

# 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,  $V$ :

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

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  $F_1 > F_j$  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 re-

turns 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.

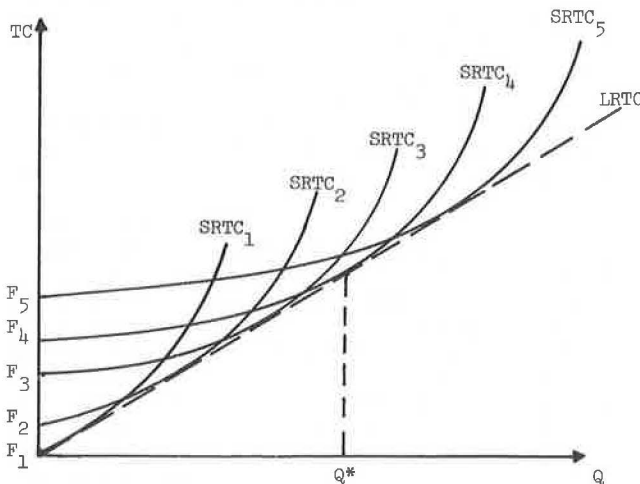
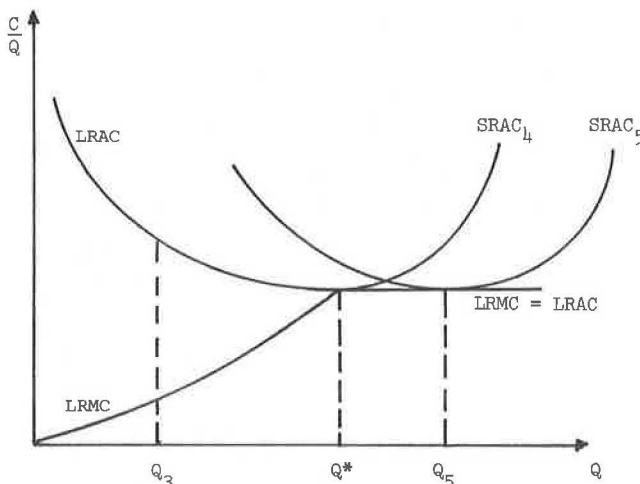


Figure 2. Rail costs with indivisibilities.



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

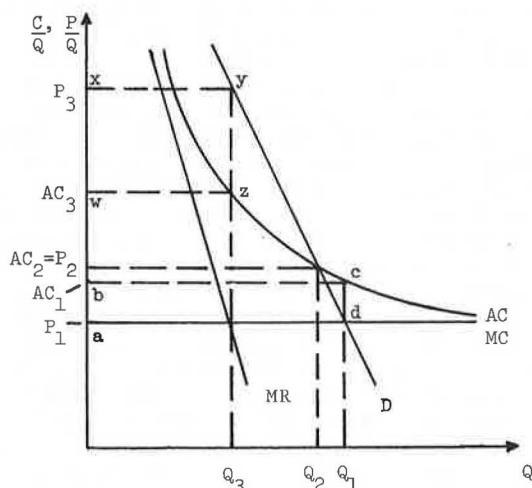
Figure 3. Case 1: D intersects AC at  $Q < \text{MOS}$ .

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

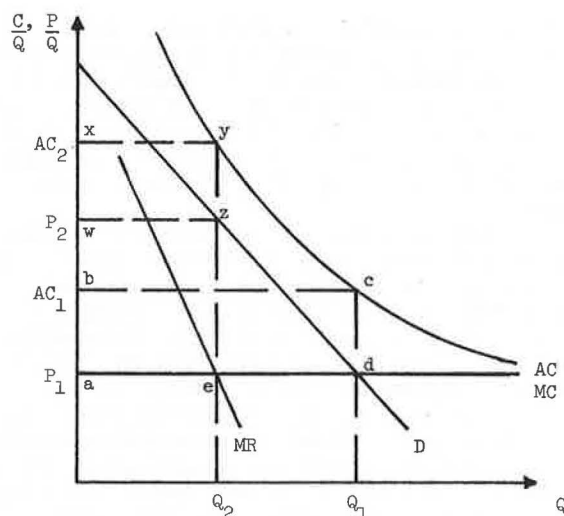
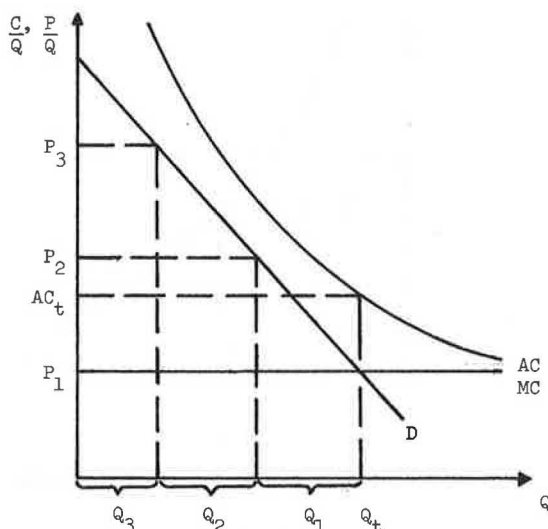


