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Estimating Effects of Railroad Abandonment

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Estimates were developed of the potential for rail-service termination and of the probable transport-related effects that such loss of rail service would have on the freight-transport system, transport costs of affected rail users, resulting public- and private-sector investment requirements, and energy consumption. All estimates were developed for lines on which service either had been recently terminated or might be terminated in the future. A survey was conducted of a sample of users of these lines. Estimates of the overall effects of abandonment were developed by a computer program from an analysis of survey responses and from waybill data for shipments originating or terminating on the lines under study. About 80 percent of present rail shipments to or from facilities that lose rail service would continue to be made to or from these facilities by another mode, with most of these made entirely by truck or by a combination of truck and rail. About half of the remaining shipments would continue to be made to or from other locations in the general area. The average increase in transport-related expenditures of affected rail users would be about 17 percent of present railroad charges. It was also estimated that abandonment of the lightest density lines under study would generally result in a small reduction in fuel consumption, while abandonment of uneconomic lines with more moderate traffic densities would result in increased fuel consumption.

The Railroad Revitalization and Regulatory Reform Act of 1976 (4R Act) and other recently enacted legislation contain provisions that can result in increased rates of abandonment of unprofitable branch lines by railroads and that will permit subsidies for continued service on many of these lines. The purpose of this legislation, of course, is to improve the financial health of the currently ailing railroad industry. However, any increase in the rate at which branch-line service is terminated can be expected to have side effects on the rest of the transport industry, on the present users of affected lines, and on the local economies of the predominantly rural areas served by these lines.

This paper presents the methodology used in a recently completed study (1) designed to produce information about the extent of some of these effects. In particular, estimates were developed of the potential effects of railroad abandonment on traffic on the remainder of the freight transport system, transport costs of affected rail users, resulting public- and private-sector investment requirements, and energy consumption. Some of the major results of the study are presented here. Additional data may be found in Weinblatt and others (2) and in the complete report (1).

**Mr. Weinblatt was with CONSAD Research Corporation, Pittsburgh, Pennsylvania, when this research was performed.*

METHOD OF ANALYSIS

For this study, four sets of lines, which had either recently lost rail service or could lose service in the future, were identified:

1. Excluded lines: 8500 km (5282 miles) of line in the Northeast excluded from the Final System Plan (FSP) for Consolidated Rail Corporation (Conrail) (3);
2. Abandoned lines: approximately 4200 km (2600 miles) of line in the Northeast excluded from FSP on which service was discontinued on April 1, 1976;
3. Lines with petitions pending (PP): 9752 km (6060 miles) of non-Conrail lines located throughout the country on which abandonment petitions were pending as of July 23, 1976; and
4. Apparently uneconomic (AU) lines: 48 900 km (30 400 miles) of non-Conrail lines located throughout the country that appeared to be uneconomic on the basis of a computer analysis of traffic data.

For each of the four sets of study lines, estimates of the annual volume of shipments originating or terminating on these lines were obtained for seven regions and 16 commodity groups. For the abandoned and excluded lines, shipment data were acquired from the United States Railway Association waybill files for 1973; for lines with petitions pending and uneconomic lines, data were obtained from the Federal Railroad Administration One-Percent Waybill Sample for 1972, 1973, and 1974. Kilometer and shipment data for the PP and AU lines have been detailed in Weinblatt (4), along with a description of the procedure used in determining the apparently uneconomic lines. Preliminary estimates of the volume of shipments generated by the portions of these two sets of lines in 31 southern and western states were also included in the Transportation Secretary's Report to Congress, mandated under section 904 of the 4R Act (5,6).

Due to space limitations, the results in the latter part of this paper will be presented only for a fifth set of lines, consisting of the apparently uneconomic lines plus those excluded lines that had not already been abandoned. Thus, this fifth set consists of those lines in service in the summer of 1976 that could lose service in the next few years.

The 53 000 km (33 000 miles) of line in this set represent about 16.5 percent of the nation's total railroad system (7). However, only about 2.5 percent of the nation's railroad traffic (8) originates on these lines, and only about 1.1 percent of all traffic terminates on them.

Rail-User Survey

Users of lines in any of the four sets studied were selected by quota sampling in order to obtain appropriate representation of shippers and receivers of commodities in each of the 16 commodity groups. A sample of 364 rail users was selected for the survey using telephone and mail methods. Usable responses to an eight-page questionnaire were obtained from 310 affected or potentially affected facilities. This information included

1. Present use of rail and of alternate modes (commodities, annual volumes, origins, and destinations),
2. Transport capabilities (equipment owned, availability of rail siding),
3. Size (annual sales volume, employment), and
4. Expected effect of abandonment on operation (volume, modal usage, new or modified facilities and equipment).

