0.00	925	0.00
721,600	2.45	402,891	1.53	449,319	1.69	567,475	1.90
5,955,637	20.24	6,280,465	23.85	5,932,516	22.26	6,965,499	23.33
20,895	0.07	16,171	0.06	19,425	0.07	22,925	0.08
1,023,252	3.48	840,155	3.19	831,140	3.12	997,073	3.34
34,234	0.12	26,430	0.10	21,039	0.08	27,721	0.09
2,909,385	9.89	2,582,462	9.81	2,347,806	8.81	2,309,000	7.73
37,580	0.13	26,895	0.10	15,626	0.06	13,259	0.04
38,561	0.13	30,186	0.11	36,221	0.14	38,566	0.13
11,403	0.04	9,114	0.03	10,789	0.04	13,028	0.04
1,544,108	5.25	1,289,950	4.90	1,526,615	5.73	1,610,564	5.39
106,534	0.36	75,526	0.29	74,145	0.28	78,090	0.26
1,829,449	6.22	1,699,200	6.45	1,669,464	6.27	1,761,559	5.90
9,701	0.03	7,369	0.03	8,184	0.03	1,761,559	0.03
3,273,292	11.12	2,924,115	11.10	3,076,504	11.55	3,359,670	11.25
1,016,153	3.45	883,509	3.36	843,391	3.17	912,539	3.06
156,619	0.53	123,442	0.47	102,776	0.39	107,442	0.36
1,629	0.01	1,747	0.01	2,676	0.01	3,667	0.01
1,105,740	3.76	880,900	3.35	906,007	3.40	1,023,705	3.43
1,555,198	5.28	973,480	3.70	815,924	3.06	955,016	3.20
104,511	0.36	71,226	0.27	52,203	0.20	56,715	0.19
175,719	0.60	114,757	0.44	75,287	0.28	80,735	0.27
174,424	0.59	127,861	0.49	131,363	0.49	147,184	0.49
2,116,406	7.19	1,956,632	7.43	2,291,888	8.60	2,859,473	9.58
3,545	0.01	3,232	0.01	2,760	0.01	3,506	0.01
18,541	0.06	12,807	0.05	10,657	0.04	11,697	0.04
569,579	1.94	414,950	1.58	423,273	1.59	495,751	1.66
73,167	0.25	75,691	0.29	82,596	0.31	118,944	0.40
37,385	0.13	38,996	0.15	43,661	0.16	66,979	0.22
196,812	0.67	127,985	0.49	101,578	0.38	90,384	0.30
642,237	2.18	588,995	2.24	552,023	2.07	436,547	1.46
1,329,610	4.52	1,413,891	5.37	1,802,519	6.76	2,206,655	7.37
17,685	0.06		0.00		0.00	13,055	0.04
29,428,148	100.00	26,333,773	100.00	26,646,985	100.00	29,853,259	100.00

1981		1982		1983		1984	
Total Tons (000s)	Percentage of Total	Total Tons (000s)	Percentage of Total	Total Tons (000s)	Percentage of Total	Total Tons (000s)	Percentage of Total
138,056	9.63	131,532	10.54	142,204	11.05	151,128	10.57
485	0.03	352	0.03	434	0.03	547	0.04
49	0.00	36	0.00	28	0.00	27	0.00
113,719	7.94	62,576	5.01	68,413	5.32	85,503	5.98
518,472	36.18	513,891	41.17	489,243	38.01	566,647	39.65
1,208	0.08	1,035	0.08	1,405	0.11	2,082	0.15
108,953	7.60	83,786	6.71	96,145	7.47	108,188	7.57
360	0.03	276	0.02	312	0.02	430	0.03
81,429	5.68	75,630	6.06	75,198	5.84	72,058	5.04
532	0.04	364	0.03	251	0.02	191	0.01
498	0.03	328	0.03	391	0.03	421	0.03
123	0.01	80	0.01	109	0.01	148	0.01
79,399	5.54	65,017	5.21	71,641	5.57	69,823	4.89
689	0.05	478	0.04	510	0.04	541	0.04
40,073	2.80	34,939	2.80	36,524	2.84	37,654	2.63
134	0.01	129	0.01	185	0.01	217	0.02
103,695	7.24	89,043	7.13	99,333	7.72	107,424	7.52
38,926	2.72	31,553	2.53	33,606	2.61	35,301	2.47
1,974	0.14	1,539	0.12	1,505	0.12	1,538	0.11
29	0.00	35	0.00	49	0.00	54	0.00
48,590	3.39	37,693	3.02	41,239	3.20	44,745	3.13
53,106	3.71	31,815	2.55	32,026	2.49	36,130	2.53
1,700	0.12	965	0.08	828	0.06	901	0.06
1,755	0.12	1,165	0.09	876	0.07	985	0.07
1,717	0.12	1,200	0.10	1,348	0.10	1,493	0.10
22,165	1.55	18,737	1.50	22,200	1.72	26,134	1.83
35	0.00	30	0.00	50	0.00	62	0.00
158	0.01	124	0.01	120	0.01	139	0.01
33,875	2.36	22,529	1.81	24,414	1.90	28,803	2.02
1,238	0.09	1,357	0.11	1,286	0.10	1,433	0.10
1,095	0.08	1,074	0.09	1,140	0.09	1,934	0.14
2,887	0.20	1,756	0.14	1,293	0.10	1,051	0.07
9,894	0.69	8,812	0.71	7,951	0.62	5,853	0.41
25,958	1.81	28,218	2.26	34,751	2.70	39,578	2.77
298	0.02	226	0.02	192	0.01	224	0.02
1,432,977	100.00	1,248,096	100.00	1,287,010	100.00	1,429,164	100.00

TABLE 3 Yearly Statistics on Cars Originated by Major Commodity Group for All Class I U.S. Railroads