Figure 5. Case 3: no intersection of D and AC, discriminatory pricing.



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:

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

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:

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

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

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

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

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

Since the net producer surplus is negative, we will refer to  $\pi$  as the net producer loss.

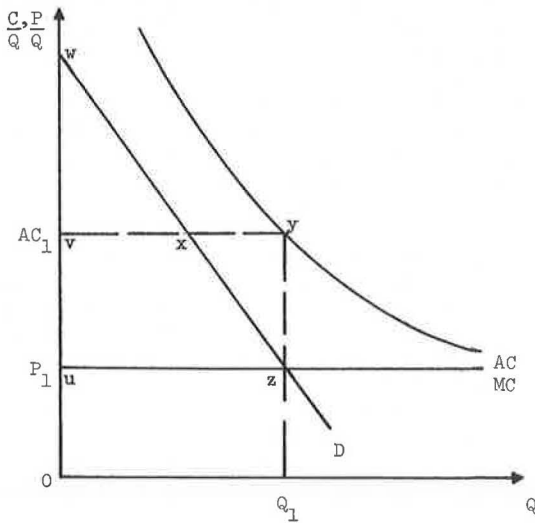
The social welfare criterion of disinvestment is based on a comparison of  $\gamma$ , the net consumer surplus, to  $\pi$ , the net producer loss. If  $\gamma > \pi$ , the line should be retained: The benefits derived from the rail service are greater than the cost of production. If  $\gamma < \pi$ , the line should be abandoned. Geometrically, the social welfare

criterion amounts to a comparison of the triangle  $vwz$  to  $xyz$  (since  $\gamma$  and  $\pi$  share the area  $uvxz$  in common). In Figure 6  $vwz$  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  $Q_1$ th 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

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

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

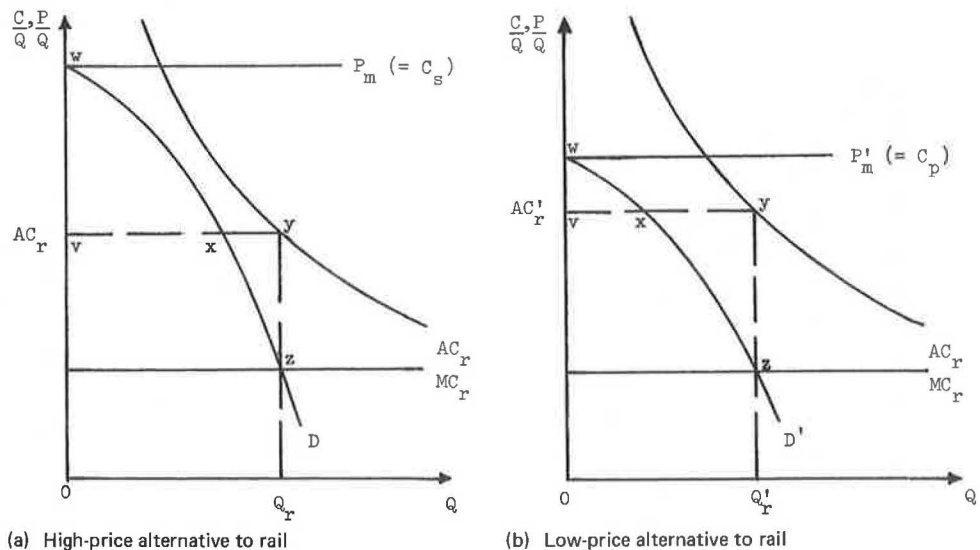


If  $\pi > 0$ , the firm would earn a profit and maintain service on the line. The profitability criterion with perfect price discrimination is equivalent to comparing the triangle  $vwz$  to  $xyz$ ; it is identical to the social welfare criterion. Consequently, if the firm were able to price discriminate 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 7. Effects of alternative mode on disinvestment.