Survey Analysis

Analysis of the effects of abandonment on each rail user began with the grouping of similar shipments and the estimation of the cost to the rail user of the transport alternatives for each group. Five alternatives were considered: transshipment by rail and truck; truck (directly from present origin to present destination); barge (with transshipment by truck and, possibly, rail); trailer-on-flat-car (TOFC); and truck (to a closer market or from a closer source of supply). For each group of shipments that could be affected by future abandonments, cost estimates were developed for those alternatives that appeared to be realistic possibilities. These rail-user costs consist of transport and trans-loading costs (or charges) as well as amortization of investment costs required for new or modified facilities and equipment.

Rail-user transport costs used in this analysis were derived from a review of several retrospective studies of the effects of previous abandonments (9, 14) and approximately 20 other sources (for a complete list, see 1, pp. 38-41). Charges for rail and barge movements were estimated on an individual basis from data in the 1974 Carload Waybill Statistics (8), in Baumel, Miller, and Drinka (15), and in Kearney (16). Average rail-user costs for other means of transport and for transloading are summarized in the following table (1 Mg·km = 0.685 ton-miles; 1 Mg = 1.102 tons):

Mode	Cost (cents/ Mg·km)	Mode	Cost (dollars/ Mg)
TOFC	2.40	Transloading	
Trucking		Bulk commodities	1.65
Direct	3.42		
Rail access	5.48	Non-bulk commodities	3.86
TOFC access	4.79		
Barge access	4.79		

On the basis of these cost estimates and other available information, it was determined which transport alternative or alternatives would most likely be used for each group of similar shipments if present rail service were to be discontinued. This determination was based on several factors, including alternatives already in use for similar shipments, handling characteristics, likely availability of equipment for transshipping, estimated cost of the alternatives, value of the commodity, and the alternative which the rail user thought would be selected. For the 15 surveyed rail users who had already lost service as a result of exclusion from the FSP, the transport alternative that was in use or that would eventually be used was already known and was obtained directly from the survey. Information from these respondents was used to aid in the analysis of other surveyed rail users.

Subsequent steps in the analysis of the effects on individual rail users were performed similarly. These steps involved the

1. Probability of relocating part or all of the affected facilities and the expected cost of such relocation,
2. Probability of a facility being closed or of certain lines of business being terminated, and
3. Expected decline in business volume at the affected location.

These steps included a comparison of the estimated sales volume of the affected products with the expected increase in transport costs for continued operation at the affected facility, as well as an evaluation of the ability of the firm to pass these increased costs along to its customers or suppliers.

Expansion of Survey Results

Estimates of the overall effects of abandonment associated with each set of potentially affected shipments were developed by applying the results of the survey analysis to the waybill data for the shipments and by incorporating supplementary data from other sources as appropriate. Supplementary data values for transport costs and fuel consumption are discussed in subsequent sections of this paper.

The general procedure for estimating the overall effects of abandonment from this information is summarized as follows:

1. Obtain the total number of affected megagrams or megagram-kilometers of each commodity group in each region;
2. Multiply by one or more response factors obtained from the survey results (these factors are usually a function of the commodity group);
3. Sum, in certain instances, over two or more responses obtained in step 2 above;
4. Multiply, in some instances, by a supplementary parameter value (e.g., diesel fuel consumed per megagram-kilometer for each mode); and
5. Sum over all commodity groups to produce results by region, or over all regions to produce results by commodity group.

RESULTS

Transport Alternatives

Table 1 shows estimates of how abandonment would affect shipments that presently originate or terminate on the 53 000 km (33 000 miles) of line that could lose service. About 72 percent of these shipments are expected to continue to be made between the present origin and destination. Most of this traffic is expected either to be shipped by truck directly from origin to destination or to move by conventional rail service with trucks used for transport between the affected rail users and another rail line. About 1.5 percent of affected shipments are expected

Table 1. Total traffic potentially affected by modal conversion.

Category	Volume of Shipments (Mg 000 000s)	Percentage of Total
Change in transport mode		
1. Rail/truck	14.7	31.6
2. Truck	17.5	37.7
3. Barge/truck	0.7	1.5
4. TOFC	0.8	1.6
Change in origin or destination		
5. Change of supplier or market	3.6	7.8
6. Readjustment within area	4.8	10.3
7. Loss from area	4.3	9.3
Total	46.6	

Notes: 1 Mg = 1.102 tons.
Detail may not add to totals due to rounding.

to be transported by TOFC and a similar amount by barge (with trucks used for transport between the rail users and barge-loading points).

Another 8 percent of affected shipments would continue to be made to or from affected facilities but would be made (by truck) to a closer market or from a closer supplier.

Approximately 20 percent of affected shipments would no longer be made to an affected facility (see response categories 6 and 7 in Table 1). Such shipments would be the result of lost business volume, partial or complete relocation of an affected facility, termination of a line of business, or the closing of an affected facility. Of these shipments, however, about half will continue to be made to other locations within commuting distance of the affected facilities, including locations to which an affected rail user might relocate. Thus, it is estimated that about 10 percent of affected shipments would no longer be made to or from the areas presently served by these lines.

Although seven response alternatives are shown in Table 1, analysis of the transport implications of the last two alternatives was generally beyond the scope of this study. Therefore, unless otherwise stated, subsequent results do not reflect data for the 20 percent of present shipments that would no longer be made to or from an affected facility.

Effect on Modal Usage

The following table shows estimates of the expected change in use of the four transport modes under consideration as a result of adoption of the transport alternatives summarized in Table 1:

Mode	Billions of Mg·km
Rail	
Conventional	−9.01
TOFC	+1.22
Truck	
Direct	+6.47
Rail access	+0.38
Barge access	+0.02
TOFC access	+0.05
Barge	+0.42
Total rail shipments potentially affected, Mg·km	37.2

The figures in the above table represent changes in megagram-kilometers (1 mg·km = 0.685 ton-mile) carried by the specified mode and reflect differences in circuity among modes.

Fuel Consumption

Overall, railroads represent a fuel-efficient mode for hauling freight. However, their overall efficiency is a result of combining very fuel-efficient line-haul operations with less efficient distribution and collection service. Fuel efficiency of the latter service is particularly low on the branch lines of least density. Abandonment of such lines, combined with the use of trucks for pickup and delivery services, will result in reduced fuel consumption. However, to the extent that abandonment results in the use of trucks for direct service from origin to destination, fuel consumption will be increased. Use of TOFC as an alternate mode will also generally result in increased fuel consumption, while bimodal movement by truck and barge will normally result in a fuel saving.

Estimates of the overall effects of abandoning the study lines were developed from the above estimates of change in modal usage and from the estimates of fuel consumption by mode and type of service shown in Table 2. The results indicate that abandonment of all 53 000 km (33 000 miles) of line would result in a 5 percent increase in fuel consumption. In terms of diesel fuel, this increase would be about 2200 m^3 (8 million gal) annually.

Because of the relative fuel inefficiency of light-density operations, present fuel consumption per megagram-kilometer for shipments generated by these lines is somewhat higher than the national average for railroad operations. This is particularly true for the lines with the lightest traffic densities. Indeed, if only the lines with petitions pending were abandoned, an 11 percent saving in fuel consumption would result.

Transport Costs

Estimates of the change in rail-user expenditures for shipments that would continue to be made to or from an affected facility were derived from the estimated changes in modal usage, waybill data for railroad charges of potentially affected movements (adjusted to 1976 dollars using the U.S. Bureau of Labor Statistics' Railroad Freight Price Index), the average costs to rail users noted earlier in this paper, and average barge transport charges of 0.52 cents/Mg·km (0.76 cents/ton-mile) obtained from the survey analysis.

Increased transport costs are estimated to average about $3.00/Mg ($2.70/ton), which represents 17 percent of the average railroad charges currently in-

Table 2. Fuel consumption data by mode and type of service.

Mode[a]	Approximate Energy Consumption per Net Mg·km (J/Mg·km)	Consumption of Diesel Fuel (m^3/Mg·km)
Rail		
General	0.97	1.95
TOFC[b]	1.11	2.23
Local service[c]	-	6.0[d]
Truck		
Rail access	3.87	7.7
All other	2.63	5.3
Barge	0.69	1.39

Notes: 1 J/Mg·km = 0.001 384 Btu/ton-mile, 1 m^3/Mg·km = 386 gal/ton-mile,
1 m^3/km = 425 gal/mile.

[a] Except where noted, data obtained from Leilich, Prokopy, and Ruina (17).
[b] See Rice (18).
[c] Estimated by linear regression (1, pp. 51-52) on Harbridge House estimates of local-service fuel consumption on 10 abandonable lines in Wisconsin, New Hampshire, and Massachusetts (19, 20).
[d] Plus 183 m^3/km annually.

curred by these shipments. Except for increased handling (transloading) costs, these estimates do not include any changes in the nontransport components of operating costs; for many medium- and higher-valued commodities, reduced inventory costs will do much to balance the increased expenses for direct trucking. No estimate of increased expenditures was made for shipments that would no longer be made to or from an affected facility.

Capital Investment

Estimates of capital investment and related effects that would result from loss of rail service were derived from the results of the analysis of the rail-user surveys and supplemented by data on motor-carrier capital requirements (1, pp. 42-45; 2) and on highway construction and maintenance costs (1, pp. 45-49; 22, 23).

If all 53 000 km (33 000 miles) of line were to be abandoned, it is estimated that approximately 320 firms would relocate part or all of their facilities at a total cost of $130 million (an average of about $400 000/facility). Another $120 million would be required by rail users to purchase vehicles and other equipment and to modify existing facilities. Motor carriers and firms that either supply or purchase from affected rail users would be expected to invest $320 million in vehicles and in expanding related facilities. Annual costs for road and bridge construction would increase by an estinated $5.8 million, and those for road and bridge maintenance by $6.5 million.

Abandonment and Subsidy Costs

From the estimates generated during this study, it is possible to develop further estimates indicating that the cost of subsidizing continued operation of all 53 000 km (33 000 miles) of line will be appreciably higher than the total private- and public-sector costs of abandoning these lines (see 1, pp. 73-78). Subsidy costs, however, will tend to be greatest (per carload or per megagram) for the lines with the lightest traffic densities, while the benefits of subsidy (i.e., avoidance of abandonment costs) will tend to be greatest for the abandonable lines with the heaviest densities. Thus, there are undoubtedly some lines for which the transport-related costs of abandonment would exceed the cost of subsidization. Discrimination among the lines in question can only be made after detailed and specific studies.

This study has focused on the transportation economics of shipments on light-density lines rather than on social, economic, or environmental impacts on individual communities. Consideration of these factors would increase the number of lines for which the benefits of subsidy would exceed the cost of subsidy. However, it would still appear that, for most uneconomic lines, an assistance program enabling rail users and local communities to adjust to the loss of rail service would be more cost-effective than continued operation under subsidy.

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Abridgment

Use of Mobile Communications in the Trucking Industry

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Mobile radio use has become a widely adopted component of modern transportation systems. Communication and transportation may serve as substitutes for or complements to transportation systems. As a substitute, communication can often replace a trip by accomplishing the trip's objective without direct personal contact. The telecommunications industry is developing extensive technology for information handling and transmitting. Thus, when the purpose of a trip is to move information rather than goods or persons, electronic communication may be substituted. Transportation and communication can also be complementary. As in most of the areas to be described in this paper, communication is used to increase the efficiency of vehicle operations. Routing and scheduling changes can reduce mileage, increase load factors, and bypass inclement weather or delaying traffic conditions.

However, the difference between the substitutive and complementary relationships of communication and transportation is not always clear-cut. For example, through the use of mobile communication, a freight vehicle can be dispatched to make a nearby pickup or delivery that was not requested in the original dispatch.

DEFINITION

Mobile communication has been defined as voice or signalling communications services between base stations and mobile units, either hand-carried or vehicular. This definition can be expanded slightly by adding that information transmission can occur between humans, between machines, or between humans and machines. The use of electronic signalling for automated control purposes, often encountered in the transportation area, could thus be included. Also included in this definition are mobile communications in the area of safety and special radio services. This area covers aviation; marine and land mobile radio use by state and local governments (e.g., police, fire, forestry, highway departments); industrial (e.g., in-plant manufacturing uses, construction site communications, service and supply vehicle links); land transportation (e.g., railroads, passenger buses, delivery trucks, taxis, automobile emergencies); disaster communications; and other experimental, hobby, and personal convenience uses.

APPLICATION

Any communication between vehicles or between vehicles and fixed stations by visual, electronic, or other signals generated or received by devices within the vehicles can be considered mobile communication. Extensive use of two-way radio communication has significantly increased efficiency and service quality. A reduction in the number of pickups and deliveries, increased shipment requests, and reductions in fuel consumption or the number of vehicles required have all been noted by mobile communications users in the transportation sector.

REGULATION

Land mobile radio use is controlled by the Federal Communications Commission (FCC) as part of the land transportation radio service sector of the Safety and Special Radio Services Bureau. Motor freight and passenger carriers, taxi operators, railroad radio users, and automobile emergency systems—including highway maintenance vehicles—are included in this sector governed under FCC Rules and Regulations (part 93).

Applications for broadcast frequencies are made to an officer of the FCC who coordinates them with existing users and other applicants before forwarding them for commission approval. The radio spectrum available for land transportation users is broken down for different services (e.g., rail, freight, passenger, automobile emergency). A further breakdown is made to ensure the compatibility of signal characteristics and message types.

The use of citizen-band radio by trucking companies is greatest where the spectrum is overcrowded. It is rare to find citizen-band radio used for dispatching in low-density urban or rural areas. Furthermore, most companies have one allocated frequency—and only a few have two or more (in each separate area of operation)—but frequencies must be shared with other users in crowded urban areas. Loading is generally high, i.e., 20-200 units/frequency, although