Commodity	1978		1979		1980	
	Total Cars (000s)	Percentage of Total	Total Cars (000s)	Percentage of Total	Total Cars (000s)	Percentage of Total
Farm products	1,437,547	6.63	1,574,042	6.94	1,804,502	8.27
Forest products	10,850	0.05	11,086	0.05	8,814	0.04
Fresh fish or other marine products	1,506	0.01	1,190	0.01	1,052	0.00
Metallic ores	1,383,143	6.38	1,455,320	6.42	1,237,414	5.67
Coal	4,052,965	18.68	4,960,061	21.87	5,371,780	24.62
Crude petroleum, natural gas, and gasoline	21,098	0.10	14,099	0.06	13,659	0.06
Nonmetallic minerals	1,457,749	6.72	1,430,951	6.31	1,356,463	6.22
Ordinance or accessories	7,541	0.03	7,854	0.03	6,879	0.03
Food and kindred products	1,725,755	7.96	1,666,891	7.35	1,631,606	7.48
Tobacco products	9,823	0.05	10,896	0.05	9,405	0.04
Textile mill products	39,053	0.18	25,865	0.11	16,896	0.08
Apparel–finished textile products	7,293	0.03	7,644	0.03	5,336	0.02
Lumber and wood (except furniture)	1,417,204	6.53	1,352,324	5.96	1,192,355	5.46
Furniture and fixtures	88,955	0.41	73,739	0.33	55,355	0.25
Pulp, paper, and allied products	828,225	3.82	823,187	3.63	812,989	3.73
Printed matter	7,897	0.04	6,957	0.03	5,059	0.02
Chemicals	1,309,323	6.04	1,351,519	5.96	1,283,165	5.88
Petroleum or coal products	687,959	3.17	679,436	3.00	578,700	2.65
Rubber and miscellaneous plastics	143,044	0.66	142,095	0.63	108,240	0.50
Leather or leather products	2,805	0.01	2,520	0.01	2,219	0.01
Stone, clay, and glass products	766,613	3.53	774,654	3.42	652,353	2.99
Primary metal products	832,286	3.84	864,810	3.81	722,121	3.31
Fabricated metal products	86,377	0.40	77,368	0.34	65,678	0.30
Machinery except electrical	93,835	0.43	80,458	0.35	74,564	0.34
Other 36 categories	133,477	0.62	124,513	0.55	96,063	0.44
Transportation equipment	1,242,638	5.73	1,174,618	5.18	934,422	4.28
Instruments or photographic goods	2,391	0.01	2,479	0.01	1,697	0.01
Miscellaneous products of manufacturing	14,656	0.07	14,014	0.06	11,124	0.05
Waste or scrap materials	638,465	2.94	644,417	2.84	576,563	2.64
Miscellaneous freight shipments	40,965	0.19	47,128	0.21	45,000	0.21
Containers returned empty	100,228	0.46	97,936	0.43	80,325	0.37
Freight forwarder traffic	231,947	1.07	207,705	0.92	164,845	0.76
Shipper association traffic	497,690	2.29	518,895	2.29	460,957	2.11
Miscellaneous mixed shipments except forward	1,072,597	4.94	1,119,088	4.93	1,130,297	5.18
Less than carload traffic	56	0.00	1,127	0.00	10	0.00
Total	21,693,812	100.00	22,681,783	100.00	21,819,054	100.00

Source: Interstate Commerce Commission Quarterly Commodity Statistics Reports.

TABLE 4 Summary of Coal Car Loads as a Percentage of Total Car Loads by Railroad

Railroad	1979	1980	1981	1982	1983
Baltimore & Ohio Railroad Company	32	37	40	42	35
Bessemer & Lake Erie Railroad Company	35	35	36	73	61
Boston & Maine Corporation	4	6	5	9	8
Chesapeake & Ohio Railway Company	48	57	58	65	60
Consolidated Rail Corporation	19	22	22	24	22
Delaware & Hudson Railway Company	1	2	1	2	3
Elgin, Joliet & Eastern Railway Company	30	31	32	39	38
Grand Trunk Western Railway Company	4	6	4	6	5
Norfolk & Western Railway Company	43	49	51	53	46
Pittsburgh & Lake Erie Railroad	30	33	25	50	46
Western Maryland Railway	45	52	60	67	N/A
Clinchfield Railroad Company	64	71	74	80	N/A
Florida East Coast Railway Company	0	0	0	0	1
Illinois Central Gulf Railroad	16	18	19	24	23
Louisville & Nashville Railroad Company	35	37	40	39	N/A
Seaboard Coast Line Railroad	9	11	12	14	24
Atchison, Topeka & Santa Fe Railway Company	10	11	15	15	16
Burlington Northern, Inc.	29	41	40	41	42
Chicago & North Western Transportation Company	11	14	14	15	13
Chicago, Milwaukee, St. Paul & Pacific Railroad	16	18	18	17	14
Denver & Rio Grande Western Railroad Company	36	37	41	46	41
Duluth, Missabe & Iron Range Railway Company	1	1	0	0	0
Kansas City Southern Railway Company	16	21	22	29	29
Missouri-Kansas-Texas Railroad Company	8	13	19	22	20
Missouri Pacific Railroad Company	13	16	17	22	24
St. Louis Southwestern Railway Company	0	0	0	0	0
Soo Line Railroad Company	2	2	1	2	2
Southern Pacific Transportation Company	2	4	4	5	5
Union Pacific Railroad	14	17	21	21	19
Western Pacific Railroad Company	1	0	2	5	6
Detroit, Toledo & Ironton Railroad Company	19	22	10	12	8
Southern System	19	22	22	25	23

1981		1982		1983		1984	
Total Cars (000s)	Percentage of Total	Total Cars (000s)	Percentage of Total	Total Cars (000s)	Percentage of Total	Total Cars (000s)	Percentage of Total
1,617,079	7.68	1,543,595	8.44	1,641,763	8.67	1,756,742	8.39
8,565	0.04	6,324	0.03	8,053	0.04	10,371	0.05
1,143	0.01	912	0.00	677	0.00	658	0.00
1,354,342	6.43	760,315	4.16	812,219	4.29	1,001,003	4.78
5,728,491	27.20	5,603,304	30.63	5,216,878	27.54	6,061,046	28.94
15,131	0.07	12,356	0.07	17,160	0.09	25,514	0.12
1,261,644	5.99	948,684	5.19	1,075,447	5.68	1,203,562	5.75
6,410	0.03	4,902	0.03	5,252	0.03	7,481	0.04
1,529,726	7.26	1,358,974	7.43	1,315,498	6.95	1,233,632	5.89
16,887	0.08	12,096	0.07	8,349	0.04	6,645	0.03
23,667	0.11	15,939	0.09	19,119	0.10	20,801	0.10
7,100	0.03	4,886	0.03	6,309	0.03	8,447	0.04
1,242,608	5.90	991,461	5.42	1,074,081	5.67	1,050,586	5.02
65,545	0.31	44,933	0.25	47,664	0.25	46,935	0.22
866,419	4.11	733,765	4.01	744,084	3.93	740,583	3.54
4,132	0.02	4,743	0.03	8,009	0.04	9,451	0.05
1,298,154	6.16	1,096,703	6.00	1,215,703	6.42	1,311,795	6.26
605,546	2.88	465,513	2.54	494,576	2.61	529,289	2.53
104,476	0.50	80,097	0.44	77,211	0.41	78,615	0.38
1,453	0.01	2,089	0.01	3,405	0.02	3,620	0.02
682,119	3.24	509,777	2.79	538,281	2.84	576,022	2.75
756,895	3.59	456,212	2.49	440,384	2.33	487,400	2.33
54,749	0.26	34,885	0.19	33,405	0.18	36,559	0.17
66,456	0.32	43,434	0.24	38,057	0.20	40,457	0.19
86,686	0.41	66,162	0.36	80,369	0.42	88,859	0.42
938,023	4.45	799,829	4.37	954,066	5.04	1,140,979	5.45
1,835	0.01	1,555	0.01	2,704	0.01	3,341	0.02
9,716	0.05	7,693	0.04	8,917	0.05	10,001	0.05
604,413	2.87	405,210	2.22	416,281	2.20	479,537	2.29
58,176	0.28	63,272	0.35	63,602	0.34	73,183	0.35
68,680	0.33	83,455	0.46	105,148	0.56	204,237	0.98
162,071	0.77	109,965	0.60	82,524	0.44	67,231	0.32
540,191	2.56	512,628	2.80	443,003	2.34	326,397	1.56
1,273,499	6.05	1,507,526	8.24	1,942,634	10.26	2,304,554	11.00
1	0.00		0.00		0.00		0.00
21,062,027	100.00	18,293,194	100.00	18,940,832	100.00	20,945,536	100.00