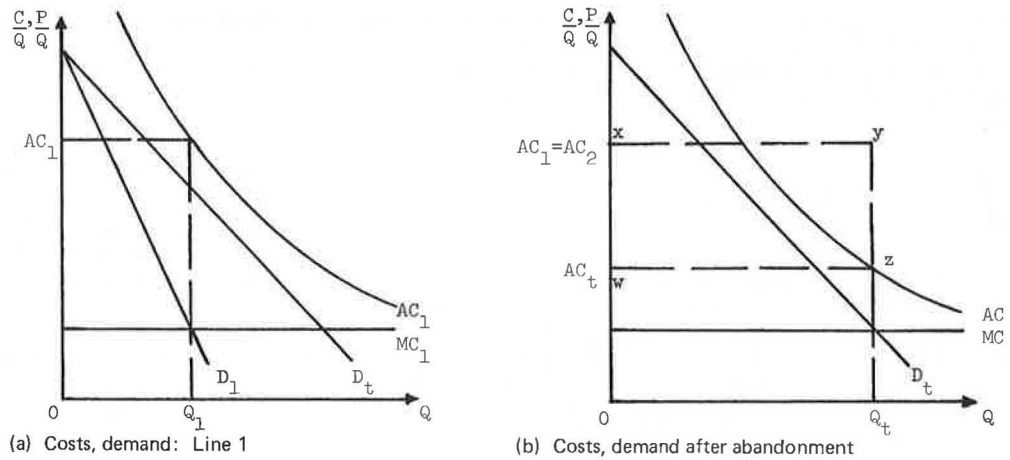


(a) High-price alternative to rail

(b) Low-price alternative to rail



Figure 8. Disinvestment criteria with parallel lines.



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  $vwx$  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 allocationaly 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  $P_s$  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  $D_i$ .

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

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

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,  $Q_i$ , can be provided at a much lower cost,  $AC_i$ ; 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:

$$\pi = (P \times Q) - (C_b \times Q_b) - (C_o \times Q_o) \quad (9)$$

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

$$\pi = (TR - TR') - (TC - TC') \quad (10)$$

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

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#### REFERENCES

1. A. A. Walters. *The Economics of Road User*

- Charges. World Bank Staff Occasional Paper, No. 5, 1968.
2. A. J. Harrison. *The Economics of Transport Appraisal*. Halstead Press, New York, 1974.
  3. K. T. Healy. *The Effects of Scale in the Railroad Industry*. Yale Univ. Committee on Transportation, New Haven, CT, 1961.
  4. Z. Griliches. *Cost Allocation in Railroad Regulation*. *Bell Journal of Economics*, Vol. 3, Spring 1972, pp. 26-41.
  5. T. E. Keeler and K. A. Small. *Optimal Peakload Pricing, Investment, and Service Levels on Urban Expressways*. *Journal of Political Economy*, Vol. 85, Feb. 1977, pp. 1-25.
  6. J. Robinson. *The Economics of Imperfect Competition*. St. Martin's Press, London, 2nd Ed., 1969.
  7. A. F. Friedlaender. *The Dilemma of Freight Transport Regulation*. Brookings Institution, Washington, DC, 1969.
  8. K. Bhatt, M. Beesley, and K. Neels. *An Analysis of Road Expenditures and Payments by Vehicle Class (1956-1975)*. Urban Institute, Washington, DC, 1976.
  9. K. Bhatt, R. McGillivray, M. Beesley, and K. Neels. *Congressional Intent and Road User Payments*. Urban Institute, Washington, DC, 1976.
  10. B. J. Allen. *The Economic Effects of Rail Abandonment on Communities: A Case Study*. Univ. of Illinois, Urbana, PhD dissertation, 1974.
  11. C. P. Baumel, J. J. Miller, and T. P. Drinka. *A Summary of an Economic Analysis of Upgrading Branch Lines: A Study of 71 Lines in Iowa*. Iowa State Univ., Ames, 1976.

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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