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 ($i = 1, \ldots, m$), j be a commodity index ($j = 1, \ldots, n$), 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 $P_{ij} = P_{ij}(x_{1j}, x_{2j}, \ldots, x_{mj})$, $i = 1, \ldots, m$; $j = 1, \ldots, n$, 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

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

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.

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

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

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, . . . , 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.

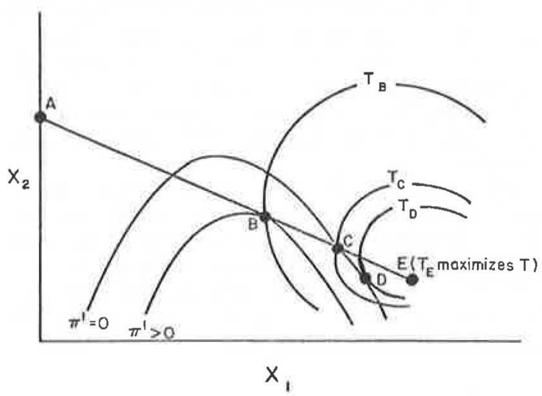


Figure 2. Mode 1 negative profitability when mode 2 clears.

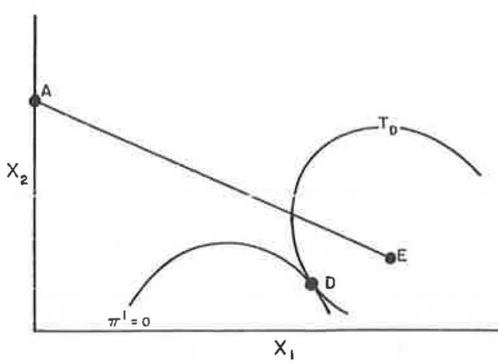
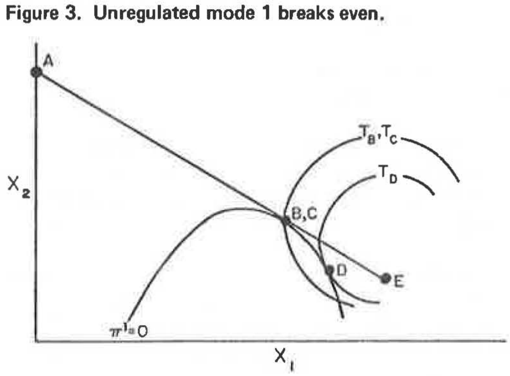


Figure 3. Unregulated mode 1 breaks even.



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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