TABLE 5 Summary of Car-Mile Statistics Arrayed by Commodity Group Extracted from the 1981 ICC Waybill Sample

Commodity	Total Car-Miles (000s)	Percentage of Total	Average Revenue per Car-Mile (cents)	Average Cost per Car-Mile (cents)	Average Contribution per Car-Mile (cents)	Total Contribution ($)
Farm products	1,110,747	8.74	201.14	175.23	25.91	287,777,910
Forest products	9,818	0.08	178.96	141.43	37.53	3,684,526
Fresh fish or other marine products	1,163	0.01	137.81	129.19	8.63	100,331
Metallic ores	248,642	1.96	288.63	190.46	98.16	244,079,258
Coal	2,444,294	19.24	214.11	154.07	60.05	1,467,700,385
Crude petroleum, natural gas, and gasoline	6,297	0.05	269.90	215.63	54.27	3,417,460
Nonmetallic minerals	360,029	2.83	243.44	217.76	25.69	92,487,285
Ordinance or accessories	4,202	0.03	473.07	131.64	341.43	14,346,467
Food and kindred products	1,310,333	10.32	205.94	172.90	33.04	432,980,083
Tobacco products	25,189	0.20	142.46	125.39	17.07	4,299,961
Textile mill products	21,731	0.17	136.78	111.51	25.27	5,491,628
Apparel—finished textile products	6,578	0.05	141.95	115.67	26.28	1,728,772
Lumber and wood (except furniture)	673,825	5.30	191.29	169.40	21.89	147,466,697
Furniture and fixtures	79,757	0.63	118.33	100.21	18.12	14,451,069
Pulp, paper, and allied products	895,577	7.05	178.68	147.51	31.17	279,128,370
Printed matter	6,239	0.05	157.17	139.02	18.15	1,132,196
Chemicals	952,994	7.50	289.16	193.80	95.36	908,782,596
Petroleum or coal products	300,225	2.36	275.29	195.58	79.71	239,303,416
Rubber and miscellaneous plastics	100,971	0.79	144.44	121.08	23.36	23,590,412
Leather or leather products	1,169	0.01	77.13	68.79	8.34	97,482
Stone, clay, and glass products	406,432	3.20	229.54	172.47	57.06	231,929,226
Primary metal products	531,255	4.18	260.87	170.90	89.97	477,994,363
Fabricated metal products	52,184	0.41	186.25	126.58	59.67	31,137,371
Machinery except electrical	74,957	0.59	189.46	117.87	71.59	53,658,928
Other 36 categories	79,845	0.63	187.67	123.98	63.69	50,852,402
Transportation equipment	767,174	6.04	233.22	144.87	88.35	677,795,284
Instruments or photographic goods	1,587	0.01	159.95	119.33	40.62	644,554
Miscellaneous products of manufacturing	9,283	0.07	150.12	106.62	43.51	4,038,879
Waste or scrap materials	208,503	1.64	250.95	207.87	43.09	89,836,727
Miscellaneous freight shipments	24,018	0.19	199.82	134.80	65.03	15,618,178
Containers returned empty	51,123	0.40	62.07	112.64	-50.57	-25,852,992
Freight forwarder traffic	191,076	1.50	83.22	58.90	24.31	46,451,591
Shipper association traffic	320,889	2.53	81.86	66.54	15.32	49,156,593
Miscellaneous mixed shipments except forward	1,422,962	11.20	77.50	72.72	4.78	68,003,078
All other categories	1,221	0.01	279.16	153.72	125.44	1,530,984
Total	12,702,697	100.00	198.84	152.04	46.80	5,944,841,470

TABLE 6 Summary of Car-Mile Statistics Arrayed by Commodity Group Extracted from the 1982 ICC Waybill Sample

Commodity	Total Car-Miles (000s)	Percentage of Total	Average Revenue per Car-Mile (cents)	Average Cost per Car-Mile (cents)	Average Contribution per Car-Mile (cents)	Total Contribution ($)
Farm products	1,040,470	8.52	198.59	184.21	14.38	149,596,477
Forest products	8,519	0.07	182.80	146.91	35.89	3,057,230
Fresh fish or other marine products	539	0.00	140.00	131.69	8.32	44,856
Metallic ores	121,209	0.99	318.37	218.03	100.34	121,626,660
Coal	2,672,043	21.88	226.10	155.29	70.82	1,892,269,469
Crude petroleum, natural gas,.and gasoline	4,940	0.04	270.63	241.51	29.12	1,438,234
Nonmetallic minerals	274,694	2.25	267.71	235.56	32.15	88,304,419
Ordinance or accessories	3,345	0.03	449.53	150.44	299.08	10,004,644
Food and kindred products	1,189,263	9.74	207.69	180.73	26.96	320,577,133
Tobacco products	20,778	0.17	144.27	150.64	−6.37	−1,323,364
Textile mill products	19,265	0.16	129.16	108.34	20.82	4,010,769
Apparel—finished textile products	3,086	0.03	203.22	139.76	63.46	1,958,177
Lumber and wood (except furniture)	579,654	4.75	200.71	189.15	11.56	67,011,005
Furniture and fixtures	58,822	0.48	116.36	106.51	9.85	5,793,071
Pulp, paper, and allied products	810,136	6.64	195.65	161.07	34.58	280,158,865
Printed matter	4,693	0.04	151.24	126.26	24.98	1,172,283
Chemicals	867,353	7.10	312.10	216.97	95.13	825,079,352
Petroleum or coal products	258,952	2.12	299.61	223.77	75.83	196,374,962
Rubber and miscellaneous plastics	78,404	0.64	147.79	129.55	18.24	14,297,234
Leather or leather products	1,845	0.02	65.32	65.01	0.32	5,821
Stone, clay, and glass products	320,115	2.62	252.02	198.31	53.71	171,937,084
Primary metal products	340,889	2.79	270.40	185.33	85.07	289,995,162
Fabricated metal products	36,363	0.30	176.60	125.27	51.33	18,664,823
Machinery except electrical	39,399	0.32	217.31	129.84	87.47	34,463,306
Other 36 categories	63,250	0.52	171.78	117.69	54.09	34,212,101
Transportation equipment	721,666	5.91	237.41	152.33	85.08	613,969,536
Instruments or photographic goods	2,523	0.02	114.44	102.00	12.44	313,748
Miscellaneous products of manufacturing	8,765	0.07	148.40	114.51	33.89	2,970,378
Waste or scrap materials	164,429	1.35	254.44	216.92	37.52	61,689,574
Miscellaneous freight shipments	30,159	0.25	195.06	134.75	60.31	18,188,448
Containers returned empty	45,635	0.37	67.06	119.83	−52.77	−24,083,277
Freight forwarder traffic	152,220	1.25	72.37	60.77	11.60	17,662,219
Shipper association traffic	359,136	2.94	70.82	63.06	7.76	27,870,598
Miscellaneous mixed shipments except forward	1,905,129	15.60	68.70	68.77	−0.06	−1,219,230
Less than carload traffic	132	0.00	67.39	122.67	−55.27	−73,190
All other categories	1,722	0.01	242.60	192.50	50.10	862,872
Total	12,209,983	100.00	197.63	154.64	42.99	5,248,881,449

