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Part 1
Railroad Planning

Procedures for Developing State Rail Plans

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Several state rail plans have been developed under the Regional Rail Reorganization Act of 1973 and the Railroad Revitalization and Regulatory Reform Act of 1976. These plans typically use an index method to rank those lines that are eligible for continuation subsidies. The usefulness and applicability of the index procedure, however, are characterized by several problems. The purpose of this paper is to review these problems and to present an alternative method of ranking branch rail lines. This method is the benefit-cost ratio approach, which was used to develop the Iowa Department of Transportation rail plan. The ratio provides estimates, first, of the dollar value of each rail line to shippers, receivers, and the community and, second, of the annualized present dollar value of the cost of operating, maintaining, and upgrading the rail line.

The Railroad Revitalization and Regulatory Reform (4R) Act of 1976 provides up to $360 million in financial assistance to states for "transitional continuation of service on light density rail lines that are necessary to continued employment and community well-being throughout the United States." To become eligible to receive financial assistance under this act, a state must develop a state plan for rail transportation and local rail assistance (1). A similar eligibility requirement was specified in the Regional Rail Reorganization (3R) Act of 1973. This act provided $90 million in rail service continuation subsidies for each of two years to states in the northeast region.

Under the 3R Act (2, 3, 4), several state rail plans have been developed, most of which are based on criteria and guidelines suggested by the Rail Services Planning Office (RSPO) of the Interstate Commerce Commission (ICC). The procedure typically used in these plans is to (a) identify a set of specific variables presumed to be affected by rail abandonment, (b) quantify the potential impact of abandonment of individual rail lines on each variable, (c) develop a weighting value for each variable, and (d) develop a composite index value for each rail line. The computed index is then used to rank the eligible lines for continuation subsidies. Factors typically included in the composite indexes include

1. Projected increase in fuel consumption,
2. Projected increase in air pollution,
3. Projected number of jobs lost,
4. Projected wages lost,
5. Projected taxes lost,
6. Projected sales lost,
7. Projected increase in consumer prices,
8. Historical number of cars shipped or received,
9. Operating cost of alternative modes, and
10. Subsidy required to continue operation of the line.

There are several reasons why the index method was used in the initial state rail plans. First, it provided a means of aggregating a number of diverse but seemingly obvious impacts of rail abandonment into one number. Second, it enabled planners to develop a ranking of lines in the relatively short time required by the Regional Rail Reorganization Act of 1973. Third, it provided a method of comparing branch lines that was accepted by legislators.

Closer examination of the index procedure, however, reveals several problems inherent in this method. Recent studies have indicated that rail abandonment has had little or no effect on a number of the variables included in the indexes. Fuller and Hyman (5) estimated the impact of abandonment on fuel consumption on a rural, low-volume, class 1 branch line in Wisconsin. They concluded that, if the freight were hauled by truck to the nearest railhead and shipped from that point by rail, abandonment of the case line in Wisconsin would result in a net reduction of 74 496 L (19 682 gal) of diesel fuel used annually. Emissions of three pollutants also would decline. This evidence suggests that trucks are more fuel efficient on short hauls than are trains operating on low-volume, low-speed, rural branch lines.

Two types of studies have been made to determine the impact of rail abandonment on firms and communities. One type of study has estimated the potential impact of abandonment on towns that currently have rail service. Poth (6, 7), for example, asked shippers and receivers located on rail lines threatened with abandonment what they thought the effect of abandonment would be on their businesses and communities. These subjective estimates were then used as coefficients to quantitatively estimate the direct and indirect effects of abandonment. Fink and Goode (8) used a telephone survey of businesses located on "potentially excess" lines in Pennsylvania to obtain subjective estimates of direct potential employment loss from proposed abandonment of the lines. Using the subjective estimates and a multiplier, Fink and Goode calculated the total direct and secondary employment loss if the lines were abandoned. The Poth and the Fink and Goode studies forecast large income-employment losses from potential rail abandonment.

A second set of studies measured the actual impact of abandonment on communities. Bunker and Hill (9) measured the impact of rail abandonment on agricultural production and on associated grain-marketing and fertilizer supply firms located on two abandoned rail lines by comparing the growth of the firms located on the abandoned rail lines with the growth of nearby firms. The chief impact was on fertilizer dealers. There was no clear indication that abandonment had any significant impact on total employment.

Due (10) measured employment and population in two Oregon counties before and after abandonment of a branch line. Allen (11) measured population growth, transportation costs, and firm adjustments in 10 communities before and after rail line abandonment. Due and Allen concluded that the short- and long-run effects of abandonment on these variables were relatively small.

Sloss, Humphrey, and Krutter (12) attempted to measure the overall effects of rail abandonment on the development of nine test counties that had lost a major portion of their trackage. These nine counties were compared with nine control counties that had either no abandonment or relatively little abandonment. Sloss found no significant impacts attributable to abandonment. Economic indicators included in this study were change in total bank deposits, change in total value added by farm products, change in value added by manufacturing, change in number of employees in manufacturing, change in new capital expenditures, change in retail sales, and change in wholesale sales.

Miller, Baumel, and Drinka (13) used an analysis-of-variance model to compare growth performance measures of cooperative grain elevators located on abandoned rail lines with cooperative grain elevators located on existing rail lines. They found no significant differences in the rate of growth of sales, earnings, and assets of the two groups of cooperatives. They also compared performance measures of towns located on abandoned rail lines with towns on 71 branch rail lines in Iowa. They found no significant differences in the rate of growth of population, retail sales, bank demand deposits, bank loans and discounts, and bank surpluses, reserves, or undivided profits. Demand deposits and bank loans and discounts were interpreted as gross measures of income in the communities.

The results of the available studies that have examined the actual rather than the potential impacts of abandonment strongly suggest that many of the community and firm factors included in the index method of ranking branch rail lines may not be relevant for many branch rail lines.

Simat, Helliesen, and Eichner, Inc. (14), compared the actual impacts of abandonment with impacts predicted by the protesters at Interstate Commerce Commission abandonment hearings. Businesses located on 10 abandoned lines were examined in the study. The study concluded that a number of small individual businesses were severely hurt. One of the 10 lines examined in the study was the Chicago and Northwestern line between Holstein and Moville, Iowa. The 1973 study indicated that Nitro Gas Company and Spencer Chemical Company (Pierson, Iowa) and Fullerton Lumber Company (Moville, Iowa) were forced out of business by the rail abandonment. A visit in June 1977 to Pierson and Moville, however, revealed that Nitro Gas had sold its facilities to the Spencer Chemical Company, which was sold to the Gulf Oil Corporation. The Farmers Cooperative Elevator Company at Pierson then purchased the original Nitro Gas fertilizer facilities. These facilities are still intact and are handling a greater volume of fertilizer than ever. Fullerton Lumber still is in operation and has operated continuously since the rail line was abandoned. These findings cast doubt on the validity of the retrospective study's results.

The effect of line closure on local property taxes has been included in several state rail plans. Johnson identified three problems with this procedure (15, p. 13):

> First, Section 306 of the Revitalization Act prohibits assessment and tax rates at levels higher than those applied to other commercial and industrial property in the taxing jurisdiction. Secondly, railroad land and properties of closing firms will continue to be owned by someone and thereby will continue to generate property tax revenues with or without the presence of the railroad. The only reduction in tax base will result from reclassification of abandoned rights of way to agricultural and forestry use. The third point is the most important. Property tax is not a real value. Property taxes are portions of the value of property. The value of property depends on rents returned in production. Thus, property tax reductions with line closure are already counted in rent reductions accompanying declining output.

Thus, property taxes do not seem to be a relevant variable for the index procedure.

The index method also has further problems. Apart from the fact that the index method relies on projected impacts rather than on actual impacts of abandonment on the variables, the index method disregards the ability of labor to move to alternative jobs and the ability of capital to be shifted to other employment activities. The composition and distribution of employment can vary over time.

Johnson (15) has pointed out that the factors included in the indexes do not distinguish net effects from gross effects of rail abandonment or rail preservation. Johnson argues correctly that this has led to double counting of benefits. He cites one example in which area income losses were approximated by the total annual sales of firms likely to close if the railroad line were abandoned. Another benefit included in the index was the loss of property taxes paid by these firms. Because taxes are paid from the firm's sales, property taxes were counted twice. Similarly, job losses were counted twice when job losses were included in the index as a separate variable along with area income losses measured by firm sales, inasmuch as the wages and salaries are paid from firm sales.

The weighting system also creates problems with the index method. Some state rail plans have based the weighting system on surveys of citizen ranking of preferences. There is no assurance that the weighting system derived from citizen surveys or assigned by the planners will approximate the actual relative importance of each variable in the index.

Finally, the index method is useful as a decision tool only if a fixed amount of funds previously has been allocated to branch-line maintenance and upgrading subsidies; the method is not helpful in deciding how much should be allocated, however. For example, if a given line has an index value of 62 and a variable operating loss of $375/car, this value is of little use in deciding whether to provide a $375/car subsidy to maintain the line. The index method cannot answer the important question, Should the line be subsidized and (or) upgraded? An alternative analysis is needed to determine whether a given line should be subsidized and (or) upgraded.

A benefit-cost ratio (16) can provide the information needed for this decision. The benefit-cost ratio for retaining the line rather than abandoning it is defined as the net additional product transportation and handling costs of abandoning the line divided by the net additional cost of retaining the line. The net additional transportation and handling costs incurred if the line is abandoned include

1. Net additional trucking costs to or from a nearby rail station or to or from market if this is less expensive than trucking to the nearby rail station,
2. Net additional rail transport costs to or from the market—increased or decreased rail rates—if the product is trucked to or from a nearby rail station,
3. Net change in product handling costs,
4. Net change in shipper or receiver facility costs,
5. Net change in product value if the product is shipped to a different market after abandonment, and
6. Net change in highway maintenance costs from the increased trucking.

Other additional costs appropriate to an individual rail line that can be added to the numerator include

1. Rail line operating deficit, net of ownership costs;
2. Annualized present value of the upgrading costs to the appropriate class level, net of salvageable materials; and
3. Annualized present value of land and salvage materials forgone if the line is retained rather than abandoned.

This ratio, properly computed, will provide an estimate of the dollar value of the line to shippers, receivers, and the community compared with the annualized present-value dollars invested in operating, maintaining, and upgrading the rail line. The individual benefits in the numerator and the individual costs in the denominator are each weighted by \$1. A ratio greater than 1.0 indicates that the value accruing to shippers, receivers, and the public from operating the line exceeds the cost of retaining the line. A ratio less than 1.0 indicates that less than \$1 in shipper, receiver, and community benefits would be returned for each \$1 invested in retaining the line.

Several computer algorithms are available for estimating the ratio (16, 17). Although considerable effort is required to estimate the ratio for a given line, this procedure is less costly than making possibly erroneous decisions based on indexes having no clear meaning.

The procedure of computing benefit-cost ratios for each light-density rail line has been used by the Iowa Department of Transportation in developing its state rail plan (18). The objective of the rail plan is to categorize the state's branch lines into six separate rail system priority levels. Initially, the Iowa Department of Transportation consulted with citizen and rail advisory committees to identify a base mainline rail system. This base system includes the principal interstate mainlines in Iowa and consists of approximately 40 percent of the total state trackage. The remaining 60 percent branch-line system is divided into six 10 percent priority levels that indicate the economic importance of the lines.

An iterative procedure was used to obtain each priority level. For example, the 50 percent system was obtained by the addition of branch lines to the 40 percent mainline system on the basis of the highest benefit-cost ratio. Benefit-cost ratios were computed for individual branch lines, assuming that only the 40 percent base mainline system existed. Then, the branch line with the highest benefit-cost ratio was added to the 40 percent system. Next, the benefit-cost ratios for selected nonsystem branch lines affected by the addition of the first line were recomputed. Finally, the branch line with the highest benefit-cost ratio of all remaining nonsystem branch lines was added to the rail system. Branch lines were added into the system until all remaining 10 percent priority levels were established.

The results of the analysis provided a ranking of the branch lines that the state of Iowa considered for financial support. These results were then combined with potential industrial and natural resource developments and expected changes in the mainline railroad system to develop a final state rail plan. This procedure enables rail planners to determine the most economically efficient use of upgrading funds from railroad companies, rail users, and state and federal governments. An analysis that compares the cost to the public, if the branch line is abandoned, with the cost of retaining the line is a better rule for the allocation of resources than is the index method.

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Review of the Branch-Line Policy Established by the Railroad Revitalization and Regulatory Reform Act of 1976

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The purpose of this paper is to define and analyze the new rail branch-line policy established by the Railroad Revitalization and Regulatory Reform (4R) Act of 1976. On the basis of the statutory provisions, relevant Interstate Commerce Commission and Federal Railroad Administration regulations, and comments filed by the various parties in the relevant abandonment rule-making proceedings, the paper addresses the major procedural and substantive changes regarding abandonment and local rail service assistance and their effects on the allocation of resources in the rail industry and on the balance of power among the various groups involved. One of the important changes made by the 4R Act is the new advance-notice requirements, which include the system diagram maps and the new notice of intent. Another important addition to the procedures is the provision enabling people, firms, and communities to make financial offers; the railroads and the offerors of financial assistance are also permitted to negotiate an agreement that would keep the line in service. In addition, new accounting standards for branch lines and abandonments and a new local rail continuation subsidy program were established. The statutory provisions and regulations do not, however, clarify the criteria by which petitions are granted or denied. One major conclusion is that the new branch-line policy may not help the railroads because the policy has not increased the probability that a particular line will be permitted to be abandoned and, furthermore, the allowed subsidy may not be compensatory. The new branch-line policy may also bring less efficient allocation of resources than the old policy.

The bankruptcies of the Penn Central and several other northeastern railroads in the early 1970s produced the fear of mass abandonments and the realization that railroads were no longer capable of cross-subsidizing uneconomic branch lines. In recognition of the need for facilitating rail abandonment by more expeditious and less expensive methods, the Interstate Commerce Commission (ICC) developed the "34-carload" rule.

At about the same time, Congress passed the Regional Rail Reorganization (3R) Act of 1973, which established, among other things, a new branch-line policy that would apply only to a 17-state region in the Northeast and Midwest. This new federal policy for the 17-state region was based on two premises. First, the railroads should not be forced and cannot afford to continue to cross-subsidize uneconomic rail services. Second, those rail users and communities that are economically dependent upon the cross-subsidized rail service should not be unduly disadvantaged by this policy change. The new policy requires the use of an external subsidy.

The Railroad Revitalization and Regulatory Reform (4R) Act of 1976 indicates that the basic branch-line policy developed in the 3R Act will continue but on a national scale. The 4R Act does make, however, important procedural and substantive changes in the branch-line policy.

The purpose of this paper is to attempt to define and analyze the new federal branch-line policy as finally established by the 4R Act. The sections in the act that are most relevant to the branch-line issue are discussed first. The new abandonment procedures are discussed, and then the subsidy and financial assistance provisions are reviewed and analyzed. The major implications of the new branch-line policy and procedures are discussed and conclusions are then drawn.

4R ACT AND THE BRANCH-LINE ISSUE

Almost all sections of the 4R Act affect, directly or indirectly, the viability of branch lines and thus are relevant to the branch-line issue. The most relevant sections are discussed below.

Sections Directly Addressing the Branch-Line Issue

Title 8 (Local Rail Service Continuation) of the 4R Act contains most of the provisions that establish the procedures and shape the policy with respect to light-density lines. In particular, sections 802 (Discontinuance or Abandonment) and 809 (Conversion of Abandoned Railroad Rights-of-Way) formed the basis of the rule making in which the ICC promulgated the new abandonment procedures and standards. Section 803 (Local Rail Service Assistance) contains the provisions establishing the amount of the subsidy for rail service continuation and the mechanism for allocating the subsidy to the states outside the 17-state region.

Sections 804 (Termination and Continuation of Rail Services) and 805 (Continuation Assistance) integrate the procedures for abandonment and the allocation of subsidy for the lines covered by the 3R Act with the program established by the 4R Act.

Several other sections not under Title 8 also have a direct effect on the branch-line issue. Section 904 (Rail Abandonment Report) of Title 9 (Miscellaneous Provisions) requires the U.S. Department of Transportation (DOT) to conduct a study of the potential effects of any abandonment of any line in the 31-state area outside the 17-state region. In addition, section 309 (Rail Services Planning Office, RSPO) of Title 3 (Reform of the ICC) requires the RSPO to develop an accounting system that will permit the collection and reporting by the railroads of branch-line data.

Sections Having Indirect but Important Effects on Branch Lines

Section 303 (ICC Hearing and Appellate Procedure) requires the ICC to make a final decision within a certain time period, thus preventing the previous long delays in abandonment decisions. Section 307 (Uniform Cost and Revenue Accounting System) requires the ICC to issue regulations prescribing a uniform cost and revenue accounting and reporting system for all railroads by June of 1977. The ICC has stated that it will use this new accounting system on branch lines.

Section 503 (Classification and Designation of Rail Lines) of Title 5 (Railroad Rehabilitation and Improvement Financing) may have a very important effect on the continuation of local rail service for many communities. One use of the classification process is to help form priorities among groups of rail lines, including branch lines, for which applications for financial assistance have been made under section 505 (Rehabilitation and Improvement Financing).

Section 810 (Rail Bank) contains provisions that enable the Secretary of Transportation to purchase rail lines that serve areas in which fossil fuel, natural resources, or agricultural production are located.

NEW ABANDONMENT PROCEDURES

Although the 4R Act made a number of significant changes in the abandonment procedures, much of the basic framework remains. Many of the changes were made to integrate new subsidy provisions into the abandonment process.

Section 802, which added a new section 1a to the Interstate Commerce Act, formed the basis of the procedures implemented by the ICC and the RSPO in their joint rule-making proceeding in ICC Docket Ex Parte No. 274 (Sub-No. 2), Abandonment of Railroad Lines and Discontinuance of Rail Service. By order served on November 5, 1976, the ICC published its final regulations governing abandonment of rail lines and discontinuance of rail service. Several parties filed petitions for reconsideration of the final regulations. The ICC served its report on the petitions on May 3, 1977. In addition, 23 railroads and the Association of American Railroads (AAR) filed a petition of review of orders and regulations of the ICC's final regulatory terms as did a group of national railway labor organizations.

Important Changes in the Abandonment Procedures

The changes in the abandonment procedures discussed below are those that either contribute most in removing defects in the old procedures or have the most important implications for the carriers and/or shippers and communities.

New Advance-Notice Requirements

Possibly the most important procedural changes made were those that increase the awareness of the affected shippers and communities of the impending abandonment and assist them in responding to the abandonment filing. The ramifications of not providing advance warning have been studied (1, pp. 171-172). These changes resulted from the new statutory provisions and regulations that require each carrier to submit a diagram map and the new provisions increasing the information requirements of the notice of intent.

New section 1a(5) of the Interstate Commerce Act requires each carrier to submit to the ICC a diagram of its rail system. The section states that each diagram shall include "a detailed description of each line of railroad which is 'potentially subject to abandonment,' as such term is defined by the Commission" and "shall also identify any line of railroad as to which such carrier plans to submit an application for a certificate of abandonment of discontinuance in accordance with this section."

In its promulgation of the regulations, the ICC and the RSPO expanded the required number of categories to five.

1. All lines that the carrier anticipates will be subject to an abandonment application within the 3-year period following the date on which the diagram is filed with the ICC.
2. All lines potentially subject to abandonment that the carrier has under study and believes may be subject to a future abandonment application because of anticipated operating losses or excessive rehabilitation.
3. All lines for which an abandonment application is pending before the ICC on the date on which the diagram is filed with the ICC.
4. All lines that are being operated under the rail service continuation provisions of section 1a(6)(a) or the Interstate Commerce Act or of section 304(c)(2) of the 3R Act, as amended, on the date on which the diagram is filed with the ICC.
5. All other lines that the carrier owns and operates.

The system diagram map will serve a number of useful functions. Category 2 will make shippers and communities served by the rail service aware of the possibility of losing their rail service months before the actual abandonment application is filed. Thus, the shippers and communities can either take action to save the service (i.e., increase the use of the line, pay more for the service, arrange for a subsidy offer if the line is abandoned, etc.) or make plans to switch to alternative transportation modes. Several parties in the rule making argued that not all of the effects of categorizing may be positive. These parties argued that listing a line in category 2 would stigmatize the line and would preclude any possibility of industrial development or increased traffic.

Category 1 will serve a slightly different purpose by providing a minimum warning time for the shippers and affected communities. A line must appear in category 1 for at least 4 months before it can be put up for abandonment if the abandonment is opposed. Thus a shipper or community served by such a line should be in the final processes of switching to alternative modes, making final plans to challenge the abandonment, or making final arrangements to subsidize the line. This should reduce the resentment on the part of shippers and communities that is caused by a surprise abandonment application. A more rational, less emotional response from the shippers and communities should result from the new regulations.

Section 1a(2)(a) of the Interstate Commerce Act greatly expands and changes the type of public notice the carrier must serve before making an abandonment application.

The new notice of intent will advise people of their right to recommend approval, disapproval, or other action by the ICC. Furthermore, it advises interested persons on how to become parties to an abandonment proceeding and explains in detail how a person should file written comments or a petition to investigate. The notice also instructs interested people on how to obtain additional information concerning the abandonment or financial assistance for maintaining the line if it should be abandoned.

The new regulations with respect to notice of intent should make the affected shippers and communities much more knowledgeable of their most appropriate response. The railroads should benefit from these regulations, since the number of frivolous petitions should be reduced.

It should be noted that section 1a of the Interstate Commerce Act requires the ICC to institute an investigation on receipt of any petition requesting such an investigation. Before the 4R Act, the ICC could use its discretion in instituting an investigation when it received a petition to investigate. This procedural change may counterbalance the effect of the new notice-of-intent regulations.

New Financial Assistance Provisions

The new regulations relating to offers of financial assistance fall largely into two categories—those relating to the submission and evaluation of financial offers and those relating to the negotiations between the railroad and the offeror of financial assistance.

Section 1a(6)(a) of the Interstate Commerce Act outlines a procedure for the ICC to follow whenever it finds that public convenience and necessity permit abandonment so that offers of financial assistance can be made and evaluated. The ICC promulgated regulations that established a three-stage process for the submission and evaluation of financial offers:

1. The ICC must publish in the Federal Register the finding that the present and future public convenience and necessity permit the proposed abandonment.
2. Prospective offerors of financial assistance, who can be a shipper, a community, a state agency, or anyone having an interest in keeping the rail service, must file and serve their offers to the ICC within 15 days after the publication in the Federal Register.
3. Within 30 days of publication, the ICC must decide whether the offeror is financially responsible and the offer likely to cover (a) the cost of acquisition or (b) the difference between the revenue atributable to the line and the avoidable cost of providing the service on the line, including a reasonable return on the value of the line.

These determinations are extremely important because the carrier must be protected from a time-delaying and therefore costly negotiation period based on a frivolous offer; the shipper and community must also be given an opportunity to maintain the service by not having a genuine legitimate financial offer rejected by the ICC.

If the ICC finds that a financially responsible person has made a reasonable offer, then section 1a(6) of the Interstate Commerce Act requires the ICC to postpone the issuance of a certificate for a reasonable time, not to exceed 6 months, so that the carrier and the offeror can negotiate and execute a binding agreement. The implications of the regulations promulgated to deal with the negotiation period and with the options the ICC has if the negotiations fail proved to be both controversial and important.

The regulations concerning the actual negotiations have several important features. First, the parties are permitted, in fact encouraged, to negotiate an agreement before the issuance by the ICC of a final decision. This makes the 15-day time limit for submitting financial assistance offers more reasonable.

Second, the parties do not have to agree to the final estimated subsidy payment or acquisition price appearing in the carrier's application or in the offer. Unlike the 3R Act, the 4R Act contains no provisions compelling the railroad and offeror of subsidy to enter into an agreement. This omission by Congress may have extremely important consequences on the branch-line problem.

Third, during the negotiation period the railroad must continue service over the line and thus suffer the losses during this time period. In the Ex Parte No. 274 (Sub-No. 2) rule-making proceeding, the Association of American Railroads (AAR) argued that this arrangement would induce a potential subsidizer to delay reaching a final agreement. In addition, it would encourage an insincere subsidizer to make an offer just to have the carrier continue service for the additional 6 months.

In promulgating the regulations, the ICC developed four options it could use if the negotiations fail. The first option is simply for the ICC to issue a final certificate. The second and third options apparently will allow the ICC to keep the line in operation, with or without subsidy, for a short period of time. The fourth and most controversial option, which permits the ICC to reopen the underlying abandonment case, has important ramifications.

The basic issue with respect to this fourth option is whether the ICC has the authority to reopen the underlying abandonment proceeding on the basis of the failure of the parties to come to an agreement. The ICC viewed this option as a necessary lever to handle the problem of a recalcitrant carrier refusing a reasonable offer. The ICC defended its regulations in its final report by stating that newly enacted section 17(9)(g) of the Interstate Commerce Act allows the ICC to reopen any proceeding "on grounds of material error, new evidence, or substantially changed circumstances." The ICC views the rejection of a financial offer as clearly a substantially changed circumstance under the terms of section 17(9)(g) of the Interstate Commerce Act, in some situations as a determining factor in influencing the ICC's initial finding in the case.

The ICC's planned use of this fourth option is intimately related to the basic issue of whether or not the ICC can require the parties to enter into an agreement. The ICC can essentially require the railroads to come to an agreement by using or threatening to use this fourth option.

This set of options will undoubtedly increase the carrier's uncertainty about the outcome of the abandonment application, which could inhibit the carrier from putting up lines for abandonment or force the carrier to accept offers that are not fully compensatory. Thus, cross subsidization will remain a part of the branch-line policy.

New Accounting Standards and Procedures

Two different rule-making procedures were involved in developing the accounting standards. Section D of the regulations promulgated in Ex Parte No. 274 (Sub-No. 2) contains the national accounting standards and procedures by which the evidence supporting an abandonment application will be accumulated and the financial offers formulated and evaluated. In a separate proceeding, Formal Docket (F.D.) No. 36366 (Branch Line Accounting System) the RSPO promulgated regulations that determine, among other things, the lines on which the carriers must maintain branch-line accounting.

The national accounting standards for determining costs and revenues on the branch lines, as developed in Ex Parte No. 274 (Sub-No. 2), are largely modeled after the standards developed by the RSPO in Ex Parte No. 293 (Sub-No. 2), Standards for Determining Rail Service Continuation Subsidies, which established the standards to be used in the 17-state region for determining the "revenue attributable to the rail properties," the "avoidable costs of providing service," and "a reasonable return of the value," as those terms are used in the 3R Act.

The AAR, among others, believes that the regional and national abandonment standards with respect to accounting should differ more than they actually do. In its brief, the AAR argued that Congress repudiated the accounting standards established by the RSPO under the 3R Act by providing precise and different definitions of the terms "avoidable cost" and "reasonable return" in section 802 of the 4R Act (section 1a of the Interstate Commerce Act). The ICC and RSPO, however, followed the standards and definitions promulgated by the RSPO under the 3R Act, which did not contain definitions of terms, when promulgating the national abandonment regulations.

The economic implication of this issue is that the regulations may produce a subsidy amount that is not compensatory to the railroad. Apparently Congress, having been convinced by an industry witness that the regulations promulgated under the 3R Act produced subsidy amounts that were not compensatory, increased the allowable avoidable costs and reasonable return by putting the precise definitions of the terms in the statute. In its brief the railroads argued that the regulations promulgated under the 4R Act would not be compensatory because deferred maintenance allowances are not adequate, because the carriers will not be allowed to include the cost of equity capital in their calculation of their cost of capital, and because historical cost, instead of current cost, is used to determine the cost of equipment.

This issue of noncompensatory subsidy is directly related to the issue concerning the ICC's power—or lack of it—to require the carrier to enter into a subsidy agreement.

The regulations promulgated in F.D. No. 36366, Branch Line Accounting System (49 CFR 1201), only provide for a reporting and codification of the data derived from the substantive accounting standards developed in Ex Parte No. 293 (Sub-No. 2) (Regional Standards) and Ex Parte No. 274 (Sub-No. 2) (National Standards).

Though not addressing substantive accounting procedures, the regulations promulgated in F.D. No. 36366 will have a substantial impact on shaping the new branch-line policy by establishing those branch lines on which the carriers must maintain a system of accounts. This will be accomplished by bringing together many of the different issues and procedures resulting from the various rule makings based on the 4R and 3R Acts and by requiring each carrier to provide annual reports and line-specific information to various parties on all the branch lines for which it must maintain accounts.

In the regulations promulgated in F.D. 36366, the RSPO established the accounting burden of branch lines by requiring the carrier to collect the revenue, cost, and service unit data specified in parts 1121 and 1125 of the Code of Federal Regulations (e.g., the national and regional abandonment standards, respectively) for the following lines: (a) lines designated as falling in categories 1, 2, 3, or 4 in the system diagram map; (b) lines subject to a directed service order under section 304(d)(3) of the 3R Act; and (c) lines subject to a rail continuation service agreement entered into before the designation of the line on the system diagram map.

An important trade-off exists in connection with this accounting requirement. In the F.D. 36366 rule-making proceeding, the Missouri-Kansas-Texas Railroad Company and the AAR argued that it would cost the railroads millions annually to maintain accounts for those lines falling into categories 1 and 2. On the other hand, the RSPO argued that the line-specific information would help both the local communities in preparing for the possible loss of rail service and the state agencies in developing rail plans and in establishing priorities among specific rail group projects.

If in fact the accounting requirement proves to be extremely burdensome to the carriers, two unfortunate effects might result. First, carriers would not put lines in category 2 at all, and, second, carriers would put lines up for abandonment after the minimum time (4 months) in category 1. Thus, the advance-notice benefits of the system diagram map would be reduced. The filings of the initial system diagrams with the ICC indicate that this concern may be overstated. As of July 1977, more than 13 700 km (8500 miles) of line were listed under catetory 1 and more than 7000 lines were listed in category 2.

The regulations in F.D. 36366 state that the accounting methodology set forth in the national standards (49 CFR 1121) is to be applied by the carrier to any branch that has been designated on a system diagram map in categories 1, 2, or 3 and to any branch that is the subject of a rail service continuation agreement entered into pursuant to section 1a(6)(a) of the Interstate Commerce Act. On the other hand, the regional accounting standards (49 CFR 1125) shall be applied to any line that is the subject of a rail service continuation agreement entered into pursuant to section 304 of the 3R Act.

Another important aspect of these regulations is that they require each carrier to publish its branch-line accounting data. First of all, the carriers must file a yearly report with the ICC listing account-by-account totals of the aggregate revenue, cost, and service unit data for all branch lines for which it must maintain accounts. Despite the substantial disaggregation of the data into a number of various accounts, the data in the report will be useful for only a limited number of purposes.

Another requirement, one more helpful to the public and more costly to the carrier, is that the carrier make available for inspection and examination by the ICC and by the designated state agencies in the states in which the relevant lines are located the records, accounts, working papers, and other documents reflecting the revenues, cost, and service unit data of each branch line for which it must maintain data. The regulations in Ex Parte No. 274 (Sub-No. 2) and Ex Parte No. 293 (Sub-No. 2) confer similar privileges of inspection to the subsidizer and prospective subsidizers, but only after the carrier has submitted an abandonment application.

This provision is the only one that allows the designated state agency, which presumably will keep the relevant communities informed of the financial viability of their lines, to monitor the actual condition of the lines that fall into categories 1 and 2. Thus, this provision should serve a vital function by keeping the communities and shippers on the marginal lines abreast of the economic conditions of the line. On the other hand, this requirement of providing specific line data to the ICC and designated state agencies before the line is put up for abandonment, along with the burden of maintaining accounts as noted above, might exacerbate the problem of carriers not putting lines into category 2 and keeping the line in category 1 for only the required minimum time of 4 months.

Not Changing Abandonment Procedures

One of the strongest criticisms of the old abandonment process has been that the criteria by which the petitions are granted or denied is not clearly delineated (1, pp. 168-169). The new procedures do not alleviate this problem. The railroads (and the shippers and communities) will face as much if not more uncertainty of what the outcome of an abandonment case will be as they did in the past.

First of all, the controversial, short-lived, 34-carload rule was discontinued largely due to the views of the overwhelming majority of parties participating in the Ex Parte No. 274 (Sub-No. 2) rule making. In past cases where the carriers "passed" the 34-carload rule, they could be fairly certain that the ICC would permit the abandonment. Second, the 4R Act has made the abandonment process a multistep process, permitting discretionary action by the ICC at the various steps, and thereby increasing the uncertainty to the railroads.

