Benefit-Cost Analysis in Rail Branch-Line Evaluation

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Section 5 of the Department of Transportation Act of 1966, as amended by the Local Rail Service Assistance Act of 1978, requires that a "methodology for determining the ratio of benefits to costs of projects" be included in state rail plans. This paper discusses some of the key issues that should be addressed in these methodologies. First, common errors are identified that occur in branch-line benefit-cost analyses that are submitted to the Office of State Assistance Programs of the Federal Railroad Administration. Techniques for avoiding these errors are suggested. A basic analytical framework for the evaluation of branch-line projects is presented that is then extended to cases in which projects are expected to (a) affect related transportation services and (b) produce improvements in the quality of branch-line service. Problems that arise from the relocation of capital and labor are also discussed.

Under Section 5 of the Department of Transportation Act of 1966, as amended by the Local Rail Service Assistance Act (LRSA) of 1978, federal funds are available to the states for enhancing the viability of lignt-density rail lines or for mitigating the effects of abandonment of such lines. The financial assistance can be used in any of the five ways enumerated in the act--subsidy, acquisition, rehabilitation, substitute service (e.g., construction of new connections or team tracks), or new construction.

One of the major purposes of LRSA was to alter the eligibility criteria under state assistance programs so that railroad lines do not have to be already abandoned to be eligible for assistance. In order to ensure that federal money is not used to perpetuate economically inefficient and unneeded railroad lines, the following provisions were made part of the legislation:

1. Section 803(a) of LRSA states that, in order to be eligible for funds, a state must have a rail plan that "includes . . . a methodology for determining the ratio of benefits to costs of projects . . ."; and
2. Section 803(b) states that, until such benefit-cost methodologies are developed, projects can be funded "on a case-by-case basis where [the Secretary] has determined, based upon analysis performed and documented by the state, that the public benefits associated with the project outweigh the public costs of such project."

Since the passage of this legislation, the terms "public benefits" and "public costs" have been defined in a variety of ways. Some analysts have assumed that public costs and benefits refer to funds that leave and arrive at the state treasury. However, the amount of money received by the state treasury has little if anything to do with public benefit. We argue below that public benefits and costs should be considered in the context of the economy of the nation, the individual states, and the local regions.

The objective of this paper is to aid the analyst in estimating the true economic benefits and costs of rail branch-line projects. Although it is conceded that economic measures of the contribution of proposed projects to the efficiency of the state or national economy do not constitute the complete set of desirable measures of project effectiveness, it is our contention that economic measures are essential and that they should be correct and not misleading.

The next section of this paper discusses some common errors in branch-line benefit-cost analyses submitted to the Office of State Assistance Programs of the Federal Railroad Administration (FRA) and suggests ways of avoiding them. Ways in which benefit-cost analysis can be applied to branch-line projects are then suggested under some typical scenarios to measure their efficiency benefits, i.e., real additions to the welfare of society. Space limitations do not permit discussion of the distributional consequences of projects for shippers, carriers, state and local governments, and different income groups. These are treated in an FRA publication (1), which also discusses intangible benefits and costs and environmental effects.

OVERCOMING COMMON MISTAKES AND MISCONCEPTIONS

Benefits

Since the passage of the Railroad Revitalization and Regulatory Reform Act of 1976, some state planning agencies have attempted to measure the benefits and costs of rail branch-line investments. Most of these analyses considered as benefits the annual transportation cost savings to shippers, tax revenues saved or generated, and decreased government spending (e.g., lower unemployment compensation payments) and compared them with the annual government costs of assisting the line. This approach is based on some misconceptions and produces misleading results.

One serious misconception is that the increases in government revenue are real benefits. A state could, at no cost to its government, simply double all taxes. From the viewpoint of the state government, the benefits of this policy far outweigh the costs. From the public's viewpoint (or the state-economy viewpoint), such an action could produce a substantial disbenefit. Thus, although it is important to know which parties (including the government) gain and lose from a project, increased tax revenues do not constitute a meaningful measure of benefits. Taxes are simply transfer payments within the economy. Tax payments neither reduce the inputs required to produce goods and services nor increase the output of goods and services. Clearly, then, taxes are not benefits.