TABLE 7 Summary of Car-Mile Statistics Arrayed by Commodity Group Extracted from the 1983 ICC Waybill Sample

Commodity	Total Car-Miles (000s)	Percentage of Total	Average Revenue per Car-Mile (cents)	Average Cost per Car-Mile (cents)	Average Contribution per Car-Mile (cents)	Total Contribution ($)
Farm products	1,178,057	8.95	190.25	155.99	34.26	403,544,958
Forest products	8,925	0.07	171.45	141.83	29.62	2,643,552
Fresh fish or other marine products	650	0.00	116.00	114.10	1.91	12,396
Metallic ores	137,472	1.04	311.76	206.43	105.33	144,795,138
Coal	2,538,934	19.29	224.77	150.88	73.90	1,876,209,351
Crude petroleum, natural gas, and gasoline	6,459	0.05	265.40	224.34	41.06	2,652,246
Nonmetallic minerals	269,319	2.05	268.52	229.61	38.90	104,772,613
Ordinance or accessories	4,215	0.03	296.41	144.63	151.78	6,397,486
Food and kindred products	1,163,582	8.84	195.09	163.57	31.52	366,727,617
Tobacco products	10,821	0.08	124.04	108.82	15.22	1,646,857
Textile mill products	26,743	0.20	117.78	94.71	23.07	6,170,270
Apparel—finished textile products	6,194	0.05	147.16	106.16	40.99	2,539,311
Lumber and wood (except furniture)	637,082	4.84	199.45	184.42	15.03	95,725,245
Furniture and fixtures	62,868	0.48	104.96	95.67	9.29	5,840,405
Pulp, paper, and allied products	798,685	6.07	189.16	150.98	38.18	304,934,895
Printed matter	9,280	0.07	102.67	90.87	11.81	1,095,583
Chemicals	911,226	6.92	301.01	189.38	111.64	1,017,288,252
Petroleum or coal products	255,763	1.94	295.23	209.65	85.57	218,868,326
Rubber and miscellaneous plastics	74,794	0.57	128.20	109.47	18.73	14,006,262
Leather or leather products	3,136	0.02	70.95	65.27	5.69	178,327
Stone, clay, and glass products	328,356	2.49	255.22	191.14	64.08	210,409,124
Primary metal products	288,397	2.19	260.55	181.82	78.73	227,061,658
Fabricated metal products	32,143	0.24	148.22	120.96	27.26	8,760,753
Machinery except electrical	25,837	0.20	168.77	110.53	58.24	15,046,750
Other 36 categories	82,382	0.63	168.15	113.70	54.45	44,855,647
Transportation equipment	817,441	6.21	241.94	123.63	118.32	967,168,935
Instruments or photographic goods	2,245	0.02	97.65	81.67	15.99	.358,981
Miscellaneous products of manufacturing	9,140	0.07	97.67	85.47	12.20	1,115,492
Waste or scrap materials	156,719	1.19	258.81	212.45	46.35	72,641,476
Miscellaneous freight shipments	26,998	0.21	216.55	132.53	84.02	22,683,511
Containers returned empty	66,005	0.50	55.31	110.06	−54.75	−36,137,226
Freight forwarder traffic	131,637	1.00	67.48	61.48	6.00	7,901,354
Shipper association traffic	350,789	2.67	64.31	63.89	0.42	1,462,291
Miscellaneous mixed shipments except forward	2,733,718	20.77	62.85	69.94	−7.08	−193,587,903
All other categories	5,757	0.04	176.44	158.79	17.65	1,015,978
Total	13,162,289	100.00	184.42	139.39	45.03	5,926,805,911

TABLE 8 Summary of Ton-Mile Statistics Arrayed by Commodity Group Extracted from the 1981 ICC Waybill Sample

Commodity	Total Ton-Miles (000s)	Percentage of Total	Average Revenue per Ton-Mile (cents)	Average Cost per Ton-Mile (cents)	Average Contribution per Ton-Mile (cents)	Total Contribution ($)
Farm products	89,133,133	11.90	2.51	2.18	0.32	287,777,910
Forest products	532,488	0.07	3.30	2.61	0.69	3,684,526
Fresh fish or other marine products	49,709	0.01	3.22	3.02	0.20	100,331
Metallic ores	21,415,879	2.86	3.35	2.21	1.14	244,079,258
Coal	223,403,486	29.83	2.34	1.69	0.66	1,467,700,385
Crude petroleum, natural gas, and gasoline	515,826	0.07	3.29	2.63	0.66	3,417,460
Nonmetallic minerals	30,280,191	4.04	2.89	2.59	0.31	92,487,285
Ordinance or accessories	214,751	0.03	9.26	2.58	6.68	14,346,467
Food and kindred products	70,903,523	9.47	3.81	3.20	0.61	432,980,083
Tobacco products	788,674	0.11	4.55	4.00	0.55	4,299,961
Textile mill products	467,105	0.06	6.36	5.19	1.18	5,491,628
Apparel–finished textile products	100,480	0.01	9.29	7.57	1.72	1,728,772
Lumber and wood (except furniture)	35,885,049	4.79	3.59	3.18	0.41	147,466,697
Furniture and fixtures	900,352	0.12	10.48	8.88	1.61	14,451,069
Pulp, paper, and allied products	41,992,093	5.61	3.81	3.15	0.66	279,128,370
Printed matter	261,084	0.03	3.76	3.32	0.43	1,132,196
Chemicals	76,750,293	10.25	3.59	2.41	1.18	908,782,596
Petroleum or coal products	19,767,786	2.64	4.18	2.97	1.21	239,303,416
Rubber and miscellaneous plastics	2,005,746	0.27	7.27	6.10	1.18	23,590,412
Leather or leather products	23,566	0.00	3.83	3.41	0.41	97,482
Stone, clay, and glass products	25,953,514	3.47	3.59	2.70	0.89	231,929,226
Primary metal products	35,287,315	4.71	3.93	2.57	1.35	477,994,363
Fabricated metal products	1,565,388	0.21	6.21	4.22	1.99	31,137,371
Machinery except electrical	2,026,527	0.27	7.01	4.36	2.65	53,658,928
Other 36 categories	1,638,846	0.22	9.14	6.04	3.10	50,852,402
Transportation equipment	17,925,160	2.39	9.98	6.20	3.78	677,795,284
Instruments or photographic goods	31,670	0.00	8.01	5.98	2.04	644,554
Miscellaneous products of manufacturing	156,045	0.02	8.93	6.34	2.59	4,038,879
Waste or scrap materials	11,067,307	1.48	4.73	3.92	0.81	89,836,727
Miscellaneous freight shipments	444,396	0.06	10.80	7.29	3.51	15,618,178
Containers returned empty	900,684	0.12	3.52	6.39	−2.87	−25,852,992
Freight forwarder traffic	3,629,687	0.48	4.38	3.10	1.28	46,451,591
Shipper association traffic	5,748,369	0.77	4.57	3.71	0.86	49,156,593
Miscellaneous mixed shipments except forward	27,174,719	3.63	4.06	3.81	0.25	68,003,078
All other categories	63,041	0.01	5.40	2.98	2.43	1,530,984
Total	749,003,744	100.00	3.37	2.58	0.79	5,944,841,470