For example, the two new opportunities for discretionary action by the ICC involve its decision on whether a financially responsible person has made a reasonable offer and its decision on whether to reopen the underlying abandonment case if and when the negotiations fail; this will greatly increase the uncertainty for the carrier.

As in the past, the criteria used by the ICC in weighing the burden of the railroad against the community's need for the service has not been clearly delineated. More exact accounting practices will increase certainty in the calculation of losses, but this will not necessarily increase the certainty with respect to the most important calculation—whether or not the public convenience and necessity will permit the abandonment. The impact of this uncertainty will be discussed below.

LOCAL RAIL FINANCIAL ASSISTANCE PROVISIONS

Sections 803 and 805 of the 4R Act are the two sections that provide for federal financing of rail service continuation subsidies. Providing federal short-term financial assistance to communities and shippers, however, is not new with the 4R Act. Title 4 of the 3R Act established a system whereby the states in the 17-state region were eligible to receive up to $180 million in federal assistance for a local rail service program under a two-year program.

Effects on the Regional Subsidy Program

Section 805 of the 4R Act changed the local rail service financial assistance program for the 17-state region, as established by section 402 of the 3R Act, in several important ways. Most of these changes were made to make the subsidy program established earlier for the 17-state region consistent with the recently established national program. As of April 1, 1978, the 17 states in the region have operated under the program developed for the rest of the nation.

First, the federal government's share of the cost increased from 70 percent for each of 2 years to 100 percent in the first year to 90 percent in the second year, thus making the program in the 17-state region consistent with the national subsidy program.

Second, the number of legitimate users for the funds was increased. Under the provisions of the 3R Act, the money could only be used for rail continuation subsidies. The provisions did provide for loans so that lines could be acquired or rehabilitated, but these loans could only be used if the recipient of such a loan was no longer eligible to receive rail continuation subsidies. The 4R Act permits this money to be spent on rail continuation subsidies, for purposes of acquisition of the line, for purposes of rehabilitation, and for purposes of constructing or improving facilities necessary to accommodate traffic previously handled by rail.

Third, the method of allocating funds to the states was modified to make it consistent with the method used for the rest of the United States.

National Program Established

The provisions in section 803 of the 4R Act developed the local rail continuation assistance program for the 31 states outside the region and for all the states after April 1, 1978. The program made some significant changes from the program established for the 17-state region by the 3R Act. First, the financial assistance that the states receive can be used for a larger number of purposes, thus permitting a community or shipper to take the action most appropriate for its situation.

Second, the federal share of the financial responsibility was increased to 100 percent for the period from July 1, 1976, to June 30, 1977; 90 percent for July 1, 1977, to June 30, 1978; 80 percent for July 1, 1978, to June 30, 1979; and 70 percent for the next 2 years. Furthermore, the states may contribute their portions of the costs by in-kind benefits such as forgiveness of taxes under FRA standards and procedures (49 CFR 267).

Third, the subsidy program was lengthened from 2 to 5 years, and, fourth, the method for allocating the money to the states by the Secretary of Transportation, established by the rules under the 3R Act, was modified.

Procedures for States to Receive Federal Money

Section 803 of the 4R Act established the procedure the states have to follow in order to receive federal funds. Along with section 802 of the 4R Act, this section ties the federal local rail service continuation subsidies to the actual abandonment. The FRA published the final regulations implementing these procedures in January 1978, after being delayed by the Office of Management and Budget. Several of the more important aspects of the statutory provisions and the regulations promulgated by the FRA follow.

Methods of Allocating Funds to States

The 4R Act entitles each state to an amount equal to the total amount authorized and appropriated for such purposes, multiplied by a fraction whose numerator is the trackage in a state eligible for rail service assistance and whose denominator is the trackage in all of the states eligible for rail continuation service assistance. At a minimum, however, each state is entitled to no less than 1 percent of the funds appropriated.

If the funds allocated to this program become scarce, this method of allocating funds may tend to work to the disadvantage of the states in the Midwest and Northeast, which contain those lines in the worst operating condition. A state in the Midwest or Northeast will require more subsidies than a state in the West, given the same amount of eligible trackage.

Conditions for a State to Receive Funds

Each state must establish a state rail plan, which must be approved by the FRA, before it can receive any federal funds. It should be noted that the secretary must make available to the states funds for planning purposes. A total of $15 million is set aside for planning purposes, with a limit of $5 million to be allocated for each of 3 fiscal years, the last one ending September of 1978. A state's share of the planning funds will be proportional to its rail continuation subsidy entitlement. In addition, this state rail plan must be administered by a designated state agency, which must be capable of making an equitable distribution of the federal funds.

The FRA's regulations provide detailed requirements for the states to follow in establishing their rail plans. The state rail plan must contain a detailed map of the state's entire rail system and must identify different classes of service. The state rail plan must also indicate how the local and regional governmental bodies, railroads, railroad labor, rail service users, and the public generally participated in the planning process.

Furthermore, each line in the state eligible to receive financial assistance must be analyzed in some detail with respect to its condition, its future viability prospects, the effects of its abandonment on the state, the costs of using other rail services or other modes, and whether or not the line should receive federal or state assistance.

Conditions for a Line to Receive Federal Funds

First, the ICC must have found that the public convenience and necessity permit the abandonment of the line or that the line is eligible under Title 4 of the 3R Act.

Second, the line must be included in the state rail plan and considered worthy of receiving federal funds by the state officials. Thus, if a community is attempting to maximize the probability of maintaining its rail service, it must first lobby with the state officials to get the line it is served by into the proper category in its state rail plan.

Third, the designated state agency must submit the application for funds for a particular line. As part of this submission, the designated state agency must provide information with respect to the applicant's authority, responsibility, and expertise in local rail service matters and on how the federal subsidy will be used.

EFFECTS OF THE NEW BRANCH-LINE POLICY

Obviously the history of decisions and actions under the new branch-line policy and procedures is insufficient to permit a before-and-after study of the effects of the new branch-line policy. Based on previous studies of abandonments, economic theory, and comments of the parties participating in the various abandonment rule-making proceedings, however, two effects of the new branch-line policy and procedures can be foreseen: first, their effect on the balance of power among the involved groups of participants (an income distribution issue) and, second, their effect on the allocation of resources (an efficiency issue).

Effect on the Balance of Power Among Participants

The rules and procedures established under the new policy suggest a shift in the balance of power among the railroads, the shippers on the branch line that is proposed for abandonment, the other shippers using the railroad, the stockholders of the railroad, and the general tax-paying public.

Railroads

Overall, the railroads did not receive significant benefits as the result of the new branch-line policy. The criteria developed by the ICC do not suggest an increase in the probability that it will permit a particular line to be abandoned. The new procedures might indirectly increase the probability of a line's being abandoned if the new advance-warning provisions and the federal government paying for most of the continuation subsidy for 5 years reduce the number and intensity of the protests from shippers and communities. In addition, the ICC may develop a lower threshold for permitting abandonment, given the increased possibility of lines being retained through subsidy.

On the other hand, the new accounting and reporting requirements may inhibit the railroads from putting lines into category 1 or 2 and thus actually reduce the rate of abandonment. The cost of maintaining accounts and the damage that might be done by divulging individual branch-line data may outweigh the cost of continuing service over an uneconomic line. In addition, even if the railroads are permitted to abandon a line, the accounting standards set up in Ex Parte No. 274 (Sub-No. 2) may not permit them to receive adequate subsidy. Thus, the railroads may have to continue to cross-subsidize the line, albeit to a lesser degree, even if the service over the line receives an external subsidy.

Rail Users Not Shipping Over Uneconomic Branch Lines

Obviously, if the railroads will not be able to abandon any more uneconomic branch lines than in the past, and if the continuation subsidy proves not to be compensatory on the lines that receive it, the other "captive" shippers using the system must continue to finance the cross-subsidy. If these shippers must cross-subsidize the users on the uneconomic branch line as before, and cross-subsidize the shippers using lines receiving inadequate external subsidies, they will actually be worse off under the new policy, if only slightly.

Stockholders of Railroad

If demand factors are such that the railroad management cannot pay for the uneconomic branch lines by increasing or maintaining excessive rates for the other shippers on the line, then rail earnings will be reduced, ceteris paribus. The return to the stockholder will be reduced, or possibly eliminated, if the burden of maintaining uneconomic branch lines causes bankruptcy of the carrier.

Shippers Using the Line and Affected Communities

The shippers using the rail service and the involved communities appear to have gained the most from the new branch-line policy and procedures. To be more precise, the real winners will probably be the shippers of agricultural products and other bulk commodities who are paying less than costs dictate. Under the new policy, these shippers receive a cross-subsidy if the line is not abandoned and are likely to receive an external subsidy if the line is abandoned.

General Taxpayers

The loser under the new policy appears to have been the general taxpayer, who will finance a large portion of the subsidy. The local rail service assistance program reflects the political realities of railroad abandonment. The amount of subsidy is insignificant compared to other federal expenditures. In addition, the financial impact on the general taxpayers is extremely small compared to the impact on the handful of shippers who would be hurt by abandonment. Furthermore, by making the federal commitment much larger than the local and state commitment, the burden of financing these subsidies would appear to have been shifted to someone else.

Effect on the Allocation of Resources

Most economists agree that external subsidies create less allocative inefficiencies than cross-subsidies. If the nation decides that uneconomic rail service should be continued, then the general taxpayers should finance the subsidy, not the other users (or stockholders) on the line.

As noted above, however, the new abandonment procedures do not indicate that the cross-subsidy will be reduced. If the rate of abandonment of those lines that should be abandoned does not increase, then the magnitude of the cross-subsidy will not be reduced. Thus, as the policy has been established, the misallocation of resources caused by the external subsidy will be added to the misallocation of resources caused by the current practice of cross-subsidization. The substitution of external subsidies for cross-subsidies, which would have decreased the misallocation of resources, all other things being equal, was not permitted by the new legislation and regulations.

The external subsidy program itself was established in a way that creates a misallocation of resources. First, the size of the federal commitment is out of proportion to the benefits the nation receives from maintaining branch lines. The use of subsidies, if properly implemented, improves the allocation of resources. In the case of local rail service, however, the external factors are largely local in nature. Therefore, most of the subsidy should be financed by local taxpayers.

Second, if the subsidy program was established to help save the local communities from economic disaster, the approach is inefficient. Past studies indicate that, in the majority of cases, the communities suffer little from the loss of rail service (2). A more productive approach to helping these communities economically would be to make this conditional grant less conditional. The communities should be allowed to invest the money in projects that would produce a larger benefit-cost ratio.

Third, more emphasis should be put on uses of the money other than continuation subsidies, as outlined by section 1a of the Interstate Commerce Act. In many cases, efficiency in allocation would be improved by devoting more money to help shippers make the switch to other modes of transport. Presumably, the rail continuation subsidy provisions provide only transitory help and thus will aid shippers. If these subsidies turn out not to be transitory in nature, however, then the shippers will continue to use a mode that, based on cost-revenue considerations, should not be used.

Fourth, as argued by Baumel, Drinka, and Miller (3), the nature of the branch-line subsidy program will not increase the efficiency of the local rail service and, thus, will not help the national constituency. By switching a portion of this aid from these lines to lines that are still able to provide valuable service to the rural and agricultural communities but need rehabilitating, a much larger return on investment of these public funds would be realized.

CONCLUSIONS

Though the full impact of the new branch-line policy will take time to fully reveal itself, two important but tentative conclusions can be reached.

First, unless the new legislation and regulations will have some indirect and unexpected effects on the decision processes of the ICC, the railroads will not be helped by the new policy. The legislation and regulations give incentives to the communities and shippers affected to continue using the uneconomic lines at least in the short run. The railroads, on the other hand, were given no tangible incentives and little encouragement to abandon burdensome branch lines.

The policy developed reflects a "political pareto optimal" solution to the light-density branch-line problem. By moving to the new policy, some were helped (communities, but mainly individual shippers), some were not hurt but not helped (the railroads), and some were hurt by such a small amount as to create no political problem (the general tax-paying public).

Second, Congress incorrectly assumed that the program that was appropriate for the 17-state region under the 3R Act was appropriate for the entire nation. The largely federally financed subsidy program under the 3R Act was undoubtedly a correct approach, given the situation where one particular region was facing massive, widespread abandonments occurring in a short period of time.

Under the 4R Act, however, the ICC will act on abandonment of lines on a case-by-case basis, and thus the impact of an abandonment decision on a large multistate area will be minimal. Therefore, more of the subsidy should have been financed by the state and local governments. Because of this and other characteristics of the rail continuation subsidy program, the new branch-line policy may cause a greater misallocation of resources than the old policy.

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Class 2 Railroad Operating Costs

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Multiple regression analysis was used to develop predictive equations for the estimation of operating costs associated with the provision of class 2 railroad service. Annual report data for 102 carriers was the basis for the construction of five equations, each of which pertained to estimation of a specific type of operating cost. Categories included were maintenance of way, maintenance of equipment, traffic, transportation, and general. Five specific predictor variables were included in the analyses: carrier geographic location, ownership, main trackage, traffic volume, and one other depending on the particular type of cost being estimated. In addition, an equation was developed for the prediction of the sum in dollars of the individual costs. All equations appeared to be correctly specified, and each exhibited an acceptable explanatory ability. The research

findings from this study should provide significant insight into the expected magnitudes of the costs of operating a light-density line independent of class 1 ownership. The results will be of specific interest to states involved in developing and updating their state rail plans. Areas of primary application include branch-line economic viability analyses and efforts to rank branch lines in order to determine the best candidates for federal or state assistance or both.

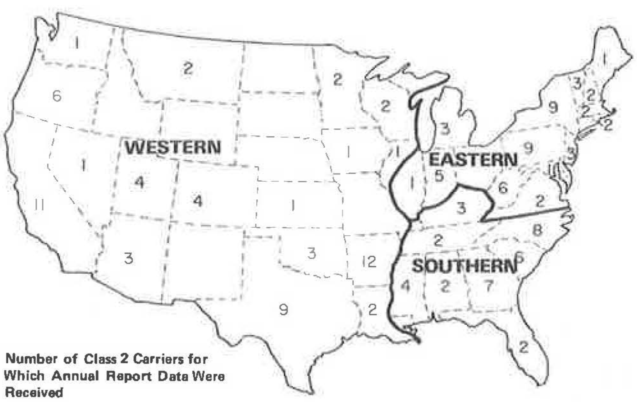
Section 803(j) of the Rail Revitalization and Regulatory Reform (4R) Act of 1976 provides for a federally sponsored program of financial assistance to the states for the provision and continuation of local rail service. There are, however, several criteria that must be met by the respective states in order to receive such assistance from the Secretary of Transportation. The major prerequisite is the development by each state of an adequate plan for rail services as part of an overall planning process for all transportation services, including a suitable process for updating, revising, and amending such a plan. In addition to a number of other components that must be included in an acceptable state rail plan, the planning methodology must include procedures for branch-line economic viability analyses and for prioritization of branch lines in order to determine which are the best candidates for federal or state assistance or both.

The research reported in this paper is designed to provide information of use in estimating the cost of providing rail freight service over light-density lines. Specifically, a study was undertaken of operating cost data for the population of class 2 rail carriers that were unrelated in terms of ownership to a class 1 railroad. Using a variety of data concerning the characteristics of the specific rail line operations, a series of equations was developed, each designed to explain a particular type of operating cost that was seen to be relevant. In addition to the five equations developed for each type of operating cost, an overall relationship was developed that permits the single-equation estimation of total operating expenses for light-density lines being operated independent of class 1 ownership.

ACQUISITION OF DATA

In order to study the factors affecting costs associated with a short-haul railroad operation, it was first necessary to define the types of information that would be important to such an investigation. A listing of the various categories of information follows. It should be noted that our original calculations in customary units have been retained throughout this paper.

Figure 1. Geographical locations of carriers included in data analyses.



Category	Subject
Railway operating expenses	Maintenance of way and structures Maintenance of equipment Traffic Transportation rail line General
Rail line characteristics	Location Ownership type Distance operated Connections with other carriers, etc.
Physical characteristics of the operation	Weight of rail Number of crossties Gauge of track Types of power equipment Ownership of freight cars, etc.
Employees, service, and compensation	Executives, officials, and staff assistants Professional, clerical, and general Maintenance of way and stores Transportation: yardmasters, switch tenders, and hostlers Transportation: train and engine
Rail line operation	Train-miles Locomotive unit-miles Car-miles Revenue and nonrevenue freight traffic Traffic by commodity types, etc.

Included are those related to railway operating expenses; rail line characteristics; physical characteristics of the operation; employees, service, and compensation; and rail line operation. The main objective of the analyses was to explain the various types of railway operating expenses associated with rail line operations.

Implementation of the methodology required that the above types of data be made available for a number of existing short-haul carrier operations. A majority of the information needs were found to be available for such carriers on selected pages of their annual reports to the Interstate Commerce Commission (ICC) for the year 1974.

Having thus determined the source of such information, it was necessary to identify the carriers for which the data would be acquired. There were a total of 196 class 2 line-haul carriers (defined in 1974 as those having less than $5 million in gross revenues) that were neither controlled nor operated by class 1 carriers. Elimination of the larger carrier bias was considered essential in selecting the short-haul carriers for study. Thus, each of the 196 carriers was subjected to a rigorous scrutiny to determine whether data on it were particularly desirable. For several reasons, 26 of the 196 were considered unsuitable for analysis; 17 were involved in passenger operations; 4 did not operate throughout the entire year of 1974 (the latest year for which annual report data were available from the ICC); 1 was a switching road; 1 had evidence of class 1 ownership; and 3 were dropped for other reasons.

Thus, the ICC was requested to provide the pertinent annual report data for 170 carriers for the year ending December 31, 1974. It was found subsequently that the data were available for only 148 of the 170 carriers requested. Figure 1 shows the number of carriers by state for which data were received. The information received was considered as the primary data base for use in the analysis that followed.

It should be acknowledged that some of the additional information needs were fulfilled by reference to American Short Line Railway Guide (1). This source provided a substantial amount of current data on all existing class 2 railroad operations.

ANALYSIS OF THE DATA

This particular phase of the research methodology required that each of the relevant variables be studied intensively and that efforts be made to understand the relationships among various sets of those variables. The overall objective was to produce a number of cost-estimating equations that would be of value when we attempted to predict likely magnitudes of costs associated with the operation of a light-density line independent of class 1 ownership. As previously mentioned, "historical" data were obtained for the operations of 148 class 2 line-haul carriers that were neither owned nor operated by a large carrier. It was hoped that such a study of past experiences would provide significant insight into the potential levels of each of the relevant types of costs.

Multiple regression was the statistical technique selected for developing the equations. As used here, the technique may be best described as one that provides descriptive ability; that is, it allows a study of the linear dependence of one variable on others. In addition, use of this approach permits the efficient computation of quantitative measures that may be used to assess the predictive accuracy of the entire equation as well as measures that evaluate the individual contributions of each independent variable toward an explanation of variation in the dependent variable. The six dependent variables used in this study are shown below.

Variable	Description
TOTMOWS	Total maintenance of way and structures, $000
TOTMOE	Total maintenance of equipment, $000
TRAFFIC	Traffic expenses, $000
TOTTRANS	Total transportation rail line, $000
TOTGEN	Total general expenses, $000
GRANDTOT	Grand total railway operating expenses, $000

More specific information regarding the particular types of expense items included in each is available in the annual reports to the ICC.

Preliminary Considerations

The first major step taken was to construct simple frequency distributions for each of the study variables. Considerable attention was then devoted to a study of those distributions, and the notion of using all data for each of the 148 carriers was reconsidered. A decision was made at that point to eliminate from further consideration all carriers having gross freight revenues in 1974 of $1 million or more.

Because the analysis was aimed at developing cost equations that would be appropriate to the independent provision of service over light-density lines, it was felt that very few of such potential new lines would be capable of generating revenues of such magnitude. The elimination of all carriers having gross freight revenues equal to or greater than $1 million reduced the list of carriers by 43 to a new total of 105.

Examination of the frequency distributions constructed for variables of 105 carriers revealed three additional carriers that were eliminated from further study. One was dropped because its main trackage of 259 km (161 miles) was substantially greater than any of the other carriers; the next longest was 107 km (67 miles). Two other carriers having respective operating ratios (operating costs as a percentage of operating revenues) of 10 and 973 were likewise deleted from further consideration. Such ratios were considered to be rather unusual in light of the range of the 35-315 exhibited by others of the 105 carriers. The remaining portions of the analysis were then based on the resulting sample of 102 class 2 line-haul carriers having operating revenues in 1974 of less than $1 million.

Methodology

Following the initial phases of analysis, attention was devoted to the functional form of the actual cost-estimating equations. Several objectives were necessary to consider. First, each equation should contain a variety of variables that would help to explain variation exhibited by the respective dependent variables. Second, all independent variables should represent measures that can be estimated with some degree of accuracy before an independent carrier operation is implemented. Third, it was desired that the regression analyses for each dependent (cost) variable be conducted in a consistent manner. This was necessary in order to ensure that the various cost-estimating equations all would require similar, perhaps identical in some cases, data inputs. Finally, each of the resulting equations was to be evaluated in terms of its statistical validity.

Five types of independent variables were ultimately selected for inclusion in the multiple regression analyses: carrier location, ownership, main trackage, traffic volume, and one other depending on the particular type of cost being estimated. Each of these will be discussed in turn.

Carrier Location

The geographic location for each of the 102 carriers studied was determined by reference to the map of ICC districts included in Figure 1. Of that number of carriers, 38 were located in the eastern district, 25 in the southern, and 39 in the western. There were other methods of locational segmentation that were considered, but each was either too arbitrary or categorized the carriers into so many areas that any resulting statistical analysis would lose much of its validity.

For purposes of the regression analysis, three dummy variables were constructed for a carrier's location. They were

1. EASTERN: carrier located in eastern district,
2. SOUTHERN: carrier located in southern district, and
3. WESTERN: carrier located in western district.

Ownership

Three different types of ownership were identified: independent, shipper/industry, and government unit. There were 40 carriers owned independently, 57 owned at least in part by shippers and/or local industry, and 5 owned by local or state government units. Ownership status, like location possibilities, required the creation of three dummy variables:

1. INDEP: carrier ownership independent,
2. INDUSTRY: carrier ownership shipper/industry, and
3. GOVT: carrier ownership government unit.

Main Trackage

Early stages of the analysis provided a strong indication that this variable would be helpful in explaining a variety of cost data. The relevant measure computed for each carrier was the total distance of single or first main track plus that of second and additional main tracks. Excluded was trackage associated with passing tracks, crossovers, turnouts, and way and yard switching tracks. The variable included in the analysis was TRAKMAIN, main trackage, in miles. The sample of 102 carriers revealed that distances ranged from 1 to 67, and the mean and median were 14.08 and 10.25, respectively.

Traffic Volume

There are several ways in which this category of variable may be measured, the most appropriate of which is carloads moved. Unfortunately, the ICC does not require that carriers filing annual reports indicate the magnitudes of such a variable. Although such carriers are required to submit data concerning car-miles, it is difficult to transform such a measure into the actual number of loaded freight cars handled without making a perhaps unreliable assumption regarding average length of haul. Since all cars do not necessarily travel the entire length of a given line, an assumption that they did so would introduce an unnecessary bias. To overcome such shortcomings, the total amount of revenue freight carried by the respective railroads in 1974 was used as the measure of traffic volume: TOTTNSRV, total tons revenue freight carried. Although this variable was coded in thousands for input to the computer analysis, its actual value was seen to range from as low as 1000 tons to as high as 1 039 000 tons. The mean revenue freight was 212 592 tons and the median was 120 500 tons.

Other Variable

Depending on the particular dependent variable being investigated, a fifth independent variable was introduced from the following list:

1. XTIESREP: number of ties replaced per mile,
2. LOCMILES: total locomotive unit-miles,
3. NUMCONNS: number of connecting carriers, and
4. ADMIN: administration costs.

Results of correlation analyses indicated that the number of ties replaced per mile of track in 1974 would be helpful in explaining expenditures for maintenance of way and structures, and also for the grand total of railway operating expenses. Such a variable is interesting in that once a predictive equation has been developed value inputs for estimation purposes may be based on the category of track class desired as indicated by Federal Railroad Administration (FRA) track standards. Table 1 provides a summary of such standards for FRA class 1 (10-mph maximum speed) and FRA class 2 (25-mph maximum speed), and normalized track. As can be seen, these three classes will require yearly replacements of 21, 33, and 93 ties/km (34, 54, and 150 ties/mile), respectively, assuming a conservative average tie life of 20 years.

Table 1. FRA track standards and necessary tie renewal rates.

Item	Class of Track		
	1	2	Normalized[a]
Maximum distance between nondefective ties, center to center (in)[a]	100	70	21
Minimum number of nondefective ties/39 ft of track	5	8	22
Minimum number of good ties required per mile	677	1083	3000
Average necessary tie replacements per mile per year to maintain track standard by average installed tie life			
10 years	68	108	300
20 years	34	54	150
30 years	23	36	100

Note: Assuming a total of 3000 ties/mile of track.
[a]Track is maintained on a normalized basis when one-half of the useful life of the track components remain. Theoretically, this standard of maintenance will preserve the entire capital investment in perpetuity.

Locomotive unit-miles was used as an additional independent variable in the estimation of costs associated with maintenance of equipment and transportation-rail line. The values of this variable were determined by adding together the number of unit-miles reported for road service and train and yard switching. Once the predictive equations have been developed, an estimate of locomotive unit-miles may be developed for a proposed operation by using the following computational formula:

$$\begin{aligned}\text{LOCMILES} &= \text{unit-miles road service} + \text{unit-miles switching}\\ &= 2 \times L \times F \times 52 + (0.35) \times 2 \times L \times F \times 52\\ &= (1.35) \times 2 \times L \times F \times 52 \end{aligned} \quad (1)$$

where

L = length of line in miles,
2L = round-trip distance,
F = service frequency (round trips per week), and
52 = weeks per year.

Such an estimate is based on operating frequency, length of line, and an adjustment (0.35) for average switching miles as developed from the data available.

The number of other carriers with which connections were made varied from one to five for the carriers investigated. It was found that 74 of the 102 had only one carrier with which freight was interchanged and that there were only three carriers having more than three connections. This variable was incorporated into the multiple regression analysis that pertained to the estimation of traffic expenses.

Finally, there was strong evidence to indicate that administrative expenditures would help substantially in explaining general expenses. Components of the administrative expense are salaries and expenses of general officers, clerks, and attendants; general office supplies; and legal expenses. Other notable general expenses are insurance and other expenses such as employee health and welfare benefits, pensions, and stationery and printing.

In summary, the above discussions of independent variable categories represent end results of rather extensive preliminary investigations. Although the number of variable candidates that could have been included in the above categories was large, the results of the preliminary analyses strongly indicated that those discussed above were likely to be consistently valuable in explaining variation in each of the respective dependent variables.

Intermediate Results of Regression Analyses

This section presents the empirical results of application of the technique of multiple regression to the task of deriving cost-estimating equations. The general form of the regression model used is

$$Y' = A + B_1 X_1 + B_2 X_2 + \ldots + B_k X_k \quad (2)$$

In this equation, Y′ represents the estimated value for Y, the dependent variable, A is the Y intercept, and the B's are the regression coefficients respective to each independent variable. The functional form implies that, once such a relationship has been derived by empirical analysis, the value of the dependent variable may be estimated in a given case by adding to the constant term (A) the sum of a number of products, each resulting from the multiplication of an independent variable value and the corresponding regression coefficient. The general form may be expressed more concisely as

$$Y' = A + \sum_{i=1}^{k} B_i X_i \tag{3}$$

The independent variables to be included in the intermediate analyses are listed below (the dependent variables were listed previously). Such variables are in the order in which they were discussed in the immediately preceding discussion of methodology.

Variable	Description
EASTERN	Carrier located in eastern district
SOUTHERN	Carrier located in southern district
INDEP	Carrier ownership, independent
INDUSTRY	Carrier ownership, shipper/industry
TRAKMAIN	Main track mileage, miles
TOTTNSRV	Total tons freight carried, $000
XTIESREP	Number of ties replaced per mile
LOCMILES	Total locomotive unit-miles, $000
NUMCONNS	Number of connecting carriers
ADMIN	Administration, $000

Table 2 presents the results of the individual multiple regression analyses for 86 observations. Information relating to the estimation of each respective dependent variable appears in the appropriately labeled column of that table. For example, the first column shows the results of the analysis for which total maintenance of way and structures was the dependent variable, the second for total maintenance of equipment, etc. While the rows are identified by the independent variables of interest, the body of the table includes information in each cell regarding the coefficients that were computed for the values of independent variables in the respective regressions. The lower part of the table provides data of a summary nature pertaining to each equation.

The first of the equations produced will be described in detail to allow more meaningful interpretation of the results achieved. The form of the cost-estimating equation is

$$\begin{aligned} \text{TOTMOWS} = {} & 19.619 - \underset{(10.656)}{8.138}\ \text{EASTERN} - \underset{(11.667)}{9.066}\ \text{SOUTHERN} \\ & - \underset{(20.029)}{26.731}\ \text{INDEP} - \underset{(19.743)}{30.036}\ \text{INDUSTRY} \\ & + \underset{(0.378)}{2.679}\ \text{TRAKMAIN} + \underset{(0.019)}{0.114}\ \text{TOTTNSRV} \\ & + \underset{(0.053)}{0.182}\ \text{XTIESREP} \end{aligned} \tag{4}$$

Keeping in mind that TOTMOWS is expressed in thousands of dollars, any estimate derived from use of this equation should be adjusted accordingly. Referring to this equation and the first column of Table 2, the constant or intercept term is 19.619. The coefficients for the independent variables, EASTERN, SOUTHERN, etc., are -8.138, -9.066, etc., respectively. The numbers in parentheses are the standard errors for each calculated regression coefficient. They are helpful in evaluating whether the coefficient values are significantly different from zero in a statistical sense.

Independent variable coefficients that are in fact significantly different from zero (as evaluated by use of the partial F-value) are appropriately noted in the particular cells of Table 2.

Included for TOTMOWS are those respective to TRAKMAIN, TOTTNSRV, and XTIESREP, all of which were significant at the 0.01 level. The other variable coefficients (for EASTERN, SOUTHERN, INDEP, and INDUSTRY) are not significant, and hence their in-

Table 2. Intermediate results of regression analyses.

Independent Variable	Dependent Variable					
	TOTMOWS	TOTMOE	TRAFFIC	TOTTRANS	TOTGEN	GRANDTOT
CONSTANT	19.619	5.328	-7.289	29.292	4.562	81.505
EASTERN	-8.138 (10.656)	4.565 (7.372)	-0.025 (1.867)	-12.221 (9.611)	2.802 (2.820)	-14.140 (29.712)
SOUTHERN	-9.066 (11.667)	-3.337 (8.051)	4.444 (2.039) SIG.05	-20.943 (10.497) SIG.05	3.262 (3.099)	-24.549 (32.529)
INDEP	-26.731 (20.029)	0.957 (13.740)	5.182 (3.458)	-10.725 (17.913)	-1.579 (5.226)	-57.791 (55.844)
INDUSTRY	-30.036 (19.743)	6.969 (13.565)	1.948 (3.426)	1.839 (17.686)	-1.589 (5.163)	-45.652 (55.047)
TRAKMAIN	2.679 (0.378) SIG.01	-0.383 (0.280)	0.176 (0.069) SIG.05	-1.007 (0.365) SIG.01	0.059 (0.100)	4.634 (1.055) SIG.01
TOTTNSRV	0.114 (0.019) SIG.01	0.028 (0.017)	0.006 (0.003) SIG.10	0.137 (0.022) SIG.01	0.013 (0.005) SIG.025	0.587 (0.052) SIG.01
XTIESREP	0.182 (0.053) SIG.01					0.194 (0.149)
LOCMILES		1.941 (0.254) SIG.01		3.683 (0.331) SIG.01		
NUMCONNS			4.492 (1.231) SIG.01			
ADMIN					1.069 (0.047) SIG.01	
Summary						
R^2	0.613	0.660	0.409	0.864	0.904	0.701
F-value	17.661	21.600	7.723	71.079	105.098	26.067
Standard error	40.923	28.345	7.176	36.954	10.828	114.098
Dependent variable mean	67.695	37.507	6.811	81.034	37.035	230.438

clusion in the equation constitutes an error in specification of the functional form of the equation. Because the results currently being discussed were "intermediate" in nature, there was ample opportunity to make necessary changes before the development of final results.

The lower part of Table 2 gives a variety of information important to an understanding of the statistical validity of the various equations. In the case of estimation of total maintenance of way and structures expenses, there were 86 carriers for which data were used to develop the relationship described above. Although this is somewhat short of the 102 carriers for which data were available, the difference was due to a failure by some carriers (16 to be exact) to report all the necessary information in their annual reports. The R^2 value of 0.613 indicates that the equation was successful in explaining 61.3 percent of the variation in the dependent variable TOTMOWS. The entry in the next row shows the computed F-value of 17.661, which is significant at the 0.01 level, indicating that the set of particular independent variables selected for inclusion was significant in explaining variation in the dependent variable. Finally, the standard error 40.923 is actually the standard deviation of actual values of the dependent variable (TOTMOWS) from the values predicted by the equation. For reference purposes, the mean value of the dependent variable computed for the sample of 86 carriers is shown on the bottom line of Table 2. The table below has been included to show the means and standard deviations for all variables included in the analyses.

Variable	Mean	Standard Deviation
TOTMOWS	67.6953	63.0269
TOTMOE	37.5070	46.5453
TRAFFIC	6.8105	8.9444
TOTTRANS	81.0337	96.1611
TOTGEN	37.0349	33.5025
GRANDTOT	230.4383	199.7320
EASTERN	0.3721	0.4862
SOUTHERN	0.2558	0.4389
INDEP	0.3953	0.4918
INDUSTRY	0.5465	0.5008
TRAKMAIN	14.5465	12.2586
TOTTNSRV	207.7791	246.3794
XTIESREP	96.9397	87.0024
LOCMILES	13.8721	17.5836
NUMCONNS	1.3605	0.7180
ADMIN	26.7046	28.3680

The other columns of Table 2 should be reviewed in a similar manner. The most striking observation to be made is that, overall, only a small number of variable coefficients were statistically significant. In fact, of the 42 coefficients (exclusive of the constant term) appearing in the table, only 16 were significant at the 0.10 level or more. Thus, any attempt to reduce this specification error definitely would affect the consistency of variable inclusion desired among the various equations. The existence of such a number of nonsignificant values required the omission of certain variables (i.e., those least significant) from the final regression analysis.

On the positive side, all equations were significant in their ability to explain dependent variable behavior, and the R^2 values that ranged from 0.409 to 0.904 are generally acceptable for this type of research. It was interesting to note that the dummy variables constructed for location and ownership were not very helpful in general, but that the remaining selected independent variables proved to significantly contribute to the explanation.

In summary, the intermediate results discussed in this section provide sufficient indication that the relationships studied were in fact valid, but that their functional forms should be subjected to a thorough reevaluation. It was necessary to incorporate certain changes to ensure that each equation was specified properly.

Final Results of Regression Analyses

A variety of approaches were used in order to improve the intermediate results. The correlation matrices originally computed for all relevant variable pairs were reviewed, as were the frequency distributions for all variables. It was concluded that the regression results previously discussed had taken advantage of the major types of variables related to the particular dependent variables of interest.

It would have been possible to add more variables of the types already considered, but the possibility of extreme multicollinearity among independent variables was a chief deterrent. If variables highly related to variables already in the equation were added, it would have been almost impossible to separate the influence of each on the dependent variables. R^2 values would have been likely to increase, but the presence of this type of specification error would have provided results with greatly reduced meaning. Other attempts at producing more valuable and efficient relationships included using stepwise (both step-up and step-down) regression procedures and experimenting with various combinations of independent variables in the equations.

The results of the above efforts are shown in Table 3. Although the format of the table is identical to that of Table 2, there are considerably fewer entries, so it is obvious that the number of independent variables included in the final cost-estimating equations has been reduced. Reference to the R^2 value for each equation, however, indicates that such simplification did not reduce appreciably the explanatory ability of the remaining independent variables. A comparison of the F-values and standard errors of the intermediate and final results indicates that the overall statistical validity of each equation has increased and that estimation based on the use of the final results may be made with greater precision. F-values were all significant at the 0.01 level. Each of the particular equations developed will be examined in detail and interpreted as is appropriate.

Total Maintenance of Way and Structures

The form of the equation that may be used to predict this type of expenditure is

$$\text{TOTMOWS} = -14.916 + \underset{(0.371)}{2.738}\ \text{TRAKMAIN} + \underset{(0.018)}{0.114}\ \text{TOTTNSRV} + \underset{(0.052)}{0.198}\ \text{XTIESREP} \qquad (5)$$

As would be expected, larger expenditures are suggested for operations that have longer main trackage, haul more freight, and pursue more intensive policies regarding maintenance of way. Because TOTMOWS is expressed in thousands of dollars, an increase of one main track mile will increase expected expenses by $2738, and the carrying of each additional thousand tons of freight will add $114 (at 1974 price levels). In addition, the setting of track standards at FRA class 1 (average renewal of 34 ties/mile per year) will contribute $6732 (32 × 0.198 expressed in thousands) to the total. FRA class 2 (54 ties) will add $10 692, and normalized

(150 ties) $29 700. It should also be noted that each of the independent variables in the equation was seen to be highly signficant on the basis of partial F-tests.

In terms of overall explanatory ability, the R^2 value indicated that the relationship shown accounted for 59.9 percent of the variation in total expenses for maintenance of way and structures. Although the F-value indicates significance of the equation at the 0.01 level, the practice of deferring maintenance as pursued by some carriers may have resulted in less valid results than would have been obtained otherwise. Also, extraordinary costs incurred by some carriers, particularly with regard to maintenance of structures, surely affected the variation that remained unexplained by the equation. The equation presented, however, should prove to be of value for estimation purposes in its present form.

Total Maintenance of Equipment

The relationship derived for estimating the magnitude of this category of expense contains fewer independent variables:

$$\text{TOTMOE} = 5.888 + \underset{(0.016)}{0.031}\ \text{TOTTNSRV} + \underset{(0.228)}{1.817}\ \text{LOCMILES} \qquad (6)$$

The total revenue freight carried is also included in this equation (as it is in each of those remaining to be discussed). Its significance was measured at the 0.10 level, and its meaning for estimation purposes is that expenditures for maintenance of equipment are expected to increase by $31 for each additional thousand tons carried. The total locomotive unit-miles variable, however, contributes $1817 for every thousand miles to predicted maintenance of equipment expenditures.

Although only two independent variables (and the constant term) were included in this regression, it still explained approximately 64 percent of variation in expenditures for maintenance of equipment. It had been anticipated that data regarding number of locomotives and their total horsepower per line would have contributed significantly to an explanation. Investigations, however, indicated that most of their respective abilities to contribute had been captured by the two variables included in the equation.

Traffic

This particular variable was perhaps the most difficult to explain, largely because it exhibited the least variability of all dependent variables. In addition, expenditures in this category generally represent a very small percentage of total operating costs. The average for 86 carriers was $6811, but about 10 percent of those studied indicated no traffic expense at all. The following equation was developed for estimating this type of expense:

$$\begin{aligned}\text{TRAFFIC} = -5.554 &+ \underset{(1.775)}{4.469}\ \text{SOUTHERN} + \underset{(1.590)}{3.427}\ \text{INDEP} \\ &+ \underset{(0.068)}{0.176}\ \text{TRAKMAIN} + \underset{(0.003)}{0.006}\ \text{TOTTNSRV} \\ &+ \underset{(1.216)}{4.457}\ \text{NUMCONNS} \qquad (7)\end{aligned}$$

The inclusion of two dummy variables, SOUTHERN and INDEP, indicates that both location and ownership type are important variables for prediction of traffic expenses. The relationship suggests that $4469 would be added to the constant term of -$5554 if the line is in the ICC's southern district, while $3427 would be added if the carrier is independently owned.

This information indicates that carriers having such characteristics are likely to spend greater sums for activities such as advertising, soliciting and securing traffic, and preparing and distributing tariffs governing such traffic. It is understandable that carriers that are independently owned would find it necessary to place greater emphasis on such expenditures than carriers owned, for example, by an on-line shipper.

Table 3. Final results of regression analyses.

Independent Variable	Dependent Variable: TOTMOWS	TOTMOE	TRAFFIC	TOTTRANS	TOTGEN	GRANDTOT
CONSTANT	-14.916	5.888	-5.554	7.108	5.806	15.318
EASTERN						
SOUTHERN			4.469 (1.775) SIG.025	-15.590 (9.546) SIG.15		
INDEP			3.427 (1.590) SIG.05			
INDUSTRY						
TRAKMAIN	2.738 (0.371) SIG.01		0.176 (0.068) SIG.025			4.830 (1.028) SIG.01
TOTTNSRV	0.114 (0.018) SIG.01	0.031 (0.016) SIG.10	0.006 (0.003) SIG.10	0.150 (0.022) SIG.01	0.012 (0.005) SIG.025	0.588 (0.051) SIG.01
XTIESREP	0.198 (0.052) SIG.01					0.234 (0.144) SIG.15
LOCMILES		1.817 (0.228) SIG.01		3.367 (0.313) SIG.01		
NUMCONNS			4.457 (1.216) SIG.01			
ADMIN					1.076 (0.044) SIG.01	
Summary						
R^2	0.599	0.643	0.407	0.845	0.902	0.694
F-value	40.834	74.776	10.973	149.182	381.442	61.924
Standard error	40.634	28.140	7.101	38.526	10.620	112.532
Dependent variable mean	67.695	37.507	6.811	81.034	37.035	230.438

Two measures of the scope of operations, TRAKMAIN and TOTTNSRV (see Table 3) also have significant explanatory ability. Although their coefficients are respectively smaller in magnitude than those included in other cost-estimating equations, average traffic expenditures are also smaller.

Lines that have greater numbers of connecting carriers also tend to spend more for this expense category. The average figure of $4457 per connection tends to support the notion that those lines having a variety of connecting carriers, and hence a greater range of services to offer, incur greater costs to secure traffic volumes.

Total Transportation for Rail Line

This type of expense is extremely important. The analysis indicated that, for the 86 carriers studied, transportation expense averaged approximately 35 percent of total operating expenses. The explanatory relationship developed was

$$\begin{aligned} \text{TOTTRANS} = 7.108 - &\underset{(9.546)}{15.590}\ \text{SOUTHERN} + \underset{(0.022)}{0.150}\ \text{TOTTNSRV} \\ &+ \underset{(0.313)}{3.367}\ \text{LOCMILES} \end{aligned} \qquad (8)$$

The presence of the dummy variable SOUTHERN was due in large part to the fact that prevailing wages for train and engine employees were substantially lower for southern district roads than for those located in other parts of the country. In 1974, average hourly wages for class 2 operating personnel were $3.54, $4.21, and $4.82 for carriers studied in the southern, eastern, and western districts, respectively.

Also important to consider is that labor costs represent approximately 50 percent of transportation expenditures, and the variable SOUTHERN actually represents a surrogate for such costs. If data had been available for the study carriers regarding the degree of labor organization, perhaps even greater insight would have been provided.

Also contributing to an explanation was total revenue freight carried and locomotive unit-miles, each significant at the 0.01 level. Transportation expenses are estimated to increase by $150/1000 tons freight carried, and by $3367/1000 locomotive unit-miles. The inclusion of these variables provides strong evidence that measures of the scope of operations are extremely important when attempting to explain expenditures for the provision of transportation service.

The relationship derived was quite acceptable. The computed R^2 value of 0.845 and an accompanying high level of significance as measured by the F-value indicate that the equation was responsible for a great deal of explanation of variation in transportation expenses.

Total General Expenses

Because such expenses are largely composed of those related to administration, the following equation was able to explain over 90 percent of variation in the dependent variable relating to general expenses.

$$\text{TOTGEN} = 5.806 + \underset{(0.005)}{0.012}\ \text{TOTTNSRV} + \underset{(0.044)}{1.076}\ \text{ADMIN} \qquad (9)$$

The estimation procedure requires that $12/1000 tons of freight and $1076 for each $1000 of administration expense be added to the constant term of $5806. Once again, TOTTNSRV provides an indication of the scope of operations, implying that more intensive operations incur greater levels of general expenses.

Grand Total of Railway Operating Expenses

Although estimates derived from the preceding five equations could be added together to construct an estimate of the grand total, it was felt that separate treatment of the total would provide information of additional interest. The use of multiple regression analysis resulted in the following equation:

$$\begin{aligned} \text{GRANDTOT} = 15.318 + &\underset{(1.028)}{4.830}\ \text{TRAKMAIN} + \underset{(0.051)}{0.588}\ \text{TOTTNSRV} \\ &+ \underset{(0.144)}{0.234}\ \text{XTIESREP} \end{aligned} \qquad (10)$$

Incorporated are variables related to main trackage, total revenue freight carried, and number of ties replaced per mile per year. Each of these has been discussed previously with respect to estimation equations for individual types of costs.

The ability of this equation to explain the grand total of railway operating expenses was quite satisfactory, as measured by the R^2 value of 0.694 and an associated high level of significance. Additional variables could have been included, but the possibility of introducing extreme multicollinearity kept those included to a minimum.

SUMMARY

The preceding describes the development of equations appropriate to the task of estimating both individual types and total of railway operating expenses for class 2 railroad operations. Each relationship shown was seen to be statistically significant and properly specified with regard to particular variables included. It is strongly suggested that the actual use of the estimating procedures be accompanied by a keen sense for special characteristics of individual lines, implying that unusual costs are sometimes incurred. If such a conscientious effort is pursued, the equations developed are likely to provide significant insight into the expected magnitudes of the costs of operating a light-density line independent of class 1 ownership.

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Simple Analytics of Rail Costs and Disinvestment Criteria

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Recent estimates have indicated that a significant amount of excess capacity exists in the rail freight industry. The techniques used to estimate branch-line viability have varied widely, however, and in many cases there is no economic basis for the viability analysis. This paper develops the microeconomic concept of plant indivisibilities and demonstrates the effects of minimum efficient scale on the costs of providing branch-line service. Using this characterization of rail costs, it is shown that the demand curve can lie entirely beneath the declining average cost curve, making it impossible for total revenue to equal total cost with a single price. The concepts of consumer and producer surplus are introduced, and a social welfare criterion of optimum disinvestment is developed. That criterion is compared to the private profitability criterion. The two are shown to be equivalent with perfect price discrimination and to depend implicitly on the pricing of alternative modes, as illustrated by a model including both rail and motor freight service. Certain simplifying conditions are then relaxed in order to take account of rail network interdependencies: parallel rail lines and the "feeder effect" or the movement of branch-line originations over the main-line network. No empirical estimate of rail costs or demand is included. Rather, the paper develops heuristic models of branch-line disinvestment that may serve to inform empirical investigations.

The U.S. rail freight system is highly complex and interdependent. Producing rail service entails origination and termination, line-haul carriage, and switching, classification, and routing. There are numerous measures of output, including carloads, car-kilometers, megagrams, ton-kilometers, and train-kilometers. Regardless of which measure of output is used, rail service is highly heterogeneous and has widely varying commodity types and service characteristics. Furthermore, however output is measured, there are many critical factors that affect costs: length of haul, seasonal variations in volume of traffic, directional imbalances in traffic flows, and variations in the prices of factor inputs, and terrain, climatic conditions, and other physical characteristics. Finally, because many factor inputs are used in the production of joint products, allocable costs are a relatively small proportion of total costs, and there exists no theoretically definitive method of allocating joint costs among different units of output.

For all these reasons, there is no single proper model of rail costs. Nevertheless, in order to delineate the central aspects of the branch-line problem, it will be useful to abstract away from these manifest complexities and consider what might best be termed heuristic models—those that incorporate fixed plant indivisibility—of rail costs. Alternative criteria of branch-line viability are developed. A special attempt is made to differentiate between optimum disinvestment standards based on private profit and social welfare (i.e., consumer surplus). Then the network interdependencies of branch lines are acknowledged, and their effects on viability criteria analyzed.

MODELS OF RAIL COSTS AND CAPACITY

An essential characteristic of transport service is its locational nature; one cannot discuss rail costs and capacity of rail plant without specifying their spatial dimension (1, 2). Hence, in this section and the next, we shall define a rail line as a physical link connecting two points, A and B, separated in space. Given this market, our concern is with the connection between cost per unit of output and quantity of output and the quantity of output and the level of capacity. We shall assume all units of output to be identical in all relevant respects and shall measure the quantity of output, Q, in trips.

First, we assume that all factors of production are perfectly divisible and that the technology imposes no indivisibility constraints. For example, we might think of this as the ability to connect A to B with one-tenth or one-hundredth of a rail line, if necessary. When factor prices are given and constant, cost is a function of fixed factors, F, and variable factors, V:

$$C = C(Q) = \bar{F} + V(Q) \qquad (1)$$

With perfect divisibility, we are assuming that the quantity of F can be adjusted exactly to minimize costs for the planned level of output. For very small levels of output (i.e., approaching zero trips), the firm would use a production process with F = 0, and all costs would be variable. In Figure 1 are shown a family of cost curves for various levels of F. As F (fixed investment) increases, the capacity of the rail plant increases correspondingly. Thus, the total cost curve associated with $F_i > F_j$ turns upward at a higher level of output. The total cost curve for $F_1 = 0$ is represented by $SRTC_1$, for which all costs are variable.

As expected output increases, the firm could adjust F to minimize the total cost of production. The best scale for a given F occurs at the point where the short-run marginal cost (SRTC) curve turns sharply upward; this optimum capacity is the point at which the slope of the SRTC curve is equal to the slope of a line connecting that point to the origin (i.e., the short-run average cost).

The long-run total cost (LRTC) curve is defined as the line that connects the points of optimum capacity for all possible levels of F; the LRTC is shown as the dashed line in Figure 1. Since we have specified that it is possible to perfectly adjust plant size to output, there are an infinite number of SRTC curves, and the LRTC would be tangent to each of them at their optimum capacity levels. By assuming perfect divisibility of all factors, and no economies of scale, the LRTC curve must necessarily be a straight line through the origin.

It is critical to differentiate short-run from long-run costs precisely. According to usage here, short-run refers to any period of time less than or equal to the life of any fixed factor investment. Since the firm could continuously renew the fixed factors associated with a given plant size—and thereby remain on the same SRTC curve—short-run might refer to eternity. Thus, a firm is always operating on a short-run cost curve, the one that corresponds to the actual level of investment. However, the firm is operating on the long-run cost curve only if it has chosen the level of investment that minimizes total costs for the actual level of output. Long-run cost curves are, in this sense, theoretical constructs describing optimum rather than actual firm behavior.

We should pause here to clarify two terms frequently confused in the transportation literature: economies of scale and economies of density (3, 4). Long-run cost curves of the type shown in Figure 1 denote constant returns to scale, i.e., costs per unit of output. Since we have defined output with respect to a particular market (with only one rail line), the concept of economies of scale is exactly equivalent to that of economies of traffic density. As Q increases, holding route-kilometers constant, both scale and density increase correspondingly. Without specifying the market (or holding route-kilometers constant), economies of scale are not the same as economies of density: two firms of like size (say, in number of car-kilometers), can have very different traffic densities.

The assumption of perfect divisibility of all factors of rail service is, to most observers, immediately suspect. It is impossible, we all know, to provide rail service from A to B without some irreducible minimum cost in fixed factors, including at least the right-of-way, the trackage, and its maintenance (that part of which is required even when output is zero).

Suppose, for example, that this minimum investment were represented by F_4 in Figure 1. (The curves corresponding to F_1, F_2, and F_3 are purely fictional.) Accordingly, the portion of LRTC to the left of Q* does not represent long-run total costs when these indivisibilities are taken into account. Rather, the actual LRTC curve in this case is represented by $SRTC_4$ to the left of Q* and

Figure 1. Rail costs with perfect divisibility.

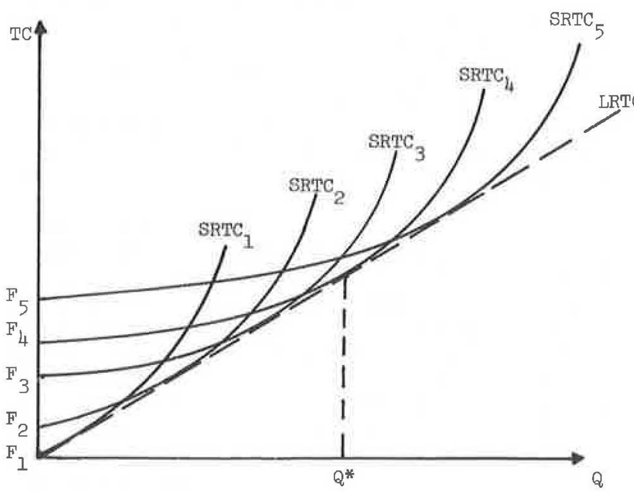
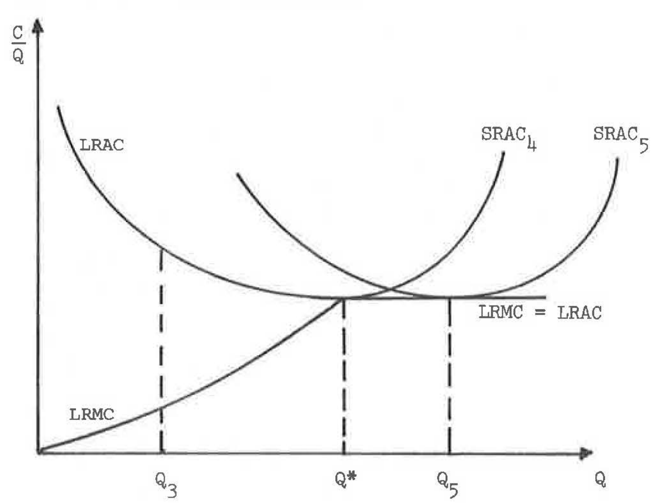


Figure 2. Rail costs with indivisibilities.



by LRTC only to the right of Q*; in Figure 2 are shown the average (SRAC and LRAC) and marginal (LRMC) cost curves derived from the revised LRTC.

In Figure 2, the LRAC curve is flat (and therefore equal to LRMC) to the right of Q*; it has a negative slope (and therefore lies above LRMC) to the left of Q*. The acknowledgment of indivisibilities consequently introduces long-run economies of scale (or traffic density). Q*, the optimum capacity of the minimum plant required to connect A and B, thus represents the minimum efficient scale in this market.

Under what circumstances would these economies of scale matter? So long as the number of trips between A and B exceeds Q*, the firm can adjust capacity to output, i.e., adopt that combination of F and V that minimizes total costs. The familiar dictum of economic efficiency would prevail: With output > Q*, SRMC = SRAC = LRMC = LRAC, and at (socially optimum) marginal cost pricing, total revenue equals total cost. Thus, economies of scale due to plant indivisibilities are of no particular consequence so long as output exceeds minimum efficient scale.

In the case of railroad branch lines, however, the level of output is often less than the posited minimum efficient scale. The firm is prevented from reducing the investment in fixed factors to some theoretically optimum level because of indivisibilities and must therefore operate on the downward sloping portion of the LRAC curve—i.e., at a point on LRAC significantly above the minimum LRAC. But by no means does that fact alone indicate that the branch line in question is excess capacity or that it would be socially best to abandon service over the line. In order to make such a judgment, we need to consider both the costs of rail service and the demand for rail service, a matter to which we now turn.

CRITERIA FOR BRANCH-LINE DISINVESTMENT DECISIONS

In this section, we shall attempt to delineate the analytics of alternative criteria for the branch-line disinvestment decision. Although there is no single such criterion, most empirical studies have utilized the profitability of the branch line to the firm owning the line. We shall differentiate between private (carrier profitability or, synonymously, financial viability) and social standards for disinvestment.

We should also note at this juncture the interdependence of pricing decisions and investment decisions (5). Again, most previous studies of branch lines have failed to acknowledge this critical fact by simply using current revenues in their viability calculations. Few industry analysts would argue, though, that the present rail rate regime is best by any standard. We will be careful, therefore, to clarify the disinvestment issue by elucidating the impact of alternative pricing policies on the establishment of abandonment criteria.

Let us consider the provision of rail service from A to B, where output is treated as a homogeneous quantity measured by Q. Assume a "stylized" version of rail costs, characterized by (a) fixed costs greater than zero, (b) constant marginal costs, and (c) declining average costs at levels of output less than the minimum efficient scale. Empirical validation of this characterization is reported elsewhere (6, 7). Likewise, assume a stylized version of demand for rail service: Although individual shippers may be sensitive to service variables other than price, such as frequency of service and loss and damage rates, assume that demand (D) is simply a function of price; i.e., Q = D(P). Having posited that rail costs and demand jointly determine disinvestment

Figure 3. Case 1: D intersects AC at Q < MOS.

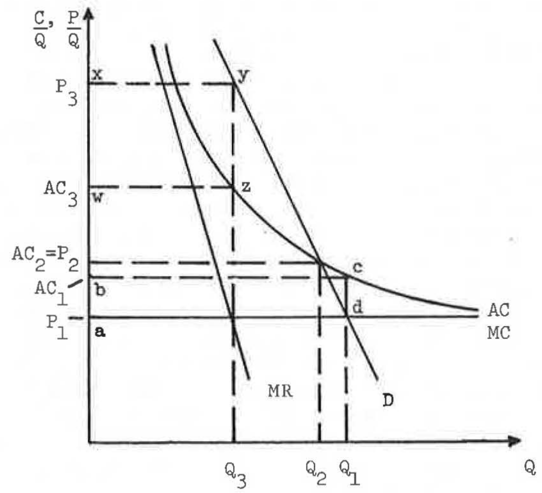


Figure 4. Case 2: no intersection of D and AC, uniform pricing.

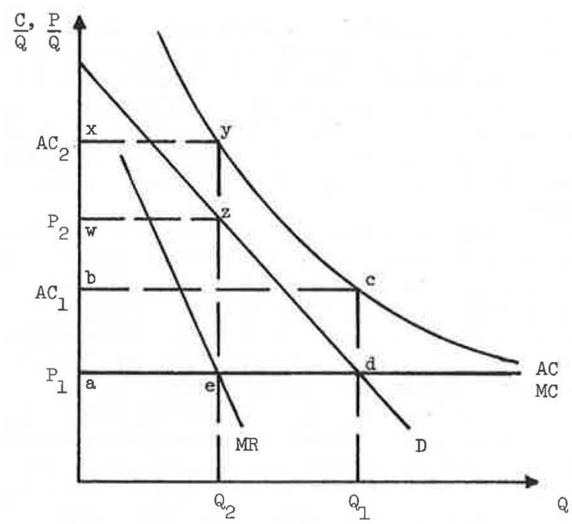
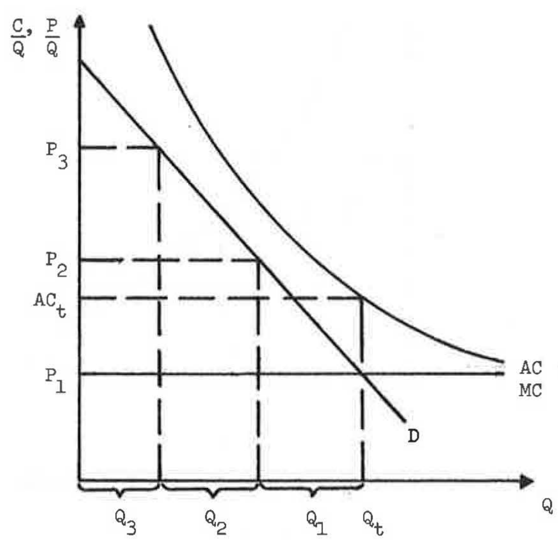


Figure 5. Case 3: no intersection of D and AC, discriminatory pricing.



criteria, we shall consider several simplified cases that illustrate the range of branch-line pricing and disinvestment decisions.

In case 1, Figure 3, the demand curve intersects the average cost curve at less than minimum optimum scale (MOS) output. With marginal cost pricing at P_1, the firm would produce at Q_1; in that event, total cost would exceed total revenue, and the firm would earn a negative profit:

$$\pi = (P_1 \times Q_1) - (AC_1 \times Q_1) = (P_1 - AC_1) \times Q_1; -\pi = abcd \qquad (2)$$

By pricing at average cost, $P_2 = AC_2$, output at Q_2, the firm could eliminate this loss and operate at break-even level; total revenue would equal total cost. The firm could also (assuming it is an unconstrained monopolist) set price at profit-maximizing P_3, where marginal cost is equal to marginal revenue, thereby earning an economic profit:

$$\pi = (P_3 \times Q_3) - (AC_3 \times Q_3) = (P_3 - AC_3) \times Q_3 = wxyz \qquad (3)$$

The profitability of the line, and thus the question of whether it should be abandoned under the profitability criterion, depends entirely on which pricing scheme prevails. The case thus provides an important lesson in disinvestment decisions: The fact that a line is losing money (earning a negative economic profit) does not, per se, mean that it should be abandoned, even under the private profitability standard. The proper response may be to allow the carrier to raise its rates on the line(s) in question.

In Figure 4, the essential feature of case 2 is that the entire demand curve lies to the left of the average cost curve. Average cost pricing is not feasible, since there is no intersection of D and AC. The firm can make the cost price marginal at P_1 and will thus incur a loss as shown in Equation 2. Alternatively, the firm can profit-maximize by pricing at P_2. Again, the firm earns a negative profit, since the average cost of producing Q_2, AC_2, is greater than P_2 ($-\pi = wxyz$). By definition, then, when the demand curve has no intersection with the average cost curve, there is no single price at which the firm can break even on the line. This fact has provided a rationale for price discrimination in the rail industry.

Figure 5, case 3, also features no intersection of D and AC. Here, though, the firm practices "second degree" price discrimination by segmenting the market, for instance by commodity type and by charging different rates to different shippers (the rate for each shipper being dependent on its elasticity of demand). As illustrated, the firm charges rates P_1, P_2, and P_3, and produces Q_1, Q_2, and Q_3 under each respective rate. Total output is Q_t, the average cost of which is AC_t. Total revenue is

$$TR = (P_1 \times Q_1) + (P_2 \times Q_2) + (P_3 \times Q_3) > TC = AC_t \times Q_t \qquad (4)$$

and the firm earns an economic profit. Whereas in case 2, with uniform pricing, the branch line would fail the profitability test, discriminatory pricing enables the line to pass that standard. Under what circumstances will price discrimination allow the firm to at least cover costs and thereby provide the economic incentive to retain the line in service?

Examine Figure 6, case 4. Again, D lies to the left of AC, and there is no single price at which the firm could earn a nonnegative profit on the line. Should the line be abandoned? According to the traditional standard of allocational efficiency, no. The demand curve represents the benefit derived from successive units of output; the area under the demand curve between zero and Q_1

represents the benefit derived from Q_1 units of output. Assuming that the income effect of any price change is zero (6), the net consumer surplus is the difference between the total benefit of Q_1 and the total amount paid for Q_1. With marginal cost pricing at P_1, the net consumer surplus is defined as

$$\gamma = \int_0^{Q_1} D^{-1}(Q)dQ - (P_1 \times Q_1) = uwz \quad (5)$$

The net producer surplus as defined here is the difference between the total revenue received for Q_1 and the total cost of producing Q_1; in case 4 this is defined as

$$\pi = (P_1 \times Q_1) - (AC_1 \times Q_1) = uvyz \quad (6)$$

Since the net producer surplus is negative, we will refer to π as the net producer loss.

The social welfare criterion of disinvestment is based on a comparison of γ, the net consumer surplus, to π, the net producer loss. If $\gamma > \pi$, the line should be retained: The benefits derived from the rail service are greater than the cost of production. If $\gamma < \pi$, the line should be abandoned. Geometrically, the social welfare criterion amounts to a comparison of the triangle vwx to xyz (since γ and π share the area uvxz in common). In Figure 6 vwx is greater than xyz; therefore, under the social welfare standard, the line should be retained.

There would remain, however, the troublesome matter of the firm's negative profit under marginal cost pricing. One method of resolving this problem is price discrimination, as discussed in case 3. Suppose now that the firm exercises perfect price discrimination, by which we mean the firm charges the maximum price for each unit of output that any customer is willing to pay (6, p. 187). The demand schedule represents the amount some customer is willing to pay for the Q_1th unit of output. Thus, with perfect price discrimination, the total revenue received for Q_1 units of output is equal to the area under the demand curve between zero and Q_1. By definition, perfect price discrimination thereby eliminates all consumer surplus. The producer surplus is equal to total revenue minus total cost; by producing the last unit where price equals marginal cost, the net producer surplus is defined as

$$\pi = \int_0^{Q_1} D^{-1}(Q)dQ - (AC_1 \times Q_1) = 0wzQ_1 - 0vyQ_1 \quad (7)$$

If $\pi > 0$, the firm would earn a profit and maintain service on the line. The profitability criterion with perfect price discrimination is equivalent to comparing the triangle vwx to xyz; it is identical to the social welfare criterion. Consequently, if the firm were able to price discriminate perfectly, both private profitability and social welfare criteria would lead to the same disinvestment decisions.

There remain to be discussed the effects of alternative modes on the branch-line disinvestment issue. The shape of the demand curve for any good or service reflects the availability and prices of close substitutes. We have, according to the Marshallian partial-analytical tradition, treated these as constant and given. Let us now examine the particular effects of shifts in these exogenous parameters on the alternative disinvestment criteria. Specifically, we want to take account of the effect of price of motor freight service (although of course the principle is generalizable to other modes as well) on the demand for rail service in the branch-line case.

For simplicity, assume that

1. Motor freight is the only alternative mode;

Figure 6. Case 4: consumer surplus criterion compared to perfect price criterion.

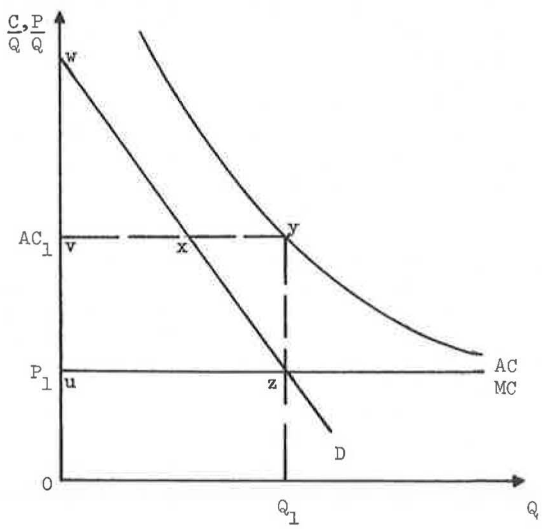
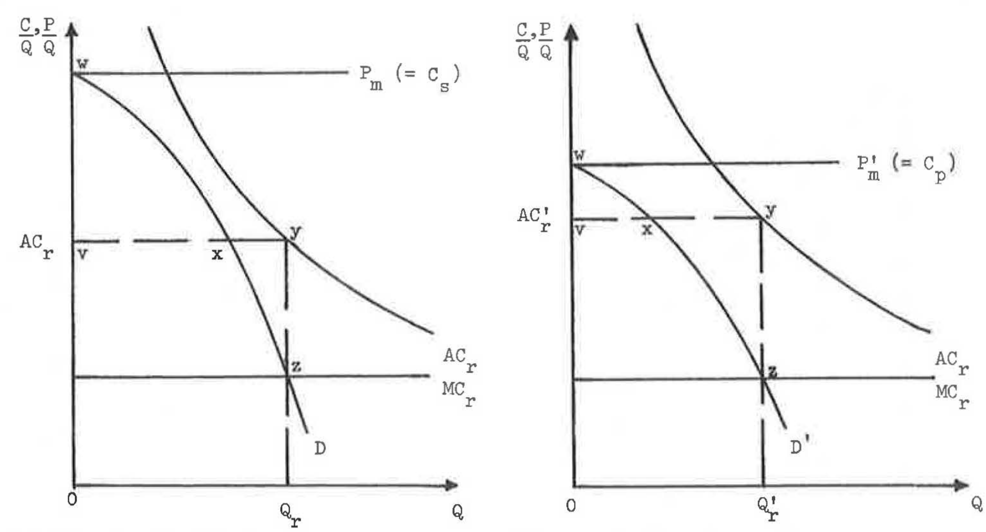


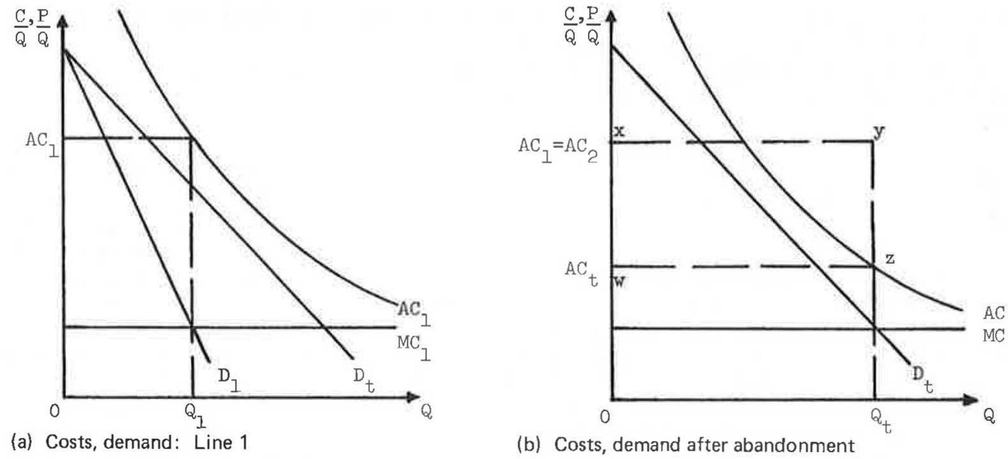
Figure 7. Effects of alternative mode on disinvestment.



(a) High-price alternative to rail

(b) Low-price alternative to rail

Figure 8. Disinvestment criteria with parallel lines.



(a) Costs, demand: Line 1

(b) Costs, demand after abandonment

2. Motor freight rates are equal to long-run marginal costs, which are constant; and

3. Rail and motor freight are close substitutes for most shippers.

Suppose, as in Figure 7a, that the price of motor freight service is at P_m. Then we would expect the demand for rail service to approach zero as the price of rail approaches that of motor freight service, which is to suggest that, if the price of rail service exceeds that of motor freight, then all traffic moving in the market moves by motor freight. In order to employ the social welfare (or firm profitability with perfect price discrimination) disinvestment criterion, we compare the area vwx to the area xyz. In this case, the former is greater than the latter, and the line should be kept.

Now assume that, for whatever reasons, the price of motor freight service is decreased to P_m', as shown in Figure 7b. Then, given the connection between the demand for rail service and the price of close substitutes, we expect and depict a concomitant downward and leftward shift in demand from D to D'. The new demand schedule reflects two consequences of the decrease in P_m. First, at all rail prices the quantity of rail service demanded is now less than before, and, second, the demand for rail goes to zero at the new lower price P_m'. As a result of the price change, the area wvx is now less than xyz, and, according to our social criterion, the line should be abandoned.

This simplified mode-comparative model draws our attention to two exceedingly important aspects of transportation investment planning. The first is the inherent interdependency of public or private investment in alternative modes of transport. The second is the necessity, in making (dis)investment decisions, of recognizing the crucial difference between market prices and social costs.

We have every reason to believe that the enormous public investment in highways and inland waterways in the past several decades has significantly reduced the costs of providing motor freight and inland barge service (7, pp. 35-50). These cost savings—and service improvements—have greatly increased the competitive advantages of motor and water carriers and have concomitantly reduced the demand for rail service, as represented graphically in the shift from D' to D in Figures 7a and 7b. Branch lines that were once privately viable and/or at least socially justified are now redundant. Unfortunately, prevailing regulatory attitudes indicate a failure to accept the implications of this development. Attempts by regulators to maintain existing patterns of service within a mode (particularly rail) often ignore the effects of increasing availability and decreased prices of alternative modes.

The modal interdependency issue is further complicated by the apparent disparity between current motor freight and inland waterway user charges and the true social costs of production (8, 9). Suppose that in fact motor freight service is subsidized and that the price, P_m', covers only the private costs of producing motor freight service, shown as C_p in Figure 7b. The subsidization of motor freight has the obvious effect of reducing demand for rail service from what it would be otherwise, as represented by D'. Under these conditions, the branch line in this market is certainly not privately viable, since even with perfect price discrimination the firm would incur losses. Furthermore, given the subsidization of motor freight, it is not socially best to also subsidize rail service in order to keep the branch line in operation. If (and it would be allocationally more efficient) motor freight operators were charged user fees that reflected the social costs of production, C_s, and price of motor freight service were increased to P_m in Figure 7a, then the continued operation and, possibly, subsidization of the rail line would be justified. Any analysis of excess capacity in the rail freight industry must, therefore, take proper account of the frequent and sizable divergences between market prices and social costs in the transport sector.

NETWORK EFFECTS ON BRANCH-LINE DISINVESTMENT CRITERIA

In the previous section, we examined alternative disinvestment criteria under the assumption that the branch line can be treated in isolation for the purposes of cost-benefit analysis. So long as traffic originating on a particular branch line terminates on the same line, and so long as there is but one line serving a market, that line is the proper unit of analysis. This seldom being the case, we must necessarily expand our models to take account of the interactions between a specific branch line and the rest of the rail system. While we obviously cannot deal with all of the network interdependencies, we will attempt to delineate those systemic effects that bear most directly on the branch-line issue.

Consider first the case of parallel branch lines: two or more lines serving essentially the same market. Suppose there are two lines serving the market A and B that serve no intermediate points. We assume that both lines have the same cost function and face the same demand curve, as shown in Figure 8a for one of the two lines. We expect shippers to be indifferent between service on the two lines, so that with identical prices the demand curve for each line is one-half the total demand curve D_t.

Given this division of traffic between the two lines, it is apparent that neither line, if examined in isolation, is financially viable or socially justified, since in both cases

$$\int_0^{Q_i} D^{-1}(Q)\,dQ < (AC_i \times Q_i) \quad \text{for } i = 1,2 \tag{8}$$

The problem, simply stated, is that there is not enough demand for rail service to justify both lines. By abandoning either one, the remaining line, shown in Figure 8b, becomes socially justified and financially viable. The same quantity of service, Q_t, can be provided at a much lower cost, AC_t; the savings are equal to the area wxyz, which is in turn equal to the fixed costs associated with the abandoned line.

There are numerous variants of this parallel line case, not the least important of which applies to higher volume branch lines (and main-lines as well). In many cases, the curve representing total demand for rail service in a market intersects the average cost curve to the right of minimum efficient scale output. The demand curve facing each line, however, lies inside the AC curve, which suggests that, on the basis of line-specific analysis, both lines should be abandoned. As in the previous case, significant savings can be achieved by consolidating the traffic onto one line and abandoning the other. When total output exceeds minimum efficient scale, neither price discrimination nor subsidization of the remaining line would be required.

We readily acknowledge that the parallel lines problem is more often than not greatly complicated by the fact of intermediate traffic along the lines. When individual shippers lose service through consolidation and abandonment, this needs to be taken into account in the disinvestment analysis. But the central point we wish to make should not be obfuscated by that complicating factor: The application of branch-line disinvestment criteria must refer to the relevant market, not to individual lines.

The other systemic effect of vital importance in assessing branch-line viability has been termed the "feeder effect." Our previous analysis assumes that the length of all trips originating on the line is equal to the length of the line. In most cases, trips originating on branch lines move onto the main-line system to their final destination. Thus, in order to evaluate profitability or social value of a branch line, we must take account not only of the loss of service on the line but also of the possible loss of the traffic over the main-line network as well.

The computation of the private profitability standard in that case is straightforward:

$$\pi = (P \times Q) - (C_b \times Q_b) - (C_o \times Q_o) \tag{9}$$

where C_b is the average cost per unit of output on the branch, and C_o is the marginal cost per unit of output off the branch (i.e., on the main-line network). The product of C_b and Q_b is equal to the total cost of maintaining the branch line in service. We use the marginal costs of service off the line because those are the only costs that would be saved if the traffic were lost.

The assumption is frequently made that all traffic originating (or terminating) on a line would be lost if the line were abandoned, but retrospective studies of rail abandonments have found that not to be the case (10, 11). If the main-line portion of some of the traffic is retained, then it is appropriate to attribute to the branch line only the net revenues of those shipments lost if service were discontinued. Thus, the proper measure of branch-line profitability is defined as

$$\pi = (TR - TR') - (TC - TC') \tag{10}$$

where

- TR = total revenues with branch service,
- TR′ = total revenues if branch is abandoned,
- TC = total cost (of on-branch and off-branch service) with branch, and
- TC′ = total cost of providing service retained after abandonment.

Simply put, the relevant criterion is the difference in revenues and costs after abandonment. Note that if all traffic were lost, TR′ and TC′ would be equal to zero, and the profitability standard would reduce to the one presented above.

The consumer surplus standard of branch-line viability in the feeder is equivalent to that developed for the case of the isolated investment project for the following reason. The consumer surplus criterion measures the area under the demand curve; the actual demand for rail service on a particular branch line would implicitly include the total trip length, not just that portion of the trip on the branch line itself. Given the comparative advantage of rail over motor freight on longer hauls, and the cost of transshipment from truck to rail, we would expect that the longer the haul (of shipments originating on the branch) the more inelastic the demand curve and, hence, the greater the divergence between the profitability and social welfare standards (assuming the firm is charging a single profit-maximizing price).

Thus, while demand curves for rail service are exceedingly difficult to measure empirically, the consumer surplus principle applies, even in cases where there is systemic interdependence between the branch line and the main-line network.

Finally, we readily acknowledge that these models abstract considerably from the complexities of actual branch-line abandonment cases. Nonetheless, it is hoped that these economic constructs may be useful in conceptualizing and conducting branch-line case studies. To the extent that these models can be used to inform empirical investigations, they will have served their purpose.

ACKNOWLEDGMENTS

This paper is a modified version of part of my doctoral dissertation, Rationalizing the Rail Freight Industry, for the Department of Economics, University of California, Berkeley. The empirical portion of the dissertation applies the disinvestment criteria developed in this paper to a network model of the U.S. rail system and develops estimates of excess rail trackage and the costs and benefits of its abandonment.

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Strategic Planning Studies Within British Rail

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Over a period of 3 years, British Rail has been carrying out a long-term strategic planning exercise that has looked at the role rail transport is likely to play in the overall transport scene in the United Kingdom. This paper describes in broad outline the nature and scope of the strategic studies and deals with the overall philosophy of strategic planning at the level of a national network. Some of the major study findings are briefly presented.

For over 3 years, beginning at the start of 1974, the staff of British Rail in conjunction with Loughborough University and Cranfield Institute of Technology were engaged in a series of studies that examined the long-term position of rail transport, both passenger and freight, within the United Kingdom. This overall study, which set out to examine the scale of operations the railways could expect in the period around the year 2000, was approached from the viewpoint of strategic planning, examining the long-term issues and factors that will affect rail travel in Britain. An attempt is made here to outline the underlying rationale of the project and to describe in the broadest terms the interrelated structure of the individual substudies that as a whole comprise the strategic studies.

In previous work discussing the overall assessment process, I have discussed the difficulties associated with assessment in the strategic sense. In the short term, the assessment process is a fairly clearly defined procedure of formulating the level of supply and demand associated with the innovation, specifying the scale of impacts (including those that are economic), and selecting from the available solutions by an appropriate evaluation procedure. Assessment procedures used in the past seem to have maximum validity where the process is used in the short term, where the technologies being compared are essentially similar, where the scale and nature of impacts are essentially similar, and where the planning horizon is limited. The more simple the assessment procedure, the more difficult it becomes to relax these constraints.

In much work that relates to long-term planning, the assessment has related to the introduction of new technology. Frequently, where new transport technology has been considered, the overall assessment procedure has been rudimentary, largely neglecting nonfinancial impacts. In seeking examples of such evaluations one might cite the assessment of Concorde and the Report of the Interdepartmental Committee on Intercity Travel in the United Kingdom. Experience and discussions with a number of planners and technologists have previously led to the identification of six criteria areas that appear to be considered in the evaluation of long-term transport commitments. These criteria or factor areas have been stated to be the following:

1. The availability of the technology or its potential for development.
2. Estimation of demand for travel at a fairly rudimentary level of consideration, taking cognizance of such variables as money cost, travel time and a limited number of socio-economic factors including comfort and convenience.
3. The optimality of financial resource allocation.
4. Environmental effects in the areas of: amenity, noise pollution, air pollution, safety, water pollution and solid waste pollution.
5. Socio-political impacts on the various levels of the national and local community.
6. Constraints on solutions imposed by the limited availability of natural resources.

STRATEGIC PLANNING VERSUS SHORT-TERM PLANNING

In approaching the problem of strategic planning for the railways, the British Rail Strategic Studies team was aware that any methodology developed or used should reflect the needs of long-term planning rather than conform to the more conventional wisdom of many studies, the methodology of which has grown out of the planning procedures developed for urban transportation in the 1960s and 1970s.

From the outset it was realized that the conventional form of benefit-cost studies was likely to be an unsuitable and unusable evaluation procedure for planning with the time horizons envisaged. It should be remembered that the strategic studies were oriented to an examination of rail transport in the year 2000, 25 years ahead, rather than to developments over the next 25 years. In the context of long-term planning, it is worthwhile briefly examining the difficulties associated with conventional economic analysis.

The mechanics of discounting require the use of interest rates that must be projected forward, in this case for a quarter of a century. An examination of the historical movement of discount rates over the last 50 years would indicate that a planner is being optimistic if he or she feels that he or she can estimate discount rates for 5 or 10 years ahead with any degree of accuracy. Only the most daring would care to project interest rates 25 years ahead. Logically it would appear to be unwise to predicate decisions on a basic parameter that could well have an inbuilt error of over 100 percent in its assumed value.

Possibly even more important is the fact that this form of analysis is by its very nature a short-term tool clearly unsuitable for strategic studies. This becomes quite apparent when one considers the condition of a long-term analysis with high interest rates. Long-term benefits and disbenefits of even large magnitudes are discounted to insignificantly small amounts in strategic analysis. Another problem arises from the fact that cost-benefit analysis works on the Hicks-Kaldor principle that we can justify penalizing one individual by the greater gain of another individual or group.

In much short-term transport planning this principle has been used to justify the undesirable externalities of transport schemes that can impinge on certain sections of the community only. These externalities, it has been argued, must be borne by the few for the greater good to the whole community. Applied to long-term planning, this argument, which even in the short term is at its best debatable, is highly contentious. Clearly it could result in the approval of a course of action that optimizes the economic conditions of one generation while leading to economic disaster for a later generation, provided that it is suitably separated by a gulf of time and interest rate levels. Even in the private sphere, analysis procedures that led to such conclusions could well be considered unacceptable; in the public sphere, where the government must be considered to be working in the interest of not only the current generation but also for posterity, the implications would be totally unacceptable.

Even at the mechanical level of the calculation, the long term predicates against the use of this form of analysis, which traditionally relies on cost and time differentials and the costing of externalities. Over the long term, the estimation of cost differentials is remarkably difficult. Experience of the variations in road, rail, and air costs in the last 4 years since the studies started bears strong witness to this. Estimates of the level of cost differentials by the year 2000 would justifiably be open to substantial uncertainty and would be difficult to sustain.

More predictable are future modal performance levels that can give estimates of modal time differentials, but the utility of the reliability of these figures is lost in attempting to convert time differentials to any form of generalized cost. There is little general agreement on the value of saved travel time for the present day; to attempt to estimate that value 25 years ahead would appear to be futile.

Equally important in any economic analysis is the costing of the external benefits and disbenefits. In terms of some of the externalities that arise from transport, such as noise, pollution, community severance, land take, mobility levels, institutional impacts, and resource depletion, it is clearly impossible to cost these successfully in terms of either current or future monetary terms. The cost of an externality is so intricately bound to living standards that any estimated costs would necessarily be computed in a way that at least once removed them from current estimates, about which there is anyway little agreement and much debate.

Long-term forecasting and the techniques necessary to achieve it are a much neglected area; planning efforts have largely centered on producing short-term forecasts or at least forecasts based on short-term methodology. There has been a healthy (or perhaps unhealthy) disrespect among planners for the projections of a number of "futures" organizations. Yet most planners would agree that long-term planning can really be effective only if backward-seeking rather than forward-seeking models are used in conjunction with analysis of fiscal and other resource use. The unsuitability of forward-seeking models is perhaps emphasized by the eventual abandonment of the transport recommendations based on a number of rather elaborate conventional land-use and transport models. Some planners and decision makers have claimed with some justification that a forward-seeking model is simply another term for extrapolation, a procedure that can lead to the perpetuation of unsatisfactory trends.

In long-term transport planning, the principal considerations should be related to the overall scale of operations and the infrastructure requirements contingent upon the findings. Consequently, the degree of precision required is far less accurate than for the 5-year forecast of traffic for planning wagon or coach replacement, street widening, or container purchasing. It is in this contextual framework that the forecasting procedure was developed for the strategic studies.

MODELING AND THE LEVEL OF UNCERTAINTY

The level of certainty that any forecaster places on his forecasts must relate to the certainty that can be placed on the underlying model variables. Ideally, model variables are of a causal rather than of an associative nature. In truth, even the best causal variables are tightly bound into the social structure. Stability of social structure gives the best conditions for confidence in forecasting models.

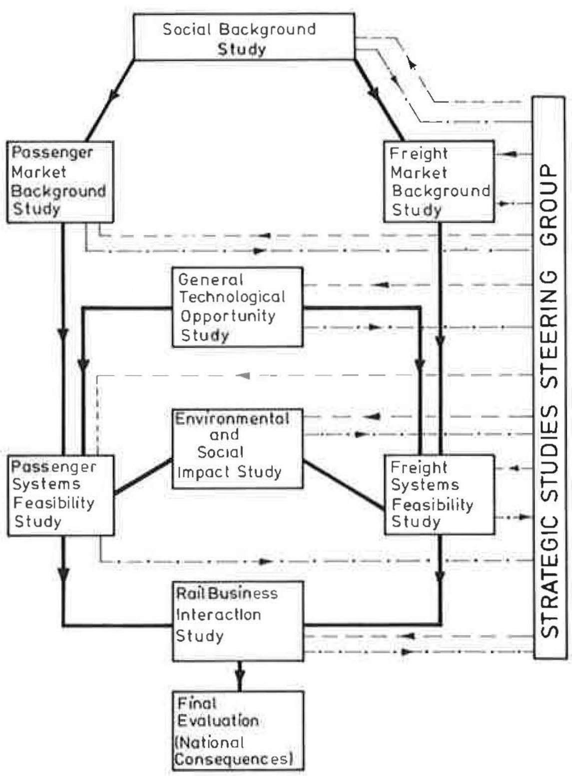
Under conditions of substantial social change, models become unreliable and, under radical change, they become useless. The structural changes over the last few years in income distribution in Britain that were accompanied by substantial changes in real costs of transport and other goods and services have meant that many predictions developed 10 years ago are already substantially incorrect. As these structural social changes harden, their effects will become even more apparent. For example, earlier forecasts developed on car ownership levels and annual travel predictions have already substantially overpredicted observed values, and the difference between those predictions and observed figures can be expected to worsen.

Referring back to the six areas of evaluation criteria discussed earlier, we can see that these factors, as well as being the criteria by which a scheme is evaluated, are also to a large degree the underlying factors for which the causal model variables are surrogates. Over time we can expect the level of importance of these variables to change, possibly substantially. Under these conditions, a model built from a number of surrogate variables is likely to be substantially more important in society's view. For example, if real per capita income in Britain continues to grow over the next 25 years, environmental considerations could become of paramount importance. Faced on the other hand with major economic problems and the approach of the much predicted exhaustion of fossil energy resources, economic survival could reverse the order of consideration of resources and environment, with the latter possibly becoming insignificant.

Given this level of uncertainty, conventional modeling in terms of regression analysis was considered to be an unjustifiable method for predicting the status of transport in the United Kingdom in the year 2000. Regression implied a level of certainty about the future that the study team could not sustain. Furthermore, the technique could assign to a few statistically significant variables the implication of causal relationships that might be neither provable nor even defensible. It was therefore decided to use the technique of scenario building in conjunction with category analysis to attempt to structure a range of futures for the United Kingdom depending on some fundamental variations in assumptions about the economic state and the level of environmental concern.

In the opinion of the team, the models are robust and cover a range of futures sufficient for decisions to be made so that the implications of alternative decisions are clear. On the other hand the forecasts are not precise, nor are they expected to be wholly accurate. The forecasting procedure and the modeling techniques are, however, integrated into the total structure of the

Figure 1. Structure of British Rail strategic studies.



studies, so that at each stage of the planning process each study could be related to the scale of envisaged futures in terms of individual scenarios.

STRUCTURE OF THE BRITISH RAIL STRATEGIC STUDIES

It was envisaged at the beginning of the overall project that the strategic studies should be divided into nine separate subareas as shown in Figure 1. Each study is briefly summarized in what follows.

Social Background Study

Based on the opinions and advice of 27 respondents in business, academic, and government circles, a Delphi survey was carried out to explore how the demand for transport would change over the next 25 years and how rail would contribute to satisfying that demand. The area explored in the course of the survey was the broad field of the social changes that would determine the nature of the British economy and consequent life style in the years up to the year 2000. Some of the areas examined included

1. The economy: economic growth, prices and incomes, real income, income distribution, employment sectors, and occupations;
2. Life style: demographic variables, class structure and class consciousness, developments in family structure, leisure patterns, geographical mobility, environmental considerations, environmental legislation, urban structure, and regional policies;
3. Travel: expenditures, mobility deprivation, valuation of time, and journey to work; and
4. Work-related issues: attributes of the working population, including education, school-leaving age, retirement age, sex split, working hours, vacations, and unemployment; size and structure of organizations, pressure groups, social accountability, and human rights; attitudes to work, worker participation, and automation in shift working.

The Delphi study was supplemented by a confidential survey of major industries, whereby the individual industrial forecasts could be compared and related to the findings of the Delphi work. Some of the principal findings of the social background study are shown below.

1. Gross domestic product up and real income to increase 50 percent;
2. Switch to be made from manufacturing to service industries;
3. Total population to grow only slightly from 50 million, but with regional distributions;
4. Income distribution remarkably stable;
5. Pressure for environmental improvement to be great;
6. Geographical mobility to increase especially for middle classes;
7. Travel expenditure to grow rapidly with increased income;
8. Power of occupational pressure groups and trade unions to increase;
9. School leaving and retirement to be a more gradual process than now;
10. Working hours to be more flexible;
11. Statutory holidays and annual holidays to increase;
12. Greater demand for shift work and greater resistance to it to be made;

13. Worker participation at board and plant level to increase; and

14. Automation expected to increase markedly in the 1980s.

Passenger Market Background Study

The passenger market study modeled by category the total market for passenger travel in the United Kingdom in both the urban and interurban areas for trip purposes designated into the categories of to-and-from work, education, and in the course of work and leisure. These figures are constructed in the context of social scenarios.

Freight Market Background Study

Based on the future development of industry and commerce and the future location of population, a forecast was made of the total demand for freight transport in the United Kingdom in the year 2000. The forecast was generated in terms of origin, destination, and commodity type. Base data principally came from British Rail traffic statistics, the 1967 Road Goods survey updated to 1972 by British Rail, the National Ports Council statistics, and the IMEG Consultants report, National Pipeline Network Study. A forecast of the future total freight market was generated from a number of growth rates determined from the social background study (most likely, least likely, etc.) and a derived relationship linking freight ton-kilometers to the index of industrial production.

General Technological Opportunity Study

This study was a state-of-the-art review of both freight and passenger aspects of transport technology (both developed and in development). From the viewpoint of operating characteristics and likelihood of change in these characteristics due to technological innovation, the study examined rail and competing technologies.

Within the passenger area, innovations in interurban rail technology were examined, as were changes in conventional rail, light rail, and light guideway systems, in the suburban and urban areas. Competitive technologies were similarly analyzed. In the interurban area it was expected that technological changes in the motor car, the long-distance bus, and the short-haul aircraft would provide the major areas of competitive changes. Within the urban-surburban context, the areas of technological change examined were the motor car, the bus and its infrastructure, and dual-mode systems.

The technological changes in freight movement systems concentrated on improvements to conventional rail freight technology, major innovations such as the trailer-rail and speed link shown below, to bring about major changes in the general merchandise market and anticipated changes in the major competing freight mode, road transport.

System	Innovations
Modified freightliner	Increased number of terminals, train turnaround at 2-h intervals at terminal, trains formed from 30 standard wagons, 120-km/h operation
Trailer-rail	Road trailer with detachable rail bogie
Speed link	Small container system with automatic loading and unloading at minor depots, trains formed at major depots only

Environmental and Social Impact Study

The Environmental and Social Impact Study (ENOSIS) was carried out not as an integrated unit, but in such a way that, using the results, the impact of one scheme could be designated at level X while a second scheme would have an impact level Y. Clearly, to be able to set definite and quantitative impacts would necessitate the ability to define a socioeconomic trade-off matrix. Recognizing that these trade-offs are not currently definable and possibly never will be, the study treats a number of separate areas within the context of the scenarios developed from the social background study. The topic areas selected are safety, accessibility and mobility, land take and building loss, and pollution and noise. Some of the principal findings are noted below.

In the safety study, the road carried 4 times as much freight and 15 times as much passenger traffic as rail. The costs of 1973 casualties at 1975 prices by two costing procedures (1£ = \$2.30) were

	Accident			
Mode	Type	No.	TRRL Cost (£000 000)	Melinck Cost (£000 000)
Road	Fatal	7 406	229.9	1457.5
	Serious	108 333	182.1	1154.3
	Slight	347 426	18.1	114.1
Rail	Fatal	78	2.4	15.4
	Serious	145	0.2	1.5
	Slight	2 810	0.1	0.9

The accessibility study indicated that the following conclusions can be drawn:

1. Journeys to and from work are longer for wealthier people;
2. Longer interurban journeys are made mainly by car for higher income groups;
3. Travel for shorter personal business and leisure by both car and public transport is biased to wealthier people; and
4. Three regions, East Anglia, the North, and Wales, have high per capita expenditure on transport due to poor public transport and need for high car ownership.

The pollution study, which was carried out in two customary units—emissions per passenger-mile in milligrams and per ton-mile in milligrams—provided the following levels.

	Emissions per Passenger-Mile (mg)			
Pollutant	Road Gasoline	Road Diesel	Rail Diesel	Rail Electric
Carbon monoxide	28 420	775	630	0
Hydrocarbons	1 440	155	130	0
Aldehydes	45	25	20	0
Nitrogen oxides	990	465	380	Trace
Sulfur oxides	110	710	250	0
Lead	40	0	0	0

	Emissions per Ton-Mile (mg)			
Pollutant	Road Gasoline	Road Diesel	Rail Diesel	Rail Electric
Carbon monoxide	370 910	1720	760	0
Hydrocarbons	18 830	350	150	0
Aldehydes	590	50	25	0
Nitrogen oxides	12 980	1032	460	Trace
Sulfur oxides	1 470	680	695	0
Lead	500	0	0	0

The noise study revealed that the total numbers of people dissatisfied with existing transport systems were 4.84 million with roads, 3.37 million with airports, and 0.105 million with rail.

On a passenger-mile basis, land take for rail, the study revealed, is less than one-half that for road-based schemes.

Passenger Systems Feasibility Study

Taking the forecasts of the passenger market background study for the year 2000 and the general appraisal of the technology likely to be available at that time, this study was designed within a range of scenarios to develop forecasts using models developed in the passenger and freight market studies. The scenarios such as the passenger scenario shown below enabled the team to identify the range of options to be evaluated for guided and nonguided systems in terms of the possible scenarios of policy and legislation and energy and resources availability. They could also determine the characteristics of the available passenger transport systems in the year 2000 and the likely level of the total passenger travel market and the modal split at levels within the range of option. They were also able to evaluate the options in terms of their financial, environmental, and social effects and, where appropriate, in terms of net social benefit or loss.

Scenario		
Mode	No.	Characteristics
Nonrail (No change in rail cost or quality)	1	Little change in car/bus cost and quality
	2	Increased car costs but no changes with average car speeds; some restrictions in town
	3	As for scenario 2 but changes assumed greater
Rail (Scenario 2 used as a starting base)	4	Reductions in journey time for rail travel
	5	Creation of a combined public transport network with great coordination
	6	As for scenario 5 but with rail price changes to spread demand

Freight Systems Feasibility Study

The remit of the Freight Systems Feasibility Study team was to examine the output of the freight market study in terms of size of market and quality of service requirements and to

1. Devise candidate rail-based guided transport systems for the various market groupings and determine their potential market penetration at various potential performance-characteristic levels (costs, receipts, volumes);
2. Identify the likely nature of competing systems, and evaluate their performance on the same basis, and their likely level of market penetration; and
3. Summarize the overall effect of selected candidate systems on the national freight transport situation in financial, environmental, and social costs and benefits at (a) the commercial modal split level and (b) a range of higher levels of market penetration. The most likely forecast is listed below in millions of customary tons.

	Forecast (000 000 tons)	
Freight	1972	2000
Total market	1963	2500
Bulk market	1090	1300
Rail bulk market	190	260-300
General merchandise	590	900
General merchandise > 80 km	–	200
General merchandise rail potential	–	20

Rail Business Interaction Study and Final Evaluation

The business interaction study recognizes that passenger and freight traffic share the railway's infrastructure and that, although the level of demand of freight and passengers may be to a very large extent independent, the two businesses interact significantly on the supply side. The study takes the outputs of the individual freight and passenger studies according to the various scenarios of social and environmental control and converts the individual forecast traffic flows into trains on the peak average working day.

This level of train demand is related to the existing route network and compared to network and route capacity. From this comparison the study derives a measure of the additional route infrastructure in terms of trackage and location needed to accommodate the total combined traffic.

Other areas within the realm of this study were an estimate of the costs of provision of additional infrastructure, methods of constraining demand so that existing facilities can cope without the construction of additional infrastructure, and various strategies to optimize service levels, such as the segregation of high-speed intercity passenger services.

VALUE OF STRATEGIC PLANNING

Having described the study structure and the philosophy behind the strategic studies as they are to date and in their final form when completed, it is worth attempting to evaluate strategic planning both as it might be and as it is exemplified by the studies reported here.

The results of the studies obviously cannot be assumed to be definitive and accurate projections of the future. These could be attained only if all the temporal and local deviations from the generalized assumptions of growth were known. In the long term, political and technological discontinuities are likely, and, as Drucker has pointed out, there is no way of forecasting across a technological jump. This is equally true for political discontinuities, as 1973 would indicate.

However, the studies must be regarded as useful in that they indicate the nature of the effects of different policies. Given that the overall methodology is acceptable, the scale of differential outcomes is likely to be similar to those projected. The methodologies chosen in our forecasting techniques have purposely been simple and robust, for it is our opinion that sophisticated techniques are unwarranted in this type of long-term planning.

The outcome of strategic studies should be an indication of the scale of real investment and identifiable impacts with respect to different policy options. We are confident that these studies have achieved this goal.

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Part 2
Surface Freight Regulation

Freight Transportation and Regulation of Intermodal Competition

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The Interstate Commerce Commission's rules for rate making have traditionally emphasized considerations of equity rather than economic efficiency. A theory for efficient pricing can be advanced as a means of improving the allocation of transportation resources. This paper summarizes two possible pricing schemes. Under the first, called totally regulated second best (TRSB), prices and entry are controlled for all modes to maximize economic efficiency while allowing a mode with economies of scale to break even. Under the second, called partially regulated second best (PRSB), modes without economies of scale are unregulated, and price and entry controls are imposed on a mode with economies of scale in order to maximize economic efficiency for all transportation activities. The paper compares PRSB and TRSB in terms of the potential information requirements, administrative costs, and problems in implementation and shows why each may be of interest as a public policy alternative. Finally, the paper contrasts the actual tariffs in the U.S. rail industry in 1961 with the rules for efficient pricing suggested by the PRSB alternative. The analysis suggests that the rail rates for agricultural commodities may have been too low and that the rail rates for manufactured commodities may have been too high to be economically efficient.

The regulation of freight transportation in this country has become increasingly complex over the past few decades. At the heart of the problem one finds that extensive rivalry among alternative transport modes has developed and is commonly referred to as intermodal competition. Almost all kinds of freight can be carried either by railroad, over waterways, or via motor carriers over the highway. Liquid or gaseous products often go by pipeline, and a small portion of the freight transported in this country is shipped by air.

Freight transportation presents a radical departure from the textbook case for regulation, which is usually developed for a single-product firm that has a monopoly in its market and which operates with economies of scale. First, intermodal competition means that shippers may have a choice in purchasing transportation service instead of having to deal with a single supplier. In addition, transportation firms will usually supply many kinds of service and must be regarded as multiproduct rather than single-product firms. Finally, while some of the competing modes operate with economies of scale, others do not.

In light of the increased intermodal competition of the past few decades, many questions regarding the appropriate stance of regulation have been raised. Should all modes be regulated if some of the modes are not characterized by economies of scale? Should any of the modes be regulated? If some or all of the modes are to be regulated, what kind of pricing, entry, or other controls are needed in order to efficiently use transportation resources? What do economic principles tell us about the relationships among tariffs, the allocation of shared costs (i.e., those incurred in the provision of two or more services), and the extent to which intermodal competition may be desirable?

INTERSTATE COMMERCE COMMISSION RATE MAKING: EMPHASIS ON EQUITY

The regulation of intermodal competition has not been an easy task for the Interstate Commerce Commission (ICC). Congress attempted to state some guidelines for the ICC in the Transportation Act of 1940. The preamble to the act declared that the national transportation policy included all of the following objectives:

> To provide for fair and impartial regulation of all modes of transport subject to the provisions of this Act, so administered as to recognize and preserve the inherent advantages of each; to promote safe, adequate, economical and efficient service and foster sound economic conditions in transportation and among the several carriers; to encourage the establishment and maintenance of reasonable charges for transportation services, without unjust discriminations, undue preferences or advantages, or unfair or destructive competitive practices; to cooperate with the several States and the duly authorized officials thereof; and to encourage fair wages and equitable working conditions; —all to the end of developing, coordinating and presenting a national transportation system by water, highway, and rail, as well as other means, adequate to meet the Commerce of the United States, of the Postal Service, and of the national defense.

Congress did not state in detail how these objectives were to be met. It was not clear exactly what constituted "sound economic conditions," "reasonable charges," "unjust discriminations," "undue preferences or advantages," or "unfair or destructive competitive practices." The resolution of these issues awaited further definition by administrative law, court decisions, and additional legislation.

An issue that became increasingly thorny was that of pricing. Should the rates for one mode, for example, railroads, be set at levels that preserve competition from other modes, even if lower rail rates would cover marginal costs? The preservation of all modes might not be consistent with the provision of transport services at the lowest possible rates. The practice of setting rates in order to preserve intermodal competition is known as umbrella rate making, since it provides a protective umbrella for modes that might otherwise be eliminated. Congress addressed this practice in the Transportation Act of 1958, which states that umbrella rate making should not be the primary objective of rate making:

> Rates of a carrier shall not be held up to a particular level to protect the traffic of any other mode of transportation, giving due consideration to the objectives of the national transportation policy declared in this Act.

Although this legislation stated one way in which rates should not be set, it failed to resolve the hard pricing and entry control issues left open in the 1940 statute. The ICC has found itself confronted with a very difficult task, the need to set forth an operational rate-making scheme that achieves the generally defined and sometimes seemingly inconsistent congressional directives.

The commission has generally attempted to require that the minimum rate a carrier may charge for transporting a given commodity over a specified route should generate revenues that cover a fair share of the total costs incurred by the carrier. Over the past two decades a number of administrative law and court cases have focused on the development of an acceptable cost basis for calculating minimum rates and on an appropriate concept of a fair share of costs. In the courts the most famous of these was the Ingot Molds case [American Commercial Lines, Inc., v. Louisville and National Railroad Co., 392 U.S. 571 (1968)]. Among the ICC cases, the most comprehensive treatment of rate-making rules was ICC Docket 34013, entitled Rules to Govern the Assembling and Presenting of Cost Evidence (337 ICC 298, July 30, 1970). It is not the purpose of this paper to discuss these cases in detail, since that has been done elsewhere (1), but I shall summarize several basic rate-making principles that have emerged from them.

First, at the minimum, the rate for any service should be set so that the revenue generated covers out-of-pocket or incremental costs. Weiss and Strickland have noted that "out-of-pocket costs have been regarded generally in these cases as equivalent to what economists refer to as 'incremental' or 'marginal' costs.... [and] are defined generally as the costs specifically incurred by the addition of each new unit of output and do not include any allocation to that unit of pre-existing overhead expenses" (2).

Second, "More generally, 'fully allocated (or distributed) costs' are representative of the full expense level assignable to particular services." The ICC defines fully allocated costs as the "out-of-pocket costs plus a revenue-ton and revenue ton-mile distribution of the constant [overhead] cost, including deficits, [that] indicate the revenue necessary to a fair return on traffic, disregarding ability to pay" (259 ICC 475, 1945).

And, third, "The allocation of constant costs to particular services, for rate making purposes, should result in the assignment of an equitable portion of such expenses to the particular services, and no single method can be considered as universally applicable to all transportation services."

Several observations can be made regarding the alternatives for rate making that the ICC proceedings have addressed. There has been an emphasis on the fairness of rates rather than on rates leading to an economically efficient allocation of resources. The commission understands the law to mean that rates should at least cover marginal costs (this does bear some relationship to economic efficiency). But at the heart of the Ingot Molds case and ICC Docket 34013 was the notion that each service should cover a fair portion of shared costs, i.e., those costs that are incurred in the provision of two or more services and that cannot be unambiguously attributed to the provision of any single service.

The emphasis on equity rather than economic efficiency has occurred because of two things. First, congressional directives have repeatedly charged the administrative process with the obligation to be fair. The administrative process is an adversary one. When cases involving intermodal competition are heard, the various modes will seek to protect their positions in transport markets wherever possible. Other interest groups who might be affected by a ruling, such as shippers and organized labor, will also strive for gains and, at the minimum, argue against their own losses. Consequently, the very nature of the administrative process makes equity considerations virtually inevitable.

Second, economic theory has only recently made significant progress in addressing the problems of economically efficient pricing for multiproduct firms engaged in intermodal competition. The existence of economies of scale, common or joint production costs, and multiple modes has contributed to the difficulties in describing the relationships between efficient prices and the structure of transport markets. I shall now discuss those relationships.

OPTIMUM PRICING WITH INTERMODAL COMPETITION

Multiproduct Monopoly Without Intermodal Competition

I shall begin the discussion of efficient pricing by examining the case of a multiproduct firm with a monopoly in each of its markets. Suppose a firm produces n services in quantities $x_1, x_2, \ldots, x_n$ and assume that the cost function for the production of these commodities can be represented by $C(x_1, x_2, \ldots, x_n)$. Then basic economic principles indicate that the most efficient allocation of resources is achieved when the price equals marginal cost in each market, where the marginal cost can be written as $\partial C/\partial x_i$ for the ith service. Since this is the most efficient pricing scheme, economists sometimes refer to it as "first best." The first best pricing rule can therefore be written as

$$P_i - (\partial C/\partial x_i) = 0, i = 1, 2, \ldots, n \quad (1)$$

Unfortunately, for many regulated firms, the pricing rule suggested by Equation 1 would lead to a deficit. Policy makers have essentially three alternatives in this case. First, they can subsidize the firm by an amount at least large enough to cover the deficit so that the firm will remain in business. Second, they can allow the firm to engage in some form of price discrimination in some of its markets, although regulators have been reluctant to resort to price discrimination on the grounds that it is unfair for some consumers to pay more than others for the same service simply because they are willing and able to do so. In addition, price discrimination may be difficult to implement even if regulators desired to use it, for one of two reasons: It may be difficult to identify those consumers willing and able to pay more for a service; it may also be difficult to prevent arbitrage in the market, in which case the firm would quite likely observe most or all of its sales being made to customers who can purchase at the lowest tariff and then resell to other customers.

With both the subsidy approach and price discrimination it may be possible for the firm to continue to reach a first best operating point without incurring a deficit, as long as consumers who are just willing and able to pay a price as large as the marginal cost of the service would be able to purchase it. However, if policy makers reject these two approaches, they will have to charge prices that are different from marginal costs if the firm is to avoid a deficit. This has led to the definition of the so-called "second best" problem, which refers to the determination of the prices that lead to the greatest economic efficiency possible while avoiding (a) a deficit for the firm, (b) direct subsidization of the firm, and (c) price discrimination.

A set of second best pricing rules was developed by Baumol and Bradford in a classic article in 1970 (3). The rules derived are those that maximize economic efficiency (as measured by the sum of consumer and producer surplus) subject to a constraint that allows the firm to avoid a deficit. For simplicity, assume that the demands for each of the services of the monopoly firm are independent of one another; i.e., a change in the price of one service will not affect the quantity of another service consumers wish to purchase. Then the second best prices are those that satisfy Equations 2 and 3:

$$R \triangleq \{[p_i - (\partial C/\partial x_i)]/p_i\} \epsilon_{pi} = \{[p_j - (\partial C/\partial x_j)]/p\} \epsilon_{pj} \quad (2)$$

for all i, j and

$$\sum_{i=1}^{n} p_i x_i - C = 0 \tag{3}$$

where ϵ_{p_i} equals $(p_i/x_i)(\partial x_i/\partial p_i)$, the price elasticity of demand in the ith market, and the terms equal to R, as defined in Equation 2, are sometimes called Ramsey numbers from early work on the theory of second best by Frank Ramsey (4).

Equation 3 represents a condition in which the firm is breaking even (total revenues equal total cost). Equation 2 represents the well-known rule that in each market the amount by which price deviates from marginal cost is inversely related to the price elasticity of demand. The theory can be extended to cover the case in which the demands are interdependent; this results in a slightly more complicated form for the Ramsey numbers. The basic idea remains unchanged in characterizing second best; namely, the Ramsey numbers are equal in all markets, and the firm is earning no monopoly profits.

There is an essential difference between the approaches to pricing taken by regulators and by Baumol and Bradford. Regulators tend to allocate shared costs first and then judge the fairness of prices based on that allocation. In the work of Baumol and Bradford, efficient prices are determined directly, based on a combination of cost and demand information. No prior allocation of shared costs is undertaken, and second best prices may be quite near or quite far from the prices regulators determine from fully distributed costs. It is possible to determine how shared costs should be allocated in order to reach second best once the efficient prices have been found, but such an allocation would be performed after prices are determined, not before.

Nature of the Problem With Intermodal Competition

The basic principle of first best pricing remains the same where there is intermodal competition. Resources are allocated most efficiently when the price charged by each mode in the transport of each commodity equals the marginal cost for that activity. If all modes could remain profitable at an equilibrium when marginal cost pricing is followed, there would be no reason to regulate any of the modes, at least on grounds of economic efficiency. There would be no need to look for second best prices since no firm would incur a deficit at first best prices.

The problem of second best does arise if one or more of the modes would incur a deficit at first best prices. Several questions about the second best problem arise in this case. Should prices deviate from marginal costs in all modes at second best, or only in those modes that do not break even with marginal cost pricing? What do the second best pricing rules look like with intermodal competition? Are there any special entry control problems that might be encountered in attempting to achieve second best?

A Model of Second Best

The following model for determining second best prices with intermodal competition has been developed by Braeutigam (5). The basic assumptions made in that work are as follows:

1. There are m modes that provide transport services between two points. Only one of these modes (mode 1) is characterized by economies of scale. In other words, if the services of mode 1 were all priced at marginal cost, the profits for the firm would be negative.
2. There are many suppliers of transport service in each of the other modes, so that each of the modes 2, . . . , m would be competitive without regulation. With free entry, the supply of transport services in each of these modes is assumed to be perfectly elastic.
3. Each mode may transport any or all of n commodities. Let i be a modal index (i = 1, . . . , m), j be a commodity index (j = 1, . . . , n), and x_{ij} be the amount of commodity j transported by mode i.
4. All carriers of mode i provide identical service in the transport of commodity j. Restated, this means that there is intramodal homogeneity in the carriage of a particular commodity.
5. There is intermodal service differentiation. In transporting commodity j, carriers of one mode will provide service that differs from the service of carriers of other modes. This recognizes that motor carriers, water carriers, and railroads may differ in the speed of transport and reliability and in other aspects of service quality.
6. For our purposes, the demand for transportation of commodity j via any mode is independent of the demand for transportation of commodity k($k \neq j$) via any mode. Formally, let $P_{ij} = P_{ij}(x_{1j}, x_{2j}, \ldots, x_{mj})$, i = 1, . . . , m; j = 1, . . . , n, where P_{ij} represents the (inverse) demand for transport of commodity j via any mode i. In addition, let s_{ij} equal the price corresponding to the (perfectly elastic) supply function for mode i in the transportation of commodity j, and $C^1 = C^1(x_{11}, x_{12}, \ldots, x_{1j};$ factor prices) be the total cost function for mode 1. Factor prices are assumed to be constant.

Given these assumptions, second best prices for all modes could be determined by maximizing the sum of consumer and producer surplus for all modes, subject to a constraint that the first mode break even, following the basic approach of Baumol and Bradford.

The model also assumes that there are zero income effects associated with the demand functions, p_{ij}, so that the welfare measure of consumer and producer surplus can be written as a path-independent function of the outputs x_{ij}, $\forall_{ij}$. The measure of consumer and producer surplus can also be used if there are nonzero income effects, as shown by Willig (6). The sum of consumer and producer surplus can be represented by T, where

$$T = \sum_{j=i}^{n} \left[\int_{w=0}^{x_{1j}} P_{1j}(w, 0, 0, \ldots, 0)\,dw + \int_{w=0}^{x_{2j}} P_{2j}(x_{1j}, w, 0, 0, \ldots, 0)\,dw \ldots + \ldots + \int_{w=0}^{x_{mj}} P_{mj}(x_{1j}, x_{2j}, \ldots, x_{m-1,j}, w)\,dw \right] - C^1 - \sum_{i=2}^{m} \sum_{j=1}^{n} s_{ij} x_{ij} \tag{4}$$

Formally, the problem is written $\max_{(x_{ij},\ \forall_{ij})} T$, subject to

$$\sum_{j=1}^{n} p_{ij} x_{ij} - C^1 \geqslant 0 \tag{5}$$

Let us refer to this as a totally regulated second best (TRSB), since all modes are regulated both by price and entry controls. In order to achieve TRSB, the following conditions must be satisfied.

$$R \triangleq \{[P_{1j} - (\partial C^1/\partial x_{1j})]/P_{1j}\}\,\{P_{1j}/[(\partial P_{1j}/\partial x_{1j})x_{1j}]\};\ j = 1, \ldots, n \tag{6}$$

$$R \triangleq [(P_{ij} - s_{ij})/P_{ij})]/[(\partial P_{ij}/\partial x_{ij})(x_{ij}/P_{ij})] - [(P_{ij} - s_{ij})/P_{ij}];\quad i = 2, \ldots, m;\ j = 1, \ldots, n \tag{7}$$

and

$$\sum_{j=1}^{n} P_{1j} x_{1j} - C^1 = 0 \tag{8}$$

where R represents a number between zero and minus one, and is the intermodal counterpart to the Ramsey number of Equation 2 for the case of the multiproduct monopoly.

These conditions can be interpreted as follows. Equation 8 states that at TRSB mode 1 will just break even, as in the case of the multiproduct monopoly. Equation 6 displays the extent to which the prices in mode 1 will exceed marginal cost. The first term in brackets represents the amount of this deviation as a fraction of the price level. The second term in brackets is the reciprocal of the quantity (not price) elasticity of demand.

The administration of a TRSB pricing scheme becomes particularly complex because of the condition required by Equation 7, which one could think of as the appropriate Ramsey number analog for modes 2, . . . , m. The numerator of the left side represents the amount by which price deviates from marginal cost in those modes, stated as a fraction of the price itself. A similar expression appears in the denominator. The first term in the denominator represents the cross elasticity of the inverse demand, P_{1j}, with respect to the quantity x_{1j}.

It can be shown that, when the services provided by different modes are imperfect substitutes for one another (i.e., when $\partial p_{1j}/\partial x_{kj} < 0$ for $k \neq j$), then the prices for transport will be held above marginal costs in modes 2, . . . , m. Since this condition would serve as a signal for more firms to enter into those markets without restrictions, the regulator would have to prevent free entry or else impose a set of excise taxes to achieve TRSB prices. Otherwise entry would occur until the prices were driven down to marginal cost.

Implications for the Administrative Process

There can be little doubt that the execution of the TRSB scheme represents an enormous task for regulators. Some might argue that there is a striking similarity between the outlined program and the one we presently observe for intermodal competition, particularly since regulators presently do control tariffs and conditions of entry. One could even argue that regulators attempt to require higher tariffs on commodities with more inelastic demands through a consideration of "value of service" and that this is generally consistent with the rules of Equations 7 and 8.

However, it would be difficult to carry the analogy much farther. The data requirements for a determination of second best prices are very large. The information required on the numerous cross elasticities of demand alone might be enough to make the outlined program unwieldy.

Even if regulators were committed to a program of second best, there are other difficulties at least as important as information-related ones. For example, suppose that mode 2 represents motor carriers and that a regulator attempts to limit entry in order to hold price above marginal cost for motor carrier services. Then the presence of an unregulated sector of motor carriers, as we have in this country, may present an overwhelming problem related to entry control. If regulated tariffs are held above marginal costs, shippers who would otherwise have used motor carrier will have incentives to buy their own trucks to privately carry their own commodities. If private carriage remains unregulated, as it is today, then entry into this activity would not be prevented by the rules applying to regulated carriers.

This is not a hypothetical problem. As Paul Roberts has observed, shippers today engage in this practice: "A typical strategy [of shippers] is to [privately] haul the higher-rated commodities and the regular hauls, but to leave the lower-rated commodities and the overflow for the regulated carrier" (7).

As a result, although the intent of regulation may be to proscribe entry, the probable effect would simply be to change the form of entry to circumvent the rule.

A Variation: Partially Regulated Second Best

The problems of entry control, data acquisition, and general administration lead us to ask if there is not some modified form of second best that might be of interest. One rather interesting candidate would be a program that allowed the modes without economies of scale ($i = 2, \ldots, m$) to clear their markets and that concentrated on the prices set by the mode with economies of scale. This would release the administrative process from acting on the $n(m - 1)$ rates for those modes, and, in addition, it would not involve itself in the problem of entry controls for modes that would be competitive without regulation. The administration of regulation under this system would be much simplified.

Let us refer to this variation of second best as partially regulated second best (PRSB). Formally, we could state the PRSB problem as the maximization of the sum of consumer and producer surplus for all modes together, subject to a break-even constraint for mode 1 and market clearing conditions for all other modes. The market clearing conditions mean that

$$P_{ij} - s_{ij} = 0, \text{ for } i = 2, \ldots, m; j = 1, \ldots, n \tag{9}$$

It can be shown that the following conditions must be satisfied at

$$\sum_{j=1}^{n} P_{1j} x_{1j} - C^1 \geqslant 0 \tag{10}$$

and

$$R \triangleq \{[P_{1j} - (\partial C^1/\partial x_{1j})]/P_{1j}\}\, \epsilon_{P1j}; j = 1, \ldots, n \tag{11}$$

where $\epsilon_{P_{1j}}$, as before, refers to the price elasticity of demand in the market for x_{1j}.

Note that the pricing rules for PRSB, where intermodal competition exists, are the same as the ones developed by Baumol and Bradford for a multiproduct monopoly. The Ramsey number of Equation 11 must be the same in all markets and must depend only on information about price, marginal cost, and the price elasticity of demand for the first mode.

Comparison of First Best, Baumol and Bradford, TRSB, and PRSB

Let us step back for a moment to relate the various pricing rules we have discussed in this section to one another. The pricing rules of Baumol and Bradford (Equations 2 and 3) are conceptually appropriate when the services produced by mode 1 have demands independent of one another. If there are other modes, then the TRSB pricing rules imply that it may be efficient (second best) to alter the market-clearing outcome for other modes in order to satisfy the break-even requirement for the first mode, even if those modes would be quite competitive without regulation.

There are several reasons why regulators may not attempt to follow a program leading to TRSB. They may perceive the interactions among the services of mode 1 and other modes to be small, or they may simply be unaware of the interaction. They may also recognize the potentially large information and administrative requirements for such a program or the difficulties in controlling entry as effectively as would be required. There may be other reasons for which regulators may decide to let the potentially competitive markets clear. In any of these cases the rules for PRSB may be of interest.

To illustrate the relationship between several possible pricing schemes with intermodal competition, let us consider a special case, which can be represented on a graph. Assume that there are only two modes, mode 1, which has economies of scale, and mode 2, which lacks scale economies. Only one basic service is provided by each mode: That provided by mode 1 is differentiated from that of mode 2. However, all firms in mode 2 provide a homogeneous service. Thus, we have retained the assumption of intermodal service differentiation and intramodal service homogenity from the earlier work. Mode 2 has a supply schedule $s_2(x_2)$, which relates the quantity of service that would be provided, x_2, to the price of that service. The supply schedule need not be perfectly elastic, but we assume that it is always less negatively sloped than the inverse demand schedule in the market, $P_2(x_1, x_2)$. Mode 1 has an inverse demand schedule $P_1(x_1, x_2)$ and a cost function $C^1(x_1)$.

Figure 1. Mode 1 profitability when mode 2 clears.

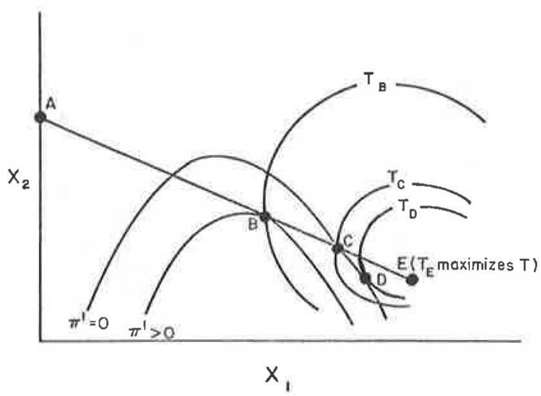


Figure 2. Mode 1 negative profitability when mode 2 clears.

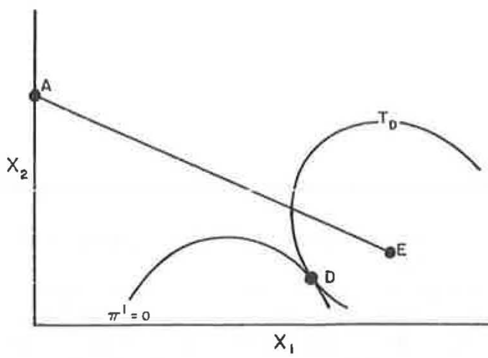
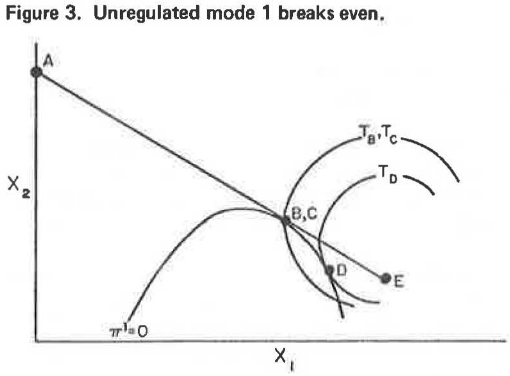


Figure 3. Unregulated mode 1 breaks even.



In Figure 1 (1, Figure 1) we have placed the quantities of the outputs x_1 and x_2 on the axes. It is possible to represent the set of (x_1, x_2) combinations that satisfy the market clear condition

$$P_2(x_1, x_2) - s_2(x_2) = 0 \tag{12}$$

by the set of points AE. The locus has a negative slope under the assumptions we have made, since

$$dx_2/dx_1 = -\{(\partial P_2/\partial x_1)/[(\partial P_2/\partial x_2) - (\partial s_2/\partial x_2)]\} < 0 \tag{13}$$

The points on AE can be thought of as a reaction function for mode 2; i.e., given any level of output x_1, then mode 2 suppliers will supply x_2.

It is also possible to represent isoquants of the sum of consumer and producer surplus, shown by the curves T_B, T_C, T_D, and T_E. It can be shown that these isosurplus curves have the slope

$$dx_2/dx_1 = -\{[P_1 - (\partial C^1/\partial x_1)]/(P_2 - s_2)\} \tag{14}$$

Along AE the curves are vertical, since $P_2 - s_2 = 0$. T increases along AE as x_1 increases up to a level of output at which P_1 equals the marginal cost of x_1. E therefore represents a first best point, since both modes are charging prices equal to marginal costs. Therefore, T is maximized at E.

The profit for mode 1 can be expressed as

$$\pi^1 = P_1(x_1, x_2) - C^1(x_1) \tag{15}$$

which means that the isoprofit curves for mode 1 will have the slope

$$dx_2/dx_1 = -\{[P_1 + (\partial P_1/\partial x_1)\, x_1 - (\partial C^1/\partial x_1)]/(\partial P_1/\partial x_2)\, x_1\} \tag{16}$$

Since x_1 and x_2 are imperfect substitutes for one another, the slope will be positive when the marginal revenue exceeds the marginal cost of x_1 (for levels of x_1 less than the profit-maximizing level) and negative when the converse is true. The shapes of these curves are as shown in Figure 1. The ordering of the curves can be established by noting that, at any given level of x_1, the profit of mode 1 will increase as x_2 decreases, since

$$\partial\pi^1/\partial x_2 = (\partial P_1/\partial x_2)\, x_1 < 0 \tag{17}$$

Figure 1 is drawn to illustrate the case in which mode 1 can earn some extranormal profit for some of the market-clearing points in the market for x_2. If both modes were unregulated, mode 2 would clear and mode 1 would choose the highest isoprofit curve that comes into contact with AE. Thus, point B represents the point that would occur with total deregulation.

If a regulator wanted to maximize efficiency, it could direct the firms to operate at E, where both modes price at marginal cost. However, the profits for mode 1 would

Table 1. Comparison of actual with economically efficient tariffs for the 1961 U.S. rail industry.

Commodity Group	Proportion of Total Revenue Generated by Service $P_i x_i / \Sigma P_i x_i$	Actual Price Minus Out-of-Pocket Cost as Ratio to Actual Price	Price Elasticity of Demand	Ramsey Number
Agricultural products	0.15	0.15	-0.5	-0.075
Animals and products	0.03	0.10	-0.6	-0.060
Mined products	0.25	0.06	-1.2	-0.072
Forestry products	0.07	0.15	-0.9	-0.135
Manufactured and miscellaneous	0.50	0.32	-0.7	-0.224

be negative at E because of its economies of scale. A regulator might choose to set tariffs for both modes and control entry so that a totally regulated second best point is achieved. In doing so, it would try to reach point D, where the greatest economic efficiency is achieved while still allowing mode 1 to break even. Note that D lies below the segment AE, so that mode 2 does not clear at TRSB.

For reasons discussed earlier, a regulator might choose a partially regulated second best point, such as C. At C mode 1 breaks even, and mode 2 clears its market.

The relationships of the curves would be different if mode 1 could not break even any time mode 2 clears its market. This possibility is reflected in Figure 2. There exists no PRSB point and no totally unregulated point where mode 1 avoids a negative profit. Mode 1 can only break even when the market for mode 2 does not clear, and the most efficient operating point at which mode 1 breaks even is the TRSB location at D.

In between the situations of Figures 1 and 2 is the special case in which mode 1 can just barely break even with total deregulation. This is depicted in Figure 3. The unregulated (B) and PRSB (C) solutions coincide in this case. This suggests that if only small profits would be earned by mode 1 without regulation, then an unregulated system would achieve nearly the same economic efficiency as PRSB but without incurring the administrative costs of the latter.

RAILROAD RATES AND RAMSEY EFFICIENCY

It is of some interest to ask how the rates that have been in effect compare with the rules for economically efficient pricing we have just discussed. Of particular importance is the issue of optimum pricing in the intermodal competition among railroads, motor carriers, and water carriers, since those three modes provide transportation services viewed as generally (though imperfectly) substitutable for one another.

As the model of second best suggests, it is important to know which mode (or modes) has economies of scale in applying Ramsey rules for efficient pricing. Although a comprehensive treatment of this topic will not be attempted here, certain observations should be made before looking at any data.

The issue of scale economies in railroads is not a closed one. Many empirical studies have been made to test for the existence of economies of scale. The results have been mixed. For example, Klein used 1936 data to find statistically significant, though modest economies of scale (8). However, studies by Borts (9) and Griliches (10) have concluded that scale economies are not prevalent for the larger railroads, although the evidence is less clear for the smaller ones.

Water carriage is the least likely of the three modes to operate with economies of scale. Indeed, water transport markets appear to be quite competitive; only a small percentage of this traffic is regulated.

Motor carrier activities are probably not characterized by economies of scale, at least for most of their operations. There is some empirical work, such as that of Chow (11), that suggests that economies of scale may be present in the less-than-truckload segment of general freight motor carriage and that constant returns to scale are present for the totally regulated segment.

However, perhaps the best empirical work on scale economies in motor carriage is that of Friedlaender (12). She approaches the issue by using advanced production theory and econometric techniques to test for economies of scale and concludes that, without regulation, motor carriers

> Could be expected to face U-shaped average cost curves in which minimum average costs would be reached at a low level of output, [and that] it is likely that the trucking industry would be competitively organized, with the efficiently sized firm being quite small relative to the relevant market.

The existence of a healthy, unregulated portion of the industry, particularly for agricultural commodities, lends reinforcement to the conclusions of Friedlaender.

It is not our purpose to criticize these empirical studies. Rather the intent is to suggest how actual tariffs might be changed to lead to more efficient use of our economic resources—if one of these modes has scale economies (and railroads appear to be the most likely candidate) and the other modes (motor and water) do not.

Table 1 (13, Table 4.2) contains data on the U.S. railroad industry for 1961. For each of the five commodity groups in the industry, data are reported for (a) the proportion of total revenue generated by that service (column 2), (b) the deviation of price from out-of-pocket cost, expressed as a fraction of price (column 3), and (c) the price elasticity of demand for that service (column 4). If columns 3 and 4 are multiplied by each other, one would produce Ramsey numbers calculated according to Equation 11 (column 5). It can be shown that the Ramsey numbers will all be equal and take on a value between zero and minus one at a PRSB solution (determined by Equations 10 and 11).

If we believe that the assumptions required in the PRSB model are satisfied (and this is discussed further below), then we may suggest directions or changes in tariffs that would bring the Ramsey numbers closer to each other and thereby increase economic efficiency. Specifically, if the demand for each commodity is assumed to become more inelastic as the price decreases, then a Ramsey number closer to zero can be produced by lowering the tariff. In particular, this suggests that agricultural commodities have been tariffed at too low levels and that manufactured and miscellaneous commodities have been priced at too high levels for either to be economically efficient. Restated, this suggests that it may be possible to increase economic efficiency by raising agricultural rail tariffs and lowering tariffs on manufactured and miscellaneous commodities, while leaving railroad profit levels unchanged.

We should close this section by emphasizing that this analysis is offered as a suggestion. Some rather strong assumptions have been made in the face of sparse data.

First, I have assumed that out-of-pocket costs, as reported by the ICC, are close to marginal costs. The statement of Weiss and Strickland, cited earlier, provides support for this assumption. I have also assumed that the demand schedules for various commodity types are independent of one another—in other words, there are no (or small) cross elasticities of demand across commodity categories. Last, water and motor carriers operate so that their prices are equal to their marginal costs. This is probably not a bad assumption for most of the water carrier industry and for much of trucking (in both cases the unregulated parts). However, the assumption is questionable, particularly for the regulated portion of the motor carrier industry.

Nevertheless, the analysis suggests that the "traditional rate structure" that holds down agricultural rates and holds up manufactured commodity rates may very well be the source of economic inefficiency.

CONCLUSION

In this paper I have attempted to develop and emphasize four major points.

1. The ICC rules for rate making in the presence of intermodal competition have emphasized equity considerations rather than economic efficiency. This has occurred because of the rather vague congressional directives that emphasize equity and because of the structure of the administrative process as an adversary one.
2. A theory for efficient pricing with intermodal competition can be advanced as a means of improving the allocation of transportation resources. In this paper I have summarized two possible pricing schemes. Under the first, called totally regulated second best, prices and entry would be controlled for all modes in order to maximize efficiency while allowing all modes to at least break even (particularly a mode with economies of scale). Under the second, called partially regulated second best, modes without economies of scale would not be regulated, and prices and entry controls would be imposed on a mode with economies of scale in order to maximize economic efficiency for all transportation activities taken together. The rules for pricing and entry for both TRSB and PRSB are shown in the paper.
3. If regulation of prices and entry for all modes were effective and administratively costless, the economic efficiency of TRSB would exceed the efficiency associated with PRSB. However, regulation is not administratively costless and may not be effective for a number of reasons developed in the paper. Therefore, PRSB may be attractive as a public policy alternative.
4. Actual tariffs in the U.S. rail industry in 1961 have been contrasted to the rules for efficient pricing suggested by the PRSB alternative. The analysis suggests that the rail rates for agricultural commodities may have been too low and that the rail rates for manufactured commodities may have been too high to be economically efficient.

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Vehicle Size and Weight Regulations, Permit Operation, and Future Trends

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This paper reviews current limits on truck sizes and weights, present practices in permit issuance, and current trends in vehicle sizes and weights. Present legal limits on sizes and weights are summarized, and the permit operations of several states are reviewed. Future trends in the sizes and weights of trucks are indicated. Problems of and implications for the present highway system are identified and discussed.

The size and weight of commercial vehicles operating on the public highways of this nation are controlled by various federal, state, and local regulations (1, 2, 3), including the provisions of the Federal-Aid Highway Act (U.S. Code, Vol. 5, section 127, 1956 and 1974). While these limits are fixed, all of the states allow movements exceeding them through the use of oversized-overweight vehicle permits available by special application. Some permits are issued annually on a routine basis. Other "one time only" moves can be extremely complicated and require extensive engineering study before a decision on the permit can be made. The trends shown in vehicle sizes and weights through permit operation reflect potential future changes in truck transportation.

The objectives of this paper are

1. To present a summary of present legal limits on sizes and weights,
2. To summarize permit operations of several states,
3. To indicate future trends in the sizes and weights of vehicles, and
4. To discuss some problems in the present system and suggest improvements that might be made.

SUMMARY OF LEGAL LIMITS

Historical Perspective

The public good has been served through government regulation of the size and weight of commercial vehicles. The reasons justifying these regulations were probably best summarized by the Interstate Commerce Commission (ICC) in 1941; the reasons included protection of existing highways and bridges, conservation of state resources, promotion of safety, and control of competition between different forms of transportation.

Before 1956, individual states had exclusive jurisdiction in the regulation of vehicle size and weight. However, in that year, the federal government entered the arena with the passage of the Federal-Aid Highway Act of 1956. Section 127 of that act stated that no federal highway funds were to be allocated to states that allowed vehicles to operate on the Interstate systems with single-axle loads in excess of 80 kN (18 000 lb), tandem-axle loads in excess of 140 kN (32 000 lb), gross vehicle weights exceeding 325 kN (73 280 lb), and overall width greater than 245 cm (96 in). However, if the state limits established in July 1956 were greater than those described above, then the higher limits were to continue in effect. These regulations effectively restricted truck sizes, since federal aid constituted the major portion of the funds for new highway construction and rehabilitation.

Studies after passage of that act concluded that the limits could indeed be raised (4). After much heated debate, the Federal-Aid Highway Act of 1974 amended the 1956 act by raising single-axle and tandem-axle limits to 90 and 150 kN (20 000 and 34 000 lb), respectively. Gross vehicle weights were to be determined by the "bridge" formula but were not to exceed 355 kN (80 000 lb). Specifically, the bridge formula is

$$W = 0.227[3.28LN/(N-1) + 12N + 36] \qquad (1)$$

where

W = overall gross weight on any group of two or more consecutive axles as the mass in megagrams,
L = distance in meters between the extreme of any group of two or more axles, and
N = number of axles in the group under consideration.

References for actual calculation of the gross vehicle weight are available (5). This bridge formula relationship demonstrates that, if gross vehicle weights are increased, an increase in vehicle length and the number of axles may be required on short bridge spans to maintain the bridge stresses at an acceptable level. For long bridge spans the large dead loads relative to the live loads make it possible to increase gross vehicle weights.

Weight Limits

The present legal weight limits for steering axles, single axles, tandem axles, and the entire vehicle are summarized by state in Table 1 (1, 6, 7). These loads range from 80 kN (18 000 lb) to 105 kN (24 000 lb) for a single axle and 140 to 200 kN (32 000 to 44 000 lb) for a tandem axle as shown in Figure 1. Tandem axles are normally defined as axles with a spacing between 100 and 245 cm (40 and 97 in) apart. Most single-axle maximums are between 80 kN and 100 kN (22 000 lb), whereas load limits for tandems are primarily in the range of 140-160 kN (32 000-36 000 lb).

The method for determination of gross vehicle weight (GVW) is indicated in the final column of Table 1. For GVW calculation, most states rely on the bridge formula itself or a table of weights using a combination of factors included in the bridge formula calculation. It should be noted that some states, such as Michigan, impose seasonal weight limitations lower than normally allowed (1).

Geographical distributions of single- and tandem-axle and GVW limits are included in Figures 2, 3, and 4. It is noteworthy that practically all the states that had single- and tandem-axle weights higher than the 1956 legislated maximums are located on the East Coast. On the other hand, states west of the Mississippi are regulated by the federal limit on axle loads. The distribution of gross vehicle weight limits is just the opposite. States east of the Mississippi have limits lower than the federally imposed 355 kN (80 000 lb), while states west of the Mississippi typically have limits greater than the federal maximum. Movements exceeding the federal limits in the western portion of the country require routine permits.

Length Limits

A summary of state regulations with regard to the length of straight trucks, truck trailers, and tractor-semitrailer, tractor-trailer, and truck trailer combinations is included in Table 2. The range of allowable maximums for combination lengths is about 17.0-24.5 m (55-80 ft). Double and triple trailers are allowed to operate by permit in many states, yielding an effective length maximum of 32.0-33.0 m (105-108 ft) as shown in Figure 5. Most state regulations allow either 17.0 or 20.0 m (55 or 65 ft) in length under routine, non-permit operation as illustrated in Figure 6.

The geographical distribution of maximum lengths for combinations exhibits a marked division approximately midway between the East and West Coasts as shown in Figure 7. Roughly one-half of the western states allow legal maximums exceeding 20.0 m (65 ft), while states to the east are restricted to combination lengths less than or equal to 20.0 m (65 ft) under non-permit operations.

In addition, nearly half of the states in the East do not allow the operation of multiple combinations on their highways. In the West, this is considered common practice; all of the states allow the operation of "double" truck-trailer configurations and five states allow "triple" operations as shown in Figure 8. Doubles are configurations with a truck-tractor attached to a semi-trailer, which is pulling a full trailer. A triple combination typically includes a truck-tractor followed by a semi-trailer and two full trailers. (The operation of these vehicles is sometimes restricted to time of day and by weather limitations.) The lack of uniformity in legal configurations from state to state presents problems for the hauler passing through a state that regards certain configurations as illegal that are completely legal in adjacent states. The economic implications resulting from this practice are discussed later.

The maximum length for single trucks varies from 10.5-17.0 m (35-56.6 ft) and exhibits no geographical pattern. The lack of uniformity in this area of regulation is readily apparent in Figure 9.

Table 1. Axle and GVW limits.

	Vehicle Weight (kN)				
State	Steering Axle	Single Axle	Tandem Axle	GVW	GVW Basis[a]
Alabama	63.5	90	175	355	B
		(100)[f]	(200)[f]	(410)[f]	
Alaska	2.0[b]	90	150	(485)[f]	T
Arizona	NS	90	150	355	T
				470P[g]	
Arkansas	55.5	80	140	325	A
California	55.5	90	150	355	T
Colorado	NS	90	160	355	B, V
		(80)[f]		(380)[f]	
Connecticut	2.5[b]	100	165	325	V
Delaware	3.0[b]	90	160	355	T, V
			(180)[f]		
Florida	2.5[b]	100	200	355	B
Georgia	NS	90	180	355	B
Hawaii	–[c]	105	15[illegible]	360	B
Idaho	3.5[b]	90	150	355	B
				470P[g]	
Illinois	NS	80	140	325	T, V
Indiana	3.5[b]	80	140	325	
		(100)[f]			
Iowa	NS	80	145	325	T
Kansas	NS	90	150	355	T, B
				380	
Kentucky	2.5[b]	90	150	355	A
		(95)[f]	(160)[f]	365	
Louisiana	3.0[b]	90	150	355	A
Maine	2.5[b]	100	150	355	B, V
			(170)[f]		
Maryland	NS	100	(185)[f]	330	T, V
Massachusetts	3.5[b]	100	160	355	T, V
Michigan	3.0[b]	90	150	355	A, B
				605	
Minnesota	53.5	90	150	355	B
Mississippi	63.5	80	140	325	T
Missouri	NS	80	140	325	T
		(100)[f]			
Montana	NS	90P[g]	150P[g]	340	T
				470P[g]	
Nebraska	80.0	85	150	425P[g]	T
	90.0	90P[g]			
Nevada	NS	90	150	355, (485)[f], 575P[g]	B
New Hampshire	2.5[b]	100	160	355	B
New Jersey	3.5[b]	105	160	355	B
New Mexico	2.5[b]	95	150	385	T
New York	3.5[b]	100	160	355	B
North Carolina	2.5[b]	90	170	355	V
North Dakota	2.5[b]	90	150	355	B
				(470)[f]	
Ohio	3.0[b]	90	150	355	T
Oklahoma	NS	90	150	355	T
				(400)[f]	
Oregon	2.5[b]	90	150	355	T
				470P[g]	
Pennsylvania	3.5[b]	105	165	325	V
Rhode Island	NS	100	160	355	V
South Carolina	NS	90	155	355	B
		(100)[f]	(175)[f]	360	
South Dakota	NS	90	150	355	T
				(425)[f]	
Tennessee	53.5	80	140	325	A
Texas	3.0[b]	90	150	355	B
Utah	NS	90	160P[g]	375P[g]	B
				470P[g]	
Vermont	2.5[b]	100	160	355	T
		(105)[f]	(170)[f]		
Virginia	3.0[b]	90	150	355	T
		95	(160)[f]		
Washington	2.5[b]	90	150	355	B
	3.0[d]			470	
West Virginia	NS	90	150	355	T
Wisconsin	58.0	90	150	355	B
Wyoming	NS	90	160	355	B
				(450)[f]	
Washington, D.C.	80.0[e]	100	170	325	T

Note: 1 kN = 225 lbf.

[a]GVW basis: T = gross weight controlled by a table of axle spacing up to a specified maximum; A = gross weight controlled by axle limits up to, in most states, a specified maximum; B = gross weight controlled by "bridge" formula; and V = gross weight controlled by maximum limits for specific vehicle types.
[b]Per 25 mm (1 in) of tire width.
[c]Maximum for each wheel is allowable tire pressure x tire area up to 53 kN (12 000 lb).
[d]For tires greater than 30 cm (12 in) wide.
[e]80-355 kN (22 000-80 000 lb) allowed with wide tires.
[f]Numbers in parentheses signify non-Interstate limits where different from Interstate limits.
[g]Permits required.

Height and Width Limits

The regulation of vehicle height and width is the most uniform of the many size and weight limits. This is most likely due to the physical restrictions placed by structure heights passing over the highway and by previous uniformity of lane widths. In approximately 87 percent of the states, maximum height is 410 cm (13.5 ft). Maximum width is 245 cm (96 in) in 80 percent of the states (1 cm = 0.39 in). Examination of the lists of exceptions below shows that even the excepted states have uniformity among themselves.

State	Width Limit (cm)
Connecticut	260
Idaho	260
Maryland	260
Massachusetts (over 45 kN)	260
Rhode Island	260
Washington	260
Hawaii	275
All other states	245

State	Height Limit (cm)
Arizona	425
California	425
Colorado	425
District of Columbia	380
Idaho	425
Maine	425
Montana	425

State	Height Limit (cm)
Nebraska	440
Nevada	425
Utah	425
Washington	425
Wyoming	425
All other states	410

In the final analysis, only Hawaii has established width limits in excess of 245 or 260 cm (96 or 102 in), and only the District of Columbia restricts vehicle heights less than 410 cm (13.5 ft).

The present maximum width of 245 cm is primarily limited by present roadway geometrics. The present manufacturing technology is capable of increasing axle widths up to 260 cm. However, increases beyond 260 cm would require significant retooling. Operation of vehicles on the Interstate system, where pavement lanes of 365 cm (144 in) or greater predominate, probably would not be as impaired by vehicle width increases up to or beyond 260 cm as much as city streets or local roads would. On these facilities, lane widths of 305-335 cm (120-132 in) are often found.

A significant number of structures would need to be raised on the highways, including the Interstate system, if vehicle heights were increased. Clearances of approximately 425 cm (14 ft) have been permitted by many jurisdictions in the past. Those clearances have been reduced by pavement overlays under overcrossings. Clearances would be further reduced if gross vehicle weights were increased and pavement sections were reconstructed to carry the additional loads.

PERMIT OPERATIONS

Use of Oversize-Overweight Permits

The need for regulation of the size and weight of vehicles has long been recognized to provide safety to the traveling public, to conserve the highway transportation facilities, and to regulate competition among transportation modes. However, all states have recognized the need to allow vehicles and loads exceeding these limits to move over our highways when such movements can be shown to be in the best interests of society and when no feasible alternative exists. Use of the public highways by oversize-overweight vehicles is controlled by state authorities through the issuance of special vehicle permits.

Permits are obtained through state agencies, usually, but not always, the state transportation agency. Most applications require similar information including name, address, vehicle dimensions, weight information, and route information. In addition, movers are required to post a bond to cover possible problems and to demonstrate to state authorities proof of liability and property damage insurance of a certain amount. Application is made, and at times issuance is routine. However, there are times when movements require an engineering analysis and review of the route requested to determine the possibility of pavement and/or bridge damage. The permit fees seldom reflect the costs incurred by such analyses.

Number of Permits Issued

In 1969, a national inventory of permit issuance was

Figure 1. Distribution of 1977 axle maximum weights.

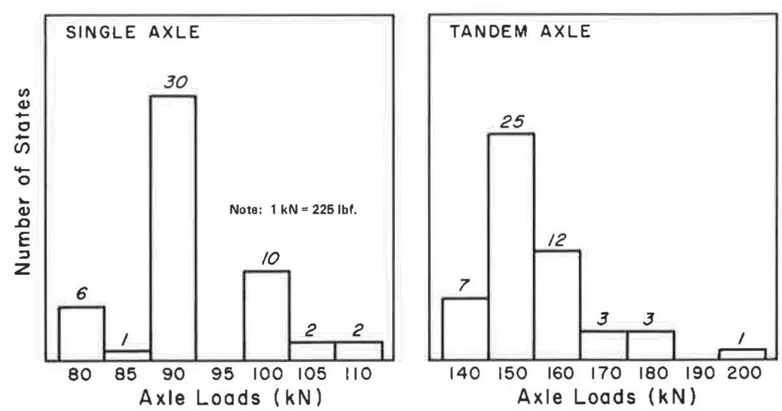


Figure 2. Single-axle maximum weights.

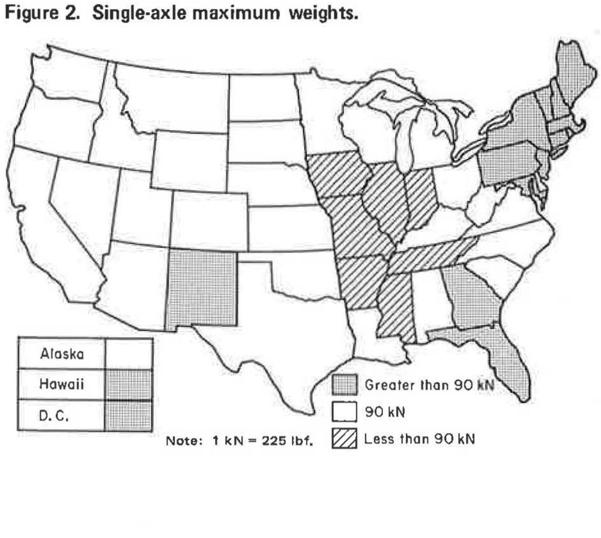
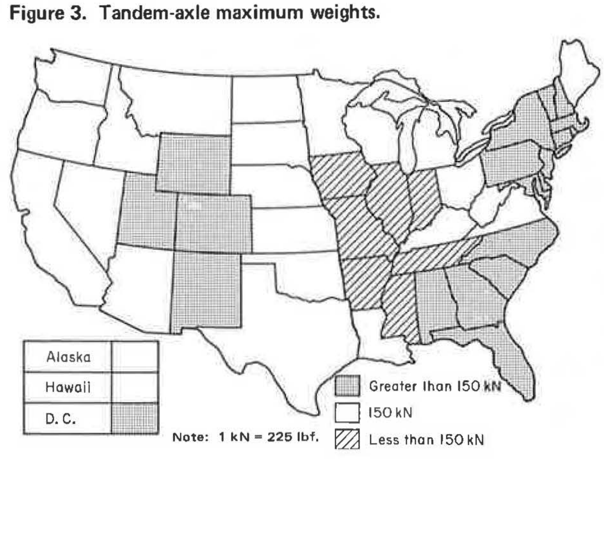


Figure 3. Tandem-axle maximum weights.



undertaken to determine basic data necessary for further study of the scope and economic impact of oversize-overweight permit operation (8). Samples of permits issued for the year 1966 were coded and the data processed into a variety of classifications. The summary of all oversize and overweight permits issued is included in Tables 3 and 4 (10). Total number of permits issued was 2 151 282. Forecasts for 1975 were on the order of 3.9-4.7 million permits.

Since this study, no other comparable compilation of data on the frequency of issuance of oversize-overweight permits has been undertaken. For this report, several states were contacted directly, and requests were made regarding the frequency of permit issuance. The table below was constructed with data supplied by several of the states contacted; data for 1966 are from Roy Jorgensen and Associates (8). While it is risky to draw substantial conclusions from these limited data, a conservative estimate would indicate that at least 3.0 million permits were issued in 1975.

State	No. Permits Issued 1966	1975	Percentage Change
Idaho	24 466	23 488	-4
Kansas	51 491	~60 000	16
Michigan	94 099	76 895	-18
Nevada	5 641	8 716	55
Pennsylvania	151 774	247 314	63
Texas	234 514	325 533	39
Utah	25 540	65 785	157

Figure 4. Combination GVW maximum weights.

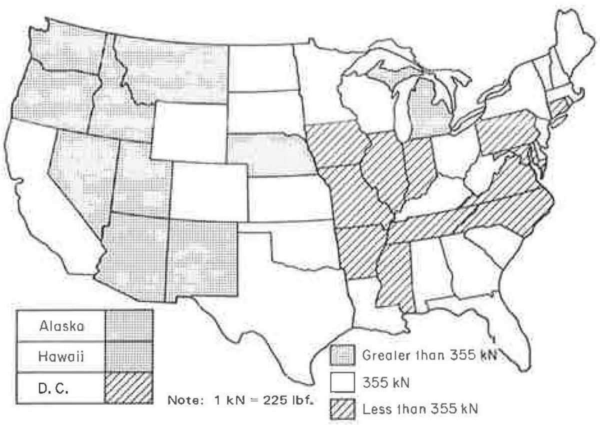


Table 2. Vehicle and combination length limits.

State	Length (m) Straight Truck	Semi/Full Trailer	Combination	Remarks
Alabama	12.0	NS	17.0	-
Alaska	12.0	13.5	21.5	-
Arizona	12.0	NS/40	20.0	32.0 m with permit, I-15 only
Arkansas	12.0	NS	20.0	-
California	12.0	12.0/12.0	20.0	-
Colorado	10.5	NS	20.0	-
Connecticut	17.0	NS/12.0	17.0	-
Delaware	12.0	12.0/NS	20.0	-
Florida	12.0	NS/10.5, 12.0	17.0	10.5 m, 2-axle; 12.0 m, 3-axle; 33.5 m toll roads
Georgia	17.0	NS	17.0	-
Hawaii	12.0	NS	17.0, 20.0	17.0 m tractor-semitrailer, 20.0 m other
Idaho	12.0	NS	23.0, 29.0	23.0 m designated highways, permits required
Illinois	13.0	13.5	17.0, 18.5	17.0 m tractor-semitrailer, 18.5 m other
Indiana	11.0	NS	20.0, 30.0	30.0 m toll road only
Iowa	12.0	NS/10.5	18.5	-
Kansas	13.0	NS/13.0	20.0, 33.0	33.0 m toll road only
Kentucky	10.5	NS	17.0, 20.0	17.0 m tractor-semitrailer, 20.0 m tractor-semitrailer, both on designated highways only
Louisiana	10.5	NS	20.0	-
Maine	13.5	13.5/13.5	17.5	-
Maryland	12.0	NS	17.0, 20.0	20.0 m designated highways only
Massachusetts	10.5	NS	17.0	-
Michigan	12.0	NS	18.0, 20.0	20.0 m tractor-semitrailer and trailer
Minnesota	12.0	13.5/13.5	17.0	-
Mississippi	10.5	NS	17.0	-
Missouri	12.0	NS	17.0, 18.5, 20.0	17.0 m tractor-semitrailer, 18.5 m motor vehicle transporters, 20.0 m other
Montana	12.0	NS	18.5	21.5 m permit, 26.0 m permit on designated highways
Nebraska	12.0	NS/12.0	18.5, 20.0	18.5 m tractor-semitrailer, 20.0 m other
Nevada	12.0	NS	23.0, 32.0	32.0 m permit
New Hampshire	10.5	NS	17.0	-
New Jersey	10.5	NS/10.5	17.0	-
New Mexico	12.0	NS	20.0	-
New York	10.5	NS/10.5	17.0, 33.0	33.0 m toll road only
North Carolina	10.5, 12.0	NS	17.0	10.5 m, 2-axle; 12.0 m, 3-axle
North Dakota	12.0	NS	20.0	10.5 m, 2-axle; 12.0 m, 3-axle
Ohio	12.0	NS	17.0, 20.0, 30.0	17.0 m tractor-semitrailer, 20.0 m other, 30.0 m toll road
Oklahoma	12.0	NS	20.0	-
Oregon	12.0	12.0/NS	23.0, 32.0	23.0 m designated highways, 32.0 m permit only
Pennsylvania	10.5	NS	17.0, 30.5	30.5 m toll roads only
Rhode Island	12.0	12.0/NS	17.0	-
South Carolina	10.5, 12.0	NS	17.0, 18.5	Over 10.5 m need 3 axles, 18.5 m auto transports
South Dakota	10.5	NS	18.5, 24.5	24.5 m designated highways
Tennessee	12.0	NS	17.0	-
Texas	13.5	NS	20.0	-
Utah	13.5	13.5/13.5	20.0, 23.0, 33.0	23.0 m permit, 33.0 m designated highways, permit
Vermont	18.5	NS	18.5	-
Virginia	12.0	NS	17.0	-
Washington	10.5	12.0/NS	23.0	23.0 m permit
West Virginia	10.5, 12.0	NS	15.5, 17.0	10.5 m, 2-axle; 12.0 m, 3-axle; 17.0 m designated highways
Wisconsin	10.5	13.5/13.5	18.0	-
Wyoming	18.5	NS	26.0	26.0 m daylight operation only
Washington, D.C.	12.0	NS	17.0	-

Note: 1 m = 3.3 ft.

Figure 5. Maximum and minimum sizes and weights for 1977.

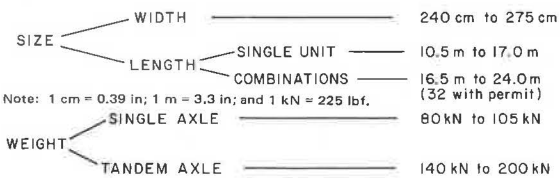


Figure 6. Distribution of 1977 combination maximum lengths.

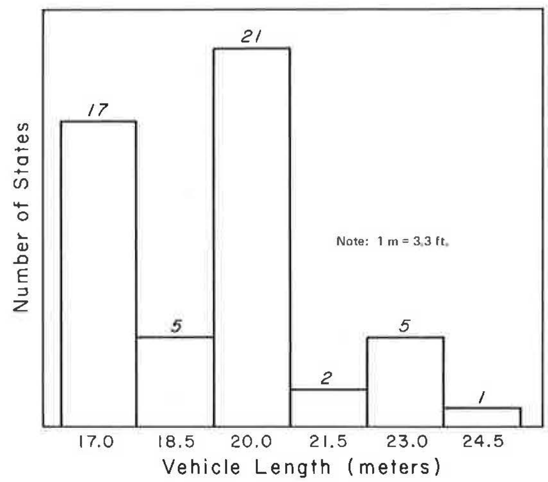


Figure 7. Combination maximum lengths.

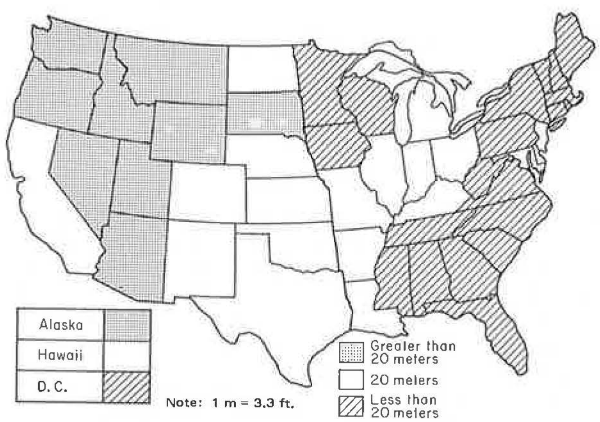


Figure 8. Multiple combinations.

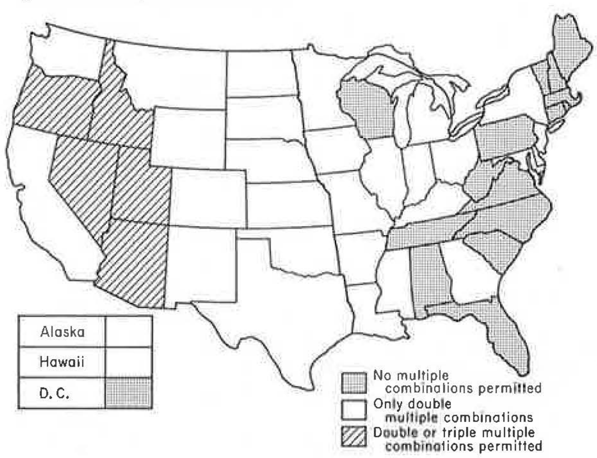
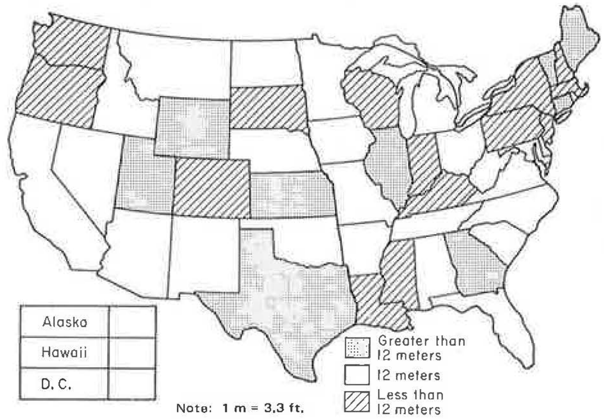


Figure 9. Straight truck maximum lengths.



The increase in permits issued is matched by a desire on the part of commercial vehicle operators for larger and heavier loads. It is likely that greater numbers of permits will be issued in the future with the increasing use and public acceptance of longer vehicles (i.e., triple trailers in several western states) and government recognition of the short-run fuel savings from larger, heavier loads. This of course comes at a time when transportation fuel is receiving attention as a significant portion of our national energy picture. However, the increased energy and economic efficiency provided to truck operators must be evaluated against increased construction and maintenance costs and energy.

Trends for the Future in Size and Weight Regulations

Studies (9, 10) have indicated possible new higher size and weight regulations as illustrated in Table 5. Winfrey reported benefit-cost ratios on the order of 2 to 15 for a single-axle limit increase to 115 kN (26 000 lb) and tandem-axle increase to 200 kN (44 000 lb) for several highway types (9). The Goals Report has indicated that single unit length rather than total vehicle length should be the concern of highway regulatory agencies (10). All indications are that the vehicle of the future will be larger and heavier, and perhaps wider.

Larger and heavier vehicles have been seen to improve the efficiency of operation by reducing operating costs, particularly labor costs, and increasing operating energy efficiency (11). However, increased gross vehicle weight may create damage to existing bridges and pavements unless vehicle lengths are increased sufficiently and more axles are added to retain lower axle loadings. Further, the influence of increased vehicle size and weight on safety must be considered. A major research project by the Federal Highway Administration is presently studying this impact in depth.

CONCLUSIONS AND RECOMMENDATIONS

At the moment, a major problem regarding the regulation of commercial vehicle size and weight is the lack of uniformity among states. This has caused considerable costs to carriers at locations where crossing state lines has meant the necessity of changing vehicle configuration. A classic example is the approximately 130-km (80-mile) section of I-90 in Pennsylvania. Both New York (on I-90) and Ohio allow the operation of doubles. Pennsylvania does not. Operators are forced to break down the doubles combinations and travel through Pennsylvania in single configurations. One source has

Table 3. Overdimension permits issued in 1966.

State	Overlength Only	Overwidth Only	Overheight Only	Overlength and Overwidth	Overlength and Overheight	Overwidth and Overheight	Overlength, Overwidth, Overheight	Oversize Dimensions Not Specified	Total Oversize
Alabama	333	5 966	300	900	67	700	1 966	0	10 232
Arizona	2 948	10 640	631	16 182	74	2 881	1 715	0	35 071
Arkansas	3 597	18 893	167	18 407	0	1 904	2 115	0	45 083
California	3 405	33 273	2 739	16 461	336	18 563	13 319	59	88 155
Colorado	3 248	17 151	664	16 138	210	6 322	4 820	0	48 553
Connecticut	2 106	10 549	527	10 753	32	1 222	2 110	0	27 299
Delaware	2 662	5 780	70	8 127	0	175	420	0	17 234
Florida	3 099	3 733	293	27 085	27	1 584	5 622	0	41 443
Georgia	1 436	12 665	248	22 365	0	957	5 210	0	42 881
Idaho	749	7 577	101	13 163	21	962	1 690	0	24 263
Illinois	2 272	29 906	603	24 687	115	3 348	2 444	231	63 606
Indiana	1 907	10 726	270	29 466	356	1 570	13 372	140	57 807
Iowa	1 334	5 963	333	600	100	1 364	4 878	33	14 605
Kansas	1 195	12 340	533	24 929	36	6 851	5 428	0	51 312
Kentucky	2 009	7 812	50	16 401	0	715	1 287	0	28 274
Louisiana	8 392	22 415	952	31 886	250	5 473	14 250	0	83 618
Maine	1 318	6 229	27	6 646	60	363	346	0	14 989
Maryland	1 745	607	36	39 664	213	71	759	0	43 095
Massachusetts	1 301	3 366	0	8 602	0	1	3	0	13 273
Michigan	6 572	14 687	173	36 078	180	1 016	4 406	0	63 112
Minnesota	5 211	11 157	169	14 117	104	1 697	1 874	34	34 363
Mississippi	474	18 691	344	13 701	104	1 442	1 778	0	36 534
Missouri	7 327	21 485	362	23 015	70	2 467	1 830	0	56 556
Montana	304	22 223	562	2	29	0	14	0	23 134
Nebraska	841	6 221	315	10 928	42	10 896	1 594	19	30 856
Nevada	0	5 359	0	0	0	0	0	0	5 359
New Hampshire	644	2 731	0	5 242	6	83	254	0	8 960
New Jersey	5 011	19 695	543	17 459	97	2 115	3 795	0	48 715
New Mexico	1 322	9 009	379	12 047	194	2 512	2 892	0	28 355
New York	1 874	11 143	68	29 280	0	238	1 798	753	45 154
North Carolina	202	4 755	126	23 288	25	683	1 846	0	30 925
North Dakota	532	3 903	342	5 477	157	1 888	2 295	0	14 594
Ohio	1 163	20 150	499	27 656	259	5 345	5 805	0	60 877
Oklahoma	8 134	22 922	1 991	28 687	198	10 651	15 080	0	87 663
Oregon	3 833	6 082	274	12 095	137	1 283	6 698	0	30 402
Pennsylvania	244	45 506	122	87 352	3 904	366	14 030	0	151 524
Rhode Island	137	555	15	579	4	77	65	0	1 432
South Carolina	1 095	3 090	81	19 361	60	1 130	226	0	25 043
South Dakota	757	7 596	62	7 488	24	1 056	527	19	17 529
Tennessee	1 850	7 736	82	16 054	112	135	873	692	27 534
Texas	34 926	48 614	3 638	55 799	882	26 096	61 132	0	231 087
Utah	3 999	2 128	81	2 280	365	285	5 227	0	14 365
Vermont	160	1 115	19	2 906	9	47	19	0	4 275
Virginia	4 858	10 646	531	25 584	143	570	3 329	0	45 661
Washington	8 636	26 487	355	19 326	0	4 069	3 905	0	62 778
West Virginia	2 626	9 986	311	9 946	289	1 714	2 036	14	26 922
Wisconsin	6 791	5 566	66	5 658	66	924	4 585	0	23 656
Wyoming	2 833	12 699	1 033	7 733	533	4 000	1 567	0	30 398
Washington, D.C.	243	196	39	316	136	179	874	0	1 983
Total	157 655	607 724	21 126	851 916	10 026	137 990	232 108	1994	2 020 539

claimed that nearly 5700 m^3 (1.5 million gal) of diesel fuel are lost annually in this operation (12).

Clearly, these nonuniform regulations do pose a problem for just keeping informed. A study currently under way has as its objective a quantification of the costs of this nonuniformity.

One report listed some problems regarding permit issuance in the year 1966 (8). The most important of these was the variance in laws, regulations, and philosophies. While this aspect of permit issuance was only briefly discussed in this paper, the investigation done does not indicate that any strides toward uniformity have taken place. Conversations with public utilities officials indicated that some steps toward uniformity have been made in rate regulation; however, the progress in oversize-overweight vehicle permits is questionable.

This investigation also indicated a paucity of data regarding permit issuance by each state. Only about 33 percent of the states contacted had raw data regarding the numbers of permits issued. The classification of these data was extremely difficult. One state kept a monthly record of permits issued divided into six classifications based on vehicle type. Over 50 percent of the entries for every month were in the miscellaneous category.

A good data base on the movements of oversized permit vehicles would help in the evaluation of the benefits and costs incurred by increasing vehicle sizes and weights. Larger, heavier loads can cause a significant increase in the damage to pavements if axle loads are increased. Bridges can also be damaged by increasing vehicle weights. Short-span bridges are most affected by increased axle loads. Medium-span bridges would be adversely affected by increased gross vehicle weights. However, long-span bridges would not be significantly influenced by increased loading, since the live load would be small relative to the dead load for the bridge. The effect of increasing vehicle load on bridge decks has not been adequately quantified at this time; however, increased axle loads are felt to be a major contributor to accelerated bridge deck deterioration. The knowledge of permit movements combined with information on illegal overloads can be used effectively to evaluate the efficacy of increasing vehicle size, to set permit fees, and to assess overload penalties.

For intelligent study and proper decisions to be made, it is necessary for the raw data to be available. Considerable work needs to be done in this area so that an accurate and reliable data base, locally and nationally, will be available for assessing appropriate permit fees and to perform further research in this area.

The trend of increased vehicle size and weight may be expected to continue. Increased vehicle size and weight yield efficiency in the form of reduced operating costs and decreased fuel consumption per unit of payload. However, construction and maintenance costs and energy may be expected to increase. The magnitude of this trade-off must be evaluated not only with respect to

Table 4. Overweight permits issued in 1966.

State	GVW Only	Axle Only	GVW and Axle	Unknown	All
Alabama	0	0	0	0	0
Arizona	5 050	0	0	0	5 050
Arkansas	67	0	7 452	34	7 553
California	103	0	45 068	0	45 171
Colorado	1 362	35	35 140	12 889	49 426
Connecticut	272	111	11 555	32	11 970
Delaware	-	-	-	-	-
Florida	0	0	7 514	0	7 514
Georgia	0	0	7 073	0	7 073
Idaho	19	21	4 403	20	4 463
Illinois	29	57	20 097	1 000	21 183
Indiana	5 903	5 933	1 201	273	13 310
Iowa	4 435	33	0	4 393	8 861
Kansas	325	36	13 131	0	13 492
Kentucky	0	0	8 392	615	9 007
Louisiana	53	0	8 502	351	8 906
Maine	0	0	3 899	0	3 899
Maryland	108	0	12 810	36	12 954
Massachusetts	-	-	4 240	-	4 240
Michigan	-	-	0	27 632	27 632
Minnesota	414	419	3 314	-	4 147
Mississippi	5 615	184	54	456	6 309
Missouri	4 835	0	0	0	4 835
Montana	249	1 110	3 724	7 060	12 143
Nebraska	2 085	63	2 039	0	4 187
Nevada	0	107	1 117	176	1 400
New Hampshire	6	0	4 247	21	4 274
New Jersey	11 793	0	38	295	12 126
New Mexico	46	0	3 475	0	3 521
New York	77	0	22 081	753	22 911
North Carolina	5 690	607	2 124	0	8 421
North Dakota	3 954	124	0	2 607	6 685
Ohio	0	30	31 273	0	31 303
Oklahoma	88 696	0	0	0	88 696
Oregon	10 500	0	7 200	478	18 178
Pennsylvania	100	100	29 700	0	29 900
Rhode Island	118	0	184	0	302
South Carolina	0	21	179	0	200
South Dakota	251	12	2 380	0	2 643
Tennessee	42	66	4 307	692	5 107
Texas	789	4 703	86 071	0	91 563
Utah	0	0	12 253	81	12 334
Vermont	0	0	658	12	670
Virginia	0	0	12 225	0	12 225
Washington	22 209	909	15	0	23 133
West Virginia	2 474	86	6 682	0	9 242
Wisconsin	233	6 558	3 906	0	10 697
Wyoming	500	0	9 232	0	9 732
Washington, D.C.	56	0	1 539	20	1 615
All	178 458	21 325	440 494	59 926	700 203 +12 803[a]
Grand total					713 006

[a]Michigan issued 12 803 permits that exceeded axle limits and that, in other states, would have exceeded gross limits.

gross vehicle weight and axle loadings, but also for specific truck configurations.

A cursory evaluation indicates that a truck may be increased in gross vehicle weight if axle loads are not increased and the weight is spread out over an increased length. Maintaining present legal axle loads would eliminate pavement damage, damage to short-span bridges, and the potential accelerated wear of bridge decks. Triple trailers could meet these restrictions. However, the impact of increasing the length and weight on safety must also be considered. The effects that this configuration and increased weight would have on safety are not well defined at this time. More comprehensive research and evaluations must be performed to confirm the efficacy of increasing vehicle size and weight.

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Table 5. Past, present, and proposed sizes and weights.

Application	Actual 1956-1975	Actual 1975	FHWA Research Proposal[a]	1985 Proposed[b]
Weight, kN				
Single axle	80	90	115	115
Tandem axle	140	150	200	200
Maximum GVW[c]	325	355	535	535
Width, cm	245	245	260	260
Length, m				
Single trailer	-	-	-	13.5
Double or triple trailer	-	-	-	8.5
Single-unit vehicle	-	-	12.0	13.5
Overall combination vehicle	-	-	20.0	-
Tractor-semitrailer	-	-	17.0	-

Note: 1 kN = 225 lb; 1 cm = 0.39 in; 1 m = 3.3 ft.

[a]See NCHRP report (11). [b]See Fleet Owner (12). [c]Subject to bridge formula.

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Performance of Public Agencies in Safety and Environmental Regulation

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Industrial safety and environmental regulation are major recent additions to the external activities affecting enterprise organizations. The advent of these programs continues the trend for organizations to bear increasing administrative costs for such programs. Management studies indicate that the relative rank of executives dealing with such matters equals the rank of executives concerned with principal production activities, yet none of the legislation gives attention to the impact of the program on individual enterprise. Both public agencies and enterprises must make preparations for better performance in regulation if the growing needs of public policy are to be met. Public agencies should in turn improve their capacities for the inevitable conflict and its resolution. A key step in this direction is the use of discovery procedures by independent research institutions. Enterprise should systematically measure the total impact of public policy on its organization by means of the social audit so that the costs and benefits to the enterprise of all public policies can be computed. The social audit should be supported by a financial statement and a management audit. Self-reporting is recommended as a means of achieving these audits.

Transportation enterprise, whether public or private, must solve two major problems if it is to survive in the world. It must produce its technical output in an efficient manner, and it must solve the host of problems thrust upon it from the operating environment. In the first case, enterprise must deal mainly with internal factors, but, in the latter, the influences are external, usually beyond its control.

Safety and environmental regulations, such as the National Environmental Policy Act, the Environmental Protection Act, the Federal Water Pollution Control Act, and the Clean Air Act, are among the latest additions to the many external forces that enterprise encounters. These major additions highlight what may be a long-term trend. The external challenges to the management organization may be growing faster than the core management concerns with the basic technical production processes. Hugh Heclo, in his recent study of the federal management establishment (1), documents the great increase of mid-level positions to deal with a host of staff and external conditions, even as the total federal work force shows no increase over a considerable period. A study by the Institute of Transportation Studies of the University of California at Berkeley showed that the executive specialists assigned to deal with external operating conditions in mass transit enterprises held comparable rank in the organization to those specialists dealing with the core production processes (2). And this factor held, regardless of the size of the organization or the type of technology used.

The same California study, drawing on the research methodologies of Joan Woodward and the Tavistock Institute of London, showed that the production-oriented management structure could be rationally related to measures of technology employed by the firm (3). But there was no such limit on the organizational problems concerned with external forces, such as labor relations, regulation, safety, and environmental safeguards. And it is these problems that are the fastest growing over the long term. Many of these external problems—epitomized by safety and environmental affairs—are important issues of public policy.

It is vital, therefore, that students of management and public policy become aware of a two-fold concern: the efficient attainment of public policy goals and the efficient performance of both enterprise and public agencies in dealing with such goals. These have become a growing management problem. New tools must be forged if these needs are to be met. Research has a vital role in improving both enterprise and public agency performance in such areas as safety and environmental safeguards.

An unfortunate feature of recent legislation dealing with safety and the environment, along with other similar external problems, is that the burden on the enterprise has not been considered either by legislators or by administrators (4). This condition has led to a mindless confrontation between public interest groups and managers of enterprises. The public interest groups see vast conspiracies by enterprises trying to avoid clear moral duties, while enterprisers voice loud and persistent complaints about the burdens capriciously imposed on them. The outcry over the Occupational Safety and Health Act (OSHA) on all sides demonstrates this confrontation, but the environment supplies equally valid examples.

More recently the dilemma has been dramatized by the energy crisis. Alternate energy supplies may have to be purchased at the price of less environmental protection, but the rules for this trade-off are not established. Unless better assessment of performance in social policy areas can be determined, the important public policy actions related to our productive activities will be subject to episodic and unsystematic treatment as one crisis after another takes place.

The goal of our enterprise should be better performance in both its core activities and its externally imposed responsibilities. Despite the pressures of industrial interests, we cannot curtail these responsibilities; we must make them manageable. Improved industrial performance must be paralleled by improved public agency performance. This dual problem has not been addressed; there has been little research in this area; and, consequently, there is ambiguity, ignorance, misunderstanding, and disagreement about both enterprise and public agency performance.

Neither the enterprise nor the public agency can solve this problem alone. The agency needs broader criteria to discharge its management responsibilities, while the enterprise needs assistance in economizing its efforts to meet public obligations imposed externally.

This paper advances two hypotheses to deal with the issue of improved performance—represented most dramatically by safety and environmental concerns—by public agencies and enterprises in public policy areas.

1. The public agency is concerned primarily with conflict resolution where better performance demands a wider use of the legal concept of discovery. In discovery processes we have an effective interface between research and conflict resolution.
2. The enterprise must be provided with a basis for total economy in the discharge of its external responsibilities. The tools of this total economy must

be related to the regulatory process. The concept of the social audit seems to be the most effective approach to such an economy.

CONFLICT RESOLUTION AS A FOCUS OF PUBLIC AGENCY ACTIVITY

Controversy is not unique to environmental and industrial safety issues. The newness of the emphasis in these fields, however, has caused controversy and confusion. At least three kinds of controversy—over interests, values, and facts—seem inherent in the confusion.

1. Controversy over interests: In industrial safety, the worker and manager have separate views on the scope of programs. In environment, industry and public interest groups have similar divergencies. Conflicts of interest take place over specific points and numbers. The approach to conflict of interest is the well-known process of conflict resolution that has been applied in many fields.
2. Controversy over values: Among the principal factors generating new values are rising income expectations. Values differ among various groups in society, and these groups may change their values over time. The value dimension often involves different groups than the issues over conflict of interest. The only solution to the value problem is the political process. A piece of legislation, whether it be an environmental or a safety statute, requires constant reconsideration to accommodate value issues. Research can elucidate the cost and benefits of changing values.
3. Controversy over matters of fact: Not all safety or environmental issues are well researched, and some of the available information on these subjects is ambiguous. Some research is not available to wide sectors of industry, and in other cases the source of the research information is suspect because of the interest of the sponsoring agency. The solution to the fact problem is objective research performed in institutions having no interest in the outcome.

The administrative agency cannot focus on political issues and perforce must concentrate on what it can do best: resolve conflicts. Not only does the agency need a program design that is feasible and uses all the major incentives for attaining the objectives of the program, but it also needs objective research results that are credible to the parties. A principal difficulty with all present regulation in every field is the dependence of the agencies on the parties for most of the evidence. This dependence has weakened the credibility of the regulatory process and is at the root of the major criticisms of regulatory ineffectiveness.

Discovery is a process used in courts and administrative bodies to set the standards and dimensions of the evidence to be used. Discovery lends credibility to evidence and enables all parties to pool their evidentiary effort for more effective conflict resolution. In a field of extreme controversy, such as environmental or industrial safety affairs, discovery must be assisted by the special creation of an objective public research agency. Several states have created such agencies to assist in their enforcement of pollution control laws (5).

In the Transportation Act of 1940 a board of investigation and research was established to assist Congress and the Interstate Commerce Commission to revise and extend transportation policy from research results. The failure of the agency to survive led to several decades of frustrating search for the basis for a transportation policy. The want of adequate research data was a primary cause of this frustration.

Unless formal arrangements to incorporate research results into the evidentiary process are made, conflict resolution cannot be successful in such controversial fields as environment and industrial safety. The need for evidence to establish the bases of conflict resolution far surpasses the more popular concerns about the scope of regulation and its method.

Discussion of regulatory processes frequently contrasts direct regulatory rules with reliance on market forces, on initiatives in the courts, or on decentralization to other levels of government. None of these methods can be considered to exclude the others. A well-designed set of regulations utilizes all of them in a coordinated process (6) that entails the following.

1. Economic incentives: Internalization of costs through taxes, effluent charges, performance standards, and cost penalties utilizes normal economic incentives as a means of accomplishing regulatory objectives.
2. Liability management: Self-regulating mechanisms, whereby injured parties and groups use the legal system to protect themselves, are a well-recognized branch of legal practice. Liability management can also be used in conjunction with insurance and with well-designed policies, examples being workmen's compensation and no-fault auto insurance. A more sophisticated application in liability management is the recent growth of class action litigation.
3. Regulatory options: Direct regulation can be used to reinforce economic incentives and liability management. In other cases well-designed regulations can be limited to filling in areas outside the reach of other methods. The best approach to coordinating regulatory actions with economic incentives and liability management is rule making.
4. Political levels for administering programs: State and federal or even local levels of administration do not represent mutually exclusive choices, since most programs show that the various levels must act in coordination. Coordinative mechanisms are both legalistic, where courts have defined coordinate jurisdictions, and financial, where grants-in-aid have supported intergovernmental programs.

IMPACT ON THE ENTERPRISE

Little is known of the total impact of external public interest programs on individual enterprise. So little is in fact available that the most that can be done is to formulate a frame of reference to discuss the problem and possibly form the basis for research into the subject.

In the preceding discussion, it was shown that enterprise and individual initiative have significant roles in the regulatory processes, particularly in the internalization of costs and other uses of economic incentives. The defensive use of liability management by enterprises is also an unrealized source of initiative in many present programs. It is said, for example, that private damage suits are the mainstay of the antitrust laws, despite the publicity given major U.S. Department of Justice cases. Rule making and other devices provide a basis for coordinating economic incentives and liability management with direct regulatory actions. Performance standards form one basis for such rule making, along with prima facie showing of compliance based on discovery evidence.

What is needed is an understanding of the capabilities of various kinds of enterprises for initiative and compliance over an entire range of programs. The administrative burden that the range of social issues places on any given enterprise should also be a factor in the design of a program. This burden should be assessed objectively through data on the social performance of the enterprise.

There are precedents for this kind of far-reaching evaluation of the impact of programs on an individual enterprise. Reporting requirements for regulated enterprises have been quite detailed and have been used both as a means of control and as a basis for reasonable regulatory criteria. Environmental impact statements for some enterprises require an extensive spread of company data and company plans. Within the enterprise, reports to stockholders provide details on company operations and responsibilities.

Based on what is known about enterprise practices and capabilities, it would seem that appraisals of overall regulatory burdens could be made in three stages.

The first stage is financial reports of enterprise, which should be a base datum around which other reports could be prepared and assessed. The second stage calls for a management audit of enterprise. This audit would relate the activities necessary to accommodate public interest programs. It would reveal the numbers of people engaged in serving the programs, the nature and cost of the internal programs, the need for external assistance such as from consultants, and the relative rank in the organization of executives in charge of the various public interest activities. The last stage is the social audit of enterprise. This procedure goes beyond financial and managerial appraisal and sums up the net costs and benefits to both the corporation and society of the various external programs. The social audit enables the corporation to assess its performance in each area and to assign priorities based on financial and social effectiveness. The data from such a social audit make possible the assignment of responsibility either to the corporation or to society at large.

Following the precedent of the income tax, the various audits would be self-assessed and would be used to shape and modify a company's participation in various environmental and safety programs.

NOTES ON THE ENTERPRISE SOCIAL AUDIT

The social audit and its counterparts, the financial and management audits, are integral parts of the management process, having important enterprise as well as public objectives. The interrelationship with social policy is not a casual, philanthropic gesture. A correct appraisal of benefits and costs of social policies has a bearing on the economy of the firm and its important decisions.

No effort will be made to elucidate the entire range of possibilities for the combined auditing processes. The advantages, however, include anticipation of public policy needs and resulting economies of investment and operation. The unanticipated thrust of a safety program or an environmental matter can lead to crash purchases of systems that may not be the most economical or may be incompatible with present investments. A more timely preparation may also lead to the selection of a public policy program more in line with business incentives, performance standards, internalized costs, and liability management, instead of a harsh regulatory regime, as in OSHA. Other advantages are more effective decisions in nonregulated areas such as philanthropies, better design of products and better sales revenues, and gain in good will from better planned operations.

Is there precedent for the special treatment of firms based on a documentation of their total performance in a public policy area? There are very general differentials in regulatory standards based on size or classification of firms, as in transportation where we have class 1 rail and motor carriers that appear to be more intensively regulated than those of other designated classes. There are exempt classes of motor, water, and air carriers.

A regulatory regime based on a self-declared set of enterprise audits is a new experience in degree of regulation, which should be entirely feasible where the processes of conflict resolution are well developed, where there is objective research based on discovery, where rule making prevails as the basis for regulatory emphasis, and where the firm's own social performance can be documented to the advantage of both private and public interests.

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Internal Cross-Subsidizations in the General Freight Sector of the Motor Carrier Industry

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A major area of controversy in the debate on regulatory reform of the motor carrier industry is the degree of internal cross-subsidization between small and large shippers and shipments, localities, and different commodities. This paper uses a microlevel econometric model of the motor carrier firm, with Interstate Commerce Commission (ICC) cost study data and class rates approved by the ICC in early 1976, to determine the probable existence of internal cross-subsidizations between shipments of different weights that are moved between metropolitan areas belonging to different population categories. The paper reveals extensive cross-subsidizations of this sort and of another sort: between shipments moving in different traffic lanes and rated in different class rate classifications. The ICC's cost methodology can also cause internal cross-subsidies. Use of cost-related, point-to-point, and multiple shipment tender rates to eliminate internal cross-subsidies is recommended, as are changes in the ICC's motor carrier costing methodology.

Internal cross-subsidies frequently occur in industries where two or more products are produced from the same production process. For the purpose of this paper, an internal cross-subsidy occurs when the revenues received from the sales of one or more products exceed each product's variable, or direct, costs of production and, simultaneously, the revenues received from the sales of other products are exceeded by each product's variable, or direct, costs of production. If such a situation is permitted to continue for a considerable period of time, the buyers of the products whose revenues exceed production costs are subsidizing, through an internal transfer of funds within the business enterprise, the provision of products to buyers whose production costs exceed revenues.

As Milne (1) points out, internal cross-subsidization is a problem in transportation. Internal cross-subsidies result in price discrimination and the misallocation of economic resources. The Interstate Commerce Act has prohibited three major forms of transportation price discrimination (personal, location, and commodity). As Kahn (2) points out, one function of transportation economic regulation is to minimize the misallocation of economic resources that might occur in an unfettered, regulatory-wise, transportation system.

This paper identifies and appraises internal cross-subsidizations in the general freight sector of the motor carrier industry. First, the methodology used to identify internal cross-subsidizations is briefly discussed. The methodology is then used to identify internal cross-subsidizations in the general freight sector of the motor carrier industry between various shipper classes and localities. The paper concludes with recommendations for changes in regulatory policy and the Interstate Commerce Commission's (ICC's) cost methodology.

METHODOLOGY

The probable presence of internal cross-subsidies between various motor carrier shipment and shipper categories can be inferred by comparing the revenues realized from shipments of average density with the variable costs incurred in providing the shipments with transportation services. This is the essence of the methodology used in the research reported here to draw inferences on the probable presence of internal cross-subsidies between various less-than-truckload (LTL) shipment and shipper categories.

Three requirements had to be satisfied before the methodology could be used to determine the probable presence of internal cross-subsidies. First, a model was required to replicate the process of providing motor carrier transportation services to a wide variety of users under a host of different circumstances. One model of the motor carrier firm that met this requirement was the microlevel econometric model developed by Schuster (3).

The second requirement was data for estimating the model's parameters. This requirement was satisfied by data from the following two sources: first, operational and traffic data submitted by the 225 carriers who participated in the ICC's 1971 cost studies of the New England I and II, Central, and Eastern-Central territories (4, 5, 6, 7) and, second, the platform handling time data obtained by the ICC in its 1969-1970 special study of shipment platform handling (8). The use of the 1971 cost study data permitted conclusions to be drawn on the probable existence and extent of internal cross-subsidies for long-haul and short-haul carriers. In terms of average shipment length of haul, the carriers who participated in the Eastern-Central territory cost study were long-haul carriers, while the carriers who participated in the other three cost studies were short-haul carriers.

The third requirement for use of the methodology was for revenue data on shipments of average density. It was assumed that class 4 in the New England Motor Freight Classification and class 100 in the National Motor Freight Classification were, in general, the appropriate class ratings to be used for shipments of average density. The revenue data requirement was satisfied by using the class rates approved as a result of general revenue proceedings (New Procedures in Motor Carrier Revenue Proceedings, Ex Parte MC-82, 351 ICC 1) submitted in the autumn of 1975 by the New England, Central, Eastern-Central, and Middle Atlantic rate bureaus.

The data collected by the ICC were statistically analyzed, primarily through the use of multiple regression analysis, to estimate the parameters of the motor carrier firm model for each of the four cost study territories. Then the model was used with 1975 variable per hour and per kilometer cost data reported by the ICC (9), to estimate the variable costs of providing transportation services to LTL shipments in various traffic segments. The variable costs were then compared with shipment revenues to determine the probable presence of internal cross-subsidies between shippers in various traffic segments served by different carrier categories.

IDENTIFICATION OF INTERNAL CROSS-SUBSIDIES

This section focuses on the probable presence of internal cross-subsidies by shipment weight and traffic lane. In addition, the impact of two alternative cost methodologies on motor carrier estimated costs is discussed.

Shipment Weight

The econometric model of the motor carrier firm production function (3) was used with the sample data collected in the ICC's 1971 territorial cost studies and the 1969-1970 platform study to obtain the following estimates of mean variable costs (updated to 1975 cost levels) for the mean shipment weight in each of the eight standard ICC under-4500-kg (10 000-lb) weight brackets: (a) mean systemwide variable costs for mean shipment length of haul for the carriers participating in the 1971 cost studies of the Central and Eastern-Central territories, (b) mean variable costs for shipments moving between Boston and Torrington, Connecticut, for carriers participating in the 1971 cost study of the New England I region, and (c) mean variable costs for shipments moving between New London, Connecticut, and Scranton, Pennsylvania, for carriers participating in the 1971 cost study of the New England II territory. The costs are computed for specific points for New England I and II carriers, which approximate each territory's average shipment length of haul, because the class rate tariffs published by the New England and Middle Atlantic rate bureaus are for movements between specific points.

Table 1 shows what the single-line shipment costs per 45 kg (100 lb) are by weight bracket for shipments moved one at a time and what the percentages of the mean single-line shipment costs are for all eight weight brackets under 4500 kg (10 000 lb). Table 1 shows there is an 11- to 15-fold difference between variable shipment per-45-kg costs in the lowest and highest LTL shipment weight brackets.

The difference between the rate charged for and the variable costs of providing (the margin on) specific transportation services can be used in identifying internal cross-subsidies. If margins are positive for shipments in some weight brackets and negative for shipments in other weight brackets, internal cross-subsidies exist between shipments in different weight brackets.

Table 2 contains the margins for shipments moving under class rates in the ICC's eight standard LTL shipment weight brackets. Table 2 shows, in general, that shipments weighing less than 135 kg (300 lb) are cross-subsidized to some extent by shipments in the higher weight brackets. If constant costs in the range of 10 percent of revenues and a target profit margin, before taxes, of approximately 7 percent are assumed, Table 2 shows that LTL shipments of average density become profitable, on a fully allocated cost basis, when shipment weight exceeds 225 kg (500 lb).

A second finding is that the degree of internal cross-subsidization between shipments of different weights is a function of the shipment's class rating. Shipment density is the primary factor used to determine the rate classification into which specific commodities will be classified. Schuster (3) has shown that shipment density has little impact on terminal costs, which are the major component of LTL shipment variable costs. Therefore, for example, LTL shipments moving under class rating 50 will provide the carrier with approxi-

Table 1. Single-line LTL shipment costs by weight bracket and cost study territory.

	New England I		New England II		Central		Eastern-Central	
Shipment Weight Range (kg)	Cost Per 45 kg ($)	Percent Mean LTL Shipment Cost	Cost Per 45 kg ($)	Percent Mean LTL Shipment Cost	Cost Per 45 kg ($)	Percent Mean LTL Shipment Cost	Cost Per 45 kg ($)	Percent Mean LTL Shipment Cost
0-66	16.709	492.45	17.102	457.40	16.691	552.68	27.866	460.06
67-134	7.774	229.11	8.790	235.09	8.102	268.25	13.522	223.24
135-224	5.103	150.39	5.929	158.57	5.251	173.85	9.148	151.03
225-449	3.696	108.93	4.342	116.13	3.665	121.34	7.317	120.80
450-899	2.474	72.91	3.014	80.61	2.493	82.54	4.852	80.10
900-2249	1.767	52.08	2.207	59.03	1.697	56.19	3.548	58.58
2250-2699	1.193	35.16	1.525	40.79	1.207	39.96	2.576	42.53
2700-4499	1.146	33.77	1.491	39.88	1.111	36.78	2.457	40.56
All LTL shipment weight brackets	3.393	100.00	3.739	100.00	3.020	100.00	6.057	100.00

Notes: 1 km = 0.62 mile and 1 kg = 2.2 lb.
Cost study haul lengths were 204 km for New England I, 357 km for New England II, 288 km for the Central region, and 997 km for the Eastern-Central region.

Table 2. Margins on single-line LTL shipments by weight bracket and cost study territory.

	New England I		New England II		Central		Eastern-Central	
Shipment Weight Range (kg)	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin
0-66	-4.101[a]	142.72	-0.479[a]	103.33	-1.188[a]	108.80	-9.452[a]	162.72
67-134	-7.075	172.82	-0.574	103.17	-0.778	104.68	-8.088	138.54
135-224	-2.140	112.40	9.560	69.59	9.508	67.84	2.302	93.73
225-449	3.405	87.80	9.488	80.48	18.786	56.21	7.884	85.78
450-899	22.188	58.76	37.336	51.16	31.966	50.36	34.191	64.95
900-2249	45.966	51.81	91.998	39.70	70.046	40.60	86.483	53.43
2250-2699	74.660	46.05	158.596	33.67	110.176	36.58	146.107	48.15
2700-4499	103.173	44.26	220.080	32.92	167.218	33.67	216.880	45.91

Notes: 1 kg = 2.2 lb.
The class rate tariff bases for each class by territory were 130 for class 4 New England I, 92 for class 100 New England II, 171-180 for class 100 Central, and 601-620 for class 100 Eastern-Central.

[a]Minimum charge shipment.

mately one-half of the revenue of shipments in class rating 100, although the costs of effecting the movement of shipments in class rating 50 are only slightly lower, on the average, than the costs incurred by LTL shipments in class rating 100. Consequently, differences in revenues, without concomitant cost reductions, will cause shipments in different class rating classifications to have different degrees of internal cross-subsidization between weight brackets. Winship (Initial Statement on Behalf of Georgia Highway Express, Inc., Before the Interstate Commerce Commission, New Procedures in Motor Carrier Restructuring Procedures, Ex Parte MC-98, ICC March 8, 1976) provides evidence of the existence of cross-subsidies between rate classifications when shipment weight is held constant.

A third finding of Table 2 is that long-haul carriers, such as the Eastern-Central study carriers, may internally cross-subsidize shipments belonging to different weight brackets to a greater extent than short-haul carriers. A major implication of these last two findings is that internal cross-subsidies between shipments of different rate weights classified differently can cause long-haul motor carriers to aggressively compete only with other motor carriers for shipments where profitability, as measured by contribution margins, is relatively high.

Traffic Lane

Shipment origin-destination is a second basis by which motor carrier traffic may be differentiated. Each unique origin and destination pair is termed a traffic lane. The machine-readable pickup and delivery trip data collected in the ICC's 1971 territorial cost studies indicate the locality from which pickup and delivery trips were made and can be used to determine pickup and delivery costs for different metropolitan areas. Since pickup and delivery costs are the major component of terminal expenses, which, in turn, are the major component of variable cost for the vast majority of LTL shipments, the ICC-collected cost study data can be used to obtain an appreciation of how motor carrier costs and internal cross-subsidies vary by traffic lane.

One basis by which traffic lanes may be differentiated is the population of the metropolitan area in which each traffic lane's origin and destination is located. Schuster (3) and Schuster and others (10) have shown that the pickup and delivery cost model's parameters vary with the population of the urban area in which the trip is made. Consequently, urban areas may be paired by population category to obtain an indication of the differences, if any, in motor carrier variable costs and contribution margins that may exist by traffic lane. An appreciation of the possible magnitude of any differences in costs and contribution margins that may exist due to urban area population can be obtained by viewing motor carrier costs and contribution margins in small, medium, and large urban areas for carriers participating in the Central and Eastern-Central territorial cost studies.

Tables 3 and 4 contain estimates of contribution margins for shipments originating and terminating in five urban area population categories served by carriers participating in the 1971 Central and Eastern-Central territorial cost studies. The contribution margins were determined by using 1975 cost data with the class rates approved by the ICC in general revenue proceedings in early 1976. These tariffs provided, in general, for uniform freight rates throughout each cost study territory.

The data provide five major findings. First, shipments originating and terminating in urban areas belonging to different urban area population categories have different mean costs. In general, LTL shipment per-45-kg (100-lb) costs increase as the populations of the urban areas in which the shipment originated and terminated increase.

Although this result is the opposite of the frequently heard statement that it costs motor carriers more to serve small than large urban areas, this result was anticipated for the following two reasons. First, pickup and delivery costs increase as urban area population increases. This is due to the large size and higher degree of traffic congestion. Second, since systemwide line-haul load factors were used to compute line-haul costs, total variable costs would be expected to fluctuate in accordance with the pickup and delivery costs experienced in the metropolitan areas where individual shipments originated and terminated.

These results should not be interpreted as stating, with a high degree of certainty, that motor carriers experience lower costs in serving smaller urban areas than larger urban areas. However, they do establish a need for the computation of line-haul load factors and variable costs on a traffic lane basis in order that relatively accurate costs of serving different urban areas may be computed. In this regard, it should be noted that only the costs of TL and the larger LTL shipments will probably be sensitive to traffic lane load factors, as Schuster (3) has shown that it is only for these shipment categories that line-haul costs are a relatively large proportion of total variable costs.

Second, shipment profitability appears to be a function of the traffic lane in which the shipment moves when LTL shipment class rates are uniform throughout a rate-making territory. Tables 3 and 4 show that shipments moved between urban areas in the lower population categories have higher margins than shipments moving between urban areas in the higher population categories. Again, this is a tentative conclusion based on the use of average systemwide line-haul load factors reported in ICC cost publications. As previously discussed, load factors for specific traffic lanes are needed in order to determine the true margins realized by motor carriers on specific shipments.

Third, it appears that internal cross-subsidies do exist between shipments moving in different traffic lanes. The cross-subsidies appear to be most serious between traffic lanes composed of urban areas with populations in excess of 2 500 000 people and other urban areas. In traffic lanes composed of urban areas with populations in excess of 2 500 000 people, the shipments weighing less than 225 kg (100 lb) are subsidized to a greater extent by shipments moving in other traffic lanes.

Fourth, the problem of internal cross-subsidization between traffic lanes appears to diminish as shipment weight increases. The percentage difference in margins ranges from 81.7 percent for shipments in the lowest LTL shipment weight bracket, to 3.96 percent for shipments in the highest LTL shipment weight bracket.

Finally, the problem of internal cross-subsidization between traffic lanes may be more of a problem for long-haul than for short-haul carriers. This conclusion is based on the higher percentage differences in traffic lane margins for Eastern-Central territory carriers than for Central region carriers.

Cost Methodology

The cost methodology used to determine motor carrier costs can also cause internal cross-subsidies. If the cost methodology fails to indicate to the decision maker the economic relationships between alternative courses of action, the misallocation of economic resources has a high probability of occurrence. In the pricing of motor carrier services, economists (11, 12, 13) generally agree that the price should reflect the marginal, or avoidable, costs of providing the transportation services.

The cost methodology used in this paper to compute motor carrier costs determines the marginal, or avoidable, costs of providing specific bundles of transportation services. In contrast, the ICC's Highway Form A cost methodology (14, 15) focuses on determining the average cost per 45 kg (100 lb) of providing motor carrier transportation services under a wide range of conditions. Table 5 shows that the ICC's Highway Form A methodology, in general, tends to understate the costs of single-line LTL shipment traffic that weighs less than 900 kg (2000 lb) and to overstate the costs of single-line traffic in the higher LTL shipment weight brackets.

The Form A cost methodology averages the high per-45-kg costs of single shipment tenders with the low per-45-kg costs of multiple shipment tenders to arrive at a per-45-kg cost for the shipments making up each weight bracket. This averaging process results in a redistribution of shipment costs from the lower to the higher LTL shipment weight brackets. In contrast, the cost methodology used in this paper permits the user to determine the marginal costs associated with either single or multiple shipment tenders.

The effect of the average costing of this methodology is to present decision makers with cost data that fail to reflect the economic advantages accruing to motor carriers if shippers used practices that reduced motor carrier costs. In turn, by failing to know the economic consequences of alternative transportation strategies that could be followed by the shipper, carriers are unable to fashion rate structures, causing shippers to use shipping practices to reduce both carrier costs and shippers' total distribution costs. Consequently, the Highway Form A cost methodology causes shippers who use shipping practices that reduce carrier costs to cross-subsidize shippers who use, from the carrier's point of view, inefficient shipping practices.

RECOMMENDATIONS

The above analysis has shown that it is highly probable

Table 3. Margins on single-line LTL shipments for the Central region by weight bracket and urban area population.

Shipment Weight Range (kg)	Population 25 000-49 999		Population 100 000-249 999		Population 500 000-999 999		Population 2 500 000-4 999 999		Population 5 Million or More	
	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin
0-66	2.451	81.84	0.997	92.61	-1.211	108.97	-4.445	132.93	-4.919	136.44
67-134	3.061	81.61	1.537	90.76	-0.801	104.81	-4.213	125.32	-4.721	128.37
135-224	13.408	54.62	11.896	59.77	9.486	67.92	5.982	79.77	5.458	81.54
225-449	22.992	46.41	21.356	50.22	18.766	56.26	15.012	65.01	14.438	66.35
450-899	36.736	42.96	34.836	45.91	31.942	50.40	27.760	56.89	27.102	57.92
900-2249	75.267	36.17	73.229	37.90	70.013	40.63	65.399	44.54	64.659	45.17
2250-2699	114.437	34.12	113.275	34.79	110.145	36.59	105.733	39.13	105.025	39.54
2700-4499	171.708	31.89	170.550	32.34	167.190	33.68	162.484	35.54	161.716	35.85

Notes: 1 kg = 2.2 lb.
1975 costs used with rate basis 171-180, class 100, Central States Class Rate Tariff approved in early 1976.

Table 4. Margins on single-line LTL shipments for the Eastern-Central region by weight bracket and urban area population.

Shipment Weight Range (kg)	Population 25 000-49 999		Population 100 000-249 999		Population 500 000-999 999		Population 2 500 000-4 999 999		Population 5 Million or More	
	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin	Absolute Margin ($)	Percentage Margin
0-66	-1.068	107.08	-4.924	132.67	-6.855	160.04	-11.752	177.98	-13.379	188.78
67-134	-0.616	102.94	-4.633	122.08	-6.680	131.83	-11.852	156.48	-13.575	164.69
135-224	9.851	73.16	5.845	84.07	3.728	89.84	-1.510	104.11	-3.265	108.90
225-449	16.068	71.02	11.802	78.71	9.438	82.98	3.709	93.31	1.799	96.76
450-899	42.939	55.99	38.462	60.58	35.861	63.24	29.674	69.58	27.908	71.70
900-2249	96.154	48.23	91.295	50.84	88.348	52.43	81.474	56.13	79.173	57.37
2250-2699	154.865	45.04	150.682	46.53	147.824	47.54	141.460	49.80	139.337	50.55
2700-4499	226.305	43.56	221.836	44.68	218.678	45.46	211.736	47.20	209.417	47.77

Notes: 1 kg = 2.2 lb.
1975 costs used with rate basis 601-620, Class 100, Eastern-Central Class Rate Tariff approved in early 1976.

Table 5. Comparison of single-line LTL shipment costs in dollars per 45 kg for mean shipment length of haul.

Weight Bracket (kg)	New England I		New England II		Central		Eastern-Central	
	ICC Costs Per 45 kg	Single Shipment Costs Per 45 kg	ICC Costs Per 45 kg	Single Shipment Costs Per 45 kg	ICC Costs Per 45 kg	Single Shipment Costs Per 45 kg	ICC Costs Per 45 kg	Single Shipment Costs Per 45 kg
0-66	9.911	16.709	14.169	17.102	11.781	16.691	17.326	27.866
67-134	4.369	7.774	8.083	8.790	6.369	8.102	9.916	13.522
135-224	3.690	5.103	5.324	5.929	4.138	5.251	7.512	9.148
225-449	2.677	3.696	4.058	4.342	3.163	3.665	5.972	7.317
450-899	2.425	2.474	3.308	3.014	2.403	2.493	4.821	4.852
900-2249	1.683	1.767	2.538	2.207	1.773	1.697	3.767	3.548
2250-2699	1.309	1.193	1.943	1.525	1.369	1.207	3.072	2.576
2700-4499	1.207	1.146	1.759	1.491	1.204	1.111	2.730	2.457

Note: 1 kg = 2.2 lb.

that internal cross-subsidizations exist between different traffic categories in the general freight sector of the motor carrier industry. The internal cross-subsidies appear to be of the greatest magnitude for shipments that are members of different weight brackets. In addition, cross-subsidies also appear to exist between shipments rated in different class rate classifications, between shipments moving in different traffic lanes, and as a result of the cost methodology used by the ICC for motor carriage. These conclusions yield four major recommendations for regulatory policy.

First, the data clearly indicate a need for freight rates, particularly in the lower LTL shipment weight brackets, that are more closely related to cost. The extensive use by general freight carriers of the railroad rate classification has caused, to a great extent, motor carrier profitability to be a function of the carrier's adeptness in practicing market segmentation and aggressively pursuing profitable traffic, and not a function of the carrier's efficiency in providing transportation services. In addition, the great disparity between revenues and costs in the lower LTL shipment weight brackets has caused carriers to maintain rates on the profitable, larger LTL shipments at such high levels that many shippers have been able to implement cost-effective private carriage operations.

A second recommendation is that the ICC should encourage point-to-point rates, rather than rates based on distance scales, in those traffic lanes where (a) the costs of providing motor carrier transportation services are significantly different from average costs and (b) the total shipment weight in the traffic lane is relatively large. It may be possible to group traffic lanes having similar costs into rate categories and thus establish a rate structure only slightly more complex than that currently provided by distance scales.

Third, the ICC should encourage the use of multiple tender rates for smaller LTL shipments in localities that have higher than average pickup and delivery costs. Estimates of the cost savings that carriers can realize through the implementation of multiple shipment tender rates are provided by Schuster (16).

A final recommendation is that the motor carrier cost formulas used by the ICC need revision. They are now geared to providing information on the average costs experienced by carriers. While this category of cost data is useful in general revenue proceedings, it is of marginal usefulness in the evaluation of specific transportation prices. What is needed, in this latter instance, is cost information that can be used to reflect the economic relationships between alternative transportation prices and that permits the ICC and other interested parties to more accurately estimate the magnitude of internal cross-subsidies.

The magnitude of internal cross-subsidies in the general freight sector of the motor carrier industry can be more accurately estimated if the ICC takes the following action. First, type of commodity, revenue, and shipment length of haul data should be included in the traffic data used in the ICC's territorial cost studies. Inclusion of these data categories will permit both more accurate estimates of the magnitude of all types of internal cross-subsidies and determinations of the magnitude of two types of internal cross-subsidies that cannot be accurately estimated with the data currently in the public domain—internal cross-subsidies between different commodities and for different shipment lengths of haul. Type of commodity, revenue, and shipment length-of-haul data are currently included in the rate bureaus' continuous traffic studies and should be provided by rate bureaus to the ICC with other traffic data for use in the territorial cost studies.

Two other actions the ICC needs to take are concerned with the revision of their motor carrier cost formulas. First, the cost formulas need to be revised to determine the avoidable costs of specific motor carrier transportation services. Griliches (17) says, "The studies underlying the [railroad] cost study are at least ten years behind the state of the art in statistical investigations of economic data." These remarks are equally applicable to the ICC's costing of motor carriage.

Finally, the ICC's data-processing procedures and the motor carrier cost formulas should be revised to determine load factors by traffic lane. The data required to compute traffic lane load factors are currently reported to the ICC by carriers participating in territorial cost studies; however, the traffic lane data are not currently converted to machine-readable form.

The accomplishment of these recommendations will not be a panacea for the internal cross-subsidy problem; however, they will permit better determination of the magnitude of any internal cross-subsidies that might exist and to reduce their magnitude, if public policy deems them to be socially undesirable.

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Observations on Proposals to Relax Motor Carrier Regulatory Entry Controls

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The paper provides a carrier management perspective on continuing efforts by the Interstate Commerce Commission (ICC) to administratively reform motor carrier entry regulations. The normative framework as proposed by the ICC in which relaxation of entry controls would theoretically (a) result in significantly higher transport prices for small businesses and rural communities, (b) endanger the financial health of the motor common carrier industry, (c) militate against high-priority sociopolitical programs, and (d) nevertheless lead to less, not more, competition in most origin-destination city pair freight transport markets is described. Informed research of scientific quality to test the propositions put forth is requested.

The focus of motor carrier regulatory reform seems to have shifted recently toward administrative and policy changes within the Interstate Commerce Commission (ICC). Specifically, on July 6, 1977, an ICC staff task force submitted a report and set of recommendations to Chairman A. Daniel O'Neal entitled Improving Motor Carrier Entry Regulation, and the commission immediately began holding hearings on the recommendations.

Those staff task force recommendations aimed at simplifying the administrative process at the ICC are commendable. However, a handful of the recommendations taken together could seriously damage the nation's common carrier system and seriously impact the financial health of the motor carrier industry. This paper discusses the potential implications of a select few task force recommendations.

TASK FORCE RECOMMENDATIONS THAT COULD DAMAGE THE COMMON CARRIER SYSTEM

In recommendation 16, the task force suggests "that the Commission make it a practice to grant, without regard to opposition, a limited-use contract carrier permit to contract carriers serving only a single shipper or affiliated shippers." In recommendation 33, it asks the Commission to consider, among other things, "(w)hether independent truckers should be allowed to lease their equipment to private carriers, either on a long-term or on a trip-lease basis," and "(w)hether private carriers should be given more freedom to trip lease their vehicles on backhaul movements." These recommendations, taken together, would greatly increase the ability of private fleet operators to remove freight from the common carrier system by providing them with freight return-load capability.

Common Carrier Concept Versus Economic Theory

Recommendations 16 and 33 seem to reflect a concern that in some instances individual shippers are required to use the common carrier system for transportation service that could be obtained cheaper by an alternative method in the absence of regulation. Examples of regulation frustrating efforts by individual shippers to minimize transportation costs abound and offend notions of economic efficiency. Such specific examples, in fact, are the most powerful ammunition of the forces of deregulation as they "go public" with their case.

Allowing each shipper to use any possible method to minimize his or her individual transportation costs, however, is not and should not be the objective of national transportation policy. Rather, rational policy making starts with the recognition that the objective of our national transportation system is to optimize efficiency of the system. A basic principle of systems theory and analysis is that system optimization often requires suboptimization of individual components. We should expect the efficiency of the nation's transportation system as a whole to be greater than the sum of its parts.

The task force itself noted that the policy matters under consideration should not be predicated on "self-serving proposals. A sound transportation system is the common denominator that permits competition to exist in other segments of the nation's economy." Transportation policy makers have long recognized that a vibrant free enterprise system requires the availability of adequate, stable transportation service at reasonable rates. The cost to many firms or communities in an economy of providing individually for their own irregular or minimum transport requirements would be prohibitive in relation to the shippers' profits or revenues.

Since the availability of adequate, stable transport service to such firms and communities is fundamental to the free flow of commerce, the law requires common carriers to provide service to all at reasonable rates without regard to the profitability of the freight of an individual shipper or group of shippers. Common carriers, unlike private and contract carriers, have a service obligation. The incentive for common carriers to accept this service obligation is the expectation that overall returns will be adequate because of ICC price and entry controls. A special role of regulation under this common carrier concept is that it affords the carrier the opportunity to distribute the cost of the service obligation across all users.

Capacity in the form of facilities and equipment must be available to service both the seasonal peaks and valleys in equipment and driver requirements and the natural imbalances in the two-directional flows of freight on origin-destination (O-D) lanes. The existing common carrier system tends to spread an average cost of this service capacity over all users. The relaxation of entry controls, as recommendations 16 and 33 suggest, would make it possible for large shippers to avoid paying this average cost of capacity by searching out opportunities to balance backhauls, etc. In such an environment, after all the opportunities to balance transport requirements were exhausted by this privileged class of users who would pay no cost of capacity to serve seasonal or directional imbalances, users at the margin (usually small shippers with very irregular requirements) would end up paying for the entire cost of capacity caused by the natural imbalance of freight. Per-unit costs of common carriers would rise substantially. The small shippers, unable to have their own private fleets, would have to absorb large increased transport costs, find some other transportation alternative, or be forced out of business.

To be sure, eventually much of the natural imbalance in the flow of freight would be eliminated because of bankruptcies of marginal producers or the relocation of plants to communities able to support the remaining common carrier service. The highly unstable demand functions faced by individual common carriers in such an environment would be dampened by consolidation of many smaller carriers into a few larger firms. The process of carrier consolidation would create efficiencies that would help keep prices lower than they otherwise would have been; and with the eventual reduction of common carrier transport capacity, prices would drop back from the absurd levels reached during the chaotic shakeout period.

Whether prices or quality of service could get back to current levels would depend on (a) how much freight was left on the common carrier system, (b) the extent to which large shippers with private fleets and contract carriers caused bankruptcies of small shippers and deaths of small communities reliant on common carrier service, (c) whether public policy would allow the motor common carrier system to become highly oligopolistic, and (d) whether the "reformed" regulatory structure would be strong enough to control the pricing practices of such an industry. Considering the sociopolitical implications of these questions, what the level of prices and service would be at some point in the future to the strong shippers and communities who managed to survive the shakeout seems a moot point.

There is no research evidence that proves that the scenario written above would come to pass, but it is logical in projection. The absence of research evidence on such critical policy issues is in itself sobering. At the very least, the prospect of the potential shock effects to the economy of relaxed entry control demands that policy changes in this area await careful research and analysis and not be hurried along by theoretical and ideological pronouncements.

Economic research alone will not provide the answers, however, for the common carrier concept is not entirely economic in nature, but sociopolitical as well. An official (1) of the U.S. Department of Transportation made this point clearly:

> It (the common carrier concept) is a rational, legal concept that is similar in scope to other institutional problems such as eminent domain or civil rights. But there has been no tradition of legal research in the common carrier field.... Some economists may consider it a mere excuse for internal subsidization, or an archaic, outmoded institution. And yet it is a form of basic legal obligation analogous to many other institutions in economic life. Its background, implementation, and potential for growth should be explored in the best tradition of legal research.

Other Sociopolitical Objectives Versus Economic Theory

That the problem is sociopolitical as well as economic can be seen in the uneven effects that revision of the common carrier system would have on the various participants. Big shippers would benefit because they are most likely to find and successfully negotiate for opportunities to balance their transportation requirements. Big, financially sound common carriers will survive. Small shippers, small carriers, and small communities will suffer most.

An admittedly valid question is whether large shippers should be required to bear costs of capacity to serve seasonal or regional needs they can avoid through expanded private or contract motor carriage. In the laissez-faire transportation environment that free-market economists propose, such opportunities would accrue to the large shipper but at the expense of social objectives.

Much sympathy exists, for example, for the notion that development of our small towns and rural communities requires subordination of the profit motive to the public good (2, 3, 4). A majority of Americans would prefer living in rural surroundings or small towns if adequate employment were available. The economic proclivity of industry to concentrate has deprived a large proportion of the population of the right to choose the type of life they would prefer to lead. (A 1968 Gallup poll reported that 56 percent of Americans would prefer to live in rural or small communities rather than metropolises, if adequate employment were available.)

Concentration of industry at the expense of social objectives has occurred because the profit motive of private enterprise (which drives industrial location decisions) does not encompass social costs as a decision input. Since the profit motive will prevent private enterprise from giving sufficient consideration to social costs and objectives, such considerations are given effect through such media as national transportation policy.

The Urban Growth and New Community Act of 1970 makes it abundantly clear that a high-priority social objective is to preserve small towns and more evenly spread industrial development to promote future economic growth of rural areas and small communities. Unfortunately, flows of freight into and out of small communities are very unbalanced. Therefore, a regulatory policy that forces the cost of excess capacity in the national system to users at the margin who cannot negotiate opportunities to balance transport requirements will militate against more even distribution of industrial and economic development.

The economic issues involved here also concern quality of life and cannot be judged by the narrow technical efficiency focus of free-market economists.

ANALYSIS OF RECOMMENDATIONS THAT WOULD DAMAGE THE FINANCIAL HEALTH OF GENERAL FREIGHT MOTOR COMMON CARRIERS

In recommendation 4, the task force suggests that shippers, federal agencies, state and local agencies, the Commission staff, and others should be allowed to take a more active hand in initiating hearings on markets that show signs of oligopolistic control by one or a limited number of carriers. Such a recommended procedure implies that entry decisions would be made on an atomistic, case-by-case basis.

It will be shown in the following pages that the analytics involved in determining the proper number of carriers in a specific market should consider the efficiency with which that specific market segment can be integrated into motor carrier systems serving multiple markets. The qualifications of outside agencies for dealing with such complex systems questions are questionable and their involvement in these matters would be counterproductive.

Importance of Market Density to Cost-Efficient Carrier Operations

I have used econometric research techniques in a number of profitability analyses in the general freight motor carrier industry. These analyses have been done both on an intrafirm basis (analysis of the determinants of profitability of terminals and O-D lanes) and on an interfirm basis (cross-sectional analysis of the determinants of profitability of individual firms in the general freight industry). Both types of studies are discussed in a paper presented at the 1976 Transportation Research Forum (5).

This econometric research clearly demonstrates the pivotal role that lane density plays in the profitability of a general freight motor common carrier. ("Lane density" is a technical trucking term for the volume of freight handled by an individual motor carrier in an O-D city pair.) Intrafirm analysis revealed that lane density and percentage of bills rehandled at breakbulks were two of the three most important determinants of lane profitability. Rate quality was the other. These two factors are obviously highly interrelated and very much determined by market share. The cross-sectional analysis of profitability of different firms in the industry revealed that lane density was the most important factor of profitability. (It was not possible to include percentage of bills reshipped as a test factor in this study.)

Such findings are no surprise to seasoned observers of the general freight motor common carrier industry. While the industry does not have a high degree of fixed costs in the classical definition of the term, there is a very high incidence of indivisible and common costs that results in reduced average cost per unit as such indivisible and common expenses are spread over more units of demand.

There are a large number of cost efficiencies associated with increased volume for less-than-truckload (LTL) general freight carriers. Pickup and delivery (PUD) costs per shipment decline as the volume handled per day per unit increases. Volume per PUD unit per day in turn rises as the total volume per terminal increases. Platform wages per shipment decline as the total LTL volume per terminal increases, except at the largest-sized terminals, which the industry is moving away from.

Over-the-road (OTR) equipment utilization rises as volumes increase because idle time is reduced and average load per trailer rises as volume increases on a lane-by-lane basis. All long-haul LTL carriers find it necessary to operate breakbulk terminals for the purposes of consolidating shipments from several lanes in order to build efficiently sized trailer loads, to avoid having freight collect at terminals, and to meet minimum service requirements. Increased volume on a single lane can often improve the cost efficiencies of many other lanes in a carrier's system by increasing load averages and OTR equipment utilization for segments of lanes (legs) into and out of breakbulk facilities.

By way of illustration, consider Figure 1, which is a schematic representation of a typical large, long-haul general freight system. The dots represent terminals, and the triangles represent breakbulk facilities. The irregular ovals demonstrate those terminals that are assigned to each breakbulk facility. Freight typically moves between terminals and breakbulk facilities, not between terminals and terminals.

The breakbulk facility just below Chicago is at Danville, Illinois. Consider Des Moines, Iowa, which loads all of its southbound freight on a single trailer into Danville each night. At Danville, the southbound freight from each of the other terminals in the referenced ellipse is combined with the Des Moines freight onto individual trailers destined for Atlanta, New Orleans, Charlotte, Jacksonville, etc. Thus an increase in volume on the Des Moines to Charlotte lane, for example, improves equipment utilization (and thus reduces per-unit costs) for every southbound lane out of Des Moines (because freight from these lanes rides with the Des Moines freight into Danville) and for all lanes into Charlotte from each other terminal in the Danville breakbulk alignment (because freight from these lanes rides with the Des Moines freight from Danville to Charlotte). Conversely, a reduction in volume on the Des Moines to Charlotte lane will result in per-unit cost increases on each of the associated lanes.

The necessity for such breakbulk-oriented systems can be seen in the table below, which shows the number of carriers authorized to serve selected lanes and the estimated amount of LTL freight in 13 700-kg (30 000-lb) trailerload equivalents moving on the lane (in daily equivalent trailerloads of LTL freight).

Lane	Number of Carriers	Daily LTL Demand
New York-Baltimore	71	50
New York-Richmond	27	6
New York-Roanoke	11	2
Minneapolis-Los Angeles	8	5
Minneapolis-Portland	5	1-2
Portland-Minneapolis	5	1
Chicago-San Francisco	15	9
San Francisco-Chicago	15	7
Chicago-Portland	10	3

Thus, for example, on the Portland to Minneapolis lane there are five LTL carriers offering single-line service who are competing for about one trailerload of LTL freight per day. If these carriers split the freight evenly, each carrier would have approximately 4750 kg (6000 lb) of LTL freight per day. And the Minneapolis to Portland lane is larger than most of the millions of possible city-pair lanes in the United States freight market. This analysis ignores the countless possible combinations of multicarrier interline arrangements that can offer competing services on these lanes.

Importance of Market Density to the Adequacy of Service in Carrier Systems

Increases in volume on each lane for an individual carrier increase the quality of service offered on that lane and on every other associated lane in the breakbulk alignment. Speed and consistency of transit times in a breakbulk alignment are essentially a function of daily equivalent trailerloads on legs of lanes into and out of breakbulk facilities.

The daily equivalent trailer ratio is the daily amount of freight on a leg (or lane) divided by the capacity of a single trailer. Any time this ratio is perceptibly different from a whole integer (1, 2, 3, etc.), some amount of freight must be inefficiently handled (by letting freight stand on the dock for a day or longer or by running partially loaded trailers). However, as these ratios increase, the percentage of freight that must be handled inefficiently declines.

Furthermore, the number of carriers that can offer cost-efficient, quality service on an individual lane is a decision that can only be made on a systems basis. A carrier can provide efficient, competitive service on most individual lanes only if the freight that would move on each individual lane can be logically integrated into the legs of a carrier's breakbulk system.

Some "bundles" of lanes fit logically together to form efficient breakbulk systems (given that individual carriers can attain reasonable market shares on each lane); some bundles of lanes do not.

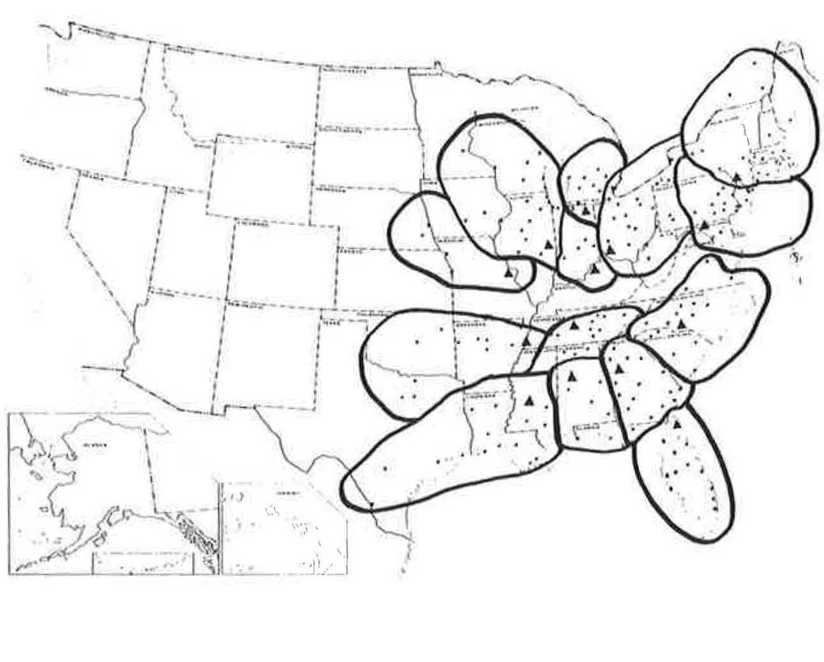
However, only a relatively small percentage of lanes—even when bundled properly into legs of a breakbulk scheme—can generate enough freight to support adequate, cost-efficient service by more than two or three carriers. Thus, the appearance of an oligopoly on individual lanes is simply a reflection of the economic realities in general freight motor carrier operations. Creation of new competition generally does not alleviate these naturally oligopolistic situations but rather creates inefficient operating conditions for all carriers in the market (until the least efficient carriers are driven from the market). There is much evidence, including the data shown in the table above, that there is currently too much competition to allow cost-efficient, adequate service by the average carriers on most lanes in the general freight markets.

The ICC has often been guilty of failing to give adequate consideration to such systems effects in deciding what impact new competitors would have on the adequacy of common carrier service. In part, the complexity of such considerations explains this failure. The ICC has much work to do in improving its procedures for these purposes. However, expanding the role of outside agencies in entry decisions—on an atomistic, case-by-case basis—is a formula for ensuring that the economic efficiency of motor carrier systems is not given adequate consideration in motor carrier entry proceedings. The appearance of an oligopoly on individual lanes is likely the only information such agencies will care to see or be capable of seeing.

CONCLUSION

Much of the analysis presented in this paper is admittedly of a subjective, undocumented nature. Unfortunately, informed opinion (and often uninformed opinion) unsupported by research evidence is characteristic of arguments on all sides of the motor carrier regulatory reform issues. Many of us have worked hard in the past to gather objective evidence on such issues both through

Figure 1. Geographical schematic of an LTL general freight carrier terminal, breakbulk alignment.



our own research efforts and by continually reminding various government agencies, trucking groups and associations, and academic and scientific institutions of the severe limitations of existing research evidence. Furthermore, we are quite comfortable that quality objective research by parties without ideological predispositions would support many if not all of the arguments we have advanced. However, such research must proceed only after the selected researchers have gained a thorough understanding of the competitive dynamics of the motor carrier industry. We stand ready at all times to be of assistance in explaining a participant's perspective on these competitive dynamics.

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