Some analysts have taken the view that, if a business must close down due to a rail abandonment, all revenue currently received by the business is an accurate measure of the benefit to the public of saving the line. This approach, however, leads to benefit estimates that are too high. To measure the benefit of saving a business from failure, the analyst should estimate the market value of its products minus the opportunity costs of its labor and material inputs under the abandonment alternative. When the labor becomes unemployed and cannot be reemployed for some time, the opportunity cost of this labor becomes zero, and the disbenefit of the lost business is revenue minus the cost of material inputs (assuming that there is a ready market for these materials elsewhere). These benefits would normally accrue during the time that the labor remains unemployed. After all the labor has been reemployed, it should be assumed that the loss in the business affected is recovered by increased output of businesses that reemploy the labor. During the period of unemployment, the state government will pay unemployment compensation. From a statewide viewpoint, this is merely a transfer payment and does not affect net benefits. From a local viewpoint, this compensation decreases the impact of abandonment and should be subtracted from the disbenefits; this decreases the net benefit of avoiding abandonment.

The lack of a consistent viewpoint contributes to these misconceptions. By adding tax revenues, increased business revenues, and decreased shippers' cost of transportation, three different viewpoints are used. Thus, the quantities are not additive. Such an approach is similar to adding the grain price paid to the farmer by the miller, the flour price paid to the miller by the baker, and the bread price paid to the baker by the consumer and calling it total revenue to the grain industry. Obviously, much has been counted twice and much has been left out by not maintaining a consistent point of view.

Two important considerations often left out of rail benefit-cost analyses are the economic life of the project and the time value of money. Often, first-year benefits of saving a rail line are seen as remaining constant and unabated forever. Similarly, annual costs of maintaining service are expected to be perpetual. Such benefit-cost comparisons simply measure annual cash inflows against annual cash outflows. However, most of the time, a project will involve initial costs (usually for rehabilitation or construction) that must be amortized over an appropriate period of time. This period, the life of the project, should be consistent with the planning horizon. The planning horizon should not exceed the length of time that the line's operator agrees to continue service, even though the economic life of materials used in rehabilitation or new construction of a railroad could be as long as 15 years or more. The benefit stream should also be shown to stop at the end of the planning horizon. Decisions that involve time periods beyond the planning horizon are arrived at independently. In addition, benefits that accrue from preventing abandonment are not usually constant each year. If abandonment did occur, disbenefits would be high the first year but would decline significantly as adjustments were made.

A proper and reasonable method for handling varying amounts of benefit and cost over time is to calculate a present value for all costs and benefits by appropriately discounting their future flows. This raises the issue of what discount rate to use. The rates usually used reflect two components: (a) the opportunity cost of money and (b) inflation. Since most projections of future flows do not account for inflation, only the opportunity cost of money should be used (perhaps around 3 or 4 percent). Alternatively, inflation could be factored into future flows and the higher nominal rate could be used (which is currently 10-15 percent).

An illustration of these two approaches follows:

Item	Net Benefits Constant $	Net Benefits Current $
Year		
1	1 200 000	1 284 000
2	600 000	686 940
3	300 000	367 513
4	150 000	196 619
5	75 000	105 191
6	37 500	56 277
7	18 750	30 108
8	9 375	16 108
Present value		
2.8 percent	2 265 450	
10 percent	1 996 355	2 265 450

The example assumes that the initial investment in rehabilitation will be $2 100 000 and that the benefits accrue due to abandonment avoidance. The first-year benefits are assumed to be $1 200 000 and to decrease by one-half each year. The third column shows the inflated benefit flows, by assuming inflation at 7 percent/year. Note that by using a 10 percent discount rate on the inflated-dollar figures, the present value of the benefits is $2 265 450, an amount large enough to justify the project. If, however, the 10 percent rate (which includes a 7 percent penalty for inflation) is applied to the constant-dollar benefits, the present value is only $1 996 355, an amount not large enough to justify the project. To perform the analysis by using constant-dollar benefits, the inflation penalty of 7 percent must be removed from the nominal interest rate, which leaves a 2.8 percent value [(1.1/1.07) - 1]. Use of a discount rate of 2.8 percent on the constant-dollar column yields a present value of benefits of $2 265 450, which is exactly the same as that obtained by projecting inflation. Thus, the project is sound. However, according to some procedures in use today, project benefits would be shown to be smaller than project costs.

The project may not be the best alternative, however, if the null or base alternative is not abandonment. Since LRSA allows funding of currently operating light-density lines regardless of the possibility of past, present, or future abandonment, the justification for the project may not be the avoidance of service loss. In this case, benefits in the category of reduced transportation costs, consumer (shipper) surplus, and producer (carrier) surplus must be considered. Reduced transportation costs can best be estimated by calculating the value of resources used in providing the service. Rate differences are often used instead. It should be recognized, however, that rates are often quite different from costs and not a good proxy for them.

In performing the analysis where abandonment is not a factor, the planner should be sure to include all benefits. Those most often excluded are the producer and consumer surpluses described below. If abandonment is probable but not certain as the null alternative, the benefits of avoiding abandonment should be multiplied by the probability that abandonment would occur in the absence of the project.

Costs

Examples of common mistakes in cost estimation are as follows:

1. Counting only forfeited loan interest: Some planners feel that when an interest-free loan is made to a railroad, only the lost interest is the cost to the public of the project. As the FRA benefit-cost guidelines (1) have argued, however, project evaluation requires the estimation of all social costs, particularly the present value of the opportunity costs of equipment, labor, and materials. These costs will be incurred regardless of the means by which they are financed. An interest-free loan implies only that more of a project is funded by the state and less of it by the railroad. This is a valid distributional consideration for state rail planners but should not affect the estimation of a project's social cost.

2. Counting only the federal share: This is often justified on the basis that, since the benefit-cost requirement is federally imposed, only the federal investment needs to be justified. It is true that the law is intended to prevent federal aid to uneconomical projects, but making a judgment

about the economic propriety of a project requires that all costs be considered.

3. Counting only the local match: This approach is often justified on the grounds that, since the federal money comes from an entitlement program, the federal share is essentially free. The only real investment, then, is the local match money; thus, only the local match needs to be justified. This line of reasoning is incorrect, because the federal funds that are used divert labor and material resources that could be used for other projects. In order to assure that only the best and most economical projects receive federal funds, it is important that all project costs be analyzed.

4. Ignoring the railroad contributions: Often, when the railroad puts up some of the money for a project, it is not included in the costs because it is not a public cost. Again, "public" is not synonymous with "government." Like federal and state funds, rail funds cause material and labor that could be used elsewhere to be tied up in the project.

A related problem concerns project definition. Sometimes a situation will arise in which a portion of a line will be rehabilitated by using LRSA funds, whereas rehabilitation of another portion is privately financed. In the analysis of this situation, one of two courses is acceptable:

1. Benefits of rehabilitating both portions could be compared with the costs of rehabilitating both portions (which includes private investment), so that the benefits that accrue from the two projects do not have to be separated; or
2. Benefits of both projects could be separated (this can be a formidable task), and the benefits of the LRSA project could be compared with its costs.

It is incorrect to compare the benefits of both rehabilitations with the costs of only the LRSA-funded part of the project.

CALCULATION OF BENEFITS AND COSTS

Primary Efficiency Benefits

Benefits that arise from different types of services provided by one investment alternative and not by another will be reflected in cost, rate, and quantity differences among alternatives. These in turn will bring about differential producer and consumer surpluses, which will measure the relative economic benefits of the various investment alternatives.

Figure 1 shows how these benefits are measured. The shaded area shows the producer and consumer surpluses for alternative 0. The hatched area shows the increase in producer and consumer surpluses that results from implementing alternative 1. As shown, the benefits can be divided into three subcategories: A, the decreased cost to provide service to the existing traffic $[q_0(c_0 - c_1)]$; B, producer surplus (economic profit) on new traffic $[(p_1 - c_1)\ (q_1 - q_0)]$; and C, consumer surplus on new traffic $[1/2(p_0 - p_1)(q_1 - q_0)]$. The expression for the total benefit is $q_0(c_0 - c_1) + (p_1 - c_1)(q_1 - q_0) + 1/2(p_0 - p_1) \times (q_1 - q_0)$.

In computing the decrease in cost to provide service, the analyst should be sure to calculate the actual change in economic resources required to move the commodities. It is also important that a clear distinction be made between these costs and the cost of the project alternative that is being evaluated. Elements within this category will vary with the project and the mode that is being analyzed but will normally include the following costs: maintenance; insurance; crew, driver, or operator; fuel; and other vehicle. Taxes levied on operations or properties are not properly considered as costs here, because they are transfer payments. However, any resources received in return for the tax payments made are costs. For example, truckers pay road-user taxes. These payments are not, as such, economic costs, but the expenditures required to provide and maintain the highways for the truck movements analyzed are costs (input resources). In truck travel, the taxes paid may be the best available measure of their share of the highway costs and therefore be an appropriate cost element. It should also be noted that, although rates would equal costs under perfect competition, this will not usually be the case for rail branch lines.

Estimating Traffic Increases

In computing the changes in producer and consumer surpluses on new traffic, the analyst first needs to forecast how much new traffic there will be. This can be done by estimating a demand curve and rate changes or possibly by doing a shipper survey. Many planners feel that a rate change would never occur with any improvement project. However, such a project may forestall a planned rate increase and, since a benefit-cost analysis compares different future scenarios, a rate difference would appear in the analysis. Also, if abandonment were the alternative to the project, rates would change substantially. Once new traffic quantities and rates are estimated, producer and consumer surpluses on the new traffic can be calculated. It should be noted that the change in the consumer surplus measures the economic value of any increased business activity of rail-using firms that results from the project.

Accounting for Effects on Related Transportation Services

In analyzing the impacts of a branch-line investment or subsidy, it is important to take into account its likely effects on competing and complementary modes of transportation. For example, in areas where truck transportation is an alternative to the shipment of commodities by rail, a branch-line investment that reduces costs and rates can be expected to induce at least some shippers to switch from truck to rail transport. In Figure 1, the increase in rail transport is shown by the distance q_0q_1 as a result of a movement along the demand function from E_0 to E_1. In Figure 2, the demand of shippers for truck transport is shown by D'_1. A decrease in the rail freight rate from p_0 to p_1 (Figure 1) might cause the demand for truck transport to shift to D'_2, so that $q'_1q'_2$ in Figure 2 equals q_0q_1 in Figure 1.

In this example, it is tempting to argue that the reduction in the original consumer and producer surpluses provided by truck transport should be subtracted from the gains depicted in Figure 1 in calculating the net social benefits contributed by the branch-line investment. This would be incorrect, however, because the reduction in demand for truck transport is merely the means by which shippers take advantage of the new, lower rail rates. It is true that the railroad will gain at the truckers' expense, but no shipper will be made worse off. If some resources of production that have been released from trucking remain unemployed, however, this must be reckoned as a social

Figure 1. Primary efficiency benefits.

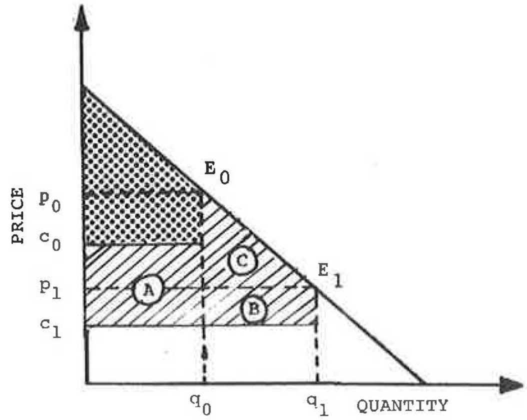
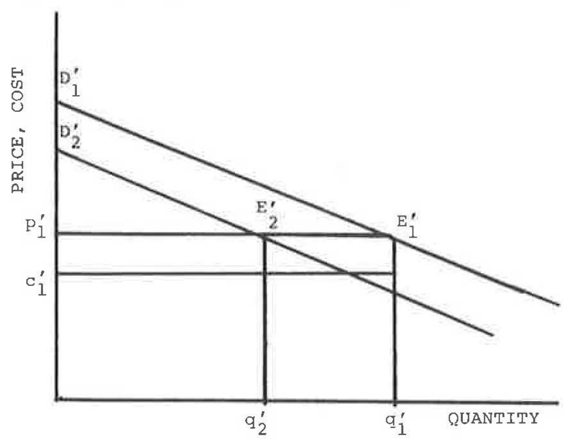


Figure 2. Project impacts on an alternative transportation service.



disbenefit. Measurement of this disbenefit is discussed below.

The foregoing analysis may require some refinement if truck owners respond to lower rail rates by decreasing their own rates in an attempt to recapture some of their lost market. Truck transport would then yield more consumer surplus, although at the expense of the producer surplus. To the extent that the lower trucking rates succeed in restoring some lost shipments, the demand for rail transport will decrease, and the measurement of area A + B + C in Figure 1 will have to be adjusted accordingly. These analytical refinements may be unnecessary, however, especially if secondary reactions to a decrease in rail rates are expected to be small.

Accounting for Benefits from Service Improvements

We have considered the case in which a branch-line investment or subsidy can be expected to yield lower rail costs and rates. We now turn to the possibility that the benefits are realized in the form of improved reliability of service, decreased loss and damage, or decreased time in transit without a decrease in rates and possibly not even in costs. There are at least three approaches to the measurement of these benefits.

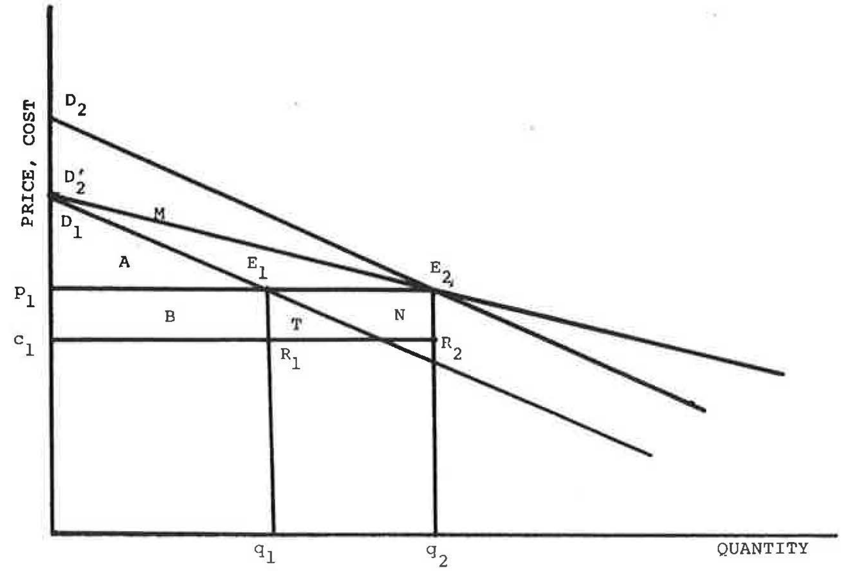
The most straightforward approach is to examine each benefit separately and to estimate its value to the shippers served by the branch line. Instead of using more-sophisticated, indirect methods, the analyst could discuss the anticipated benefits with shippers and ask them what the improvements in service would be worth to them in dollar terms. One disadvantage of this technique is that some shippers may be unwilling or unable to quantify the value of the benefits; another is that the shippers who would benefit from the branch-line improvements might be tempted to exaggerate their value in an attempt to promote the project. To safeguard against these possibilities, the analyst should arrive at an independent assessment of the anticipated improvements by considering the statements of shippers as indicative but not definitive.

A variation of the first approach is to regard uncertainty, loss and damage, and time in transit as costs borne by shippers. According to this view, the benefits calculated in the first approach can be interpreted as rate reductions. These can be translated into unit-rate reductions and applied to Figure 1. This approach has the advantage of being consistent with the valuation of projects that decrease costs and rates; i.e., the benefits of all projects that are considered will be measurable in terms of increases in consumer and producer surpluses.

An improvement in branch-line performance may also be thought of as the displacement of the existing quality service by higher-quality service. In Figure 3, D_1 is the original demand function, and D_2 is the demand for the improved transportation. Since the only point normally known on D_1 is E_1, some other point must be estimated, even if it can be assumed that D_1 is linear. The point that is perhaps the least difficult to estimate is the intercept of D_1 with the price-cost axis. The price at that point should be at the level that is just high enough to cause the last shipper to stop shipping. It is also the level that defines the highest price that a shipper is willing to pay to make a shipment. Depending on whether the shipment is defined as mode specific or not, reasonable estimates can be made.

In the absence of any evidence to the contrary, it is reasonable to assume that the new demand function is parallel to D_1. In some cases, however, it may be appropriate to assume that D_2 has the same intercept with the price-cost axis as does D_1. Such an assumption implies that in either case (with or without the improvement that is being evaluated), the highest price that anyone is willing to pay for the shipment is the same. The demand function D'_2 illustrates this case. The intercept of D_1 with the price-cost axis can be estimated by using the price for a competing mode, such as truck. This approach can be justified by the assumption that if the rail price (rate) should reach that level, all shipments would be made by some competing mode and none by rail. Whether the original and shifted demand functions are parallel or have a common price-cost axis intercept, the geometry of Figure 3 is illustrative of the benefit calculation. At the original rate p_1, the amount carried by the branch line is expected to increase from q_1 to q_2 because of improved service. The original amount of consumer and producer surpluses, area A + B, has been replaced by the larger area A + B + M + N + T. Thus, the area M + N + T measures the benefit yielded by the branch-line investment. This technique is attractive because of its conceptual simplicity; it requires only that the analyst be able to estimate the increase in branch-line traffic attracted by the improved service. It is not necessary to evaluate the benefits of improved reliability, decreased loss and damage, faster delivery, and so forth. A serious weakness of this approach is that the benefit

Figure 3. Benefits from service improvements.



calculation is highly sensitive to two factors, both of which are susceptible to considerable error. First, in arriving at an estimate of increased tonnage, the analyst may have little or no information to work with and thus be able to make little more than an educated guess. Second, the slope of the new demand function is unknown. In Figure 3, it is only assumed to be the same as the slope of the original demand function or to have the same intercept on the price-cost axis. A slight deviation of the estimated slope from the true (unknown) slope would be a source of inaccuracy in calculating area M + N + T (the increase in consumer and producer surpluses).

Secondary Efficiency Benefits

Secondary efficiency benefits usually result from avoiding abandonment. The variations among alternatives in modes and types of transportation services may cause companies to relocate and move onto or away from the branch line concerned. Such moves entail the relocation of resources such as labor and capital to different productive uses.

In many cases, these resources are shifted to new uses almost immediately, which offsets initial losses. Whenever there is a delay in shifting resources to new uses, there is a loss of production, which is a secondary efficiency disbenefit attributable to the alternative that caused it. Even when the offsetting change occurs, it may not be one that employs resources as effectively (i.e., it does not create as much producer and consumer surplus) as was the case originally. In such a case, the diminished surplus may be considered a disbenefit; however, such changes are probably small enough to be ignored.

Before the offsetting change occurs, labor, capital, and materials may remain idle. Until these resources are reemployed elsewhere, their value is lost. Prior to abandonment, such resources had a value equal to their opportunity costs; now that they remain unemployed, their opportunity cost is zero. Since the disbenefits are calculated as changes in opportunity costs, the disbenefit is equal to the previous opportunity cost of the resources. This disbenefit would decline over a period of time as the resources become reemployed.

When a business relocates, there would be moving costs involved. These moving costs can be added to the disbenefits of the alternative that caused the relocation.

The evaluation of secondary efficiency benefits depends on the point of view taken. If it is the national viewpoint, offsets to disruption of production should occur more rapidly than when a local point of view is adopted. When a local viewpoint is used, however, certain transfer payments become real benefits (or disbenefits). For example, unemployment compensation would normally be supplied by the state to residents of a local area who become unemployed. Since this is a transfer from outside the local area and the local area does not provide resources in return for the transfer, receipt of this compensation is a real benefit to the locality. Thus, the disbenefits of unemployment should be reduced by the amount of additional unemployment compensation received if a local viewpoint is adopted. From a state or national point of view, however, unemployment compensation is a transfer payment and can be ignored when net efficiency benefits are computed.

CONCLUSION

The comparison of public benefits and public costs as required by LRSA need not be a fearsome and mysterious chore. An ample amount of relevant theory and applications exists to provide the necessary framework and guidance for doing the required calculation. This paper is intended to increase the communication on the subject among all interested parties.

Benefit-cost comparisons of this type should be embedded in a broader-based evaluation scheme. They are intended to measure the economic value of the projects concerned. In this particular instance, measurement of public benefits against the required public costs is mandated by the federal legislation that continues the Rail Branch Line Continuation Assistance Program. Analysis of the distribution or incidence of the economic and noneconomic effects of each project is essential to the broader-based evaluation.

Adherence to the principles in this paper and avoidance of the pitfalls that it points out will go a considerable way toward production of meaningful benefit-cost comparisons.

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Theory for Estimating Traffic Diversions on a Restructured U.S. Railroad System

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Each proposal to restructure the U.S. railroad system involves an analysis of the extent to which traffic will shift from existing routes to new routes offered by the restructured network. Classically, this exercise was conducted manually by traffic clerks and marketing personnel; however, the recent availability of machine-readable nationwide railroad traffic data enables these analyses to be done efficiently by a computer. An elementary model of traffic diversions suitable for estimating traffic diversions that result from a limited restructuring of the U.S. railroad system (i.e., individual mergers such as the Burlington Northern and the St. Louis-San Francisco Railway Company) is based on the redistribution of traffic among existing routes and new routes on the merged railroads. However, if all or most of the railroads are merging or changing configuration, all or most of the existing routes will be modified and therefore all new routes must be generated; this is termed the advanced model. This paper develops in detail the underlying theory for estimating traffic diversions on a vastly restructured railroad system. Historical shipper behavior data are presented to justify route selection and traffic assignment procedures. A stepwise application of the method is described and results are presented.

At present, the railroad industry is besieged with proposals that call for the restructuring of the operating jurisdictions of its various constituent companies. Proposals to merge, acquire, abandon, provide direct service, or otherwise consolidate are being forwarded by the railroad industry as well as by government agencies such as the Interstate Commerce Commission (ICC), the Federal Railroad Administration (FRA), the United States Railway Association, and the New England Regional Commission of the U.S. Department of Commerce. This jostling for position is not new. The railroad industry has undergone a continual restructuring of its geographical operating territory during its 150-year life. The current trend was, in a sense, spurred by the bankruptcy of the Penn Central Transportation Company and the enactment of the 1976 Railroad Reorganization and Regulatory Reform (4R) Act, but it is also simply the newest cycle of railroad geopolitics. A previous cycle founded the Penn Central, the Burlington Northern, the Seaboard Coast Line and the Louisville and Nashville Railroad Company (Family Lines), and the Chesapeake and Ohio, Baltimore and Ohio, and Western Maryland Railway Companies (the Chessie System). The present cycle may lead to mergers of the Burlington Northern and St. Louis-San Francisco Railway Company; the Chessie System and Family Lines (CSX); Missouri Pacific and Union Pacific; the Boston and Maine Corporation, Maine Central Railroad Company, and the Bangor and Aroostook Railroad Company (New England Rail Company); Core-Consolidated Rail Corporation (Core-Conrail); Core-Chicago, Milwaukee, St. Paul and Pacific Railroad Company (Core-Milwaukee); controlled liquidation of the Chicago, Rock Island, and Pacific Railroad Company; and a host of abandoned lines. Each proposal has either been formally presented to the ICC or is under active study by government agencies. Other restructuring of conventional and bureaucratic interests go as far as to include consolidations that would lead to a U.S. railroad system composed of only several east-west and north-south railroads.

A major impact of these consolidations is that the shippers who patronize the railroad industry will be faced with a significantly different logistic environment and with different intramodal as well as intermodal competition. This will cause the shippers to rethink their logistic patterns and thus there will be a significant effect on the distribution of traffic, which will affect the fundamental operation and validity of economics of each member carrier of the restructured railroad system.

The purpose of this paper is to describe a computer-based analytical method for estimating the shipper's logistic response to a vastly restructured system of railroad networks and thus its impact on traffic distribution, revenue potential, and costs of each railroad. In a recent publication, Kornhauser (1) described a method for estimating the effect on traffic flow of a limited restructuring of the U.S. railroad system, i.e., the evaluation of the traffic impact of a single merger or a single abandonment. This elementary theory of traffic diversions is based on the premise that a shipper will need to make only incremental changes in logistics patterns as the result of a single merger. Thus, routing decisions are heavily biased toward historical routing patterns. This premise allows for the reliance on historical traffic data and the creation of new routes only in those markets in which new single-carrier service is created by the merger. Otherwise, traffic is assumed to be shifted among existing routes.

Faced with a vastly restructured railroad system,