TABLE 9 Summary of Ton-Mile Statistics Arrayed by Commodity Group Extracted from the 1982 ICC Waybill Sample

Commodity	Total Ton-Miles (000s)	Percentage of Total	Average Revenue per Ton-Mile (cents)	Average Cost per Ton-Mile (cents)	Average Contribution per Ton-Mile (cents)	Total Contribution ($)
Farm products	82,622,436	11.61	2.50	2.32	0.18	149,596,477
Forest products	461,129	0.06	3.38	2.71	0.66	3,057,230
Fresh fish or other marine products	26,708	0.00	2.83	2.66	0.17	44,856
Metallic ores	10,754,366	1.51	3.59	2.46	1.13	121,626,660
Coal	249,118,104	35.01	2.43	1.67	0.76	1,892,269,469
Crude petroleum, natural gas, and gasoline	400,337	0.06	3.34	2.98	0.36	1,438,234
Nonmetallic minerals	23,661,257	3.33	3.11	2.73	0.37	88,304,419
Ordinance or accessories	182,914	0.03	8.22	2.75	5.47	10,004,644
Food and kindred products	64,406,806	9.05	3.83	3.34	0.50	320,577,133
Tobacco products	633,152	0.09	4.73	4.94	−0.21	−1,323,364
Textile mill products	401,550	0.06	6.20	5.20	1.00	4,010,769
Apparel–finished textile products	58,444	0.01	10.73	7.38	3.35	1,958,177
Lumber and wood (except furniture)	32,339,378	4.54	3.60	3.39	0.21	67,011,005
Furniture and fixtures	635,988	0.09	10.76	9.85	0.91	5,793,071
Pulp, paper, and allied products	39,422,567	5.54	4.02	3.31	0.71	280,158,865
Printed matter	160,111	0.02	4.43	3.70	0.73	1,172,283
Chemicals	71,223,982	10.01	3.80	2.64	1.16	825,079,352
Petroleum or coal products	17,816,645	2.50	4.35	3.25	1.10	196,374,962
Rubber and miscellaneous plastics	1,612,144	0.23	7.19	6.30	0.89	14,297,234
Leather or leather products	32,423	0.00	3.72	3.70	0.02	5,821
Stone, clay, and glass products	21,888,894	3.08	3.69	2.90	0.79	171,937,084
Primary metal products	23,155,410	3.25	3.98	2.73	1.25	289,995,162
Fabricated metal products	1,005,844	0.14	6.38	4.53	1.86	18,664,823
Machinery except electrical	1,100,588	0.15	7.78	4.65	3.13	34,463,306
Other 36 categories	1,112,067	0.16	9.77	6.69	3.08	34,212,101
Transportation equipment	16,702,848	2.35	10.26	6.58	3.68	613,969,536
Instruments or photographic goods	49,401	0.01	5.84	5.21	0.64	313,748
Miscellaneous products of manufacturing	182,450	0.03	7.13	5.50	1.63	2,970,378
Waste or scrap materials	8,421,390	1.18	4.97	4.24	0.78	61,689,574
Miscellaneous freight shipments	542,256	0.08	10.85	7.49	3.35	18,188,448
Containers returned empty	714,694	0.10	4.28	7.65	−3.37	−24,083,277
Freight forwarder traffic	2,328,486	0.33	4.73	3.97	0.76	17,662,219
Shipper association traffic	5,585,327	0.78	4.55	4.05	0.50	27,870,598
Miscellaneous mixed shipments except forward	32,702,322	4.60	4.00	4.01	0.00	−1,219,230
Less than carload traffic	1,798	0.00	4.96	9.04	−4.07	−73,190
All other categories	93,095	0.01	4.49	3.56	0.93	862,872
Total	711,558,072	100.00	3.39	2.65	0.74	5,248,881,449

TABLE 10 Summary of Ton-Mile Statistics Arrayed by Commodity Group Extracted from the 1983 ICC Waybill Sample

Commodity	Total Ton-Miles (000s)	Percentage of Total	Average Revenue per Ton-Mile (cents)	Average Cost per Ton-Mile (cents)	Average Contribution per Ton-Mile (cents)	Total Contribution ($)
Farm products	94,162,829	12.82	2.38	1.95	0.43	403,544,958
Forest products	485,831	0.07	3.15	2.61	0.54	2,643,552
Fresh fish or other marine products	25,497	0.00	2.96	2.91	0.05	12,396
Metallic ores	12,437,075	1.69	3.45	2.28	1.16	144,795,138
Coal	241,934,082	32.95	2.36	1.58	0.78	1,876,209,351
Crude petroleum, natural gas, and gasoline	547,157	0.07	3.13	2.65	0.48	2,652,246
Nonmetallic minerals	23,475,699	3.20	3.08	2.63	0.45	104,772,613
Ordinance or accessories	242,410	0.03	5.15	2.51	2.64	6,397,486
Food and kindred products	63,096,478	8.59	3.60	3.02	0.58	366,727,617
Tobacco products	296,296	0.04	4.53	3.97	0.56	1,646,857
Textile mill products	544,041	0.07	5.79	4.66	1.13	6,170,270
Apparel—finished textile products	108,876	0.01	8.37	6.04	2.33	2,539,311
Lumber and wood (except furniture)	36,543,457	4.98	3.48	3.22	0.26	95,725,245
Furniture and fixtures	711,827	0.10	9.27	8.45	0.82	5,840,405
Pulp, paper, and allied products	39,261,129	5.35	3.85	3.07	0.78	304,934,895
Printed matter	246,660	0.03	3.86	3.42	0.44	1,095,583
Chemicals	74,364,484	10.13	3.69	2.32	1.37	1,017,288,252
Petroleum or coal products	17,697,867	2.41	4.27	3.03	1.24	218,868,326
Rubber and miscellaneous plastics	1,437,702	0.20	6.67	5.70	0.97	14,006,262
Leather or leather products	41,532	0.01	5.36	4.93	0.43	178,327
Stone, clay, and glass products	23,476,194	3.20	3.57	2.67	0.90	210,409,124
Primary metal products	19,812,997	2.70	3.79	2.65	1.15	227,061,658
Fabricated metal products	882,926	0.12	5.40	4.40	0.99	8,760,753
Machinery except electrical	573,312	0.08	7.61	4.98	2.62	15,046,750
Other 36 categories	1,570,113	0.21	8.82	5.97	2.86	44,855,647
Transportation equipment	18,948,679	2.58	10.44	5.33	5.10	967,168,935
Instruments or photographic goods	48,763	0.01	4.50	3.76	0.74	358,981
Miscellaneous products of manufacturing	147,846	0.02	6.04	5.28	0.75	1,115,492
Waste or scrap materials	8,562,373	1.17	4.74	3.89	0.85	72,641,476
Miscellaneous freight shipments	487,906	0.07	11.98	7.33	4.65	22,683,511
Containers returned empty	824,782	0.11	4.43	8.81	−4.38	−36,137,226
Freight forwarder traffic	1,905,088	0.26	4.66	4.25	0.41	7,901,354
Shipper association traffic	5,228,777	0.71	4.31	4.29	0.03	1,462,291
Miscellaneous mixed shipments except forward	43,968,058	5.99	3.91	4.35	−0.44	−193,587,903
All other categories	253,949	0.03	4.00	3.60	0.40	1,015,978
Total	734,354,056	100.00	3.31	2.50	0.81	5,926,805,911

Economies of Density

There is considerable literature on the cost structure of the railroad industry. Economists have generally used regression analysis of cross-sectional cost data, with each firm constituting an observation, to estimate industry cost curves. Keeler (10) has made a detailed review of this literature. He finds a general consensus in recent studies that have correctly distinguished returns to firm size from returns to traffic density. These studies, which include Harris (11) and Friedlaender and Spady (12), "give strong evidence of increasing returns, up to a rather high traffic density relative to tonnages moving over most route-mileage in the United States" (10,p.54).

More specifically, Keeler (10,p.54) states: "While the exact density at which railroad costs flatten out completely is not known, it is known that the cost curve for freight services becomes almost flat at around 7 million to 10 million net ton-miles per route-mile (NTM/RM), depending on commodity type and other circumstances." Keeler's conclusions are illustrated in Figure 1, which shows the average cost declines sharply with increases in volume up to about 7 million NTM/RM, at which point the curve becomes more horizontal; further increases in volume do not substantially reduce average costs. However, railroads typically have large differences in traffic densities among their lines.

Based on 1981-1982 waybill data, Class I railroads' aggregate traffic densities range between 1 million and 6 million net ton-miles per route-mile. However, railroads typically have large differences in traffic densities among their lines.

To address the importance of coal to railroad economies of density, lines were dichotomized into those with and those without coal traffic. Thus coal route-miles were isolated from noncoal route-miles. The tools used for this section of the study were the 1981 and 1982 ICC waybill sample flowed over the Federal Railroad Administration's network model. Table 11 gives results for the U.S. railroad system as a whole. First it is necessary to clarify the meaning of the data in the table and then the implications will be explored.

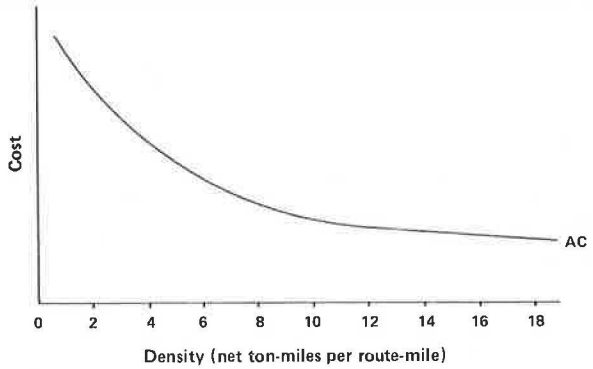

FIGURE 1 Economies of density in the rail industry.

Column 1 provides statistics on route-miles over which coal traffic flowed in the 1981 or 1982 waybill sample. Approximately 96,000 route-miles, out of a total of approximately 200,000 mi, have coal traffic. Based on all traffic that moved over these lines in 1981 and 1982, the 96,000 mi are divided into the six FRA density classes based on gross ton-miles per route-mile (GTM/RM). The average density (in net

TABLE 11 Statistics on Route-Miles by Density Class and Average Total Densities for the Total U.S. Railroad System

	(1) Route-Miles Handling Coal (all existing traffic)		(2) Route-Miles Not Handling Coal (all existing traffic)		(3) Route-Miles for Total System (all existing traffic)		(4) Route-Miles Handling Coal (coal traffic only)	
Density Class	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage
1	13,673	14.20	80,924	77.45	94,592	47.12	54,861	57.00
2	21,740	22.58	13,510	12.93	35,250	17.56	23,536	24.45
3	15,121	15.71	3,669	3.51	18,785	9.36	8,304	8.63
4	17,825	18.52	3,098	2.97	20,924	10.42	4,694	4.88
5	13,392	13.91	1,760	1.68	15,153	7.55	2,992	3.11
6	14,512	15.08	1,523	1.46	16,034	7.99	1,858	1.93
Total	96,263	100.00	104,484	100.00	200,738	100.00	96,245	100.00
Average density (NTM/RM)	6,853,898		1,093,902		3,675,439		2,227,779	

Note: Class 1 < 1 million GTM/RM, Class 2 < 1-5 million GTM/RM, Class 3 < 5-10 million GTM/RM, Class 4 < 10-20 million GTM/RM, Class 5 < 20-30 million GTM/RM, and Class 6 > 30 million GTM/RM.

Source: 1981 and 1982 ICC waybill sample flowed over the FRA network model.

ton-miles per route-mile) for the 96,000 route-miles, again based on all traffic flowing over these miles, is also given.

Column 2 provides statistics on route-miles that did not have coal traffic in the 1981 or 1982 waybill sample. Approximately 104,000 route-miles, out of a total of 200,000 mi, did not have coal traffic. The 104,000 route-miles are divided into density classes based on all traffic moving over these lines.

Column 3 is the sum of Columns 1 and 2. It provides statistics on all route-miles, dividing these miles into density classes. Column 4 provides additional information on the 96,000 route-miles that had coal traffic in the 1981 or 1982 waybill sample. In this column, the 96,000 mi are divided into density classes on the basis of coal traffic only. The average density for these lines is also given.

An example will clarify the difference between Columns 1 and 4. Assume a given route-mile carried a total of 7 million gross tons, of which 3 million gross tons were coal traffic. In Column 1, this route-mile of track would be included in density class 3 (5 to 10 GTM/RM). However, in Column 4, which measures the density based on only the coal traffic, the route-mile density could be classified in density class 2. Tables 12-15 give identical statistics for the Chessie System, Burlington Northern (BN) and the Norfolk and Western (N&W) railroads, and Consolidated Rail Corporation, the four largest coal-hauling railroads by total coal revenue (ranking based on 1983 commodity statistics from ICC Form QCS).

These tables clearly illustrate the importance of coal in achieving economies of density. The addition of coal traffic density to the line density created by all other traffic raises the U.S. average line density from 4.6 million NTM/RM to 6.8 million NTM/RM. A comparison of Column 1 with Column 2 shows that densities in the corridors that handle coal traffic are substantially higher than densities in those that do not have coal traffic. Column 1 for the N&W and BN show average density in the range in which Keeler found that the cost curve for freight services flattens out, and densities for noncoal lines are well below the minimum optimal level. BN's and N&W's average density for route-miles that handle coal only (Column 4) is significantly above the U.S. average. This illustrates the impact that coal has on these railroads' route-mile densities. In the following section, implications for both shippers and railroads will be discussed.

IMPLICATIONS FOR CARRIER AND SHIPPER STRATEGIES

The foregoing analysis has important policy implications for both railroads and shippers. First, the superior revenue contribution and the high volume of coal place it in a pivotal position for determining the future financial well-being of the railroad industry. Coal has revitalized the railroads in two ways. First, it produces substantial revenues; as shown previously, coal traffic generates approximately 22 percent of total railroad revenues and as much as 62 percent for some of the major coal-hauling

TABLE 12 Statistics on Route-Miles by Density Class and Average Total Densities for the Chessie System

	(1) Route-Miles Handling Coal (all existing traffic)		(2) Route-Miles Not Handling Coal (all existing traffic)		(3) Route-Miles for Total System (all existing traffic)		(4) Route-Miles Handling Coal (coal traffic only)	
Density Class	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage
1	2,031	26.69	3,207	89.28	5,237	46.76	3,260	42.83
2	2,077	27.29	279	7.77	2,355	21.03	2,397	31.49
3	903	11.87	16	.45	919	8.21	726	9.54
4	481	6.32	52	1.45	533	4.76	420	5.52
5	1,142	15.01	5	.14	1,147	10.24	762	10.01
6	976	12.83	33	.92	1,009	9.01	46	.60
Total	7,610	100.00	3,592	100.00	11,200	100.00	7,611	100.00
Average density (NTM/RM)	5,693,402		562,660		4,048,791		3,037,351	

Note: Class 1 < 1 million GTM/RM, Class 2 < 1-5 million GTM/RM, Class 3 < 5-10 million GTM/RM, Class 4 < 10-20 million GTM/RM, Class 5 < 20-30 million GTM/RM, and Class 6 > 30 million GTM/RM.

Source: 1981 and 1982 ICC waybill sample flowed over the FRA network model.

TABLE 13 Statistics on Route-Miles by Density Class and Average Total Densities for the Norfolk & Western Railway Company

	(1) Route-Miles Handling Coal (all existing traffic)		(2) Route-Miles Not Handling Coal (all existing traffic)		(3) Route-Miles for Total System (all existing traffic)		(4) Route-Miles Handling Coal (coal traffic only)	
Density Class	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage
1	684	13.28	3,036	87.72	3,719	43.18	2,649	51.40
2	1,103	21.41	217	6.27	1,320	15.33	899	17.44
3	1,187	23.04	165	4.77	1,352	15.70	589	11.43
4	1,027	19.93	4	.12	1,031	11.97	228	4.42
5	310	6.02	4	.12	314	3.65	251	4.87
6	841	16.32	35	1.01	876	10.17	538	10.44
Total	5,152	100.00	3,461	100.00	8,612	100.00	5,154	100.00
Average density (NTM/RM)	8,692,639		724,795		5,510,080		5,233,973	

Note: Class 1 < 1 million GTM/RM, Class 2 < 1-5 million GTM/RM, Class 3 < 5-10 million GTM/RM, Class 4 < 10-20 million GTM/RM, Class 5 < 20-30 million GTM/RM, and Class 6 > 30 million GTM/RM.

Source: 1981 and 1982 ICC waybill sample flowed over the FRA network model.

TABLE 14 Statistics on Route-Miles by Density Class and Average Total Densities for the Burlington Northern, Inc.

	(1) Route-Miles Handling Coal (all existing traffic)		(2) Route-Miles Not Handling Coal (all existing traffic)		(3) Route-Miles for Total System (all existing traffic)		(4) Route-Miles Handling Coal (coal traffic only)	
Density Class	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage
1	1,525	10.43	14,010	83.85	15,535	49.58	8,073	55.20
2	3,155	21.58	1,761	10.54	4,917	15.69	2,065	14.12
3	1,648	11.27	572	3.42	2,220	7.09	1,318	9.01
4	3,325	22.74	135	.81	3,460	11.04	1,133	7.75
5	2,715	18.57	169	1.01	2,884	9.20	1,086	7.43
6	2,254	15.42	62	.37	2,316	7.39	950	6.50
Total	14,622	100.00	16,709	100.00	31,332	100.00	14,625	100.00
Average density (NTM/RM)	9,433,966		671,782		4,790,393		5,038,578	

Note: Class 1 < 1 million GTM/RM, Class 2 < 1-5 million GTM/RM, Class 3 < 5-10 million GTM/RM, Class 4 < 10-20 million GTM/RM, Class 5 < 20-30 million GTM/RM, and Class 6 > 30 million GTM/RM.

Source: 1981 and 1982 ICC waybill sample flowed over the FRA network model.

railroads. Complementing this revenue-producing capability is the impact of coal on the cost structure of the railroads. Because railroads exhibit important economies of density, high coal volumes can improve profitability by reducing average costs.

Second, the study has important implications for actual railroad investment and disinvestment policies. Referring again to Table 11, route-miles with coal traffic have substantially higher traffic-densities than do lines without coal traffic. A vast majority of low-density lines do not carry coal. These lines represent 81,000 route-miles out of 95,000, or 85 percent of the lines classified as having traffic densities of 1 million GTM/RM or less (Class I). On the other hand, 63 percent of the lines with coal are in the highest four density classes, and only 10 percent of the non-coal-carrying lines are in these four classes.

Moreover, average traffic densities are six times higher for lines with coal traffic than for lines

TABLE 15 Statistics on Route-Miles by Density Class and Average Total Densities for the Consolidated Rail Corporation

	(1) Route-Miles Handling Coal (all existing traffic)		(2) Route-Miles Not Handling Coal (all existing traffic)		(3) Route-Miles for Total System (all existing traffic)		(4) Route-Miles Handling Coal (coal traffic only)	
Density Class	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage	Route-Miles	Percentage
1	1,908	21.87	11,793	92.31	13,700	63.72	4,635	53.10
2	2,549	29.21	684	5.35	3,233	15.04	2,935	33.63
3	871	9.98	182	1.42	1,053	4.90	704	8.07
4	1,016	11.64	34	.27	1,050	4.88	377	4.32
5	529	6.06	54	.42	583	2.71	77	.88
6	1,853	21.24	29	.23	1,882	8.75		.00
Total	8,726	100.00	12,776	100.00	21,501	100.00	8,728	100.00
Average density (NTM/RM)	6,774,088		315,802		2,896,784		1,402,474	

Note: Class 1 < 1 million GTM/RM, Class 2 < 1-5 million GTM/RM, Class 3 < 5-10 million GTM/RM, Class 4 < 10-20 million GTM/RM, Class 5 < 20-30 million GTM/RM, and Class 6 > 30 million GTM/RM.

Source: 1981 and 1982 ICC waybill sample flowed over the FRA network model.

without and almost twice that of the system as a whole. The comparison is even more striking for the major coal-hauling railroads. For example, BN's system average traffic density is 4.79 million NTM/RM (Table 14) compared with a U.S. railroad average of 3.67 million. Furthermore, BN's average density for lines with coal is 14 times higher than for route-miles without coal.

Given the importance of economies of density, rail management has strong incentives to build its plant around high-volume core routes, which for many railroads are largely synonymous with their coal routes. At the same time it is recognized that noncoal traffic can and has historically yielded high densities. These core routes in most cases represent the best maintained and engineered corridors. However, management also has strong incentives to invest in facilities that handle noncoal traffic as long as this traffic relies heavily on the coal core. Such a multiproduct service approach allows for a larger, more diverse traffic base, which can ensure greater utilization of the fixed plants. It also reduces the vulnerability of the railroads to minor shifts in coal or other traffic. Comparing Columns 1 and 4 of Table 11, it can be seen that the addition of noncoal traffic to coal lines more than triples average traffic density and significantly reduces the percentage of lines operating below minimal efficient density. This is also true of the four coal-carrying railroads in Tables 12-15.

Coal may also be expected to influence railroad management's decisions on abandonment. Most of the low-density noncoal lines may ultimately be in danger of abandonment. Such abandonment will not occur immediately because many of these lines may yield a higher return as going concerns than they would if abandoned and sold. However, as these lines deteriorate, maintenance may be reduced to minimal levels until the lines are no longer serviceable. Thus abandonment may likely be stretched out over time as railroads focus on their high-density corridors.

The investment implications of this study also relate to shippers of captive coal. As discussed previously, the ICC's coal rate guidelines prescribe SAC as a basis for determining maximum reasonable rates. The analysis presented in this paper demonstrates that publicly available data such as the waybill sample can be used to develop first-order approximations of route-mile densities and the SAC of serving that system. Such preliminary analyses are relatively inexpensive and can yield information on important questions such as (a) How would densities on the proposed stand-alone system compare with current system densities? (b) How would stand-alone costs compare with system average costs to the extent that traffic densities influence cost? (c) How much grouping of traffic is necessary to achieve minimum efficient density and the accompanying low costs? The results of such a preliminary analysis would be useful in determining whether a full-blown stand-alone analysis is justified and in identifying cost and traffic data that can be used in the detailed study.

This study clearly demonstrates the importance of grouping in computing SAC. A comparison of Columns 1 and 4 of Table 11 shows the importance of including noncoal traffic in the stand-alone system. These data can be viewed as representative of a stand-alone coal system for the U.S. rail system as a whole, with extremes on retention and exclusion of noncoal traffic. In other words, Column 1 assumes 100 percent traffic retention, and Column 4 assumes a coal-only system. As can be seen, the addition of noncoal traffic to coal lines more than triples average density, significantly reducing the percentage of lines operating below minimal optimal scale. This means that issue traffic's share of SAC in a rate proceeding will be substantially reduced by grouping coal and noncoal traffic.

Depending on the retention of noncoal traffic, a coal system's density would be within the 2.2 to 6.6 million NTM/RM range shown in Columns 1 and 4. This suggests that typical densities on stand-alone systems would be comparable with the average density on the current system (3.6 million NTM/RM for the United States) or even above that level. To illustrate, if half of the traffic were retained, the stand-alone system density would be 4.5 million NTM/RM.

For the major coal-hauling railroads, stand-alone densities are likely to be higher than the national system average. For example, BN's traffic density would range from 5.0 million NTM/RM with no noncoal traffic to 9.4 million NTM/RM with total traffic retention. Furthermore, under the coal rate guidelines, shippers could select the least cost and highest density system that carries their coal.

Clearly, stand-alone systems would be selected on the basis of traffic densities instead of on the basis of coal-only lines. There is evidence that traffic densities of lines that carry coal would generally be greater than current system densities and that SAC, to the extent densities are a factor, would be below current system average costs.

In summary, the results of the analysis have similar implications for both railroads and shippers. By rationalizing their systems, concentrating on high-density lines over which coal travels, railroads can lower the cost of providing service to the extent that increased traffic densities produce cost economies. Shippers, in developing stand-alone systems, also have every incentive to maximize cost economies by grouping traffic and raising the stand-alone systems' density. Finally, the analysis points to a readily available procedure and data base for determining line segment densities. These estimates can be used by the railroads in formulating their investment policies and by the shippers in fabricating their stand-alone systems.

CONCLUSION

The importance of coal to the rail industry has been established. The prominence of coal in total revenue contribution leaves no doubt as to the role it plays in the financial health of the industry. The impact that coal has on line segment densities is also pronounced. Lines that carry coal have approximately three times the average density of those lines that do not carry coal.

The implications of coal revenue contributions and traffic densities for railroad and shipper strategies have also been explored. Given that costs are a function of density, line segment densities will have a substantial impact on railroad investment decisions. With the adoption of ICC maximum rate guidelines and the SAC constraint contained therein, shippers should choose their stand-alone systems on the basis of traffic densities.

REFERENCES

1. Railroad Deregulation: Impact on Coal. Energy Information Administration, U.S. Department of Energy, 1983.
2. Critical Issues in Coal Transportation Systems. Maritime Transportation Research Board, National Research Council, Washington, D.C., 1979.
3. S.A. Desai and J. Anderson. Rail Transportation Requirements for Coal Movements in 1980. U.S. Department of Transportation, April 1976.

4. G. Elmes. Coal Transportation: An Undervalued Aspect of Energy Modeling? Transportation Research, Vol. 18A, No. 1, 1984.
5. J.N. Heller. Coal Transportation and Deregulation. The Energy Bureau and Serif Press, 1983.
6. F.J. Beier. Electric Utilities and the Movement of Coal. Transportation Journal, Vol. 21, No. 4, Summer 1982.
7. Coal Rate Guidelines--Nationwide. ICC interim decision issued Feb. 1983, final decision issued Sept. 1983.
8. S. Fine and R. Owen. Documentation of the ICC Waybill Sample. Office of Policy and Analysis, Interstate Commerce Commission, Nov. 1981.
9. Z. Griliches. Cost Allocation in Railroad Regulation. Bell Journal of Economics, Vol. 3, Spring 1972.
10. T.E. Keeler. Railroads, Freight and Public Policy. Brookings Institution, Washington, D.C., 1983.
11. R.G. Harris. Economics of Traffic Density in the Rail Freight Industry. Bell Journal of Economics, Vol. 8, No. 2, Autumn 1977.
12. A.F. Friedlaender and R.H. Spady. Equity, Efficiency and Resource Rationalization in the Rail and Regulated Trucking Industries. Massachusetts Institute of Technology Press, Cambridge, 1980.

Publication of this paper sponsored by Committee on Freight Transportation Planning and Marketing.

Factors That Determine Mode Choice in the Transportation of General Freight

F. R. WILSON, B. G. BISSON, and K. B. KOBIA

ABSTRACT

This study examines the factors that influence the mode choice decisions of shippers of general freight commodities in the Atlantic provinces of Canada. The study employed a mail-response questionnaire directed to randomly selected manufacturers to determine the basis of each firm's decision to ship by its regular mode. Respondents were required to identify the product shipped most frequently by the firm and the most regular origin-destination link. They were then required to provide pertinent details, such as transit time, shipping costs, and frequency of shipments, relating to the shipment of that product on the identified origin-destination link. Linear logit models were used to determine the variables that influence the selection of various modes for goods shipments and the relationship between the utility of each mode and the explanatory variables. The models obtained were as intuitively expected. It is concluded that logit analysis using survey data represents a valid and potentially more useful methodology than the use of waybill data. It is recommended that further research using the suggested model forms and data obtained from personal interviews of shippers would improve the quality of the results and provide a greater understanding of the shipper mode choice decision process.

Freight transport carriers in Canada face two serious challenges. One is the slowdown in growth of the freight transport market over the next two decades, as predicted in a paper published by Transport Canada (1, p.i). It is stated in the paper, however, that during the 1980s this growth rate is expected to drop to about 3 percent annually. The reasons given for this lower rate of growth include "a slower pace of economic growth, higher energy costs, higher labor income relative to productivity increases, and relatively fewer technological gains, which could otherwise reduce prices and lower costs."

The other challenge is deregulation of the freight transport market. These challenges will take the form of increasing competition for a slow-growing market. The major problem facing carriers, therefore, under the twin threats of economic and regulatory instability, is the determination of the combinations of service and price that specified categories of shippers would find acceptable for the shipment of their goods.

Transportation Group, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada.