STUDY OF COST STRUCTURES

AND

COST FINDING PROCEDURES

IN THE

REGULATED TRANSPORTATION INDUSTRIES

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Prepared For

United States Department of Commerce

November, 1959

R. L. Banks & Associates

National Transportation Library

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R. L. Banks & Associates

Transportation Consultants

November 18, 1959

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Mr. John J. Allen, Jr.
Under Secretary of Commerce for Transportation
United States Department of Commerce
Washington 25, D. C.

Dear Sir:

In accordance with our contract of June 24, 1959, we have conducted a study of cost structures and cost finding procedures in transportation. Our findings are described in the report submitted herewith.

Throughout this study we have received very helpful cooperation from many individuals, carriers and organizations. It is fair to state that only this cooperation made the necessary research possible.

We are particularly indebted to Professor Dwight R. Ladd, of the University of Western Ontario; Professor Frank M. Weida of George Washington University; and Dr. Myles E. Robinson of the National Coal Association for their incisive commentary; and to Mr. Lorimer Courtney of the Bessemer & Lake Erie Railroad and Mr. F. Wascoe of the Southern Pacific Company for time and assistance generously provided. None of these gentlemen of course, bear any responsibility for the conclusions drawn herein. Many other individuals connected with industrial firms, governmental agencies and carriers of all types also made substantial contributions to the study, and their help is much appreciated.

It has been a pleasure to serve you in this challenging assignment.

Yours very truly,

Robert L. Banks

Robert L. Banks

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Forward

The study of transportation costs is an extensive, relatively neglected, but dynamic subject. In view of its importance to the well-being of the national transportation network, it is a subject that bids fair to receive increasing attention, although many have found it difficult to comprehend, due both to the inherent conceptual obscurities which attach to its substance and because of the esoteric terminology used by those who work in the field. This report attempts, while reviewing the nature and status of cost-finding, to provide both an elementary understanding for those who seek to learn, and a stimulus towards greater achievement by those who already understand.

Precis

1. Cost knowledge has acquired increasing significance as a standard for testing the compensatory character of rates, a matter brought into focus by increasing intermodal competition.

2. The meaningful application of specific costs to particular situations has been impeded because

(a) many transport costs cannot be measured with absolute precision;

(b) there are many inherent difficulties in relating past cost experience to future operating results;

(c) too little is known about demand factors, which have a decided and important influence on costs;

(d) cost standards are themselves inadequately defined;

(e) value-of-service concepts continue to play an important role, and the desireable emphasis attaching to these is unclear to many; and

(f) clearly defined governmental objectives have been lacking.

3. Transportation costs can be separated into two categories, according to their behavior. First, fixed costs, which are a prerequisite for conducting a business, and are uninfluenced by traffic fluctuations. Second, variable costs, which fluctuate with traffic volume and are perhaps also responsive to other factors, such as the size of the firm and its plant.

4. Where separate products are produced by certain activities of the transport firm, such as railroad freight and passenger service, a further dichotomy is useful. Some costs may be incurred in the production of both services, and others are assignable to each service separately.

5. The costs of motor, water and air carriers are almost entirely variable; they are highly responsive to the volume of traffic. Pipeline costs are about half fixed and half variable, which means that the costs of these carriers will not rise or fall nearly as rapidly as business fluctuates. Railroad cost characteristics are not unanimously agreed to, but are thought to possess fixed costs of a magnitude between motor carriers and pipelines.

6. Railroads have a large element of common costs within the framework of carrier-borne expense. The common costs of other carriers are found to a significant extent in facilities provided at government expense.

7. Improved transport cost-measurement relates to more precision in

(a) separation of fixed from variable costs;
(b) separation of directly assignable from common costs; and
(c) association of specific costs with specific traffic.

8. Such improvement has been hindered by the fact that much cost data are now derived from a general financial accounting system designed to reflect net income, not for cost development.

9. Meaningful cost comparisons between the different forms of transportation are also difficult, since these depend on consistency, similarity and completeness of coverage, which are presently lacking.

10. A basic prerequisite for improved standards of cost ascertainment is the establishment of vigorously defined regulatory objectives related to a national transportation policy based upon rational use of our transportation resources.

11. The most appropriate cost standard for implementing such a policy is long-term marginal cost, which tests the compensatory character of rates by their impact on net income of the transport firm.

12. When related to such a criterion, transportation cost analysis can yield more precise answers through improvements in data collection, processing and analysis.

13. An ad hoc body composed of representatives from each Federal agency regulating transportation should be constituted for the purpose of bringing about a greater degree of comparability in the Uniform Systems of Accounts prescribed for regulated carriers, so as to facilitate valid intermodal comparisons.

14. The reporting requirements imposed on various carriers should be revised and re-oriented towards cost ascertainment needs to a greater extent than at present; unneeded reports should be eliminated.

15. Reporting burdens on various types of carriers should be equalized; more factual information from motor and especially water carriers is desireable.

16. The prospective Census of Transportation should be undertaken as soon as possible, to provide an improved basis for forecasting probable traffic volumes.

17. All regulatory agencies, and the Interstate Commerce Commission in particular, should make much more extensive use of electronic data processing in their cost analysis programs.

18. The carriers themselves, assisted as appropriate by the Federal government, should begin to develop computer cost analysis programs which will produce data adequate for regulatory purposes, for use in common by principal sizes and types of carriers.

19. The application of advanced statistical methods to transportation cost analysis holds the greatest promise of improved precision in this area; these methods have not yet been sufficiently tested to enable their adoption as the standard for regulatory cost presentations.

20. Consideration should be given to superseding "Rail Form A" by a procedure modeled after the "Direct and Unit Cost Method" used by the Southern Pacific Co. This is free of several defects in "Rail Form A", employs certain advanced mathematical methods, and represents a desireable compromise between traditional methods and those which are theoretically ideal.

21. Pending replacement of "Rail Form A" consideration should be given to adjustments involving (a) the possible deletion of Fully Distributed Costs from the formula; (b) the use of "percent variable" in a manner more directly related than at present to anticipated traffic volumes and carriers being analyzed; and (c) the substitution of engineering for accounting standards in determination of maintenance costs, so as to eliminate the maintenance deferrals which distort unit railroad costs as presently computed.

22. Present methods of motor and water carrier cost ascertainment seem adequate; improvement here depends largely upon the availability of better information.

23. The "ATA Formula" method should be modified to enable adjustment of computed values to accord with specific route conditions, where these are known or can be estimated.

24. A continuing effort should be made, under Federal sponsorship and with state cooperation, to measure long-term marginal costs as they pertain to the use by regulated carriers of facilities provided at government expense.

PART ONE

THE PLACE OF COSTS IN TRANSPORT POLICY

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This is an economic assessment of transportation costs. It examines why such costs are important, what their characteristics are, and how these are analyzed at present. It also suggests what appear to be desirable objectives in the use of costs, and indicates where efforts should be focused to reach these.

The principal emphasis is on the role of costs and "costing" in the formation of public policy. The use by and meaning of costs to individual transport enterprises is also frequently mentioned, since in a regulated environment this is pertinent to the use of costs by public bodies.

Section 1.
Some Basic Concepts

By the term "cost"is meant the total expense, both cash and non-cash, incurred to sustain the operation of a transportation enterprise. This includes both replenishment of operating expenditure and return upon capital in amounts sufficient to attract investment as the need arises.

A knowledge of costs and their relationship to traffic and rates is basic to effective public policy and intelligent business behavior. But the cost knowledge essential to carrier management relates primarily to expenditures of the transportation firm itself, whereas the proper concern of regulatory bodies comprehends cost incurred both within and outside the individual firm.

For meaningful administration of their public duties, regulatory bodies must concern themselves not merely with carrier cost, but also with intercarrier and intermodal cost comparisons. Likewise they are required to weigh the cost elements of time, risk and obsolescence embodied in consumer evaluation of service. Finally, they need to consider these transportation costs not charged directly through carrier books of account, but assumed instead by government.

The differences between carrier and regulatory concern with costs serve to emphasize a point essential to fuller understanding: costs are highly complicated phenomena which vary widely under differing circumstances, and are frequently difficult if not impossible to measure with precision. Accordingly, the cost which is significant varies from one situation to another. Therefore, meaningful cost analysis always starts with the question: What purpose are these costs to serve?

The point is perhaps best illustrated by a brief examination of the differences between corporate and public cost useage. Corporate cost knowledge is required by the profit incentive which underlies the existence of the firm. In this framework cost analysis is essential, since it provides the only effective means for control of expense, and for its measurement against revenue in profit determination.

Thus corporate cost analysis is primarily concerned with the measurement of net income for the firm. To this end costs are developed to:

(a) control expenditure
(b) evaluate performance
(c) aid in budgeting
(d) stimulate incentive programs and evaluate supervision
(e) assess changes in the scope and nature of services provided
(f) analyze trends and forecast future capital needs
(g) improve scheduling
(h) guide sales programs
(i) determine rate and fare selection.

Regulatory bodies, by contrast, use cost knowledge to fulfill their obligation to ensure that the public is provided with safe, adequate, economical and non-discriminatory service. Since competition is, in theory, the device employed to attain these objectives, and since costs and rates would be equal under conditions of perfect competition, cost analysis provides regulatory agencies with a means to assess the competitive imperfections indicated by undue margins between costs and rates. Thus cost knowledge is an essential tool in:

(1) preventing the imposition of "unreasonable" rates under conditions of monopoly or monopolistic competition

(2) pinpointing discriminatory practices

(3) ensuring a proper level of return to investors in transportation enterprises

(4) evaluating acquisitions and mergers and

(5) balancing the expense to be incurred or avoided by additional or diminished service against probable public demand at various rate levels.

Despite the implications of cost for both corporate and public policy in transportation, an awareness of its central significance has been a relatively recent development. This has been a result of displacement of the railroads from their former predominance of inland transportation. Prior to the development of motor carriers, pipelines, and airlines, the railroads had only water competition, and that embraced but a minor fraction of their operations. As a practical matter rail transportation operated under conditions of monopolistic competition (i.e., few sellers and many buyers) at many traffic points.

It has been held that the rate wars so frequently emphasized in historical writings on rail transportation have commanded an emphasis far out of proportion to their importance, and that the rate pattern of the period was predominantly stabilized at levels profitable to the railroad.[1/] This would go far to explain an absence of management concern with costs, for "a lack of adequate cost data may not seem important to management where there is an absence of competition, profit margins are substantial and costs are not an essential factor in determining selling prices."[2/] Under the circumstances it is not surprising that the Interstate Commerce Commission in its early days intended to underestimate the significance of cost data. In a typical case it found:

> The cost of transportation if any one article of commerce can never be disposed of with accuracy... If the carrier desired to make the cost of any particular traffic appear large or small, it would not be difficult to swell or lessen it by such figures as would appear plausible in each case.[3/]

Such an observation flowed naturally from the original regulatory preoccupation with monopolistic pricing and its concommitant phenomena of market restraints and discriminatory rate-cutting. In this environment the meaningful measure of reasonableness was embodied in the concept of fair return on fair value, prescribed by the Supreme Court in 1898.[4/]

Section 2. Current Central Role of Costs

The passage of time has brought fundamental changes in the character of the nation's transport system, and it is these which have attached a greater significance to cost knowledge. The advent of newer kinds of carriers, a vast increase in public aids to transportation, a revitalization of water transport, and a newly acquired shipper freedom to use private transportation have displaced the rail monopoly. The user of transportation no longer compares Railroad A with Railroad B. His alternatives are now much greater. He finds, in some cases, as many as three or four kinds of carriers offering to serve him. An intense competition for traffic, both among the various types of regulated carriers, and between them and private carriage has created a new transportation environment. In lieu of the "seller's market" of the railroad era, when shipper-carrier litigation about maximum rate levels dominated the administration of public policy, the user of transportation service now occupies the role of beneficiary-observer as the regulated carriers engage in price and service competition for his traffic.

In these circumstances, cost data take on a new importance. In rate-making, for example, the ICC found:

While cost is not the only factor to be considered in determining a reasonable rate, it may become the dominant factor where two different modes of transport are competing for the same traffic. [5/]

Under such conditions, typical of those which now command attention, the regulatory responsibility in determination of just, reasonable and fair rates has shifted from protection of the public, or users of transportation, to the guardianship of carrier needs for revenue adequate to provide service. In the present transportation posture, the custodians of the public interest in transportation are no longer greatly concerned with monopolistic attempts to maximize rates. Their attention is now devoted to proposed rate reductions reflecting attempts to meet the rates of regulated competition, or to anticipate the costs of self-performed service by shippers.[6/] To deal with this changed direction, the ICC has applied the "reasonably compensatory" test, originally interpreted as requiring a rate which must:

(1) Cover, and more than cover, the extra or additional expense in handling the traffic to which it applies

(2) Be no lower than necessary to meet existing competition

(3) Be not so low as to threaten extinction of legitimate competition, and

(4) Impose no undue burden upon other traffic, nor jeopardize an appropriate rate of return.[7/]

If rates are tested on the grounds that they cover the expense of handling the traffic to which they pertain, then the determination of such expense becomes a critical element in the rate-making process. In the absence of any economic mandate for administration of the test, however, the ICC has found no single standard for adjudicating rate adjustments between competing modes of transportation. In various cases it has seemed to adopt conflicting bases for judging compensativeness.

Although the Rule of Rate-Making embodied in Section 15(a) of the Interstate Commerce Act was amended by the Transportation Act of 1958 to provide that "the rates of a carrier shall not be held up to a particular level to protect the traffic of any other mode of transportation," it remains to be seen whether recent application of the out-of-pocket cost standard in two important cases[8/] can be construed as the permanent adoption of a single cost-finding basis in competitive situations.

Although primary attention has centered on competition between established modes, the increased service offerings of new forms, such as piggyback and containerized services, which have different cost characteristics, also serve to highlight the important relationship between Costs and competition.[9]

The new significance of cost knowledge is by no means confined to the rate-making process, however. It also has a very definite bearing on the changing extent and nature of the routes served by common carriers, especially in passenger service. The building of a great national highway network has accelerated pressures for withdrawal of rail passenger service, and oftentimes its replacement by common carrier air transportation. Cost data are essential to consideration of such proposals, and their relationship to each other, since a major element in assessing proposed service adjustments is to compare present revenues and costs with those likely to be avoided should railway service be abandoned, or which would be experienced through the inauguration of air service.

It seems beyond question that safeguarding the public convenience and necessity is a valid regulatory function. There may be some question, however, as to whether the "public" has been very carefully defined. The "public" in such cases has always been taken to be the shippers and receivers on a branch rail line or the passengers regularly using or expected to use the passenger service in question. In a case of undisputed excess of costs over revenue, the financial loss becomes a part, in effect, of the carrier overhead. Thus it involves a loss which must be recovered either out of higher charges for other services, or by subsidy from government. In this way a much greater "public" may be subjected to the hardship of higher rates, fares or taxes as a result of retention of unprofitable rail or institution of replacement air service.

The implications for public policy of the cost of regulated passenger service have been illuminated by Louis J. Hector in a forceful critique of the regulatory apparatus:

> The CAB in recent years, for instance, has been busily engaged in certificating subsidized local air service into the smaller cities of the country as the railroads reduce or terminate passenger service to those towns. The Board has done this on the general theory that the Board's job is to promote air travel, and that as the railroads pull out the airlines should move in and take up the slack. The ICC has permitted the railroads to reduce or eliminate passenger service because they have been losing so much money on it. But the airlines lose money too when they take over local passenger service in small towns. The only difference is that the U.S. government makes up the loss to the airlines in the form of subsidy.[10]

Thus intermodal competition, the advent of new forms of transportation, the expenditure of public funds for both transportation facilities and transportation service; each relates to and affects the objectives and use of cost analysis in this essential sector of the economy.

Section 3. Cost Limitations

The meaningful application of specific costs to particular situations in transport regulation has lagged substantially behind the growing awareness of the implications of "cost" for rate levels traffic volumes, and service standards. There are four basic reasons for this.

Absolute Precision Unattainable. First, many transportation costs, even those which have already been incurred, cannot be measured with complete precision and related to components of traffic. The classic example of this is maintenance expense attaching to intercity traffic ways, which for railroads, highways and waterways is a function of both the passage of time and traffic volume. The physical plant of these traffic channels is exposed to action of the elements and to the passage of traffic. Drainage systems become clogged, embankments erode, the impact of rain, snow and frost necessitates offsetting expenditure to keep channels open, highways smooth and tracks aligned in a manner suitable for passage of traffic. But passage of traffic itself contributes to erosion, through impact on road surfaces, wear on rails and wash against channel embankments. A continuing and largely unresolved issue has centered about attempts to define the proportion of way maintenance cost properly chargeable to traffic and time, respectively, and once the latter is isolated, its appropriate attachment to traffic components.

By contrast, other transportation costs can be traced directly to their source. Most costs of vehicular movement, such as fuel and wages of operating personnel, can be determined with adequate accuracy and related to the traffic to which they pertain.

Thus some transportation costs can be assigned directly to traffic and others cannot, although they are apportioned or distributed amongst traffic or user groups by more or less arbitrary methods, which attempt compromise between theory and experience, between mathematics and empirical observation. The objective of cost analysis is to isolate cause and effect relationships; that is, to find out what costs are incurred by doing a specific thing. Some costs are simply not caused by doing a specific thing, but are caused by doing many things. The question of how these latter "must" be apportioned or distributed amongst traffic or user groups is not a question of cost analysis, but rather a policy question of how much overhead can or should be collected from particular users. This is pricing, not costing. Where costs of both types, assigned and apportioned, are inseparably mixed, and together relate to the production of multiple services, as in railroad transportation, for example,[11] meaningful cost derivation becomes somewhat obscured in a mass of involved computations and complex numbers which lend a not altogether justified air of precision to the computed results.

Difficulty in Relating Past to Future. Second, meaningful cost development has also been hindered by the difficulties inherent in relating past cost experience to future operating results. Excepting only past period subsidy ascertainment in air transport, the appropriate costs for consideration in either rate or service(i.e., public convenience and necessity) cases, are future costs. In either situation the relevant question always is: "What will be the change in future total profit (future total revenue minus future total cost) as a result of the proposed change in price or service?" Very obviously, the starting point for determining future costs is past cost. These past costs must be adjusted for known or anticipated changes in price-levels, operating conditions, technology, and the general economic situation. It is often stated that these adjustments are just guesses, and so they are. It is well to remember, however, that the simple extrapolation of past data, despite all of the seeming arithmetic precision which surrounds it - may be of limited pertinence to the future.

Past data, then, are only the starting point in estimating future costs. In order for these to be a useful starting place, it must be decided whether the most recent period of time or a longer period will provide the most useful basis for projections. In any cost estimate this will clearly depend on the relevant length of the projection. This is, to project one month ahead, data for the most recent month will most likely be more relevant than those relating to any other previous month (except, perhaps, in cases of pronounced seasonality). By the same token, data for the most recent month will hardly be relevant to a projection into the indefinite future.

It seems apparent that most regulatory proceedings, whether they concern price chances or service adjustments, relate to an indefinitely long future. An abandonment is clearly a rather permanent and long-run act, as is the institution of service to a previously unserved route or point. A price change is not permanent, but a new freight rate is usually expected to govern for a fairly long period. The future costs and revenues relevant to a regulatory appraisal of these decisions must be long-run, and consequently, the past costs used as a basis for these predictions should be long-run. To the extent that the past is relevant to the future, it is clearly the typical past that is relevant for whatever period of time is involved. For a long-run future, the past month or six months or year is unlikely to be typical.

Thus meaningful cost development for most regulatory purposes relates to the future primarily. Where inadequate selection of the typical past is compounded by inadequate adjustment to reflect future operating conditions, and to this is added the ingredient of insufficient market information, computed results must necessarily diverge from actual cost.

Absence of Defined Cost Standards. Third, ignoring for the moment the technical difficulties described above, it can be observed that the development of meaningful cost data has been hindered in perhaps a more significant sense by conceptual uncertainties regarding not merely the costs themselves, but also the situations in which they may be appropriately applied. An illustrative example is the variety of bases relied upon in ICC rate proceedings to measure "out-of-pocket" (variable) railroad costs. The range of permitted and presumably relevant data relied upon to establish this single significant cost level has included, among others:

(1) Directly assignable cost only

(2) Directly assignable cost plus apportionments of indirect railway operating expenses

(3) Directly assignable cost plus apportionments of indirect railway operating expenses, rents and taxes

(4) Directly assignable cost, plus apportionments of (a) indirect railway operating expenses, rents and taxes, and (b) return on equipment

(5) Directly assignable cost, plus apportionments of (a) indirect railway operating expenses, rents and taxes and (b) return on road and equipment.[12/]

The proportion of out-of-pocket to total cost has of course varied with the method employed, with corresponding confusion in establishment of their pertinence to the situation assessed.

No single cost standard is suitable for the variety of rate cases which the Commission must adjudicate, but the absence of a policy pronouncement clearly definitive of those costs construed as relevant to various kinds of cases has very likely hindered meaningful cost ascertainment in this area.

In evaluating service adjustments, a similar obscurity has perplexed the participants. Various concepts such as "above the rail," "direct," "avoidable" and "fully apportioned" costs have been introduced and relied upon in rail service reduction or abandonment proceedings,[13/] and a like uncertainty as to costs properly attaching to the inauguration of new, or the suspension of existing service, beclouds the decisions of the Civil Aeronautics Board.[14/]

<u>Value-of-Service</u>. Fourth, in the quasi-judicial regulatory environment, cost becomes the one element of "fact" which can be challenged, analyzed and argued over. Cost calculations, because they involve mathematical processes, unfortunately create an illusion of precision, and the assumption is frequently made that costs can be measured with the same precision that one can measure a person's height and weight. "Either it takes 50 gallons of fuel to move a rig from here to there or it doesn't." Such treatment ignores the fact that on a large carrier there may, at any one point in time, be literally thousands of different things being done, and to sort out precisely the ultimate effect upon cost of any one of these things is virtually impossible. Such treatment, also indicates an ignorance of the fact that the measuring tools of the accountant, statistician and economist are far removed from the precise measuring tools of the physicist or engineer.

The price-maker knows that precise measurement is illusory, especially in terms of final future financial impact. The regulator may know this too, but because he is cast in the role of impartial finder and arbiter of facts, he must discharge his responsibility to judge the "facts" of record. Therefore, a primary objective of future price regulation should be to attain a perspective on the place of costs in price-making and consequently in rate hearings.

Casting aside the imperfections in current cost ascertainment and presentations, the fact remains that were it possible in rate-making to ascertain with complete precision either the out-of-pocket (marginal) cost or the full (average total) cost of the service to be measured, neither would fully serve the regulatory purpose. As will later be shown, reliance solely upon average total cost pricing would hinder optimum utilization of the transport plant, whereas complete resort to marginal rates would produce revenues insufficient to cover total costs of the transport service. Another element therefore also enters into the development and execution of a socially desirable policy, namely, demand. As a reflection of market conditions and user judgments, demand factors, embodied in the so-called value of service concepts, must continue to supplement cost ascertainment for regulatory purposes. At the present time, however, there cannot be very much argument over price/volume estimates, because it soon becomes apparent that with the current state of knowledge about transport market forecasts, such argument centers more directly on guesswork. This points up the absence of adequate data for demand measurement; without it many cost computations must necessarily be of limited value to the regulatory agencies. In short, more balance is needed between cost and demand data development.

The service adjustments (i.e., abandonments or route extensions) considered in public convenience cases must also take appropriate account of costs, but judgments must be similarly shaped by tempered consideration of true public needs and ability to pay.

The limitations of cost in the regulatory process are well illustrated by Commissioner Murphy's recent listing of eleven considerations which govern the ICC in its rate determination. 17/ Only two of these relate directly to cost, and but four others have cost implications. Cost knowledge, in short, is essential to the regulatory process, but it is not the final, nor the complete yardstick for regulatory guidance.

PART TWO

TRANSPORTATION COST CHARACTERISTICS

PART TWO. TRANSPORTATION COST CHARACTERISTICS

Section 4. Costs in Perspective

The transportation industry is first of all immense, in terms of revenues and in terms of the vast quantity of resources devoted to its operation. Transportation is in fact not one, but a complex of industries all devoted to the common purpose of providing place utility for the goods and people in our economy. Twenty percent of our gross national product and 12% of net civilian investment is accounted for by transportation.[1/] These figures illustrate the central position that transportation occupies in the economy, and the necessity of regulating it wisely.

The product which the transportation industry sells is the ton-mile in freight service and the passenger-mile (or passenger journey) in passenger service. This is, of course, an oversimplification, since the "product" is actually an aggregate of infinite combinations of markets, routes, commodities and types of ton-mile or passenger-mile services. Thus transportation is essentially a multiproduct industry, in which a single strip of space devoted to intercity movement carries local and through passengers, coach and first class passengers, the personal belongings and baggage of these travelers, the U. S. mail, small packages being "expressed," manufactured goods, animals to market, and bulk commodities of the extractive industries. To provide the service required by each involves, in the typical situation, the concurrent output of many products. This output is made possible by facilities which, in many respects, differ from those used in the manufacturing industries. But they involve the same input factors: men, money, materials and space. In transportation these are merely combined differently, to meet the nature of the output.

Cost, in transportation as elsewhere, is a measure of the use of these factors of production. As in other economic activities, transportation incurs cost in two basic ways: (a) for use of the capital it requires, and (b) for the labor and materials it consumes in its current operations. These fundamental cost categories, capital on the one hand, and operating expense on the other, are of primary significance in assessing transport costs. This is due to the fact that their relation to total corporate cost differs among the different modes of transportation. This fact is basic to understanding of all that follows.

In many respects, valid analogies can be drawn between transportation and the electric power industry. For example, production and consumption occur simultaneously in both. No storage or inventory is possible in either. Therefore sufficient capacity must be maintained to meet peak demands, or else part of the demand will not be satisfied. This extra capacity is both in the form of geographical coverage by the transportation network and in standby capacity.

On the other hand, transportation is unlike the utility sector in that with the former production must occur at the point of consumption. This precludes facility location on economic grounds alone.

There are about 3,000 motor, 100 rail, 80 pipeline, 30 air and 120 water carriers of various types which play an important role in interstate commerce and are subject to regulation at the Federal level. Countless others are regulated at state, and occasionally, county or local levels. This large number of firms of each type plus the notable trend towards intermodal shipments means that any given shipment or trip is likely to use the facilities of more than one carrier. Thus cost characteristics of a particular product (or service) are frequently shaped by the joint endeavor of several firms. In most industries shortcomings on the part of a particular firm merely enhance the competitive position of other firms in the industry; but in transportation, inadequacies by one firm may adversely affect the costs experienced by several (or all) firms in the same mode.

Government plays a larger role in transportation than in most other industries. For motor, air and water carriers it furnishes numerous facilities, as it did for many rail carriers in their development period. For all modes it controls entry and departure from the field. These activities, plus governments' interest in service and labor standards, day to day operating practices, and price regulation, also have a direct and substantial bearing on the cost experience of the carriers.

Cost Classification

Costs can be classified in several different ways. To assess their relationship to both economic objectives and to profit contribution, costs can usefully be compared in three different frameworks:

(a) Fixed costs versus variable costs. Fixed costs remain constant at virtually any traffic volume and over relatively long periods of time. Variable costs (all other costs) usually vary more or less in proportion to the volume of traffic.

(b) Common costs versus directly assignable. Common costs are incurred in the production of more than one type of service, thus can not be allocated*to any particular service. Directly assignable costs on the other hand are incurred in the production of only one type of service.

(c) Total costs versus costs per unit. Total costs are all the costs incurred by the firm, and may be segregated in the manner of (a) or (b) above. Cost per unit represents the association of specific costs with specific quantities of output (traffic).

*directly

It is important to remember that considerations (a) and (b) above involve no more than a different segregation of the same total cost. It is analogous to cutting the same pie in two different ways, as Figure 1 shows. Using railroad costs for illustration, total cost "A" is divided into its fixed and variable components. By contrast, "B" shows total cost divided between directly assignable costs and those incurred in common by more than one type of service. Directly assignable cost in "B" is further fragmented into components associated with freight and passenger service: these are designated as "solely related" costs. The two distinct separations of total cost shown in "A" and "B" are not mutually exclusive, and do not lose their particular characteristics when superimposed, as in "C."

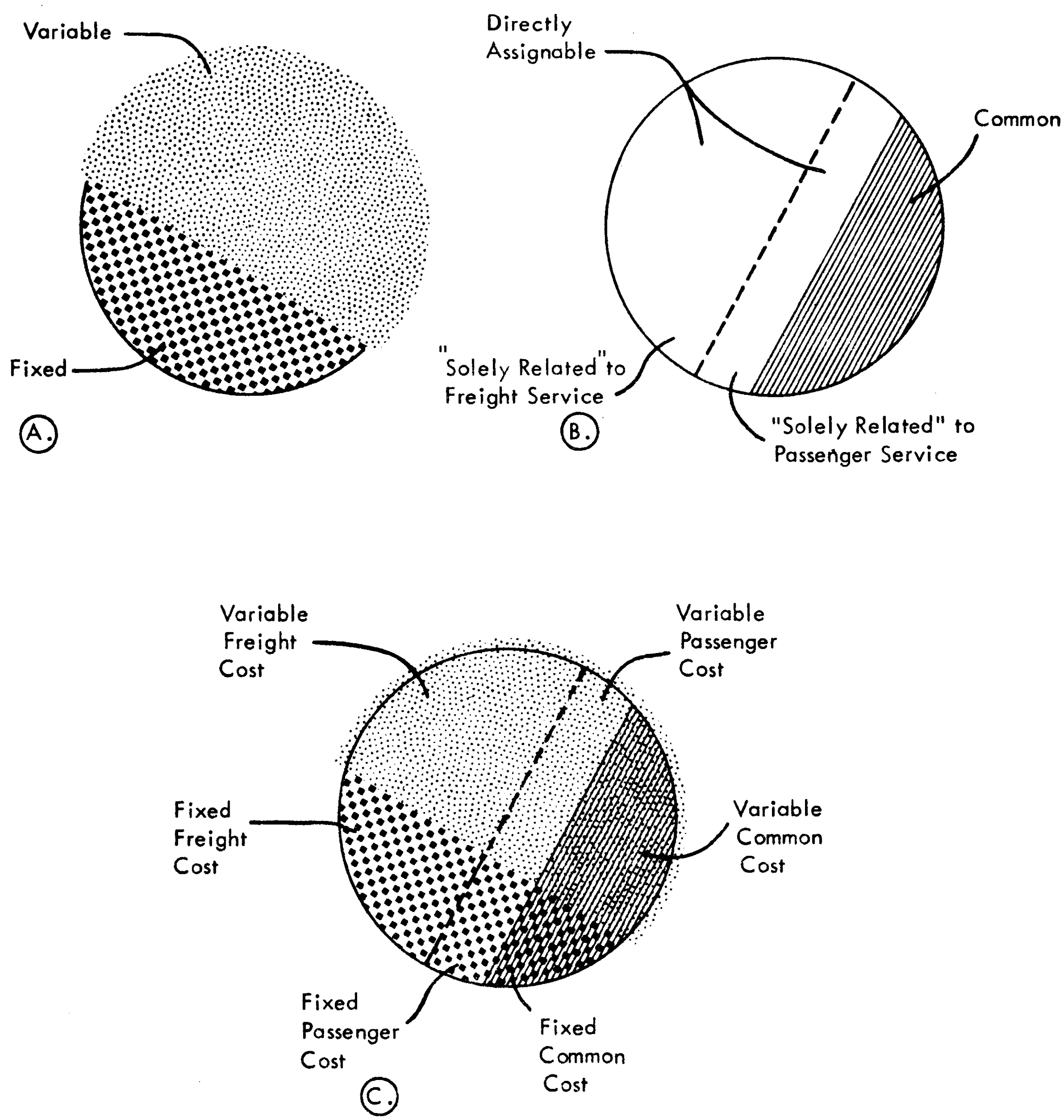
In its exploration of cost characteristics and ascertainment, this report devotes relatively more attention to railroads than to other types of transportation. This emphasis is unrelated to the predominant historical position of the rail carriers, it originates rather in the basic and only useful purpose of transport cost analysis: to determine, in terms of cost, what occurs when a carrier handles, or ceases to handle, specific traffic. It happens that fulfillment of this basic purpose is more difficult for rail than other carriers due to (a) the large proportion of fixed and common costs inherent in the physical characteristics of the railroad plant, and (b) the resultant higher degree of complexity in associating rail costs with rail traffic.

To a markedly lesser extent fixed costs are also present in the air and water carrier industries. These likewise have a substantial element of common costs, but much of this is related to the government-built facilities which they use. Furthermore, the common costs of these carriers reflected in their current operating expense are predominantly associated with one major category of service or product, and not, as with the railroads, fragmented more equally between them.

With absence of ownership in their roadbed, and relatively small equipment units and capital requirements, motor carrier costing presents fewer technical handicaps to adequate cost-finding. The adjustment of capacity through addition or elimination of vehicle units facilitates identification of expenses with traffic, and limits the potential long-run economies of scale. Common costs are present, but occupy a much less prominent role.

These intermodal differences are fairly obvious, and have often been considered. By contrast, similarities which may be of equal or greater importance in their public policy consequences have received relatively less attention. These involve, first, potential discrepancies between user costs and user taxes relating to government provided facilities. This is an area much discussed about which relatively little is known, despite some strenuous but spotty efforts at measurement.

TOTAL COST COMPONENTS



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Second, they include distribution costs which are a function of transportation use: inventory, packaging, warehousing, purchasing, risk, interest, obsolescence, and so forth. Here too, relatively little is known, but there have been incipient attempts at measurement which indicate the costing problem is not insuperable.[2/] Third, a consideration also of consequence is the impact of transportation upon land use, land values, urban congestion and the alternative uses of scarce human and material resources. Practically nothing has been done to measure costs attaching to these interactions. The combined weight of these factors indicates that there is a substantial gap between the corporate and total economic cost of all types of transportation.

In a very real sense, therefore, the conventional scope of transportation costing deals with dimensions somewhat less than the all-inclusive economic cost of transportation. By the same token, therefore, intermodal cost comparisons based on available data are, and will continue to be, imprecise, pending the development of more sophisticated techniques for assessing costs not reflected on carrier books. However, since corporate costs provide the only readily available data, and probably constitute the largest fraction of total transportation costs, comparisons must necessarily be principally on this basis, despite the possible consequence that the results may be somewhat misleading.

Due to this limitation in available data, the term "total cost" is limited in this report to total corporate cost, as distinct from total economic cost.

Section 5. Fixed and Variable Costs

One of the most elusive problems in transportation cost finding is the separation of fixed from variable costs. As to both business in general and transportation in particular, the quantitative segregation into these two categories is of controlling significance in cost appraisal.

The General Case

Any business commits itself, for a period of time, to establishment. The costs of having this establishment (physical plant, ad valorem taxes, property protection, minimum supervisory staff, etc.) will be incurred during the lifetime of the establishment more or less independently of the extent of the activities which it carries on. This group of costs is called fixed costs.

During the life of the establishment, the business will engage in producing and selling its products or services. It will earn revenue from its sales and it will incur costs for producing and selling, which are in addition to the basic costs of the establishment. These costs are designated as variable costs.

If a company sells its products or services at a price which is greater than the variable costs incurred in producing and selling, it will have dollars left over to meet the costs of its establishment, i.e., fixed costs. If the process of production and sale with dollars left over is repeated sufficient times, the company will have enough dollars to meet the fixed costs, and dollars received in excess of both variable and fixed costs are profit.

Whether or not each turn of the production and sale cycle yields the same amount or proportion of dollars is irrelevant. Profitable operation depends on receiving more than enough of these marginal dollars, from whatever source, to meet the fixed establishment costs. It makes no difference that one particular product or service brings in half the marginal dollars required and the other half comes in varying amounts from a large number of products or services. Indeed, an attempt to collect a stated proportion of the fixed costs, i.e. to "fully distribute" costs may inadvertly lead to smaller profits. (See Appendix A for illustration.) "Distribution" of a portion of fixed cost to variable product costs has nothing to do with the process of judging whether a price is compensatory; it is in itself a process of price making.

The only test of compensativeness (looking not at the business as a whole, but rather at each specific kind of output or traffic) is to compare revenues (price times volume) with variable cost. To be sure, a company will lose money in the long run if it fails to cover its fixed costs out of the difference between revenue and variable cost.

It avoids this, however, not by "distributing" these fixed costs but by maximizing the spread between the revenue from selling the service and the variable cost of producing the service.

"Distribution" of fixed cost to individual services is a method of price fixing, and does not result in a relevant measure of cost. The only sound point of departure for the pricing process is a measure of variable cost.

<u>The Transportation Case</u>

The significance of fixed and variable costs and of their relationship to each other can best be stated in terms of a cost function. This describes, graphically or by formula, the relationship between cost expressed in dollars, and various levels of traffic expressed in physical output units (such as available ton-miles or gross ton-miles). Figure 2 illustrates such a cost function.

For a carrier of any given size, total cost (C_1 or C_2) is comprised of both fixed and variable elements, as can be seen by examining the costs at both T_1 and T_2 volumes of business. The"True Cost Function" shown in Figure 2 is a graphic statement of the total costs of the firm at various levels of business. At the present level of traffic (T_1) total costs are C_1; if the proposed traffic (T_2) were acquired, total cost would become C_2.

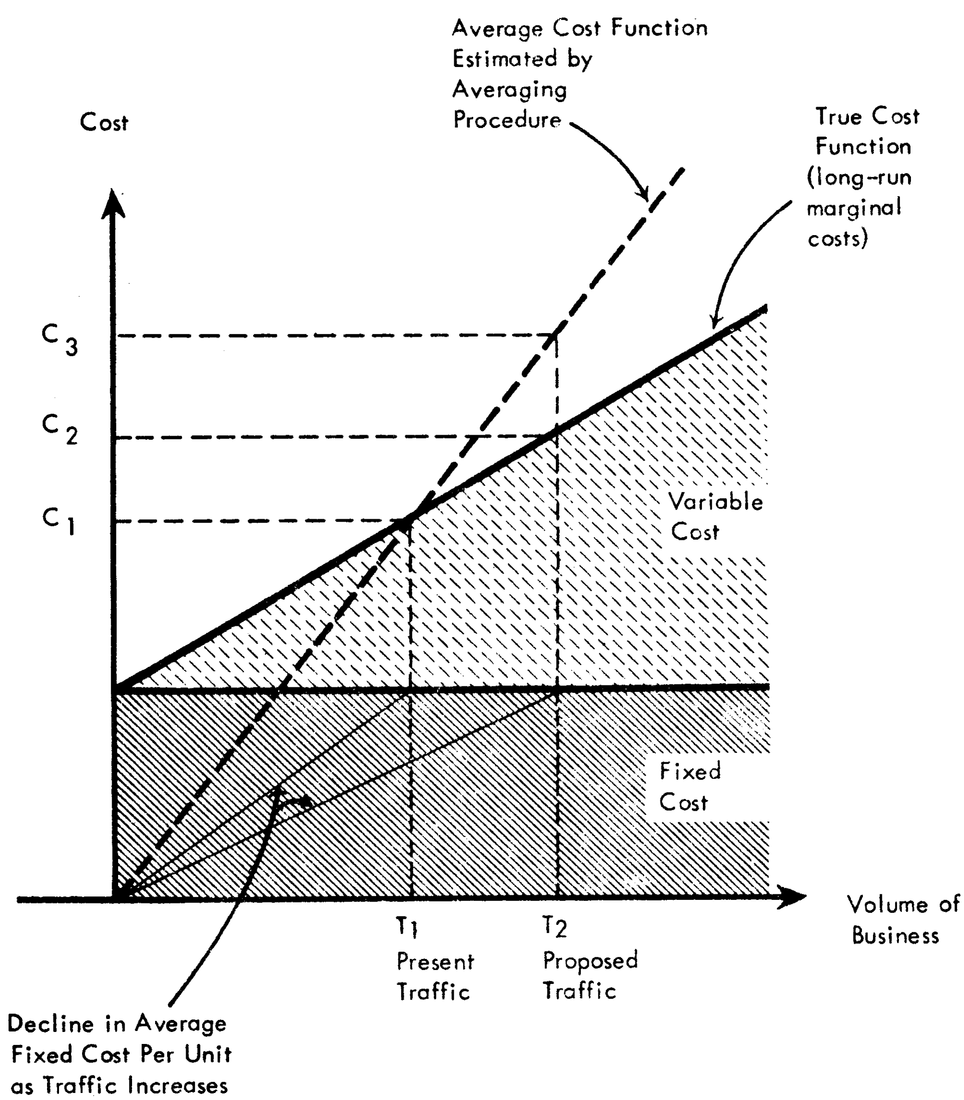
Fixed costs are so designated because they do not fluctuate in relation to the level of business. Whether at volume T_1 or T_2 or any other, fixed costs hold constant. Consider the significance of this characteristic as business increases from T_1 to T_2: fixed costs at T are no larger than at T , but there are more units of output (or traffic) over which to spread them. The average fixed cost per unit has gone <u>down</u> at T_2.

Total variable cost, on the other hand, increases directly with increases in volume. For example, if the variable (or product) cost is $ 200 to carry 100 passengers, then it will cost $ 400 to carry 200 passengers. The variable cost here is $ 2.00 per passenger; the <u>total</u> variable cost is $ 2.00 times the number of passengers carried. Since variable costs vary directly*with volume (as we have assumed in our elementary model) the cost per unit remains constant, as illustrated by our $ 2.00 product cost per passenger. The rate of change ($2 per unit) is customarily called marginal cost.

These distinctions are of lesser consequence where technology permits the facile adaptation of cost to traffic, as with corporate expense incurred by air, motor and water carriers. They are of importance however, where inherent physical characteristics preclude short term adjustment of many cost components to traffic fluctuations, as in the rail and pipeline industries. Even with these however, there are indications that the plant size of a going concern can in the very <u>long run</u>, be adjusted to traffic volume.

*and more or less proportionately

SIMPLE COST FUNCTION



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What is the significance of fixed and variable costs? A separation into the two elements is essential for the determination of the True Cost Function, hence for the determination of the cost of additional or subtracted business. The significance of sizeable fixed costs is that after the variable costs have been met, there is a large residual which must also be covered if the firm is to have any net income. This residual can be covered in any way possible; no mathematical formula can determine how. In fact, the application of mathematical formulasto this particular problem can be a detriment to increasing net income, as is illustrated in Appendix A.

The transport industries differ from each other in the composition of their fixed and variable costs, as Figure 3 illustrates. Industry A is typified by very low fixed costs at the typical volume of operation, whereas Industry B has high fixed costs. For Industry A the average cost function (total volume divided by total cost) is a fairly close approximation of the true cost function. But in Industry B the average cost function is a poor measure of true costs: for levels of business <u>below</u> the typical level it drastically understates costs, for additional business it drastically <u>overstates</u> the increased costs.

In the transportation industries the corporate cost behavior of airlines, most inland water carriers, and motor truckers resembles Industry A. This is so because their operations are conducted in small units, (trucks, vessels, planes), which are cost entities in themselves. As business increases, these firms purchase additional equipment. Most of the fixed costs in these technologies exist <u>outside</u> the firm; "conventional accounting" provides a satisfactory measure of their costs,since most costs can be meaningfully associated with a single production unit.

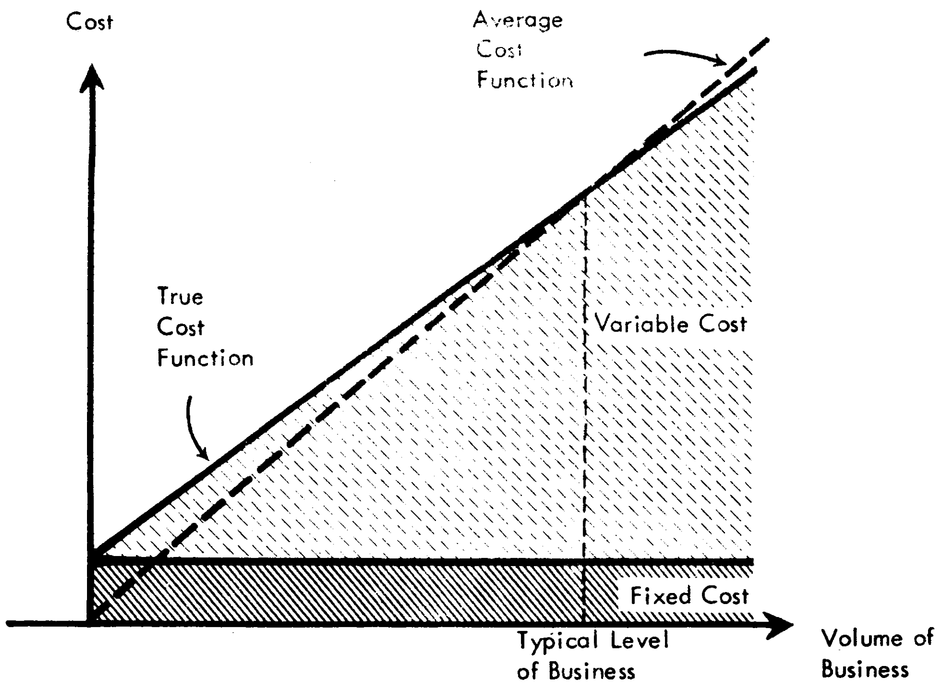
On the other hand, railroads and pipelines resemble Industry B. Large fixed costs are a prerequisite to operations: land for right-of-way, tracks, yards, pipelines, pumping stations, signal systems. Heavy volume is the only way to lessen the impact of these fixed costs. As a consequence of these characteristics, railroads pose by far the most complex cost analysis problem; until now pipelines have carried a limited number of commodities in which their cost advantage has been so markedly superior that little or no cost precision has seemed necessary.

<u>Fixed Costs</u>

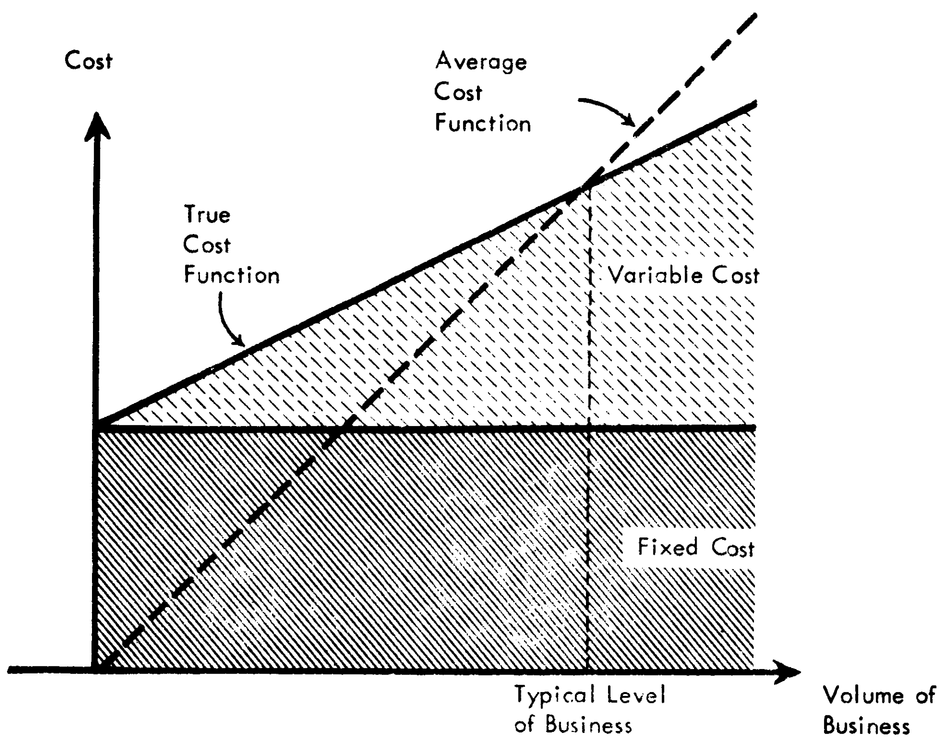
Railroads have large fixed costs for a considerable period of years. Roadbeds, rights of way, bridges last for half a century or more. In recent years technological developments have hastened the economic obsolencence of line-haul equipment and terminal facilities. Thus, the modernization drive manifested by dieselization, centralized traffic control, and electronically controlled yards has resulted in the write-off of old and the introduction of new

Figure 3

VARYING INDUSTRY COST STRUCTURES



INDUSTRY A



INDUSTRY B

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fixed costs; new depreciation bases and new fixed charges on indebtedness. Indeed, there is some evidence, treated later in this report, that technological progress may be in the process of altering conventional concepts of rail cost "fixity," and in its place substituting a type of inverse variability, inasmuch as by contrast with pre-World War II days the rail carriers today handle more traffic with a smaller fixed physical plant.

Investment affords a reasonable measure of the significance of fixed costs, especially in the railroad industry where two-thirds of investment is in road and structures, which are rather permanent, and only one-third in equipment.

For railroads fixed costs loom large because the investment is large relative to output. This relationship is measured by the annual capital turnover; the ratio of gross revenues to capital investment. For railroads the usual ratio has been 1 to 3; that is, there have typically been 3 dollars of invested capital for every dollar of annual receipts. In other words, the average capital turnover required a three year period. In the war years, the ratio was higher than 1 to 3, and in a prior year like 1932, it was as low as 1 to 6. By way of contrast, the steel industry has a capital turnover of once a year or better, while department stores average 3 or 4 times annually.

The following table indicates the extreme position of the railroads in the relatively prosperous year of 1955:

	Turnover Ratio (Sales/Net Assets)
Total Manufacturing	2.2
Iron & Steel	1.9
Meat Packing	8.4
Autos & Trucks	4.9
Non-Manufacturing	
Food Chain Store	11.2
Restaurants and Hotels	2.9
Air Transport	2.8
Shipping	1.2
Electric Power, Gas, etc.	0.7
Class I Railroads	0.6

More recent data on transportation companies indicate the following comparative turnovers: [3/]

	1957	1958
12 Largest Railroads [4/]	0.57	0.51
6 Largest Airlines [5/]	2.44	2.37
6 Largest Steamship Companies [6/]	1.10	0.88
Greyhound Bus	2.36	2.33
Consolidated Freightways	n.a.	3.55

In brief, it would appear that railroads have the smallest capital turnover in the transportation industry, with airlines enjoying a considerably larger turnover and motor trucks and buses the largest. [7/] It follows that such fixed costs as property taxes, fixed rents and interest would loom larger in the railroad cost picture and play a more prominent role in their rate making processes, than would be the case with other agencies of transportation.

Pipeline companies, like the railroads, have large fixed plants, and since their capacity is not fully utilized, a substantial proportion of their expenses are constant in the short run, more so than in any other mode of transportation. Pipeline operating ratios have usually been lower than 50, as compared with the motor carriers, whose operating ratios exceed 90.

Variable Costs

Variable costs may be calculated by comparing total carrier costs incurred when a described service is performed with those incurred in its absence. Examples of such costs are the wages of flight crews, drivers and trainmen, and fuel. Other costs, such as depreciation of equipment partially accrue with traffic (wear and tear) and partially with other factors (obsolescence, weather). One authority believes that the variable costs of railroads are probably "less than 50% of total costs for the short run." [8/] Such is not the case in the trucking industry, where the additional traffic will most likely involve adding an entire transportation unit (tractor, trailer and driver). Thus the out-of-pocket cost incurred by the addition of another unit is only slightly lower than average cost prior to handling the additional traffic, and is almost equal to average cost after the addition of such traffic. It is commonly agreed that at least 90% of all operating expenses, rents, and taxes of motor freight carriers are variable. The great bulk of all costs are direct, since the narrow gap between revenues and expenses motivates variation in fleet size in response to current levels of capacity and profits. Additional traffic handled therefore raises total cost more or less in proportion to the increase in traffic, and thus the out-of-pocket cost of additional traffic is not substantially less than the full or average cost of handling all traffic.

Air carrier cost characteristics are basically similar to those of motor carriers, although the short run proportion of fixed to total costs is growing as equipment becomes larger. A dozen years ago the standard flight unit was a DC-3 costing $ 100,000 and costs were fixed for only relatively small increments of passengers. As jet aircraft costing $ 5,000,000 are introduced, depreciation expenses and ancillary equipment with less variable characteristics loom larger in the total framework of air transport cost. In effect variability is present as before, but only in response to larger increments of traffic. Inland water carrier cost characteristics are substantially similar to those of highway transport. The principal capital outlays by the carriers themselves pertain to barges and towboats, the government providing their navigational channel, and shippers in many instances providing a large part of terminal facilities.

The relative importance of out-of-pocket costs among the various agencies of surface transportation is reflected by the approach of the ICC staff in measuring comparative unit costs. For example, in "New Automobiles in Interstate Commerce," [9/] the Commission's staff submitted cost studies of transporting automobiles by railway, highway and waterway. Both out-of-pocket and fully distributed (i.e. out-of-pocket plus constant) rail cost were computed. However, out-of-pocket cost levels were not computed for either motor or water carriers. As for the motor carriers, the staff "considered that over a long period such costs for carriers engaged almost exclusively in the transportation of new automobiles would closely approach their full costs, with the probable exception of some part of the general overhead." Similarly, it believed that for water carriers engaged exclusively in the transportation of new automobiles, the out-of-pocket costs "approximated the fully distributed costs, excluding only some of the general expenses."

Unit Cost

Essential for rate-making purposes is an association of costs with pricing units, of which the simplest method consists of dividing total costs by total units of production. However few producers of transportation or of tangible items originate only one product. Therefore, an overall average total cost per unit, computed on the basis of total costs divided by total units of all types of output, is of limited usefulness, since certain costs are more closely or fully associated with some products than with others, and still other "threshold" costs (such as land costs for a railroad) are more properly identified with the existence of the firm than with any specific product. At best, average total costs are useful to compare cost levels at different periods of time, or for attaining approximations of cost levels of different companies during a single time period.

Each major traffic category in the multiple-output transportation industries consists of not one, but several components, and the largest, freight, consists of thousands of sub-divisions, each of which is distinguished from the others by the quantity, quality and nature of the transportation services it requires. Accordingly a meaningful cost discussion must relate to a specific category of traffic and with respect to freight, to the cost characteristics of the specific commodity. As the ICC succinctly put it, cost studies "based on system average costs are necessarily of limited value in determining transportation costs fairly apportionable to particular kinds of traffic, because of the inevitable conjecture as to whether conditions affecting the average figures similarly come into play in the case of particular traffic." [10/] Consequently, unit cost ascertainment in the regulatory process requires first, the isolation of costs associable with the traffic or service being costed; second, determination of the variable portion of such costs; and third, the division of such variable portion by the units of actual or anticipated traffic.

Rate-Making Significance of Fixed and Variable Costs

In surface transportation, variable costs have been equated, for all practical purposes, with what are desiginated as "out-of-pocket" costs. [11/] However, since carrier revenue requirements must cover not only the variable, but also a portion of the overhead burden or fixed expenses, including return on investment, this additional dimension is calculated by what are designated as "fully-distributed" costs. These comprise the out-of-pocket or variable costs plus an apportionment of the constant expenses. They thus show the extent of the constant costs which are present in the operation and which must be recovered over and above the out-of-pocket expenses, from total revenues received, though not necessarily from revenue on particular traffic being analyzed. Also, these "fully distributed" costs provide comparisons of the relative costs of transportation for different regions or territories, or single carriers, based on total expenses. The comparative showing of fully distributed in addition to out-of-pocket costs has been justified on the grounds that the comparison assists in the determination of the limits within which recognition can be given to the value-of-service or demand factor, and that such costs also provide a helpful standard by which to test the compensatory character of rates and to evaluate the extent to which noncost considerations(value of service or declarations of public policy) have entered into rate-making. [12/]

These ends are undoubtedly served by the use of fully distributed costs. Their use in the current manner leaves unanswered however, whether the same or similar judgments are attainable without the distortions inherent in the distribution of constant costs. To distribute all costs over the traffic being costed poses judgment problems which, improperly resolved, may lead to error.

What is involved here is illustrated by three possible methods of fixed cost apportionment, each of which has a different significance, and each of which can, when used, give a substantially different answer. The cost analyst begins with a finite quantity of "fixed" cost, determined as a residual by application of a variability factor to the total body of costs. (This variability factor is itself open to question, but that is another matter, treated below.) This body of fixed cost can be treated as though the primary function of the carrier is to move tonnage, and as though most costs are weight-related, in which case the analyst distributes the constant cost on a prorata ton and ton-mile basis, in accordance with the practice commonly followed by the ICC staff. In the alternative the analyst can assume that his constant costs are largely of the same characteristics as his variable costs, in which case he distributes the constant on the same basis as the out-of-pocket costs already assigned. Not satisfied with either of these, the analyst can assume that constant costs should be allocated on the basis of the traffic's ability to bear the burden of such costs, in which case the distribution involves an apportionment on the basis of revenue. In each case a more or less arbitrary judgment has been employed for the primary purpose of ensuring that all costs have been accounted for. The case has been well described by Ford K. Edwards as follows:

> Although there always seems to exist a strong pressure on the cost man to produce full cost figures, e.g., figures that will use up all the expenses, it should be emphasized that any distribution of the total costs over units of traffic being differentially priced represents a statistical tool and nothing more. Such figures are akin to a level which a surveyor uses to gauge his elevations; like the surveyor's instrument, they are no guide in themselves as to whether the engineers to follow should build a high road or a low road. As long as the full costs are understood for what they are, i.e., analytical tools and nothing more, they can be quite helpful. [13/] (emphasis supplied)

A problem arises however from the tendency to confuse a useful but necessarily imperfect measuring mechanism with "true" cost. For both carriers and regulatory agencies this tendency is difficult to suppress, nothwithstanding its inherent distortions. In the case of the individual firm, the use of fully allocated costs may be highly limited. For many management decisions it would be wiser to allocate only those common costs that represent variable overhead. Particularly in short run decisions, it is economically sounder to concentrate less on the equity of having each commodity or service bear its fair share of the overhead and more on the relevancy of the problem under consideration (e.g. moving X tons for Y miles) to the total body of constant costs.

Likewise, regulatory bodies concerned with somewhat broader problems have had a demonstrated reluctance to approve as compensatory rates which do not cover, and more than cover, all costs which can be associated (in however arbitrary a manner and however irrelevant from the economic point of view) with the traffic to which they apply.

The fact that almost all costs are variable in the motor and water carrier cost structure assumes significance for the rate-making process when viewed in the light of their competitive relationship to the railroads. Railroad operating expenses, rents and taxes have been construed by the ICC as 80% variable, with return on equipment 100% and on road only 50% variable. [14/] By contrast, motor carrier costs are estimated to be about 90% [15/] variable. Since theoretically, their competitive rates can be profitably made at some point slightly above variable costs, this would be equivalent to a level approximating 90% of their average total costs. In such a rate competition, therefore truck rates could fall only to a level somewhat exceeding 90% of their average total costs before acquiring a non-compensatory character, whereas the railroads have a somewhat greater cushion or spread between average total and variable cost. Put in another fashion variable costs are a continuous function of output and, by definition, their unit cost remains constant*regardless of output. Fixed costs, on the other hand, being constant in total dollars, must vary inversely with output in terms of unit cost.

* within a given time period

Accordingly, increases in volume tend to reduce the sum of variable plus fixed unit cost for those carriers with sizeable fixed costs. Because of these cost relationships, the railroads have in theory, an inherent advantage over motor carriers to the extent that cost of service elements are influential in the rate-making process. (It should be noted that as a practical matter this advantage is farfrom universal, it is noticeably absent in many short-haul and specialized movements where trucks are the low cost carrier.)

> The relationship between fixed and variable costs is the prime factor in determining the competitive position of the motor carrier in the transportation field or system. Stated differently, the large proportion of out-of-pocket expenses provides a very high floor to the rate level of the carrier. Since approximately 90% of the costs are variable, or out-of-pocket, the carrier has relatively little room for price competition. [16/]

Also,

> The conclusion may be reached that the costs for the trucking industry over an extended period are very largely proportional to volume of business moved. This is characteristic of industries where there are a very large number of small producers in the field or where a few of the big operators perform the service with a plant consisting of a large number of small units (trucks), the number of which over a period of time, becomes adjusted to the volume of transportation service performed. [17/]

The term "constant costs" however, is a convenience used to designate expenses unrelated to short term traffic fluctuations, and only improperly construed in the literal sense. When traffic volume increases to the point where the maximum efficiency of a staff and plant are attained, constant costs then become variable with additions in output. At that point newly acquired revenue that then fails to cover average total (unit) costs will also fail to cover out-of-pocket costs. "Low rates made to encourage traffic when the carrier was operating at much below capacity may need to be scrutinized to see that they are not throwing a burden on other traffic." [18/]

There is a natural tendency on the part of carriers with a large proportion of constant costs to offer incentive rates to attract added volume that will cover out-of-pocket costs and make some contribution to the overhead burden. Regulatory bodies properly regard these with caution, analyzing them to see that the fixed costs have not become variable, or while remaining fixed are being met.

In short, out-of-pocket costs establish a floor below which the carrier cannot go in fixing rates. [19/] But as the ICC has warned "if all or a large proportion of railroad rates were brought down to such a level the vitality of the railroad system would be destroyed." [20/] The rails would then be unable to meet their large fixed costs.

Fixed and Variable Costs in the Railroad Industry.

Because of its rate-making implications, assessment of fixed and variable costs is unavoidable in the railroad industry. Attempts at solution have been both complicated and controversial. They involve problems of definition, of concept and of measurement.

Definition

Basic to variability determination is a definition of the time dimension involved.

> The distinction between fixed and variable cost cannot be examined therefore without the specification of the time period in which the adjustment to changes in the volume of traffic can be made. Consider, for example, the elimination of rail passenger service from a branch line. The initial effect is merely the reduction in train service and station costs, and only these might be considered as variable. Over a longer period, however, the level of accounts for maintenance of way and structure and maintenance of equipment may be reduced so that part of these costs become variable with changes in the volume of traffic. Over some longer period even general administrative expenses might be reduced as less administrative effort is required for the numerous problems of passenger traffic management. [21/]

Consequently, it would appear that an appropriate time-period for measurement of variability would be one in which management has had ample time to adjust cost to typical traffic volume.

Since variable costs in transportation are equivalent to the economic concept of marginal cost, the phrase "long-term marginal cost" is useful in describing cost behavior which comprehends elimination of the inevitable lag between traffic variation and responsive adjustment in operating expense. It follows that any prospective traffic which is offered at rates above the level of long-run marginal cost will reduce the burden of fixed cost on existing traffic.

But how long a time-period is "long-run"? one leading cost analyst, for example, does "not agree that out-of-pocket costs should include 100% of a stated percentage return on investment in equipment and 50% of a stated return on investment in road property. Because of the significant effects of imbalance and seasonality of traffic, he is of the opinion that the railroads have, <u>during the greater portion of any given year</u>, considerable excess capacity in equipment and motive power." [22/] (Emphasis supplied) Such an analysis is indicative of the absence of agreed definitions. Greater clarity may accrue if out-of-pocket or variable cost was fragmented into-the three separate concepts to which it has been applied. These differ from each other primarily in terms of the time dimension that each comprehends, and in the common useage the distinction between them is often overlooked and definitions become hazy. These concepts are (a) very short-term cost, which takes into consideration only those expenses directly traceable to the traffic in question, such as added fuel cost; (b) short term marginal cost, which includes both traceable and some other expenses, but allows insufficient time to permit plant to adjust to the changed level of activity, and hence does not reflect the altered operating costs of the changed plant; and (c) long-run marginal cost, which not only reflects the traffic impact on all categories of cost but also permits reasonable time for plant adjustment. The concept to which reference is made above appears most closely to approach short-term marginal cost. For this reason we believe it to be inappropriate, since equating out-of-pocket with variable cost has no economic significance unless such out-of-pocket cost contains a fairly conclusive measure of variability. This seems impossible to secure in a relatively short time period. Hence the long-run yardstick, which involves, a period long enough to shake out laggard but nonetheless/ variable cost function, is preferable.

In a recent rate case a railroad presented variable cost data based upon analyses of operating expenses, payroll taxes and equipment rents. The ICC found such a short-run estimate of variable cost to be unacceptable, and added what it construed to be the variable portion of ad valorem and Federal income taxes, depreciation on road property and return on investment, stating that, "Although taxes and return do not vary materially from time to time as traffic volume changes, it is considered that over a longer period of 10 or more years, for example, they are influenced by fluctuations in the amount of traffic handled" [23/] These added expenses increased computed variable cost by 23 to 26 percent. A Commissioner, dissenting apparently on the ground that the Commission's restated costs included "certain items generally regarded as fixed costs," (a view which coincided with that of the respondent in the case) went on to say, "It is perfectly true, of course, that over a relatively long period taxes and investment in carrier property and equipment will be found to be closely related to traffic volume." [24/] This appears to imply that a rate may be compensatory even if in the long run it would fail to cover all costs incurred by the traffic to which it applied, thus causing the carrier to lose money. In our view, the Commission's decision showed an encouraging awareness of the fundamental economic meaning of long-term marginal cost.

Thus, a determination of an appropriate time period for measurement of variable cost is essential for regulatory guidance and meaningful cost computations; erroneous definition can produce substantial quantitative inaccuracies which defeat both private and public objectives.

Concept

The concept of marginal cost has been much discussed, and is accepted by transportation economists, but it has not up to the present secured consistent acceptance as a price-making standard by the regulatory agencies. The conceptual obscurity which surrounds the subject of variability, and its economic expression as long-term marginal cost, is illustrated by the following exchange of views at an ICC practitioners panel devoted to this subject:

Q.: ... you made a statement, if I heard you correctly, to the effect that if a rate failed to return to the carrier the fully allocated costs of performing the service, that thereby there was cast a burden on other traffic. Did you mean by "fully allocated costs" the fully allocated out-of-pocket cost, or were you referring to this fully distributed cost?

A.: I am speaking of total costs.

Q.: It was my understanding - and this may be a basic matter - that the out-of-pocket costs were those costs which the carrier would escape if it didn't handle the traffic at all?

A.: That is right.

Q.: Therefore, if a particular item of traffic returns to the carrier something in excess of the costs which it would not escape or which it would escape if it didn't handle that traffic, it thereby, by definition, contributes something to the other costs over and above that and could not, conceivably, cast any burden on any other traffic. Am I wrong......?

A.: It contributes something but not enough.

Q.: At least it casts no burden if it bears a rate that returns something in excess of its out-of-pocket costs?

A.: If the carrier's profit at the end of a year is reduced by such a situation, it has cast somewhat of a burden.

Q.: But if it contributes something over and above, or something to the carrier which the carrier wouldn't get if it didn't handle it, it obviously can cast no burden?

A.: I still think it casts some burden, yes.

Q.: You and I are in disagreement. [25/]

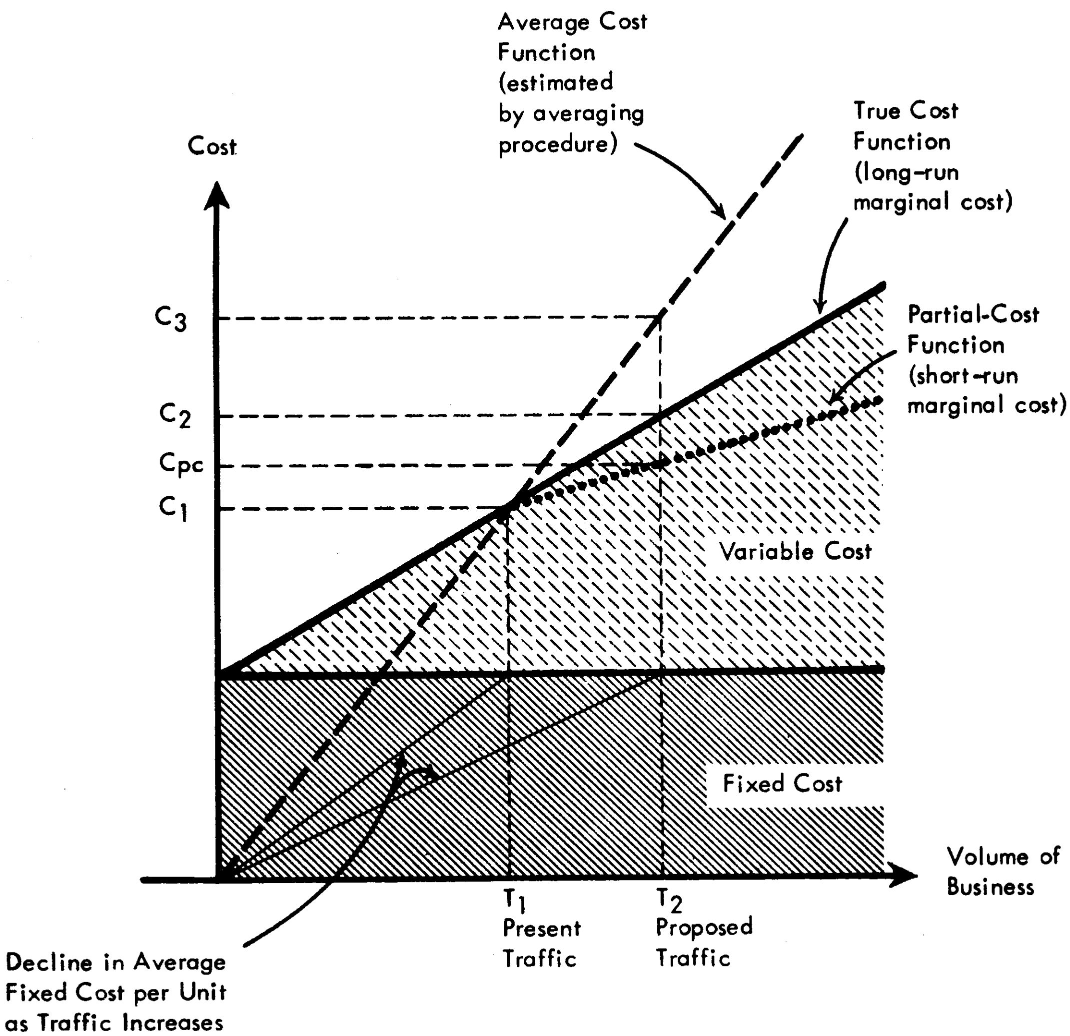
Some of the literature treating of marginal cost also contributes to the conceptual difficulties, no doubt due to inadequate definition of terms. For example, in a recent discussion of the subject, it is stated that "In recent years the 'gospel of marginalism' has captured the fancy of many transportation economists. These economists believe railroad rates should be based, largely if not wholly, on the 'marginal' (or additional) cost incurred in moving an added unit of traffic (whether this unit be expressed in hundredWeight, tons or carloads)." After thus correctly defining marginal cost, the discussion continues, "... any rate equal to marginal cost will contribute nothing to 'the burden' (i.e., fixed costs and those not readily allocated). The'burden' includes great bundles of variable costs which cannot be assigned to specific pieces of traffic." [26/]

Everyone may of course define his own terms but "burden" as commonly understood and used is the difference between variable cost and total cost (i.e., between out-of-pocket costs and the total revenue required to meet operating expenses, rents, taxes, and return, as well as deficits from unprofitable services). The difference between these two dimensions is usually regarded as substantially equivalent to fixed or constant cost. Thus in effect, the above text contradicts itself by assuming that fixed cost includes variable cost. Perhaps the apparent supposition that burden includes non-traceable cost explains this paradox, but if so, it begs the question, since the economic objective is to separate long-run variable costs from fixed or non-variable costs.

Figure 4, may assist to clarify this conceptual difficulty. As before, present volume of traffic is represented by T_1. Obviously no one would suggest reducing all rates up to this volume to the variable cost level, since nothing would be left to cover fixed costs, and a fortiori net income would long since have disappeared. Additional business (T_1 to T_2) is contemplated. What is the "cost" of the added business? The "average cost" function, which is nothing more or less than an extrapolation of past experience, would yield the result C_3. The true cost function would yield the result C_2. By definition this includes all costs, not just those costs which are easily assignable. In the above quotation the "marginal" cost referred to seems to be a function like Figure 4's "Partial-Cost Function," which does not include all added costs. It would represent easily traceable costs or costs which are affected in the short-run, i.e. short-term marginal cost, C_{pc}. If the "gospel of marginalism" is to be deplored, a clear distinction must be drawn between the Partial-Cost Function and the True Cost Function. In drawing such a distinction, it must not be overlooked that at volume T_2 (assuming reasonable stability in demand) all traffic carried at volume T_1 remains with the carrier, and presumably continues to pay the same rates as it did before, thus contributing revenues sufficient to cover fixed costs.

Assuming no carrier disposition to grant rate reductions to purely marginal levels for existing traffic sources (and no persuasive reasons have been advanced to indicate that this would be a practical consequence of a marginal pricing policy), all the cost that has to be covered is the added cost of volume (T_1 to T_2), which is represented by(C_1 to C_2). This is the true variable cost, i.e., long-term marginal cost. Any rate above this cost adds to net income, even though that rate may not approach C_3.

TRUE AND PARTIAL-COST FUNCTIONS



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Washington November, 1959

The application of marginal pricing in a hypothetical case, is described in Appendix B.

The conceptual difficulty with variable costs is further illustrated in the ICC's Statement No. 5-58, Rail Carload Cost Scales by Territories for the Year 1957. This shows "out-of-pocket" and "fully distributed" costs for numerous weight and mileage blocks. If we consider, for example, 70-ton hopper car loads in the Pocahontas Region, [27/] and plot the car-mile costs for various mileages, they yield the two cost functions shown in Figure 5. The manner in which "fully-distributed cost" is presented in both tables and graph is likely to be misleading. In regulatory consideration of rate proposals involving added traffic the temptation is very strong to conclude that a rate cannot be compensatory unless it covers "fully distributed cost." Figure 4 and Appendix B demonstrate that net profit can be increased if a rate for added business exceeds long-run marginal costs.

In Figure 4, "fully distributed cost" at present traffic levels is fixed cost plus variable cost; "out-of-pocket cost" is simply variable cost. Hence a change in traffic volume from one level to another does not involve fixed costs, since these will not in any way be altered. The significant point for regulatory agencies and for carriers in considering prospective additional traffic, is that all added costs are represented by the variable or out-of-pocket costs; any rate above this level adds revenue in excess of increased expense. Thus the concept of fully distributed cost has no relevance to pricing added traffic.

Measurement

Difficulties with definitions and concepts are only part of the variability problem, however. Adding to the obstacles these pose for meaningful cost ascertainment is the actual technical hardship of measuring variability with precision.

Due to their inherent physical characteristics the railroads (and pipelines) have a greater proportion of fixed to total cost than do their competitors. Yet the issue is of major consequence for motor and water carriers, too, since accurate determination of variability in rail operations, when related to pricing based on long-run marginal cost, inevitably results in maximizing the area of competition between the three modes.

Measurement of "fixity" and "variability" has proved to be among the most difficult technical aspects of transportation cost-finding. This is attributable in major part to the fact that the extent or degree of variability is itself a function of traffic volume. Figure 6, an assumed total cost curve, illustrates the problem. At traffic volume 1, 2, and 4, variable cost is 50, 66 2/3, and 75% of total cost, respectively.

In the very long run, of course, when fundamental changes in traffic volume induce responses in the size and structure of the fixed plant itself, there is a dynamic impact on "fixed cost," which will ultimately lose its constant characteristic, and tend to vary.

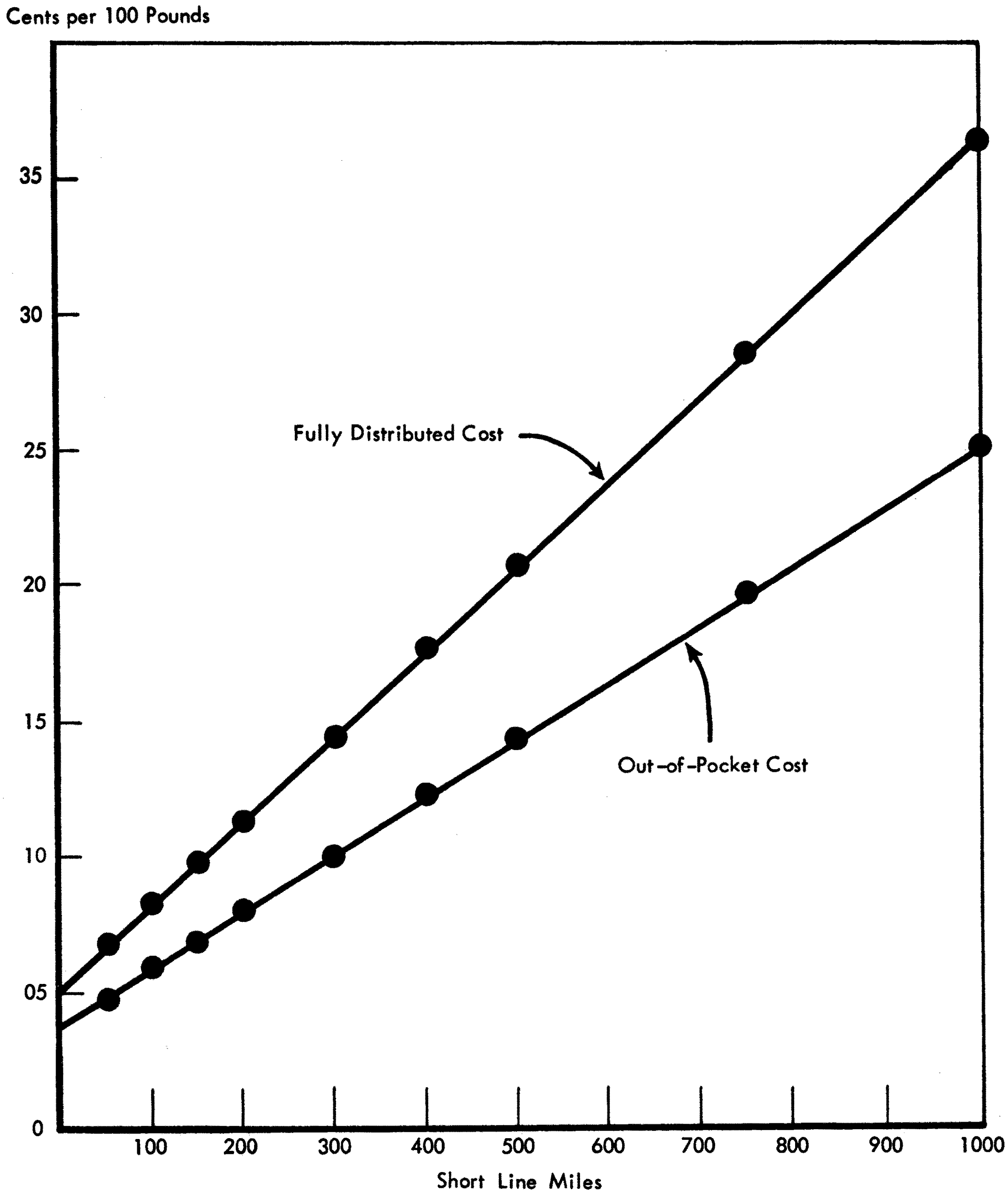
Recognition of the nature of variability has thus posed a dilemna for economists and cost analysts since the beginnings of the railroads. Time and again, over the last century and a quarter, they have attempted by various means, mathematical and empirical, to isolate the variable portions of total cost. These efforts are described in Section 11. The most recent authoritative pronouncement was that of the ICC staff, which in 1954 concluded that the appropriate coefficients of variability, based on 1951 and 1952 traffic levels, were: operating expenses, rents and taxes, 80%; return on investment in road, 50%; and return of investment in equipment 100%.

The more recent of these studies analyzed cross sections of varying numbers of carriers, so as to observe through simple correlation (utilizing the formula $Y = a + b_x$) the impact of traffic density upon carrier operating expenses and capital investment. 28/

The ICC studies measured in the various railroad geographical districts and regions, variation in operating expense by analysis of the relationship per mile of road between freight service operating expenses, rents and taxes and gross ton-miles of cars, contents and cabooses in freight trains. Variation in investment was computed through analysis of the relationship per mile of road between reproduction cost new, land and rights and working capital on the one hand,

Figure 5

CARLOAD COSTS WITH INCREASING MILEAGE
POCAHONTAS REGION HOPPER CAR WITH 70 TON LOAD
ACCORDING TO ICC CARLOAD MILEAGE COST SCALES
YEAR 1957 OPERATIONS



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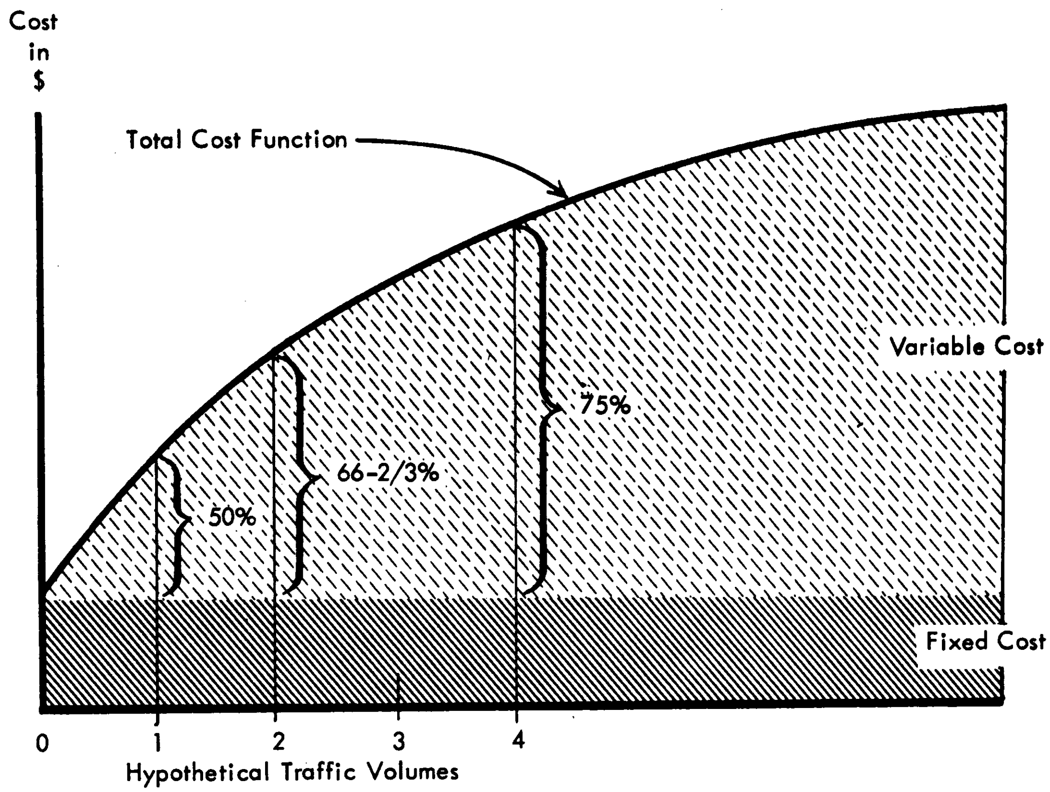
VARIABLE COST PORTIONS DIFFER WITH TRAFFIC VOLUME



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and gross ton-miles of cars, contents and cabaooses in freight and passenger trains, on the other. The computed percents variable for 1946 are shown in the table on page 2 - 26. [29/]

Similar data were derived for the years 1944 and 1951. The ICC staff also analyzed variability in individual operating expense accounts and plant investment over various time periods, 1939 to 1946 and 1939 to 1952. It was concluded that

> ... the long-term analyses ... indicate the operating expenses to be between 80 and 90 percent variable, and the plant investment to be upwards of 50 percent variable. The latter figures are believed to be more representative of the long-run influence of added traffic on the carriers' operating expenses and capital charges than is the wartime experience showing the operating expenses to be over 90 percent variable, and the plant to be relatively fixed. [30/]

Recognition was given to the various computed values by provision that the ICC rail cost formula be designed "so as to permit the computation of the out-of-pocket costs based on any selected percent variable." [31/]

The ICC staff studies summarized above have been the most comprehensive and intensive effort to isolate variability. But they have left the problem in far from complete solution.

To begin with, despite the imputed suggestion that "percent variable" was a dynamic factor, the apparent if unofficial, adoption of the 80-50-100 composite percent by the staff has led to its employment in a wide variety of situations by all but the most sophisticated technicians. It is used for one railroad, and for many. It is applied to Eastern, Western and Southern railroads alike, despite the Commission's own determinations of greater specificity. It has been related to costs in each of the past five years, despite negative deviations exceeding 10% in freight gross ton-miles from 1951 and 1952 traffic levels upon which it is based.

Thus, in current applications of "Rail Form A" the failure to alter the "percent variable" to reflect changes in traffic volume actually understates fixed expenses and overstates out-of-pocket expenses during periods of low railroad activity. For example, if operating costs were $ 1,000,000 in 1957, out-of-pocket costs would be $ 800,000 or 80 percent, while fixed costs would be the difference or $ 200,000. Suppose in 1958, operating costs were $ 700,000 out-of-pocket costs would be $ 560,000 and fixed costs would be $ 140,000. Have fixed costs gone from $ 200,000 to $ 140,000 in the span of a single year? The effect of applying this procedure to the railroads as a whole, and upon three individual carriers is shown in the table on page 2 - 27. Despite the almost universal application

--Percent Variable for Operating Expenses and Value, 1946. Based on District and Region Trends with Density 1/

Average haul	United States (excl. Poco.)		Eastern district		Southern district (incl. Poco.)		Southern region (excl. Poco.)		Western district	
group (miles) (1)	No. of roads (2)	Percent variable (3)	No. of roads (4)	Percent variable (5)	No. of roads (6)	Percent variable (7)	No. of roads (8)	Percent variable (9)	No. of roads (10)	Percent variable (11)
Freight operating expenses, rents and taxes: 3/										
	(5.791 GTM)		(8.613 GTM)		(6.546 GTM)		(5.152 GTM)		(4.747 GTM)	
100 - 199..	44	83	18	80	12	77	12	73	14	86
200 - 299..	24	94	8	93	10	78	7	86	9	82
300 - 399..	8	96	-	-	-	-	-	-	8	95
400 & over.	5	108	-	-	-	-	-	-	5	110
100 & over.	81	87	26	80	22	76	19	80	36	80
Cost of reproduction-new: present value of lands and rights and working capital including materials and supplies: 2/										
	(7.054 GTM)		(10.538 GTM)		(7.672 GTM)		(6.261 GTM)		(5.764 GTM)	
100 - 199..	42	95	17	93	12	89	12	87	13	53
200 - 299..	24	98	8	118	10	91	7	98	9	16
300 - 399..	8	3/	-	-	-	-	-	-	8	3/
400 & over.	5	24	-	-	-	-	-	-	5	20
100 & over.	79	89	25	86	22	90	19	89	35	49

1/ The average densities are shown in millions.

2/ Carriers excluded from study of Freight Operating Expenses were the Missouri & Arkansas Railway, Toledo, Peoria & Western Railroad on account of incomplete 1946 statistics.
Carriers excluded from study of Freight & Passenger Value were the Missouri & Arkansas Railway, Toledo, Peoria & Western Railroad and Bessemer & Lake Erie and Denver & Salt Lake. The latter two roads were excluded because not typical of the group being compared and the remaining two railroads had incomplete statistics for 1946.

3/ No relation found.

"CONSTANT" PORTION OF RAILWAY OPERATING EXPENSE, RENTS AND TAXES
IN 1953 COMPARED WITH 1954 BY I.C.C. METHOD

	All Class I Railroads	Reading Company	Norfolk & Western Ry.	Southern Ry. Co.	Union Pacific Railroad
1. Total Railway Operating Expenses, Rents and Taxes, 1953 ($000,000)	8,732	106	133	201	441
2. Total Railway Operating Expenses, Rents and Taxes, 1954 ($000,000)	7,384	92	125	191	406
3. "Constant" Railway Operating Expense, Rents and Taxes, 1953 (1 x 20%)	1,746	21	27	40	88
4. "Constant" Railway Operating Expense, Rents and Taxes, 1954 (2 x 20%)	1,477	18	25	38	81
5. Decline in "Constant" Expense, 1954 vs. 1953 ($000,000)	269	3	2	2	7
6. Decline in "Constant" Expense, 1954 vs. 1953 (%)	15.4	14.3	7.4	5.0	8.0

Source: Interstate Commerce Commission, Statistics of Railways in the United States.

of the "percent variable concept" substantial doubts continue to assail its users. Since it segregates cost into only three very broad categories (operating expenses, return on way and structures, return on equipment), it obviously fails to take into account the fact that some operating expense accounts have a higher variability than others. Therefore, as the amount of expenses shown in these individual operating expense accounts deviates from the values contained when the 80 percent figure was computed, so will the overall percent figure deviate from 80 percent, and substantial error could result. For example, if each account were to be individually analyzed, one year's experience might show a large increase in those accounts which have a high out-of-pocket percent applied to them, while at the same time the size of the accounts which have a low out-of-pocket percent applied to them have remained constant. The result would be an over-all variable portion far exceeding 80 percent. This basic defect is however, glossed over in the current rail cost-finding procedure.

By its lumping together all types of operations, the "percent variable" also fails to deal with the fact that with separation of expense according to the type of service or terrain different variabilities might be shown. For example, one would expect costs to be highly responsive to traffic variations on heavy-duty main lines, but branch lines and local freight trains probably have much excess capacity and hence would have a much lower percentage of variable costs. Very likely also variability may fluctuate with carrier size, a possibility completely ignored at present.

These uncertainties indicate that the "percent variable" as currently used and defined by the ICC is but a way station on the road to precision. Dissatisfaction with its use continues to assert itself, as in the following recent statement:

> The method used to compute the (50%) variable is unsound in principle because it attempts to measure an increase in investment required by additional traffic by the relationship in a single year of density to cost of road per mile of some 75 carriers having totally different conditions with respect to both the nature and character of traffic, construction and the nature and character of the terrain traversed with respect to grade, alignment, and urban congestion and value of lands. These differences represent variable factors far more significant than the factor taken as controlling - i. e. traffic density. [32/]

The same source illustrates also a lack of confidence in the Commission's use of the data determined. It provides, and we have reproduced in Appendix C:

> a chart showing the traffic density and value per mile of road of each of the 84 carriers shown in the three

charts [33/] used by the Cost Section. On this chart we have drawn lines representing 50% 75% 90% and 100% percents variable. The following show the number of observations respectively above and below these lines. [34/]

	Above	On	Below
50 Percent Variable	27	3	54
75 Percent Variable	31	5	48
90 Percent Variable	35	6	43
100 Percent Variable	38	4	42

The conclusion is reached:

> These results not only condemn the arbitrary choice of the 50% variable but if the relations used have any meaning at all, which we deny, they show that the increase in investment is 100% variable with additional traffic. [35/]

Irrespective of the validity of these conclusions, they depend, like much of the traditional theory of transportation economics, on a static state of technology. There are indications, however, that dynamic technological advances may be in the process of upsetting the conventional thinking. For example, the reproduction cost of railroad property used in transportation service has increased over the years as measured in absolute terms, but if measured in constant dollars and related to traffic volume (as in the table on the next page) it is evident that an irregular but nonetheless pronounced shrinkage has characterized this standard of investment in the rail plant. This trend would seem to indicate, perhaps not conclusively, an inverse relationship between aggregate investment and aggregate traffic.

From the foregoing it is evident that even if and when agreement is reached upon definition and concept, substantial difficulties yet remain in the appropriate measurement of variability and its application in particular cases.

If it is assumed, without conceding, that no improved techniques of measurement can be evolved, it is nevertheless quite clear that present practice does not realize the precision potential of present methods. The application of a common percent variable under all conditions is obviously but an expedient. If "percent variable" must be used, the margin of error in its application would be diminished by separate values computed for individual geographical territories. Better yet would be the development of mechanics for determination of percent variable by individual expense account. To be preferred to any of these is the derivation of variability by statistical cost functions, as is now undertaken to some extent by individual carriers. [36/]

COMPARISON OF REPRODUCTION COSTS OF ROAD PROPERTY
AT 1910-1914 PRICE LEVEL WITH GROSS TON-MILES
CLASS I RAILROADS OF THE U.S.

Year Ended	Road Property 1/ Amount (billions)	Road Property 1/ Index (1919=100)	Gross Ton-Miles 2/ Amount (billions)	Gross Ton-Miles 2/ Index (1910=100)
1919	17.0	100	1,030 3/	100
1929	N.A.	N.A.	1,402	136
1939	13.9	81	1,089	106
1949	13.0	76	1,487	144
1950	13.0	76	1,588	154
1951	13.0	76	1,681	163
1952	13.0	76	1,643	160
1953	13.0	76	1,622	157
1954	13.0	76	1,497	145
1955	13.0	76	1,625	158
1956	12.9	76	1,654	161
1957	12.9	75	1,587	154

1/ Excludes capitalized overhead expenses, equipment, land and rights.
2/ Excludes locomotives and tenders.
3/ Gross ton-miles for 1919 unavailable; estimated by ratio of 1919 to 1922 car miles.

Source: Interstate Commerce Commission; Association of American Railroads.

Section 6. Directly Assignable and Common Costs

Another major problem in transport cost finding relates to the substantial fraction of total cost, which under most conditions cannot be directly assigned to particular types of traffic. This stems from the fact that transportation is essentially a multi-pro duct industry, with several services typically using the same facilities, and with huge expenditures made on behalf of all of them.

Directly Assignable Costs

Directly assignable costs are those which are immediately traceable to particular items of output; in transportation they are said to be costs which can be allocated to particular traffic. They are largely composed of the actual expense involved in moving equipment from point to point, and costs incurred on behalf of specific traffic or traffics. These costs are similar to what the ICC labels "solely related costs" in passenger or freight service, and in connection with rail branch lines whose existence is "solely related" to one particular freight commodity. In truck transportation fuel and driver wages are directly assignable costs: here their identity with variable costs is at once manifest. Similarly, in air and rail transport, plane and engine fuel and crew wages comprise the largest proportion of so-called directly assignable cost. The concept of "above the rail" costs frequently employed in rail passenger curtailment cases, is substantially equivalent to directly assignable cost, and as such falls short of measuring all costs properly associated with the service being analyzed.

Common Costs

Common costs are those incurred by several types of traffic, e. g., in rail by freight and passengers, (or LTL and truckload, in the case of motor freight carriers. Since such costs cannot be allocated, they must be apportioned. For example, if a particular flight carries all types of traffic, or a train carries mail and express as well as passengers, the wage and fuel costs of the flight or of the train movement are largely (but sometimes not exclusively) common to all the types of traffic. These costs may be compared with the cost of a stewardess or food on the plane which would be cost traceable to passengers only, a single traffic component. In other words, costs are common when incurred on behalf of more than one service.

The common portion of total airline costs appears to be very high, under typical operations. Evidence submitted by United Airlines in the Air Freight Rate Investigation [37/] indicated that 61.4% of the company's total costs were incurred not directly for any particular service but for all forms of traffic together. A similar computation by American Airlines indicated that 76% of that carrier's total expense consisted of common costs.

Common costs, while not precisely separable with respect to a product service, may nonetheless be variable with output. Thus, all flying operations and maintenance expenses of a plane carrying mail, express, freight and passengers represent common costs incurred directly on behalf of all four traffic categories. The same is true of a rail car carrying express and mail.

Railroads too, have a substantial proportion of common expense. The most familiar, and largely unresolved, common cost situation in railroading involves the apportionment of mutually incurred expense between freight and passenger service, which at 1957 levels, involved approximately $ 2,500,000,000.

The significant difference between the common cost situation of railroading and those of the other regulated carriers lies in their location. The common costs of railroads are experienced largely within the industry itself. Where more than one carrier is involved, joint facility arrangements apply. By contrast, the common costs typical of other modes occur substantially outside the transport firm.* This should not be allowed to obscure the fact that the measurement of common costs is a significant, and largely unresolved issue for these modes also.

The predominant common cost situation in motor transportation for example, centers about joint use of the highways by both private autos and trucks. Thus highway transportation offficals are faced with apportioning not only pavement costs, but also such expense as:

Right of Way Requisition	Snow Removal
Fences	Drawbridge operation
Markers and Signs	Earthwork
Traffic Lights	Guide Line Painting
Dust Palliatives	Sidewalks
Traffic Counts	Soiling, Seeding, Sodding

among the various categories of vehicular traffic.

Enormous efforts and expense have gone into attempts to resolve the common cost question in motor transportation. These involve both empirical engineering tests [38/] and abstract mathematical analyses. [39/] The more sophisticated of such studies have used the "incremental" method, which involves isolation of highway costs incurred for common use and their separation from costs incurred especially for particular groups of highway users, among which the vehicles commonly used by regulated motor carriers loom large. The practical questions are, by analogy, much the same as in the railroad industry. However, the promise of solution in the incremental method is more potential than actual; before precision can be obtained, large gaps in current knowledge remain to be filled. [40/]

* which is to say, they are borne in the first instance by the government.

RELATIONSHIP OF COMMON AND SOLELY RELATED COSTS
TO TOTAL OPERATING EXPENSES CLASS I RAILROADS OF THE U. S.
SELECTED YEARS

Item	Actual Dollars			Percent of Total		
	1950	1953	1957	1950	1953	1957
Related Solely to Freight Service	3,530,551,276	4,102,940,670	4,396,579,306	50.01	50.43	53.44
Related Solely to Passenger Service	1,257,725,460	1,417,225,891	1,352,132,187	17.82	17.42	16.43
Total Solely Related Costs	4,788,276,736	5,520,166,561	5,748,711,493	67.83	67.85	69.87
Common Expenses Apportioned to Freight Service	1,793,438,576	2,071,814,200	2,037,756,519	25.41	25.47	24.77
Common Expenses Apportioned to Passenger and Allied Services	470,879,963	536,448,113	435,897,349	6.67	6.60	5.30
Total Common Expenses	2,264,318,539	2,608,262,313	2,473,653,868	32.08	32.07	30.07
Not Related to Either Freight or Passenger and Allied Services	6,680,968	6,799,842	5,156,277	.09	.08	.06
Total Operating Expenses	7,059,276,243	8,135,228,716	8,227,521,638	100.00	100.00	100.00

Source: Statistics of Railways in the United States;
Transport Statistics in the United States.

In aviation, the costs incident to airway and airport operation are incurred in common by the regulated carriers, private or "general," and military aviation. A beginning has been made, based on relative use, towards separation of the common costs of airways, [41/] but it would appear as if no comprehensive effort has yet been directed towards the separation of airport common costs despite the fact that the issue has been aired from time to time. [42/]

Difficulties attaching to measurement of such costs have not of course, precluded attempts at cost recovery through user charges for highway and airport facilities in which governmental entities have substantial investments. A multiplicity of fees and taxes now imposed for this purpose on motor and air carriers are reflected in their operating expenses. However, these fees and taxes are quite inadequate measure of such costs. This is not to say that the user charges now imposed are, in the aggregate or in any specific case, too high or too low. The point of significance here is simply that no one really knows. The great disparity in such fees and taxes among the jurisdictions which levy them would tend to indicate that relatively little progress has been made in relating them with precision to the costs they are ostensibly designed to cover.

The point is illustrated by the table on the next page, prepared and published by the Bureau of Public Roads. The data shown exclude all Federal taxes, and state taxes enacted during or later than 1956, and apply to vehicles of the same weight and type operating 70,000 miles per year under uniform assumed conditions. Total annual road user taxes per vehicle (i.e., total taxes less property taxes) thus computed ranged, for contract carriers, from a high of \$ 2,793.83 in California, through an average of \$ 1,496.05 to a low of \$ 760.00 in Rhode Island. To be sure, the costs of highway investment and maintenance are undoubtedly influenced by terrain, traffic and weather, and perhaps by state size. These do not seem, however, fully to explain why Texas taxes are less than half of California's nor do they provide an explanation of the 37% disparity between Alabama and Georgia, nor a level of taxation upon comparable vehicles which in Arizona is 133% higher than in New Mexico.

In air transport a similar lack of obvious relationship between probable cost and actual user charges is evidenced by the table on page 2 - 36.

These data, both highway and air, are merely illustrative. They serve to show that user taxes and fees are likely to reflect other than economic factors, and hence must be considered a measure of economic cost zt some degree removed from precision.

Costs incurred on behalf of water transportation are common to regulated and exempt carriers, to pleasure craft, and often also to flood control, hydro-electric power production and other purposes

– Road-user and personal-property taxes on a gasoline-powered, four-axle, tractor-semitrailer combination, 50,000 pounds gross vehicle weight

State	Private operation								Contract carrier								
	Registration fee	Property tax	Other taxes and fees	Mileage or ton-mile tax	Gasoline tax	Total	Rank of State: Total fees and taxes	Rank of State: Total, excluding property tax	Registration fee	Property tax	Other taxes and fees	Carrier taxes and fees	Mileage or ton-mile tax	Gasoline tax	Total	Rank of State: Total fees and taxes	Rank of State: Total, excluding property tax
New England:																	
Maine	$355.00	$219.54	......	......	$1,050.00	$1,624.54	10	17	$355.00	$219.54	......	$30.00	......	$1,050.00	$1,654.54	18	25
New Hampshire	300.00	......	$116.42	......	750.00	1,166.42	39	22	300.00	......	$116.42	2.00	......	750.00	1,168.42	40	36
Vermont	590.00	......	......	......	825.00	1,415.00	23	16	590.00	......	......	......	......	825.00	1,415.00	20	27
Massachusetts	152.00	286.00	......	......	750.00	1,188.00	38	44	152.00	286.00	......	15.00	......	750.00	1,203.00	38	45
Rhode Island	155.00	200.51	......	......	600.00	955.51	47	48	155.00	200.51	......	5.00	......	600.00	960.51	47	48
Connecticut	250.00	240.92	......	......	900.00	1,390.92	26	34	250.00	240.92	......	5.00	......	900.00	1,396.92	32	37
Middle Atlantic:																	
New York	298.50	......	......	$816.00	600.00	1,714.50	6	6	298.50	......	......	......	$816.00	600.00	1,714.50	15	14
New Jersey	280.00	......	2.00	......	600.00	882.00	48	45	280.00	......	2.00	......	......	600.00	882.00	48	47
Pennsylvania	350.00	......	......	......	900.00	1,250.00	34	29	350.00	......	......	......	......	900.00	1,250.00	36	35
Delaware	219.00	......	......	......	750.00	969.00	46	42	219.00	......	......	......	......	750.00	969.00	46	44
Maryland	210.00	55.00	......	......	900.00	1,165.00	40	37	210.00	55.00	......	......	......	900.00	1,165.00	41	38
District of Columbia	170.00	......	2.00	......	900.00	1,072.00	43	40	170.00	......	2.00	......	......	900.00	1,072.00	44	41
West Virginia	317.00	107.65	......	......	900.00	1,324.65	29	31	317.00	107.65	......	39.50	......	900.00	1,364.15	34	34
Southeastern:																	
Virginia	300.00	170.74	......	......	900.00	1,370.74	27	32	300.00	170.74	......	980.00	......	900.00	2,350.74	4	4
North Carolina	400.00	166.57	......	......	1,050.00	1,616.57	11	14	700.00	166.57	......	......	......	1,050.00	1,916.57	10	9
South Carolina	282.00	317.55	......	......	1,050.00	1,649.55	7	21	282.00	317.55	......	400.00	......	1,050.00	2,049.55	7	11
Georgia	135.00	185.55	......	......	975.00	1,295.55	30	36	262.50	185.55	......	25.00	......	975.00	1,448.05	28	33
Florida	218.10	......	.50	......	1,050.00	1,268.60	31	28	256.60	......	.50	.50	300.00	1,050.00	1,606.60	20	16
Kentucky	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Tennessee	525.00	......	......	......	1,050.00	1,575.00	14	7	675.00	......	......	17.50	......	1,050.00	1,742.50	14	10
Alabama	75.00	310.44	1.00	......	1,050.00	1,436.44	22	35	75.00	310.44	1.00	......	600.00	1,050.00	2,036.44	8	12
Mississippi	333.00	160.79	......	......	1,050.00	1,543.79	15	19	654.00	160.79	......	13.00	......	1,050.00	1,877.79	12	13
East Central:																	
Ohio	338.10	......	2.00	900.00	750.00	1,990.10	4	4	338.10	......	2.00	30.00	900.00	750.00	2,020.10	9	7
Indiana	265.00	208.01	......	......	600.00	1,073.01	42	47	265.00	208.01	......	24.00	......	600.00	1,097.01	43	46
Illinois	780.00	75.58	......	......	750.00	1,614.58	12	8	780.00	75.58	......	......	......	750.00	1,614.58	19	18
Michigan	333.45	......	......	......	900.00	1,233.45	35	30	333.45	......	......	......	180.00	900.00	1,413.45	31	28
Wisconsin	620.00	......	......	......	900.00	1,520.00	17	9	620.00	......	......	20.00	......	900.00	1,540.00	22	17
Minnesota	510.00	......	.50	......	750.00	1,260.50	33	28	510.00	......	.50	7.50	......	750.00	1,268.00	35	32
Iowa	595.00	......	......	......	900.00	1,495.00	19	11	595.00	......	......	5.00	......	900.00	1,500.00	25	23
Missouri	507.00	75.89	......	......	450.00	1,032.89	45	43	507.00	75.89	......	25.00	......	450.00	1,057.89	45	43
Southwestern:																	
Arkansas	330.00	87.96	......	......	975.00	1,392.96	25	23	330.00	87.96	......	......	......	975.00	1,392.96	33	30
Louisiana	320.00	......	......	......	1,050.00	1,370.00	28	20	640.00	......	......	10.00	......	1,050.00	1,700.00	16	15
Oklahoma	486.00	......	......	......	975.00	1,461.00	21	13	486.00	......	......	4.50	......	975.00	1,465.50	27	23
Texas	336.50	119.80	......	......	750.00	1,206.30	36	39	336.50	119.80	......	11.00	......	750.00	1,217.30	37	40
West Central:																	
North Dakota	735.00	......	168.75	......	900.00	1,803.75	5	5	735.00	......	168.75	55.00	......	900.00	1,858.75	13	8
South Dakota	183.50	......	565.00	......	750.00	1,498.50	18	10	183.50	......	......	575.00	......	750.00	1,508.50	24	21
Nebraska	581.00	165.06	......	......	900.00	1,646.06	8	12	581.00	165.06	......	30.00	......	900.00	1,676.06	17	20
Kansas	545.00	186.66	10.00	......	750.00	1,491.66	20	24	545.00	186.66	......	10.00	......	750.00	1,491.66	29	31
Mountain:																	
Montana	220.00	356.05	......	......	1,050.00	1,626.05	9	25	220.00	356.05	......	255.00	......	1,050.00	1,881.05	11	19
Idaho	102.00	......	......	1,113.00	900.00	2,115.00	3	3	102.00	......	......	......	1,113.00	900.00	2,115.00	6	5
Wyoming	100.00	155.22	5.00	568.73	750.00	1,578.95	13	15	100.00	155.22	......	5.00	568.73	750.00	1,578.95	21	26
Colorado	22.50	155.22	1.00	1,694.16	900.00	2,772.88	1	1	22.50	155.22	1.00	......	1,694.16	900.00	2,772.88	2	2
New Mexico	205.80	......	......	......	900.00	1,105.80	41	38	205.80	......	......	......	......	900.00	1,105.80	42	39
Arizona	128.75	174.80	......	......	750.00	1,053.55	44	46	128.75	174.80	......	1,225.00	......	750.00	2,278.55	5	6
Utah	280.00	166.55	......	......	750.00	1,196.55	37	41	280.00	166.55	......	......	......	750.00	1,196.55	39	42
Nevada	85.50	222.65	332.30	......	900.00	1,540.45	16	22	85.50	222.65	......	332.30	......	900.00	1,540.45	22	29
Pacific:																	
Washington	325.00	......	101.50	......	975.00	1,401.50	24	18	325.00	......	101.50	42.00	......	975.00	1,443.50	28	24
Oregon	120.40	......	......	1,590.00	900.00	2,610.40	2	2	120.40	......	......	......	1,590.00	900.00	2,610.40	3	3
California	210.00	......	156.00	......	900.00	1,266.00	32	27	210.00	......	156.00	1,527.88	......	900.00	2,793.88	1	1

REPRESENTATIVE LANDING CHARGES
SCHEDULED CARRIER OPERATIONS OF DC-6 AIRCRAFT
AT SELECTED AIRPORTS AS OF SEPTEMBER 1, 1959

City	Airport	Scheduled Service[1/] Landing Charges	Ramp and Apron
Boston	Logan International	$ 12.80	$6.65
Dallas	Love Field	4.40	None[2/]
Honolulu	International	2.00[3/]	None
Houston	International	7.20	None[2/]
Los Angeles	International	8.00[4/]	N.S.
Miami	International	7.80[5/]	.50[6/]
Newark	Newark	19.04	None
New Orleans	Moisant International	8.00	None
New York	La Guardia	28.56	None
New York	International	33.32	None[7/]
Portland	International	8.00	None
San Antonio	International	7.08	None
San Francisco	International	18.40	None
San Juan	International	25.27	None
Seattle-Tacoma	International	6.40	None
Washington	National	7.70	.65

1/ Table data assume maximum gross take-off and landing weights of 95,200 and 80,000 pounds, respectively, and average of five daily flights, 30 days per month.

2/ Airline and fixed base operators furnish own ramp equipment.

3/ Non-refundable 3-1/2¢ gallonage tax is major source of airport revenue.

4/ Five carriers under long term contract have an effective rate of $5.32 per landing on a daily five-flight basis.

5/ Four carriers have long term contracts with an effective rate of $6.96 per landing on a daily five flight basis, no terminal charge is levied for their passengers.

6/ Terminal charge of 50¢ per passenger.

7/ Porter service charge of 15¢ per passenger.

Source: Manual of Airport and Air Navigation Facility Tariffs, Seventh Edition, January 1959. International Civil Aviation Organization; individual airports.

unconnected with transportation. As far as can be determined, efforts devoted towards isolation and allocation of the common costs in domestic waterway facilities have been limited in scope, method and application.

It is thus apparent that common costs pose difficult administrative and technical problems in cost ascertainment. At this writing much remains to be done with this particular matter; it cannot be allowed to remain in limbo if public policy requires an increased measure of precision in transport costing.

Joint Costs

Common costs not traceable to individual products are, in the economic sense, further classifiable into joint and alternative product costs. True jointness exists only when the production of one commodity (e.g. butter) necessarily results in the production of another (e. g. buttermilk). Therefore, an increase in the production of one commodity necessarily increases the output of the other. If, however, the output of butter resulted in a decrease in the output of buttermilk, then the products would be alternative. An example of the latter in transportation would result from relocating an aircraft bulkhead to enlarge cargo capacity, thereby decreasing the passenger cabin. An increase in time of railroad top management devoted to freight service rather than passengers is likewise a case of alternative product cost.

Illustrative of joint costs in transportation is the return movement of line-haul equipment, for supply of return capacity is totally dependent upon outward supply. An increased demand for service between points X and Y (unaccompanied by service demands between Y and X) will have to be met by a rate covering all costs encountered in the backhaul or empty return. Return traffic may be encouraged at rates approaching out-of-pocket cost for the backhaul, and revenues received from such traffic apply against entire round trip cost. However, if low rates on the backhaul stimulate sufficient traffic to warrant increased capacity or an increase in service from Y to X then the rates are uneconomic for the added capacity. The return capacity that was a "by-product" now becomes a "primary product" and the outward mileage is the "by-product". Thus the established rates are inadequate since total revenues are now insufficient to cover out-of-pocket round trip costs.

Larger carriers attempt to minimize their joint costs through operation of "cornered trade," in other words, equipment moving from A to B need not necessarily return empty directly from B to A, but instead may go under load from B to C to D to A, thus reducing the joint cost impact.

Some examples of joint costs found in the trucking industry involve vehicle time running to and from pickup and delivery stops, and "contact time" on multiple-shipment stops in pickup and delivery service. Costs of running to the stop and of "contact time" once there (locating the receiver, getting instructions, etc.) are joint costs for the traffic picked-up and delivered at the single stop. [43/]

Differences between Constant and Joint Costs

The characteristic shared by both constant and joint cost is that neither is assignable to individual units of traffic. On the other hand unit joint costs are unaffected by the extent of plant utilization, whereas constant costs are minimized as a carrier reaches the volume of output (transportation service) at which maximum utilization is obtained. At such a traffic level, the law of decreasing costs no longer applies and all costs become variable with output. By contrast, the return movement of transportation equipment is as much a joint cost when a carrier is operating at capacity as it was at a lesser traffic volume.

Common Cost Separation: Rail Passenger Deficit Measurement

Because the apportionment of mutually incurred corporate expense between passenger and freight service is a problem of minor dimensions elsewhere the rail common cost problem has received relatively more attention in the regulatory enviroment. According to the ICC separation formula, the common expenses in 1957 were almost twice as great as the expenditures directly traceable to passenger service, and a little more than half of those "solely related" to freight service.

The common costs in the railroad industry are allocated between freight and passenger service on the basis of the ICC's separation rules. [44/] These reach their objective through a two-step procedure. The first step disposes of expenses "directly or naturally" assignable, and the second, "apportions" the remainder in accordance with certain physical units performed on behalf of the respective services. The statistical usefulness of both steps is open to question. The first is dubious because it provides such latitude for the exercise of judgment as to render the reported numbers largely incomparable. The second is of doubtful validity because it assumes that the cost impact of common physical units is identical for all services. Together, they provide a separation devoid of economic meaning; they fail to measure avoidable cost.

In the case of directly assigned costs, the ICC rules are inadequate because judgments differ as to what is "naturally" assignable. For example, the rules provide that "the test of whether an item of expense is direct or common should be based upon whether <u>the service performed or the use of the facility</u> is related solely to the freight service or the passenger service, on the one hand or on the otherhand, is common to both freight and passenger services. (Emphasis supplied.) When however, the "service performed" may be in conflict with "the use of the facility," which shall govern? As Professor Dwight Ladd points out:

> The service performed in preparing a passenger locomotive to move a passenger train is related solely to passenger service. Ergo, the service is direct. Both freight and passenger locomotives use the same facility for servicing. Ergo, the service is common. "You pays your money and you takes your choice." [45/]

The implications of such a procedure for the development of comparable costs are obvious.

Non-traceable costs are divided between freight and passenger on the basis of such physical units as gross ton-miles, switching locomotive hours, or train-miles. In cases where such a relationship is impossible to establish, as in some traffic and general expense and superintendence, for instance, apportionment is on the basis of the proportionate costs directly assigned, or on the basis of "preponderant use." All these allocation procedures are arbitrary to a greater or lesser extent. For example, track expense is apportioned on a gross ton-mile basis, on the assumption that gross ton-miles in both services can be equated in cost impact. Yet the maintenance of commonly used facilities at passenger standards often involves a higher level of unit costs than track expense incurred in facilities solely related to freight service. [46/]

Additionally, the separation rules provide no basis upon which passenger expense can be segregated between its various components (milk, mail, baggage, express, coach, dining and Pullman service), nor do they facilitate the derivation of costs properly attaching to commuter as distinguished from long-distance travel. Finally, they provide little assistance in such common cost situations as the carriage of piggyback trailers in passenger trains, an operation which may become increasingly important with the passage of time.

Thus the inherent defect of the separation rules as they presently exist is that common costs are allocated on an accounting rather than on a statistical basis. That is to say, allocation is made on the basis of one independent variable, ton-miles, yard engine hours, or whatever it may be, and therefore contains the implicit assumption that there is only one factor which influences the size of particular costs. Moreover, the variable selected as the basis of allocation is assumed to be that which is significant or predominant, without a statistical investigation based on the construction of a cost function giving weight to several possible variables through correlation analysis.

Recent attempts to improve the rail common cost situation have been unsuccessful. On April 5, 1957, the ICC instituted a proceeding (Docket 32141) to consider a revision of its separation rules. "Interested persons were invited to file written views or suggestions for modifying the present rules. Particular attention was directed to the bases for distributing common expenses between freight and passenger services so as to develop a separation that will be more equitable and informative and generally more useful to us, the carriers and the general public. 47/ Among the suggestions advanced for improvement of the separation rules was that the influence of the physical factors relied upon henceforth be measured by statistical methods. However, the effort came to naught; "as the result of a hearing ..... it was determined that the present rules governing such separation produce valid results, are adequate for the purpose for which intended, and require no modification." 48/

As matters stand today, therefore, one of the basic building blocks for railroad costing, namely the fundamental separation of common costs between major services, is derived by highly questionable methods.

Section 7. Factors Affecting Cost Behavior

Traffic volume is the most significant factor affecting transportation costs, but it is not necessarily the only one. Some other factors are:

Plant Size. The size of a carrier itself would seem, by common observation, to have some relationship to its cost experience. Very small carriers are likely to have lesser costs in some respects because of personalized supervision. Very large carriers accrue cost benefits in such areas as centralized purchasing, reduced accounting costs through integrated data processing, flexibility in maintenance programming, etc., which are unavailable to smaller companies. Relatively little is known about the quantitative significance of such "size" costs, but through use of statistical cost functions more information may become available. One report found that:

> ... the obvious difference between the Nickel Plate and the Santa Fe is that one is geographically a small railroad and the other a large railroad. Some but not all of the cost behavior differences in the two roads is clearly due to this difference in the physical size of the two roads. [49/]

City Size. Areas congested by commercial and other industrial activity, overpopulation, and resultant vehicular traffic, result in lower over-the-road speeds, larger terminal facilities, and higher overhead expenses. Distance covered per man hour is lessened and costs, therefore, are higher. Examples of such cost behavior are cited in Ex Parte MC-22, which rejected motor carrier efforts to maintain constructive mileage rates to compensate for delays at ferries and tunnels in the New York metropolitan area. [50/]

City size often has an effect on operating costs because of differences in pay scales. To illustrate, an agent at a smaller community may be paid $ 250. per month while a comparable employee may have to be paid $ 300. per month in a larger city and $ 350. per month in a metropolitan area. Airlines, for example, have established separate pay scales for station employees, with pay differentials directly related to city size.

Shipment Size. Many items of expense, particularly of origin or termination are experienced in about the same magnitudes irrespective of shipment size. Accounting and clerical work, billing and collecting, in particular, are as expensive for a 50 pound as for a 20,000 pound shipment. Consequently, when cost is expressed on a ton-mile basis, unit costs are higher for smaller shipments than for larger. Similarly, the time taken to load large shipments is not proportionately as great as for small, with correspondingly higher unit labor costs for small shipments. The costs of stopping and starting, and additional mileage required to pick up small shipments or few passengers, are as great as for large or many, but they must be spread over fewer revenue units.

Moreover, special devices have been perfected to load heavy shipments in bulk, which tremendously reduce terminal handling costs, whereas package freight handling inevitably involves proportionately greater amounts of manual labor with resultant higher unit terminal costs. Small size shipments require consolidation for line-haul movement; they must be expensively handled through freight houses, or over platforms, a feature unnecessary with larger shipments. Furthermore, small shipments do not lend themselves to economical use of space, hence they give rise to unused capacity costs.

<u>Geographic Location (Topography & Climate)</u> Operating costs of all forms of transportation are responsive to both topography and climate. Extreme grades and curves require heavier equipment or greater horsepower often accompanied by increased fuel consumption and reduced speeds. Motor carriers face the hazard of road surfaces, which increase tire wear and tear, and accelerate cyclical maintenance requirements. In some areas hazards such as rain, sleet, snow, flood and landslide present special problems and when recurrent adversely affect operating cost levels.

In the case of airlines, topography and weather become increasingly important factors with the introduction of turbo-props and jets. During hot spells available pay load is reduced; at higher altitudes greater weight penalties are imposed. Unit cost of supplies, notably fuel, are also responsive to geographical disparities.

<u>Traffic Density and Composition</u> Traffic density is usually measured in terms of ton-miles or passenger-miles per mile of route operated and is a measure of route or facility utilization. If the traffic density is low, the unit transportation cost is likely to be relatively high, and such higher cost often has an impact on applicable rates. The reverse is also true, of course, since increased route utilization by all types of carriers leads (up to a point of optimum utilization) to decreasing costs per car-mile, tow-mile, vehicle-mile or train-mile.

The composition of traffic is another factor with substantial influence upon costs per ton-mile or vehicle-mile. Differences in the consist of traffic as well as variations in the size of the load carried tend to give rise to significant cost differences in such areas as platforming, billing and collection, station and ancillary handling requirements, such as heating or refrigeration, as well as in line-haul service.

As one authority has it, treating expressly of motor carriers, though his point is equally valid elsewhere:

> ... the output of the various trucking firms is far from homogeneous and indeed there are substantial quality elements which differ widely from firm to firm. The sooner we reject the idea that transport firms supply homogeneous ton-miles of service, the sooner we shall be in a position to grapple with some fundamental problems in the economics of transport.... [51/]

The point was treated, though with different emphasis, in the <u>68th Annual Report of the I C C</u>, which states, at page 29, that

> the various groups of carriers differ in regard to circuity of routes, loading practices, speeds and collateral services rendered. Consequently, a ton-mile or passenger-mile of one group cannot be regarded as the economic or even the physical equivalent of a ton-mile or passenger-mile of another group of carriers.

<u>Utilization of Equipment</u>. In all forms of transportation, a major impact on cost is exerted by the extent to which revenue-producing equipment can be (a) kept in revenue service, i.e., under load, and (b) utilized to capacity when in service. The extent to which these may be possible relates to many factors, among which are traffic composition, route structures, shipping practices, and maintenance policies.

<u>Traffic Imbalance</u> is another cost-shaping factor occuring in both freight and passenger transportation. Intercity passenger traffic is typically balanced, i.e., of equal density in both directions of flow, but there are numerous exceptions to this rule, notably in seasonal pleasure traffic to resort areas. To illustrate, eastbound trans-Atlantic ships and planes in late spring and early summer have high load factors (i.e., ratios of occupied to available accommodations), while westbound movement is sparse. In late summer and early fall the reverse is true. Because revenues must cover round trip costs, fares are higher than they would be if balanced load factors were attained. Another case of traffic imbalance with cost impact occurs in the commuter services operated by regulated bus and rail lines serving large cities. These exist to fill a public need for transportation to work in the morning and from it in the afternoon. Many of the costs attaching to such service result from its unbalanced nature, and thus again fares are higher than they would be if the traffic flow was bi-directional.

As a general rule, however, traffic imbalance is more commonly found in freight than in passenger operations. For example, a preponderance of single direction traffic handled by certain types of motor carriers requires expensive “bob-tailing” and”deadheading” of equipment not under load.

This is evident in irregular route carrier operation, where overhead and terminal expense may be typically lower than characteristic of regular route service. Such advantages may be offset, however, by the empty return of equipment, contrasted with higher round-trip load factors experienced by regular route carriers. 52/

Freight movements characteristically display a directional imbalance over long periods of time primarily because of the geographic location of extracting, processing and production centers vis-a-vis consumption concentrations. Illustrative of the case is evidence of such directional traffic disparities in domestic air freight movements during September 1948: 53/

		Thousands of Ton-Miles	
Region A	Region B	A to B	B to A
Northeast	All areas	7,401	3,675
California	All areas	4,658	6,197
Texas	All areas	296	1,462
Central	All areas	3,786	3,392
Florida	All areas	51	236
Northwest	All areas	57	199
All other	All areas	430	1,518

In this situation the CAB permitted a reduction to 60% of the general minimum air freight rates on eastbound movements, to encourage the achievement of a balanced traffic flow.

Length of Haul. It is aximatic that costs will vary with length of haul, for transportation is, basically, the coverage of distance. However, costs do not increase uniformly, i.e., at specified rate per mile for each mile of transportation, because there are terminal costs at the point of origin and at the point of destination which remain fundamentally fixed for each movement. Thus, the same cost attaches to loading and unloading 10,000 pounds of cotton goods on a trailer regardless of whether the trailer is hauled from New York to Philadelphia or from New York to Miami. It follows that total unit costs decline with distance because of the distribution of terminal expense over larger numbers of ton-miles.

The same phenomenon exists with respect to passenger terminal costs. It does not, for example, cost ten times as much to process a passenger ticket for a 200 mile trip as for one of 20 miles. In fact, with printed ticket stock, it costs no more.

Furthermore, movement costs, although highly variable, do not increase at a constant rate per mile of transportation performed. Long haul shipments allow better vehicle utilization. The omission of drop-offs at intermediate stops permits more vehicle miles per day. Thus, there are more miles performed for the depreciation cost per vehicle day and for the driver cost per day. In addition, long haul service reduces the probability of low load factors. Whenever freight is or passengers are partially off-loaded, there must be a replacement, often absent, of an equal amount to maintain the previous load factor. Moreover, in truck transportation longer hauls and larger shipments (related to the wholesale aspects of distribution) are related phenomena, so that ton-mile costs are significantly less than in short-haul small package service, (related to the retail stages in the distribution process) where both cost determinants operate to increase expense. 54/

Long haul air transportation, if accompanied by longer plane hops, has the effect of sharply reducing per mile operating costs. Aircraft are notoriously inefficient in short hops due to the time and fuel required for take offs. Likewise, comparatively little mileage is traversed in descent. It is under cruise conditions that maximum mileage is covered at minimum cost. Thus, for a flight of 250 miles a DC-6B will incur direct operating costs (flying operations, maintenance, and depreciation) of $ 1.24 per mile. The same aircraft on a 500 mile hop will reflect costs of $ 1.08 per mile. At 1,000 miles, the average mile will cost $0.98. 55/ The new prop-jet and pure jet aircraft, because of their vastly greater speed and heavier take-off costs, accentuate this characteristic of high cost short hops and lower cost long hops. In fact, it takes more miles to permit the larger, faster aircraft to attain the cruising altitude of maximum efficiency.

Nature of Handling Handling costs are closely coupled with the service performance of a carrier. Some carriers merely transport shipments between terminals, while others give service to intermediate as well as terminal points. Handling costs of a carrier performing distribution service are going to be high, by contrast with one engaged in a key-point operation. Pick-up and delivery costs are greatly affected by the nature of handling. Such questions as:

(1) Will there be interference with loading or unloading?
(2) Will extra labor be required?
(3) How are goods packaged?
(4) What do goods weigh per case, box or crate?
(5) Are goods palletized; if so, will they be loaded by mechanical means?
(6) Who does the loading and unloading?

have a great bearing on experienced costs. A pertinent case is that of motor carriers permitted to reduce their rates on cheese and oleo from New York to Washington when the shipments were on pallets loaded and unloaded by the shipper and consignee. The ICC found that it required five hours less to load and unload palletized shipments of 32,000 lbs., or 6¢ per cwt. 56/

Ancillary Service Complementary to their terminal and line-haul service, many carriers perform ancillary services as part of the comprehensive transportation package. Examples are: COD service, in-transit privileges, furnishing of demurrage, blocking and bracing, labor and materials, storage, icing and heating, and reconsignment privileges. Each of these has its own cost characteristics which cannot be ignored in overall cost calculations.

Circuity. Circuity may be defined as the percentage by which the actual miles of haul exceed the direct, short-line, or short-haul mileage relied upon for rate making purposes. Meaningful cost calculation cannot ignore the fact that deviations from direct point to point movement are typical of all forms of transportation, due to weather, traffic conditions, or terrain factors. Oftentimes, circuity is difficult to measure with respect to particular traffic, and thus averages based on broad experience are relied upon.

Passage of Time The mere passage of time affects cost behavior, most frequently in the depreciation and obsolesence of equipment, facilities and materials. In air transport obsolesence is the predominant element; in other forms of transportation, the cost of exposure to the elements looms large. In the maritime field this results in the familiar phenomenon of block obsolesence reflecting the huge wartime shipbuilding programs, followed by little or no replacement construction. Failure properly to maintain facilities, or to replace them when timely, affects cost behavior in a variety of ways. Reduced speeds, increased breakdowns and inefficiencies in general reflect costs arising when the passage of time is not given overt recognition through depreciation charges and replacement cost.

Management Determinations Some costs are distinguished from others in that they are subject to management control. [57/] These include expenditures for advertising, public relations, traffic solicitation, planning, research, and supervisory services. These items respond to management discretion since the functions are generally performed by salaried personnel, and management has leeway in deciding when to add them. Once added, they become part of the body of fixed costs, at least for the short-term.

Requirements of Law Costs are not determined merely by technological or physical conditions. In many respects they are shaped to a significant extent by influences over which the carrier itself has little control. This is particularly true for example, of labor costs, which are greatly affected by the power of regulatory bodies to determine qualifications and maximum service hours for transportation employees, and by the requirements of Federal and state legislation, such as the Fair Labor Standards Act. Whether or not such legislation is directed explicitly at transportation employees, as in the case of some states requiring crossing watchmen or additional crew members in certain situations, responsive costs are usually the result. This has been recognized by the ICC, for example, which found upon passage of the Social Security Act that, "a new item of overhead expense is the contribution for social security." [58/]

The same cost impact beyond carrier control is experienced with respect to tax levies and user charges for government-provided facilities.

Finally, the power of regulatory bodies and other government agencies to create or nullify competition obviously will raise or lower unit transportation costs, insofar as these are a function of available capacity.

Labor Agreements Costs resulting from labor agreements have been dealt with extensively in transportation literature, and will not be described here except to point out that the infringements of productivity caused by working rules and agreements in all the transportation industries undoubtedly are reflected in the cost levels experienced by the various kinds of carriers. To the extent that these obscure measurement of performance under efficient conditions, they further complicate the regulatory responsibility for intermodal comparisons.

Section 8. Cost Structures of the Major Modes

The cost structures of the principal modes of transportation can be compared in two ways, either in aggregate terms or by the illustrative analysis of a specific situation. This section and that which follows deal respectively with each.

To grasp significant aggregative cost differences, a separation must first be made between capital and operating costs experienced by the various modes. Taking capital costs initially, the table on the next page provides the key to intermodal capital cost differences. The table illustrates that the most striking difference between railroads and pipelines, and other forms lies in the very high proportion of carrier ownership which for the former two modes is devoted to land, structures and rights of way. This amounts to about 67% of aggregate net investment for the railroads, and practically 100% for the pipelines.

In contrast, the motor, water, and air transport systems do not own their rights of way. Class I motor carriers for example, have 78% of their investment in carrier property, devoted primarily to revenue producting equipment with only 21% going to the "land, land rights and structures" which constitute their terminal facilities. The public investment in the rights of way used and useful for motor transportation far exceeds the investment in operating property by the carriers. As the table on the next page shows, Class I and II Motor Common Carriers of General Commodities (an uncertain fraction of the total motor carrier industry) have about $ 625 million net investment in such property, [59/] the net depreciated investment in all publicly owned roads and streets used as rights of way by these carriers is estimated to be about $ 40 billion, with an additional $ 300 billion or so to be spent over the next 30 years for construction and maintenance. [60/]

The domestic waterways system, including the Great Lakes, the inland waterways, and the coastwise routes of the Atlantic, Gulf and Pacific coasts is also completely toll-free, [61/] without carrier investment in navigation channels.

Similarly, the air transport system includes airways and airport facilities that are largely public-owned. The federal system of air lanes, 65,000 miles in length, is equipped with toll-free navigational aids and traffic control facilities. Most airports used by commercial aircraft are publicly owned and built by Federal funds matched by the local authorities. As a result, the operating property of the airlines is made up principally of flight equipment and only to a minor extent, of terminal and maintenance facilities.

The significance of the higher proportion of railroad and pipeline ownership devoted to right of way and structures lies in the fact that such property is only slowly and with difficulty adaptable

NET INVESTMENT IN TRANSPORTATION PROPERTY
MAJOR REGULATED COMMON CARRIERS OF THE U.S.
AS OF DECEMBER 31, 1957

Item	Class I Railroads	Motor Freight Carriers	Inland & Coastal Waterways	Oil Pipe Lines	Domestic Trunk Airlines	Class I Railroads	Motor Freight Carriers	Inland & Coastal Waterways	Oil Pipe Lines	Domestic Trunk Airlines
	Millions of Dollars					Percent of Total				
Fixed Property	15,211	133	-	1,791	-	67.0	21.4	-	100.0	-
Equipment	6,746	484 1/	173	-	830	29.7	77.8	100.0	-	94.3
All Other	757	5	-	-	50	3.3	.8	-	-	5.7
Total	22,714	622	173	1,791	880	100.0	100.0	100.0	100.0	100.0

1/ Understated due to leased equipment used by many carriers.

Source: Interstate Commerce Commission; Civil Aeronautics Board.

to fluctuations in traffic volume. Thus, the Class I railroads in the year 1957 incurred $ 150 million of depreciation on road property, $ 4.5 million of insurance costs on way and structures, plus real property taxes estimated to total about $ 3¼ million. Of the latter sum, a sizeable proportion is applicable to right of way. In addition a substantial part of railroad "fixed charges", amounting in 1957 to over $ 300 million, must be assigned to right of way expense. Finally, there is maintenance of way. Although volume will have a bearing on such cost, an indeterminate portion must be incurred regardless of volume, so long as a facility is to be kept in serviceable condition. To illustrate, snow, ice and sand removal, which costs the railroads about $ 16 million annually, must be performed to some extent irrespective of the number of train movements. The maintenance of bridges, trestles and culverts, for which the railroads spent over $ 50 million in 1957, can be deferred for longer periods, but often some expenditure is necessary for even the minimum operation. Although prudent managements seek to hold such expenditures to levels commensurate with usage, there are irreducible minima. Hence, this type of capital is the source of much of the "fixity" which characterizes the cost of rail and pipeline carriers.

Equipment, by contrast, which is the major capital component of air, marine and motor carriers, is divisible into relatively small units (trains, trailers, barges, planes) which facilitate adjustment of capacity to volume within much shorter time dimensions. Equipment costs are, therefore, variable to a markedly greater extent than way and structures.

Thus a major cost difference between railroads and pipelines, and carriers of all other types, arises from ownership by the two former of their rights of way and structural facilities. This has three consequences from the cost standpoint:

(1) In relation to total capital requirements, private sources supply a larger proportionate share of rail and pipeline capital requirements. This imposes capital costs escaped to a greater or lesser extent by carriers whose facilities are supplied by public funds. The absence of need to earn a return on much of the public investment in transport facilities thus provides an unbalanced point of departure for capital cost comparisons. But, "these perplexing problems do not disturb the highway administrator, who is not concerned with paying interest on money that was not borrowed." [62/]

(2) Comparisons based solely on corporate (i.e., company-borne) costs will indicate a higher proportion of fixed costs in rail and pipeline transportation, since

the fixed costs of other types of transportation are largely outside the corporate framework.

(3) Railroads and pipelines must meet the costs of these facilities as sole users, whereas other regulated carriers can share their right of way and structure costs with other classes of users, e.g., exempt carriers, private carriers and military traffic.

By contrast with capital costs, the structure of carrier operating expense can be examined either by object or function. An objective analysis of carrier cost structures (i.e., one which relates to nature of cost incurred, by contrast with functional analyses focused upon the purposes for which costs are incurred) is possible only for certain very broad cost categories. Even with respect to these, comparisons based on published data are infeasible for certain types of carriers, as the table on the next page shows.

Labor The data confirm the not surprising fact that labor is the preponderant cost element for air, motor and rail carriers. They also reveal that this cost element is relatively smaller for pipelines and water carriers.

The importance of labor in the rail cost picture raises an additional question as to the extent to which such costs are fixed and variable with traffic. An examination of aggregate compensation by employeeclass affords only elementary guidance on this question.

Distribution of Compensation to Class I Railroad Employees by Function, Year 1957

		Compensation- ($000)	Percent of Total
I	Executives, Officials and Staff assistants	180920	3.4%
II	Professional, Clerical and general	969312	18.1%
III	Maintenance of Way and Structures	743209	13.9%
IV	Maintenance of Equipment and Stores	1196884	22.3%
V	Transportation (other than train, engine, yard)	572172	10.7%
VI (a)	Transportation(yardmasters, switch tenders and hostlers)	99992	1.8%
(b)	Transportation (train and engine service)	1595560	29.8%
	Total	5358049	100.0

Source: Table 67, "Transport Statistics in the U. S."

LEADING COST COMPONENTS OF CLASS I RAILROADS, MOTOR COMMON CARRIERS OF GENERAL FREIGHT
DOMESTIC TRUCK AIRLINES, INLAND & COASTAL WATERWAYS, AND OIL PIPE LINES, 1957

	Class I Railroads	Motor Freight Carriers	Inland & Coastal Waterways	Oil Pipe Lines	Domestic Trunk Airlines	Class I Railroads	Motor Freight Carriers	Inland & Coastal Waterways	Oil Pipe Lines	Domestic Trunk Airlines
	Thousands of Dollars					Percent of Total				
Labor (Including Payroll Taxes	5,432,027	1,787,045	78,164	156,073	636,453	66.02	59.21	34.73	40.36	46.20
Fuel (Including Taxes)	433,028	203,262	N.A.	N.A.	215,878	5.26	6.73	N.A.	N.A.	15.67
Depreciation	581,499	149,962	11,712	97,597	115,256	7.07	4.97	5.20	25.24	8.37
Insurance, Loss & Damage, Injuries to Persons	245,758	99,283	14,024	N.A.	14,108	2.99	3.29	6.23	N.A.	1.02
All Other	1,535,210	778,822	N.A.	N.A.	395,885	18.66	25.80	N.A.	N.A.	28.74
Total Expenses 1/	8,227,522	3,018,374	225,084	386,661	1,377,580	100.00	100.00	- -	- -	100.00

1/ Includes expense elements not reported objectively.

Source: Interstate Commerce Commission; Civil Aeronautics Board.

The table indicates that in 1957 21½% of labor compensation went to groups generally regarded as being relatively insensitive to small changes in traffic: executives, officials and staff assistants (3.4%) and professional, clerical and general (18.1%). Transportation employees, a group more highly responsive to volume, account for 42.3% of the total compensation; the remaining 36.2% goes to employees involved in maintenance of equipment, way and structures, and stores. In this category particularly it is very difficult to determine fixed and variable elements, since costs are subject to a high degree of management control. As two authorities put it:

> The railroads of the United States were able to cut current maintenance expenses in proportion to the decline of revenues experienced during the severe economic depression in the early thirties. Extensive improvements during the previous decade helped to make this practice possible. However, much of the reduction was postponed maintenance expense that should be credited to the maintenance cost of that period. Hourly or day-to-day fluctuations of traffic cannot be reflected in expenditures for maintenance and even some transportation expenses. However, over a period of many months or several years the ability of management to curtail maintenance expenses and reduce the standards of service with a decline of traffic has been demonstrated to be substantial. [63/]

Fuel is a significant cost component for all types of carriers, but relatively more so for motor and especially air carriers. Aggregate data on fuel expense incurred by regulated water carriers and pipeline are unavailable, but a detailed examination of the information reported by several individual carriers seems to indicate that such expense is minor for pipelines; for water carriers, like airlines, it probably constitutes the second largest cost category.

Depreciation. The proportionately larger depreciation expense of the airlines brings into focus the relative importance of obsolescence as compared with wear and tear. Air transportation has been influenced by military developments to a larger degree than the other types. The conversion of new military aircraft to commercial counterparts has made obsolete many of the prior aircraft. Thus, the higher depreciation expense of air carriers is substantially the result of the short service lives over which existing aircraft have been depreciated, and has little relationship to the economic usefulness of the aircraft being depreciated.

The wear and tear element of depreciation is dependent upon the prospective life of the property and equipment and, allegedly, varies between companies because of the "different conditions which surround the use of the property in each individual case." [64/] But for many carriers the fundamental question remains whether depreciation conditions vary as much as depreciation policies. Each company uses its own judgment, taking depreciable property bases that may differ widely from those reported to the Internal Revenue Service. It is not unusual for carriers to use on basis for reporting to stockholders and another for tax purposes. Moreover, as is well known, most rail carriers utilize for certain property a replacement and betterment accounting system in contrast with the depreciation accounting utilized by other carriers.

For these reasons, aggregate reported depreciation has many incomparable elements and is little more than a guide to the policies of the different modes; it certainly is only a very gross measure of relative depreciation cost in the economic sense.

Somewhat greater detail is revealed when carrier cost components are examined in relation to the operating function for which incurred, as shown in the table on the next page. It should be emphasized that the figures in the table comprehend substantially all air, rail,and oil pipeline operations, only small groups of these types being excluded. For these modes, therefore, the figures are likely to be more representative than for motor and water carriers, where enormous groups of firms are omitted from the data by virture of relief from detailed reporting requirements or exemptions from regulation. At the same time it should be emphasized that the data although far from fully comparable, are arranged for maximum functional comparability within the framework of present accounting systems.

The table indicates that "transportation" (i.e., movement) costs are a substantially lower proportion of total operating expense for pipeline and rail than for other modes of transportation; that railroad maintenance costs are a relatively larger element of total cost than for pipe and airlines, with motor and water carriers spending proportionately least for these purposes. Water, motor and rail carriers have about the same reported proportion of depreciation expense, at a level significantly lower than air and especially pipelines. "Traffic" expense, i.e., sales promotion, solicitation, advertising, etc., is much more significant for air carriers than for any of the other types, while water and motor carriers have the highest relative proportions of equipment and facility rentals, tax and license costs, a very heterogeneous category, are much lower for water and air carriers than for the other modes, and there appear to be significant differences in the levels of administrative and general overhead costs.

In addition to these general findings, certain specific observations seem pertinent with respect to particular types of carriers.

<u>1. Motor Freight Carriers.</u> Because of the changing number of motor carriers reporting to the ICC from year to year, we have also

COMPARISON OF PRINCIPAL OPERATING EXPENSE CATEGORIES BY FUNCTION
MAJOR REGULATED COMMON CARRIERS OF THE U.S., 1957

	Class I Railroads	Motor Freight Carriers 1/	Inland & Coastal Waterways Class A & B	Oil Pipe Lines	Domestic Trunk Airlines	Class I Railroads	Motor Freight Carriers	Inland & Coastal Waterways Class A & B	Oil Pipe Lines	Domestic Trunk Airlines
	Thousands of Dollars					Percent of Total				
Transportation										
Gathering				34,670					8.31	
Line Haul		461,323 2/	112,800	109,453	516,439		37.49	50.11	26.21	37.49
Terminal		220,243	17,818		217,207		17.90	7.92		15.77
Total	4,094,780	681,566	130,618	144,123	733,646	44.27	55.39	58.03	34.52	53.26
Maintenance										
Ways & Structure	1,279,662					13.83				
Equipment	1,482,358	152,375 3/	23,688 3/	74,650 3/	270,328 3/	16.03	12.38	10.53	17.88	19.62
Total	2,762,020	152,375	23,688	74,650	270,328	29.86	12.38	10.53	17.88	19.62
Depreciation	581,499	69,067	11,712	97,597	145,484	6.29	5.61	5.20	23.37	10.56
Traffic	259,642	47,434	4,826		157,560	2.81	3.86	2.14		11.44
Equipment & Facility Rentals (Including Purchased Transportation)	273,116	62,593	21,757	7,011	13,854	2.95	5.09	9.67	1.68	1.01
Taxes & License 4/	748,081	86,278	2,204	30,889	30,228	8.09	7.01	.98	7.40	2.19
General Administrative & All Other	529,581	131,105	30,277	63,280	26,420	5.73	10.66	13.45	15.15	1.92
Total	9,248,719	1,230,418	225,082	417,550	1,377,520	100.00	100.00	100.00	100.00	100.00

1/ Data of 258 common carriers of general freight operating principally owned equipment.
2/ Includes pick-up and delivery.
3/ Includes structural maintenance of owned property.
4/ Excludes Federal Income Taxes.

Source: Interstate Commerce Commission; Civil Aeronautics Board.

analyzed the costs of five large motor carriers, [65/] one from each major region of the country, over a 5 year period, as shown in the following, table:

	Percent of Total Operating Expense		
	1954	1958	Change
Line-haul expense	56.09	55.80	- 0.29
Pick up & delivery expense	12.89	14.03	+ 1.14
Platform expense	12.59	12.72	+ 0.13
Billing and collecting	2.73	2.63	- 0.10
Loss and damage	1.58	1.51	- 0.07
General overhead	13.84	13.10	- 0.74
Other	0.28	0.21	- 0.07
Total	100.00	100.00	

During the intervening five years, in which these carriers enjoyed a ton-mile growth of 4%, only the relative proportion of pick up and delivery expenses and general overhead changed appreciably. All other costs showed a remarkably stable relationship to the total. The decline in general overhead is surprising only to the extent that it is minor in light of the sizeable increase in volume. In other words, for these five large carriers, general overhead increased almost in proportion to traffic, thus confirming its predominantly variable character.

Part of the rise in reported pick-up and delivery cost is due to an increase from 66.6% to 73.0% in the proportion of total pick-up and delivery costs charged to non-purchased transportation paid for on a time basis. It is therefore possible that increased volume in 1959 may in fact have been accommodated without truly proportionate increases in this cost category.

2. Air Transportation

(a) Domestic Trunk Lines ...The CAB affected a realignment of reported costs as of January 1, 1957. However, a reconciliation of old and new reported costs during the period 1953 through 1957 leads to the conclusion that of all cost categories only promotion and sales, general and administrative costs and depreciation decreased in proportion to the total. Thus, as volume increased, the costs applicable to flying, maintenance, passengers, and servicing the aircraft increased, thereby increasing their proportionate share of total expense. Promotional costs, general expenses and depreciation were not as responsive to traffic, and thereby dropped in relation to total costs.

(b) All Cargo Carriers...Having fewer indirect expenses (no passenger service, for example), flight costs (including maintenance) necessarily loom larger in the total cost picture of the cargo carriers. Between 1953 and 1957, flight expense and maintenance costs usually constituted 60-63% of all costs for these carriers. There have been significant shifts, however, in their indirect costs: general services and administrative expenses have experienced a relative decrease, while depreciation has increased in proportion to total. This inverse relationship has been created by the introduction of larger equipment to bring operating costs down; first the DC-6A, then L-1049H, both accompanied by phase-out of the war surplus*and C-46 types. At the same time increasing volume, resulting from an increased capacity of the larger aircraft, did not require proportionate increases in general services and administrative costs.

A breakdown between movement and terminal costs indicates that 67% of total air cargo carrier operating cost is attributable to intercity (direct flight, line-haul) movement, in contrast with 56% for the analogous function by motor carriers. However, the truckers' line-haul cost includes equipment depreciation, while the air cargo carriers segregate an additional 7% to cover that cost.

Unlike motor carriers, however, the all cargo air carriers do not have costs comparable to pick-up and delivery included in their operating expenses.

3. Oil Pipelines. Oil pipeline costs are collected in two groups: gathering line and trunk line expenses. The gathering lines are those which connect the field tanks (where oil is initially stored) with storage tanks adjacent to the trunk lines. The trunk lines carry either crude from the storage tanks to the refinery, or finished products from refinery to consuming centers. [66/]

About one-quarter of total oil pipe-line costs is gathering line expense, while three-quarters is trunkline cost. Because the number of lines reporting to the ICC varies from year to year, we have analyzed the cost composition of five leading companies, over the period 1953-57. [67/] Their cost structure has varied as follows:

Gathering Lines	1953	1957	Change
Maintenance - Depreciation	3.7%	4.8%	+ 1.1
- All other	6.0	6.0	- -
Transportation	8.9	10.0	+ 1.1
General Office Salary & Expense	1.3	1.5	+ 0.2
Other Operating Expenses	2.9	3.3	+ 0.4
Total	22.8	25.6	+ 2.8
Trunk Lines			
Maintenance - Depreciation	15.9%	16.4%	+ 0.5
- All other	15.9	14.5	- 1.4
Transportation	31.2	29.3	- 1.9
General Office Salary & Expense	4.4	4.2	- 0.2
Other Operating Expenses	9.8	10.0	+ 0.2
Total	77.2	74.4	- 2.8
Total Operating Expense	100.0	100.0	

* DC-4

In all cases, it is clear that maintenance is the major cost category, with pipeline repair, approximating 19-20% of the total, being the largest single maintenance cost. Although transportation cost is secondary to maintenance, 54-55% of total transportation costs represent pumping station operation, so that this is the largest single pipeline expense, involving about 21% of total oil pipeline operating cost.

Impact of Volume Changes

Concluding our examination of aggregate carrier cost structures was a brief analysis of short-term variation of operating expense with traffic volume for Class I railroads, motor common carriers of general freight, oil pipelines, and domestic trunk airlines. This required first, the elimination of cost changes arising from causes other than volume, e.g., changes in wage rates, changes in amount of overtime, vacation pay, efficiency, etc. With time limitations precluding the development of a price deflator suitable to all agencies of transportation, the "Wholesale Price Index for all Commodities Other Than Farm Products and Foods" was used to deflate costs applicable to years other than the base year. The selected base year was 1953, allowing study of the four following years through 1957.

When total operating expenses are thus deflated and costs related to increasing revenue ton-miles, the resultant cost per ton-mile (i.e., average total cost) has decreased for each form of transportation. This is shown in Appendix D, from which it appears clear that increases in volume have outstripped the growth of costs, thereby reducing average unit costs. This is as might be expected in light of the fact that in the time period analyzed, not all costs could have been variable. The degree of variability of costs with volume in this short-term may be summarized from Appendix D thus:

	1953 - 1957		
	Changes in		
	Volume	Costs	%Variability
Class I Railroads	102.0	90.8	89.0
Motor Common Carriers of General Freight	106.8	104.3	97.7
Oil Pipelines	128.5	108.3	84.0
Domestic Trunklines	167.3	158.1	94.5

As might be expected, the analysis shows that oil pipelines have the least, and motor carriers the most variable cost characteristics, with railroads and airlines tending to be relatively low and high, respectively. The findings of this analysis are sketched briefly below for carriers other than railroads, whose variability characteristics are treated extensively elsewhere.

Motor Carriers of General Freight. Appendix E sets forth the percentage by which specified groups of expenses are variable with (a) vehicle miles, (b) tons of freight, and (c) number of inter-city shipments. The study covers a four year time span, 1953-57. It is clear that for all categories of costs, change in vehicle-miles operated is the most certain determinant of change in cost. Costs are somewhat less responsive to changes in tonnage and to number of shipments, probably because the capacity available at any given time is capable of handling more shipments and increased tonnage with minor added costs, whereas additional mileage automatically means increased capacity and attendant additional costs.

Regardless of the measure used for volume increases, it appears that labor is the most highly variable cost component, and insurance the least. It is worthy of comment that depreciation costs have been more variable in the 1953-57 period than the sum total of operating expenses, and that office and administrative expenses have not been "fixed" nor resisted volume changes. This is probably due to the fact that the industry as a whole has many relatively small firms and therefore any marked increase in volume must be met by fleet expansion and additions to the office complement.

Platform expenses, it seems, will remain fairly stable for a period of increasing traffic volume and then spurt upward, to a point where further increases in volume can be accommodated. Thus we have variability by steps and what appears to be a relatively fixed expense for some time becomes variable with a further increment in volume. Our analysis showed that platform costs and volume varied in the following manner:

	Volume in tons 1953 = 100	Platform Expense per ton (cents)
1953	100.0	219.46
1954	99.2	220.89
1955	112.8	218.36
1956	118.4	217.79
1957	118.7	230.05

Billing and collecting expenses remained fairly stable, averaging for the carriers analyzed, about 35¢ per shipment at any volume.

The predominant variability of motor carrier cost is confirmed by the 1953-57 experience, in which directly assignable costs outpaced volume rises; and terminal, billing, depreciation and general overhead expenses were responsive to traffic changes.

The expansion of depreciation with growth is manifested also by the five large carriers previously referred to, whose reported costs were examined for the period 1954-58. [68/] As a group they increased their depreciation expense as follows:

	1954-1958
Line-Haul Equipment Depreciation (A/c 5021)	+ 58%
Pick-up and Delivery Equipment Depreciation (A/c 5025)	+ 56%
Average Equipment Depreciation Expense	58%

However, for these firms the percentage of variability of "general overhead" was smaller than that of other categories. The percentage by which expense categories (deflated to 1954 levels) varied with changes in ton-miles of intercity freight was, for the period 1954-58 as follows:

Line haul expense	97.4	
Pickup & delivery	106.6	(expense increased more than traffic)
Platform expense	99.0	(expense increased in almost direct proportion to traffic)
Billing and collecting	94.2	
Loss and damage	93.6	
General overhead	92.7	
Other	73.7	(expense increased less than traffic)
Average All Expense	97.9	

Thus it appears that for the larger companies, with more extensive general overhead, additional volume can be served with less than proportinate increases in cost. This, as we noted above is not true of the industry as a whole with its myriad of small companies.

Of the larger carriers it may be concluded that transportation costs, line haul and pickup and delivery, which together equal 70% of total expense, are highly variable at all times. The remaining 30% of total cost is less variable in the short run. It is the influence of these and similar large firms upon the aggregate reported costs of motor general freight carriers which unquestionably produced the decreasing unit costs shown in Appendix D.

Domestic Trunk Airlines. Appendix F sets forth the percentage variability of the functional cost categories that accompany changes in air traffic volume as measured by revenue ton-miles. It will be noted that over the five year period 1953-58, Flying Operations, Maintenance and Passenger Service, all of which are costs related to aircraft movements, were fully variable. Aircraft and Traffic Servicing was less than fully variable between 1953-1956 and then mounted rapidly to exceed, costwise, the growth in volume. This is largely attributable to the increase after 1956 in larger aircraft vis-a-vis small aircraft. The ground handling of the larger aircraft called for increased crews in order to meet traffic peaks at scheduled departure times.

The addition of larger piston equipment in the immediate pre-jet period explains also the transformation in the variability of depreciation expenses. Between 1953 and 1956 this cost was not very responsive to volume, but then with the addition of enlarged fleets there was a surge of depreciation costs applicable to the new acquisitions. Promotion and sales and general and administrative expenses have been less prone to follow volume.

Each of the above mentioned functional classifications of airline cost contains elements of diverse variability. To illustrate, Flying Operations although of predominately variable characteristics, also contains aircraft rental expenses, which replace depreciation of owned aircraft. Such rentals are usually fixed on a monthly basis and increased traffic does not affect them. Flying Operations also includes insurance, a cost usually based on aircraft valuation. In addition this functional expense covers the monthly base pay portion of the pilot and copilot salaries, items which are fixed for the duration of a labor contract. To illustrate, a 6-year Eastern Airlines pilot flying L-1049 planes under rates effective September 1, 1958 would earn per month (flying half day and half night):

	60 hours	70 hours	80 hours
Base Pay	$ 310.00	$ 310.00	$ 310.00
Hourly Pay	492.00	574.00	656.00
Mileage Pay	247.50	300.00	355.00
Gross Weight Pay	144.00	168.00	192.00
Total	$1193.50	$1352.00	$1513.00
Pay per Hour	19.89	19.31	18.91

Thus, due to the fixed element of base pay, increasing capacity by flying another hour will cost less than the cost of the previous hour.

Obviously, increased traffic if handled by existing available seat-miles, involves no additional Flying Operations expense, while seat-miles added to take care of increased traffic will cost something less than previous average costs per seat-mile. If, however, the increased seat-miles required to accommodate increased traffic cannot be furnished by the existing aircraft and an additional aircraft is required, then the added seat-miles will cost more per unit simply because the fixed costs cited above will have to be duplicated. For example, another aircraft will mean another crew, with fixed base pay for the added crew; the added aircraft will take additional hull insurance, etc. In short, the variability of cost of Flying Operations with volume ranges from (a) zero (if no added seat miles are required and only a higher load factor results from increased traffic) through

(b) almost 100% variability (if added miles must be flown with existing aircraft) to (c) above 100% variability if new aircraft are required to fly the additional seat miles required by increasing traffic. In the long term, this means that Flying Operations expense is of a completely variable nature.

Oil Pipe Lines. For these carriers variability of costs with volume is relatively low. Maintenance costs are most responsive to traffic fluctuations, and as a whole trunkline expenses are less sensitive to traffic changes than gathering line costs.

Pipeline expenses vary in three respects: (a) with line diameter, including interest and depreciation on the pipeline itself, service costs of construction, cost of materials, property taxes, and maintenance; (b) with horsepower, outlays for electric power, labor, maintenance and operation of pumping stations, and the interest, depreciation and property taxes on the investment in these stations; and (c) with length of line, including in addition to the initial cost of tankage, surveying rights of way, damages to terrain crossed, and the maintenance and operation of a communication system. [69/]

Thus, as the industry has grown, depreciation and maintenance costs climbed with the expansion of lines, but operating costs (Transportation) then dropped with increased output. The larger the line diameter, the lower the overall cost per barrel-mile (and hence per ton-mile) for any given number of barrels per day. For any given throughput, the larger the diameter, the lower the cost per ton-mile (up to the point of diminishing returns). To illustrate, for a throughput of 100,000 barrels per day, costs per barrel-mile will decrease from .051¢" for a 10 3/4" line to .016¢ for an 18″ line and then rise, costing .017¢ for a 24" line. Similarly, for a 10 3/4" line, a throughput of 25,000 barrels costs .035¢ per barrel-mile. The cost drops to .031¢ if the throughput is raised to 50,000 barrels, but for 75,000 barrels, the cost rises to .038¢. [70/]

From 1953 to 1957, barrel-miles produced and hence ton-miles carried, increased 28½%. Trunkline depreciation, however, outpaced this growth due to new mileage. Operating costs (Transportation) and General Office Salaries and Expenses dropped as volume grew.

Aggregate cost comparisons clearly yield only a partial, though broad, picture of transport cost characteristics. For more incisive analyses, unit costs must be investigated.

Section 9. An Illustrative Case

Cost comparisons based on aggregated data for various kinds of carriers provide much illuminating information, but the sheer mass of numbers tends to obscure many more subtle but nonetheless meaningful cost comparisons, and implications for cost use. Moreover, data in the aggregate are significantly removed from the unit costs upon which the pricing process relies.

For development of unit costs and a description of their application to traffic, it is therefore necessary to turn from aggregated to specific costs, from the general to the particular situation.

To this end a comparison was made in 1957 rail, motor carrier and water carrier costs, between competitive points where all three types of carriers share in the movement of a single commodity group. No single commodity nor pair of points can be said to be fully representative, but the movement of manufactured iron and steel [71/] from the mills at Birmingham, Alabama to domestic outlets at New Orleans, La., will serve to illustrate the cost characteristics of the three transportation forms. The comparison utilizes methods which in general conform to those used by the ICC staff, except where otherwise indicated. As such it shares the inherent deficiencies of those methods, which are nonetheless the best available at this time for specific commodity intermodal cost comparisons.

The distance between Birmingham and New Orleans is 322, 354, 365 and 598 statute miles by air, rail, highway and water, respectively. Thus normal door to door truck service is "overnight." Line-haul railroad service approximates 12 hours and in the absence of a special switching time-study, "Rail Form A" provides for an additional full day to cover switching requirements at both origin and destination terminals, or a total of 60 hours in all. Water movement on the Warrior, Black Warrior and Tombigbee Rivers requires 4½ days (plus additional time at Birmingport to gather sufficient traffic to justify operations).

Just as elapsed time varies considerably between the three forms, so does the revenue load which they normally carry. The average revenue truckload approximates 15 tons; the rail equivalent exceeds 35 tons. Despite a nine-foot draft limitation and low lock capacity on this particular inland water route, each barge can carry 700 to 800 net tons and tows as large as ten or more barges can be handled.

It was determined that substantial return traffic was available to water and motor carriers between these points (limestone and other furnace feed for the former, coffee and other Central and South American staples for the latter). However, in the absence of evidence to the contrary, it was assumed that the rail box-cars handling this traffic would conform to average Southern Region experience, i.e., one-third will move northward empty. [72/]

Within these general parameters, unit costs were computed by several different methods, each of which has been used in cost presentations to regulatory bodies. Cost of movement by rail was derived on four separate bases: (1) at the total expense level without separation between variable and fixed cost portions; and after such separation at (2) the out-of-pocket level; and with full distribution of constant costs on (3) a ton and ton-mile basis, and (4) on the basis of proportionate revenues received for the traffic, Motor carrier costs were established on a total expense and out-of-pocket basis. Barge costs were calculated only on a total expense basis. The results by each method and a comparison with the rates applicable to the traffic, are shown in the following table:[73]

	Basis and Cost Per Cwt.				
				Full Distribution	
	Rate Per Cwt.	Total Expense	Out-of-Pocket	Ton/ Ton-Mile	Revenue Basis
Rail	48¢	21.311¢	16.475¢	21.797¢	26.023¢
Motor	48	46.52	41.87	N. A.	N. A.
Water	43.2	16.824[74]	N.A.	N. A.	N. A.

Unit costs computed at the total expense level are graphically segregated between (a) line-haul and terminal components and (b) objective components, in Charts I-A and I-B, respectively. Unit costs computed at out-of-pocket level for rail and motor carriers are compared with the total expense level for water carriers in Charts II-A and II-B, which show, respectively, the line-haul and terminal cost components, and the objective cost components, Chart III provides a graphic comparison between costs fully-burdened on the (a) ton and ton-mile; and (b) revenue basis, with (c) costs in which the constant elements have been distributed on the basis of out-of-pocket cost. These comparisons are provided in a generally familiar framework even though, as elsewhere described, the fully burdened costs have little relation to expenses added or avoided by handling or not handling this traffic. The charts do, however, provide (i) a measure of the relative costs of the three types of transportation; (ii) an indication of how the cost spread between them varies according to the method of computation; and (iii) a separation of the components of unit cost in a manner which shows the nature of the corporate expense incurred by each form of transportation.

Rail unit costs (given the commodity, loads, distances and other factors assumed for this illustration) are characteristically at a level between water, which is lower, and motor which is higher. In this connection Chart IV demonstrates that with lighter loads and shorter hauls, a reversal takes place in the relative costs of rail and motor transportation, with the latter assuming the role of low cost carrier for many commodities moving in interstate commerce. Unfortunately, time limitations precluded a detailed cost analysis in such a situation, but even with the factors used to ascertain the cost of steel movement, the respective areas in which these two forms operate at maximum relative advantage is clear.

This point is important and must be understood: there are relatively few points between which the three surface forms compete for carriage of a single commodity; the need to select one such for illustrative purposes precluded specific demonstration of the area in which motor carriers are relatively more economic, since this does not often occur where trucks and barges compete for traffic. But nonetheless, as Chart IV shows, there is a significant transport area in which motor carriers have a distinct cost advantage.

The relative unit cost levels of the three forms for the illustrative movement, and their variation by method of cost computation is indicated in the following table:

[75/]

	Index Water = 100
Water (Total Expense,all water)	100
Rail (out-of-pocket)	185
Water (Total Expense, incl. rail haul)	189
Rail (Total Expense)	239
Rail (Full Burden: Ton/Ton-Mile	278
Rail (Full-Burden: Revenue)	352
Motor (out-of-pocket)	470
Motor (Total Expense)	522

The significance of this table stems from the principles involved more than from the numbers themselves. Shorter hauls and lighter loads than those used for illustration will narrow the gap between rail and motor costs. Similarly, longer rail hauls and loadings decrease the rate of cost spread between rail and water transport. An area is reached at which the costs of competitive modes are in the same order of magnitude. It is in this critical area that the cost computation method, and the cost level of a particular kind of carrier deemed to be compensative, may together greatly influence determinations concerning proposed competitive rates. Obviously, this critical area is reached sooner when motor costs are compared with fully burdened rail costs, or when out-of-pocket rail costs are compared with water line costs. As a result, if these regulatory comparisons are made on the basis of fully burdened rail costs they tend to narrow the intermodal competitive range.

The nature of the expense which comprises unit cost for the three types of carriers, by various cost ascertainment methods, is shown in the following tables:

Unit Cost Components in Cents Per Hundredweight, Manufactured Iron and Steel, Birmingham to New Orleans, Rail, Motor and Water Carrier Year 1957

Cost Component	Total Expense Level Rail	Total Expense Level Motor	Total Expense Level Water	Out-of-Pocket Rail	Out-of-Pocket Motor
1. Return, incl. F.I.T.	3.956	-	-	2.568	-
2. Wages	2.120	13.58	1.828	1.319	12.23
3. Fuel	.839	3.35	.812	.669	3.03
4. Trans. - Other	4.126	5.52	2.572	3.680	4.96
5. Maint. of Way	3.286	-	-	2.631	-
6. Maint. of Eqpt	3.842	7.75	1.513	3.059	6.97
7. Taxes, Licenses	[1.643]	4.45	-	[1.320]	4.00
8. Depreciation	[1.391]	3.83	.570	[1.109]	3.45
9. Gen. O'vhd.	2.909	6.27	1.157	2.322	5.64
10. All Other	.233	1.77	.243	.227	1.59
11. Rail to B'port	-	-	8.129	-	-
12. Total Excl. Line 11	21.311	46.52	8.695	-	-
13. Total Inc. Line 11	21.311	46.52	16.824	16.475	41.87

Notes: Brackets indicate figures shown for comparative purposes only; values actually integrated with other cost components.
Line 7 excludes Federal Income Taxes.
All other costs include for rail, loss and damage and l.and d. clerical; for motor carrier, casualties, insurance, safety and billing administration; for water carrier, casualties, insurance, safety and p.r. taxes.

Unit Cost Components as Percent of total Manufactured
Iron and Steel, Birmingham to New Orleans
Rail, Motor and Water Carrier
Year 1957

Cost Component	Total Expense Level Rail	Motor	Water	Out-of-Pocket Rail	Motor
1. Return, incl. F.I.T.	18.56	-	-	15.59	-
2. Wages	9.95	29.19	21.02	8.01	29.19
3. Fuel	3.94	7.20	9.34	4.06	7.20
4. Trans. - Other	19.36	11.87	29.58	22.33	11.87
5. Maint. of Way	15.42	-	-	15.97	-
6. Maint. of Eqpt.	18.03	16.66	17.40	18.57	16.66
7. Taxes, Licenses	E.L.	9.57	-	E.L.	9.57
8. Depreciation	E.L.	8.23	6.56	E.L.	8.23
9. Gen. O'vhd.	13.65	13.48	13.31	14.09	13.48
10. All Other	1.09	3.80	2.79	1.38	3.80
11. Total	100.00	100.00	100.00	100.00	100.00

E.L. = Elsewhere included.

Fragmentation of unit cost in this manner discloses that return on investment, a capital cost not generally calculated for motor and water carriers, is a significant additive to rail expense on either total or out-of-pocket bases. The data also show that, per weight unit hauled, wage costs and fuel expense are a smaller proportion of total rail cost, by contrast with water or motor carriers. Maintenance of way is a larger element of rail cost than largely corresponding fees and taxes are for motor carriers. The overhead burden of all forms is approximately equal, amounting to between 13 and 14 percent in each case, or the total expense level.

It should be emphasized that this comparison has its limitations. It is something less than completely accurate due to (1) incomparable cost determination methods, (2) dissimilarities in service offered and (3) varying amounts of total cost borne by government and reflected in corporate costs either imprecisely or not at all.

Railroad costing, for example, tends to obscure depreciation, taxes other than federal income tax, and casualties, insurance and safety expenses whose identity is explicitly retained in the motor carrier and barge cost structures. Though an integral part of other distributions, railroad depreciation amounts to 1.3¢ per cwt. on the Birmingham - New Orleans movement (6.7% of total cost), by contrast with the 0.6¢ and 3.8¢ of such cost incurred by water carriers and motor carriers, respectively. (This situation might be considerably altered if rail, ties and ballast were depreciable and if the ICC approved depreciation rates comparable to those of the Internal Revenue Service.

Taxes, fees and licenses are likewise submerged in the conventional rail cost analysis. However, in the present case they amount to 1.6¢ or 8% of total cost, including payroll taxes. In contrast, motor carrier taxes excluding payroll taxes amount to 4.45¢ or 9.6% of total cost. The comparative absence of gasoline and licensing taxes is offset for railroads by incurred maintenance of way and structures expense amounting, in this case to 3.3¢ or 15.4% of total unit cost.

An examination of cost development by type of carrier will serve both to illustrate the principles employed, and to highlight their significance.

Railroad Costs

Total Expense Level. Railroad costs so computed include expenses, rents, taxes and return on investment including income taxes and make no distinction based on volume or variability. They are, however, based on the Interstate Commerce Commission Cost Section's Southern Region costs for the year 1957.[76/] These are derived from the aggregate expenses of all Class I roads in that regional group. Each of these companies has lines of varying physical characteristics and traffic densities. Their resulting average costs thus contain an indeterminate error margin when applied to specific traffic; the magnitude of such error is infeasible to ascertain without access to proprietary information.

As shown in Appendix G, Southern Regional rail cost, including a 4% return on investment in road and equipment, have been assembled into 12 categories, of which four amounting to 65% of the total and line-Haul,[77/] and the remainder very largely "per car" costs in terminal operations not affected by distance.[78/] The twelve cost categories are described in Appendix H.

Appendix G indicates that 51.3% of the total cost of 21¢ per cwt. (Col. "K", Lines 1,2,3,6,7,8, 12 and 15) directly attaches to cars and car-miles. Over half of the 51.3% is substantially related to terminal switching and billing; thus this portion of railroad expense tends to fluctuate with cars handled irrespective of heavy, light or complete absence of load. Insofar as "Rail Form A" provides guidance to the components of rail cost, it demonstrates that the car, loaded or empty, is far the most important single element of railroad costs. This apparently is the rationale underlying recent rail efforts to publish rates designed to increase average per-car loading, so that (1) more units of load may share car costs and (2) fewer cars will be required.

Whereas some effort has been made to improve car utilization it appears that the railroads have devoted relatively more attention to increased train utilization, through increases in train size. The expenses that can be reduced or avoided by elimination of train-miles are segregated on line 3 of Appendix G, and amount to 10% of total unit cost. These expenses include the wages of train and enginemen since they tend to be paid on a train-mile basis. But such cost does not include train fuel, as this is properly a function of gross ton-miles (and the elimination of one train is likely to increase the fuel consumption of other trains on a given engine district).

In brief, doubling the size of all trains would decrease costs by approximately 5%. Since such a policy would tend to increase per them rentals, disrupt yard operations and reduce the quality of service offered, it might very well induce costs which outweigh such reductions.

Fully Burdened Level. Since World War II costs presented at rate proceedings have seldom been prepared at a total expense level. A separation between constant and variable cost has been accomplished in the manner previously described in Section 5. Based on such separation, the ICC Cost Section prepares "fully distributed" costs by recognizing 20% of the expenses, rents and taxes, 50% of the return on road property (as contrasted with equipment) plus all of the passenger and ICC deficits (and accompanying returns) as a constant expense not related to volume. Since the advent of "Rail Form A" the Cost Section has distributed this expense among the units of traffic being costed on a ton (for terminal) and ton-mile (for line-haul) basis apparently because (1) the movement of tonnage is the primary function of the railroads and (2) heavy tonnage commodities are likely to have low cost characteristics enabling them to absorb this added expense. Appendix I and Chart III compare, for the illustrative traffic, such "fully distributed" cost with (1) a fully burdened cost in which the constant portion is simply an additive to computed out-of-pocket expense, derived from the ratio of constant expense to total freight revenues in the Southern Region, and (2) a fully burdened cost in which the constant or fixed costs are distributed in proportion to out-of-pocket cost. An assumption that all traffic is equally able to, and should share constant costs underlies the fully burdened distribution on a revenue basis, whereas distribution of constant on the basis of out-of-pocket assumes that fixed cost should be apportioned in the same ratio as variable cost is allocated. On the"fully distributed" and "out-of-pocket" bases, constant cost components are 43 and 46 percent of variable cost elements, whereas on the fully burdened revenue basis, the constant equals 90 percent of the variable portion of total unit costs. In any event, it is clear that fully distributed costs are at a level substantially above out-of-pocket, irrespective of the basis used. In the present case, the ton/ton-mile distribution places "full costs" one third higher than out-of-pocket, while the revenue distribution of the constant portion adds 58% to computed out-of-pocket costs.

<u>Out-of-Pocket Level</u>. Appendix J and Charts II-A and II-B relate to rail out-of-pocket cost, which is total expense and return less the constant elements thereof. Of the total freight expense previously computed at 21.3¢, the out-of-pocket portion amounts to 16.5¢, or 77.3% including all of the return on investment in equipment, and half of the return on investment in road property in addition to 80% of the expenses, rents and taxes. The 12 category expense breakdown remains substantially unaltered and the cost distribution procedures are identical.

Since most branch and some main lines have low-tonnage trains, these could carry additional traffic at relatively little cost. Branch line roadbeds can often accomodate additional traffic at low additional cost. For such operations, it may be that "Rail Form A" overstates out-of-pocket costs, at least on a short-term basis. By the same token, the main line operations of some railroads may be found to contain higher than 80% variability if, for example, the majority of trains are run at full-tonnage. Thus, sizeable parts of the "Rail Form A" distribution between out-of-pocket and constant based on nation-wide percentages, may require elaborate adjustment to be suitable to some railroads.

<u>Motor Carrier Costs</u>

<u>Total Expense Level</u>. Appendix K, relating to the development of motor carrier costs at the total expense level, is derived from the

Cost Section's 1957 analysis of Southern Region motor carriers, [79/] which segregates expense into two line-haul and four terminal categories. Of total cost so computed, the line-haul elements constituted 87% The cost distribution by category is described in Appendix L.

Use of the Cost Section data for single line movement, adjusted to the total expense level would have brought total cost of the illustrative traffic to in excess of 61¢ per hundredweight. This was inappropriate for three reasons. First, the data represent the aggregated costs of all regulated Southern general commodity carriers. For this reason they reflect a considerable element of less-than-truckload operations by the typical carrier which are unquestionably at higher cost levels. This involves gathering and distribution costs escaped by the illustrative traffic. Accordingly, these atypical characteristics of the illustrative traffic were provided for by a single-stop cost and appropriate loading time derived from the Commission's records. Second, despite such adjustments, it is possible that the derived costs nonetheless overstate terminal expenses due to special loading techniques (e.g., cranes capable of loading trailers in well under an hour) and because tractors and trailers in this service very likely proceed from a single shipper's dock to a single destination. Third, the Cost Section data assume a reduction in return load to 23,371 lbs.[80/] to meet the Commission's view that return characteristics should be considered in cost calculations. However, in the absence of detailed information on return load characteristics, the illustrative traffic has been analyzed only on a one-way basis.

To some extent this may offset the overstatement of round-trip expense based on the Commission's cost scales since we are informed that various carriers handling the illustrative traffic use vehicle owner-operator drivers, whose pay scales on long distance hauling tend to be lower than the regional averages.

Adjustments of the type described are almost always necessary in analyzing motor freight costs in view of both the special characteristics of many kinds of carriers, and the typically closer margins between motor carrier costs and revenues.

The cost section has only recently recognized return on investment as an element of motor carrier cost.[81/] Time limitations precluded specific calculation of return in analyzing the illustrative traffic. This will not significantly affect the computed costs, inasmuch as return is believed to be an additive slightly exceeding 1% (by contrast with over 10% in rail transport generally) because of the relatively lower investment requirements of the industry. Motor carrier profit requirements have been handled largely, if imprecisely, on the basis of a standard operating ratio of 93%.[82/]

Out-of-Pocket Level. All motor carrier costs are held by ICC conventional methods to be 90% variable with traffic volume; thus the computed costs out-of-pocket are simply 90% of those in Appendix K.

Obviously, the spread between out-of-pocket and total expense levels is much narrower in motor than in rail transport.

Barge Costs

The total expenses shown in Appendix M for water carrier operations between Birmingham and New Orleans are based on 1957 data reported to the ICC by the Warrior and Gulf Navigation Company. In the absence of any standard water carrier cost formula, the company's expenses have been distributed between towboat, barge and terminal operations in a manner similar to that which has been employed by water cost analysts in rate proceedings before the ICC.[83/] The resulting 8.7¢ total unit cost of water movement is relatively higher than the typical barge operation, due primarily to draft and lock limitations on the Warrior, Black Warrior and Tombigbee Rivers. Costs analyzed for the illustrative tow were based on a revenue load of 5,500 tons, whereas Mississippi River tows, for example, are occasionally operated with loads as high as .46,000 tons.

The computed total unit expense includes no return on investment or any form of profit allowance, inasmuch as these are not provided for in conventional water carrier cost analysis.

River movement costs are, however, only part of the total cost picture, inasmuch as the illustrative traffic, like many commodities lacking waterfront origination, must be moved from an inland point to navigable water. This has been provided for by a 21-mile rail haul computed on the 1957 regional out-of-pocket basis, assuming movement in a 719 cwt. gondola at average train weights and regional empty return factor. It is interesting to note that the computed costs attaching to this short rail connection almost equalled the water cost for the ensuing circuitous 577-mile water route to New Orleans.

The low terminal element in total waterline unit cost (2.7¢ per cwt.) reflects the use of machanical trans-shipment devices; commodities which cannot be efficiently handled in bulk are very costly watercarrier traffic.

Little study has been given to establishing the effect of increasing volume on barge operations; it is believed that the variable costs must approximate average total costs if only for the fact that barge loadings are generally very near maximum. Out-of-pocket costs are therefore not computed.

From the foregoing, it is patent that the costs computed for water carriers, like those for motor carriers, do not reflect operations at their most economic. In the illustrative case this is due (a) to the relatively less advantageous physical characteristics of the Warrior River route, and (b) to the essential rail connection from mill origins. Despite these factors, the computed costs do establish that, insofar as ICC methods are a guide to relative cost magnitudes, water carrier corporate costs are, given appropriate traffic characteristics, at a far lower level than those incurred by other kinds of carriers.

Piggy Back Costs

Although there is no piggyback service now offered between Birmingham and New Orleans, we have hypothesized the costs attaching to such an operation, assuming two motor carrier trailers, each under 15 ton load, and both on one Clejan-type rail flat car. The cost computation, which involves obvious adjustments for weight of both car and loan, essentially combines the previously computed rail line-haul cost elements with (a) motor carrier pickup and delivery costs, as described above and (b) the special switching costs attaching to piggyback service, as derived from the data in recent ICC proceedings.

The results indicate that piggyback cannot compete costwise with heavily loaded boxcars in the carriage of such commodities as manufactured iron and steel. On the other hand, due to the motor-carrier type terminal handling, it would appear to provide a desirable compromise between low cost slow rail and high cost fast motor freight service. When other-than-movement costs are taken into account, this may well yield lower overall costs to many shippers. A comparison of computed cost in the illustrative case is shown in Chart IV and yields the following results:

Motor, Rail, and Piggyback Out-of-Pocket Cost
Manufactured Iron and Steel, Birmingham to New Orleans

All Motor Service (15 ton load)	41.87 cents per cwt.
Piggyback Service (30 ton load)	25.529 cents per cwt.
All Rail Service (35 ton load)	16.475 cents per cwt.
Piggyback cost differential under Motor	39%
Piggyback cost differential over Rail	55%

*   *   *   *

Service dissimilarities involve costs not measured in the conventional analysis. Chief among them is the time differential, represented in the illustrative case by a half-day motor carrier schedule, the two and a half day rail time and the five or more days required for barge movement.

If total unit cost is divided by miles per hour of total travel time, the relative cost levels of the three transportation forms would be reversed. On this basis, the motor carrier would have a unit cost of 1½¢, the railroad of 3½¢, and the water carrier of 5½¢ per hundredweight. Such time costs, whose impact is mainly on transport users, are difficult to measure with precision. That they are a true economic cost, however, is confirmed by motor carriage of many commodities apparently handled more economically by rail. Moreover, the value of time is reflected in the opportunity to carry lower inventories and reduce purchasing, obsolescence and interest costs.

Other costs also escape the conventional analysis. Thanks to the pneumatic tire, the lack of switching, and the absence of slack action, motor carrier loads require far less bracing and packaging, and experience less damage. Loading and unloading costs are reduced through more specialized forms of equipment. It is thus apparent that cost analysis as now conducted deals with expenses substantially less than the composite of total economic cost.

Section 10. Areas of Probable Advantage

It cannot be too often reiterated that transportation costs are not a static phenomenon. They fluctuate daily, seasonally and annually, depending on the weather, differences in volume and nature of traffic, the efficiency of men and equipment, length of haul and other variables. They fluctuate between geographic areas, different commodities, in separate localities, and among carriers providing services competitive in all respects. Hence conclusions about cost advantage are necessarily generalizations.

Nevertheless, certain conclusions have been drawn from time to time which merit review and reassessment in the light of the latest available information.

In 1944 the Board of Investigation and Research concluded that "under average conditions, the motor truck is much more economical than rail transportation for handling less-than-carload quantities. Water transportation is cheaper than the truck."[84/] The Board found also, that "for bulk freight, the lowest costs for all distances are by barge.[85/] The railroad is cheaper than the truck carrier for transporting carloads all distances over 60 miles, and rail transportation is as cheap as truck for shorter distances."[86/]

In a more recent review of comparative economy, the ICC found that:

> The principal inherent advantage of water carriers was ... low-cost handling and carrying of bulk and other volume-moving commodities. The outstanding inherent advantage of rail transportation lies in the relatively low cost of large scale movements of various commodities, particularly those with heavy-loading characteristics, and of long-haul movements of various commodities. Direct cost savings [from truck transport] was limited to inventory savings from fast truck shipment in relatively small lots and to the less expensive packing requirements. Fast shipment was cited as the outstanding advantage of air freight, often desirable to shippers despite far higher unit costs and rates.[87/]

The most recent comprehensive attempt to assess areas of relative economic advantage was undertaken by a group of economists at Harvard University, and is described in The Economics of Competition in the Transportation Industry.[88/] Their conclusions are as follows:

1. Bulk Commodities.

Rail-water: " ... under the most favorable rail cost conditions, and under the least favorable vessel-operating conditions, water carriers, particularly if the specialized bulk type, clearly have a pronounced line-haul cost advantage over rail. Furthermore ... the difference is so substantial that the insitutuion of user charges on waterways would not basically alter the situation."

Water-pipeline: Water is of these two modes, the less costly, except where there are expensive terminal costs. But since there is no back-haul in pipelines, wherever pipelines are justified by high volume they pose a real threat to water.

Rail-pipeline: Heavy loading (60,000 - 70,000 lbs) rail line-haul costs are six to seven times more than the most efficient pipeline; their terminal costs are also usually less than rail. Pipelines, however, require a large warket. In the future they may be a leading competitor for all liquefiable commodities.

2. High-value Commodities.

Truck-rail: Rail carload and rail piggyback are cheaper than trucks. Long-run marginal line-haul cost, per revenue ton-mile, at 1951-52 price-levels are found to be:

Load (lbs)	Truck	Carload	Clejan Piggyback
10,000	5.64	---	1.408
20,000	2.73	1.161	.857
30,000	1.82	.878	.673
40,000	2.73	.738	.857
50,000	2.18	.653	.747
60,000	1.82	.598	.673
70,000	2.34	.555	.778

When terminal costs are considered, some piggyback should be substituted for rail carload.

Water-rail: Rail is substantially more economical than package freighters, such as have operated on the Great Lakes.

Water-truck: Water was found less expensive at all lengths of haul.

3. Passenger Traffic.

An auto with two or more passengers is the cheapest form of intercity passenger transport. Bus and long distance air costs were also found to be very low. Rail coach is low cost for short heavy density movements; rail first-class is the most costly of all types.

Limitations of time and resources precluded as intensive an investigation during the preparation of this report; likewise costs of package freight and passenger transportation were excluded. With regard to freight transportation however, we consider the detailed cost investigation described in Section 9 to represent conditions which permit general conclusions to be reached as to the areas of probable economic advantage for the different kinds of transportation. We find that for bulk commodities, assuming the existence of mechanical transshipment facilities, water transport is undoubtedly by far the least costly method of transport, all costs considered. At points inaccessible to water transport, or for commodities of high value non-bulk nature the cost advantage in every case will depend on three factors: length of haul, weight of load and inherent nature of the commodity being transported. With heavier loads and longer hauls railroads can provide a less costly service; where loads are lighter and hauls are shorter the motor carriers will be more economical.

To reduce these generalizations to specific terms, we have computed, for each of the major ICC commodity classifications, the out-of-pocket costs of rail and motor carrier movement on a national basis, using reported average loads by each type of carrier. The results are shown in Chart V. They indicate, based on ICC data and cost-finding methods, that motor carriers have a clear cost advantage over rail at all lengths of haul for the average shipment of animals and products, due primarily to the light-loading characteristics of this traffic. The motor carriers are also more economic for average shipments of products of agriculture and manufactured items at lengths of haul up to 100 miles, for products of forests up to 60 miles, and for mine products up to about 35 miles. At greater lengths of haul, assuming average loads and conditions, railroads are the more economic carriers. To attain these results, which assume the possibility of competition between rail and motor carriers at all lengths of haul for all kinds of traffic (a condition which does not in fact exist), certain adjustments were required to permit comparison of like with like. These computational details are described in Appendix N.

As indicated previously, piggyback or containerized service may well be more advantageous than either rail or truck for many kinds of traffic at lengths of haul exceeding 100 miles, providing technological standardization can be attained.

At a time of rapid technological innovation, however, it is unwise to assume that the areas of relative economic advantage which obtain today will remain static. For example:

> ... it now costs about four times as much per mile to ship a ton of goods by truck as it does by rail. An important part of this gap is caused by the fragility of our highway pavements. Every state now has to impose a limit on truck weight and size. This keeps truck loads smaller than they might be and raises the costs of fuel and labor for each ton carried. For the time being, the engineering of the vehicle has outrun the engineering of the roadway - but this is not likely to last . . . A lot of research is going on in the field of materials - metal, plastics, rubber and glass - and in the field of pavement construction. With improved pavements, the average intercity truck load of the future could weigh up to a hundred tons. If this should happen, the present four-to-one cost ratio of trucking to rail haulage would come down, probably to three-to-one, or even lower... [89/]

There is of course, no way of forecasting whether such developments will equal or exceed the slow but steady progress to automated railroads. One authority holds that:

> The approach to automation is a very logical continuation of push-button railroading. Push-button operation implies that an operator makes certain observations and then decides that a particular operation should be made. He then operates a push-button corresponding to his decision. With automation, there would be sensing devices to make the various observations automatically and this information would be fed to the computer. The computer then takes the varous items of information into account and performs an operation automatically in much the same way as if a push-button had been operated. The usual type of train communication may be supplemented or replaced by a system patterned after the so-called "data-link" that is being developed for air traffic control. This will permit a rapid exchange of information between each train and headquarters, much more rapid than can be done by voice communication. It is this type of system which may be used to perform the equivalent of pushing buttons for control of the locomotive. The train can then be placed under remote control from headquarters with no operator being required at the controls of the locomotive.[90/]

Another trend which is discernable is the ultimate possibility of cost-based competition between air and motor carriers for certain kinds of high-value, low density freight. Successive increases in capacity, range and power of cargo-carrying aircraft have brought corresponding decreases in operating cost per revenue ton-mile. It is estimated that:

> An aircraft with direct operating costs of four cents per available ton-mile can be considered reasonably certain for the near future. Indirect costs are assumed to remain in their present relationship to direct costs, about 50 percent of the latter. With a break-even load factor of 60 percent, these costs would make possible average rates of 10 cents per ton-mile . . . [91/]

thus greatly narrowing the spread between air and truck costs, with corresponding enhancement of the possibilities for competition between these modes at the longer distances. The trend of air and motor carrier costs per revenue ton-mile is shown in Chart VI.

PART THREE

<u>TRANSPORTATION COST ANALYSIS</u>

PART THREE. TRANSPORTATION COST ANALYSIS

Section 11. Evolution of Cost Analysis

The beginnings of transport cost analysis appear to stem from the accounting methods employed by mercantile establishments to assess their shipping operations in the 17th and 18th centuries. This influence lingered until the very beginnings of the railroad era.[1/] At this point in time, the huge, obvious and visible capital investment requirements of the railways attracted the attention of economists and engineers. Their subsequent efforts were largely directed towards theories which would explain the fixed and variable nature of railroad costs. A twentieth century development has been the increasingly intensive effort to meet regulatory requirements by association of first rail, and later truck and barge costs with specific traffic units.

Cost Theories

Rail cost behavior began to be studied very soon after the advent of this form of transport. In,1839 an American engineer named Charles Ellet, Jr. not only recognized the distinction between variable and fixed costs, but concluded that for a specific railroad 85% of total expense was variable with traffic and only 15% fixed. Ellet's emphasis originated in his belief that standards of construction and operation could be made to conform with traffic volume. A hundred years elapsed before another authority assigned so high a percentage to variable costs. All other early treatises, for example those by Dupuit in 1844 and 1849, Belpaire in 1847, and Lardner in 1850, held consistently to the view that the substantial costs incurred by right-of-way, track, engines and cars, created a situation in which most costs were "fixed". From this it was concluded that additional business could be handled at relatively little added cost.[2/]

In 1874 AlbertFink, then vice-president of the Louisville & Nashville R.R., published a profound analysis of railroad costs. He too found that fixed elements were controlling in the total rail cost structure and concluded that decreasing unit cost was the dominant economic feature of the railroad industry. The important thing about this report was, however, that it was issued primarily in defense of the practice of charging high rates on branch lines where there was no competition and of charging low rates on the denser lines of traffic, which as it happened were the routes subjected to active competition which kept rates down.[3/]

In 1888 appeared one of the classic works of transportation economics: <u>The Economic Theory of Railway Location</u> by A. M. Wellington, who also took the position that substantial areas of cost were unaffected by traffic levels. Examples of such expenses were: "Salary of the president and other officers; maintenance of works and plant against the deterioration which comes with time, irrespective of work done; salaries of local freight and passenger agents, a portion of whom must be employed anyway, whether considerable sales are made or not."[4] Wellington estimated that only a third of total rail expense was affected by considerable changes in traffic volume.[5]

This was the theory, but Wellington had trouble reconciling it with his observations."... It must be admitted that there are some strange anomalies in the records of maintenance of way expenses which seem to indicate that such expenditures will continue to bear a nearly constant ratio to the train expenses proper, as they have in the past.[6]

The next important theorist to affix the cachet of respectability to the decreasing cost doctrine was Sir William Acworth, who in 1904 wrote, "On the whole, a common and probably roughly accurate estimate is to say that half of the total expense is fixed; half varies with the traffic. That is to say, if it costs x to deal with 1,000,000 units of traffic, 5,000,000 units will not cost 5x, but 1/2x+(1/2xX5) = 3x. Therefore, the heavier the traffic the lower (the return on capital remaining equal) need be the rate.[7]

T. M. R. Talcott in the same year concluded that additional business could be handled for only a 25% to 45% increase in cost.[8] The next searching examination of rail cost behavior was undertaken by Professor William Z. Ripley, who in 1913 concluded that out-of-pocket costs were only one-half of operating expenses and one-third of total costs.[9]

Several of these treatises were supported by voluminous mathematical calculations. Some were frankly designed to support the doctrine of differential charging: high rates cover all costs, lower rates cover variable costs and contribute something to overhead. "... the existence of fixed costs provided a justification for charging anything the traffic might bear, be it much or little."[10] Wellington apparently stood alone with his candid admission of conflict between observation and preconception.

The net effect of this mass of doctrine was persuasive. Just prior to World War I the ICC found:

> It has been roughly estimated that of the total costs only about 50 percent are what may be termed out-of-pocket costs ...In other words, when the carrier claims that the cost of moving the coal is 4 mills the actual outlay on the part of the carrier for the particular business is not much in excess of 2 mills.
>
> Anything above the out-of-pocket cost of handling is a contribution to general expenses, and to that extent tends to relieve rather than burden other traffic.[11]

In 1919 a committee of eight railway engineers, under the chairmanship of W. L. Yager, studied the variability of maintenance of way costs. In what is known as the "Yager Formula", they concluded that at 1917 traffic levels only one-third of maintenance of way expenses varied with changes in traffic.[12/]

From this brief survey of railway cost theories it is evident that most of these economists or engineers were in general agreement as to the low cost of additional business. It seems likely this was due to the fact that they may have looked at cost and traffic fluctuations over a relatively short period of time. And most of them fell under that alluring concept that has always tempted railwaymen: additional, business can always be handled for virtually no additional cost; the additional car on an existing train costs almost nothing.

But a reaction to the high-fixed-cost doctrine was setting in, spearheaded by Dr. M. O. Lorenz, later to serve with distinction as head of the ICC's Bureau of Statistics. As early as 1915 Lorenz found that maintenance of way costs were 80% to 90% variable with traffic.[13/] J. M. Clark in 1923 found that for the country as a whole 75% of all costs were variable with traffic. And for heavy-density lines, variability approached 100%.[14/] Similarly, cost studies submitted by railroads in ICC cases showed much higher out-of-pocket costs than had foxmerly been supposed. The Transcontinental Cases of 1922 assumed 33 1/3% of maintenance of way expenses, 100% of maintenance of equipment expenses, and from 10% to 100% of transportation expenses were variable with volume of traffic.[15/] In the 1928 Lake Cargo Coal Case the Chesapeake and Ohio concluded that 69.3% of total freight operating expenses were variable.[16/] A 1929 study of the Oregon-Washington R.R. & Navigation Co. showed 84% of total Oregon freight expenses varied with traffic.[17/]

The great depression of the thirties produced carrier operating economies that would not have been thought possible in earlier years; it very likely stimulated the cost theory pendulum to its farthest swing in this new direction when, in 1940, Professor Kent T. Healy estimated that in the long run almost all costs were variable:

> All this does not imply the inapplicability in its day, of the older theory, which stated that additional traffic could be carried at little extra cost because of the large element of fixed items in cost, nor does it mean that theory does not apply even now under certain conditions. The implication is rather that, under present conditions of maturity, most main line railroad facilities and the operation thereon have had a chance to become closely adjusted to the density of traffic handled and the revenue derived therefrom, so that average unit costs tend to be nearly uniform over a wide range of densities and the costs of handling additional increments of business are not likely to be much below the average costs.[18/]

Dr. Ford K. Edwards, in his detailed 1943 studies for the Class Rate Investigation, [19] found that between 70% and 80% of operating expenses, rents and taxes and between 50% and 70% of total investment were variable with changes in traffic volume.[20]

The current conclusions of the ICC, detailed in Section 5, are largely based on Edwards' work; they are a substantial departure from the high-fixed-cost theories dominant during the first century of railroads. To this extent the Commission's concept of variability represents the beginning of a realistic link to pricing policies appropriate for modern conditions. If uncertainty prevails, it relates to difference in degree, for which the means of resolution may now be at hand.

Rail Costs

In the early days of the ICC the central cost problem was measurement of total carrier cost against total carrier expense, so that a rate of return could be computed as the surest defense of the public against monopoly. The prevailing view of preponderant fixed cost in the railroad industry quite naturally led to the assumption that it was infeasible to measure costs associated with particular traffic. The ICC itself disposed of the matter with almost cavalier unconcern, finding that:

> ...the element of cost of service which may at one period have been recognized as controlling in fixing rates has long ceased to be regarded as the sole or most important factor for that purpose.[21]

Consequently, the vast majority of rate proceedings were decided in the complete absence of any cost data, since the measure of reasonableness was tested by a comparison with other rates, and only rarely did relatively primitive cost data appear in evidence. When it did, cost development was limited to directly assignable expense plus a prorata apportionment of all other costs. The distinction between constant and variable costs was appreciated, but often disregarded in the light of the judicial pronouncement that:

> ...in determining the cost of the transportation of a particular commodity, all the outlays which pertain to it must be considered. We find no basis for distinguishing between so-called "out-of-pocket" costs, or "actual" expenses, and other outlays which are none the less actually made because they are applicable to all traffic, instead of being exclusively incurred in the traffic in question... The outlays which exclusively pertain to a given class of traffic must be assigned to that class, and the other expenses must be fairly apportioned. It may be difficult to make such an apportionment, but when conclusions are based on cost the entire cost must be taken into account.[22]

As late as 1923, two eminent authorities took the position that:

> Since railroad operations are carried on under conditions of joint [i.e. common] cost, no regulatory body can use cost of service as the basis of determining the reasonableness of an individual rate. Cost is simply not ascertainable... Cost cannot therefore be established as the basis for rates, even if there were not other reasons for not using it. The usual measure of a fair price, cost plus a profit, cannot be a tool of the Interstate Commerce Commission considering the reasonableness of individual rates... Instead there is a "flexible limit of judgment which belongs to the power to make rates. [23/]

It appears that the origins of modern unit cost ascertainment are related to attempts by the ICC to discharge its obligations under the Hoch-Smith Resolution of 1925. By this action the Congress, acting on behalf of depressed agriculture, directed the Commission to establish for farm products "the lowest possible lawful rates compatible with the maintenance of adequate transportation service."[24/] Hence the Commission found new uses for the cost-of-service principle when subsequent proposals to increase rates appeared to violate the intent of the Resolution.

Locklin pointed out in 1928: "Prior to the passage of the Resolution the reasonableness of proposed increases in individual rates was largely determined upon the basis of rate comparisons. At the present time however, a definite showing must be made of actual or relative cost of service..." Each such showing however, was developed by the carrier or party concerned in the traditional manner, i.e., in a way which was appropriate to his convenience, ingenuity and resources; the Commission set no standards for cost ascertainment. This situation was criticized in the late twenties and early thirties, by the National Industrial Traffic League, and the National Association of Railroad and Utility Commissioners, who proposed that the ICC adopt a system of routine cost finding which provided for elaborate segregation and allocation of receipts and expenses. Public hearings were held, and Commissioner Eastman concluded the proposed systems were not sufficiently perfected for application.[26/]

In 1930 the ICC first published Carload Rate Tables, which furnished very approximate cost data from then available statistics.[27/]

The growing importance of cost ascertainment as an aid to enlightened regulation was brought into focus by Section 13 of the Emergency Railroad Transportation Act of 1933, which required that the Federal Transportation Coordinator "investigate and consider...cost finding in rail transportation."[28/]

The underlying reasons for this were described as follows:

> [Because of] great and unusual difficulties. . . in ascertainment of specific service costs, the tendency in rail transportation has been to dismiss the task as impossible, and to deal with the cost problem only in a very broad and general way. Such attempts as have been made from time to time to ascertain specific costs have taken the form of special studies rather than any continuous and regular routine.
>
> In recent years, however, new interest in railroad cost finding has developed and grown quickly. One reason for this has been the extent to which other large industries have found it both practicable and beneficial to adopt continuous routine systems of cost finding, not only for control of expenditures but also for product pricing. Another and more important reason has been the great development of competition from other forms of transportation, making it essential for the public regulatory authorities as well as the various transportation agencies to have as definite knowledge as possible of service costs in order, particularly to prevent rate cutting from being carried beyond sound economic limits.[29/]

In 1936, after an extensive study of the subject, the Coordinator reported that:

> The present fog with relation to over-all costs for rail transportation is due to the fact that each witness is free to devise his own cost structure and to submit evidence on that basis.[30/]

To improve the situation, the Coordinator had selected J. H. Williams "who had had extensive experience with cost finding in other industries" to direct an extensive research project on the subject." Mr. Williams was instructed by the Coordinator to give particular attention, in connection with his study, to the desirability of arriving, if possible, at a system of continuous routine cost finding which would not impose a heavy new burden of accounting or statistical expense upon the railroads.[31/] This instruction relates to a most significant factor in the development of adequate unit costs: the necessity for building them from an accounting structure primarily devised for another purpose.

The results of these studies, issued in 1936, although they tended to focus attention on the need for more precise cost ascertainment were, in other ways, a disappointment. It had been suggested for example, that a procedure be devised for separation of fixed from variable costs on the grounds "that to know the cost that does vary with the volume of business and represents what in rate regulation is known as out-of-pocket cost, would be helpful in determining a limit below which rates should not go." It was reported however, that:

> ...no effort has been made in this direction because it is felt that any deductions made from the over-all cost on this basis would be purely a matter of expediency based upon the exigencies of the situation rather than the cost, that there should be very few of them, and that there is no need for exact figures in making such deductions.[32/]

The principal features of the suggested approach to routine cost-ascertainment were as follows:

(1) Provision of certain cost data by the rail carriers in the form of supplements to their annual reports to the ICC

(2) Designation of accounting divisions on each carrier to reflect varying geographic, operating and traffic conditions

(3) Determination of "base" costs. This involved the separation of total freight operating expense on each carrier between carload and less-carload categories. Four types of carload costs were then derived for each of eight types of car: terminal, local freight train, through freight train, and other than train

(4) Adjustment of "base" costs to provide for fluctuations in maintenance of way expense over a period of several years

(5) Addition of a return on investment factor to computed "base" costs

(6) Modification of "base" costs to cover special situations, and

(7) Conversion of computed results to a basis of cents per ton-mile or hundredweight-mile for statement in the same terms as freight rates.[33/]

In brief, the Coordinator's plan provided a method for computing average total costs, and made no attempt to come to grips with the variability problem.[32/]

A great advance was made two years later with the publication in 1938 of Dr. Ford K. Edwards' Study of Rail Cost Finding for Rate Making Purposes, for the California Railroad Commission.[34/] The basic plan was similar to, but simpler than present "Rail Form A". Constant costs were separated from variable costs, and measured by linear regression methods. Variable line-haul running costs were allocated among one or more of five units of service: locomotive-miles, locomotive ton-miles, train-miles, trailing gross ton-miles, and car-miles.[35/] Switching cost was measured in terms of engine hours; station costs in carloads. Traffic and general expenses, taxes and return were subsequently added as multipliers to directly allocated expense, and the various units combined for computation of (a) full unit cost and (b) out-of-pocket cost as a 70.3% variable proportion.

Edwards' general concept, which embodied the most significant advance in rail cost-finding since inception of the railroads, was originally applied in 1941 by the ICC staff in the first issue of "Rail Form A," designed to provide a relative measure of the cost of rail freight service in the major rate territories of the United States, which was information required in the Class Rate Investigation, ICC Docket 28300. The objective here was the aggregation of expense and the derivation of average unit costs for regions and groups of railroads, not for individual carriers.[36/]

Subsequently, the Commission's staff developed a number of formulas,[37/] involving the same basic methodology, but adapted to the re-requirements of specific situations, such as intermodal competition, revenue division controversies, and passenger train deficit measurement. These formulas involved extensive special studies to provide essential data not reported to the Commission, and by contrast with "Rail Form A", none has been widely used.

The design of "Rail Form A" was altered in 1947, 1951 and 1953 to provide for revisions in rail accounting classifications, to accord with altered concepts of appropriate cost distribution over service units, and to reflect changes in methods of deriving out-of-pocket cost. In 1957 the formula was reissued to provide an improved organization of its basic schedules, and to reflect the use of miscellaneous regional operating factors developed from special studies by the ICC staff.

In its earlier editions "Rail Form A" provided for the determination of variability by individual expense account. Later this feature was dropped, and the formula (always providing for the separation of out-of-pocket from constant expense) was non-committalon the specific variable proportion of expense. The 1957 edition, however, included printed reference to the 80-50-100 composite percent variable mentioned in Section 5. The widespread use of the formula for purposes other than that for which it was originally designed was met by the following significant paragraph:

> Although Rail Form A has principally been used for the purpose of developing costs for large groups of carriers, it is also adaptable to small groups of carriers and to individual carriers. It is suggested that individual carriers should make every possible effort to develop their own operating factors for use in applying this formula to their expenses and statistics. Where this course will be unduly burdensome, the territorial factors developed by the Cost Finding Section in special studies which are included in the appendices of this formula may be used. It is preferable, however, that each carrier develop its own factors.[38/]

Water Carrier Costs

The development of unit costs for domestic water-line operations has not been subjected to the searching examination applied to railroad costs. As a result, water cost computations today represent very little advance over methods employed twenty or more years ago. They involve simply an aggregation of total carrier operating expense (including taxes, if any, and occasionally an allowance for interest or return) and their proration over the units of traffic. This method has been used for both inland and coastal water carriers. It derives average cost at the total expense level, but fails to take into account the substantial gap between out-of-pocket and fully-burdened cost which necessarily follows from the relatively large capital investment required for this type of transportation, especially where such carriers have their own terminal facilities. Cost analysts have recognized this deficiency in water line costing, and special studies have been made to measure variability in specific cases.[39/] All too often, however, variability is estimated on a more or less arbitrary basis,[40/] or simply ignored. The fact remains that as of now there are no current and comprehensive studies of water cost variability, primarily because the data reported by regulated carriers are inadequate for this purpose.

Motor Carrier Costs

Although motor carrier freight service began to be a factor in interstate commerce during the twenties, the typically small size of trucking companies precluded the keeping of effective records. Thus the first motor carrier cost analyses were based on engineering field studies related to determination of what cost should be, rather than a reflection of actual cost incurred.[41/]

The development of unit costs for carriers was investigated by the Federal Coordinator in the early 1930's and involved the simple aggregation of line haul, terminal and general expense elements, and the derivation for each of a cost per ton originated.

With the passage of the Motor Carrier Act of 1935, a prescribed accounting system provided an initial if unsatisfactory basis for uniform analyses of motor carrier costs. In 1940 the National Traffic Committee of the motor carriers sought to devise uniform costing procedures for carriers of general freight, and in 1942 the Cost Section of the ICC attempted detailed analyses of motor carrier costs on a special study basis. These efforts disclosed that the prescribed accounting system was the chief obstacle to improved cost-finding.

In 1945, responding to an inquiry from Commissioner Mahaffie, the Cost Section took the position that it was then infeasible on three grounds to devise a motor carrier cost formula: The accounts did not lend themselves to cost-finding; most carriers did not separate line-haul and terminal expense; and there was a paucity of reliable operating and traffic statistics.[43/]

During the following three years the Commission made several special studies of motor carrier cost problems, and effective January 1, 1948, the prescribed accounts were revised for reasons which included an increase in their cost finding usefulness. Thus this relatively recent date marks the beginning of motor carrier cost analysis as practiced today. The amended accounting system facilitated separation of total expense among truckload and less-truckload traffic, the segregation of line-haul and pick-up and delivery expense into time and mileage elements, and the fragmentation of terminal expense among its platform and billing and collecting components. This enabled the Commission afterwards to devise and issue a motor carrier cost formula, designated as "Highway Form A", designed to develop both territorial and individual motor carrier costs. In its early studies,the ICC staff divided total line-haul expense by total hundred-weight miles, and applied the computed unit cost to all shipment sizes.

In subsequent revisions of "Highway Form A", requirements were provided to relate cost to shipment size and to break out expenses attaching to "peddle-trip" operations serving intermediate consignment origins and destinations beyond pickup and delivery range, but within 75 miles of carrier terminals. Finally, in both "Highway Form A" and the shortened procedure provided by "Highway Form B," interest on depreciated investment and an allowance for profit were added cost components.

Although the motor carriers have themselves made few studies of variability, the Commission concluded, after a cross-section analysis of these carriers that operating expenses, rents and taxes are between 90 and 100% variable with traffic fluctuations, and a factor of 90% has been customarily employed in the conventional costing and reflected in current issues of ICC motor cost formulas.

As with rail carriers, the ICC has also attempted to develop formulas to deal with specialized cost situations. An example is "Highway Form F", which provides a method for determining the cost of transporting liquid petroleum products by tank truck carriers.

Airline Costs

The very real desire of the aviation industry for a "standard" method of assessing relative (as distinct from absolute) economics of competitive aircraft, led in 1944 to the development by the Air Transport Association of America of the first universally recognized formula method for estimating direct operating costs of aircraft. It should be emphasized that "direct cost" as used in aviation is not synonymous with the term as used by economists. The former useage denotes costs attaching to the movement of aircraft; the latter is a synonym for variable cost. This first version of the ATA formula was in turn developed from a paper, "Some Economic Aspects of Transport Airplanes" presented by W. C. Mentzer and H. E. Nourse of United Airlines, which appeared in the Journal of Aeronautical Sciences in April and May 1940.

These first applications of formula costing to aviation were based on statistical data obtained from airline operation of DC-3 aircraft and extrapolated to encompass the direct operating costs of larger aircraft which were then being introduced.

Subsequently, the first ATA formula method (1944 edition) was revised in 1949 because "it was determined that the 1944 method... fell short of its goal due to rising costs of labor, material, crew, and fuel and oil."[44/] The 1949 edition of "standard method" was again revised in 1955 for essentially the same reason (i.e., increased cost levels and changed conditions from 1949) plus the need to amplify the method to encompass turbine powered aircraft being developed for airline use.

Section 12. Currently Used Procedures

There has been an enormous amount of literature devoted to cost analysis, both within and outside of the transportation industries. A report such as this must necessarily be limited to considerations of some of these procedures, which are not in all cases those most widely known. Our purpose will however, be served by an examination of a relatively few cost-finding methods which have been or are being used or suggested by governmental entities, carriers and others.

It should be noted that "cost finding" is a term which seems to be peculiar to the regulated forms of transportation. In the conventional business terminology cost finding involves "cost collection" and "cost processing" as well as "cost analysis."

It is noteworthy also that current practice tends increasingly toward reliance on formulas as a substitute for (1) analyses of specific operations, and (2)derivation of cost estimates reflecting actual experience in a proper time dimension. This trend results from (a) the inherent human desire for short-cut "approved" methods for ascertaining answers to complex problems; (b) the excessive workloads imposed on carrier and regulatory personnel concerned with these matters; and (c) the unending search for a single model applicable to a variety of situations. Unfortunately, the interaction of these factors often leads away from precision rather than towards it.

"Rail Form A"

"Rail Form A" was, when it appeared, the most comprehensive rail cost analysis yet made, and it was addressed to a very broad question. It met its objectives so well that it has since provided the basis for all ICC rail cost finding,and thus a quondam achievement has created a present problem: "Rail Form A" is now used altogether too frequently in ways not intended at its inception. This is the significant issue with respect to this method.

The institutionalization of yesterday's successes is of course a common phenomenon not limited to cost analysis. In some areas this does no harm, and may even promote desirable ends. It is probable, for example, that "Highway Form B" yields answers of sufficient precision for regulatory guidance. The entrenched position of "Rail Form A" on the other hand precludes fundamental progress in railroad cost analysis, despite the fact that both ICC staff and others have used it with all the ingenuity and imagination possible within its conceptual framework. For this reason the present discussion is limited to a consideration of the deficiencies inherent in the method, since its procedures have already been detailed in Section 5 and 9, and the mathematics which underlie the method are examined in Section 15.

In terms of its national policy impact, the deficiencies of "Rail Form A" relate to the inaccurate results it produces for the guidance of regulators attempting to assess issues of intermodal rate competition. Obviously inaccurate cost measures will increase the likelihood of regulatory misjudgments: downward rate adjustments may conceivably be permitted the railroads when these would attract traffic which would thereby be carried at a loss. In other situations the use of "Rail Form A" may fail to indicate that the rail carriers are in fact the lost cost mode. The continued use of "Rail Form A" does not assure rational use of our transportation resources. This is why a fundamental reappraisal of the method seems timely.

Specifically, the defects of this method are:

(a) It involves the use of averages which fail to reflect the peculiar cost characteristics of individual traffic components or of particular routes or facilities. It ignores, for example, the functional differences among railroad yards, which are many and varied. Likewise, it combines lower main line and higher branch line unit costs to arrive at aggregates fully representative of neither type of operation. Since a particular traffic uses specific facilities, not average facilities, the use of average costs necessarily results in over and underestimates, as the case may be.

(b) To develop several important operating factors required for its computations necessitates elaborate and expensive special studies.[45/] In the absence of these, the analyst must resort to arbitrary adjustments.

(c) It fails to provide separate and explicit measurement of all the unit costs associated with the movement of traffic, e.g., it aggregates all costs associated with train operation, without separate assessment of the many operating characteristics which vary by route, location and function.

(d) It inadequately arrives at a separation of fixed from variable cost, and then compounds this inadequacy by the uniform application of the derived "percent variable" to every situation: local, regional and national.

(e) It assumes the existence of cost as an absolute capable of precise measurement, and gives no weight to the fact that costs differ by purpose; that added cost of prospective traffic may not be identical with costs avoided or "escaped" through decrements of such traffic.

(f) It attempts no refinement of the major rail common cost problem, the separation of expense between passenger and freight service, beyond that provided for in the ICC's rules; it therefore uses basic data which are open to question where railroads provide passenger service.

(g) It facilitates the development of "cost" numbers which are devoid of economic meaning, i.e., the pro rata distribution of unrelated constant costs among particular segments of traffic.

(h) It often computes costs based on one year's experience of a single carrier. If for no other reason, the incidence of deferred maintenance casts considerable doubt that such a basis affords an adequate measure of cost over the long term. Per contra, it seems likely that maintenance costs are greatly influenced by cyclical business fluctuations.
(i) It assumes that railroad cost functions are uniformly linear, which is demonstrably untrue, and

(j) It requires the assumption of a fair rate of return (which may in itself have no basis in reality) on property evaluated on either of two uncertain bases, and then assigns return on road property and half the return on equipment as a cost uniformly attaching to every traffic or operation analyzed. Thus, with respect to return alone there are at least three problems unresolved by "Rail Form A":

(1) What basic property value is appropriate?
(2) What constitutes a "fair rate of return"? and
(3) How much of the return is appropriately assignable to particular traffic?

Some of these defects can be lessened, as hereinafter suggested, but this seems similar to plugging one of several leaks in a dike. A far preferable step is to reexamine the possibilities for substitution of improved procedures now available.

Motor Carrier Cost Finding

The motor carrier cost finding methods used by the ICC involve in essence the computation of average costs by straight-line accounting methods, using information reported to the Commission, supplemented by special studies. The method is described at length in ICC Statement No. 1-54, Explanation of the Development of Motor Carrier Costs with Statement as to Their Meaning and Significance.

In summary, the method involves the separation of total highway freight expenses and taxes between intercity operations (both peddle and terminal); pickup and delivery service; platform handling, billing and collecting; expenses unrelated to the traffic; and general overhead. It also provides for determination of the related service units: vehicle or power-unit miles, ton-miles, shipments billed, tons given platform handling, etc.

Intercity and pickup and delivery expense is separated between mileage and time elements, with a further separation of pickup and delivery costs between single and multi-stop service. Costs are allocated to weight brackets, and adjusted for both line-haul circuity and shipment density. Many additional refinements designed to isolate specific cost determinants are provided for, if desired, and a procedure is given for the assembly of unit costs in a manner which facilitates distinctions betweeen single carrier and interline traffic, and the construction of round-trip truckload and less truckload unit costs by mileage block and weight bracket for each type of haul.

A separation of constant from out-of-pocket portions is possible, derived from a linear regression analysis made by the ICC staff. [46] The distribution of constant cost can be based on revenue contributions; in accordance with the out-of-pocket distribution, or on a ton and ton-mile basis (the latter being favored in the Commission's own work). The entire method is incorporated in the formula known as "Highway Form A", which for complete analysis requires the execution of several supplementary studies. "Highway Form A" can be used for ascertainment of single-carrier, interline, or carrier group costs.

A simplified formula cast in the same mold is designated as "Highway Form B". Its use is restricted to the ascertainment of single-carrier out-of-pocket cost, and its use eliminates the need for extensive special studies.

A technique known as the McWilliams Formula,[47] employed by many motor carrier groups and organizations, is essentially a reorganization of "Highway Form A." The differences between the two relate to detail; the underlying approach is essentially similar.

An interesting departure from the ICC method of motor carrier costing is practiced by the California Public Utilities Commission, which bases its minimum rate levels on unit cost and performance data developed from engineering time and motion studies, observed operations and the records of carriers which it considers "reasonably efficient operators." Thus, its rate-making cost data relate not to all involved carriers, but to those firms which are in effect, a standard for efficient performance. In this manner the Commission strives to meet its objective of sustaining a strong common carrier network in the face of intense competition from proprietary trucking.[48]

ATA Method

In air transportation the most widely known cost finding method, that sponsored by the Air Transport Association and known as the "ATA Method," was not developed for regulatory rate-making, but for the entirely different purpose of assessing relative aircraft economic performance.

The 1955 currently used edition of the "ATA Method"[49] provides a number of arithmetic and algebraic formulas related to the expense accounts prescribed by the CAB, which together are used to produce estimates of so-called direct aircraft operating expense (i.e., movement, maintenance and depreciation costs attaching to flight equipment).

Unlike mathematics, physics or chemistry, however, airline cost analysis is far from an exact science reducible to precise formulas. The costs achieved by and reported for an airline operation are simply the end-products of a multitude of human, material and operating factors most of which are interrelated and yet individually variable. For example, the unit costs achieved for flight crews, only one of many elements comprising the overall cost of operating an airplane, depend among other factors on the design, speed and weight of the plane, the required crew complement, the specific provisions of crew member working contracts, the efficiency of crew utilization, the amount of day or night flying, the length of airplane stage distance, route characteristics, and average delay experience. As related to a specific type of airplane, the net of these variables differs substantially between companies, routes, and with the passage of time. Consequently, the ATA Method, which uses past industry averages to predict future absolute costs for specific companies, aircraft or routes, is obviously more likely than not to produce substantially erroneous estimates.

While a formula method could be devised which would reasonably reflect the industry average of all these variables at a precise time in the past, it would require constant revision to be useful for the future in predicting even average industry results. This is the basic weakness in the "ATA Method", which seeks to apply static factors to a dynamic industry.

Specifically, since all the factors related to airline experience (pilot pay contracts, costs for labor, fuel, insurance, etc.) in the current "ATA Method" are derived from 1954 and 1955 average industry experience, it is obvious that these elements in the current series of formulas do not reflect current, much less immediate future expectancy) even on an average basis. It is understood that these elements are now in process of revision, and may be more frequently revised hereafter. Nevertheless, many of the basic relationships expressed in the individual formulas themselves would remain to produce substantial error.

The introductory comments in the ATA Formula provide a useful frame of reference for analyses of its many defects. It is first stated that:

> The objects of a standardized method for the estimation of direct operating costs of an airplane are to assist an airline operator and aircraft manufacturer in assessing the economic suitability of an airplane for operation on a given route and to provide a ready means for comparing the operating economics of competitive airplanes under a standard set of conditions.[50]/

It would appear that these two objectives, if taken literally are contradictory. Since the formulas are built on a standard (average) set of conditions, the estimates derived therefrom should not be expected to produce absolute values (costs) representative of those which a specific airline would likely achieve on a particular route, unless by coincidence both the experience of the operator and the operating conditions on the route happened to resemble closely the standard values of the formula method.

Although the ATA formula method is all too frequently literally applied so as to obtain estimates of absolute operating costs, the introductory statements to the method indicate that this is not intended. For example, it is stated:

> Any system evolved for these purposes must essentially be general in scope, and for simplicity will preferably employ standard formulae into which values appropriate to the airplane under study are substantiated. Clearly, these formulae, seeking to give mathematical precision to complex economic problems, by their very nature can never attain this aim completely, but it can be closely approached by ensuring that the method in the first place quotes realistic universal averages.

This appears properly to place the user of the formula method on notice that derived cost estimates should be regarded only as approximations of cost levels based on formula factors representing past industry averages.

Other introductory statements, often disregarded in practice, caution the user. For example,

> It is recognized that, with present [1955] rapid development in airline operation, frequent revision will need to be made if the Method is to retain its value. This applies with particular emphasis to the introduction of turbo-prop and turbo-jet powered airplanes. Data specifically applicable to turbine powered airplanes are based largely on conjecture and the results obtained therefrom should be used with caution. These (turbine) formulae are designed to provide a basis of comparison between differing types of airplanes and should not be considered a reliable assessment of actual true value of the operating costs experienced on a given airplane. Where data is lacking, the user of the method should resort to the best information obtainable.[51/]

Subsequently, the following appears: "Costs computed by these formulae are for comparative purposes only."

Only in the very first quotation above do we find an implication that the "ATA Method" may be used to estimate the operating costs of an airplane on a specific operation. The subsequent qualifications clearly indicate that the sponsors of the Method did not intend its use for the "estimation of absolute costs on a specific route of a specific airplane." This implication interpreted rationally instead of literally would appear to suggest that the Method could be used to estimate the relative performance and costs of differing airplanes under an assumed standard set of route conditions. This is a valid objective which a properly constructed formula method might well satisfy.

A detailed examination of the ATA Formula is provided in Appendix O. Together with the foregoing, it impels the following conclusions:

(a) The Method uses factors based on data reflecting cost levels of a particular year which thus grow rapidly obsolete in the dynamic technology of aviation.

(b) The Method factors are based on average results of the commercial air carrier industry, and their frequent application to specific routes yields values significantly removed from individual route experience.

(c) The Method is limited to cost characteristics of aircraft, but it provides no means for associating these costs with specific classes of traffic. Likewise, it does not purport to deal with the great mass of airline expense incurred for station operations, ground services other than airplane maintenance, or carrier administration.

(d) As presently constituted the Method excludes certain elements of expense formerly construed as indirect, which the CAB, through a revision of its prescribed accounting system in 1957, now considers as directly related to flight operations and maintenance.

(e) The Method makes no allowance for such practical operating exigencies as traffic delays, weather variations and circuity. This follows from the declared objective of evaluating "operating economics of competitive airplanes under a standard set of conditions".

(f) Any formula method of airline costing must be revised at least annually to retain even its original degree of validity.

(g) A formula method can be useful for evaluating the economics of competitive aircraft under standard conditions. To be useful for this purpose the formula must be based on cost concepts and factors which reasonably reflect current experience. If this were the sole objective of the "ATA Method" it is probable that the present concept could be simplified to a few basic parameters expressive of aircraft performance and efficiency while abandoning the mass of individual formulas which seek to duplicate sub-accounts of the prescribed expense classification.

Direct and Unit Cost Method

The Direct and Unit Cost Method is the designation given to the general technique of cost analysis used by the Southern Pacific Co. (In some respects it resembles procedures in use by the Chesapeake & Ohio, Canadian Pacific and Canadian National.) Of all the costing methods used by individual railroads, it combines in optimum proportion (1) a substantial improvement over conventional procedures and (2) feasibility for fairly expeditious widespread application.

In essence, this method derives pertinent costs of various services or traffic through a composite of directly assignable wages, payroll taxes and fuel expense with statistical analysis of all other expense accounts, individually or in groups, in the prescribed railroad accounting system. Since this analysis is designed to develop unit costs for expenses which cannot be directly related to the traffic or operations being costed, it rests upon the aggregate experience of the carrier during a given year, or period. The analysis varies in detail, depending on the nature of the accounts being analyzed (including, significantly, a cyclical correction for maintenance expense) but the basic objective in each instance is to ascertain the variable portion of expense. This is derived by regression analysis (simple or multiple as seems indicated) of the relationship between individual expenses or expense account groups and different measures of traffic volume, such as terminal carloads, yard engine-hours, train-miles, car-miles, gallons of fuel, locomotive unit-miles, and gross ton-mile, depending on the specific account, or account group.

The variable portion of each account or group is divided by the number of input or service units related to the account to obtain variable cost per input unit. The service units involved in particular operations are related to the computed variable cost per unit, and total applicable cost is derived from combination of these with the previously ascertained directly assignable costs.

Despite certain differences in underlying philosophy, which motivated adjustments in computed unit costs, as discussed in Section 5, the ICC has recognized the basic validity in this method and accepted its use in regulatory cost determinations. A detailed description of its use for costing a specific commodity movement is found in the Commission's decision in Lumber-California and Oregon to California and Arizona, decided August 10, 1959.[52/]

Berge Method

Professor Stanley Berg of Northwestern University, a champion of railroad passenger service, published his analysis of railway passenger costs in 1956.[53/] Prof. Berge holds that for predominantly freight railroads the profitability of passenger business "is best measured by the extent to which the revenue added by passenger service exceed the expenses which could be avoided by its elimination."[54/] This is a good statement of the problem.

But Berge then equates avoidable cost with the ICC.'s directly assigned passenger expense. "While directly assigned operating expenses related solely to passenger and allied services do not include all avoidable costs, they are a far better measure of avoidable costs than the sum of all costs assigned and apportioned in accordance with the rules of the Interstate Commerce Commission."[55/] Thus Berge chooses to ignore common costs, which are at the core of the problem. Furthermore, he accepts "directly assignable"

The costing techniques of the Bureau of Air Operations of the CAB relate to the development of airline aircraft operating expenses, locals station costs, and general servicing expenses. These have been applied principally to forecasting probable costs to be incurred by local service carriers in public convenience and necessity proceedings involving route extensions.

The aircraft operating expenses are developed by a correlation between length of hop and cost per departure for each plane type (e.g., DC-3, Martin, Convair, etc.) A straight line correlation technique is used in the nature of $Y = a + bx$, where "a" is a constant representing the cost per departure or stop, and "b" is the cost per mile flown. The technique assumes that once a plane has taken off, the cost per mile varies at a constant rate. It does not allow for differences in cost per mile resulting from the ability to attain more efficient cruising altitudes with variations in length of hop. Once a take-off is made, it is assumed that the average cost of a 200 mile flight will be double that of a 100 mile flight, and four times the average cost of a 50 mile hop. This simple method does not provide for the fact that the total operating cost curve of an airplane decreases rapidly at the short stage lengths and then levels off.

The Bureau's development of station costs has changed frequently in recent years. In the Pacific Northwest Case [56] for example, the Bureau correlated station costs with aircraft departures. In the Pacific Southwest Case[57] the Bureau correlated station costs with tone enplaned and number of employees. It is noteworthy that the number of employees is itself a dependent variable and is determined by a number of independent variables such as the hours per week during which a station is operated, the number of schedules and size of aircraft serving the point, the clustering of departures, etc.

The Bureau's derivation of regional and system servicing expenses is dependent upon revenue ton-mile relationships, corrected for changes in the haul density index. It is generally agreed that costs will decline as the volume per departure increases. However, the Bureau has evolved a Haul Density Index which consists of revenue ton-miles times tons per departure times average haul:

$$\text{Revenue Ton Miles} \times \frac{\text{Revenue Tons}}{\text{Revenue Aircraft Departures}} \times \frac{\text{Revenue Ton Miles}}{\text{Revenue Tons}}$$

Inasmuch as the revenue tons in the above equation cancel out, the resultant Haul Density Index equals $\dfrac{(\text{Revenue Ton-Miles})^2}{\text{Revenue Aircraft Departure}}$

Thus, in forecasting the extent to which costs are diminished by changes in the Haul Density Index, the diminution varies with the square of revenue ton-miles, assumption which is not buttressed by empirical date.

Although BAO costing techniques are constantly being improved, the data is all too frequently limited to few observations because of the limited number of carriers with which the Bureau is concerned. As a result, assumed correlations are frequently poor correlations.

Post Office Method

Inasmuch as the operations of the U. S. Post Office Department are primarily concerned with transportation and distribution, albeit of a highly specialized nature, it seemed appropriate briefly to examine the Department's cost ascertainment methods,[58/] since these relate to public policy matters and are an expicit consideration of the National Transportation Policy.

The revenues and expenses of the Post Office Department rare distributed to twelve classes or services largely on the basis of four one-week studies per year. These studies are conducted at a large and carefully selected sample of 449 "cost ascertainment" offices which aggregate 44.67% of all U.S. postal receipts.

The primary problem is, as in many other transport operations, the proper distribution of common costs, viz., "...only a small part of the expenditures for postal operations are susceptible of direct allocation. Practically all of these expenses are incurred in rendering service jointly in connection with the several classes of mail and special services and are apportioned on formulas designed to measure the use of postal facilities.[59/] However, the composition of the formulas is not described in the Department's "Cost Ascertaiment Report." As applied therein they would appear in essence to be simply an accounting method for complete distribution of revenues and expenses which will facilitate comparisons of each among the various types of mail and special services. Since the "costs" so derived are nothing more than apportionments of expense using "straight-line" methods, the effect of volume upon cost is not dealt with. "Cost" will vary from year to year for reasons that the costing method evidently does not attempt to assess. The striking conceptual similarity is with the ICC rules for separation of total expense between freight and passenger servise.

The costs accounted for are limited to actual expenditures by the Department for labor, materials and services. Since labor is the preponderant element, costs will be highly responsive to volume, in the absence of any attempt to assess the hugh body of cost which attaches to the rent-free occupancy of Federal buildings. In this respect, the situation of the Post

Office Department resembles that of the regulated carriers using government-provided facilities without charge. In the absence of any approach to this problem, there is no way to determine with precision the relative economic status of the various services provided by the department.

Responsibility Accounting and Standard Costs

Among the infinite variety of pertinent internal procedures currently used by transportation firms, two commend themselves as having the greatest potential usefulness for improved cost-finding precision. Limitations of time and space preclude more then the briefest description of these methods, and it is certainly true that cost ascertainment for rate-making has been a minor factor in their installation by a few progressive transport enterprises. Nonetheless, mention of these methods here seems justified for the reason that improved internal cost measurement and control will inevitably enhance the precision of cost presentations to regulatory bodies.

Responsibility accounting is the technique which makes the manager, by contrast with the function or object of expenditure, the focal point of the bookkeeping and accounting system. The underlying philosophy of this procedure is that costs tend to flow along established lines of authority, and that the organization chart of each enterprise provides a ready made means for the isolation and identification of expenditure. Responsibility accounting then, is a technique which retains the identity of expenses and accounts with respect to the man who is responsible for them, and at the same time does this in a manner which can preserve desirable identification of functional costs and facilitate consolidation of data for preparation of normal financial statements.

The method seems ideally suited to organization like the typical airline, trucking or railroad company whose activities are widely dispersed and not easily divisible into convenient costing units. This is particularly true since responsibility accounting is in practice compatible with extant accounting procedures, prescribed or otherwise, and would appear to yield handsome benefits in improved budgetary and cost controls. This follows from the fact that expenditures are recorded only in relation to clearly defined cost centers, and the responsibility for expenditure in each cost center is one individual's: the line of organizational authority corresponds with the line of responsibility for control and expenditure of funds. Since cost behavior in each cost center can be analyzed as frequently as desired, much improved budgetary and cost control is an inevitable result.

With all these apparent advantages, it is unclear why responsibility accounting has not been adopted by large numbers of regulated carriers; the answer perhaps lies in high initial costs of installation; perhaps in lassitude. In any event, the method has been used by many public utilities for up to twenty years, and great benefits are claimed. This alose would seem to merit extensive investigation by the responsible financial officers of the regulated carriers.

Another and more sophisticated system is that designated as standard costs. The standard cost method, now widely used in heavy industry, has been defined as "an accounting plan which compares actual net profits with predicted net profits based on computation of the standard cost of production, budgets of expense, and budgets of sales volume; with analyses of variations from predicted results, by their causes.[60/]

In the CAB's General Passenger Fare Investigation, the examiner's initial decision found that:

> The Bureau *[of Air Operations]* attempts to establish something akin to standard costs as used by management in the business world in the sense that it would determine what the carriers' unit costs should be under honest, economical, and efficient management. It sets up standard unit costs per available ton-mile, contends that these can be met, and contends that operations not meeting them are perforce not honest economical and efficient management.
>
> Standard costs are widely used in industry. They are typically figures in terms of costs per unit of production used by manufacturers to serve primarily as goals to be striven for in management's attempt to control costs and as measures of the success achieved by this effort. As goals, they are costs based upon approved methods and quantitative standards set to represent proper usage of cost factors. As measures of performance, they are cost figures with which actual costs may be compared. The essence of a standard cost is the existence of underlying physical standards which measure the amounts of material, labor and services which should be used in manufacturing a given product.
>
> The air-transportation industry is not shown in this record to have utilized the device of standard costs as a technique of management control, and evidence has not been presented to enable a conclusion as to whether it is a technique feasible for use in the industry.[61/]

It would appear that most carriers can estimate standard production (i.e., operating) costs within reasonable limits of accuracy, or could if they determined it necessary, but the requisite estimation of sales volume might be more difficult. The development of improved forecasts of traffic volume is in any event essential to more accurate estimation of future costs, whether "standard" or any other variety. Thus, the objectives of "standard" costs" represent an ultimate goal for all carrier managements under competitive conditions, since only through some method of this sort will it be possible to measure not only how much an operation costs, but also what it should cost, and the causes of excess cost. Such a method would permit costs associated with particular traffic to be isolated by cost centers utilized in service the traffic, and the extent to which each was used could also be determined. From this it would be merely a matter of arithmetic to develop unit costs for various commodities and services. These benefits to management from a "standard cost" method would seem to provide better building blocks than presently exist for rate-making cost analyses.

From the foregoing brief descriptions of current cost-finding methods in transportation, it is obvious that in many cases uncertainty remains as to the relationship between the costs as computed and the specific individual routes, segments or facilities on which the transportation service is performed, or the specific traffic to which the cost is attached. Likewise, the computed costs fail to dispose of the apprehension that the cost of a common measure of transportation service, such as the ton-mile or passenger-mile may not properly reflect cost functions largely related to other factors such as length of haul, traffic composition or "mix", and the presence or absence of terminal services. Finally, in surface transportation, there is continuing confusion as to the portion of total cost properly assessable for rate-making. Despite these shortcomings in transport cost analyses, it is a fact that considerable progress has been made in the recent past, due to the efforts of many persons, firms and agencies who seek to refine and improve the current techniques.

Section 13. Cost Comparisons

Cost analysis is a tool for decision making. It facilitates evaluation by providing a means of comparison. The computed costs are useful only if they are compared with:

(a) a corresponding budget
(b) anticipated or actual revenues
(c) the cost of other firms
(d) the same operation or activity in another period
(e) an altered level of operations.

Such comparisons may of course be in a short or long-term framework; they can be of an internal nature by carrier management, or relate to the development and execution of public policy; they may involve all or part of a single carrier, a group of carriers of the same type, or concern carriers of different modes. In many cases, comparisons will involve several considerations simultaneously, and it is infeasible to describe all possible uses to which cost comparisons are put.

A brief description of several types of cost comparison, of the components on which they are based, and the variables which they take into account, will serve to illustrate some of the inherent problems in this area. Comparisons between actual and budgeted costs will be excluded from the discussion since these are essentially of a proprietary nature. That is to say, actual budget cost comparisons provide a point of departure for a variety of essential decisions relating to such matters as improved efficiency, long term planning, sales development and the isolation of abnormal cost elements. But this type of cost comparison merits altogether separate treatment and is tangential to our major purpose.

In considering the following selected examples of cost comparisons, it should be borne in mind that these are most reliable when like is compared with like, i.e., when the costs are compared in a manner which takes all pertinent variables into account, and when the costs to be computed contain the same components arranged in the same way. If either of these conditions is absent from the comparison, its reliability diminishes.

Intermodel cost comparisons of major public policy significance are based on corporate (i.e., carrier-borne) cost alone, which of course leads to substantial incomparability, but even within this framework major deficiencies result from reliance upon different concepts as to the cost appropriate for comparison. For example, railroad out-of-pocket costs calculated and published by the ICC staff include not only a return on investment but the Federal Income Tax that such a return would require. Water, motor and air carriers customarily exclude/cost component from their regulatory cost presentations.[62/] such a tax

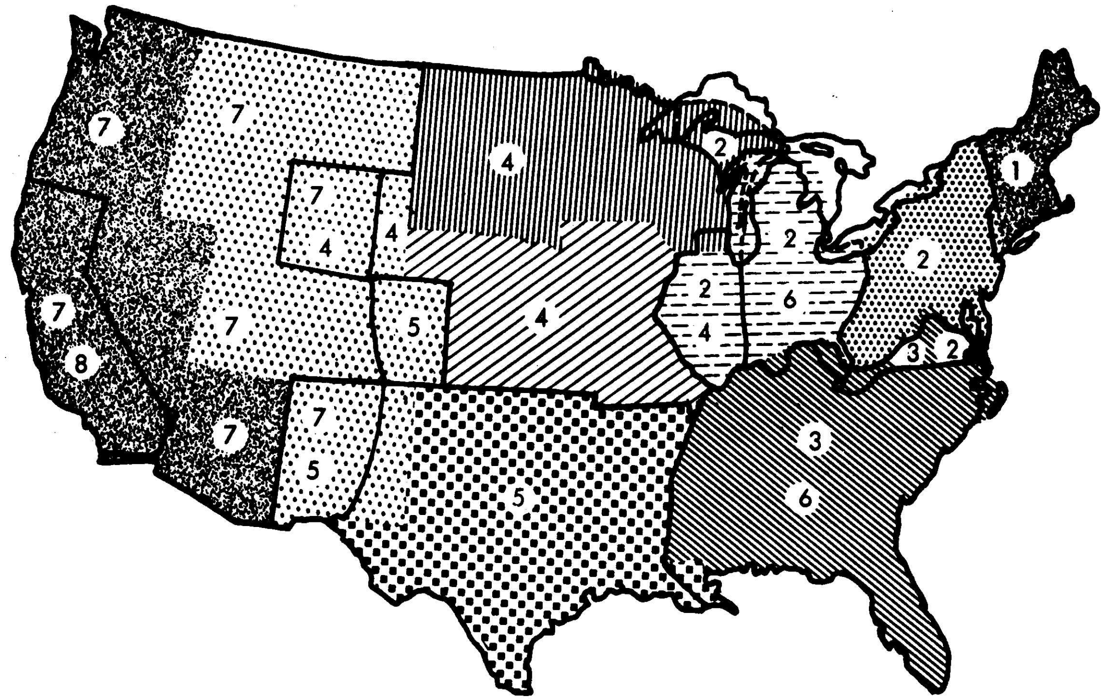
Similarly, the deficits from passenger and less-carload operations are included in "fully-distributed" rail costs as presently computed by the ICC staff; other types of carriers have deficit services also, but the burden of these is not included among the costs computed for rate proceedings, perhaps because they are not readily ascertainable from the prescribed accounting systems.

Valid intermodel cost comparisons are further vitiated by differences in depreciation rates and policies, and variations in the capital costs experienced by the different forms. For these to be taken into account would, with presently available methods, require elaborate adjustments.

Another type of obstacle to valid cost comparisons for rate-making has its origins in the disparate geographical boundaries of statistical areas from which cost data are developed, and of rate territories in which they are applied. The former are established by the ICC[63/] and the latter by the rate bureaus of the various types of carriers. Both are shown, and the difference between them illustrated in Figures 7 and 8.

Figure 7

**COMPARISON OF ICC GEOGRAPHICAL GROUPING OF MOTOR CARRIERS
FOR STATISTICAL PURPOSES
WITH SELECTED MOTOR CARRIER RATE MAKING BUREAUS**



Geographical grouping of Motor Carriers:

- New England Region
- Middle Atlantic Region
- Central Region
- Southern Region
- Northwestern Region
- Mid-Western Region
- Southwestern Region
- Rocky Mountain Region
- Pacific Region

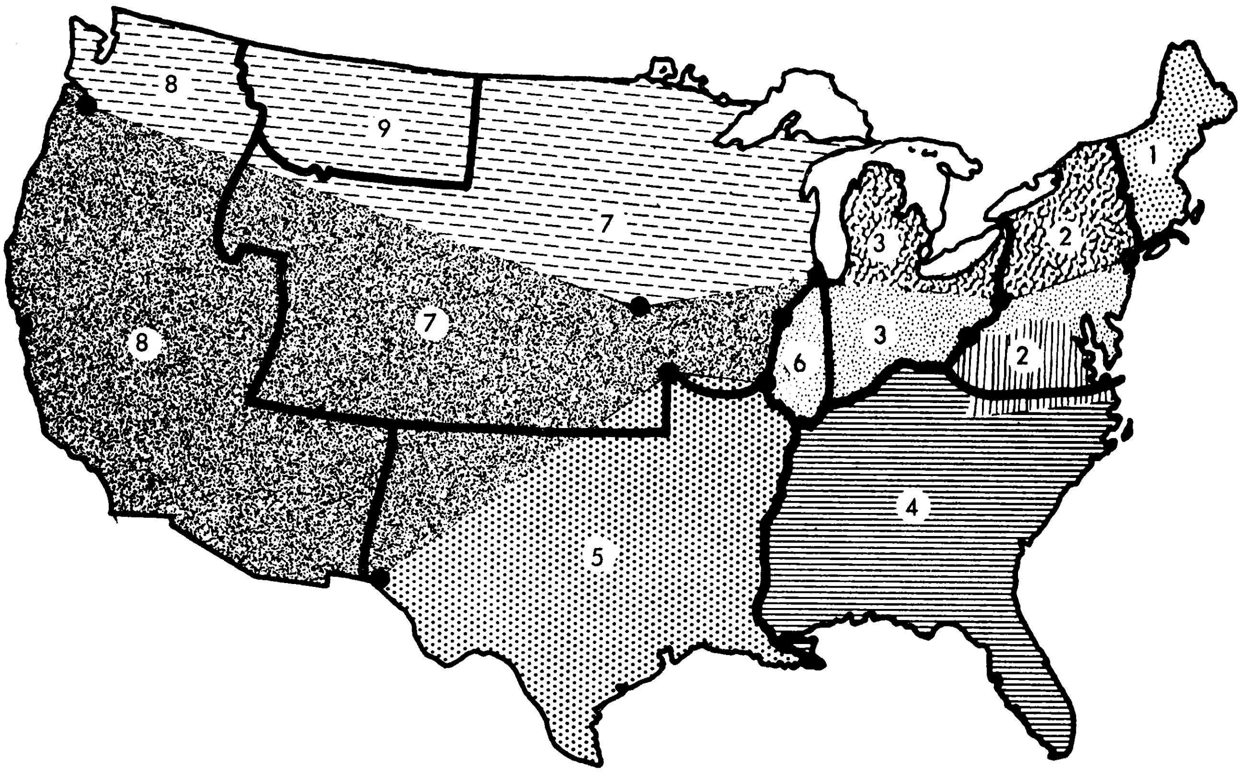
Selected Motor Carrier Rate Making Bureaus:

1. The New England Motor Rate Bureau, Inc.
2. The Eastern Motor Carriers Association, Inc.
3. Southern Motor Carriers Rate Conference
4. Middle West Motor Freight Bureau
5. Southwestern Motor Freight Bureau, Inc.
6. Central and Southern Motor Freight Association
7. Rocky Mountain Tariff Bureau
8. Pacific Southwest Freight Tariff Bureau

R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

Figure 8

**COMPARISON OF ICC GEOGRAPHICAL GROUPING OF RAILROADS
FOR STATISTICAL PURPOSES
WITH MAJOR FREIGHT-RATE TERRITORIES**



Geographical grouping of railroads for statistical purposes:

Eastern District
- New England Region
- Great Lakes Region
- Central Eastern Region
- Pocahontas Region
- Southern Region

Western District
- Northwestern Region
- Central Western Region
- Southwestern Region

Major Freight-Rate Territories:

1. New England Territory Railroads
2. Trunk Line Territory Railroads
3. Central Territory Railroads
4. Southern Freight Association
5. Southwestern Freight Bureau
6. Illinois Freight Association
7. Western Trunk Line Committee
8. Trans-Continental Freight Bureau
9. Montana Lines Committee

R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

An example of the problem these differences pose in proceedings involving intermodal rate comparisons is provided by Syrup-Keokuk Iowa to Chicago, Ill.[64/] In this case the Wabash R.R., seeking to recapture traffic, supported its proposed rate application with Western District costs. But the protesting motor carriers pointed out, quite properly, that the Wabash is classified as an Eastern District railroad, and its costs are collected in the aggregate data from which Eastern District average costs are computed. Thus with boxcar traffic in average-weight trains the following cost differences were pertinent.[65/]

Line-Haul		Eastern	Western	Percent East Over West
O.P.Cost	Per Car-Mile	18.75105¢	13.59482¢	37.9
	Per Cwt-Mile	.01164	.01094	6.4
Terminal				
O.P.Cost	Per Car	5960.052	5787.212	3.0
	Per Cwt	1.279	.303	322.1

In this case the compensatory nature of the proposed rate largely hinged upon the Commission’s determination as to the propriety of Western District costs applied to an Eastern carrier. The Commission held this to be proper, but substantial doubt remains that valid regional comparisons can be made where the Pocahantas Region includes operations as far west as Manitowoc, Wis., and the Southern Region has tentacles extending northwestward to Sioux Falls, S.D. Anomalies such as these point up the need for homogeneous carrier classification in which factors other than geography may be taken into account.

To the extent that cost comparisons in rate proceedings are based on the aggregate experience of groups of carriers, which is frequently the case, they may also be deficiant in obscuring the relative efficiency of individual carriers desiring to participate in the traffic.

Present procedures contain the implicit concept that costs are similar within a whole territory. Obviously this is not so. The cost of switching in snowy and congested yards in Minneapolis will differ from yards in Texas; mainline costs in the desert will not be equivalent to mainline costs in the Rockies. Variations in unit costs may reflect far more diverse operating conditions within the same territory than obtain with average variations between territories. Published data are almost wholly inadequate to deal with situations of this type; adjustments to take them into account require more or less elaborate special studies. If the rational use of transportation resources is construed to be a desirable public policy objective, possibly this aim is not served when rate comparisons ignore cost differences between carriers of the same type.

In its 1944 study, for example, the Board of Investigation and Research, using the Edwards Cost Formula, found a variation of over 200 percent between high and low cost railroads for an identical boxcar load and length of haul. Extreme cost variations were found in every area of the country. One New England road provided a 300 mile haul of 25 tons at a 1939 cost of between 11 and 12 cents per hundredweight, while it cost a neighboring line in the same territory about 16½ cents to provide the same transportation service.[66]

In a more recent case, it was shown that a hypothetical movement of 3,000,000 tons of iron ore between New York and Youngstown, Ohio would cost annually $1,530,000 more if moved on the New York Central than on the Erie.[67] Unfortunately, comparisons of this type are all too rare.

In cases where published data now available provide comparisons between carriers, individually or by region or district, these are often invalidated by (a) computation from an average cost base, and (b) the heterogeneous nature of carrier groupings. Chicago, for example, is served by railroads from each of the major geographical classifications. For each such classification the ICC staff computes and issues cost scales based on the "Rail Form A" method.[68] Since the costs so calculated are based on average area experience, and since this is different in each case, switching cost at Chicago will depend upon the arbitrary assignment of a railroad to a particular district or region, with the following 1957 result:

District or Region	Chicago Example	Out-of-Pocket Box Car Switching Cost [69]
Southern	Illinois Central	$ 9.61
Pocahontas	Chesapeake & Ohio	11.30
Western	Santa Fe	13.84
Eastern	Pennsylvania	17.39

Thus a literal construction of the carload cost scales leads to an 81% difference in average cost per boxcar switched between high and low cost carriers at the same terminal. Obviously cost differences exist in such a complex interchange point as Chicago, but equally obvious is the fact that "Rail Form A" is a poor guide to such differences. It is most likely that none of the above figures reflects the "real" switching cost at Chicago, but they are the only publicly available data.

Unit expression of computed costs also creates occasional difficulties for intermodel comparisons. It is relatively easier to compare like units within one of the transportation industries whether or not the units are gross ton-miles, revenue ton-miles, available ton-miles or weight/load factors. Care must be exercised, however, in the use of these for intermodal comparison. The concept of gross ton-miles has little relevancy outside the railroad industry; available ton-miles may be irrelevant to actual transportation costs.

The inherent nature of the Uniform Systems of Accounts also contributes to a certain obscurity in cost comparisons. Much vehicle and driver time in truck transportation must arbitrarily be allocated between line-haul, and pick-up and delivery service, which undermines the probability of completely valid comparisons between such carriers. J. C. McWilliams, for example, points out that intercity vehicle-miles of peddle runs, which are not treated separately in motor carrier reports to the ICC, have been reported in at least four different ways by regulated carriers:

(a) As a component of total intercity vehicle miles as defined in Schedule 9003 of the Motor Carrier Annual Report

(b) As a component of total intercity vehicle-miles, including pickup and delivery mileage enroute

(c) As a component of total pickup and delivery hours, and

(d) As components of both intercity vehicle-miles and pick-up and delivery hours.[70/]

In air transportation likewise, the efficacy of the basic records suggest that the gap between accounting for expenditure and the development of meaningful costs for comparative purposes can be wide and significant. An example is found in the varying methods used to allocate Maintenance Burden (a sub-functional expense classification including all overhead activities attaching to periodic and other maintenance and repair of property and equipment). This expense, which approximates 6% of total airline operating costs, is allocated between (1) maintenance of flight equipment, by class and (2) other ground property maintenance. Air carriers are permitted to apportion this sizeable common cost at their option as to method, provided that they advise the CAB of the procedure followed.[71/] The methods currently used by 13 certificated carriers are set forth in Appendix P. They reveal that five different allocation procedures are used by these carriers for this single expense. This suggests that the frequent comparisons of direct flight expense by carrier and aircraft type may not be based in all instances upon the same ingredients, particularly since to begin with Maintenance Burden itself is a composite of several other objective account allocations. An improvement might result if costs of this type were eliminated altogether from comparisons of direct flight expense.

Other factors also impair effective comparability among carriers of the sam type. When, for example, new equipment is received it is typically placed in service on the routes with longest hauls, highest speeds and heaviest traffic densities. Older equipment is shifted to routes with less favorable operating characteristics. This was the case ten years ago when diesel locomotives began replacing steam in large numbers; it is true today with increasing replacements of piston by turbine powered aircraft. Consequent costs per gross ton-mile or available seat-mile tend to be distorted, since the reported comparisons between equipment fail to provide for comparability of assignment, and thus omit adjustment for a significant variable.

When cost comparisons move through the time dimension, they tend to be affected by many variables, which are not always adequately considered.

The forecasting techniques followed by the air carriers in the General Passenger Fare Investigation [72/] are a leading case in point. American Airlines, for example, projected the future cost of reservations and ticketing on the basis of the cost per passenger for these services during the first seven months of the then-current year. Thus the past average cost was projected into the future without considering the impact of changes in volume. Years subsequent to the most immediate were forecast on the basis of a flat provision for labor and material increases each year. This technique illustrates what is referred to as the accounting approach, which assumes the perpetuation of present average costs and does not presume to assess the marginal costs which attach to increments or decrements of traffic.

If in this case we assume further, that an airline such as American has experienced an increasing percentage of passengers carried for their entire journey on one plane, without connections of any sort, either with other American schedules or with other carriers, this may ultimately lead to simpler reservation and ticketing procedures. Over a period of time, forecasts of reservation and ticketing costs may therefore entail other variables in addition to traffic volume. Multiple correlation may be useful for proper assessment of such variables. (See Section 15).

Forecasts of future period cost by regulated air carriers frequently use statistical correlation rather than the accounting approach, but simple correlation is favored over multiple. Illustrative thereof is the forecast of United Airlines in the same proceeding. To forecast Ground Operations, Ground and Indirect Maintenance, Traffic and Sales and General and Administrative expenses, United developed a straight line correlation over a period of years between these expenses and (a) available ton-miles, and (b) revenue ton-miles. Costs were projected on both bases and the cost presented for regulatory consideration was the arithmetic average of the two projected costs.

Another situation in which conventional cost comparisons are not too precise involves abandonment applications for railroad branch lines. In such cases the railroads have been accustomed to use and the ICC to accept, the so-called 50% Rule. This in effect concedes that it has not been practicable to isolate costs which attach to the main line movement of traffic originating or terminating on a branch line. Accordingly, in branch line abandonment cases such costs are computed in the following way:

(1) Total carload revenue is determined for all traffic originating or terminating on the branch line

(2) Total revenue-miles of haul, both main and branch are determined for all cars originating or terminating on the branch line

(3) Revenue is prorated between main line and branch line in the same proportion as their share of revenue-ton-miles

(4) Main Line cost is assumed to be 50% of Main Line Revenue.

When so computed, the cost comparisons are likely to be something less than precise as the following table shows:

Comparison of 1958 with 1956 Operating Results
Scribner-Oakdale Line, C & N W RY.[73/]

		1956	1958	Percent Increase 58/56
1.	Number Carloads Handled	1036	2225	115
2.	System Revenues	$ 138,267	$ 470,855	241
3.	On Line Operating Expense	298,832	280,564	(6)
4.	Beyond Line Operating Expense (50% Rule)	25,525	134,535	427
5.	Total Operating Expense	324,357	415,099	28
6.	Net Revenues	(186,090)	55,756	--

The 50% Rule is/as ubiquitous in abandonment cases as percent variable in rate cases; in both a uniform application to all situations may lead to erroneous determinations. The potential application of traffic sampling techniques as described in Section 15, would substantially reduce the cost of costing such traffic, and enable greater precision to be attained in measurement of its beyond-branch-line costs.

The foregoing discussion affords only the briefest sketch of current inadequacies in cost comparisons; many others could be cited.

Apart from defects in method, which are treated elsewhere in this report, it must be concluded that transport cost comparisons between equipment types, between carriers of the same mode, and between carriers of different modes, are often deficient at present. This does not imply that most or all current cost comparisons are inadequate. Due to the wide variety of situations in which costs are compared, it is likely that many data have sufficient intrinsic homogeneity to facilitate valid determinations; if error exists it may have a constant impact.

Nonetheless, it is clear that the deficiencies which do exist originate in at least four ways:

(1) Lack of similarity in the cost ingredients being compared

(2) Lack of uniform treatment in the distribution of expenditures to expense accounts or performance data to operating statistics

(3) Lack of identification between the areas from which costs are developed and those in which they are applied, and

(4) Lack of consideration of all variables which affect cost behavior.

Recommended steps for minimizing these infirmities are set forth in Part IV.

Section 14. The Role of Prescribed Accounts and Reports

In the transportation industries cost analysis has almost universally proceeded from data which were already being collected and which were generally available. These are the numbers which the regulatory agencies require carriers to collect and report in a manner prescribed by uniform systems of accounts and reports,[74/] which have the force of law. So far so good: there are obvious advantages in working with numbers already in existence as against constructing whole sets of new ones. Unfortunately, however, these numbers are often far from ideal cost building blocks. Their use continues because up to the present the importance of accurate cost information has perhaps been insufficiently appreciated. There are signs that a greater appreciation of cost significance may be in process; when this occurs perhaps a system of numbers can be devised which will incorporate improved provision for cost ascertainment while continuing to yield data adequate for other purposes. In the interim, however, the existing prescription of accounts will continue to limit the accuracy, comparability and validity of most transport cost-finding, and in particular that which is accomplished for regulatory proceedings.

To a considerable extent, despite discrepancies to be discussed later, the Uniform System of Accounts for Railroads has served as a kind of model for all the surface transportation industries. This system traces its origins back to 1879,[75/] and was actively developed by the ICC during the years 1907 through 1914, when the structure of accounts in substantially the form used today became effective.[76/] Its inadequacy as a basis for cost ascertainment relates to the fact that it was originally developed for entirely different purposes. Access to carrier accounts and authority to impose their construction in a uniform manner was originally sought by the Commission as a means of discovering disguised rebates; its regulatory genesis was part of the general campaign to insure collection of railroad freight rates at published tariff levels.[77/] From this its underlying purposes were broadened to include the general assurance of integrity in railroad accounts. This was to be accomplished by "securing from each carrier a correct statement of net revenue from operations, monthly as well as annually, and also an annual exhibit which shall correctly portray the financial standing of each and every respondent corporation."[78/]

In its day the ICC railroad accounting system represented a substantial advance over contemporary practice; in discussing the contribution made by it and other government-sponsored accounting systems one authority has observed:

> There can be no doubt that administrative agencies have been a significant influence in the development of accounting during most of the last half century. They have forced the maintenance of better records; they have enlarged the amount and detail of data collected; they have probably contributed to the development and improvement

> of accounting methods . . . On balance it seems probable that accounting thought and practice has progressed farther and faster under the stimulus of such agencies than it would otherwise have done.[79]

But the purpose of the ICC rail accounting system was not cost-determination, it was to ensure the construction of accurate, objective and honest income statements and balance sheets. In short, the system, then and now, is largely directed to general financial accounting, not cost accounting.

By contrast with the measurement of financial status of business enterprises, which is the function of general accounting, cost accounting concerns itself with the costs of production: specific costs at specific places. As Professor Ladd puts it, "Cost data for control purposes and for decision making purposes must be built up to conform to the particular place and time and setting in which the activity is being carried on."[80] Unfortunately, the general financial accounting and reporting systems prescribed for railroads and other carriers have too often been used as <u>the</u> basis for cost accounting. When so used they are bound to yield imprecise results. In the final analysis the problem relates to the <u>method</u> of accumulating cost data, i.e., to the prescribed system if no other is available. In the general run of business enterprise "the cost accountant has the alternative of selecting the method best suited to the use which is considered primary, and using the costs developed by this method for all other purposes, or of developing costs specifically for each intended use. More and more companies are adopting the second alternative..."[81] All too often the second alternative is not applied in regulated transportation. And general accounting systems, because devised for other purposes, are unlikely to be good sources for developing specific cost information; this is true whether or not the accounting system is prescribed. But even if the prescribed systems were to be the only source of cost data, some of the accounts could be made more helpful if they were constructed so as to avoid aggregating unrelated types of expenditure. Professor Ladd cites rail Account 402 "Train Supplies and Expenses" asan example, commenting, "The combination of the wages of car cleaners, the ice in the water cooler, the cost of detouring, and 'apparatus for testing the sight and hearing of enginemen and trainmen' into one account surely makes the use of such an account for developing cost building blocks most difficult at the very least." [82] It should be recognized, moreover, that all large organizations which need to develop cost information have these same problems. Some public utilities have found ways to devise sound costing methods from prescribed accounting systems. Many large and complex manufacturing industries, while not burdened with prescriptive systems, face much the same problems, and have overcome them.

With rare exceptions, all types of regulated carriers depend largely on prescribed accounting systems as the basis for cost analyses. Of all such systems, that followed by the certificated airlines affords the most information for the cost analyst, since for these carriers at least some expense elements are fragmented geographically, by object and function. On the other hand it has been observed that motor freight carriers tend to "rely on ICC computations of costs for rate-making and these studies report results for the average type of traffic. Such cost studies do not investigate the costs for special classes of traffic offering significant opportunities for better utilization of truck capacity than the typical general merchandise traffic pattern."[83/]

The important role of the prescribed accounts as the point of departure for most transport cost ascertainment as presently practiced merits an examination of their characteristics, and the effect of these upon intercarrier and intermodal cost comparisons. Those parts of the prescribed accounts covering operating expenses, rents and taxes for Class I railroads, Class I motor carriers of property, Class A inland and coastal waterlines, oil pipelines and Group III certificated airlines are arrayed for facile comparison in Appendix Q. Such a comparison reveals significant variations.

There is as might be expected, no uniformity among the prescribed accounts for various types of carriers. Such uniformity as exists is intramodal, not intermodal. The extant disparities are only partially due to inherent physical characteristics; many of them are of institutional origin. In their broadest outlines these incomparable features are brought into focus by the following array of the major functional operating expense groupings (excluding rents and taxes where these are not construed as operating expense) now prescribed for large carriers of each type.

MAJOR FUNCTIONAL EXPENSE GROUPINGS
DELINEATED BY UNIFORM ACCOUNTING SYSTEMS
FOR LARGE REGULATED CARRIERS, AS OF 1959

Rail	Motor	Water	Pipe	Air
Maintenance of Way and Structures			Maintenance[2]	
Maintenance of Equipment	Equipment Maintenance[1]	Maintenance Expenses[1]		Maintenance Burden[1] Direct Maintenance
Transportation-Rail Line	Transportation Terminal	Transportation Expenses:Line Svce. Transportation Expenses:Terminal Svce.	Transportation	Flying Operations Passenger Service Aircraft Servicing Traffic Servicing Servicing Administration
Traffic	Traffic	Traffic Expenses		Reservations and Sales Advertising & Publicity
Miscellaneous Operations				
General	Admin.& General Insurance & Safety	General Expenses Casualties & Ins. Depreciation and Amortization	General Office Salaries, Expenses	General & Administrative Depreciation & Amortization
			Other Operating Expenses[3]	
		Motor Carrier Oper. Operating Taxes Operating Rents		

Notes: 1/ Includes structural maintenance of owned property
2/ Includes Maintenance of Equipment
3/ Includes Casualties, Ins. & Rents
Source: Appendix Q.

It should be emphasized that there are numerous overlapping and inconsistent expense areas, and exceptions to the table as set forth. Nevertheless, the comparisons as shown reflect the structural backbone of the prescribed systems. With these qualifications the table discloses that:

1. Maintenance of Way cost, which in 1957 accounted for over 17% of U. S. Class I railway operating expense, is only for these carriers, a separate and distinct corporate functional expense. Comparable expenses are borne by pipelines, but for them the distinction between way and equipment is somewhat blurred. The way maintenance costs of motor carriers are an indefinable element of tax end license expense, which for truck lines is segregated from operating expense proper. Way maintenance costs are altogether absent from the accounts of air and water carriers (which do provide for maintenance expense of privately owned structures), although maintenance costs are certainly incurred through operation of the federal airways and waterways systems.

2. There are substantial differences in the treatment accorded rents, taxes, depreciation and insurance expense.

Rents. Water carriers are the only transport type which provide a separate major functional expense category for this kind of cost, although for other modes it is of equal or greater importance. The airlines and motor lines distribute rents among their various major expense categories, pipelines include rents among "other operating expenses," while for railroads they are partially included and partially excluded from operating expense defined as such. A major portion of railroad rents are separately provided for in their income statements.

Taxes. Airline tax payments (with a prior separation between payroll and other) are distributed among the entire spectrum of major functional expense classifications. At the other extreme, no functional separation of any sort is provided for railroad and pipeline tax accruals, which lump together in a single account not construed as an operating expense, taxes applicable to social welfare, real property, business conduct and income. A separation between Federal and other taxing jurisdictions is provided by both kinds of carriers, and payroll taxes are separately shown by the railroads, in the annual report these carriers render to the ICC.

Water and motor carriers occupy a middle ground insofar as tax accounting is concerned. The former show payroll taxes as an operating expense, and other kinds of taxes are charged to separate accounts and so shown in their reported income statement. Motor carriers have the most complete account separation of taxes by type, but none are construed as operating expense, and all are combined as "operating taxes and licenses" in the income statement, although such treatment obscures the expense properly allocable to various services and facilities.

Depreciation. Air, motor, and water carriers construe depreciation as a major functional expense category, while pipelines and railroads treat this cost as a subordinate element of the maintenance function. Motor carriers exclude depreciation as an operating expense proper; they treat it as an additive to operation and maintenance expense.

Insurance. A complete separation among major operating functions is required of the railroads and airlines for this cost, whereas the waterlines and motor carriers must treat it as a function properly combined with casualties and "safety" costs, respectively. Pipelines gather insurance costs in a single account included among "Other Operating Expenses."

3. The distinction between line-haul transportation and terminal expense, while not altogether sharp, is more clearly defined with respect to motor and water carriers than it is with railroads.

4. Air transportation account groupings attempt to provide much more incisive functional distinctions than are required of other carriers; their promotional emphasis is emphasized by two major functional classifications: Advertising and Publicity, and Reservations and Sales, which for other types of carriers are integrated in the single Traffic function.

5. Despite the recent growth of their ancillary motor operations not conducted as separate entities, railroads are not required separately to report the financial (as distinct from the operating) results of these activities, although such data are demanded for trivia such as railroad owned hotels and restaurants. By contrast, full disclosure is required for the much smaller motor operations of water carriers.

b. As is evident from the foregoing, there is an inconsistent interpretation of "operating expense" defined as such. For the rail carriers this excludes equipment and joint facility rents, and taxes. For the motor carriers it excludes depreciation and amortization, and taxes. Pipelines exclude all taxes, while water and airline exclude only Federal income taxes.

Other significant disparities are not evident from the preceding table, such as:

1. The prescribed air carrier accounts embody a dual classification of both functional and objective expenditure which the surface carriers lack.

2. Oil pipelines alone have a prescribed major distinction between gathering and trunk lines. Railroads and truck lines can also be classified in such a manner, but are not.

3. The railroad rules for separation of expense accounts between classes of service (i.e., freight, passenger and other) find no counterpart in other forms of transport, although the other kinds of carriers typically provide different types and classes of service. (It could be said, for example,

that a separation between truckload and less-truckload traffic is as fundamental to the motor carriers.) On the other hand, air carriers are the only kind of transport required to allocate and apportion expense among specific types of equipment.

4. There are many differences between the modes as to nature of the items to be charged to individual accounts, in fact so many of these exist, as to preclude precision in comparability. To various railroad repair accounts, for example, materials and labor are both charged, while separate accounts are maintained for these distinct cost components in the airline accounting system. A typical case is that of office rent for transportation supervisory employes. In the railroad accounts this is charged to A/C 371 "Superintendence," together with the salaries of the persons who work in such offices. In the motor carrier accounts, supervisory compensation and other costs are separated, with rent being charged to A/C 4285, "Transportation Operating Rents." This is one of a number of functional accounts, lacking rail or water counterparts, which include rental payments for real and other property, except revenue equipment. The corresponding cost for water carriers is charged to A/C 483, in which all rents except boat charters are gathered together under the designation "Other Operating Rents."

Some of these differences are not only intermodal; they also obscure the determination of costs attaching to specific kinds of traffic handled by a given carrier. Illustrative of this is rail A/C 373, "Station Employes," which includes compensation paid to 36 job classifications of agents, clerks and attendants and 26 job classifications of "labor at stations." The pay of stockyard superintendents, detectives, and coal handlers, among others is charged to this one account. Obviously, special studies are required for even approximate measurement of costs associated with specific traffic. Under these circumstances, meaningful intermodal comparisons are largely unattainable, even though in a general way motor carrier personnel (whose compensation is charged to A/C 3212, "Salaries and fees: Billing and Collecting", and 4313, "Other Office Employees") perform the functions of many of the railroad agents, clerks and attendants mentioned above, and a similar comparison can be made between rail "labor at stations" and motor carrier A/Cs 4340, "Salaries and Wages; Platform Employes," and 4350, "Other Terminal Employes."

5. There is much latitude within the accounting systems for the exercise of individual judgment. This is doubtless an essential feature of any accounting system, but the varying interpretations now practiced do lead to widespread incomparability. Some of the effects this has upon the development of unit costs in the rail industry have been described by Professor Ladd.[84/] For other types of carriers, the same results are to be expected. The CAB Uniform System of Accounts and Reports provides at paragraph 2.2 that:

(a) Revenues and expenses attributable to a single natural objective account or functional classification shall be charged accordingly.

(b) Revenue and expense items which are common to two or more natural objective accounts shall be charged to the objective accounts to which they predominantly relate.

(c) Expense items contributing to more than one function shall be charged to the general overhead functions to which applicable, except that where only incidental contribution is made to more than a single function an item may be included in the function to which primarily related, provided such function is not distorted by including an aggregation of amounts applicable to other functions.

How this type of latitude affects cost computations may well be illustrated by the manner in which objective expense element 38, "Light, Heat, Power and Water," was distributed among the major functional groups by three trunk airlines.

1958 Percentage Allocation of
Light, Heat, Power and Water Expense.[85/]

	American	Northwest	Northeast
Maintenance Burden (5300)	66.1	41.6	38.0
Passenger Service (5500)	1.7	--	0.4
Aircraft Servicing (6100)	3.3	19.6	12.0
Traffic Servicing (6200)	8.7	10.1	24.2
Servicing Administration (6300)	5.8	0.01	4.7
Reservations and Sales (6500)	11.9	6.2	10.7
Advertising and Publicity(6600)	0.15	--	--
General and Administrative (6800)	2.3	22.4	9.9

(Note: Rounding has been employed)

Although all three carriers allocated the largest share of this expense to one function, remaining distribution had no pattern relating to route structure, size, or other discernable influence, indicating that in the absence of a clearly defined standard, individual judgment or varying company policy governed the allocation. Many similar situations can be found elsewhere in the data reported by all types of regulated carriers.

6. Where individual latitude is not granted, the accounting systems often establish arbitrary rules which tend to obscure accurate cost determinations. An example of this is found at page 18 of the Uniform Accounting System for Motor Carriers, which rules in this manner concerning the classification of wages of drivers and helpers:

> The separation of drivers and helpers' wages between the "line haul" and "pickup and delivery" subdivisions of account 4230, Drivers and Helpers, shall be made according to the type of service performed by the employee. Thus, if a driver makes a line haul trip, whether terminal-to-terminal, peddle, or other, his wages for the trip shall be charged to the "line haul" subdivision of the account, irrespective of whether the vehicle used for the trip has been classified as "line haul" or "pickup and delivery." Similarly if a driver is engaged in the carrier's general pickup and delivery service, his wages while so employed shall be charged to the "pickup and delivery" subdivision of the account, irrespective of whether the vehicle used in making the pickups and deliveries has been classified as "pickup and delivery" or "line haul."

In short, on a given trip, the vehicle expense can be an element of line-haul cost, while its driver's wages are charged to terminal operations.

From this brief survey several conclusions emerge:

(1) The same cost components are not present in the prescribed accounts for all carriers. The absence of way expense for water and air carriers, and the difficulty of determining this for motor carriers leaves little doubt on this point.

(2) Average unit cost of those expenses reflected on carrier books can be determined, but the prescribed accounts are very likely to be deficient in providing information pertinent to particular situations. Thus the limitations of the accounts themselves limit the attainable precision in cost-finding.

(3) The accounts are largely historical in nature; they provide little help in isolating the causes of cost, which may be the most relevant factors to consider in assessing proposed rate of service charges.

(4) Cost segregation by specific equipment type or geographical location, two elements of major consequence in cost-finding, are almost completely absent from the accounts of all regulated carriers except airlines.

(5) It is understandable that air carrier accounts, promulgated by the Civil Aeronautics Board, should be noticeably different from surface carriers. What seems difficult to explain however are the many disparate arrangements not grounded in physical distinctions which characterize the various uniform system originating in a single body, the ICC.

(6) In both the CAB and various ICC accounting systems, there is no recognition given to the distinction between fixed and variable costs so basic to meaningful analyses by both management and regulatory bodies.

(7) Cost data based on corporate accounts alone do not provide a determination of true cost to society because many costs are not reflected in carrier accounts. For example, "It is not possible at the present time to secure data for automotive transport that is comparable to that which is obtainable for railroads. Over-all comprehensive records are not kept, nor is depreciation or obsolescence recorded for a good deal of the facilities."[86/] Hence, since real economic costs of each mode necessarily include the cost of government-provided facilities, such as highways, waterways and airways, most current cost knowledge derived from carrier accounts (and related statistical data which constitute the only reasonably available source of pertinent cost experience) represents a significant departure from complete cost assessment.

Section 15. Modern Statistical Techniques: Key to the Future

The deficiencies in current cost ascertainment procedures used by the transportation industries are a reflection of their typically predominant multi-product and common cost characteristics. As a result the methods used have been based to greater or lesser extent upon certain arbitrary assumptions and upon averages. In its simplest terms the difficulty arises because cost and production (or traffic) are not experienced simultaneously; there is often a substantial time lag between the two. The cost analyst is thus often faced with the difficulty of reconciling use in one period with expense incurred in another. Moreover, production when it does occur is likely to be common or joint, that is to say, it may involve several simultaneous types of output, for example, passengers and freight, or several types of either. This compounds the difficulties of measuring cost-output relationships. Nevertheless, such measurement is essential, and there appears to be progress towards its achievement.

One cost development procedure which can hardly be described as a "method" but which is nonetheless frequently and successfully used is simply to ask people what they think. An experienced operating man can often predict with accuracy what changes in inputs (costs) a change in output (traffic) will involve. A trained and knowledgeable observer can frequently predict such changes after a period of observing the operation, if essential conditions remain unaltered.

Occasionally, cost analysis may be made by a simple extension of the cost collection and processing procedure. Where a relationship is known to be extremely short-run and direct (as in the case some daily wages and hours worked) a mere gathering of the data will provide useful answers.

In some instances, analyses may be made by conducting physical tests in order to determine relationships. The Illinois' road test is an example.[87/] Because of the cost involved and the difficulty in duplicating actual limitations such procedures are of limited use to the regulated carriers.

By far the largest efforts in the costing of regulated transportation have been expended in the ICC attempts to develop railroad costs. Although these efforts have not yet resolved many pertinent questions, as Section 12 indicates, they have nonetheless made a notable contribution to transport cost analysis and to its acceptance as an essential activity by shippers, carriers and regulators.

A fundamental feature of this effort in recent years has been its use of correlation analysis. Correlation analysis involves measurement of behavior so as to determine the relationship between a dependent variable and an independent variable or variables. Typically, cost (input) is taken as the dependent variable and volume of traffic (output) as an independent variable. The procedure involved is simply a measure of the extent to which changes in one or more factors (traffic volume, size of firm, land values, number of competitors, etc.) are related to, or cause changes in, another factor, namely, cost. Cost can be thus analyzed either in the aggregate or by individual expense account. The latter will of course yield more refined results.

These relationships can be determined mathematically in accordance with the least squares method by use of a number of standard formulae, each of which is also expressed by a curve, or function. The method involves the determination of values, designated as coefficients (or weights) for each independent variable, when these are multiplied by that variable, they will produce a more accurate quantitative measure of the dependent variable than any other mathematical method. In each case selection of the formula to be used, and the derivation of an estimating equation depends on the judgment and knowledge (theoretical and applied) of the statistician and his awareness of the nature of the activity being analyzed. There is no mechanical way of determining when each formula may appropriately be used. In practice, the most satisfactory of such measures are derived from the simultaneous experience of a great many carriers, in what is called a "cross-section" analysis. The resulting relationships reflect the cost characteristics of the function being analyzed and have most frequently been expressed by a straight line representing the algebraic equation $y = a + bx$.

Correlation analysis by the ICC Cost Section method is, however, limited to measurement of only two variables, aggregate cost and traffic. Implicit is the assumption that fluctuations in traffic volume are the great, if not the sole, determinat of cost. In short, the ICC provides a means of establishing the extent to which fuel expense, for example, will increase as a result of increased production of gross ton-miles. But the method used to arrive at this relationship avoids specific analysis of fuel expense, or of any individual cost category. It correlates only aggregate traffic volume with aggregate operating expense and/or investment. As a result, the variable and constant portion of fuel, wage, supply and other expense is derived by the application of computed aggregate variability to total expense divided by total relevant service units. Thus, in practical effect, if it is established that the variable portion of freight expenses, rents and taxes per mile of road amounts to $3.264 per thousand gross ton-miles, then every increase or decrease to any level of traffic will be based on that single figure.

Thus, the ICC cost ascertainment method essentially involves first, the collection of basic data for individual expense categories assembled in accordance with prescribed accounting methods. Second, the costs so assembled (less passenger expense previously eliminated in accordance with the Commission's Separation Rules), are fragmented by means of linear correlation, into fixed and variable categories. Lastly, the fixed and variable portions of each expense account are distributed over the units of output (traffic) in a manner which supposedly reflects the cost per unit. In other words, the aggregate expense of a particular type is apportioned in accordance with some physical performance measure which presumably determines the cost per unit of work.

Several deficiencies of this technique have already been discussed. Here we are concerned solely with the correlation analysis employed to define the fixed and variable portions of expense. This is inadequate on two grounds.

First, the analysis is aggregative - which is to say it is applied only three times: once to investment in road; once to investment in equipment; and once to the great mass of various expense accounts comprising the sum of railway operating expenses, rents and taxes. Such a procedure ignores the fact that individual expense accounts are variable to a different degree or extent, irrespective of the stimuli to which exposed. In other words, trainmen's wage expense will be much more immediately responsive to traffic fluctuations than will expense of drawbridge operations. Yet the variability of both is by present methods, treated identically, despite awareness of differences which exist.

Second, the analysis is forced to assume that only one variable, namely traffic volume, has a significant relationship to cost. Moreover, the influence of this variable, since measured by linear correlation, can be expressed only in the linear fashion described above. In other words, variations in traffic will induce proportionate variations in cost, irrespective of traffic density. This assumption of linearity in each cost function is a substantial defect in method, since there is imposing evidence that many transportation cost functions have a curvilinear character,[88/] which is to say that a given increment of traffic will be more costly at one level of business than at another.

These defects in the ICC costing methods can be minimized, and possibly eliminated, through the substitution of curvilinear for linear correlation. This means use of multiple correlation, a mathematical method which is particularly applicable to measurement of cost-quantity relationships which by their nature are beyond the sphere of direct observation. Relationships of this type, so frequently found in transportation of all kinds, require arbitrary allocations when conventional methods are relied upon. (It should not be overlooked that conventional methods may yield fully satisfactory measures of directly traceable costs, and for these, multiple correlation adds nothing.) The great virtue of multiple correlation is its potential for objective isolation of the significant interactions between cost, capacity and traffic volume.

Though, a relatively new concept in transportation, multiple correlation is a well established technique in other fields. It was first used in the field of genetics, during the last quarter of the nineteenth century when a group of English biologists under Karl Pearson, whose following came to include statisticians and biometrists, turned to statistical methods for a successful solution to the problems.[89/] In the past twenty years, the method has been widely used by industry, the first large scale application being a study of U. S. Steel Corporation costs prepared by Dr. T. O. Yntema in 1940.[90/] In subsequent years it has found a wide variety of practical uses.

> For example it has been used to determine the relationship between the output of corn and various factors such as amounts of fertilizer used, rainfall and average temperatures; it has been used by psychologists to study the determinants of skill in operating complex machinery or delicate instruments; it has been used by engineers to minimize the effect of errors in the observed results in certain types of experiments, and it is used by business men for market analysis, and for a variety of other purposes, including cost analysis.[91/]

simple

Multiple correlation, while cast in the same mold as the ICC/correlation method, goes beyond it in order to measure the impact of not merely two, but of any number of variables in determining the shape of the cost curve. This method assumes, that there may be factors other than variations in output (traffic volume fluctuations) which influence cost behavior. Size of physical plant, as measured in track-miles, route-miles, investment, or geographical scope, is possibly one of the most important of the hitherto overlooked variables, and its relationship to cost is provided for by the introduction of a third dimension into the costing procedure, in a manner where the relationships between the variables is graphically demonstrated in geometric form. If more than three variables are determinative, the relationship among them may be shown analytically and the probable error measured.

Multiple correlation is a very special and restricted case of the general problem of finding mathematical models to describe the law of behavior of physical phenomena. Essentially, the determination of cost functions is a problem of Systems analysis. The mathematical problem is to describe the variability in the dependent variable and to ascertain (a) how much or what part of the variability in the dependent variable is explained by the independent variables and (b) the law (mathematical formula) connecting the independent variables with the dependent variable. This law (mathematical formula) might be linear or it might be curvilinear or it might be exponential or some other form depending upon a through study of the behavior of the system. A mathematical model for multiple correlation is set forth in Appendix R.

In essence, the superiority of the multiple correlation technique stems from its ability to comprehend, and reduce to numbers, the net effect on cost of several causal factors. For example, multiple correlation may be used to estimate the proportion of equipment repair expense properly assessable against owned and rented equipment. It facilitates development of user costs per vehicle-mile and owner's cost per vehicle owned, by employment of the basic equation $x_1 = a + bx_2 + cx_3$ where a is a constant; x_1 is total equipment repair expense; x_2 is ownership; x_3 is vehicle-miles; b is owner's cost and c is user's cost. The computed results moreover, are subject to confirmation by (1) mathematical tests based on probability theory, and (2) by observation. The mathematical tests enable the statistician to verify whether an apparent relationship results from chance alone, or whether it reflects a valid cause and affect relationship.

On the other hand, multiple correlation requires a careful evaluation and selection of the significant variables to be tested. The technique can be used to establish a mathematical relationship between any group of variables; in terms of cause and effect this may be actual, or fictional.

Consequently, the first order of business in meaningful usage of multiple correlation is to establish that all pertinent variables have been assembled. The next step is the construction of an appropriate mathematical model, and this accompanies the synthesis of an estimating equation, which must be tested in the process, by the probability methods mentioned above.

Summarized, there are three fundamental improvements which multiple correlation, properly applied, can bring about:

First, it will give force and effect to the fact that many transportation costs, for other modes, as well as railroads, are determined by more than one factor. Thus it will represent an improvement over perpetuation of the present assumption that only traffic volume is a cost determinant.

Second, it will afford an opportunity to divide costs into categories responsive to different influences. Under present methods, cost functions which may be determined by quiet different factors are lumped together and measured by common physical units. If multiple correlation were to be used, costs subject to different influences could be measured by different groups of variables.

Third, it would permit measurement of company size as a variable. Since many economists and statisticians believe that many cost functions are influenced by this factor, multiple correlation would afford an opportunity to test it, by contrast with present methods which eliminate possible size variations by deflation of variables to a common unit basis.

The first large-scale application of multiple correlation techniques to the transportation industry was an analysis in 1957 of avoidable cost of railroad passenger service,[92/] carried out in connection with the investigation of such service being conducted at that time by the ICC.

This study was a pioneering effort, and must be judged both as such and also in the light of the time pressures under which it was accomplished. It provides, however, a classic example of the pitfalls which lurk in the gap between the theory and application of multiple correlation. The theory requires that the variables being measured are in actual fact independent of each other. If they are not independent then linear relationships exist which make the exercise meaningless. The possibility of such "linearity" has been vigorously voiced by a critic of the study (and rebutted with equal vigor by the authors) who suggests that this early application may not be the final word on the subject.[93/]

For example, among the presumably independent variables tested in the avoidable cost study, gross ton-miles of freight and gross ton-miles of passenger service are among the most prominent. The possible existence of a linear relationship between these variables (i.e., the absence of completely independent characteristics required of all variables tested) is indicated when their sequential use completely changes the correlation coefficients. This occurs in the results computed for Running Track Maintenance in the study.[94/] In that case, where costs are expressed as a function of freight gross ton-miles and of passenger gross ton-miles, the derived freight coefficient equals $.000262 and the passenger .000087; i.e., freight is three times more costly as passenger. However, with the addition of another variable, namely size of plant, as measured by miles of running track operated the relationship is completely reversed. The freight coefficient is in this case .000315, or 1/3 less costly than passenger at .000407.

Notwithstanding such infirmaties as these, the Avoidable Cost Study, and its subsequent elaboration in The Economics of Competition in the Transportation Industries are tremendously significant works and merit wide attention.

It cannot be overemphasized that these studies are of an exploratory nature. They upset the preconceptions of many, and thus stimulate the interest which is essential to progress in the field of transportation cost finding. It is not an understatement to suggest that their appearance represents the most significant contribution to knowledge in this area since Dr. Ford K. Edwards synthesized his cost finding procedure for the California Railroad Commission.[95/]

However, these efforts, aside from technical imperfections and obscure presentation, only bring cost finding to the threshold of the future. The results are directed to the costs of large groups of railroads (and, in the last work, of other modes in the aggregate). It is to be expected, therefore, that costs for individual companies would be over or understated by the computed results, since the limited number of variables tested may not have reflected all the significant cost variables peculiar to individual firms. Consequently, methods suitable for application to individual transport enterprises remain to be fully explored.[96/]

Moreover, insofar as realistic estimates of future cost are inseparable from reliable projections of future traffic volumes, there is a great need for expanded application of sampling techniques in the transportation industries. Often the basic information is now available, but has not been analyzed simply because this involves great masses of data. However, insight into the scope and nature of the problem could many times be gained by the use of probability samples. These permit us to infer from the sample the characteristics of a massive population.

A statistically valid sample is one so drawn that every element in the population (i.e., the total universe of items being measured) has a known positive chance of being drawn. (The theories of probability were developed from experiments with throwing dice, tossing coins, and drawing cards in which conditions of “pure chance” prevailed.) Knowledge of the probability of each element’s selection permits computation of the probability that the results are correct, within stated limits, as estimates for the population from which the sample was drawn. Thus, by the means of probability theory we can conclude that a moderately large number of items (i.e., a large enough sample to possess reliability), chosen at random from a very large group, are likely within calculable limits of the larger group are almost certain to have the characteristics of the larger group.

The uses of probability sampling can be illustrated, for example, by determination of the demand characteristics for air transportation,[97/] or for intercity movements of commodities. The 1% railroad waybill sample of the ICC is a start in this direction but its limited scope restricts its usefulness. These techniques, however, can be expanded in application and refined still further by the use of tightly controlled sample designs.

A further problem relates to the cost of individual routes, services or operations within the framework of a larger establishment. It should be emphasized that useful applications of multiple correlation for this purpose are by no means confined to the railroads. The development of more accurate forecasts of probable station expense on new airline routes is an example of the usefulness of this technique elsewhere.

The numbers now available, by either conventional methods or by multiple correlation, reflect average conditions. Whether or not such methods are appropriate for the regulatory process is, of course, another question. It may well be that averages are, in many or perhaps most situations, adequate for regulatory guidance when based on homogeneous material. Irrespective of this issue, however, carrier management will need to utilize more modern methods in costing its own services. In so doing, it will do well to bear in mind that multiple correlation is not the only device useful for this purpose. There is a whole group of multivariate statistical techniques available, ranging from variance analysis to the factoring of principal components. One example is the use of hyperabolic curves determined by the basic equation $Y = \frac{1}{a + bx}$ for isolation of the several variables affecting a single expense account (as with locomotive repair expense, where wheel turnings are affected by mileage covered, and engine overhaul by hours in, or type of service). In any event much remains to be done in such specific areas as piggyback, switching expense, distribution of loss and damage between line-haul and terminal parts of movement, containerized services, equipment diversification, equipment interchange, and of course with respect to the isolation of common costs incurred by the government. It is time to recognize that in the more widespread use of modern statistical techniques lies the greatest promise for improved precision in cost finding.

PART FOUR

PUBLIC POLICY OBJECTIVES

PART FOUR. PUBLIC POLICY OBJECTIVES

Section 16. A Desirable Public Policy

A fundamental reason underlying the inadequacies in rate-making cost ascertainment has been the absence of clearly defined national transportation objectives. A multitude of conflicting aims has been molded together in a legislative potpourri designated as the National Transportation Policy whose language is also reflected in certain statutory provisions of the Civil Aeronautics Act, as amended. The regulators are enjoined to recognize inherent advantage, foster sound conditions, and promote economical service. This generic phraseology with its consequent variety of interpretations, has had an unfortunate impact on measurement of transportation cost. If inherent advantage of one mode lies in service, and of another in cost, how shall the two be equated, and what weight shall attach to each in the fixing of rates? In considering costs, what elements are controlling? Cost to the firm, to the user, or to the public? Attempts to resolve the several such dilemmas inherent in the National Transportation Policy have resulted in an abundant record of cost distortions, as the regulators have used first one and then another criterion as a determinative guide.

It is suggested that costs may best be used within an economic framework, to measure economic criteria. The economic criterion that seems most appropriate to current public policy needs is that which will secure the maximum utilization of the nation's resources. Conversely stated, a desirable public policy is one which would consciously attempt to satisfy the transportation needs of the economy with minimum consumption of scarce resources. Such a policy releases manpower, money and materials, which are not of limitless abundance, to provide an increased measure of satisfaction for other pressing demands of the national existence, while subserving both an adequate defense posture and continued assurance of high living standards. Overt* encouragement of a minimum-resource transportation policy will lower costs to consumers, encourage mass production, and foster that division of labor which is the keystone of economic progress. It would provide a political instrument for capitalizing upon the impeccable principle so ably stated by Taussig:

> No gain comes from carrying a thing from one place to another unless it can be produced at the first place so much more cheaply that it can afford the cost of carriage to the second. Ability to stand the transportation charge is the test of the utility of the carriage.[1/]

The absence of a minimum resource policy has bad the effect of generating unnecessary and wasteful distortions between cost and price in the transportation industries. It follows that the lack of clearly defined governmental objectives has served to reduce the intensity of effective (as distinguished from nominal) competition between carriers, since this can

*legislative

only be attained when cost and price approach agreement. Thus in transportation the public has been denied the benefits of competition, such as it enjoys in other sectors of the American economy.

The inadequacies in our present regulatory situation are largely attributable to the inability of the regulators, in the absence of legislative guidance, to invoke and execute a consistent policy. In considering this state of affairs it should not be forgotten that regulation is not in itself a desirable end. It serves the public interest only to the extent that it promotes competition and channels competitive forces into the public service, (i. e., towards a known national transportation objective). Beneficial regulatory administration should strive to duplicate competitive results as closely as possible, with a minimum of artificial restraints upon the action of competitive forces. In this manner it would attain a desirable compromise between short run benefits to transportation users, and the long run need for capital attraction. Under conditions of workable competition, such as prevail in most sectors of our economy, this process occurs automatically, and the lowest cost method or process is usually the only one retained. Regulation is interposed only where the public is adversely affected due to the absence of workable competition. Where new technology makes possible an increase in competition through the natural economic order, regulation should serve to stimulate this, not impede it. But it can only do so with a cost-based point of departure.

Minimum resource allocation for the satisfaction of transportation needs is not reflected solely in freight rates. In a completely rational economy, traffic would move in each case by that form of transport which would serve at the lowest total cost to the shipper. Such a cost involves not merely the freighting charge, but also the sum of other costs attaching to distribution: unreliability, warehousing, packaging, purchasing and interest. Here a fundamental dichotomy is encountered: low cost transportation for the firm may not be low cost transportation for the nation. Insofar as present procedures fail to provide an adequate measure of total social cost, this problem will remain unresolved.

Although not a complete measure of transport costs to shippers, the freight rate is clearly the largest component of such cost, [2/] and thus rate regulation becomes a critical process in the execution of a national transportation policy. The regulatory power, properly exercised, with adequate criteria for guidance, would arrogate no traffic allocation function. This, in a free society, is the province of shippers choosing among alternatives. But such choices, in the aggregate, would bring about what has been termed a rational allocation of traffic, if based upon rates determined under benevolent regulatory conditions, i.e., those in which competitive forces approached effectiveness. In such a situation the link between rates and costs would be closer than it typically is today, and fewer distortions would be induced by differential charging. In short, there would be a relative shift in emphasis between the value-of-service and cost-of-service rate making criteria. Such a shift would however, by no means eliminate altogether the use of differential pricing. This practice has in the past made a major economic contribution to the nation, by facilitating development of industries and areas unable to meet average total costs of transportation service. Today the social benefits of differential charging relate to the movement of commodities characterized by relatively elastic demand. With rates based purely on cost considerations, many such commodities would be less likely to move in interstate commerce; their consumption would be more limited, or*existant. Thus differential charging contributes to the maintenance of a vigorous economy, and should continue to do so under ideal regulatory conditions. Moreover, retention in some degree of differential charging or discriminatory pricing will serve to encourage carrier experiments designed to achieve utilization of available transport capacity, an unattainable goal with a purely cost-based rate structure.

But the value of service concept operates in the public interest only if two conditions are fulfilled, namely that differential charges cover at least, and if possible more than, the variable costs of moving the traffic to which they apply said that the traffic would cease to move in the absence of discrimination in its favor (i.e., rates which fail to meet average total cost).

Recognition of a continued role for differential charging brings in its wake the problem of separate "full cost" recovery from aggregate traffic; given some commodities which are carried at rates significantly removed from average total cost. If the theory is correct, as we believe it to be, the impact of price discrimination favoring commodities with elastic demand schedules is offset by rates above average total cost applied to commodities with typically inelastic demand. That maximum economic benefits accrue from this bidirectional thrust requires first, that competition cover as wide a range as possible, and second, that restraint be imposed upon excessive charges by carriers for non-competitive traffic. This need is met by continued investiture of regulatory bodies with power to control rate levels.

If resource conservation is to be the primary objective, then the proper cost yardstick for regulatory guidance is unquestionably long-term marginal cost. This, as previously defined, is the increment of total cost which can be attributed to the handling of additional traffic, or conversely, the saving in expense which can be realized by ceasing to handle a portion of present traffic. If the increment of cost to one mode from additional traffic offerings is greater than to another, the traffic should be handled by the mode with the smaller cost increment. If the savings to one mode exceed the costs incurred by another, traffic should be encouraged to flow via the more economic mode. The use of a measure such as this will serve to harmonize private with public objectives, since the criterion of long-term marginal costs, properly employed, coincides with net profit maximization for the individual transport firm. This follows from the fact that the most efficient firms will be those which achieve an optimum combination of the factors of production. And proper employment necessarily means use of the marginal cost criterion only as a floor for competitive rates, where minimum rate levels are at issue in intermodal competition. [3/]

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The adoption of a marginal cost criterion would seem to enable the railroads to compete more effectively than at any time since the passage of the Motor Carrier Act. In our view this is incidental and irrelevant to the paramount aim of increased competition which must be fostered if the nation is to receive maximum benefit from dynamic transport technology. The favorable effect for railroads follows from the fact that any industry with relatively large fixed costs can utilize its plant efficiently only through a differential pricing policy. Not all prices will contribute equally to overhead, but as long as an increment of business increases the net of the firm it is beneficial to accept it. Fixed-cost industries depend on volume. This, together with differential pricing, is essential in order to recover from a variety of business, or traffic, the contributions necessary to cover such fixed costs.

Under cost-based competition other modes will be impelled to attain maximum efficiency, utilizing more precise cost analyses than at present. This may very well extend the area in which such carriers have a clearly demonstrable cost advantage vis-a-vis railroads. Cost-based rates made by pipelines, for example, may ultimately deprive the railroads of much traffic now construed to be rail-bound. Cost-based competition will also serve to advance the prospects of coordinated transportation, in which each mode may participate in the overall transportation service on the basis of its inherent advantages. The total effect will be to reduce the waste of resources currently characteristic of our transport network.

Purely economic standards cannot of course, meet the whole range of national interests. Other considerations will have to be provided for, such as the need to encourage innovation, the special requirements of national defense and of the postal service, but the diseconomies*necessitated by the service of these lesser criteria should be defined as such and evaluated accordingly.

Once it is agreed that long-run marginal cost is the proper basis for judging compensativeness of rates, the regulatory agencies will be impelled to encourage greater precision in transportation cost analysis, since only with such precision can rational allocation be achieved and misallocation avoided. Because the techniques used will inevitably become involved in litigation, they should be as simple as possible commensurate with required reliability. Two relevant considerations cannot be overemphasized. First, future costs are the only relevant costs and inevitably, the future cannot be precisely measured. Second, although the arithmetic of cost calculations and the ability of modern equipment to produce an almost infinite number of decimal places give an air of great precision to calculations, there are a host of assumptions, hypotheses; and judgments involved in developing these figures which make them far from precise. New cost estimates can <u>never</u> be anything but an approach to better answers. However, with all due recognition to these limitations, the adoption of certain obvious standards will serve to minimize the infirmities previously discussed. For effective discharge of regulatory purposes, cost presentations would be:

*and subsidies

(1) Comparable in content and coverage, and stated in like terms, in order to facilitate cost comparisons between the different modes.

(2) Readily understood, or reduced to understandable dimensions, by regulatory, material and user personnel.

(3) Developed from data that should be readily accessible. This means that, to the maximum possible extent, the costs used in the pricing process should be among those which managements would in any event develop for their own purposes.

(4) Inexpensive to collate, analyze and present, so as to encourage the development of cost information without undue burden on government, carriers or users.

These goals of cost ascertainment in the regulatory process are to some degree in conflict with each other and may seem to preclude the attainment of greater precision. This would be true in terms of the present cost-finding environment but need not necessarily be controlling if, and only if, a deliberate effort is made to adjust data collection, processing and analysis towards improved assessment of long-term marginal cost. Measures to enhance this possibility are hereinafter recommended.

Section 17. Recommendations

A realistic view must impel the conclusion that improvement of transportation cost analysis to a point fully adequate for regulatory guidance may well be a difficult process, involving efforts of much greater intensity than heretofore evident. Yet the means of accomplishment are available. Individual firms are leading the way, with company-wide adoption of cost standards, responsibility accounting and electronic data processing, among other measures. Other firms should be encouraged to follow, as only through the development of improved cost yardsticks can socially beneficial competition be achieved in transportation. The regulatory agencies likewise should be provided with the incentive, authority and means to hasten the refinement of transport cost analysis. Their efforts in this direction will, however, properly implement the National Transportation Policy only if cost analysis is developed in accordance with valid economic concepts.

Assuming the establishment of clearly defined regulatory objectives, measures which will improve the quality of transportation cost analysis fall into three general categories: data collection, data processing and analytical methods.

Recommendations About Data Collection

It is a basic principle of good system design that the point of departure must be related to ultimate use. The use made by the ultimate consumer will govern the data forwarded to him as to both substance and form.

Thus the increasing use of traffic, operating and expense data for cost analysis should govern the information collected and reported by regulated carriers to a greater extent than heretofore. It is of sufficient importance, in fact, to merit wholesale review and revision of current procedures prescribed for and followed by all types of carriers. We believe that optimum results would be attained with the following measures:

1. Efforts should be made to bring about a greater degree of comparability in the Uniform Systems of Accounts prescribed for various types of regulated carriers, so as to facilitate improved intermodal comparisons. This could be best accomplished by an *ad hoc* body with representation from each of the Federal agencies regulating transportation, organized for the specific purpose of conforming the prescribed accounting systems to the maximum extent possible in view of the fact that individual expense accounts must necessarily differ by type of transportation. In view of the extant competition for passengers, and the emerging competition for freight traffic between air and surface modes, such an *ad hoc* body must, for full effectiveness, include air transport representation.* This body should aim to secure a greater degree of intermodal account comparability. This would entail the establishment of uniformity, wherever possible, as to (a) similarity

*Obviously a single regulatory agency would facilitate these and other recommendations.

in items charged to individual accounts, (b) completeness in scope of required accounts, and (c) consistency in basic data reported. Harmonious definitions of "function" and "operating ratio" [4/]would be sought. Possibilities for the provision of expenditure information by object and location would be explored, where these are now lacking. Potential uniformity in the scope of expenses designated as "operating" or "operation and maintenance" would be investigated. This would comprehend similarity in treatment of such items as rents, insurance, depreciation and taxes other than Federal income. Many present differences in accounting treatment of these items are not justified by inherent physical characteristics. Such differences lead to confusion and incomparability, and can be eliminated without impairment of account integrity. Extant differences in numeration and arrangement of groups of accounts should also receive attention.

2. The reporting requirements imposed on various carriers should be revised and re-oriented towards cost ascertainment needs to a greater extent than at present. The *ad hoc* body mentioned above would be in a superior position to review and evaluate present reporting requirements, and to design a reporting system which would meet current needs in an optimum manner. In so doing, consideration might be given to inadequacies of the following types:

Air. Costs as now reported do not permit analyses by classes of traffic. For example, there is no means of separating the costs incurred for carriage of cargo (either as a whole or in terms of mail, express or freight separately) as distinct from passengers. The Post Office and the Congress have often wanted a proper determination of the costs of carrying mail. Since mail is carried jointly in the same aircraft with other traffic including passengers, the CAB accounting system has never permitted an adequate separation of costs. For some years the relative cost of freight service by the combination carriers and the all-cargo carriers has been a subject of controversy. The CAB accounting system facilitates no valid comparisons.

Another deficiency in air carrier reporting is the lack of provision for relating traffic loads to aircraft. Prior to January 1, 1957,service, capacity and traffic by category were reported both by type of aircraft and type of service. It was at that time possible to determine the capacity provided and the average composition of traffic carried in DC-6 aircraft used for coach service as distinct from first class service, mail, express and freight service, etc. This is now impossible since capacity and traffic are currently reported in total terms, by type of aircraft, with no segregation of revenue ton-miles relating to particular classes of traffic.

Motor Carrier. ICC Motor Carrier Annual Report Form A indicates 17 types of regulated common and contract carriers, viz., of general freight, household goods, liquid petroleum, motor vehicles, mine ores, building materials, heavy machinery, etc. Since the reported operating and traffic data are largely meaningful only for general freight carriers, there is a notable dearth of information about the other types. Possibly a sub-report, specialized by carrier type, would serve the public interest.

Reported data ignore the fundamental distinction between "peddle" (or gathering) service, and true intercity line-haul operations. Likewise, there is no segregation of piggyback from all-motor operations. It may be both timely and feasible to provide for such separations in the motor carrier reports.

Reported data as to mileage, hours, and loads make no distinction between equipment types. With the equipment diversity now characteristic of motor freight carriers, this results in aggregate operating statistics which are only rough guides to specific situations. The same observation holds true for repair expense. There is likewise an absence of reported information on platform operations: tonnage handled by weight bracket, inbound and outbound, by location, for example. Finally, current motor carrier reports provide little hint of ratios between available and used capacity. Some information of this type would certainly assist the quality of motor carrier cost ascertainment.

Water Carriers. These carriers furnish less information than any other regulated mode. Cost breakouts by operation at specific terminal, by line-service route, end by size of tow ought to be considered. No information is reported as to (a) the service provided or repair expense incurred by various equipment sizes end types, (b) ratios of empty to loaded movements, (c) the boat and barge-miles operated, or (d) ton-miles of service. Without adequate operating, expense and traffic data, cost ascertaiment is substantially hindered.

Oil Pipelines. Data reported by these carriers provide no indication of the relationship between available and used capacity.

Railroads. The presently required separation of expense between freight and passenger can be substantially improved. The ad hoc body might examine recommendations made in ICC Docket 32141 for the application of statistical cost functions to this problem, and conceivably recommend that the proceeding be reopened to explore whether basic information of this type cannot be devised in a more modern manner and presented on a more meaningful basis, i.e., in terms of "avoidable cost."

There is no doubt that the present annual report of the railways to the ICC is more than a little archaic in its form. However, without a great deal more evidence from the carriers themselves to the contrary, we believe that they would continue, for their own corporate purposes, to collect practically all of the data now included in the Annual Report.

If an acceptable substitute were to be found for "Rail Form A," and a new cost basis attained for rail rate regulation, the data requirements of the regulators might well change. These changes, of course, cannot be described until the different system of regulation is developed. In the interim various data now required of railroads could be reported from available carrier records in a manner which would greatly facilitate cost-finding precision, given no substantial change in present procedures. An illustrative, and by no mean exhaustive list of such possibilities would include:

(a) A segregation of car repair and depreciation expense, as well as reported property investment by type of car.

(b) A separation of station employe costs between clerical and platform

(c) The substitution of diesel-unit miles for locomotive-miles

(d) The reporting of train-miles by type, viz., through and way or local; perhaps also car-miles by type

(e) The segregation of yard expense by yard size and function, which might involve reports by yard group size of car count, engine hours, and cars interchanged

(f) A separate report on "ad valorem" as distinguished from "all other" non-federal taxes

(g) Provision for separate showing of piggyback traffic operating and expense data.

It is relevant here once again to refer to the differing requirements of management and regulators. Management very definitely has a requirement for good cost center data, for example, but these are primarily to provide a basis for a system of cost control, budgeting and planning. We do not suggest that the expense and bother involved in modern cost collection procedures is warranted simply to provide a basis for pricing. We do believe, however, that progressive managements will develop systems to meet their own needs which will amply satisfy regulatory requirements at minimum cost, since generally it would be simple for any company to meet ICC reporting requirements from a management oriented cost accounting system.

3. Unneeded reports should be eliminated; reports required should reflect modern conditions; reporting burdens on various types of carriers should be equalized.

The elimination of useless information would involve at least the cessation of certain outmoded requirements in railroad annual reports, and could perhaps also include the disappearance of periodic reports whose continued existence as separate entities seems to serve no useful purpose. As a start in this direction, the ad hoc body might consider elimination of, or reducing the detail now required in, the following schedules of the railroad annual reports:

Schedule 411. “Mileage Operated at Close of Year.”

Schedule 411-A. “Mileage Owned But Not Operated by Respondent at Close of Year.”

Schedule 510. “Grade Crossings.”

Schedule 513. “Ties Laid in Replacement.”

Schedule 514. “Ties Laid in Additional Tracks and in New Lines and Extensions.”

Schedule 515. “Rails Laid in Replacement.”

Schedule 516. “Rails Laid in Additional Tracks.”

Schedule 517. “Gage of Track and Weight of Rail.”

Schedule 562. “Compensation of Officers, Directors, Etc.”

Likewise, there seems no reason to justify the continued requirement for the “Quarterly Report of Revenues, Expenses and Statistics” required of Class I general freight motor common carriers nor the six monthly reports of operating statistics required of Class I railroads. The useful data in these do not increase in value by the periodicty of reporting; their integration with annual carrier reports merits consideration.

Space precludes mention of other relatively less useful reports, but they exist and should be rooted out and dispensed with. There is too much need for essential data to warrant continued supply of information which no longer serves a useful purpose.

There is also, particularly for railroads, a need to rationalize reported information by the elimination of data which technological change has rendered less useful. For example, although there are only about 1,000 steam locomotives still in service in the United States, and their number diminishes daily, yet the railroads are still required by their annual reports to disclose the number of cords of wood, by type (hard or soft) which such locomotives consume. Moreover, such locomotives are still construed to be of an importance which warrants separate treatment as to investment, depreciation and maintenance expense. At the same time, more significant equipment is obscured by such bizarre expense descriptions as “Other locomotives - Repairs, Other than diesel - Other” (i.e., Repairs to Non-Yard Electric and Gas Turbine Locomotives).

Facts such as these seem to indicate that an ad hoc body of the type suggested might well devote attention to a general streamlining of reports to eliminate anachronisms and provide assurance of modernity.

The equalization of reporting burdens is another area which requires effort if comparability is to be attained. This is of particular relevance in view of the interrelationship which exists between costs, rates and traffic volume. Valid estimates of future period cost functions are largely dependent on the accuracy of projected traffic volumes, and measurement of the latter is in turn dependent to a substantial extent upon reported traffic experience. In the present circumstances, rail and air carriers provide more such information than do other modes. Although the ICC has required motor carriers to furnish annual freight commodity statistics, neither motor nor water lines furnish their regulatory agency with a waybill sample equivalent to that provided by railroads. Water carriers do, however, furnish detailed traffic information to the Corps of Engineers; [5/] thus there appears no reason why this would be unavailable to the ICC for arrangement and publication in a form comparable to similar railroad data, if this were to be requested.

Reporting burdens can also be equalized by diminishing reporting requirements imposed on rail and air carriers. It seems unrealistic to suggest that this is an attainable end in the near future, but it unquestionably in a desirable long-run goal.

4. <u>The prospective Census of Transportation should be undertaken as soon as possible, provide an improved basis for forecasting probable traffic volumes</u>.

The provision of detailed traffic information by all regulated forms would provide an inadequate basis for forecasting probable traffic volumes, due to the enormous volume of exempt and private transportation. The Census is needed as an essential step towards better rate regulation through increased precision in traffic volume estimation.

<u>Recommendations About Data Processing</u>.

1. <u>We recommend that the ICC investigate the possibility of having statistical and rate geography correspond more closely, particularly in the West</u>. For the principal purpose of facilitating comparisons with statistics of prior years, the ICC has, at least since 1920, aggregated its railroad financial operating and statistical data according to relatively static geographical classifications. As far as can be determined, the only major change that has taken place in the intervening years has been a shift of the Pocahontas Region from the Southern to the Eastern district. Since the Commission's early cost analyses began well after establishment of the present geographical groupings, it followed that they would conform to the already fixed group patterns. As indicated, the traditional railroad groupings do not in some instances provide the most useful arrangement of numbers in support of cost ascertainment. This is particularly true where large regional aggregates, as in the West, are relied upon for data in support of specific rate proposals of much narrower application. The development of separate average cost data for the Pocahontas Region indicates that it is feasible to develop

such data by regions elsewhere. This would be particularly helpful if such regions were to correspond more closely with rate territory boundries.

It would be of particular benefit, in terms of practical application of the costs computed by conventional methods, if separate data were to be developed for new regions corresponding to Mountain-Pacific and Western Trunk Line territories, in lieu of the extant Central and Northwestern Regions.

2. <u>We recommend that all the regulatory agencies, and the I.C.C. in particular, undertake to expand the use of electronic data processing in their cost analysis activities</u>. This would, in our opinion, greatly increase the possibilities for developing better cost answers in the regulatory process.

Electronic data processing (EDP) makes possible gathering, summarization and computation of data in a manner both less expensive and more accurate than previously possible, provided a sufficient volume of basic facts are to be analyzed. It should be emphasized that EDP will reduce the unit cost of costing, but it will not of itself improve the precision of cost ascertainment, unless its use is related to improved costing concepts. When such concepts are agreed upon, accounting and reporting systems can be adapted to electronic data processing for optimum effectiveness.

With a properly designed system or program, and data in card or tape form suitable for use by computers, a variety of analyses are possible at relatively little expense, which would lend themselves to improved cost ascertainment. Use of these methods would make possible the exploitation of many records which, from sheer mass, are today unused for costing purposes.

There is reason to believe that regulatory agencies have hesitated to require carrier cost accounting systems because of their expense. Use of electronic methods renders such hesitation less valid than formerly. This is especially true since many carriers are already making extensive use of EDP for routine accounting and statistical purposes.

For these reasons, EDP opens a new horizon in transport cost analysis. How much of this is pertinent to management only, and how much to the regulatory process, remains to be determined, but the regulatory bodies cannot afford to ignore the implications of expanded use of such methods.

Other governmental transportation activities are already utilizing computers for costing purposes. For example, in 1958, the Bureau of Public Roads designed high-speed computer programs:

for solving certain highway cost research problems, one of which was the development of depreciation rates of the various elements of the highway. Information obtained from an analysis of the investment in grading, surfacing, and structures for eight States was programmed on the high-speed computer for use in determining the depreciated investment remaining, for construction built from 1914 to the present date, for various highway systems. Analytical estimates of highway needs based on the relation between the growth trends in traffic and corresponding growth in the highway investment were being undertaken for the various highway systems.

Highway needs data submitted by the States were reviewed, correlated, and preliminary listings made preparatory for use in the highway cost allocation study.[6/]

Although not yet used for cost analyses, the Civil Aeronautics Board began experimenting with data processing equipment as far back as 1951, for the compilation of its Origin and Destination Airline Traffic Surveys. In 1958 the Board acquired a small computer which is currently being used to check the arithmetic and consistency of air carrier periodic reports, to facilitate timely publication of financial and traffic data by the Board. This machine is capable of cost analysis. Also, punch cards of passenger movements are sent to the CAB by the certificated airlines. The Board processes these data and releases them in its Airline Traffic Surveys, and in the series designated Competition Among Domestic Air Carriers. We are informed that the CAB plans to broaden and increase the scope of its current data processing activities.

By contrast, no information is transmitted on punch cards from carriers under the ICC's jurisdiction. Several years ago the feasibility of having carriers report their commodity statistics on punch cards was investigated, to the extent that several railroads and motor carriers did so report.[7/] After it developed that a majority of involved motor carriers lacked the necessary equipment the matter was dropped in 1958.[8/] The ICC acquired a small computer in March of that year which it employs to speed up compilation of its railroad waybill and revenue contribution studies, but regulated carriers have properly taken the lead in exploring potential applications to cost work in surface transportation, described in Appendix S.

With traffic tracing effort eased by such systems as the Chicago & North Western's "Carfax," and with a cost oriented accounting system, it is possible to visualize cost isolation by individual routes, facilities and commodities on a scale never before deemed feasible. Such specificity may exceed that required for regulatory purposes, but the CAB and the ICC should be prepared to acquire familiarity with electronically derived cost data. Thus these agencies will be in a position to design electronic accounting, reporting and costing systems as these evolve.

3. The carriers themselves should begin, assisted by their trade associations and the Federal government if necessary, to develop computer cost analysis programs which will produce data adequate for regulatory purposes, for use in common by principal sizes and types of carriers. Once regulatory objectives have been defined with clarity, and cost concepts to

service these are agreed upon, the realization of computer potentials for improved cost analyses hinges upon system design, or programming. A computer cost analysis program adequate to fully meet the regulatory purposes will be a major undertaking, involving a high degree of coordination between regulators, carriers and computer manufacturers. The initial cost of such a project will doubtless be several millions of dollars, but this will be amortized through long run savings in expense of regulatory cost presentations. It will be necessary to reach agreement on required elements of data, the form these are to take, and the manner of their processing. To be effective, provision must ultimately be made for comparable computer derived costs for carriers of each mode by size class, and perhaps by geographical or functional classification. Numerous checks and tests must be devised and incorporated. Provision must be made for outside data processing for carriers too small to have their own equipment. (This is now possible, countrywide, through firms which offer just such services.)

The ultimate procedural objective must be to obtain a variety of information with a minimum of burden. A major stumbling block will be the variety of processing systems now owned by different transport firms, but ways will be found to overcome this.

When such efforts are jointly undertaken, the burden upon individual carriers is minimized; since all will benefit, all should participate. In our view the ultimate advantage of such a program will substantially offset, and most probably exceed, the initial expense incurred by individual carriers. The financial, legal and administrative problems faced by such an endeavor are formidable; they will take time to resolve. Efforts should begin in this area as soon as possible, in recognition of its inevitability; delay can only increase the cost finally incurred.

Recommendations About Analytical Methods

An approach to improved measurement of long-term marginal cost can be attained in two ways: (l) through complete reorganization of the whole existing machinery for cost ascertainment, or (2) through procedural improvements in existing techniques. It is our belief that the former represents a distant and ultimate goal and that the latter is the only practicable course at this time.

1. The first alternative would involve a complete conceptual change from present practice. It would devise improved costing models through the use of a wide range of statistical techniques, chief among which would be multiple correlation. As an ultimate goal, the application of advanced statistical techniques to the entire spectrum of regulated carriers holds the greatest promise of greater precision in transportation cost analysis. But there are significant obstacles to expeditious application of these techniques. To begin with they are not widely understood in the transportation industries. Although the concepts are excellent and merit thorough examination, there are too few people in the business capable of utilizing and understanding them. There are extremely difficult communication problems between layman and mathematician in these technical areas. In some respects this is comparable to the layman's approach to advance weaponry; the techniques are not understood, therefore the lay public supports the effort and expense because it

has faith in the scientist. Similarly, complex costing techniques will not always meet the test of simplicity but they may be relied upon in the same manner as scientific achievement.

Furthermore, the models so far employed are too new in their specific transport application; as a consequence they have not been adequately tested; issues of methodological soundness and statistical inference remain unresolved. Neither ICC nor CAB has undertaken extensive cost analyses of this nature. Hence for the immediate future the adoption of such techniques as the standard for regulatory cost presentations would be premature; too many pertinent procedures are relatively untested, too little is known about their validity in specific situations. In short, they must first prove themselves.

To secure as quickly as possible the potential improvements which statistical costing promises, <u>we recommend that a joint industry--government task force be organized for the specific purpose of exploring the practical applications of these procedures, and the possibilities for increasing their use as a basis for transport cost analysis</u>. This ought to be a major effort; it will be costly of manpower, money and time. It ought not however prove as expensive as many past studies, such as that conducted by the Board of Investigation and Research. In our view, prospective benefits merit the assembly of a research team of perhaps 30 persons,including mathematical statisticians, economic statisticians, econometricians, computer specialists and experts in the costs of every form of transportation. The group would be provided with the funds and authority to conceive and explore scientifically and objectively, the experimental designs appropriate to such analysis. Their work would be entirely divorced from litigation of any sort, and would be supported by the transportation industries as a public service endeavor of major magnitude.[9/]

We anticipate that the initial task of such a group, and one which would shape the validity of their mathematical models, relates to correction of a major defect in most current costing methods, namely, the assumption of homogeneity in the data being analyzed. It is for example, true that the unit cost of main line rail maintenance of way in a mountainous area would have a different cost function than that of a secondary branch line in the flat mid-west grain country. Lumping them together for a multiple correlation analysis in the manner of current procedures would lead to heterogeneity and tend to produce unrealistic variability in the predicted cost as well as atypical results. Furthermore, it may be that the form of the mathematical model for the first case is not the same as that for the second. These respective models must be separately found. Hence, the aggregative procedures used by the statistical analyses so far conducted may not necessarily lead to a dependable result. In statistical costing dependable results rest in the first instance upon a classification of carriers or parts of carriers, which is homogeneous. This may be homogeneity with respect to size alone; more likely it includes also elements of economic function and physical characteristics. Determination of carrier homogeneity is in itself a large assignment, but in its absence it would be exceedingly unrealistic to assume or hope that for an individual transport firm the heterogeneous mathematical results would balance out. Despite such difficulties, it seems possible that statistical techniques may be properly developed for ultimate application in specific commodity rate cases as well as to large groups of carriers seeking broad-scale rate or service adjustments. There is also little doubt that the evolution of an adequately homogeneous classification is a prerequisite for mathematical designs suitable for meaningful data collection and processing.

2. The alternative general approach is to accept existing techniques of cost analysis, and attempt to minimize their infirmities. As a practical matter this is the approach that will have to be adopted until statistical methods are more firmly established.

In the interim period, the following amendments to current cost finding procedures offer the greatest promise:

<u>Railroads</u>

a. <u>Consideration should be given to superseding "Rail Form A" as the standard for regulatory cost presentations by a procedure modeled after the "Direct and Unit Cost Method" described in Section 12</u>. "Direct" cost, here used synonomously with "variable" cost, is by this method computed separately for individual accounts and groups of accounts containing costs not directly associable with the traffic or service being analyzed.

The method has two significant advantages by contrast with "Rail Form A". First, it avoids the use of a common coefficient of variability for all operating expense, rents and taxes. Second, it makes possible the use of simple or multiple correlation, as may seem appropriate, in variability determination for individual accounts or account groups. In this manner it represents an advance over the arithmetic commonly used today, and encourages familiarity with more advanced techniques. In some respects the analytical approach of this method may offend mathematicians In others, the method may cause concern to traditional users of "Rail Form A." In our judgment, it represents a desirable compromise between these extremes.

b. Pending the replacement of "Rail Form A" <u>consideration should be given</u> to the following adjustments.

(i) <u>Deletion of "Fully Distributed Costs" from the Formula should be seriously considered as a possible method by which potential distortion may be minimized</u>. If this were to be done the distribution of fixed or "constant" costs among service units would be eliminated in rate-making cost determinations, as a procedure devoid of economic meaning, and contributing to erroneous comparisons. Perhaps the most pungent commentary applicable to present procedures for arriving at "fully distributed cost" appeared before that term crept into the general parlance; it was critical of common cost apportionments, but with minor adjustments it applies with equal force to constant cost distribution:

> These [cost-finding] computations, then, consist of two processes. One is [the determination of variable cost] which is the ascertainment of facts; the other is apportionment [of fixed cost] which is the determination of policy. The former concerns itself with what is; the latter with what should be. One process consists of untwisting the intertwined but distinct strands of particular causation; the other of splitting the homogeneous fibres of a single cost... [Variable expense measurement] aims to find what each service costs; [constant cost] apportionment aims to determine what each service <u>ought to pay</u>.
>
> Combining the two figures seems like adding quarts to feet. The desirable course would seem to be to resolve the total "cost" into its constituent elements, one marked "Matter of Fact - ... [Marginal] Cost of Service" and the other labeled "Matter of Opinion - Mathematical Photograph of Witness's Sense of Justice...
>
> ...who should determine the broad questions of public policy which are involved in the question: What is a just apportionment of the . . . burden? If we were to levy an income tax, we should first decide whether to tax large incomes more than small incomes, and if so, how much more, and then call in a mathematician to figure the amount of each man's tax. We should hardly leave it to each appraiser to make up his own mind upon the rate of tax and the exemptions, no matter how expert he might be. Yet this is what we are doing in a rate case when we ask an expert accountant to apportion [fixed] costs. Would it not be more appropriate to qualify the authors of these computations as expert rate-makers rather than as expert accountants? [10/]

It is essential that all interested parties understand that even if absolutely precise costs could be established for each of the activities of a transportation enterprise, the sum of these costs would not equal the total cost of the enterprise. Collecting this difference from various consumers of transport service is not cost-finding; it is price fixing. We*believe that for regulatory guidance the aggregate of carrier costs unrelated to traffic should be retained in the formula, but clearly designated as an unapportioned residual;

(ii) <u>If present methods of variability measurement are to be retained, they should be related with more sensitivity to traffic volumes and carriers being analyzed</u>. Attempts should be made to measure and apply them to more homogeneous carrier groupings; there seems no justification for use of a uniform coefficient of variability in every situation. At the very least different coefficients corresponding with the varied experience of the several statistical regions should be employed;

____

*therefore

(iii) Since "Rail Form A" uses one year's experience for the derivation of unit costs, the computed results are furthest removed from long-term marginal cost in those areas where the expense cycle is likely to exceed that time period. This is particularly true of way, and to a lesser extent of equipment maintenance expense. In these areas, there is ample evidence that actual expenditure, as distinguished from "cost" is governed by availability of funds in the current or a prior period. This is due to the fact that maintenance expenditure consists of two parts, an irreducible minimum essential if a line is to carry any traffic, and that portion above this minimum which management policy considers desirable when income permits. A fair picture of maintenance expenditure must therefore be derived from costs incurred over a period long enough to enable all variables of income and policy to be influential in due proportion.

Thus the formula's use of a single year's expenditure, uncorrected for variables operative over longer periods, tends to induce significant distortions in view of the importance of these items in the total cost structure. Accordingly, <u>we recommend that consideration be given to the substitution of engineering standards for accounting records as the basis for deriving maintenance cost elements. This could be accomplished by amending the formula to provide for the inclusion of costs which reflect agreed periods of equipment and facility life</u>. Many railroad engineering departments maintain "Statements of Estimated Average Annual Maintenance of Way and Structure Expense" for various line segments, and somewhat similar schedules for various classes of equipment. These are compilations of cost figures, based upon engineering and mechanical department experience with the <u>average service life</u> of the various physical units, correlated with the current cost of these items. By the system we recommend the proportion which one year bears to the total estimated service life of each specific facility will be the annual current cost (including labor but excluding overhead accounts) which may properly be charged as an operating expense for the purposes of "Rail Form A".

Service life charts of a type in use some years ago, unadjusted to current cost levels, are shown in Appendix T. Where currently unavailable, such charts can be readily estimated by the concerned engineering departments, and thus without undue burden be integrated with current costing procedures.

Another possibility which we do not recommend, but which seems to merit further exploration, assuming the retention of "Rail Form A" in generally its present framework, is the separation of constant from out-of-pocket railway operating expenses, rents and taxes in a manner which will treat as "fixed by definition" expenses which have been empirically determined to be predominnatly unresponsive to short term traffic fluctuations, such as ad valorem taxes, depreciation and continuing contractual obligations. If such a procedure were followed it would diminish the overstatement of marginal cost which is probably inherent under certain conditions in "Rail Form A", and bring about a segregation of variable from constant operating expense which, while admittedly arbitrary, may not be worse than the application of a uniform coefficient of variability to each and every railroad in the nation. Such a “fixed by definition” concept would to some extent have the offsetting virtue of a more direct relationship than presently exists to the cost experience of the individual carrier.

Many cost components unrelated to traffic fluctuations are currently elements in larger groups of reported expense. Hence the validity of the concept cannot be definitively tested from available information. However, the fact that several accounts which can be isolated are definitely non-traffic related, as shown in Appendix U, indicates that such a procedure could be evolved, if found desirable.

Motor and Water Carriers

The present methods of water and motor carrier corporate cost ascertainment seem adequate for regulatory guidance at this time. They too can of course be improved through the application of advanced statistical techniques, although the improvement by use of such methods will not be proportionately as great as in the case of railroads.

Improved cost finding precision for these types of carriers depends, in the immediate future, upon the availability of better information, i.e., the provision of sufficient detail in the accounts of these carriers to permit of adequate cost identification for rate-making purposes.

Air Transport

Recognition should be given to the fact that many uses not intended by its sponsors have been found for the ATA Formula. Since it is unlikely that such useage can be eliminated, the formula in future issues should be modified to provide for adjustment of computed values to accord with specific route conditions, where these are known or can be estimated. This will increase its usefulness as a tool for regulatory consideration, without of course, overcoming the inherent defects in a formula approach to cost analysis.

* * * * * * * * * * * * *

Since long-term marginal costs are an appropriate yardstick not only for the railroads, but also for other kinds of transportation, a continuing effort should be made, under Federal sponsorship with state cooperation, to measure such costs as they pertain to the use by regulated carriers of facilities provided at government expense. This would involve, of course, analysis of carrier accounts also, to determine the extent to which such costs are currently defrayed by user and excise taxes. The regulatory agencies, which have thus far largely avoided coming to grips with this problem, should be encouraged to take a leading role in such activity, because in no other way can they hope to establish with any precision the total social cost of regulated transportation, which is the only cost fully relevant to the rate-making process.

A program of this type, if it is to provide useful answers, must also include an effort directed toward the segregation of highway, airway, airport and waterway costs incurred without economic justification, i. e., properly chargeable to the national defense posture. Such costs have no part in, and should be eliminated from, computations of regulated carrier cost.

Epilogue

Efforts to improve the quality of transportation cost-finding appear to be an essential prerequisite to rational allocation of our transportation resources. If they are pressed with vigor, and employ modern statistical methods, there is every reason to suppose that more accurate answers can be developed and ultimately integrated with regulatory cost presentations.

In a group of industries as varied and complex as transportation, it is easier to detect the defects in present practice than to suggest practical remedies for their improvement. The preceding recommendations are a conscious attempt to compromise the ideal with the attainable, and are made with an awareness that there is no panacea which will resolve all issues in this complex field.

Cost is but one, and by no means the only, element in the whole complicated structure of the transportation industries. Effort devoted to improved cost-finding precision should be tempered by the realization that the only alternative to the typical or average is the development of thousands of sets of numbers, one to meet each specific situation as it arises. Pressures to develop precision must be tempered by the consideration that this, too, involves a cost, and great care must be taken to ensure that the cure is not worse than the disease.

Nevertheless it is an urgent consideration that the future yield a greater understanding of transportation cost characteristics. The foregoing suggests where this understanding is dimmest and where efforts should be focused to secure an increase in knowledge which will serve the public interest.

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2. Accountants Handbook, New York, 1956, p. 6.2.

3. Haddock v. D. L. & W. RR., 3 ICC 311 (1890).

4. Smyth v. Ames, 169 U. S. 466 (1898).

5. Petroleum and Petroleum Products, California to Arizona, 241 ICC 42 (1940).

6. Rupert L. Murphy, "Problems in Transportation Rate-Making," ICC Practitioners' Journal, Washington, September 1959, p. 1138.

7. Transcontinental Rate Case of 1922, 74 ICC 71.

8. ICC, I. & S. No. 7027, Paint and Related Articles - Official Territory (1959); ICC, I. & S. No. 6933, Lumber - California and Oregon to California and Arizona (1959).

9. ICC, I. & S. 6834 et al., Piggyback Rates Between East and Texas; ICC, I. & S. M-10415 et al., Commodities - Pan Atlantic Steamship Corporation.

10. Memorandum to the President, Problems of the C.A.B. and the Independent Regulatory Commissions, Washington, September 10, 1959, pp. 41-42.

11. E.g., mail, baggage, coach passenger, pullman passenger, way freight, through freight, and mine "drags."

12. Cases illustrative of those in which the parties and/or the ICC have used various approaches to ascertainment of rail out-of-pocket cost include those mentioned in notes 5 and 8, supra; Pick-up and Delivery in Official Territory, 218 ICC 441 (1936); All Commodities, Less than Carloads Between Maine, Massachusetts and New Hampshire, 255 ICC 85 (1942);
Export Soybeans - Southwest and South to Gulf Ports, I. & S. No. 7008;
Transcontinental Divisions Case, ICC Docket No. 31503;
I. & S. Docket Nos. 6834 et al., Piggyback Rates Between East and Texas.

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13. ICC Docket No. 20681, Train Discontinuances - Chicago & North Western Railway, Exhibit of the Public Service Commission of Wisconsin, August 10, 1959; George Public Service Commission, Final Order in Docket 411 - r, application of Southern Railway Co., and Georgia Southern and Florida Railway Ry Co. for Authority to Discontinue Passenger Trains Nos. 1 and 2; August 6, 1959; and Kentucky Railroad Commission, Docket No. 752 Application of Illinois Commission Railroad to Discontinue Passenger Trains No. 103 and 104 (1956).

14. CAB Docket 9185 et al., Kanab-Page-Glen Canyon Area Investigation, Order E-13491, February 9, 1959, pp. 5-6.

15. Murphy, op. cit., p. 1143.

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2. Howard T. Lewis, James W. Fulliton, and Jack D. Steele, The Role of Air Flight in Physical Distribution, Boston, 1956; John R. Meyer, Merton J. Peck, John Stenason and Charles Zwick, The Economics of Competition in the Transportation Industries, Cambridge, Mass., 1959, Appendix D.

3. Fortune, August 1948, p. 21, and August 1959, p. 128. Ratio of gross receipts from transportation (excluding trucking revenues of railroads) to the sum of capital stock, surplus and retained earnings.

4. Pennsylvania, New York Central, Southern Pacific, Sante Fe, Union Pacific, B & O, C & O, Missouri Pacific, Illinois Central, Burlington, Southern,, and Great Northern.

5. American, United, Pan-American, TWA, Eastern, and Northwest.

6. U.S. Lines, Matson, American President, Moore-McCormack, Lykes Brothers, and American Export.

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7. H. Bowen of the First National Bank of Boston in his "Financial Analysis of the Motor Carrier Industry for 1957" finds 139 Class I motor carriers of general commodities in common carriage, each having a gross revenue in excess of $5,000,000, had a capital turnover of 5.95. 422 Class II carriers with gross revenues of $1 - $5 million had ratios of 6.3.

8. Dudley F. Pegrum, Public Regulation of Business, Homewood, Ill., 1959, p. 522.

9. 259 ICC 475 (1945).

10. Pick-up and Delivery in Official Territory, 218 ICC 441 (1936).

11. Surface "out-of-pocket" cost is not comparable to "direct aircraft operating expense". Direct aircraft costs are only those costs assignable to the movement and maintenance of an airplane, whereas the "out-of-pocket" concept includes both costs directly assigned and apportioned to freight or passenger and allied services, not limited to the movement costs of individual cars, trains or vehicles.

12. ICC Statement No. 1-54, Explanation of the Development of Motor Carrier Costs with Statements as to Their Meaning and Significance, April 1954, p. 53.

13. Ford K. Edwards, "Transportation Costs and Freight Rates", ICC Practitioners' Journal, Washington, January 1952, p. 85.

14. ICC Statement No. 4-54, Explanation of Rail Cost Finding Procedures and Principles Relating to the Use Costs, Washington, November 1954.

15. ICC Statement No. 1-54, op. cit.

16. Wm. J. Hudson and James A. Constantin, Motor Transportation, New York, 1958.

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18. Ibid., p. 5.

19. American Newspaper Publishers Assn. v. ATSF Ry., 288 ICC 7 (1953)

20. All Freight from Eastern Ports to the South 251 ICC 361 (1942).

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21. Meyer, et al., Economics of Competition, op. cit.,pp.18-19.

22. Letter of September 15, 1959, from Mr. F. Wascoe, Manager, Bureau of Transportation Research, Southern Pacific Co.

23. ICC, I. & S.Docket No. 6933, Lumber Case, op. cit.

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26. George W. Wilson, "Base Rates on Cost or 'Demand'?", Railway Age, September 7, 1959, p. 24.

27. ICC Statement No. 5-58, November 1958, p. 29.

28. For explanation of the mathematics involved, see ICC Statement 4-54, op. cit., p. 73.

29. ICC Statement No. 5-54, op. cit., p. 72.

30. Ibid., p. 86.

31. ICC Statement No. 4-54, op. cit., p. 86.

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34. Export Soybean Case, Intervener's Brief, op. cit., p. 30.

35. Ibid., p. 30.

36. Dwight Re Ladd, Cost Data for the Management of Railroad Passenger Service, Boston, Mass., 1957, pp. 95-97, 101-104, 132.

37. CAB Docket No. 1705 (1948).

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38. Completed tests of this type are described in two special reports of the Highway Research Board; No. 4, Road Test One - Maryland; and No. 22, The Washo Road Test, Part 2. Currently under way at Ottawa, Illinois is by far the most elaborate of these. This is a two year experiment being conducted on an eight mile right of way under the auspices of the American Association of State Highway Officials, and financed at an estimated total cost of over $20 million by various governmental entities and private interests. The objective is to study "pavement behavior" (i.e., cost) under stress by various types of motor vehicles. Bureau of Public Roads, Annual Report, Fiscal Year 1958, Washington, 1958, pp. 41-42.

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74. Includes 8.1296¢ of out-of-pocket railroad movement cost from the mills to Birmingport.

75. Rail portion of actual water move adjusted to water-cost basis.

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19. ICC Docket No. 28,300.

20. Rail Freight Service Costs in the Various Rate Territories of the United States, 78th Cong., 1st Sess., Senate Doc. No. 63 (1943), p. 75.

21. 1 ICC 754, 760-61 (1888).

22. Northern Pacific Ry. Co. v. North Dakota, 236 US 585, 596-99 (1915).

23. Homer Bews Vanderblue, and Kenneth Farwell Burgess, Railroads: Rates-Service-Management, New York, 1923, pp. 87, 88, 97.

24. Locklin, op. cit., p. 255.

FOOTNOTES

25. D. Philip Locklin, <u>Railroad Regulation Since 1920,</u> New York, 1928, p. 68.

26. Federal Coordinator of Transportation, <u>Report on Cost Finding in Railway Service for Regulatory Purposes</u>, Washington, 1936.

27. <u>Ibid</u>., p. 7.

28. <u>Ibid</u>., p. 5.

29. <u>Ibid</u>., pp. 6-7.

30. <u>Ibid</u>., p. 103.

31. <u>Ibid</u>., p. 10.

32. <u>Ibid</u>., p. 85.

33. <u>Ibid.</u>, pp. 41-42.

34. Calif. RR.Comm., <u>Study of Rail Cost Finding for Rate Making Purposes</u>, Case No. 4402, San Francisco, December 1, 1938.

35. <u>Ibid</u>., p. 37.

36. Sen. Doc. No. 63, <u>op. cit.</u>, p.1.

37. Rail Form B, introduced in the Automobile Case (ICC Docket 28190);
Rail Form C, introduced in the Citrus Fruit Division Case (ICC Docket 26,549);
Rail Form D, for use in I & S Docket No. 4690, <u>All Commodities, Less Than Carloads, Between Maine, Massachusetts and New Hampshire</u>;
Rail Form E, for use in <u>Transcontinental Divisions Case</u> (ICC Docket 15243);
Rail Form F, a standardized procedure for ascertainment of terminal switching cost; and
Rail Form G, for use in the <u>Passenger Train Deficit Case</u> (Docket No. 31954).

38. ICC Statement No. 2-57, <u>Formula for Use in Determining Rail Freight Service Costs</u>, Washington, July 1957, p.1.

39. <u>New Automobiles in Interstate Commerce,</u> 259 ICC 475, 508 (1945)

40. ICC, I. & S. M—10415, <u>Commodities - Pan Atlantic Steamship Corporation</u>.

FOOTNOTES

41. John C. McWilliams, Motor Carrier Cost Techniques, Washington, 1956, p.1.

42. Federal Coordinator of Transportation, Merchandise Traffic Report, 1934; and Freight Traffic Report, 1935.

43. Ford K. Edwards, "Simplification of Cost-Finding for Motor Carriers," ATA Annual Spring Meeting, Detroit, May 1948.

44. Air Transport Association, Standard Method of Estimating Direct Operating Costs of Transport Airplanes, Washington, 1955, preface.

45. ICC Statement 6-57, Percent of Empty to Loaded Freight Car-Miles by Class of Equipment and performance Factors for Way, Through and All Trains Combined reports the results of one such study. Another required at intervals is an analysis of station clerical time.

46. ICC Statement 1-54, op. cit., pp. 81 et seq.

47. John C. McWilliam , op. cit., contains a description of this method as related to the Uniform System of Accounts prescribed for motor carriers prior to January 1, 1958.

48. William H. Dodge and Richard R. Carll, "The Influence of Proprietary Trucking upon Minimum Rate Policy in California," 11 Vanderbilt Law Review 1109 (1953)

49. Air Transport Association, op. cit.,

50. Ibid., p. 1.

51. Presumably this is a recommendation to use reported experience where available.

52. The method was also described by Mr. E. C. Poole of Southern Pacific in a talk on "Railroad Cost Finding and Measures of Performance", given at Stanford University Graduate School of Business Administration, March 3,1953.

53. Stanley Berge, Railroad Passenger Service Costs and Financial Results, Evanston, Illinois, 1956.

54. Ibid.,p. 5.

55. Ibid., p. 16.

56. CAB Docket No. 5463, et al.

FOOTNOTES

57. CAB Docket No. 5645, et al.

58. U. S. Post Office Department, Cost Ascertainment Report, 1958, Washington, 1959.

59. Ibid., p. 14.

60. Accountants Handbook, New York 1956, p. 6.13.

61. CAB Docket No. 8008, et al., Initial Decision of Examiner Ralph L. Wiser, May 27, 1959, p. 134.

62. The motor carrier cost method used by the ICC has recently been reorganized to take this cost into account.

63. ICC, Transport Statistics in the United States, 1957, Part 1, p.2 and Part 7, p.3.

64. ICC, I. & S. Docket No. 7060, decided July 22, 1959.

65. ICC Statement 5-58, op. cit., Table 3, pp. 68 and 71.

66. Board of Investigation and Research, op. cit., Figure 4.

67. ICC, I. & S. Docket 6074, Exhibit of W. B. Saunders.

68. ICC Statement 5-58, op. cit.

69. Ibid., p.10. Costs shown are "Rail Form A" Group IV.

70. John C. McWilliams, op. cit.

71. CAB Uniform System of Accounts and Reports for Air Carriers, Washington, January 1, 1957, p. 24.5.

72. CAB Docket No. 8008, et al.

73. ICC Finance Docket No. 19411, Chicago & North Western Railway Company - Abandonment - Scribner - Oakdale Line, decided July 6, 1959.

74. ICC Uniform System of Accounts for Pipeline Companies, Issue of 1952; Uniform System of Accounts for Class I and Class II Common and Contract Motor Carriers of Property, Issue of 1958; Uniform System of Accounts for Railroad Companies Prescribed by the Interstate Commerce Commission, Association of American Railroads, 1947, as amended through 1958; Uniform System of Accounts for Carriers By Inland and Coastal Waterways, working copy including all changes effective on or before January 1, 1959, ICC, December 1958; CAB, Uniform System of Accounts and Reports for Air Carriers, Civil Aeronautics Board, Issue of 1957.

FOOTNOTES

75. Edward H. Bunnell, Railroad Accounting and Statistics, Chicago, 1955, p.17.

76. Numerous changes since 1914 have been addressed to detail; the underlying functional structure of the prescribed railroad accounting system has been unaltered for 45 years.

77. 19th Annual Report of the Interstate Commerce Commission, Washington, 1905, p.11.

78. Henry C. Adams, "Railway Accounting in its Relation to the Twentieth Section of the Act to Regulate Commerce," paper delivered at annual meeting of the American Association of Public Accountants, Atlantic City, 1908.

79. Werntz, Handbook of Modern Accounting Theory, as quoted in Accountants' Handbook, op. cit. 1. 1.12.

80. Ladd, op. cit., p.52.

81. Accountants' Handbook, op. cit., p. 64.

82. Ladd, op. cit., p. 57.

83. Meyer, et al., Economics of Competition, op. cit., p.100.

84. Ladd, op. cit., Chapter IV and Appendix II.

85. Source: CAB Forms 41.

86. Dudley T. Pegrum, "Investment in the Railroad and Other Transportation Industries Under Regulation", American Economic Review, May 1957, p. 422.

87. Bureau of Public Roads, op. cit., pp. 49-50.

88. United Research, Inc., "A Rejoinder to 'An Appraisal of the Aeronautical Research Foundation's Avoidable Costs of Passenger Train Service' by Dr. Melville J. Ulmer", Cambridge, Mass., 1958, pp. 8-10; Meyer et al, Avoidable Costs, op. cit., pp. 32-33.

89. Encyclopedia of the Social Sciences, New York, 1934, pp.360-66.

90. T. O. Yntema, "An Analysis of Steel Prices, Volume and Cost Controlling Limitations on Price Reductions", United States Steel Corporation T.N.E.C. Papers, Vol. I, Pamphlet 6, 1940.

FOOTNOTES

91. ICC Docket No. 31954, Railroad Passenger Train Deficit, verified statement of Dr. Earle W. Orr., Jr.

92. Meyer, *et al.*, *Avoidable Costs*, *op. cit*.

93. Melville J. Ulmer, "An Appraisal of The Aeronautical Research Foundation's Avoidable Costs of Passenger Train Service", Washington, 1958, pp. 8-10; United Research, Inc., *A Rejoinder*, *op. cit*., pp. 4-8.

94. Meyer, *et al.*, *Avoidable Costs*, *op. cit*., p. 23.

95. Calif. R.R.Comm., Case No. 4402, *op.cit*.

PART FOUR

1. F. W. Taussig, *Principles of Economics*, 3rd rev. ed., New York, 1921, Vol. II, p.391.

2. Meyer finds that remaining costs to shippers aggregate about 15% of the freight charges applicable to Manufacturing and Miscellaneous traffic, less certain commodities, *op. cit*., p. 161.

3. The suggested criterion of long-term marginal cost is of course appropriate to rates of permanent application. It may well be that rates more limited in their period of application could be justified on a short-term marginal cost basis. Such rates, for example, could reflect seasonal availability of excess equipment.

4. As used by motor carriers this includes Federal Income Tax; as used by railroads such taxes are excluded.

5. *Water-borne Commerce of the United States*, Department of the Army, Corps of Engineers.

6. *Bureau of Public Roads*, *op. cit.*, p. 49.

7. Mr. E. R. Jelsma, formerly Director of the ICC Bureau of Transport Economics and Statistics, also made substantial efforts to apply EDP to analysis of motor carrier certificates and permits.

FOOTNOTES

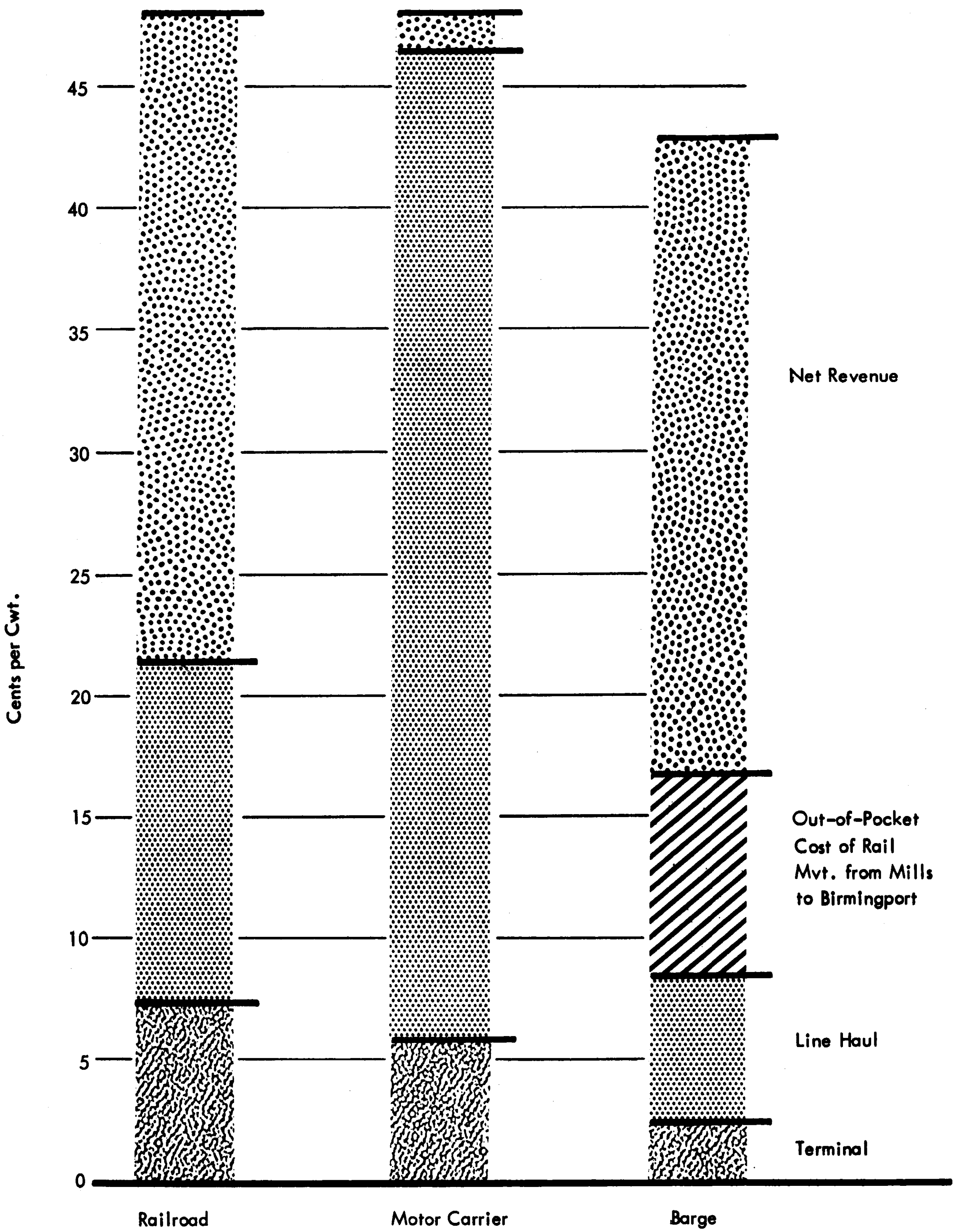
8. Conversations with Mr. Walter Nichols, Accounting Department, American Trucking Association, Inc., September 14, 1959; and Mr. C. H. Brown, Bureau of Finance, Accounting, Taxation and Valuation, Association of American Railroads, Sept. 9. 1959.

9. The task force might well consider the possibility of investigating costing techniques currently used in Great Britain, which seem in some respects to be more sophisticated than those employed here, and worthy of detailed exploration. See British Transport Review, Passim.

10. Allen S. Olmstead, 2d, "Do Cost of Transportation Exhibits in Railroad Rate Cases Show Cost?" Annals of the American Academy of Political and Social Science, Publication No. 973, Philadelphia, 1916, pp.218-19.

COMPARISON OF RAIL, MOTOR AND BARGE REVENUE AND COST PER HUNDREDWEIGHT MANUFACTURED IRON & STEEL BIRMINGHAM TO NEW ORLEANS TOTAL EXPENSE LEVEL, YEAR 1957

Line Haul and Terminal Components of Unit Cost

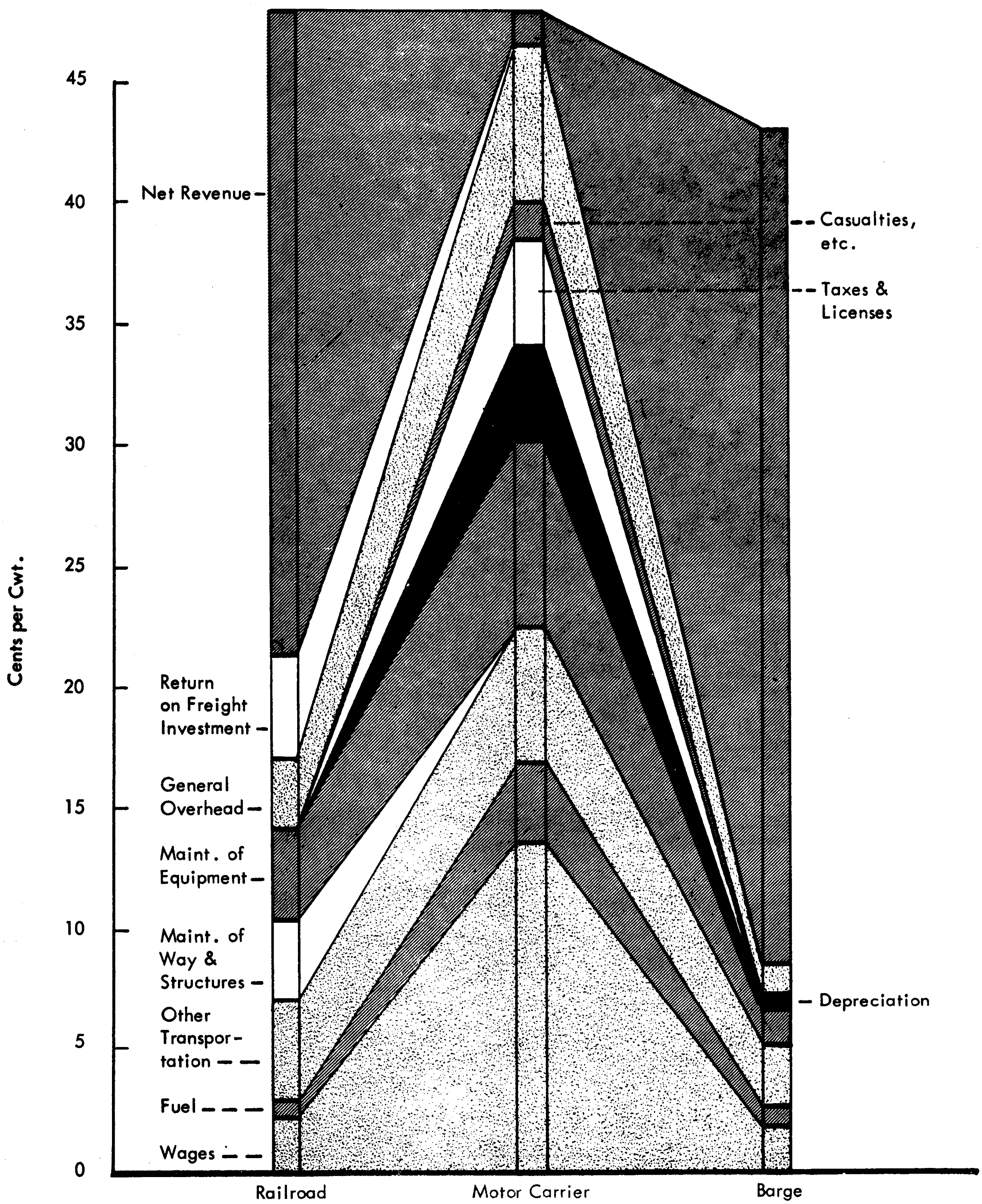


R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

Chart I b

COMPARISON OF RAIL, MOTOR AND BARGE REVENUE AND COST PER HUNDREDWEIGHT MANUFACTURED IRON & STEEL BIRMINGHAM TO NEW ORLEANS TOTAL EXPENSE LEVEL, YEAR 1957

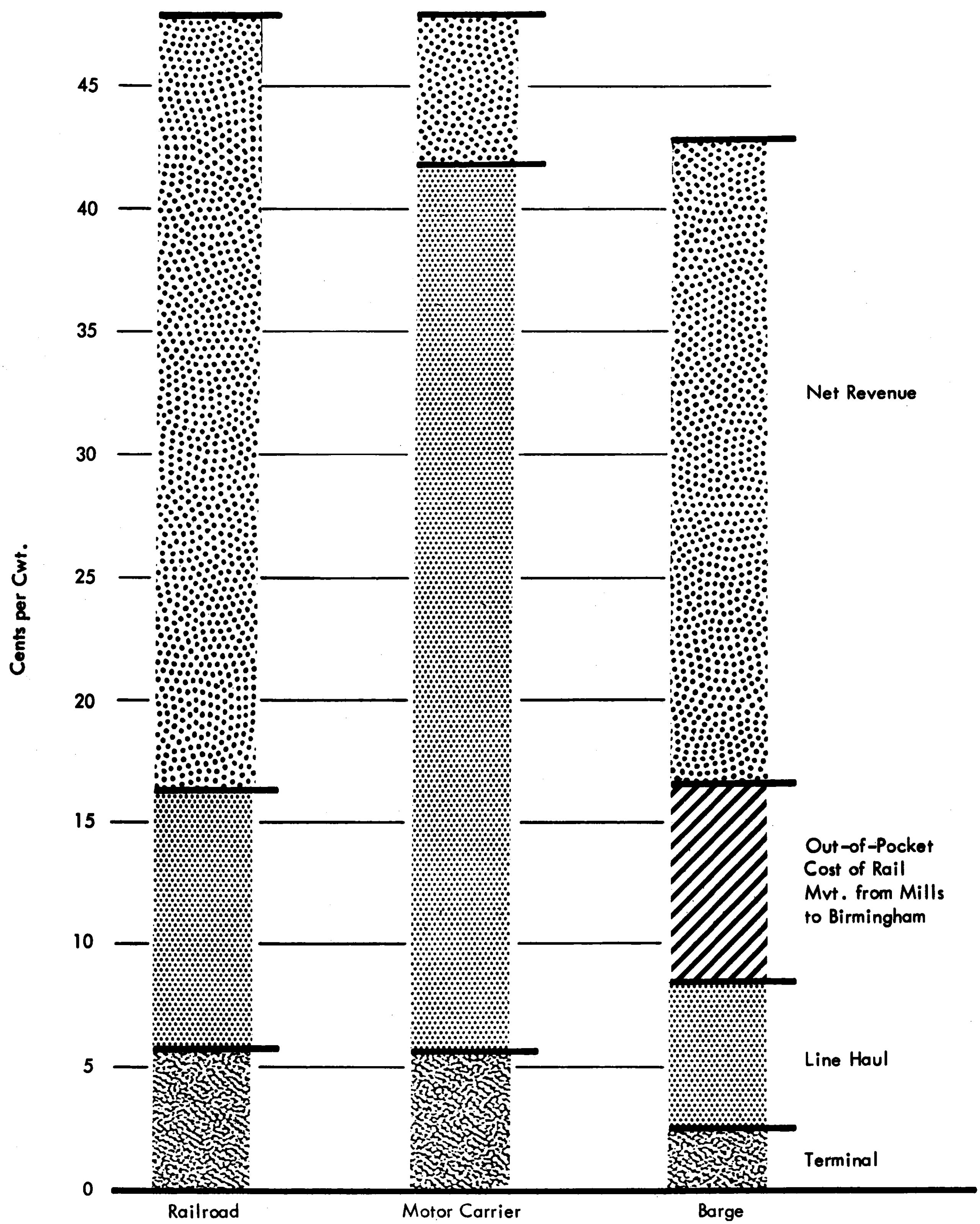
Objective Components of Unit Cost



R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

RAIL AND MOTOR OUT-OF-POCKET COST, AND BARGE COST AT TOTAL EXPENSE LEVEL COMPARED WITH REVENUE PER HUNDREDWEIGHT, MANUFACTURED IRON AND STEEL, BIRMINGHAM TO NEW ORLEANS, YEAR 1957

Line Haul and Terminal Components of Unit Cost



R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

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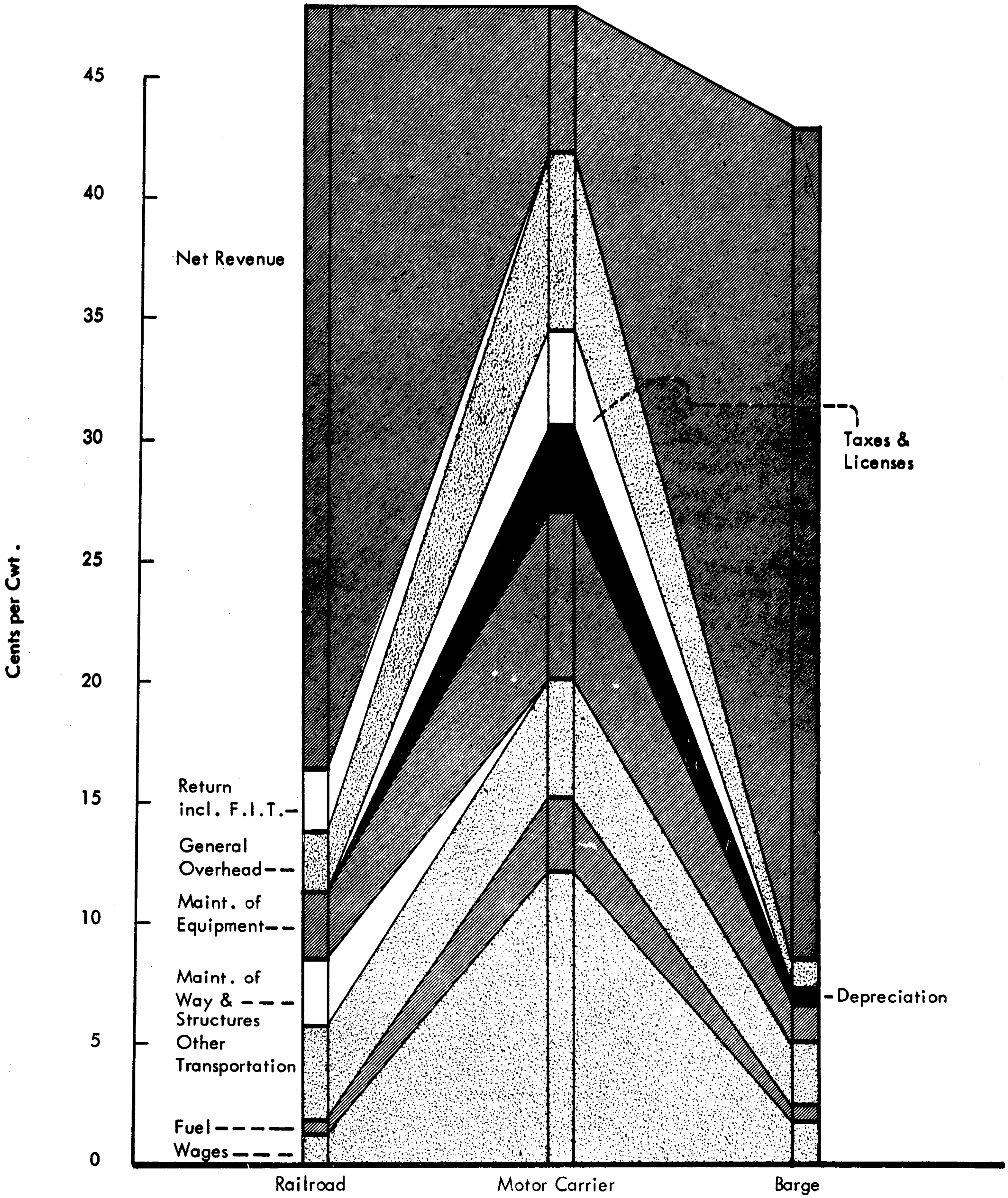
Chart II b

RAIL AND MOTOR OUT-OF-POCKET COST, BARGE COST AT TOTAL EXPENSE LEVEL COMPARED WITH REVENUE PER HUNDREDWEIGHT, MANUFACTURED IRON AND STEEL, BIRMINGHAM TO NEW ORLEANS YEAR 1957

Objective Components of Unit Cost



R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

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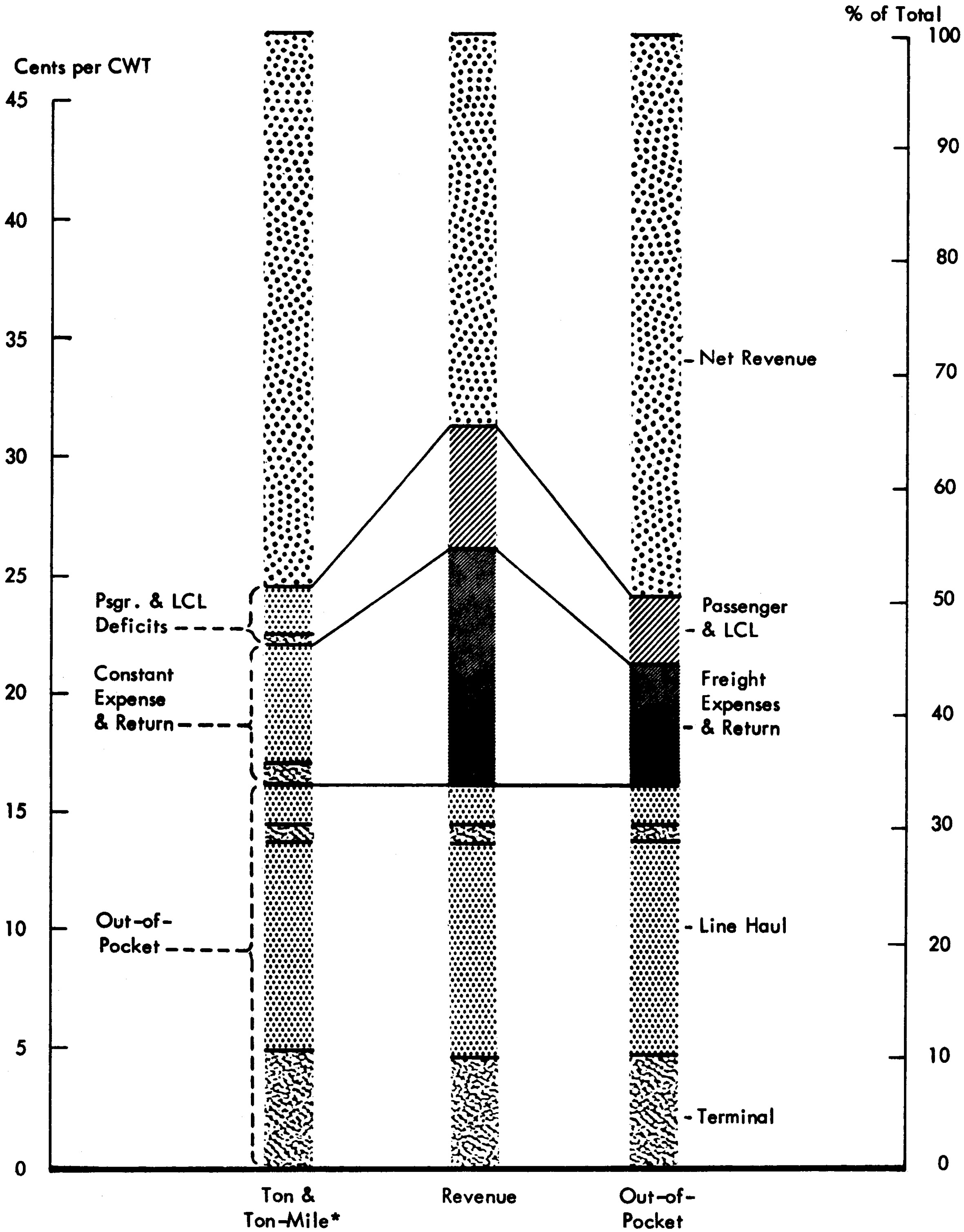
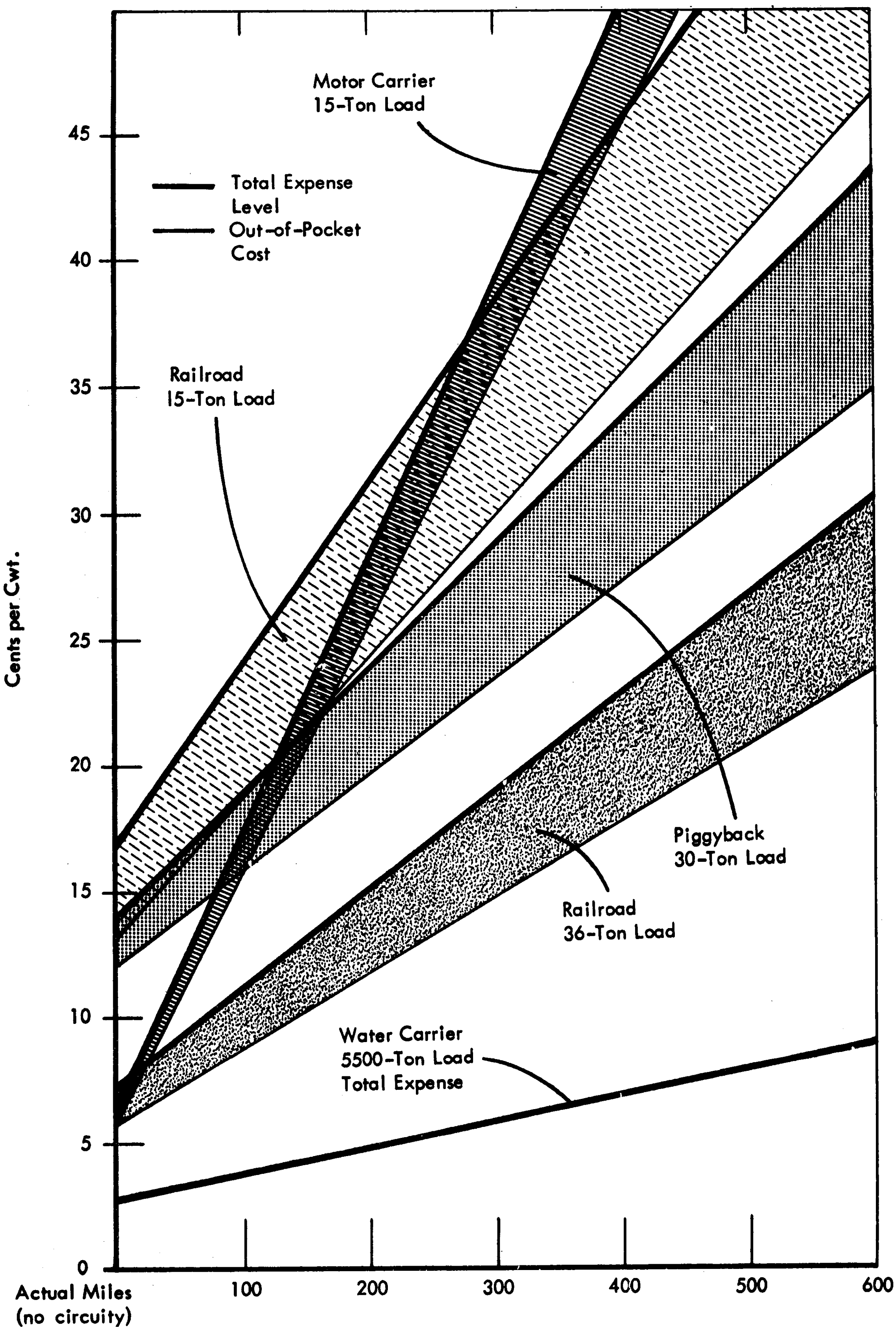
RAIL FULLY BURDENED COST PER HUNDREDWEIGHT
MANUFACTURED IRON & STEEL, BIRMINGHAM TO NEW ORLEANS, YEAR 1957,
WITH CONSTANT EXPENSE & RETURN PASSENGER AND LCL DEFICITS
& RETURN COMPUTED ON THREE DIFFERENT BASES



* Fully Distributed Cost

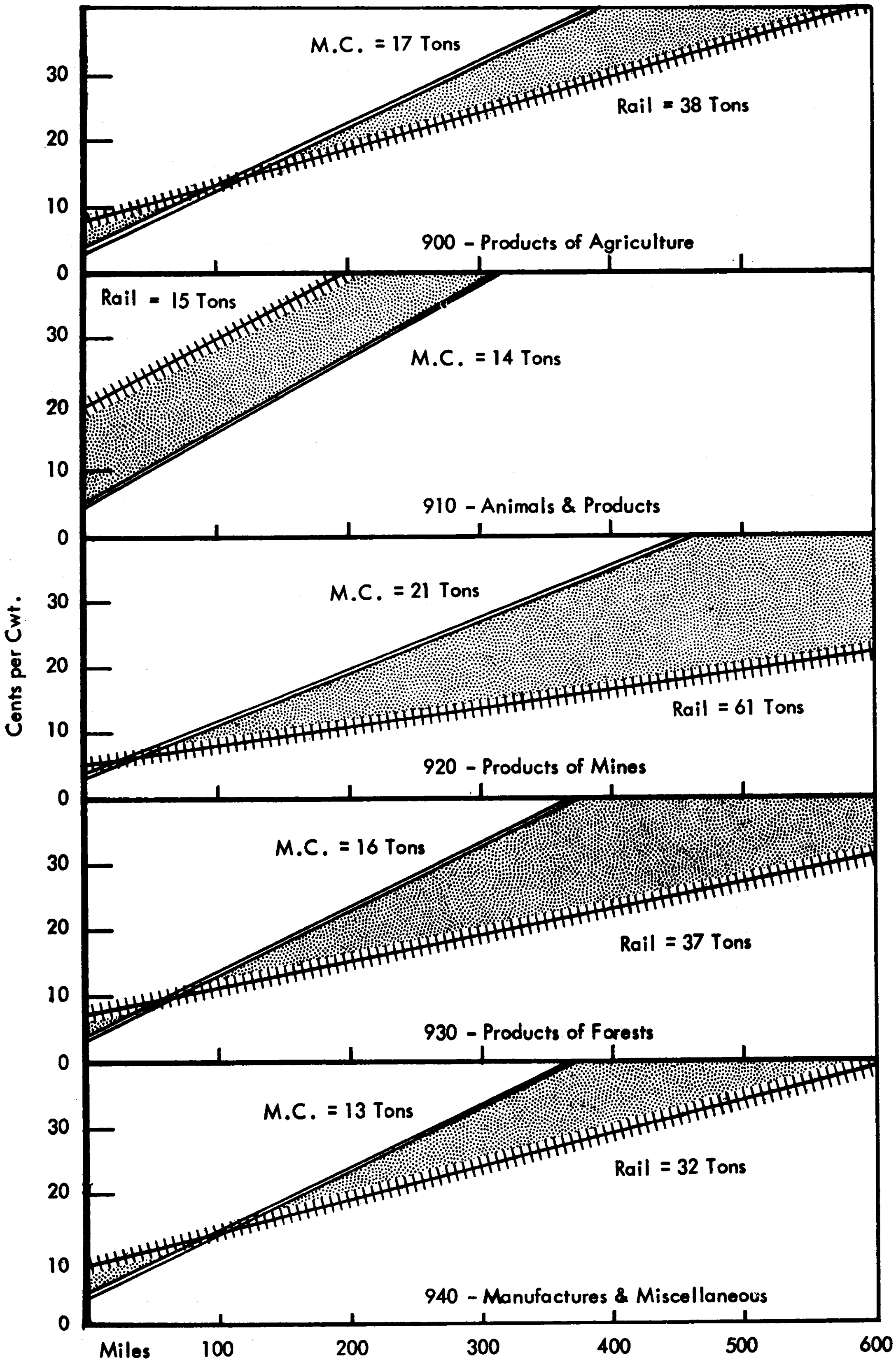
R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

COMPARISON OF RAIL, MOTOR, PIGGYBACK AND WATER CARRIER COSTS AT OUT-OF-POCKET AND TOTAL EXPENSE LEVELS UNDER VARIOUS WEIGHT LOADS BASED ON UNIT COSTS COMPUTED FOR MANUFACTURED IRON AND STEEL, BIRMINGHAM TO NEW ORLEANS, YEAR 1957



R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

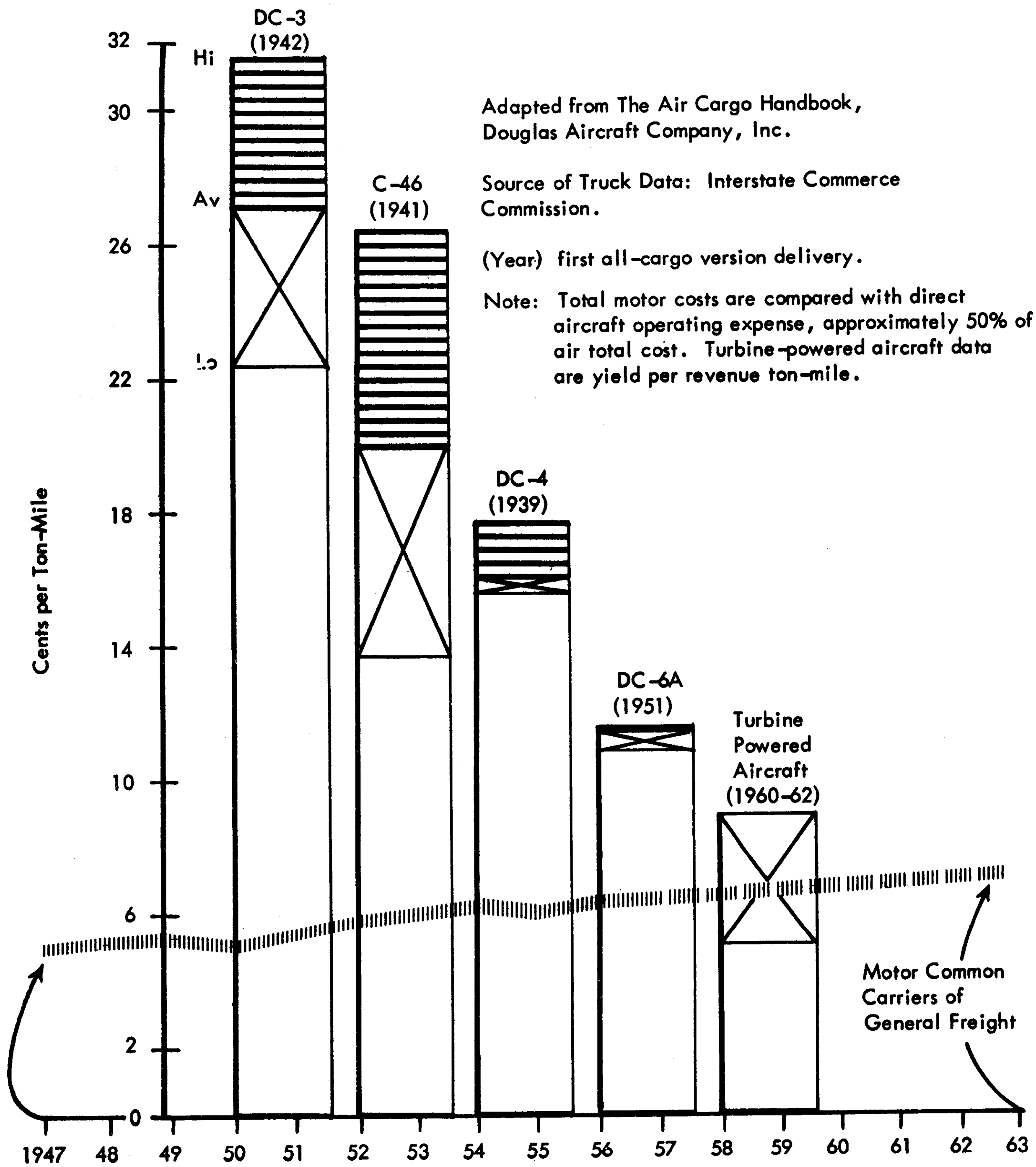
COMPARISON OF RAIL AND MOTOR OUT-OF-POCKET COSTS
AT REPORTED U.S. AVERAGE LOADS, FOR LENGTHS OF HAUL TO 600 MILES
BY MAJOR COMMODITY CLASSIFICATIONS



R. L. Banks & Associates, Transportation Consultants
Washington November, 1959

Chart VI

U.S. DOMESTIC AIRLINES DIRECT OPERATING COSTS OF ALL-CARGO AIRCRAFT, 1956 AND ESTIMATES OF TURBINE POWERED AIRCRAFT AVAILABLE 1960-1962 WITH TREND OF OPERATING COSTS PER REVENUE TON-MILE OF MOTOR COMMON CARRIERS OF GENERAL FREIGHT



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Washington November, 1959

APPENDIX A

THE FALLACY OF FULLY - DISTRIBUTED COSTS

(1) Assume the following situation in a company offering two services:

Service A		Service B	
Price	10¢ per unit	Price	8¢ per unit
Variable cost	5¢ per unit	Variable cost	5¢ per unit
Margin	5¢ per unit	Margin	3¢ per unit

Fixed establishment costs per year - 45¢

Annual operating results

Service A - 5¢ margin X 5 units equals	25¢
Service B - 3¢ margin X 10 units equals	30¢
Total	55¢
Fixed costs	45¢
Profit	10¢

(2) If the fixed costs are fully distributed proportionately to volume, the results would be as follows:

Service A		Service B	
Price	10¢ per unit	Price	8¢ per unit
Fully distributed Cost	8¢ per unit	Fully distributed Cost	8¢ per unit
Profit	2¢ per unit	Profit	0¢ per unit

Annual operating results

Service A - 2¢ profit X 5 units equals 10¢ profit

Service B - 0¢ profit X 10 units equals 0¢ profit
Profit 10¢

(3) By definition, the 8¢ price of Service B is non-compensatory. If it is raised to "compensatory levels," no sales will be made and therefore the Annual Operating results would be

Service A

Sales 10¢ X 5 units	50¢
Cost-Variable 5¢ X 5 units	25¢
Fixed	45¢
Net Loss	(20¢)

Conclusion: Reliance upon fully distributed cost may lead to incorrect decisions.

APPENDIX B

Lancey Railroad:
A Case Study of Variability

The Lancey Railroad, a small and well managed line running through the forests and gently rolling hills of Ames County, and across the state line into neighboring Langdell County, operates solely to transport high grade ore from Big Mine to Junction City, 100 miles away, where the traffic is interchanged to the Great Eastern Railroad. The characteristics of the ore, plus a favorable profile between Big Mine, Junction City and Millsite on the Great Eastern (where the ore is sintered), results in higher than average loadings on Lancey-originated ore. In recent years this business has averaged 750,000 tons annually; the Lancey's division of the through rate is $ 1.50 per ton.

The principal operating, revenue and expense statistics of the Lancey are, on an annual basis, as follows:

Operating Statistics

Tons handled	750,000
Tons per Car	75
Empty weight of car	25
Cars handled	10,000
Gross ton-miles	100,000,000

Revenue

Total Revenue = $ 1.50 times 750,000 = $ 1,125,000

Expenses

Maintenance of Way and Structures	$ 250,000
Maintenance of Equipment	175,000
Rail-Line Transportation	400,000
Traffic	50,000
General	100,000
Taxes	25,000
	$ 1,000,000

Profit

Revenue	$1,125,000	
- Expenses	-1,000,000	
		$ 125,000

Unit Costs based on this volume of business

Cost per Net Ton	$ 1.33
Cost per Net Ton-mile	.0133
Cost per Gross Ton-mile	.010
Cost per Car	$ 100.

Mining technology changed and the Big Mine Corp. decided to introduce new methods which would require 75,000 tons of coal per year, but not affect the quantity of ore produced. The nearest source of coal was a strip mine at Junction City. Express Freight, a large bulk commodity motor carrier, computed that by using newly acquired diesel and aluminum rigs, it could profitably handle the coal business at a rate of $ 1.10 per ton. The Lancey Railroad proposed a rate of $ 1.00 per ton, which was protested by Express Freight. An ICC investigation followed, at which the following pertinent points were brought out:

Express Freight had to charge at least $ 1.10 per ton or it would lose money. At the same time Express Freight took the position that the only appropriate level for minimum rates was at fully distributed cost. It is obvious, it suggested, that Lancey Railroad's proposed rates would be non-compensatory because the operating results showed costs to be $ 1.33 per ton, or $ 100. per car. Any rate below this Express Freight concluded, would be inflicting a burden on other traffic.

On the other hand Lancey Railroad sought to demonstrate the profitability of its proposed rate of $ 1.00 with the following annual data:

	Present (ore only)	Projected* (ore & coal)	Net Change * (Attributed to effect of coal)
Operating Statistics			
Tons handled	750,000	825,000	75,000
Tons per Car	75	75	--
Empty Weight of Car	25	25	--
Cars handled	10,000	11,000	1,000
Gross ton-miles	100,000,000	110,000,000	10,000,000
Revenue			
Ore 1.50 X 750,000	$ 1,125,000	$ 1,125,000	$ ---
Coal 1.00 X 750,000	--	75,000	75,000
Total	$ 1,125,000	$ 1,200,000	+ 75,000
Expenses			
Maintenance of Way*	$ 250,000	$ 262,500	$ 12,500
Maintenance of Equipment	175,000	192,500	17,500
Rail Line Transportation	400,000	430,000	30,000
Traffic	50,000	50,000	--
General	100,000	100,000	--
Taxes	25,000	27,000	2,000
Total	$ 1,000,000	$ 1,062,000	$ 62,000
Profit			
Revenue	1,125,000	1,200,000	+ 75,000
- Expenses	1,000,000	1,062,000	- 62,000
Profit (Before F.I.T.)	125,000	138,000	+ 13,000

* The effect of the projected coal traffic on existing expenses was very carefully considered by the Lancey's management. It was decided that at the former level of business Maint. of Way expense was 50% variable, Maint/Equip. 100%, and Rail Line-Transportation 75%.

APPENDIX B

Unit Costs

	Present Operation	Incremental Costs of Coal Traffic	New Costs for Projected Operation
Cost per Net Ton	$ 1.33	$ .827	$ 1.29
Cost per Net Ton-mile	.0133	.00827	.0129
Cost per Gross Ton-mile	.010	.0062	.0096
Cost per Car	100.	62.	96.55

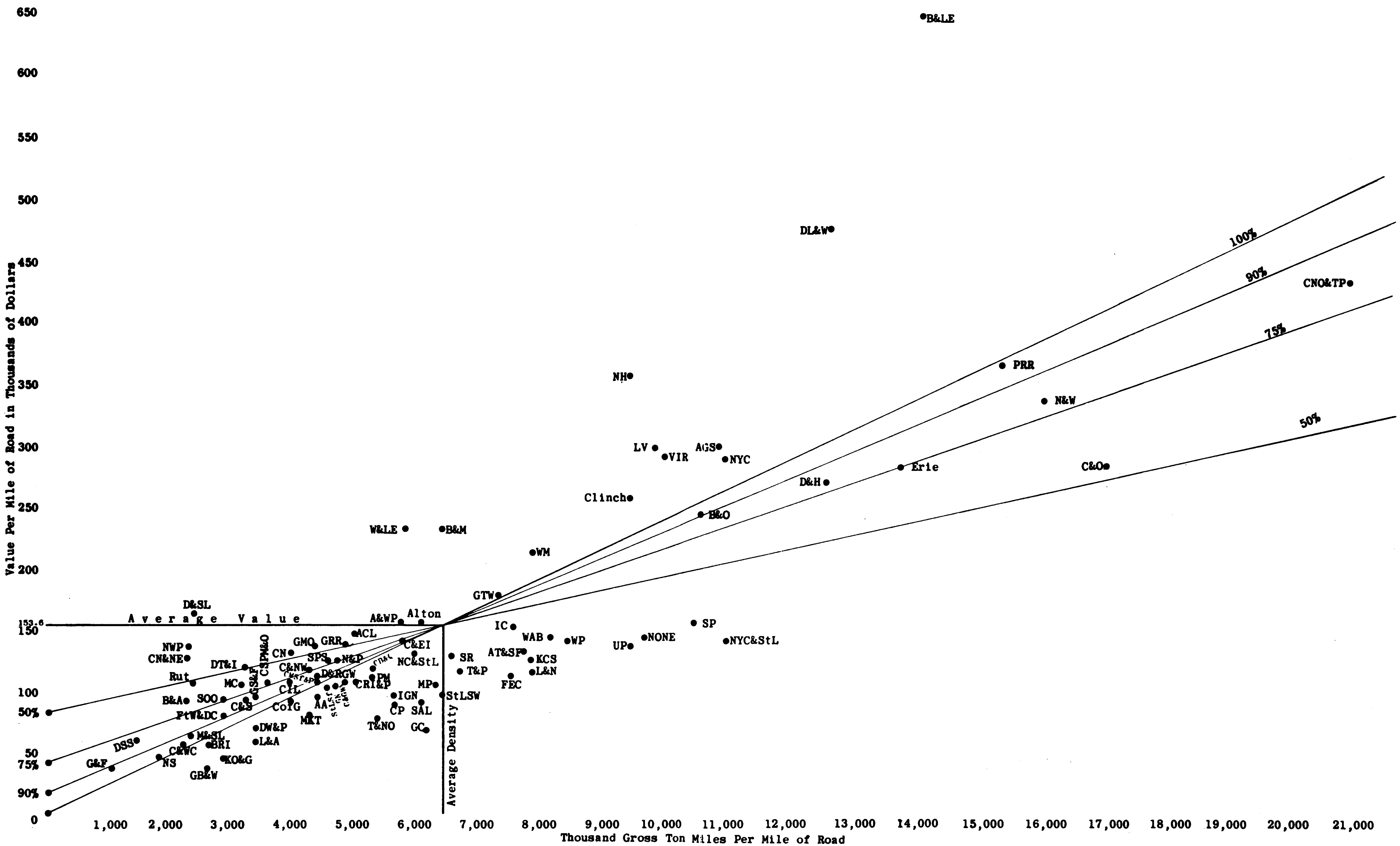
The Commission approved the Lancey Railroad's new rates on the ground that they would increase the net income of the company, therefore would be compnesatory.

After several years of operation under the new traffic conditions, the Lancey Railroad carefully analyzed its expenses and was pleased to discover that its projection of expenses had been extremely accurate.

APPENDIX C

CHART SHOWING RELATIONSHIP IN 1946 OF TRAFFIC DENSITY (GROSS TON MILES PER MILE OF ROAD) TO INVESTMENT IN ROAD (REPRODUCTION OF ROAD PLUS LANDS AND WORKING CAPITAL) OF 84 PRINCIPAL AMERICAN RAILROADS

(Taken From Cost Section's Statement 4-54)



APPENDIX D

TOTAL OPERATING EXPENSES IN 1953 DOLLARS, REVENUE TON-MILES AND COST PER TON-MILE, 1953 THROUGH 1957

	Class I Railroads			Motor Carriers of General Freight			Oil Pipe Lines			Domestic Truck Airlines		
	Total Operating Expense[1/]	Revenue Ton Miles[2/]	Cost Per Ton Mile	Total Operating Expense[1/]	Revenue Ton Miles	Cost Per Ton Mile	Total Operating Expense[1/]	Revenue Ton Miles	Cost Per Ton Mile	Total Operating Expense[1/]	Revenue Ton Miles[3/]	Cost Per Ton Mile
	($000)	(000)	(Cents)	($000)	(000)	(Cents)	($000)	(000,000)	(Cents)	($000)	(000)	(Cents)
1953	8,135,229	608,187,572	1.34	3,062,720	54,385,604	5.63	324,935	139,016	.23	790,421	1,624,867	48.65
1954	7,355,079	551,455,251	1.33	3,008,718	52,382,862	5.74	330,532	146,244	.23	875,258	1,832,603	47.76
1955	7,452,649	625,754,297	1.19	3,402,434	61,153,098	5.56	338,192	158,214	.21	984,473	2,160,068	45.58
1956	7,563,762	649,190,911	1.17	3,490,982	63,447,372	5.50	345,883	177,214	.20	1,084,170	2,417,044	44.86
1957	7,465,991	620,134,854	1.20	3,193,328	58,087,192	5.50	350,872	178,672	.20	1,250,018	2,720,030	45.96
Change -												
1957 vs 1953	-9.2	+2.0	-10.4	+4.3	+6.8	-2.3	+8.0	+28.5	-13.0	+58.1	+67.3	-5.5

1/ Operating expenses subsequent to 1953 deflated to 1953 basis.
2/ Includes Passenger ton-miles at 150 lbs.
3/ Includes passenger ton-miles at approximately 190 lbs. as reported by carriers.

Source: Interstate Commerce Commission; Civil Aeronautics Board.

APPENDIX E

PERCENTAGE VARIABILITY, SPECIFIED EXPENSE GROUPS,
MOTOR CARRIERS OF GENERAL FREIGHT 1/
1957 COMPARED WITH 1953

Item	Changes in Expenses 2/ Related to Miles Operated-All Vehicles		Changes in Expenses 2/ Related to Changes in Tons of Revenue Freight		Changes in Expenses 2/ Related to Changes in No. of Intercity Shipments Carried	
	1957 vs 1953 3/	Variability	1957 vs 1953 3/	Variability	1957 vs 1953 3/	Variability
Expenses						
Labor--Total	130.40	119.0 4/	130.40	109.9	130.40	104.4
Drivers & Helpers	132.69	121.1	132.69	111.8	132.69	106.2
Platform Employees	122.49	111.8	122.49	103.2	122.49	98.0
All Other	130.95	119.5	130.95	110.3	130.95	104.8
Materials & Supplies	110.36	100.7	110.36	93.0	110.36	88.3
Equipment Rents	88.45	80.7	88.45	74.5	88.45	70.8
Insurance	91.56	83.6	91.56	77.1	91.56	73.3
Maintenance	114.97	104.9	114.97	96.9	114.97	92.0
Office & Administration Exp.	123.43	112.6	123.43	104.0	123.43	98.8
Other Expenses	121.18	110.6	121.18	102.1	121.18	97.0
Total Operating Expenses	117.28	107.0	117.28	98.8	117.28	93.9
Depreciation	144.77	132.1	144.77	122.0	144.77	115.9
Taxes	146.21	133.4	146.21	123.2	146.21	117.0
Total Expenses Before Income Taxes	119.87	109.4	119.87	101.0	119.87	95.9

APPENDIX E

Item	Changes in Expenses Related to Miles Operated-All Vehicles		Changes in Expenses Related to Changes in Tons of Revenue Freight		Changes in Expenses Related to Changes in No. of Intercity Shipments Carried	
	1957 vs 1953	Variability	1957 vs 1953	Variability	1957 vs 1953	Variability
Operating Statistics						
Miles Operated - All Vehicles 5/	109.58					
Tons of Revenue Freight			118.70			
No. Of Intercity Shipments Carried 6/					124.94	

1/ Carriers included are (a) common carriers of general freight operating with owned equipment principally and (b) common carriers of general freight operating with owned and leased equipment or purchased transportation. Number of reporting carriers in these categories was 1,100 in 1953 and 1,199 in 1957.

2/ Expenses for years subsequent to 1953 deflated to 1953 basis.

3/ Ratio of 1957 expenses and operating statistics to 1953 (1953=100)

4/ To illustrate, Labor Increase (in 1953 dollars), 1957 vs 1953 = 130.40 =119.0
Miles Operated,all vehicles, 1957 vs 1953 = 109.58

5/ Includes owned vehicles, rented without drivers, and rented with drivers.

6/ Includes both truck load and less than truck load.

Source: Interstate Commerce Commission.

APPENDIX F

PERCENTAGE VARIABILITY, SPECIFIED EXPENSE GROUPS
DOMESTIC TRUNK AIR CARRIERS

	Changes in Expenses[1/] Related to Changes in Revenue Ton-Miles				
	1953-54	1953-55	1953-56	1953-57	1953-58
Flying Operations	97.8	94.4	90.9	100.3	99.6
Maintenance	95.7	94.8	99.0	96.6	100.8
General Services and Administrative					
Passenger Service	96.8	100.8	99.1	97.5	101.9
Aircraft and Traffic Servicing	98.4	91.3	89.6	110.0	115.4
Promotion and Sales	97.4	95.4	96.6	82.5	85.7
General and Administrative	97.6	96.1	95.4	57.2	58.3
Total General Services and Administrative	97.7	95.0	94.4	90.2	93.9
Depreciation and Amortization	105.3	84.9	75.9	90.7	84.8
Total Operating Expenses	98.2	93.7	92.2	94.5	95.9

1/ Expenses for years subsequent to 1953 deflated to 1953 basis.

Source: Civil Aeronautics Board

APPENDIX G

DEVELOPMENT OF SOUTHERN REGION COST PER HUNDREDWEIGHT,
RAILROAD BOXCAR LOAD OF 719 CWT.,
BIRMINGHAM TO NEW ORLEANS AT TOTAL EXPENSE LEVEL, YEAR 1957

Line No.	Cost Group (A)	Expense Group (B)	Total Expenses Rents and Taxes plus 4% Return on Equipment and Road Property After Taxes (dollars) (C)	Associated Service Unit Name (D)	Associated Service Unit Number (E)	Expense Per Unit (C ÷ E) (cents) (F)	Units Required for Load and Mty or at Origin and Destination (G)	Unit Expense for 354 - Mile Movement (F x G x 354) (cents) (H)	No. of Cwt. Contained in Unit (I)	Total Expense Per Cwt (H ÷ I) (cents) (J)	Percent Distribution (K)
		Line Haul									
1	I	Expenses Associated with Per Diem Cars	94,250,497	Car Miles	3,495,710,339	2.69618	1.0 (Ld) + .34 (Mty) = 1.34	1278.96	719	1.779	8.35
2	II	Expenses Associated with All Cars	44,745,306	Car Miles	4,298,003,390	1.04107	1.0 (Ld) + .34 (Mty) = 1.34	493.84	719	.687	3.22
3	III	Expenses Associated with Train Miles	155,839,209	Train Miles	67,427,990	231.119	68.78 Tons (L.E.) 1/ / 3640 Rev.Tons	1545.95	719	2.150	10.09
4	III	Expenses Associated with Gross Ton Miles	437,653,084	Gross Ton Miles	192,038,579,000	.22790	68.78 Tons 1/	5548.94	719	7.718	36.22
5		TOTAL LINE HAUL	732,488,096	-	-	-	-	8867.96	719	12.334	57.88
		Terminal									
6	IV	Switching at Origin and Destination	147,053,464	Cars Switched	21,111,122	696.569	2 + 1.8 = 3.6	2507.65	719	3.488	16.37
7	VI	Car Expense at Origin and Destination	48,199,804	CL Cars Switched	19,048,776	253.034	2 + 1.9 = 3.9	986.83	719	1.373	6.44
8	VIII	Station Clerical	63,496,429	CL Consignments Orig.& Term'd	10,915,782	581.694	2	1163.39	719	1.618	7.59
9	IX	Station Platform	4,305,895	Tons O. & T.	155,845,290	2.76293	2	5.53	20	.276	1.29
10	XI	Train Supplies and Expenses	10,476,039	CL Orig.& Term'd	10,915,782	95.971	2	-	-	-	-
11	XI	Special Service	848,057	CL Orig.& Term'd	10,915,782	7.769	2	-	-	-	-
12	XI	Total	11,324,096	CL Orig.& Term'd	10,915,782	103.740	2	207.48	719	.289	1.36
13	XII	L. & D. Claims Clerical Cost	1,517,811	CL Tons O.& T.	478,475,577	.31722	2	.63	20	.032	.15
14		TOTAL TERMINAL	275,897,499	-	-	-	-	4871.51	-	7.076	33.20
15	I-II	Interchange Expense	82,446,631	-	-	912.000	1.34	1222.00	719	1.700	7.98
16	XII	Loss & Damage	-	-	-	-	-	-	-	.201	.94
17		TOTAL EXPENSE	1,090,832,226	-	-	-	-	-	-	21.311	100.00

1/ 35.95 Tons load plus 24.5 tons tare (car) plus 34% tare (Mty Return) = 68.78 tons.

APPENDIX H

THE TWELVE CATEGORIES OF RAILROAD COST ACCORDING TO "RAIL FORM A."

In all transportation it is logical to separate costs, including return on investment between line-haul and terminal elements. In these two general headings the operations of an ordinary railroad can be broken down into twelve self-contained categories, of which five represent line-haul cost elements, [1/] according to the ICC's "Rail Form A", as follows:

I. Expenses associated with per diem cars.
This group contains the costs arising from the use of "per diem" cars, cars which are paid for by a daily rental. This amounts to 12.7% of total line-haul costs on the illustrative rail traffic in Section 9.

II. Expenses associated with all cars.
Operations such as switching should be costed on a car basis and the formula has allowed the re-switching of a car from one train to another every 200 miles. Nevertheless, the proportion of this car-mile cost amounts to only 4.9% of the line-haul cost of the illustrative traffic.

III-A Expenses associated with train-miles.
There are certain unit costs which vary almost inversely with train size. The wages paid to train and enginemen are the largest single component of expense in this category, amounting to 36.1% of the total. The total monies amount to 15.3% of line-haul cost. In proportion to its relative size a great amount of investment has been made to reduce this expense category in spite of the tendency for train-size increases to impair service quality and increase car rental costs.

1/ This treatment excludes (a) Federal Income Tax costs; (b) certain specialized costs not associated with movement of general commodities; and (c) passenger and L. C. L. deficits which are not inherently carload freight costs and which in our judgment fail to meet long-term constant requirements. The Roman numerals preceding each expense follow the useage of "Rail Form A."

III-B Expenses associated with gross ton-miles.
The last category of line-haul expense appears to be somewhat of a catch-all but many expenses fit within it. The most sizeable of these is fuel which is best distributed on the basis of the work it accomplishes: the movement of tonnage. In a similiar fashion the track structure of a railroad wears out as tonnage is carried over it. There are, however, other expenses such as the time costs pertaining to locomotives which have been included in this category for lack of a better. For example, the cost of repainting locomotives and cars and the payment of their depreciation are functions of time which the formula gathers together and lumps into a cost per gross ton-mile. Costs thus logically and otherwise associated with gross ton-miles amount to 55.0% of total line-haul cost in the illustrative case.

I-II. Expenses associated with interchange.
The final element of line-haul cost is that which, for the traffic we have costed, attaches to the interchange between the Alabama Great Southern and the New Orleans & North Eastern at Meridian, Miss. This particular matter illustrates one of the difficulties of railroad cost development. Both of these roads are subsidiaries of the Southern Railway System and no physical interchange (switching of the car to an interchange track to await pick-up by another railroad) actually takes place. Yet the statistics from which the Southern Region formula figures were derived include total cars interchanged and .55 of an "equated handling" was charged to each car. This ectoplasmic interchange, to which has been attributed non-existent switching time, helps to drive down the locomotive minutes required for various handlings in the Southern Region to the lowest level in the U. S. This cost is equivalent to 12.1% of the line-haul total.

The total line-haul cost derived from the above categories amounts to 14.034 cents per cwt. for the subject traffic. (Appendix G, lines 5 and 15, column 'J'.) This is 65.9% of the total movement cost (column K). Of the fourteen cents, 4.2 cents (30%) were distributed on a 'per car' basis while the remainder was distributed on a tonnage basis due to the fact that the car itself, exclusive of load, accounted for 47.7% of the total tons moved. Thus the car, loaded or empty is the largest single element in line-haul cost.

The remaining expenses consist of elements which do not vary with distance and are called "terminal" expenses. They break down into the following categories, largely on a "per car basis:"

IV. Switching at origin and destination.
This deals with costs related to the switching operations required in moving a car from an industry to its placement

in a line-haul train. This switching expense, 58% of which consists of crew wages, accounts for 47.9% of terminal expense.

VI. Car expense at origin and destination.
The time required for switching operations means rental and other car expense costs which must be charged to handling at origin and destination. The formula requires the assumption of 1.8 elapsed days at each terminal, and this accounts for 18.9% of terminal cost.

VIII. Station clerical expense.
This expense group reflects the cost of administering the movement of cars, requiring the preparation of waybills, etc; it amounts to 22.2% of total terminal costs.

IX. Station platform expense.
Car maintenance difficulties, shifted loads, etc., require trans-shipment of loads from time to time along with the removal of partial carloads. Though this “per ton” expense is infrequently incurred, it is spread over a large part of railroad traffic and therefore amounts to 3.8% of terminal cost.

XI. Train supplies and special service expense.
Expense related to car cleaning, the closing of hopper car doors, etc., is gathered together and divided by the carloads originated and terminated. The resulting cost is 4.0% of terminal expense.

XII-A Loss and Damage Clerical Cost.
The administration of loss and damage claims is distributed over all originated and terminated carload tonnage, and amounts to 0.4% of terminal cost in the illustrative case.

XII-B Loss and Damage Claim Cost.
The actual payments made to shippers for loss and damage are categorized by commodity type, and average nationwide expense per cwt. handled, as set forth in the Cost Section’s Statement 5-58, is used as the basis for computing this cost. The average experienced cost for iron and steel articles (0.201¢ per cwt.) amounts to 2.8% of computed rail terminal costs in the illustrative case. This is an insignificant element of transportation cost for iron and steel products, but for some commodities it can be an important cost element. It should be noted that the I.C.C. publishes no comparable data for motor and water carriers.

> Though loss and damage occurs in line-haul as well as in terminal operations there are no data upon which to effect such a segregation, and this cost is therefore regarded as a feature of terminal operation, and applied by weight regardless of distance traveled.

The above categories of terminal expense, when combined, amount to 7.277¢ per cwt., or 34.1% of total movement cost. Of this expense 6.768¢ or 93% of the total, was distributed on a "per car" basis without regard to load, while the remaining expense was distributed on a "per ton" basis. Thus to even a greater degree than in line-haul service, the car dictates assignment of terminal expenses. Combining line-haul and terminal expenses yields a total of 21.211¢ per cwt., of which 9.234 or 43.5% was assigned on a "per car" basis, while 47.7% of the gross-ton mile expense was based upon the weight of cars hauled, exclusive of loads. Thus any increase in loading per car is likely to mean lower unit costs, due to the spreading of car costs over a larger number of tons of load.

APPENDIX I

DISTRIBUTION OF SOUTHERN REGION RAILROAD CONSTANT FREIGHT EXPENSES AND RETURN
AND PASSENGER AND LCL DEFICITS AND RETURN
ON BASIS OF TONS AND TON-MILES; REVENUE; AND OUT-OF-POCKET EXPENSES,
YEAR 1957

Line No.	Item (A)	Source (ICC Sou. Region Form A, Except as Noted) (B)	Relationship to Distance: Unrelated (C)	Relationship to Distance: Related (D)	Total [(C)+(D)] (E)
1	Constant Portion of Freight Expenses, Rents and Taxes plus 4% Return on 50% of Road Prop. after F.I.T.	Sch. F, Lines 56 and 57, Cols. (3) & (5)	$ 63,456,693	$198,990,236	$262,446,929
2	Passenger and L.C.L. Freight Deficits including 4% Return after F.I.T.	Sch. G, Line 57, Cols. (3)&(5)	42,269,232	105,602,745	147,871,977
3	Constant Expenses and Return including Passenger and L.C.L. Deficits	Sum, Lines 1 and 2	105,725,925	304,592,981	410,318,906
	Ton and Ton-Mile Basis				
4	C.L. Revenue Tons Originated and Terminated; C. L. Revenue Ton Miles	Sch. G, Line 10, Cols. (5)&(6)	504,207,994	88,552,169,577	-
5	Coat Per Cwt. - Freight Expense and Return	Line 1 ÷ Line 4 x .05 Tons	.62927¢	.01124¢	-
6	Cost Per Cwt. - Passenger & L.C.L. Deficits and Return	Line 2 ÷ Line 4 x .05 Tons	.41916¢	.00596¢	-
7	Cost Per Cwt. - Interchange on Unit and Mileage Basis	1/	.22300¢	.00102¢	-
8	Cost Per Cwt. - Frt. Exp. And Return O. & T. - Adjusted for Single Interchange -Birmingham to New Orleans	2/	1.70454¢	3.61788¢	5.32242¢
9	Cost Per Cwt. - Passenger and L.C.L. Deficit. O. & T. - Birmingham to New Orleans	3/	.83832¢	2.10984¢	2.94816¢
10	Coat Per Cwt. - Total Constant Expenses and Deficits - Birmingham to New Orleans	Sum, Lines 8 ad 9	2.54286¢	5.72772¢	8.27058¢
	Revenue Basis				
11	Grand Total Freight Revenue, Sou. Region, Year 1957	F.C.S., p. 22, Line 980	-	-	$1,319,380,881
12	Ratio of Constant Freight Expenses and Return to Total Revenue	Line 1 ÷ Line 11	-	-	.19892¢
13	Ratio of Passenger and L.C.L. Deficits and Return	Line 2 ÷ Line 11	-	-	.11208¢
14	Constant Freight Expense and Return Per Cwt. - Birmingham to New Orleans	48¢ Rate Cwt. x Line 12	-	-	9.548 ¢
15	Passenger and L.C.L Deficits and Return per Cwt. - Birmingham to New Orleans	48¢ Rate Cwt. x Line 13	-	-	5.380 ¢
16	Total Constant Expense and Deficits Per Cwt. - Birmingham to New Orleans	Sum, Lines 14 and 15	-	-	14.928 ¢
	Out-of-Pocket Cost Basis				
17	Total Out-of-Pocket Costs	Sch. G, Line 25, Col. (2)	-	-	$865,784,622
18	Ratio of Constant Freight Expenses and Return to Out-of-Pocket Costs	Line 1 ÷ Line 17	-	-	.30313¢
19	Ratio of Passenger and L.C.L Deficits and Return to Out-of-Pocket Costs	Line 2 ÷ Line 17	-	-	.17080¢
20	Constant Freight Expense and Return P Cwt. - Birmingham to New Orleans	16.475¢ O.P. Cost x line 18	-	-	4.994 ¢
21	Passenger and L.C.L Deficits and Return per Cwt. - Birmingham to New Orleans	16.475¢ O.P. Cost x Line 19	-	-	2.814 ¢
22	Total Constant Expense and Deficits per Cwt. - Birmingham to New Orleans	Sum, Lines 20 and21	-	-	7.808 ¢

Column (C)	Column (D)
1/ Sch. G, Sh. 2[6]/ Line (e) Col. (3) ÷ 20 Cwt.	Sch. G, Sh. 2,[6]/ Line (g) Col. (3) ÷ 20 Cwt.
2/ Sum, Lines 5 plus 7 times two.	(Line 5 minus Line 7) x 354 miles.
3/ Line 6 times two.	Line 6 times 354 miles.

APPENDIX J

DEVELOPMENT OF SOUTHERN REGION OF COST PER HUNDREDWEIGHT,
RAILROAD BOXCAR LOAD OF 719 CWT.,
BIRMINGHAM TO NEW ORLEANS, AT OUT-OF-POCKET LEVEL,
YEAR 1957

Line No.	Cost Group	Expense Group	Out-of-Pocket Expenses, Rents, Taxes and Return After Federal Income Tax [Sched G, Col (2)] (dollars)	Associated Service Unit Name	Associated Service Unit Number	Expense Per Unit (C ÷ E) (cents)	Units Required for Load and Mty or at Origin and Destination	Unit Expense for 354 - Mile Movement (FxGx354) (cents)	No. of Cwt. Contained Per Unit	Out-of-Pocket Expenses Per Hundred-weight (H ÷ I) (cents	Percent Distri-bution
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
		Line Haul									
1	I	Expenses Associated with Per Diem Cars	76,847,187	Car Miles	3,495,710,339	2.19833	1.0 (Ld) + .34 (Mty) = 1.34	1042.80	719	1.450	8.80
2	II	Expenses Associated with All Cars	76,373,073	Car Miles	4,298,003,390	.84627	1.0 (Ld) + .34 (Mty) = 1.34	401.44	719	.558	3.39
3	III	Expenses Associated with Train Miles	124,670,567	Train Miles	67,427,990	184.894	68.78 Tons (L.+ E.) / 3640 Rev. Ton Train[1/]	1236.76	719	1.720	10.44
4	III	Expenses Associated with Gross Ton Miles	319,894,004	Train Miles	192,038,579,000	.16658	68.78 Tons[1/]	4055.91	719	5.642	34.24
5		TOTAL LINE HAUL	597,784,831	-		-	-	6736.91	719	9.370	56.87
		Terminal									
6	IV	Switching at Origin and Destination	112,686,209	Cars Switched	21,111,122	533.777	2 x 1.8 = 3.6	1921.60	719	2.673	16.21
7	VI	Car Expense at Origin and Destination	41,857,184	CL Cars Switched	19,048,776	219.737	2 x 1.9 = 3.8	853.00	719	1.161	7.05
8	VIII	Station Clerical	49,968,219	CL Consignments O. & T.	10,915,782	457.761	2	915.52	719	1.273	7.73
9	IX	Station Platform	3,359,056	Tons Orig. & Term'd	155,845,290	2.15538	2	4.31	20	.215	1.31
10	XI	Train Supplies and Expenses	8,380,831	Cl Origin. & Term'd	10,915,782	.76777	-	-	-	-	-
11	XI	Special Service	667,635	CL Origin. & Term'd	10,915,782	.06116	-	-	-	-	-
12	XI	Total, Lines 10 and 11	9,048,466	CL Origin. & Term'd	10,915,782	.82893	2	165.78	719	.231	1.40
13	XII	L. & D. Claims - Clerical Cost	1,214,249	CL Tons O. & T.	478,475,577	.25377	2	.15	20	.026	.16
14		TOTAL TERMINAL	218,133,383	-	-	-	-	3842.72	-	5.579	33.86
15		Interchange Expense	64,288,882	-	-	711.000	1.34	953.00	719	1.325	8.04
16		Loss and Damage	-	-	-	-	-	-	-	.201	1.22
17		GRAND TOTAL	-	-	-	-	-	-	-	16.475	100.00

1/ 35.95 Tons load plus 24.5 tons tare (car) plus 34% times tare (Mty Return) = 68.78 tons.

APPENDIX K

DEVELOPMENT OF SOUTHERN REGION COST PER HUNDREDWEIGHT MOTOR CARRIER LOAD OF 300 CWT.,
BIRMINGHAM TO NEW ORLEANS AT TOTAL EXPENSE LEVEL, YEAR 1957

Line No.	Expense Group	Total Expenses Associated with Group (dollars)	Associated Service Unit Name	Associated Service Unit Number	Expense Per Unit (B ÷ D) (cents)	Number of Units Required for Movement	Unit Expense Per Movement (E x F) (cents)	Number of Cwt. Handled in Movement	Cost Per Cwt. (G ÷ H) (cents)	Percent Distri-bution
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
	Line Haul									
1	Expenses Associated with Vehicle Mileage	37,974,018	Vehicle Miles	198,838,248	19.098	365	6,907.77	300	23.24	49.96
2	Expenses Associated with Vehicle Hours	27,154,899	Vehicle Hours	5,882,787	461.599	365 = 11	5,077.59	300	16.92	36.37
3	TOTAL LINE HAUL	65,128,917	-	-	-	33.4	12,048.36	300	40.16	86.33
	Terminal									
4	Pickup and Delivery - Expenses Associated with Vehicle Mileage	7,062,315	Vehicle Miles	40,276,705	17.534	5.348 1/	93.77	300	.31	.67
5	Pickup and Delivery - Expenses Associated with Vehicle Hours	28,880,552	Vehicle Hours	8,775,849	329.091	5.344 2/	1,758.66	300	5.86	12.59
6	TOTAL PICKUP AND DELIVERY	35,942,867	-	-	-	-	1,852.43	300	6.17	13.26
7	Terminal Platform	28,147,246	Cwt. Handled	177,620,500	15.847	(None)	-	-	-	-
8	Billing and Collecting	9,901,296	Shipments	17,430,647	56.804	1	56.80	300	.19	.41
9	TOTAL TERMINAL	73,991,409	-	-	-		1,909.23	300	6.36	13.67
10	GRAND TOTAL	139,120,326	-	-	-		13.957.59	300	46.52	100.00

1/ ICC Cost Section Work Table 1: 111.152 P.U. & D. Miles (Col. 3) ÷ 41,560 stops (Col. 10)= 2.674 miles x 2 (O.&T.) = 5.348 miles.

2/ ICC Cost Section Work Table 2: 30,000 lb. wgt., Col. 19, Line 22 = 160.33 mins ÷ 60 = 2.672 hrs x 2 (O. & T.) = 5.344 hrs.

APPENDIX L

<u>DESCRIPTION OF MOTOR CARRIER TOTAL COST DEVELOPMENT</u>

ICC Statement 7-58 describes the development of 1957 costs for regulated motor common carriers of general commodities in the Southern Region. In the Statement, only out-of-pocket costs are presented. For our purposes, these were adjusted to a total expense level by reference to the Commission's underlying work papers. As in rail cost development, the Cost Section sought to find reasonable “building blocks” by distributing motor carrier expenses into six categories and thereby obtaining the fundamental elements of total unit cost. These categories and their treatment in the Illustrative Case described in Section 9, are as follows:

<u>1. Line-Haul Expenses Associated with Vehicle Mileage.</u> Of the $ 65 million dollars of total expense incurred by the studied carriers, $ 38 million was related to vehicle mileage. This included, for example, fuel consumption, but excluded driver wages, inasmuch as drivers are generally paid by the hour. The total expense was divided by the number of vehicle-miles to yield a unit cost of 19.098¢ per vehicle-mile. This unit expense was then multiplied by the line-haul mileage, and the result divided by hundredweight of load. The computed cost of 23.24¢ per cwt. was 50% of total or 57.9% of line-haul cost.

<u>2. Line-Haul Expenses Associated with Vehicle-Hours.</u> The remaining $ 27 million of line-haul expense was distributed on the basis of total vehicle-hours reported to the Commission, thus deriving a unit cost of $ 4.62 per vehicle hour. This was multiplied by eleven hours, the travel-time from Birmingham to New Orleans at Southern Region's average over-the-road speed of 33.4 miles per hour. As in vehicle-mileage expense (above), the resulting figure was divided by the 300 hundredweight of load to get a cost of 16.92¢ per cwt. This figure amounted to 36.4% of total, or 42.1% of line-haul cost.

The total line-haul expense, consisting of Items 1 and 2 (above) thus comes to 40.16¢ per cwt, or 86.4% of total cost.

Terminal expense was derived in the same manner:

<u>3. Pickup and Delivery Expenses Associated with Vehicle Mileage.</u> Of the $ 36 million of pickup and delivery expense reported in Statement 7-58, the $ 7 million was associated with vehicle-miles. Dividing by these vehicle-miles produced a unit cost of 17.534 cents per mile. This figure was multiplied by the average miles per stop and the result was divided by 300 cwt. to derive a cost of 0.31 cents per cwt.

4. Pickup and Delivery Expenses Associated with Vehicle-Hours.
The remaining terminal pickup and delivery expense was divided by vehicle-hours to produce a \$3.29 cost per vehicle-hour. This was multiplied by a Cost Section special study figure which yielded the time requirement for handling 30,000 lbs., and the result again was divided by the 300 cwt. of load. The resulting 5.86¢ per cwt was 12.6% of total cost or 92.1% of terminal cost.

5. Billing and Collecting Expense.
The reported collecting and billing cost which amounted to \$ 10 million, was divided by total shipments to derive a unit cost of 56.804¢ each, irrespective of size of shipment. This cost when divided by the 300 cwt. of load produced a cost of 0.19¢ per cwt., which amounted to only 0.41% of total cost or 3.0% of terminal cost.

6. Terminal platform cost.
This was omitted from the cost calculation in the Illustrative Case, since this cost attaches mainly to the process of assembling several less-truckload shipments for handling in a common vehicle movement. This feature is absent in manufactured iron and steel, which tends to move in truckload quantities directly from shipper to receiver.

The total expense of 46.52 cents per cwt., thus consists of 23.55¢ or 50.6% of expense distributed on the basis of vehicle mileage, 22.78¢ or 49.0% of expense distributed on vehicle hours and 0.19¢ or 0.4% distributed on the basis of total shipments.

APPENDIX M

DEVELOPMENT OF COST PER CWT. FOR WATERLINE MOVEMENT, BIRMINGPORT TO NEW ORLEANS, AT TOTAL EXPENSE LEVEL, AND RAIL MOVEMENT, BIRMINGHAM TO RIVER, AT OUT-OF-POCKET LEVEL, YEAR 1957

Line No.	Expense Group (A)	Total Expenses Rents and Taxes Associated with Group (dollars) (B)	Associated Service Unit: Name (C)	Associated Service Unit: Number (D)	Expenses Per Unit (B ÷ D) (cents) (E)	Number of Units Required for Movement (F)	Unit Expense for Movement (E x F) (cents) (G)	Number of Cwt. Handled in Movement (H)	Cost Per Cwt. (G ÷ H) (cents) (I)	Percent Distri-bution (J)
1	Towboat Expense	1,808,223	Towboat Miles	182,371	992.00	577 2/	5723.84	110,000	5.2036	59.84
2	Barge Expense	409,182	Barge Days	34,252 1/	1195.00	7½	8962.50	11,000	.8147	9.37
3	Terminal Expense	506,367	Tons O. & T.	945,693	53.54	1	53.54	20	2.6770	30.79
4	TOTAL with No Profit or Return	2,723,772	-	-	-	-	-	-	8.6953	100.00
5	Rail Move from Birmingham Out-of-Pocket Cost for 21 Mile Rail Move, Mills to Birmingham, Ala.								8.1290	-
8	TOTAL Including Out-of-Pocket Rail Haul		-	-	-	-	-	-	16.8243	-

1/ 102 barges x 365 x 92% avail. = 34,252 barge days.
2/ Mileage based on "New Dimensions in Transportation," American Waterways Operators, Inc., Washington: 1956, pp. 38 and 44.

APPENDIX N

DEVELOPMENT OF AREAS OF PROBABLE ECONOMIC ADVANTAGE
RAIL AND MOTOR OUT-OF-POCKET BASIS

In Section 10, 1957 out-of-pocket rail and motor costs of average weight shipments in each of the five major commodity groups have been computed in cents per hundredweight on a nation-wide basis. The figures were derived as follows:

Railroads. Terminal costs shown in ICCStatement 5-58 were apportioned by major region on the basis of national car-types shown in the Commission's Statement TC-2 for 1956. These data were then weighted to the three major regions on the basis of One Percent Waybill Sample for the year 1957 as shown in the Commission's Statement 2-59. Thus an average terminal cost (a composite figure based on all car types handling traffic in each major commodity group), weighted for car-types and by regional rail traffic volumes, was computed on a national basis.

The weighted terminal expense per car was then multiplied by the total U. S. cars for each commodity group, as shown in Statement 2-59, and the resulting terminal cost was subtracted from the total U. S. out of pocket cost for such traffic. Line-haul cost was the net of this procedure. This cost, stated in hundredweight, was divided by the product of total tons for each commodity group times its average length of haul. Thus a line-haul cost per hundredweight-mile was derived, as reflected in Chart V.

Motor Carrier. Since much underlying motor carrier regional cost data pertain to years as far back as 1953, it was necessary to apply a cost-level factor to bring these to 1957 levels. All such earlier data were raised by 2½% per year for this purpose. Weighted average line-haul and pick up and delivery costs for the East and West were then developed by applying to each sub-region its proportion of the regional total. This was not required in the South since Commission data treat this region as a single entity.

The line-haul and pick up and delivery motor carrier regional costs for East, South and West were then weighted on the basis of railroad originations and terminations shown in Statement 2-59 so as to arrive at the weighted average nationwide line-haul vehicle-mile and terminal pick up and delivery vehicle-hour costs. The objective sought by use of a railroad basis here was to eliminate geographical distortions through derivation of composite cost reflecting comparable volume distributions (traffic mix) among the three major territories. The pickup and delivery vehicle-hour cost was then tripled to give the minimum conceivable terminal cost for motor carrier operations at railroad volume levels. (This was a deliberate effort to avoid overstating motor carrier terminal costs such as would have occurred if current Cost Section figures had been used. For example, ICC data underlying Statement 7-58 indicate that a 30,000 lb. shipment requires 5.344 hours for loading and unloading, which appears unreasonable if motor carriers were to achieve the same volumes, loading facilities, etc. as currently possessed by rail carriers.)

To the pick up and delivery vehicle-hour figure thus derived was added the Southern Region's 1957 single-stop pick up and delivery vehicle-mile figure obtained from the Cost Section's underlying work papers, used throughout with adjustment. No allowance was made for billing and collecting.

APPENDIX O

THE ATA FORMULA

The Concepts And Their Validity:

The 1955 Edition of the ATA Method provides a number of arithmetic and algebraic formulas which, in combination, have the objective of producing overall estimates of so-called aircraft direct operating expenses. These correspond to three major categories in the CAB standard system of reporting airline operating expenses which, in 1955 were referred to as direct expenses. These major expense categories are:

1. Flying Operations (CAB Account 5100).
2. Direct Aircraft Maintenance (CAB Account 5200).
3. Flight Equipment Depreciation (CAB Account 7000).

The first major category, flying operations, includes numerous different types of expense primarily related to the actual flight cost of the airplane, such as the major items of crew salaries and expenses, fuel and oil. The second category, Direct Aircraft Maintenance, includes the costs incurred directly for maintenance of the airplane and its accessories. The third category, Flight Equipment Depreciation, is merely the estimated rate of amortization of the total investment in the aircraft, its accessories and spare parts.

These major categories of airline costs as reported in 1955 included none of the overhead or administrative charges normally required in conjunction with administration of the direct airplane operation. Nor, of course, does the ATA formula method purport to provide a means of estimating the great mass of airline expenses which are required for station operations, ground services aside from airplane maintenance, or administration of the company. These categories of airline expense, normally termed indirect or overhead expenses, usually come close to and often exceed the sum of the so-called direct aircraft operating expenses estimable by the ATA formula method.

Since 1955 the standard CAB system of airline expense reporting has been substantially amended. Certain elements of expense formerly reported in the indirect expense categories have been partially distributed to the direct expense accounts. For example, insurance costs associated with the direct salary costs for pilots, mechanics and other personnel have been moved to the direct expense categories of Flying Operations and Maintenance. 1/ Thus, the formulas comprising the current (1955) edition of the ATA method exclude some elements of expense which by current CAB standards are included in direct aircraft operating cost.

1/ In addition, current CAB practice is to allocate the major share of maintenance overhead expenses (supervision, shop costs, etc.) to a category termed Assigned Maintenance Burden. This is often treated, improperly by analysts as a direct expense.

The bulk of actual direct aircraft operating expenses are accumulated on a time and/or material basis. Thus, the basis of a typical ATA formula is nominally an arithmetic combination of personnel and material costs incurred on the average for each block hour of flying. These basic hourly costs are then divided by the computed speed of the aircraft (mph) to derive unit costs in terms of cents per mile. Other unit cost values, of course, can be derived also. Costs per available seat mile can be derived by dividing cost per mile by average seating, costs per available ton mile by dividing cost per mile by tons of payload available, etc.

One such typical ATA formula can be used to illustrate both the basis of formula construction and the probabilities for error. For example, the ATA formula for estimating the cost of labor for engine maintenance is expressed as follows:

$$\text{Cost per mile} = \frac{\text{(No. Of Engines)(Labor hrs per Flight Hr)(Labor Rate per Hour)}}{\text{Block Speed}}$$

If we eliminate the denominator of this equation (Block Speed) 2/ we obtain the basic expression of cost per hour of flying. It will be seen that this formula is nothing but an arithmetic combination of the elements which produce the resulting cost. Any experienced cost analyst would follow a similar development even had he never heard of the ATA formula method provided he had a sound basis for obtaining (a) the average labor hours per engine flight hour and (b) the prevailing average labor rate for mechanics. Unfortunately, neither of these factors is readily available except from the internal statistics of each company and each varies by company, type of engine, etc.

The ATA Method solves these practical problems by providing average assumed values derived by unknown means from past experience. For example, the current edition of the method assumes an average mechanics' labor rate of $ 2.20 per hour. This is far below current averages and probably unrepresentative of an average for any individual airline.

A second discrepancy in this formula is the assumption of average labor man-hours per engine flying hour as a factor related to engine weight. 3/ The selection of engine weight as the determinant of maintenance man-hours required is at best questionable. This assumes there is a straight line relationship between weight (size) of an engine and the work required to maintain it. Design for accessibility and reliability, both important factors in practice, are ignored. As a practical matter an engine design stressing these factors may be heavier than one which does not and thus by the formula would be more expensive to maintain.

2/ The ATA formula for computation of block-speed (speed from leaving the loading position at point of origin to unloading position at destination) is subject to substantial error to be discussed. This, of course, will result in erroneous costs per mile, even if the hourly costs are correctly estimated by the basic formula relationships.

3/ Separately by (a) single row radial piston (b) twin row radial piston and (c) turbine (without differentiation between pure jets and prop-jets).

A third source of discrepancy exists in this (and other) maintenance formula. Engine and aircraft time limitation between maintenance and overhaul operations are related by safety regulations (CAR) 4/ to flight hours (take-off to landing time) rather than block hours. The difference between these times increases inversely with length of aircraft stage distance. In short-haul local service airlines, for example, the difference often exceeds 20 percent (block time 20% in excess of flight). These maintenance formulas, then, based on flight hours, automatically provide a cost per flight hour rather than per block hour. This discrepancy tends to overstate hourly costs.

It might be assumed that the overstatement caused by use of flight hours would counterbalance the understatement due to low unit labor costs. Reference to Table I will show this may not be true.

Table I provides a fair test of the validity of the estimates produced by the ATA Method for two types of aircraft in current service.

In columns 1 and 2 we have computed the actual costs per block hour and per mile for the Viscount and the DC-7 as operated by the same company. In column 3 we have computed actual DC-7 costs averaged by the domestic airlines. In columns 4 and 5 we have computed the estimated costs for these aircraft using the ATA formula.

Reference to Table I line 2b provides us with some comparisons of ATA formula estimated costs for engine labor with costs actually achieved. It will be seen that the ATA formula understates the industry average for the DC-7 by 25% and the selected carrier's experience by 52%. Viscount costs in this category, however, are overstated by 25%. Clearly, in our opinion, the formula estimates are so far from reality for either aircraft as to force the conclusion that the ATA formula for this cost category is invalid. While correction of the labor rate would improve accuracy for the DC-7 it would increase the error for the Viscount. Probably it is correct to conclude that reliance on the element of engine weight alone in the formula is not the last approach for assessing relative maintenance costs.

Comments on other formula elements: The single ATA formula element discussed above was selected primarily for simplicity of illustration. Most of the other formula elements pose similar problems. For example:

(a) Each formula involving personnel pay includes pay rate factors derived from 1954 and 1955 experience. Pay rates have increased substantially since that time.

(b) The ATA method computes crew pay by a complex arithmetic formula for each crew member. Airline first pilots are paid on the basis of very complex working agreements involving differential rates for seniority, day and night flying, design speed and weight of aircraft, etc., most of which vary from company to company. The ATA formula method has attempted to distill

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4/ Civil Air Regulations, including the policies of the Federal Aviation Agency in applying them.

these manifold and diverse factors into simplified averages whereas, as a matter of fact, it would be as simple and probably much more accurate for the analyst to use specific company contracts applicable to his problems. This, in fact, is probably what is done in most cases where such information is available.

In addition, pilot working agreements contain numerous conditions which both reduce hours of flying and increase costs. Some of these are: (1) pay for on-duty time; (2) payment on the basis of scheduled or actual hours flown, whichever is greater; (3) sickness pay; (4) deadhead pay; and (5) minimum guarantees. Since the ATA formula makes no apparent provision for these elements of cost, it is deficient in this respect.

The ATA formulas for other crew members are scaled down versions of the first pilot formula. Although other crew members are paid less than first pilots the relationships used by the ATA formula do not conform very closely to the relationships presently existing. Reference to Table I, line Ia, shows that the ATA formulas substantially understate experienced crew costs.

(c) Crew expense by ATA formula is an assumed $ 1.25 per block hour per crew member. Table I, line Ib shows this is unrealistic.

(d) Fuel costs by ATA formula appear reasonable for the DC-7 as shown by Table I, line Ic, but highly unreasonable for the Viscount. These results stem primarily from the assumption of average costs per gallon which have proven reasonable for piston engines but substantially overstated for turbines.

(e) The ATA formula for aircraft insurance is based on an assumed insurance rate (5% of cost). Rates actually vary substantially among airlines and between types of aircraft. Some airlines are self-insured. Table I shows the discrepancies which may occur between experience and ATA formula values.

(f) Section 2 of Table I illustrates the substantial discrepancies between experience and formula estimates in the maintenance categories.

(g) Flight equipment depreciation is an element of cost primarily determined by management policies. The ATA formulas are generally out of line with current policies on residual values and write off periods.

<u>The Computation of Block Speed</u>:

Economic comparisons between aircraft of different size and capacity become most useful when reduced to unit costs in terms of available seat miles or available ton miles (a large aircraft should be expected to be more costly than a small one in terms of hours or miles of flying).

To effect the transition from hourly costs to such unit costs, the proper evaluation of probable average speed <u>realizable in practice</u> is vital. For example, if the computed speed is 10% optimistic, the resulting unit costs are understated in the same degree and vice versa.

APPENDIX O

The ATA formula for computing block speed generally can be expected to overstate probable results (and thus understate unit costs per mile, seat mile or ton mile). This results primarily from a theoretical engineering approach to block speed computation which fails to make any allowance for realities experienced in operation. For example, the ATA formula assumes all aircraft will experience an average 15 mph headwind. This may be reasonable for short haul aircraft flying at low altitudes but it is probably unreasonable for large long-haul aircraft which perform best at high altitude. Secondly, the formula makes no allowances for the average course circuity found on most routes. Thirdly, no provision is made in the formula for the delays normally encountered in actual practice. Generally, some measure of delays due to traffic and weather conditions plague all operations. The importance of this factor increases percentage-wise as the average aircraft hop decreases. Some short-haul local service airlines experience delay factors up to 15 or 20 percent over scheduled block times <u>on an annual basis</u>.

<u>Is The Formula Useful</u>?

The basic answers to this question appear reasonably discernible from the comparisons afforded by Table I. From these it is apparent that few of the ATA formulas for computing specific elements of expense come very close to the values attained in actual practice today.

In column 3 for example, we have computed industry experience costs per block hour for the DC-7 for the year ending June 30, 1958. If the formulas as applied to the DC-7 were reasonably valid they should at least approximate industry averages. Comparing each item of cost in column 3 with the formula values in column 5 we see that the formula value approaches 10% of actual experience only twice. Sometimes the formula is substantially high and sometimes substantially low. For the entire Flying Operations Account the formula overstates industry experience by almost 10 percent -- this despite the fact that crew expenses are understated by almost 22 percent. For the entire Direct Maintenance group of costs the formula overstates experience by 17 percent with individual item deviations ranging from 25 percent low to 93 percent high. With these ranges of error in individual accounts it then becomes purely accidental whether or not the total balances out to resemble actual costs. Actually, the total for Flying Operations plus Maintenance (Table i, line 9) shows the ATA estimates almost 12 percent higher than the industry average.

The ATA formula also appears to fail of purpose in providing a comparative evaluation of competitive aircraft for a specific operator. Table I, columns1 and 1 shows comparative Viscount and DC-7 costs realized by the same airline. These indicate that the Viscount is approximately 25% more economic in terms of costs per seat mile (line 12). The ATA formula comparison (columns 4 and 5), however, indicates the Viscount should be only about 7 percent more economic than the DC-7 for this operator.

Actually experience with turbine aircraft now available indicates the ATA formulas for turbine aircraft are far from realistic. Apparently, the development of the formula factors for turbine aircraft failed to anticipate the potential of these engines. As an example, the formula factor for engine overhaul time anticipated only 750 hours between overhauls as against 1300 hours for reciprocating engines.

In the short period of turbine operation in the United States the period between overhaul has already exceeded reciprocating engine experience after many years of operation. The precautionary statements contained in the introduction of the ATA formula presentation have proven advisable.

On balance, the current edition of the ATA Formula Method appears so inaccurate for estimation of costs currently or for the immediate future as to be useless. Unfortunately, its existence as a supposed standard and the aura of respectability attached to it by reason of its sponsorship induces its continued use despite the fact that most competent analysts recognize its invalidity under current conditions.

We understand that the 1955 version of the ATA formula is currently in process of another revision. Such a revision, if made realistically, could result in substantial improvement. If, however, only such items as labor rates and other "standard" factors are updated without a thorough analyses of the basic validity of certain of the formula concepts, the ATA method will still have substantial pitfalls for the unwary. For example:

It would appear that all the formula concepts applicable to maintenance costs should be carefully investigated to determine whether or not relative weights and costs of engines and airframe are the most valid criteria for costing. Evidence exists that the average stage distance of the operation is an important determinant of maintenance requirements and thus hourly costs.

The present formula for computing block speed is very unrealistic. It should be changed to incorporate provisions which give recognition to such practical problems as operational delays, long and short-haul operations, etc.

If however, the ATA Formula Method were thoroughly revised to make it a reasonably accurate yardstick of costing it follows, in our opinion, that the formulas would necessarily become much more complex than those currently in use. In this event, use of the formula approach to airplane costing would probably require as much work as a non-formula cost analysis based on the latest experienced costs and operating conditions of a specific company. For comparable effort, a competent analyst should achieve more realistic results using actual experience as a base than using formula factors based on generalized industry averages and engineering concepts of cost determinants.

TABLE I TO APPENDIX O

COMPARISON OF ACTUAL AIRCRAFT OPERATING COSTS WITH
ATA FORMULA ESTIMATES

	Reported Year 6/30/59			ATA Formula Estimates 1955 Ed. Unadjusted		Percent ATA Formula Above (Below) Actual		
	Selected Airline Operating Both		Average Industry			Selected Airline Operating Both		Average Industry
	Viscount	DC-7	DC-7	Viscount 810	DC-7	Viscount	DC-7	DC-7
Expense in Dollars per Block Hour								
1. Flying Operations								
a. Flight Crew Pay	$ 35.07	$ 49.64	$ 51.15	$ 27.69	$ 39.96	(21.0)	(19.5)	(21.88)
b. Crew Expense	2.29	3.28	4.48	2.50	3.75	9.2	14.3	(16.3)
c. Fuel & Oil (including tax)	49.32	114.29	105.79	67.58	107.28	37.0	(6.1)	1.4
d. Insurance	11.58	18.67	2.12	22.92	33.84	19.8	18.1	15.00
e. Other	6.00	8.12	5.38					
f. Sub-total	$104.28	$194.09	$168.92	$120.69	$184.83	15.7	(4.8)	9.4
2. Direct Maintenance, F.E.								
a. Labor-Aircraft and Other	10.87 1/	12.66 1/	15.84 1/	17.92	22.29	64.8	76.1	40.7
b. Engines	5.77	26.15	16.83	7.22	12.54	25.1	(52.0)	(25.5)
c. Materials--Aircraft and Other	7.05 1/	21.80 1/	8.87 1/	9.91	17.10	40.6	(21.6)	92.8
d. Engines	19.17	33.93	35.97	45.00	37.58	134.7	32.6	4.5
e. Other	3.32	(.56)	(1.04)					
f. Sub-Total	$ 46.18	$ 93.98	$ 76.47	$ 80.05	$ 89.51	73.3	(4.8)	17.1
3. Depreciation--Flight Equipment	47.87	56.90	80.95	70.52	102.95	47.3	80.9	27.2
4. Total Direct Expense	$198.33	$344.97	$326.34	$271.26	$377.29	36.8	8.1	15.6
5. Actual Avg. Block Speed (Scheduled Service)	252	262	265	252 2/	265 2/			
6. Average Seats--First Class	52	64 3/	64 3/	52	64 3/			
Expense in Cents per Mile								
7. Flying Operations Total	$ 41.38	$ 74.08	$63.74	$ 47.89	$ 69.74	15.7	(4.8)	9.4
8. Direct Maintenance--Total	18.33	35.87	28.86	31.77	33.77	73.3	(4.8)	17.1
9. Sub-Total	$ 59.71	$109.95	$ 92.60	$ 79.66	$103.51	33.4	(4.8)	11.8
10. Depreciation--Flight Equipment	19.00	21.72	30.54	27.98	38.85	47.3	80.9	27.2
11. Total Direct Expense	$ 78.71	$131.67	$123.14	$107.64	$142.36	36.8	8.1	15.6
12. Total Expense per Seat Mile--(Cents)	1.513	2.057	1.924	2.070	2.22	36.8	8.1	15.6

1/ Outside repair costs divided equally between labor and materials for comparison with ATA formula estimates.
2/ The ATA formula method would use a computed block speed which would probably overstate DC-7 speed expectancy more than that for the Viscount. This would reduce the DC-7 costs per mile more than it would reduce those for the Viscount.
3/ Airline used as a basis for comparison operates DC-7 in coach configuration with 72 seats. 64 is assumed as average first class.

Appendix P

Methods used by 13 Certificated Airlines To Allocate Maintenance Burden

American

The maintenance burden and depreciation of maintenance buildings and equipment will be assigned to ground and flight property on the basis of the ratio of labor dollars expended on repair of general ground property, and each aircraft type to the total 5200 labor dollars.

Braniff

[Maintenance Burden] is transferred to Schedule P - 5.2 and is allocated to types of equipment upon the basis of total direct maintenance.

Capital

Three bases for the allocation of the various objective accounts in functional account group 5300 -- Maintenance Burden to the maintenance of the different aircraft types and general ground properties recorded in Account 5200 -- Direct Maintenance. These bases are:

(1) Direct Maintenance labor for following items:
A/c 5328, 5357, 5368 (Partial)
A/c 5338, 5344, 5349

(2) Direct Maintenance material for following items:
A/c 5331, 5357, 5368 (Partial)
A/c 5334, 5354

(3) Total direct maintenance expense for following items:
A/c 5328, 5331, 5357, 5368, 5343 (Partial)
A/c 5321, 5335, 5336, 5337, 5350, 5325, 5346,
A/c 5353, 5355, 5358, 5364, 5371, 5377

Continental

Maintenance burden is allocated by distributing the total expenses of subfunction 5300 “Maintenance Burden” plus the total of account 7075.8 “Depreciation -- Maintenance Equipment and Hangars”, between the maintenance of flight equipment, by class of flight equipment, and maintenance of ground property and equipment, on the basis of the hours of direct maintenance labor involved in each during the quarter.

APPENDIX P

Eastern

Sub function 5300, Maintenance Burden plus the total of account 75.8 Depreciation -- Maintenance Equipment and Hangars will be prorated to Direct Maintenance, by class of Flight Equipment and Maintenance of Ground Property Equipment based on direct labor dollars charged to these accounts.

Delta

Total expenses included in subfunction 5300 Maintenance Burden plus the total of account 75.8 Depreciation -- Maintenance Equipment and Hangars will be allocated between maintenance of flight equipment, by type of flight equipment, and maintenance of ground property and equipment (exclusive of maintenance equipment and maintenance buildings) on the ratio of direct labor cost by type of equipment to total direct labor cost.

Northeast

The total burden is applied to (a) Direct Maintenance -- Flight Equipment and (b) Direct Maintenance -- General Ground Property on the basis of the per cent relationship of such direct maintenance costs, but after first deducting an allocation of Burden as applicable to accounts 1420, 1689 and 1890.

United

Maintenance Burden (total 5300) plus the total of Account 75.8 Depreciation -- Maintenance Equipment and Hangars will be allocated to maintenance of general ground property and maintenance of flight equipment, by type of aircraft. The allocation will be based on dollars of direct labor expended on general ground property and on aircraft by type of equipment.

T W A

All maintenance burden and depreciation of maintenance buildings and equipment are allocated quarterly between maintenance of flight equipment and maintenance of general ground property and equipment on the basis of direct labor charged to these two maintenance categories.

Maintenance burden and depreciation of maintenance buildings and equipment thus assigned to maintenance of flight equipment, are further allocated quarterly to each type of flight equipment on the basis of direct labor charged to such types of flight equipment.

Western

Maintenance burden will be applied on Schedule P-6 to class of flying equipment and to ground equipment by allocation based upon shop direct labor hours.

APPENDIX P

PAN American

Maintenance burden assigned directly to flight equipment is allocated to each plane type on the current quarter's percentage of total flight account 5200 direct labor times the direct labor for each plane type.

The total amount of maintenance burden as reported in functional group 5300 is allocated on a cumulative calendar year basis to flight equipment and general ground property on the basis of the relationship of total productive labor costs recorded in Accounts 5225.1, 5225.2, 5225.3 and 5225.9.

National

The total in Account 5300 (Maintenance Burden) is allocated between flight equipment maintenance and ground property maintenance by dividing the total burden in Account 5300 by the direct labor in Account 5200. The rate thus obtained is allocated on a quarterly basis and any differences between actual burden costs incurred during each quarter and amounts applied at standard rates are entered in "Over or Under Applied Burden".

At the end of an accounting year the amounts allocated are adjusted to reflect actual costs for the full accounting year.

Northwest

The amounts thereby designated as Flight Equipment Maintenance Burden will, along with charges to Account 70758 -- Depreciation Maintenance Equipment and Hangars, be distributed to aircraft types in the respective entities on the basis of direct maintenance labor dollars.

Source: CAB Forms 41

APPENDIX Q

COMPARISON OF CLASS I RAILWAY OPERATING EXPENSE, RENT AND TAX[1] ACCOUNTS
WITH ANALOGOUS ACCOUNTS PRESCRIBED FOR
CLASS I MOTOR FREIGHT, CLASS A INLAND AND COASTAL WATER, OIL PIPE LINE, AND GROUP III AIR CARRIERS
AS OF NOVEMBER 1, 1959

RAILROADS		MOTOR FREIGHT CARRIERS		INLAND & COASTAL WATERWAYS		OIL PIPE LINES		AIR CARRIERS	
Account Number	Title[2]	Account Number[3]	Title[2]	Account Number	Title[2]	Account Number[4]	Title[2]	Account Number[5]	Title[2]
I. Maintenance of Way & Structures									
201	Superintendence[6]			401	Superintendence	601, 651	Superintendence	5321	General Management Personnel[6]
202	Roadway Maintenance[7]					602, 652	Repairs of Pipe Lines		
						607, 657	Repairs of Delivery Facilities		
206	Tunnels and Subways[7]								
208	Bridges, Trestles & Culverts[7]								
210	Elevated Structures[7]								
212	Ties[7]								
214	Rails[7]								
216	Other Track Materials[7]								
218	Ballast[7]								
220	Track Laying and Surfacing[7]								
221	Fences, Snowsheds & Signs[7]								
227	Station & Office Buildings	4180	Other Maintenance Expenses	404	Repairs of Buildings and Other Structures	604, 654	Repairs of Buildings	5225.9, 5325.9	Labor - Gr Pr & Eq.
		4280	Other Transportation Expenses					5328.2	Unallocated Shop Labor
		4380	Other Terminal Expenses					5246.9, 5346.9	Maint. Materials, Ground Property & Equipment
229	Roadway Buildings					605	Repairs of Pumping Stations		
231	Water Stations								
233	Fuel Stations								
235	Shops and Engine Houses	4180, 4280, 4380		404		655		5225.9, 5325.9, 5328.2, 5246.9, 5346.9	
237	Grain Elevators								
239	Storage Warehouses					606, 656	Repairs of Oil Tanks		
241	Wharves and Docks			404					
243	Coal and Ore Wharves								
247	Communications Systems					608,658	Repairs of Comm.Systems	5225.9,5325.9,5328.2,5246.9,5346.9	
249	Signals and Interlockers								
253	Power Plants								
257	Power Transmission Systems								
265	Miscellaneous Structures								
266	Road Property-Depreciation	5010	Depreciation of Structures	411	Depr., Transportation Property				
		5050	Depreciation of Furniture & Office Equipment	413	Amortization of Investment, Leased Property	613, 663	Depreciation	7075.8	Depreciation-Maintenance Equipment & Property
		5060	Depr. of Misc. Equipment						
		5070	Depr. of Improvements to Leasehold Property						
		5080	Depr. of Undistributed Property					7075.9	Depreciation-General Ground Property

APPENDIX Q
(Cont'd.)

RAILROADS Account Number	Title	MOTOR FREIGHT CARRIERS Account Number	Title	INLAND & COASTAL WATERWAYS Account Number	Title	OIL PIPE LINES Number	Title	AIR CARRIERS Account Number	Title
I.	Maintenance of Way & Structures (Cont'd)								
267	Retirements					614, 664	Extraordinary Retirements		
269	Roadway Machines								
270	Dismantling Retired Road Property								
271	Small Tools & Supplies	4180							
272	Removing Snow, Ice & Sand	4380							
273	Public Improvements-Maint.								
274	Injuries to Persons	4540 4530	Workman's Compensation Public Liability and Property Damage	476 477	Liability Insurance & Losses, Non-Marine Operation Other Insurance	634, 684 638, 688	Injuries to Persons Insurance	5355.1 5355.2 5358	Insurance Purchased, PL&PD Provisions for Self Insurance, PL&PD Injuries, Loss & Damage
275	Insurance	4530, 4540		476, 477		634, 684, 638, 688		5355.1, 5355.2, 5358	
276	Stationery & Printing					637, 687	Stationery & Printing	5350	Stationary, Printing & Office Supplies
277	Other Expenses							5353 5354 5371	Other Supplies Inventory Adjustments Other Expenses
278	Maintain Joint Tracks, Yards and Facilities (Debit)	4191	Joint Garage Expenses (Dr)						
279	Maintain Joint Tracks, Yards and Facilities (Credit)	4196	Joint Garage Expenses (Dr)						
280	Equalization - Way & Structures								
281	Right-of-Way Expense								
II.	Maintenance of Equipment								
301	Superintendence [6]	4110	Supervision	401		601, 651		5321 [6]	
302	Shop Machinery	4180		405	Repairs of Office & Terminal Equipment			5349 5225.9, 5325.9, 5328.2, 5246.9, 5346.9	Shop & Servicing Supplies
304	Power Plant Machinery	4180		405		605, 655		5225.9, 5325.9, 5328.2, 5246.9, 5346.9, 5349	
305	Shop & Power Plant Machinery Machinery-Depreciation	5040	Depreciation of Shop & Garage Equipment	411		613, 663		7075.8	

RAILROADS Account Number Title	MOTOR FREIGHT CARRIERS Account Number Title	INLAND & COASTAL WATERWAYS Account Number Title	OIL PIPE LINES Number Title	AIR CARRIERS Account Number Title
II. Maintenance of Equipment (Cont'd.)				
306 Dismantling Retired Shop & Power Plant Machinery				
308 Steam Locomotives - Repairs, Yard	Pickup & Delivery Revenue Equip. 4135 Repairs & Servicing 4165 Tires & Tubes	402 Repairs of Floating Equipment		
308 Steam Locomotives - Repairs, Other	Line Haul Revenue Equip. 4131 Repairs & Service 4161 Tires & Tubes	402		5225.1, .2, .3 Maintenance Labor-Flight Equip. 5243.1, .2, .3 General Services Purchased Outside - Flight Equip. 5246.1, .2, .3 Maintenance Materials-Flight Equip.
311 Other Locomotives - Repairs, Diesel, Yard	4135, 4165	402		
311 Other Locomotives - Repairs, Diesel, Other	4131, 4161	402		5225.1, .2, .3; 5243.1, .2, .3; 5246.1, .2, .3
311 Other Locomotives - Repairs, Other, Yard	4135, 4165	402		
311 Other Locomotives - Repairs, Other, Other	4131, 4161	402		5225.1, .2, .3; 5243.1, .2, .3; 5246.1, .2, .3
314 Freight Train Cars - Repairs	4131, 4161	402		5225.1, .2, .3; 5243.1, .2, .3; 5246.1, .2, .3
317 Passenger Train Cars - Repairs	4131, 4161	402		5225.1, .2, .3; 5243.1, .2, .3; 5246.1, .2, .3
323 Floating Equipment		402		
326 Work Equipment-Repairs	4180, 4280, 4380	405	610, 660 Repairs of Vehicles & Other Work Equip.	5225.9, 5325.9, 5328.2, 5246.9, 5346.9, 5349
328 Miscellaneous Equip.- Repairs	4180, 4280, 4380			5225.9, 5325.9, 5328.2
329 Dismantling Retired Equipment				5246.9, 5346.9, 5349
330 Retirements-Equipment			614, 664	
331 Equipment-Depreciation	5021 Depr.-Line Haul Equip. 5025 Depr.-Pickup & Del. Equip. 5030 Depr. of Service Cars & Equip.	411	613, 663	7075.1, .2, .3, .4, .5 Depr. Flight Equip. 7075.8, 7075.9
332 Injuries to Persons	4530 4560 Fire, Theft & Collision 4570 Other Insurance Expenses	476, 477	634, 684 638, 688	5355.1, 5355.2, 5358

RAILROADS Account Number Title	MOTOR FREIGHT CARRIERS Account Number Title	INLAND & COASTAL WATERWAYS Account Number Title	OIL PIPE LINES Account Number Title	AIR CARRIERS Account Number Title
II. Maintenance of Equipment (Cont'd.)				
333 Insurance	4530, 4560, 4570	476, 477	634, 684, 638, 688	5355.1, 5355.2, 5358
334 Stationary & Printing			637, 687	5350
335 Other Expenses		407 Shop Expenses 408 Other Maintenance Expenses	609, 659 Repairs of Office Furniture & Equip. 611, 661 Repairs of Other Property 612, 662 Other Expenses	5353, 5354, 5371
336 Joint Maint. of Equip. (Dr)	4191			5243.7 Aircraft Interchange Charges-Outside 5243.8 General Interchange Service Charges - Outside 5243.9 Other Services - Outside
337 Joint Maint. of Equip. (Cr)	4196			
III. Traffic				
351 Superintendence [6/]	4410 Supervision	456 Supervision		6521, 6621, General Management Personnel [6/]
352 Outside Agencies	4360 Commission Agents	432 Agency Fees & Commissions 457 Outside Traffic Agencies		6539.1 Traffic Commissions - Passenger 6539.2 Traffic Commissions - Property 6533 Traffic Solicitors 6526.1 General Aircraft & Traffic Handling Personnel 6526.3 Passenger Handling Personnel 6526.4 Cargo Handling Personnel
353 Advertising	4430 Tariffs and Schedules 4450 Advertising	458 Advertising		6559, 6659 Tariffs, Schedules & Timetables 6660 Advertising 6662 Other Promotional & Publicity Expenses
354 Traffic Associations	4420 Office & Other Expenses			5364, 5564, 6164, 6264, 6364, 6564, 6664, 6864 Memberships

RAILROADS Account Number / Title	MOTOR FREIGHT CARRIERS Account Number / Title	INLAND & COASTAL WATERWAYS Account Number / Title	OIL PIPE LINES Account Number / Title	AIR CARRIERS Account Number / Title
III. Traffic (Cont'd.)				
355 Fast Freight Lines				
356 Industrial & Immigration Bureaus				
357 Insurance	4560, 4570	477		
358 Stationary and Printing	4420, 4430			6550, 6650 Stationary, Printing & Office Supplies 6559, 6659
359 Other Expenses	4480 Other Traffic Expenses	459 Other Traffic Expenses		6553, 6653 Other Supplies 6571, 6671 Other Expenses
IV. Transportation--Rail Line				
371 Superintendence [6/]	4210 Supervision 4311 Supervisory Salaries	421, 441 Supervision	621, 671 Superintendence	5521, 6121, 6221, 6321 General Management Personnel [6/]
372 Dispatching Trains	4210		Accounts listed immediately below are comparable in a general way to railroad <u>accounts No. 372-389, 392-402</u>	6126.2 Aircraft Control Personnel
373 Station Employees	4312 Salaries & Fees - Billing and Collecting 4313 Other Office Employees 4340 Salaries & Wages--Platform Employees 4350 Other Terminal Employees	442 Agents 443 Stevedoring	622, 672 Operation of Pipeline 623, 673 Operation of Pumping Stations 624, 674 Operation of Oil Tanks 625, 675 Operation of Delivery Facilities	6126.1 Aircraft Control Personnel 6126.1, 6226.1, General Aircraft & Traffic Handling Personnel 6226.3 Passenger Handling Personnel 6226.4 Cargo Handling Personnel
374 Weighing, Inspection, Demurrage Bureaus				
375 Coal & Ore Wharves				
376 Station Supplies & Expenses		431 Port Expenses 445 Light, Heat, Power & Water 450 Other Terminal Operations		5338, 5538, 6138, 6238, 6338, 6538, 6638, 6838 Light,Heat, Power & Water
377 Yardmasters & Yard Clerks				
378 Yard Conductors & Brakemen	4235 Drivers & Helpers -- Pickup & Delivery			
379 Yard Switch & Signal Tenders				
380 Yard Enginemen	4235			
382 Yard Switching Fuel	4255 Fuel--Pickup & Delivery 4265 Oil--Pickup & Delivery			

RAILROADS Account Number	RAILROADS Title	MOTOR FREIGHT CARRIERS Account Number	MOTOR FREIGHT CARRIERS Title	INLAND & COASTAL WATERWAYS Account Number	INLAND & COASTAL WATERWAYS Title	OIL PIPE LINES Account Number	OIL PIPE LINES Title	AIR CARRIERS Account Number	AIR CARRIERS Title
IV.	Transportation--Rail Line (Cont.)								
383	Yard Switching Power Produced								
384	Yard Switching Power Purchased								
385	Water for Yard Locomotives								
386	Lubricants for Yard Locomotives	4265							
387	Other Supplies for Yard Locomotives								
388	Engine House Expenses--Yard								
389	Yard Supplies & Expenses								
390	Operating Joint Yards & Terminals (Dr)	4391	Joint Terminal Facilities (Dr)					5543.8, 6143.8, 6243.8, 6343.8	General Interchange Service Charges--Outside
								5343.9, 5543.9, 6143.9, 6243.9, 6343.9	Other Services--Outside
391	Operating Joint Yards & Terminals (Cr)	4396	Joint Terminal Facilities (Cr)						
392	Train Enginemen	4231	Drivers & Helpers--Line Haul	422	Wages of Crews			5123	Pilots & Copilots
394	Train Fuel	4251	Fuel--Line Haul Equip.	423	Fuel			5124	Other Flight Personnel
		4261	Oil--Line Haul Equip.					5145.1	Aircraft Fuels
395	Train Power Produced							5145.2	Aircraft Oils
396	Train Power Purchased								
397	Water for Locomotives			424	Lubricants & Water				
398	Lubricants for Train Locomotives	4261		424				5145.2	
399	Other Supplies for Train Locomotives								
400	Enginehouse Expenses-Train								
401	Trainmen	4231		422					
402	Train Supplies and Expenses			426	Stores, Supplies & Equipment			5524	Other Flight Personnel
								5153, 5553	Other Supplies
								5554	Inventory Adjustment
								5171, 5571	Other Expenses
403	Operating Sleeping Cars								
404	Signal & Interlocker Operation								
405	Crossing Protection								
406	Drawbridge Operation								

APPENDIX Q
(Cont'd.)

RAILROADS		MOTOR FREIGHT CARRIERS		INLAND & COASTAL WATERWAYS		OIL PIPE LINES		AIR CARRIERS	
Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title
IV.	Transportation--Rail Line (Cont'd.)								
407	Communications System Operation					626, 676	Operations of Communications System	5330, 5530, 6130, 6230, 6330 6530, 6630, 6830	Communications Personnel
								5337, 5537, 6137, 6237, 6337, 6537, 6637, 6837	Communications Purchased
408	Operating Floating Equip.			447	Tug Operations				
				448	Operation of Highway Vehicles				
410	Stationery & Printing			446	Stationery & Printing	637, 687		5550, 6150, 6250, 6350	Stationary, Printing and Office Supplies
411	Other Expenses			428	Other Vessel Expenses	628, 678	Other Expenses	6153, 6253, 6353	Other Supplies
412	Operating Joint Tracks & Facilities (Dr)							6171, 6271, 6371	Other Expenses
413	Operating Joint Tracks & Facilities (Cr)								
414	Insurance	4530, 4560, 4570		473	Hull Insurance & Damage	634, 684, 638, 688		5155.1	Insurance Purchased, PL&PD
				475	Liability Insurance & Losses--Marine Operations			5155.2	Provisions for Self Insurance, PL&PD
				477				5158	Injuries, Loss & Damage
415	Clearing Wrecks								
416	Damage to Property	4530		475		636, 686	Damage to Property	5155.1, 5155.2, 5158	
417	Damage to Livestock on Right of Way								
418	Loss & Damage--Freight	4550	Cargo--Loss & Damage	474	Cargo Insurance, Loss & Damage	627, 677 639, 689	Oil Shortage Casualty Losses	5556, 6256	Insurance--Traffic Liability
419	Loss & Damage--Baggage	4550		472	Baggage Insurance & Losses			5556, 6256	
420	Injuries to Persons			475				5556, 6256	
VI.	Miscellaneous Operations								
441	Dining & Buffet Service			421, 422, 426				5551	Passenger Food Expense
				425	Food Supplies			5553, 5554, 5571	
				427	Buffet Supplies				
442	Hotels & Restaurants								
443	Grain Elevators								
445	Producing Power Sold								

RAILROADS		MOTOR FREIGHT CARRIERS		INLAND & COASTAL WATERWAYS		OIL PIPE LINES		AIR CARRIERS	
Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title
VI.	Miscellaneous Operations (Cont'd.)								
446	Other Miscellaneous Operations								
447	Operating Joint Miscellaneous Facilities (Dr)								
448	Operating Joint Miscellaneous Facilities (Cr)								
VII.	General								
451	Salaries & Expenses of General Officers	4510 4611	Supervision (Insurance) Salaries--General Officers	461	General Officers & Clerks	631, 681	General Office Salaries	6821	General Management Personnel 6/
		4621	Expenses of General Officers	471	Supervision(insurance)				
452	Salaries & Expenses of Clerks & Attendants	4612 4613	Salaries--Revenue Accounting Salaries-Other General Office Employees	461		631, 681 632, 682	 General Office Supplies & Expenses	5331, 5531, 6131, 6231, 6331, 6531, 6631, 6831,	Record Keeping and Statistical Personnel
		4622							
453	General Office Supplies & Expenses	4623	Other General Office Expenses	462	General Office Supplies & Expenses	632, 682			
454	Law Expenses	4580 4630	Other Insurance & Safety Department Expenses Law Expenses	463	Law Expenses	633, 683	Law Expenses	6832 6840	Lawyers & Law Clerks Legal Fees & Expenses
455	Insurance	4560, 4570		476, 477		634, 684, 638, 688		6855.1	Insurance Purchased, PL&PD
								6855.2	Provisions for Self Insurance, PL&PD
								5558, 6158, 6258, 6358, 6588 6658, 6858	Injuries, Loss & Damage
456	Relief Department Expenses	4145, 4245, 4345, 4445, 4545 4645	 Employees' Welfare Expenses	465	Pensions & Relief	635, 685	Relief & Pensions		
457	Pensions & Gratuities	4145, 4245, 4345, 4445, 4545, 4645		465		635, 685		5357, 5557, 6157, 6257, 6357, 6557, 6657, 6857	Insurance--Employee Welfare
458	Stationery & Printing			466	Stationery & Printing			6850	Stationery, Printing & Office Supplies
459	Valuation Expenses								
460	Other Expenses	4680	Other General Expenses	467	Other Expenses	641, 691	Other Expenses	6853 6871	Other Supplies Other Expenses

RAILROADS		MOTOR FREIGHT CARRIERS		INLAND & COASTAL WATERWAYS		OIL PIPE LINES		AIR CARRIERS	
Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title
VII.	General (Cont'd.)								
461	General Joint Facilities (Dr)	4691	Joint Operating Expenses (Cr)					6543.8, 6643.8, 6843.8	General Interchange Service Charges--Outside
462	General Joint Facilities (Cr)	4696	Joint Operating Expenses (Cr)					6543.9, 6643.9, 6843.9	Other Services--Outside
Other Than Railway Operating Expenses									
532	Railway Tax Accruals U.S. Old Age Retirement	5240	U.S. Social Security Taxes	485	U.S. Payroll Taxes	412	Pipe line Taxes U.S. Old Age Retirement	5168, 5368, 5568, 6168, 6268, 6368, 6568, 6668, 6868	Taxes--Payroll
	U.S. Unemployment Insurance	5240		485			U.S. Unemployment Insurance	5168, 5368, 5568, 6168, 6268, 6368, 6568, 6668, 6868	
	U.S. All Other Taxes	5250	U.S. Other Taxes	486	U.S. Waterline Tax Accruals		U.S. Transportation Tax Paid by Respondents U.S. Other Taxes	5169, 6869	Taxes–Other than Payroll
	Other than U.S. Government Taxes	5230	Real & Personal Property Taxes	485	Payroll Taxes		Other than U.S. Government Taxes	5169, 6869	
				486	Waterline Tax Accruals				
		5240	Social Security Taxes	532	State & Local Income Taxes				
		5250	Other Taxes						
		8800	State Income Taxes						
		8800	Other Income Taxes						
	Rents Payable	Purchased Transportation							
536	Hire of Freight Cars 8/	4271	Equipment Rents--Intercity-with Drivers	481	Charter Rents--Transportation Property			5144.1	Rentals (Aircraft) 9/
		4272	Equipment Rents--Intercity-without Drivers					5143.7	Aircraft Interchange Charges--Outside
		4273	Other Purchased Transportation--Intercity (1) Payments to Motor Carriers and Others (2) Payments to Railroads & Water Carriers						
		4275	Equipment Rents--Pickup & Delivery--with Drivers						
		4276	Equipment Rents--Pickup & Delivery--without Drivers						
		4277	Other Purchased Pickup & Delivery (1) Payments to Motor Carriers & Others (2) Allowances to Shippers						

APPENDIX Q
(Cont'd.)

RAILROADS Account Number	RAILROADS Title	MOTOR FREIGHT CARRIERS Account Number	MOTOR FREIGHT CARRIERS Title	INLAND & COASTAL WATERWAYS Account Number	INLAND & COASTAL WATERWAYS Title	OIL PIPE LINES Account Number	OIL PIPE LINES Title	AIR CARRIERS Account Number	AIR CARRIERS Title
	Other Than Railway Operating Expenses (Cont'd.)								
	Rents Payable (Cont'd.)								
537	Rent for Locomotives [8/]	4271, 4272, 4273 4275, 4276, 4277		481				5144.1, [9/] 5143.7	
538	Passenger Train Car Rentals [8/]	4271, 4272, 4273, 4275, 4276, 4277						5144.1, 5143.7	
539	Rent for Floating Equip.			481				5344.1, 5544.1, 6144.1, 6244.1,	
540	Rent for Work Equip.							6344.1, 6544.1, 6644.1, 6844.1,	Rentals[9/]
	Operating Expenses, Rents, and Taxes, Incomparable to Rail Due to Absence of Specific Rail Accounts or Inherent Nature of Other Forms								
		4185, 4285, 4385, 4485, 4585, 4685	Operating Rents [10/]	483	Other Operating Rents [11/]	640, 690	Operating Rents [12/]	5344.1, 5544.1, 6144.1, 6244.1, 6344.1, 6544.1, 6644.1, 6844.1 [9/]	
		4675	Purchasing & Store Expenses					5334, 5834	Purchasing Personnel
		4120, 4220, 4320, 4520	Office and Other Expenses					5335, 5535, 6135, 6235, 6335, 6535, 6635, 6835	Other Personnel
								5136, 5336, 5536, 6136, 6236, 6336, 6536, 6636, 6836	Personnel Expenses
								5128.1, 5328.1, 5528.1, 6128.1, 6228.1, 6328.1, 6528.1, 6628.1, 6828.1	Trainees & Instructions
		4650	Management & Supervision Fees	464	Management Commissions			5141, 5341, 6141, 6241, 6341, 6541, 6641, 6841	Professional & Technical Fees & Expenses
		4635	Outside Auditing Expense						
		4660	Uncollectible Revenues					6866	Uncollectible Accounts
								5563	Interrupted Trips Expense
		4670	Regulatory Expenses					6865	Corporate & Fiscal Expenses
								6167, 6267	Clearance, Customs & Duties
								5272.1	Maintenance Reserve-Airframe
								5272.2	Maintenance Reserve-Aircraft Engines
		5151	Amortization of Carrier Operating Property			615, 665	Amortization Adjustments	7074.1	Developmental & Pre-Operating Expenses
		5155	Extraordinary Property Losses					7074.2	Other Intangibles
								7073	Expendable Parts Obsolescence Provisions

RAILROADS		MOTOR FREIGHT CARRIERS		INLAND & COASTAL WATERWAYS		OIL PIPE LINES		AIR CARRIERS	
Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title	Account Number	Title
Operating Expenses, Rents, and Taxes, Incomparable to Rail Due to Absence of Specific Rail Accounts or Inherent Nature of Other Forms (Cont.)									
		5210	Gasoline, Other Fuel and Oil Taxes 13/					6144.2	Landing Fees 13/
		5220	Vehicle License & Registration Fees 13/						
				429	Outside Towing Expenses				
				430	Wharfage & Dockage				
				433	Lay-up Expenses				
				444	Precooling & Cold Storage Operation				
				449	Local transfers				
				406	Repairs of Highway Equip.				
				491	Motor Carrier Expenses				
								5377.8, 5577.8, 6177.8, 6277.8, 6377.8, 6577.8, 6677.8, 6877.8	Uncleared Interchange Expense Credits
								5377.9, 5577.9, 6177.9, 6277.9, 6377.9, 6577.9, 6677.9, 6877.9	Other Uncleared Interchange Expense credits
									General Services Purchased--Associated Companies
								5242.1	Airframe Repairs
								5242.2	Aircraft Engine Repairs
								5242.3	Other Flight Equip. Repairs
								5142.7, 5242.7	Aircraft Interchange Charges
								5242.8, 5542.8, 6142.8, 6242.8, 6342.8, 6542.8, 6642.8, 6842.8	General Interchange Service Charges
								5242.9, 5342.9, 5542.9, 6142.9, 6242.9, 6342.9, 6542.9, 6642.9, 6842.9	Other Services

APPENDIX Q
(NOTES)

1/ Excluding Federal Income Tax.
2/ Title is given only at initial listing; thereafter number only.
3/ First two digits reflect functional account assignment, viz., 41, Equipment Maintenance; 42, Transportation; 43, Terminal; 44, Traffic; 45, Insurance and Safety; 46, Administrative and General.
4/ Two final digits reflect account assignment to gathering and trunkline expense, respectively. When these are below 50, expense relates to former; above 50 to latter.
5/ First two digits reflect functional account assignment, viz., 51, Flying Operations; 52, Direct Maintenance; 53, Maintenance Burden; 55, Passenger Service; 61, Aircraft Servicing; 62, Traffic Servicing; 63, Servicing Administration; 65, Reservations and Sales; 66, Advertising and Publicity; 68, General and Administrative; 70, Depreciation. Final two digits reflect 47 different objective classes of expense.
6/ Wide intermoded differences in nature of items charged, e.g., airlines accounts are limited to compensation of general officers, supervisors and immediate assistants, whereas rail accounts include this and pay of clerks and attendants, office supplies and expenses, office rents, etc.
7/ Reported expense subdivided among (a) yard switching; (b) way switching; and (c) running tracks.
8/ Reported expense subdivided among (a) mileage; (b) per diem; and (c) other basis.
9/ Air objective accounts 44.1 include rents for property and equipment; rail property rentals included in (a) miscellaneous functional accounts for minor items; and (b) in account 542 - Rent for Leased Roads and Equipiment (not shown, as construed as a "fixed charge."
10/ Includes rents on real and personal property excluding revenue equipment charged to various Purchased Transportation accounts.
11/ Includes rents for land, structures and equipment, excluding amounts charged to Account 481.
12/ Includes land and equipment rentals to some extent comparable with Rail Account 542 (see footnote 9).
13/ Incomparable to rail tax accounts, since substantially equivalent to user charges for government furnished facilities.

Source: Uniform System of Accounts for Pipeline Companies, I.C.C., issue of 1952; Uniform System of Accounts for Class I and Class II Common and Contract Motor Carriers of Property, I.C.C., issue of 1958; Uniform System of Accounts for Railroad Companies Prescribed by the Interstate Commerce Commission, Association of American Railroads, 1947, as amended through 1958; Uniform System of Accounts for Carriers by Inland and Coastal Waterways, working copy including all changes effective on or before January 1, 1959, I.C.C., December 1958; Uniform System of Accounts and Reports for Air Carriers, Civil Aeronautics Board, issue of 1957.

APPENDIX R

MATHEMATICAL MODEL FOR MULTIPLE CORRELATION

Suppose we have given N sets of corresponding values of n variables x_1, x_2, ..., x_n. Now separate the values of x_1 into classes by selecting class intervals dx_2, dx_3, ..., dx_n of the remaining variables.

The locus of means of such arrays of x_1's in the theoretical distribution, as dx_2, ... dx_n approach zero is called the regression surface of x_1 on the remaining variables. We now assume, for convenience, that any variable, x_j, is measured from its arithmetic mean as origin. Let o_j its standard deviation and let r_{pq} be the correlation coefficient of the n pairs of values of x_p and x_q. We now seek to find b_{12}, b_{13}, ..., b_{1n} of the linear regression surface

$$x_1 = b_{12}x_2 + b_{13}x_3 + \dots + b_{1n}x_n + c$$

of x_1 on the remaining variables so that x_1 computed from the regression equation given above will give the best estimates in the sense of least squares of the values of x_1 that correspond to any assigned values of x_2, ..., x_n. It follows that

$$x_1 = -\sigma_1 \sum_{2}^{n} q \frac{R_{1q}}{R_{11}} \frac{x_q}{\sigma_q}$$

where R =

$$\begin{vmatrix} r_{11}, & r_{12}, & \dots, & r_{1n} \\ r_{21}, & r_{22}, & \dots, & r_{2n} \\ \vdots & \vdots & & \\ \vdots & \vdots & & \\ r_{n1}, & r_{n2}, & \dots, & r_{nn} \end{vmatrix}$$

and R_{pq} is the cofactor of the pth row and qth column of R.

If the dispersion (scatter) $\sigma_{1\cdot 23\dots n}$ of the <u>observed</u> values of x_1 from the computed values is <u>defined</u> as

$$\sigma^2_{1\cdot 23\dots n} = \frac{1}{n} \sum (\text{observed } x_1 - \text{computed } x_1)^2$$

then it can be proved that

$$\sigma^2_{1\cdot 23\cdots n} - \sigma_1^2\left(\frac{R}{R_{11}}\right)$$

We are next interested in the dispersion of the estimated values given by the above regression equation. Since the arithmetic mean value of the estimates is zero, when the origin is at the mean of each system of variates, it can be shown that

$$\sigma^2_{1E} = \sigma^2_1\left(1 - \frac{R}{R_{11}}\right)$$

The square of the multiple correlation coefficient $r_{1.23...n}$ of order (n – 1) of x_1 with the other n - 1 variable is given by

$$r^2_{1\cdot 23\cdots n} = 1 - \left(\frac{R}{R_{11}}\right)$$

The square of the multiple correlation coefficient means the percent of total variability in the dependent variable that is explained by the independent variables and the law of relationship connecting the independent with the dependent variables. The r’s in the correlation matrix are the respective simple correlation coefficients between the variables when considered on their own in pairs. This assumes normalcy of the distributions and linearity in pairs, triads, etc., of the variables, relations which may not have been completely proved in applications thus far made in transport cost analysis. Expanding the regression equation as above given, we obtain for 4 variables

$$X_1 = \sigma_1\left[\frac{R_{12}x_2}{R_{11}\sigma_2} + \frac{R_{13}x_3}{R_{11}\sigma_3} + \frac{R_{14}x_4}{R_{11}\sigma_4} + \frac{R_{15}x_5}{R_{11}\sigma_5}\right]$$

When the regression equation is written in original units one would obtain a result like that given at page 277 of Meyer, et al. “Economics of Competition in the Transportation industries,” for Maintenance of Way and Structure Expenses for Class I railroads with over 3000 miles of total trackage (excluding the Pennsylvania and N.Y. Central) namely

$$E_w = 3{,}540{,}801 + \underset{(372)}{714}\, S_t + \underset{(.000069)}{0.000284}\, Q_f + \underset{(.000415)}{0.000772}\, Q_p$$

where w = maintenance of way expenses
t = track mileage
f = gross ton miles of freight traffic
p = gross ton miles of passenger business

In the above equation, 3,540,801 is a constant; 714 is dollars per unit of S, the size measure; 0.000284 is dollars per unit of Q_f, 0.000772 is dollars per unit of Q_p, the traffic variables.

APPENDIX S

COMPUTERS AND TRANSPORT COST ANALYSIS

1. The Attributes of Computers

An electronic computer has the following important characteristics:

(a) It can do all the work of a clerk except thinking. That is, it can read, write, distribute numbers and follow instructions.

(b) It is fast. The limitations on the speed of a computer are (i) the speed of light and (ii) the mechanical parts it needs in order to operate. Computer speed varies in the relation to the number of its mechanical parts. With no mechanical parts (such situations can exist), and assuming a mile of impulse is required to multiply two numbers, a computer would multiply 186,000 sets of numbers a second.

(c) It is accurate. A computer never “sees” anything non-existent. It never does anything in violation of instructions. It has, however, two limitations: the people who operate it can make mistakes and it is subject to mechanical (not computational) failure. Such failure is of little or no consequence, since the machine almost invariably advises its operator when this occurs. Human error also can be controlled by well-developed checking systems.

(d) Most <u>standardized</u> procedures can be executed very inexpensively once a system (program) has been designed. Where there is little computing to do (e. g., in determining individual compensation) but considerable data to be processed, computers may cost more than other office machines. But if the procedure entails data summarizing, than a computer is by far the cheapest method. For example, with a small computer, at a cost of from one to two hundred dollars, the compensation of 2000 people can be determined and summarized by several hundred different groupings or departments, all in one hour's time.

Offsetting these advantages are two serious, but by no means insoluble, problems. One is the training and availability of personnel to both handle the computer and understand its computations. The other relates to bridging the gap between basic handwritten or typed information, and data in the form (cards or tape) which the computer can use.

In the early stages of computer development one of the major problems was that the machines would unquestioningly use whatever information was supplied. Today good programing staffs are experts at editing the data furnished. This replaces the judgment that a clerk exercises as he processes data. As an illustration, assume that the cost of light bulbs is one of the pieces of information the machine is going to be given. If the figure is 65 cents, a clerk using it might inadvertently substitute $ 65. To avoid error of this type, the expert programmar will instruct the machine: "Do not accept a cost of more than $ 2.00", which permits the machine to accept all reasonable light bulb costs, and reject those obviously in error. The computer will thenceforth accept no light bulb cost exceeding $ 2.00. If such a cost is reflected on the cards or tape furnished to the computer, the machine will reject it. If worth the cost, systems can be developed so that the machine will edit the data almost to perfection. Meticulous editing is expensive when accomplished by personnel, but much less so when built into a program for gathering, summarizing and analyzing data.

For these reasons the quality of reports rendered by computers may unqualifiedly be considered the highest the world has yet known, and, on a unit basis, the least expensive. But their use is justified only if (a) there is a considerable amount of work to do and (b) the data processed are to be used in many different ways. These two conditions are met by much transport cost analysis.

2. How Computer Attributes Lend Themselves To Transportation Cost Analysis

Two criteria have generally controlled the reports regulatory agencies have required of carriers. First, these have been tailored to the information needed by the agency to perform its duty under the law, and second, their development has been shaped so as not to be unduly burdensome upon the carriers. Regulatory agencies have avoided requiring carriers to keep cost accounting systems because of the cost of maintaining such systems. Notwithstanding this, some carriers could and do maintain cost accounting systems fairly inexpensively, making increasing use of computers with the passage of time. This increasing use of computers, both for cost accounting and for other purposes, suggests that it may be timely for the regulatory bodies to review the data reasonably required for proper discharge of their rate-making responsibilities. What may have been burdensome in an era of manual data processing is no longer so in an electronic age. This is particularly true since computers not only have the technical advantages noted in Section 1 of this Appendix, but they also have the advantage of being readily available. In the past, the cost of assembling and processing much information has properly caused regulatory hesitation in ordering data compilations. An example is the proposed motor freight waybill analysis which was never implemented, evidently due to the cost burden it would have imposed. In the modern business world such considerations are less valid; computer use is no longer restricted to large firms. Private firms throughout the country now specialize in the business of data processing for firms with requirements too small to justify the acquisition of machines. These data processing enterprises usually have staffs which deal with each client's problem and actually do the work. Furthermore, there are plans in process to make available anywhere in the country, equipment rentable for short periods for operation by renter's personnel. If the necessary data processing programs were to be developed by the regulatory agencies or by each mode's national organization, this would vitiate objections to compliance by all carriers with regulatory orders for data, as optimum discharge of regulatory responsibility may require. Furthermore, the possibility exists, and certainly merits exploration, that computer manufacturers may be persuaded to absorb programming costs where data requirements are standardized and of broad application.

From time to time regulatory agencies have found it necessary to facilitate their cost analyses by ordering special studies to be made, such as the railroad station clerical study, and the 7-day study of rail empty return ratios and train characteristics. If the data processing involved in regular reporting were already being handled by computers, special studies of this type could be ordered with very little expense cast upon the carriers. If regulatory bodies were to have designed computer programs to process regular reports, then they could also develop the program by which special reports could be produced as needed. Conceivably, in the absence of support from computer manufacturers, they might even be authorized to spread the cost of programming among the carriers to which it pertained. If a (rather large) special study program cost $ 100,000 and the cost were to be spread among the Class I rail carriers, the cost per carrier would average out to less than $ 1,000 which is far less than the carriers have spent in the past to develop analogous data by manual methods.

It is also possible that some studies useful for improved cost analyses have not been made by the regulatory agencies due to inevitable time lags in obtaining the data, which often render them outmoded when received. If computers were to be widely employed, time dimensions in data collection could be radically reduced.

The net of these considerations is that the formerly unreasonable or unattainable is no longer so today. If the way to improved precision if an approach to better cost answers - lies in examination of great masses of data, this is now feasible, and in fact has been undertaken already in certain limited situations, as shown immediately below.

3. Computer Use for Costing in Recent ICC Proceedings

In at least two proceedings before the ICC, namely Dockets Nos. 31503 and 31711, the Transcontinental Divisions Cases and Fresh Vegetables from Texas, California, Arizona and New Mexico, respectively, electronic data processing has been extensively used for more effective cost development, 1/ following generally but attaining greater precision than is possible from the procedures provided in “Rail Form A”. Cost application utilizing the computer techniques employed in Exhibit No. T-632 of Docket 31503 will be used as illustrative of the method followed.

1/ Docket 31503, Exhibits T-314, T-315 and T-632. Docket 31711, Exhibits A-125 through A-132; A-142; A-147-49.

APPENDIX S

The basic data for cost development in this and related exhibits were: (1) waybills and interline abstracts for traffic information; (2) special studies of (a) the cost of particular production functions and (b) general railroad characteristics; (3) the annual reports of carriers to the ICC; (4) "Rail Form A", with adjustments; and (5) much other pertinent operating experience of record and capable of being ascertained.

The basic problem involved association of the traffic with operations pertinent to its handling or carriage. 2/ This required four major steps: first, selection of sample traffic to be costed; second, isolation of movement routes and facility useage by each traffic; third, development of actually pertinent unit costs; and fourth, the application of such unit costs to the traffic. The entire activity was motivated by a desire to refine costs associated with particular (i.e., Transcontinental) traffic, by contrast with the average costs applicable to an entire group of railroads produced by conventional useage of "Rail Form A".

After sample selection, a careful examination of waybill and abstracts developed the route, mileage, train type and special handlings required by each car for which costs were to be developed. Such specific data as

(a) origin and destination switching
(b) intermediate and interchange switching
(c) floating
(d) transloading
(e) special mileage rates
(f) platforming
(g) feeding, watering and resting livestock

were ascertained for each car, as its precise route was traced from origin to destination.

2/ Operations is used here to cover:
(1) The type of train that handled the traffic.
(2) The mileage of the train and the car, if the latter did not move the full distance.
(3) The diesel units necessary to move the train.
(4) The gallons of fuel necessary.
(5) The weight of the train.
(6) The switching required to handle the car.
a) At origin or destination, b) At interchange points,
c) At intermediate points, and for each the extent of switching.
(7) Special and unusual operations:
a) Floating b) Feed, water and rest for livestock.
c) Special mileage-car rates d) Platforming.
(8) The segment of lines over which the train operated.

Having traced the traffic, the next step was cost development for each operation. To the extent possible this was done within the framework of “Rail Form A,” but often the function to be costed was not isolated by that method. For each such missing function, special studies were made. For example, costs associated merely with livestock traffic are not treated by “Rail Form A,” but the formula does develop a cost per switch-engine-minute. In Exhibit T-632, the average switching minutes for spotting livestock cars at pens were developed by a special study, and multiplied by the “Rail Form A” cost per switch-engine-minute.

The development of train costs is indicative of the refinements made possible through extensive computer use. Whereas “Rail Form A” facilitates the development of average, way and through train costs, the Transcontinental lines by contrast computed a different train cost for every segment of line where profile characteristics could be determined. Although average train weights were assumed, diesel units and fuel consumption were explicitly related to traffic and costed accordingly. As a result, it was possible to isolate about 20 unit costs associated with the movement of a given carload, by comparison with the six used by “Rail Form A.” [3/]

These unit costs were then related to previously developed traffic and operating data, and the costs separately computed for Mountain-Pacific, Midwestern and Eastern railroad handling. In a previous manual application of unit costs to traffic which occured at an earlier stage in the same proceeding, 15 comptometer operators were required for a four month period. The same task took a small computer one day (if a large computer had been used the time requirement would have been reduced to one or two hours.)

By this description it is not meant to suggest or imply that costing efforts of this magnitude are likely to occur in a typical regulatory proceeding. The very abbreviated description is provided only to illustrate that greater precision is attainable with modern methods. However, once suitable techniques have been evolved and appropriate programs designed, data assembly and computation may become relatively inexpensive, and within the realm of reasonableness for routine application, particularly if the data required are among those which alert managements are using for internal analyses.

4. A Program for the Future

Now in use by the military are so-called intelligent sensing devices which scan basic records electronically, and automatically cut cards or tape suitable for computer use, thereby eliminating a manual operation (card punching) that has been a costly bottleneck in computer use. When commercial applications of these machines are developed (and this may well be soon) the conversion of data onto cards

3/ (1) car-mile cost way trains, (2) car-mile cost thru trains, (3) net ton-mile way train, (4) net ton-mile thru trains, (5) cost per car and (6) cost per ton.

or tapes will become a very rapid and inexpensive process. It is entirely within the realm of possibility that in 10 or 20 years (given early and widespread use of computers by the transportation industries) the president of the typical transport firm can have the entire business of the previous day completely summarized on his desk when he gets to work in the morning. Before such a picture is realized, however, there must be much more imaginative understanding of computer potentials than has heretofore been evident by either carrier management or regulatory personnel. They will have to acquire knowledge of the wide variety of useful purposes which computers serve, of which costing is but one.

It should be emphasized that the rail cost analysis summarized in Section 3 of this Appendix is merely illustrative. The same intense analysis can be used through computers to improve measurement of traffic costs by all types of carriers, especially if the firm is already using computers for its accounting and statistical summaries, as many are.

Costing is simply a specialized way of integrating the data which describes what a carrier does. If all of this data is in a form that can be used by a computer, it is then only a matter of program availability before the computer will produce the cost information at little extra expense.

The expense of developing a program for cost ascertainment would not be excessive for a typical air, barge, bus, pipeline, or motor carrier, particularly if this were done jointly to meet a common objective, such as regulatory requirements. For large rail carriers the design of such a system could run into millions of dollars. In each of these modes the cost of the design of the system would be the larger expense. Once such a program is written however, the cost of routine use may well be less than now spent for similar ends. Since data in a form that can be used by a computer lends itself inexpensively to additional analysis, a regulatory agency can, given widespread computer use, request additional data from carriers without adding greatly to cost. This then becomes a matter of setting up regular reporting regulations so that valuable additional information can be inexpensively produced.

Since the reports to regulatory bodies are standard, and much of the data handling is already done by punch cards, a program that cost several million dollars may not be an expensive item to those using it. If such a program were to be developed, say for Class I motor carriers of general freight, and it cost $ 10,000,000, an individual firm, assuming participation by the largest 200 companies, would bear a $ 50,000 burden, assuming only one year's use. But such a program, properly developed, ought to satisfy requisite needs, with minor modifications, for at least 10 years, in which case it would cost only $ 5,000 per year. The point is that if the carriers cooperate in the basic programming its cost will not be excessive and they would have large savings from the investment. Some efforts toward this type of cooperation have already been made, and they need encouragement.

Joint development of a cost ascertainment computer program, suitable for use by many carriers, would be a large undertaking, but problems of greater magnitude than this have been resolved. It is timely to explore the financial, legal and administrative requirements for such a project.

APPENDIX T

ROADWAY MAINTENANCE

ESTIMATED ANNUAL AVERAGE COST PER MILE

FOR TYPICAL SECTIONS OF LINE

Combined High Speed Passenger, and Freight Service

Item	Quantity		Price	Cost	Service Life	Cost Per Year	
Rail-131 lb. new	206	tons	$42.00	$8,652	10	$865	
#1 ties	3,168		1.55	4,910	15	327	
Angle Bars	270	pr.	4.30	1,161	10	116	
Tie Plates	6,336		.40	2,534	10	253	
Spikes	44	kegs	5.50	242	15	16	
Bolts	10	kegs	9.30	93	10	9	
Clips	6,336		.15	950	10	95	
Stone Ballast	3,200	cu.yds	1.00	3,200	40	80	
Labor on rail renewals	206	tons	8.00	1,648	10	165	
					Total		1,926
Labor - Basic per Track Mile:							
0.6 men x 260 days x 3.60 x 1 mile				= 562			
Foreman 15% of 562				84			
						646	
Extra Tie tamping - 1 mile	5,280	1.f.	0.22	1,162	3	387	
Misc.						90	
Work Train Service						30	
							1,153
Total Estimated Annual Cost - One Mile of Track							3,079
Less Salvage							
Rail 90% of 206 tons	185	tons	25.00	4,625	10	463	
10% of 206 tons	21	tons	10.00	210	10	21	
Angle Bars 80% of 270 pr.	216	pr.	1.40	302	10	30	
Tie Plates 80% of 6,336	5,069		.25	1,267	10	127	
Total Salvage							641
Net Estimated Annual Cost - One Mile of Track							2,438
							i.e. 2,500

APPENDIX T

ROADWAY MAINTENANCE

ESTIMATED ANNUAL AVERAGE COST PER

FOR TYPICAL SECTIONS OF LINE

Freight Service Only

Item	Quantity	Price	Cost	Service Life	Cost Per Year	
Rail-107 lb. part worn	168 tons	$25.00	$4,200	20	$210	
#2 ties	3,168	1.20	3,801	20	190	
Angle Bars part worn	270 pr.	1.40	378	10	38	
Tie plates part worn	6,336	0.25	1,584	20	79	
Spikes	44 kegs	5.50	242	15	16	
Bolts	10 kegs	9.00	90	20	5	
Anti-creepers	2,000	0.25	500	15	33	
Gravel Ballast	3,200 cu.yds.	0.80	2,560	30	85	
Labor on rail renewals	168 tons	6.00	1,008	20	50	
				Total		706
Labor Basic						
0.40 men x 1 mile x 260 days x 3.60			= 374			
Foreman 15% of 374			56		430	
Extra Labor, tamping, etc.	5,280 l.f.	@0.10	528	3	176	
Work Train Service & Misc.					80	
						686
Total Estimated Annual Maintenance Cost per Mile of Track						1,392
Less Salvage						
Rail 90% of 168 tons 151 tons		25.00	3,775	20	189	
10% of 168 tons 17 tons		10.00	170	20	9	
Angle Bars 80% of 270 pr. 216 pr.		1.40	302	10	30	
Tie Plates 80% of 6,336 5,069		0.25	1,267	20	63	
						291
Net Estimated Annual Cost - One Mile of Track						1,101
					i.e.	1,100

APPENDIX U

NON-TRAFFIC RELATED RAIL OPERATING EXPENSES AND TAXES IN 1950 DOLLARS
CLASS I RAILROADS

Account Number	Item	1950	1951	1952	1953	1954	1955	1956	1957
Traffic									
	Gross Ton-miles	1,854,590,855	1,951,741,628	1,901,863,458	1,872,713,189	1,727,257,442	1,862,154,704	1,891,008,442	1,814,506,355
	Index	100	105	103	101	93	100	102	98
Expense Unrelated to Traffic									
266	Road Property Depreciation[1]	132,168,611	134,600,718	137,337,791	140,815,795	143,359,205	145,941,166	147,096,127	150,841,618
	Index	100	102	104	107	108	110	111	114
305	Shop & Power Plant Depreciation[1]	10,773,035	10,721,599	10,862,369	10,896,082	10,799,564	10,774,256	10,669,465	10,526,545
	Index	100	100	101	101	100	100	99	98
331	Equipment Depreciation[1]	302,355,263	313,923,119	337,472,561	353,149,497	372,407,188	378,236,475	394,775,858	420,130,799
	Index	100	104	112	117	123	125	131	139
265	Miscellaneous Structures	452,156	583,407	504,590	520,338	371,689	441,314	428,080	460,219
	Index	100	129	112	115	82	98	95	102
270	Dismantling Retired Road Property	7,589,165	8,415,621	11,907,123	12,117,763	9,012,123	8,919,312	8,952,905	8,559,132
	Index	100	111	157	160	119	118	118	113
272	Removing Snow, Ice & Sand	26,753,994	28,473,436	20,128,957	12,895,549	13,737,883	16,216,346	17,668,557	13,479,129
	Index	100	106	75	48	51	61	66	50
404	Signals and Interlockers	41,135,064	40,782,976	43,253,102	43,233,433	41,659,643	41,489,679	42,446,766	42,466,526
	Index	100	99	105	105	101	101	103	103
405	Crossing Protection	38,330,992	35,870,654	35,622,926	33,642,780	31,053,634	29,142,798	28,434,281	27,003,275
	Index	100	94	93	88	81	76	74	70
406	Drawbridge Operation	4,341,831	4,365,993	4,656,814	4,691,499	4,591,995	4,551,409	4,629,844	4,715,305
	Index	100	101	107	108	106	105	107	109
	Non-Federal Taxes	328,100,174	314,727,402	329,638,586	333,989,867	324,699,975	340,686,436	337,494,658	337,794,450
	Index	100	96	100	102	99	104	103	103

1/ Depreciation shown in current dollars.

Source: Transportation Statistics of the U.S.;
Statistics of Railways in the U.S.

APPENDIX V

Glossary

1. Cost. In economic terms, a foregoing required to secure an objective, usually measured in money. The expense, both cash and non-cash, required to sustain the operation of a transportation enterprise.

2. Common Cost, also alternative cost, joint cost. Cost incurred by or associated with transport operations involving several services or types of traffic. Examples are railroad maintenance-of-way expense for both freight and passenger service; highway land acquisition for automobiles, buses and trucks; investment in airline ramp equipment used to load both passenger baggage and air cargo.

3. Cost Ascertainment, also cost-finding procedure. The processes involved in first, gathering basic cost information, and second, in analyzing it.

4. Cost Structure. The composition, and sometimes behavior of expenses associated with and inherent in the technology and institutions of each mode of transportation; useful in determining the relative capabilities and economic characteristics of the several transport types.

5. Fixed Cost. Also constant, threshold, indirect, overhead, shut-down, or residual cost. Also "burden."

Fixed Costs have no relationship to volume: they are unaffected by increases or decreases in production. They are incurred by an operation as a whole, can be avoided only by total abandonment, and cannot be traced to particular units of traffic. Fixed costs are the minimum costs incurred when an organization commits itself to existence; interest on investment, supervisory staff, insurance, land, are examples. Since there is no relationship between these minimum establishment costs and the amount of work accomplished, it follows that these costs cannot be meaningfully associated with any specific unit of output.

Fixed costs can be arithmetically unitized, i.e. expressed in amounts per ton-mile, per passenger-mile, per hundredweight, etc. Such a division is only a numerical exercise; it in no way describes either costs that would be added by new business or saved by reduced business.

6. Fully-Distributed Cost also fully-burdened, fully-apportioned cost. These terms can be used only in connection with unit costs, and represent the sum of variable cost per unit plus an arithmetic division of fixed costs per unit. If the magnitude of fixed cost is substantial, the "fully-distributed" cost has little relation to what will be saved or incurred as volume fluctuates. In the special sense used by the Interstate Commerce Commission, "fully-distributed" cost includes railroad out-of-pocket costs plus all remaining revenue needs necessary to cover fixed costs, passenger-train and less-carload operating deficits and return on investment after Federal income taxes.

7. Joint Cost, also by-product cost. This cost is experienced where the production of one article results ex necessitate in the production of another. In transportation the classic example is back-haul or so-called "empty return": in all modes except pipelines the production of transportation service in one direction creates capacity in the reverse direction, since equipment and personnel become available and incur cost in returning to point of origin.

8. Out-of-Pocket Cost. See variable cost. Sometimes used to define that part of variable cost whose behavior is readily measured.

9. Percent Variable. Refers to the relationship between variable and total cost at a given traffic volume. If costs are 90% variable, by definition 10% of cost is fixed.

10. Semi-Variable Cost. This term is sometimes used to describe expenses which respond with less sensitivity to traffic volume fluctuations, i.e., in less than direct proportion, or in stages or steps. Cost of this type has a fixed portion at zero production or traffic volume.

11. Total Cost, also full cost. The grand total of expenses requisite to produce transportation, i. e., the sum of fixed and variable expenses. Usually expressed in aggregate terms, but can be used to derive unit cost at the total expense level.

12. Unit Cost. Expense expressed in terms of output units: car-mile, vehicle-mile, available ton-mile, cars or tons handled. With respect to specific commodities, the expenses associated with the several outputs required to handle the traffic, expressed in cost per hundredwieght (c w t.).

13. Variable Cost, also direct, out-of-pocket, avoidable, escapable, product, assignable, directly assignable, added traffic, marginal, traced, prime, or separable cost. Variable costs include all costs not fixed. They are usually assumed to fluctuate in some relationship to traffic volume, but may be influenced also by other factors. Variable costs include some expense which is difficult to measure, such as wear and tear on highway road surfaces or railroad track structure, but difficulty in measurement is irrelevant to the test of variability which hinges solely upon whether or not the expense level changes.

APPENDIX W

To carry out this assignment in a manner which would ensure that appropriate consideration was given to representative views from all the regulated transportation industries, our own research was supplemented by comments on current cost gathering, processing and analysis, requested of a number of exceptionally well-informed individuals. This exhibit is comprised of a group of the replies received.

SPECTOR MID-STATES

Spector Freight System, Inc.

General Offices
3100 S. Wolcott Avenue
Chicago 8, Illinois

FRontier 6-0330

OCT - 4 1959

September 30, 1959

Mr. R. L. Banks
R. L. Banks & Associates
Transportation Consultants
1001 15th. Street, N. W.
Washington 5, D. C.

Dear Mr. Banks:

This is in reference to your letter of July 30th. Since it was necessary to work with our General Accounting Department to obtain as near as possible the information you are looking for in answer to your letter, unfortunately, it has been delayed passed the point the information would help you. However, it is still submitted for any value it may have.

We have made use of cost ascertainment for all of the items listed. We also use it for equipment utilization and as a guide for equipment replacement.

At the present time, we do not have an electronic computer. However, we do have an active committee studying the application of this type of equipment in our organization. So far, we have been unable to justify the cost of such equipment under our present programs. With such equipment, it is possible that we would be in a position to develop costs for specific commodity movements.

Without the use of some type of data processing equipment or some mechanical means of accumulating, sorting, and tabulating the information required, all such information would create an expensive burden on the carriers. The traffic density of various runs or routes over which the carriers operate would create such a burden referred to above. The data on teminal costs by terminal would be of assistance in rate-making. The same would apply to maintenance, fuel, and wages for various types of equipment operating in various segments of the operation without creating an unreasonable burden.

SPECTOR MID-STATES

SPECTOR FREIGHT SYSTEM, INC

R. L. Banks & Associates September 30, 1959

The idea of cost identification with each operating segment of the Company is not new to us. With the use of mechanical equipment we have developed a system to identify each item of expense by operating function within a location. The system is not profitable for small organizations because of the amount of detail involved. We do believe that the present accounting could be modified to include a better grouping of expense items. In this connection, it might be added that there is a Committee from the National Accounting and Finance Council studying this area now.

Identification of costs for rate-making purposes is one area where the present accounting system leaves much to be desired. It is believed that the Motor Carrier Industry should adopt a system that will answer their management control problems and form the basis for rate determination.

In the event your study was not completed or is still in process and you should desire further information I suggest you contact Mr. Oscar Horvitz, Treasurer, direct for additional information.

Very truly yours,

SPECTOR FREIGHT SYSTEM, INC.

John W Ferguson

John W. Ferguson
Vice President - Transportation

JWF:mjb

WATERWAYS FREIGHT BUREAU
28 E. JACKSON BOULEVARD
CHICAGO 4, ILLINOIS

WESLEY A. ROGERS
CHAIRMAN

HARRISON
7-2068

SEP 17 1959

September 15, 1959

File: A
XC: W

Advice: 674-59

Mr. R. L. Banks
R. L. Banks & Associates
1001 15th Street, N. W.
Washington 5, D.C.

Dear Mr. Banks:

The time limit set for reply to your inquiry of July 31, 1959 necessarily limits our response to general observations, in view of the complex nature of costs and cost finding procedures in transportation. As we advised you, the common-carrier barge line members of this Bureau have been considering your letter and hope that this reply will be of aid to your study.

The American Commercial Barge Line Co., Federal Barge Lines, Inc., and Mississippi Valley Barge Line Company, members of this Bureau, have received separate inquiries from you. This reply is submitted in behalf of all of the members of Waterways Freight Bureau collectively, including the three foregoing carriers to whom individual inquiries were addressed by you.

For clarity of replys the questions raised in your inquiries of the barge lines are stated herein, and followed by our comments on each.

1. "For what purposes do you or your organization use cost ascertainment (Budgetary control, supervisory control, evaluating traffic solicitation, rate negotiation and proceedings, other)?"

    The individual barge lines do use costs to a considerable extent in their daily work in connection with budgetary control, supervisory control, evaluating traffic solicitation, rate negotiation and Interstate Commerce Commission proceedings. The Waterways Freight Bureau has, up to the recent past, been concerned principally with costs of transportation by rail, due to the increasing number of rail rate reductions affecting barge transportation. For this reason, the members of Waterways Freight Bureau have become aware of the increasing need for barge costs, and through the Waterways Freight Bureau Cost and Statistical Committee, are undertaking the development of barge costs on an industry-wide basis with the cooperation of the Cost Finding Section of the Interstate Commerce Commission.

2. "As a general rule, railroad out-of-pocket expenses are considered to be 80 percent of operating expenses, rents and taxes, plus 100 percent of an agreed return on investment in equipment and 50 percent of an agreed return on investment in road property. Motor carrier out-of-pocket costs are generally construed to be at least 90 percent of total operating expense, rents and taxes.
   To what extent, in your judgment, do these rough measures of variability fail adequately to attain a suitable measure of out-of-pocket costs?"

   While the barge carriers and the Waterways Freight Bureau are conversant with the railroad out-of-pocket cost studies, it is impossible within the limited time provided to make a complete analysis of the out-of-pocket percentages developed by the cost-finding section of the Interstate Commerce Commission. Observations must accordingly be of a general nature. However, it is the firm opinion of the barge carriers that all operating expenses, rents, and taxes must be included in determining a cost basis. They do not agree with the 80% factor, nor, do the barge carriers agree that so-called out-of-pocket costing provides a proper measurement of the compensatory character of a rate. The barge carriers believe that an adequate return figure must also be used but we are unable to pass judgement on this matter until we know the amount of any agreed return.

3. "Are you aware of any variability studies, other than those circulated by the Interstate Commerce Commission, which might shed further light on this problem?"

   The barge carriers are continually studying transportation cost and are aware of other variability studies in addition to those circulated by the Cost Finding Section of the Interstate Commerce Commission. However, they are not prepared at this time to comment on these various studies.

4. "If the Commission's out-of-pocket portions, are unsatisfactory for your purpose, have you developed your own?

   If you have developed your own out-of-pocket portions, are these higher or lower than the Commission's and on what basis are they computed?"

   The barge carriers at the present time have not developed any studies relating to the variability of expenses with changes in traffic volume. Nor, has the Cost Finding Section of the Interstate Commerce Commission developed studies of this nature.

5. "What reporting improvements would you suggest to facilitate more precise measurement of cost differentials reflecting differences in transportation characteristics, for example, length of haul, volume moving or to move, special handling requirements, weight, or density? Could the same techniques be used with respect to cost differentials which reflect operating unit (plane, van, vessel, tow or train) size or performance? How could reported data be improved to facilitate measurement of varying types of service (freight vs. passenger, for example) or of varying classes of service (mail vs. baggage vs. coach vs. first class)?"

The barge carrier's are of the opinion that in order to develop accurate costs measuring differences in transportation characteristics, special studies are required. Such special studies must of necessity be of a detailed nature and thus would not lend themselves to being reported in the Annual Reports of the carriers because of the voluminous nature of the figures and the considerable expense attached to the preparation of the data. The barge carriers in conjunction with the Cost Finding Section of the Interstate Commerce Commission are continually studying the statistics reported in their Annual Reports with a view of making such information as useful as possible for the ascertainment of broad system costs.

6. "Are the company average costs developed by the ICC Formulas adequate for your cost ascertainment needs? If not, what refinements do you believe necessary? Do you use system fuel or maintenance averages? Do you use the Commission's empty ratios, or have you developed ratios of your own?"

As of the present time the Cost Finding Section of the Interstate Commerce Commission has not prepared and published barge carrier costs. As a matter of information, there is presently under study by the barge carriers and the Cost Finding Section of the Interstate Commerce Commission, the development of barge carrier costs.

7. "Please let us have your comments on the Commission's present practice of distributing constant costs on a ton and ton-mile basis. Would an apportionment related to directly assignable expenses, or to revenues, be preferable, and if so, why?"

The barge carriers realize that the distribution of cost not directly assignable, must necessarily be based on selected factors. However, for the purpose of providing information which will be useful to the rate-maker and the Interstate Commerce Commission and to measure the relative costs for the various competing agencies, some statistical distribution of the non-assignable cost is necessary. The barge carriers are unable to state that the ton and ton-mile basis of distribution is either proper, or, that if it is proper, that it is the exclusive basis of distribution for cost purposes.

8. "In lieu of the customry cost distribution to account totals, several transportation firms have attempted to develop standard for measurement of specific costs at particular locations or by specific route segments or functions. In your judgment would it be feasible to revise the presently prescribed accounting and reporting systems to reflect this type of expense measurement? Would the anticipated benefits exceed or be offset by the resources devoted to such a task?"

Please refer to No. 5 above for barge carriers' reply.

Very truly yours,

Wesley A Rogers

Chairman

List 1, 2, 3, and 4

NORTHWEST AIRLINES, INC.

1885 UNIVERSITY AVENUE

ST. PAUL 1, MINNESOTA

OFFICE OF
TREASURER

SEP 11 1959

September 10, 1959

Mr. Robert L. Banks
R. L. Banks & Associates
Transportation Consultants
1001 15th Street, N. W.
Washington 5, D. C.

Dear Mr. Banks:

In reply to your request of July 31, regarding a transportation study you are preparing, we submit for your consideration the following factual and suggested ideas.

Use of ascertained costs are one of the prime considerations in the development and administration of our budgetary program. All revenues and expenses are developed by region and within each region by department, division, section and unit so that supervisory control of functions remain within fixed budgets. We have devised our cost accounting system to reflect our operating costs broken down in the same manner as our organization. This accounting procedure, of course, differs from that prescribed by the Civil Aeronautics Board, and we have thus developed an 11 digit accounting code which gives us information to handle our cost requirements in accordance with CAB mandates and, in addition, allows us to accumulate our costs in an organizational sequence, the latter being used for internal cost ascertainment. We publish cost reports at the lowest level of organization, the unit, and in addition, prepare summaries by section, division and department. Thus any and all levels of supervision can be informed in detail as to the costs under their jurisdiction, and in the higher echelon of management, costs are generally summarized at a higher organizational level. We have found this method of cost ascertainment to be most satisfactory for internal purposes and have used it for a number of years. As mentioned above, this system is compatible with our requirements to the Civil Aeronautics Board. In comparison with other airlines, however, we are forced to depend on CAB classification.

We have, generally speaking, two measures in evaluating traffic solicitation. Quotas are established for each sales region, sales district and sales office within the districts, and, further, the quota for each sales office is broken down between the various managers and personnel comprising the individual sales offices. Whether or not quotas are attained, taking into consideration, of course, extenuating circumstances, is one main evaluating factor. A second factor which we employ quite extensively is to apply a "rule of thumb" percentage of sales costs to sales dollars generally. Local conditions cause this percentage to vary, but we feel, in the overall, this is also an effective evaluation.

Our internal costs ascertainment is of value to only a limited degree in rate negotiations and rate proceedings as, except for broad categories, these figures are not comparable with those published by other airlines and available to our company for comparison. Here we are quite dependent on figures published by the Civil Aeronautics Board. These figures from the Board that are available are voluminous (too voluminous, we feel) but they do enable us to make rather detailed comparisons between carriers for rate negotiation purposes. This applies not only to financial figures, but also operating, traffic and capacity statistics.

In the first question, page 2, you refer to, "precise measurement of cost differentials --------." We have in the past used to some extent "weighted miles". This was used in the past as a "common denominator" in evaluating maintenance costs. As a refinement to this, for purposes of more precise measurement of cost differentials, we would suggest that weighting factors be used to compensate for the following items:

1. Length of haul.

2. Configuration of the aircraft.

3. Time of day.

4. Mix of non-passenger revenue load so that average density can be determined.

5. Capacity restrictions - Here we have specific reference to the mountainous area where altitude restricts the capacity of the DC-4.

6. Length of flight.

7. Number of stops on flights.

The second question in the same paragraph, "Could the same techniques be used with respect to cost differentials ---------." The answer, we believe, is yes as the same general techniques could be used here with weighting factors as follows:

1. Gross weight of the aircraft.

2. Speed of the aircraft.

3. Cost per hour for maintenance.

4. Cost per hour for flying operations.

5. Etc.

The last question in the above referred to paragraph, "How could reported data be improved to facilitate -----------." In reply to this question a new concept should be given consideration. We have in mind a substitution for available ton miles, passenger and weight load factors. These terms could be called revenue unit miles or "potential revenue unit miles" which would substitute for available ton miles and "revenue utilization factor" which would substitute for passenger load factor and weight load factor.

The use of the passenger load factor figure in the DC-3 days was a pretty good indication of how a given airline was doing with respect to profits as this figure, for a given airline, indicated to what extent a company was above or below the break-even operation. This factor indicated capacity utilization and profit evaluation of the operation.

As the airline grew, utilizing larger equipment and expanding into non-passenger revenue, the passenger load factor figure became less valuable both from a standpoint of evaluating the capacity utilization and a standpoint of evaluating profitability. The weight load factor figure then became more significant as it gave consideration to both passenger and non-passenger factors. This factor today leaves much to be desired in reflecting (1) the capacity utilization of the airplane and (2) correlation with profitability of the airplane.

The present weight load factor figure appears inadequate in evaluating capacity utilization because arbitrary factors have been used in determining available capacities. Secondly, it does not reflect the profitability of an airplane as the various configurations of the same type of aircraft would have different break-even points.

"Revenue Utilization Factor" - This term is used to represent the ratio of "earned revenue" to "potential revenue". This can best be explained by an example: DC-7C Domestic Combination Operation.

Potential Revenue -

1.	49 tourist seats at average yield for passenger miles - (for this purpose $.05)	$2.45
2.	30 first class seats at average yield per mile - (for this purpose $0.06)	1.80
3.	Total cubature in cargo compartments minus allowance for free baggage equals cubature available for non-passenger revenue. After allowing 2½ cubic feet for free baggage for revenue passengers there is 454.5 cubic feet available for non-passenger revenue. This cubature would be evaluated in terms of revenue potential after giving consideration to "mix" of non-passenger revenue. If, for example, we determine that a cubic foot of cargo space on the average was worth .175¢ this value would then be (453.5 x .175¢ = 79¢)	.79
	Total Revenue Potential	$ 5.04

Net step in determining the revenue potential factor would be to divide the total revenue earned by the total miles flown to arrive at "average revenue utilization factor". For example, if the average earning per aircraft mile is $2.52 then the "revenue potential utilization factor" would be 50% ($2.52 divided by $5.04).

"Potential Revenue Unit Mile" - This can be accomplished by converting to units rather than dollars and cents as we have done above. As an example, a first class passenger could represent one revenue unit. A tourist passenger could represent a fraction of a unit because of a lower yield and each 100 pounds of non-passenger revenue could represent a fraction of a unit weighted to the first class passenger.

In making comparisons between carriers, the comparisons are, of course, only as valuable as the data from which they are developed. It is the aim of the Civil Aeronautics Board to attain as high a degree of conformity as possible between carriers in their reporting of data. Of course, this can never be perfect, but we believe that with minor exceptions, general conformity is attained, and we thus believe that comparisons developed from this data are meaningful.

We feel that over the years, as additional requirements have been developed by the Civil Aeronautics Board, that their reporting requirements of the air carriers have become quite burdensome, and in many instances the data reported is of little or questionable value. We feel a general overhaul of this reporting procedure should be made, and made as soon as possible. We feel the amount of data requested should be materially reduced and that the data reported should cover vital and important areas, so that in total the information is provided but with a great deal less "bulk" in our reporting to the regulatory agency. This, of course, has been a continuing problem between the agency and the carriers, and it is natural for the agency to desire all kinds of data and information in varying shapes and forms. We feel this inclination is only natural, but we do, on the other hand, feel that a re-evaluation of this area should be made periodically, and the time is appropriate at the present for this to be done. It is our understanding that various parties involved are studing this situation with a view to its improvement, and we feel that cooperation of the regulatory agency will probably be forthcoming.

Yours very truly,

Wm. J. Eiden

Wm. J. Eiden

NEW YORK CENTRAL SYSTEM

OFFICE OF COMPTROLLER

SEP 8 1959

WESLEY F. FRENCH
MANAGER OF COSTS AND CONTROLS

466 LEXINGTON AVENUE
NEW YORK 17, N. Y.

September 4, 1959

Dept. 4

R. L. Banks & Associates
Transportation Consultants
1001 15th Street, N.W.
Washington 5, D. C.

Gentlemen:

Your letter of July 31, 1959 with respect to the transportation study being undertaken by the United States Department of Commerce.

I have attempted to answer the several questions propounded in your letter in the order in which they are stated. As a background to these answers and thoughts I should like to point out that there is need for a more comprehensive treatment of the national transportation network on the part of Government. Possibly this is one of the objectives of the Department of Commerce's study. However as long as separate government agencies exist, each to regulate specific areas of the nation's transportation plant, it is unlikely that any effective measure of impartial and generally uniform regulatory practices will be achieved. Whether we are dealing with the several agencies to regulate transportation within the Federal Government or the State and local regulatory bodies, or the taxing agencies who by their varying practices can sharply influence the financial side of transportation, there is almost no uniformity of treatment accorded the nation's transportation network.

With respect to your several questions it is hoped that the following will be of at least some small use to you:

The New York Central uses cost ascertainment for rate negotiations, abandonment proceedings, budgetary control, supervisory control and, to a more limited extent, in evaluating traffic solicitation. Obviously, the methods of cost, ascertainment vary as between these several groups.

It is generally true that the procedure in connection with rate negotiations and abandonment proceedings which includes line abandonment, train discontinuance, station abandonments or centralization, and other service or property changes, is somewhat more complicated than the other cost ascertainment proceedings.

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If cost ascertainment procedures are to be made so as to provide improved comparisons among the various modes of transportation, then <u>uniform procedures</u> for accounting and the general development of statistics are prerequisite. At present, with the exception of several large functional areas of cost such as payrolls, taxes, material costs, etc. it is often difficult to find useful comparisons. As progressive breakdowns of these expenses are dealt with, comparability progressively disappears. Another difficulty with inter-mode cost comparisons is that important reports required by the Interstate Commerce Commission from carriers of a given transportation mode are not always complete and the missing data may be valuable in determining costs.

....

It would not be reasonable to require regular reporting of traffic density of various runs or routes operated in the railroad industry. If such data are desired they should be obtained by a special study of selected scope and time period.

....

Specific terminal operating data would be useful insofar as the railroads are concerned, especially with respect to the large terminals and yard facilities. However, while expense items associated with these can be more or less readily obtained, the necessary traffic items, i.e. cars, engine minutes, car-days, tons or pieces handled, etc. for use as measuring sticks are hard to come by and are generally available only as the result of special and expensive studies.

....

Maintenance costs and mileage by various types of equipment in various services should be sufficient if limited simply to maintenance costs and mileage by various types of equipment. This would be useful in railroad cost analyses. For example, Account #314, Freight Train Car Repairs, is not generally divisible except as between inspection, running, and shopping repairs. Freight car-miles are not generally divisible except as between loaded and empty. In no case is consideration given to any particular type of freight train car equipment. Thus repair costs per car-mile for given types of freight cars are not usually found. In passenger service, Account #3l7, Passenger Car Repairs, has almost as little analysis. However, some railroads do segregate this account to break out dining car repairs and perhaps motor car equipment repairs. Passenger car mileage on the other hand is broken down rather extensively by types of equipment. With respect to maintenance costs and the mileage of equipment used by other modes of transportation, the tenor of the above comments would necessarily apply.

....

There would appear to be no purpose served by separating fuel and wages to specific routes and types of service except as special needs would indicate.

....

As to the I.C.C. procedures for distributing common expenses between the different services, I believe that these are about as good as we can reasonably hope to have at this time. It should be noted that these procedures are not merely prescribed by the Commission without regard to the opinions and needs of the carriers, but rather have been established in conjunction with the carriers and have at least their tacit concurrence. It seems to me that effort could be better spent in eliminating or reducing the common expense area in basic accounting records than in arguing as to a preferable method for distributing common expenses. In other words, the more direct expense items we can ascertain, the less the impact of any error in the common expense distributions.

....

As to reporting improvements to facilitate better measurement of cost differentials, I think definite effort should be made to study the possibility of establishing a Coordinated System of Accounts and Statistics for All Transportation Modes and to set up reports which would be comparable in their organization and detail among the several modes of transport. This, of course, requires some group equipped to take the overall view of the national transportation network.

....

I have endeavored above to answer your questions as precisely as possible, but I desire to avail myself of the privilege extended in your letter and undertake to briefly set forth below our conception of the problem. I should also state that in doing this I have had discussion with our General Solicitor who has been most cooperative and of great assistance in the following.

To begin with, costing is an art, not a science. In large measure costing procedures are dependent upon economic judgments, which can be imposed upon the cost accountant by statute, administrative regulation or management. When it comes to developing costs for competing agencies, it is practically impossible to make such costs on a comparable basis because of the radically different mandated economic determinations or assumptions which have been imposed upon the several forms of transportation. For example, right-of-way costs have a sharply different connotation to waterway, highway, air, pipe line and rail carriers because of their differing obligations to provide or pay for the cost of their rights-of-way. Even where the rights-of-way are provided by government, as in the case of water, air and highway, the government absorbs differing proportions of the total cost which is assessed against taxpayers generally, and in turn absorbed, in part at least, by other forms of transportation. Even the theory of tax assessments of rights-of-way varies between pipe lines and railroads and even between classes of railroad property, depending upon state and municipal taxing theories. Problems of this kind are further compounded by the fact that there is no common rate-making philosophy applicable to the various forms of transportation. For example, the Hoch-Smith Resolution dictates a distribution of the transportation burden in railroad transportation which is radically different from the economics of providing service, yet the Hoch-Smith Resolution does not apply to other forms of transportation. In air and water transportation the economics of pricing these services are complicated in some cases by outright subsidy. Thus, if costing procedures are designed to clarify and shape pricing structures, it is almost impossible to develop cost principles or procedures under these conditions which will sufficiently reflect these radically different economic and politically dictated policies and yet permit development of reasonably comparable costs. For this reason, even if it were possible to develop identical statistics for all forms of transportation and even if uniform costing procedures were applied to such data, the resulting costs would only have a surface comparability, which would, if taken at face value, be grossly misleading. Furthermore, as long as there are politically mandated pricing policies such as the Hoch-Smith Resolution, the Fourth Section of the Interstate Commerce Act, etc. and as long as the regulatory agencies generally adhere to the view that the higher-rated articles should carry a disproportionately high percentage of the so-called transportation burden and are unwilling to accept costs as the sole criteria of pricing, it is indeed doubtful whether the development of so-called "refined" costs relating to specific commodities and specific movements warrants the expenditure of manpower and equipment necessary for their production.

On the other hand, if these cost data are designed to assist management in making both capital and current expense budgets, they may be justified provided there is no attempt to make such costs comparable to those in other industries. "Refined" costs developed by a single company over a period of years could well convey meaningful information to an individual management not only because there would be consistency of the figures but, more important, there would be a consistency of economic mandates or assumptions underlying such figures. But such a time series would have no meaning if comparison is attempted with similar figures developed by another form of transportation which is operating under different basic economic assumptions.

Finally, the development of private transportation has gone a long way toward destroying the benefits of "refined" cost accounting, which should be derived in the pricing field. The private operator is concerned solely with the gross cost of operating a truck or barge or aircraft, as the case may be, and is not materially interested in either the accuracy or the consistency of the distribution of that cost among the several commodities or classes of passengers that may be transported. Indeed, individual sales policies may dictate a different distribution of such costs among commodities transported by competing manufacturers of identical commodities. Under these circumstances, even if the carriers were permitted to price their commodities on the basis of such "refined" costs, such a pricing policy could well be rendered futile by conflicting and ever-changing demands of the shippers' sales organizations. Thus, the growth of private carriage is raising serious doubts as to whether the cost of developing "refined" costs can be justified and, in turn, it raises an even greater question as to the justification of attempting to develop such costs on a comparable basis between competing forms of transportation.

Very truly yours,

W. F. FRENCH

WFF
h

Southern Pacific Company

65 Market St., San Francisco 5

F. WASCOE
MANAGER, BUREAU OF
TRANSPORTATION RESEARCH

C. B. NINES
ASSISTANT MANAGER, BUREAU OF
TRANSPORTATION RESEARCH

SEP 20 1959

September 15, 1959

Mr. R. L. Banks
Transportation Consultant
1001 - 15th Street, N.W.
Washington 5, D.C.

Dear Mr. Banks:

Referring to our previous correspondence regarding questions involving cost finding field for potential inclusion in the Department of Commerce Transportation Study:

Southern Pacific uses cost information developed by the Bureau of Transportation Research on a non-routine basis for budgetary control, supervisory control, evaluating traffic solicitation, rate negotiations and proceedings, and other areas in which cost information plays a role in decision making.

Attached is a list of areas where cost data has been used as well as projected expansion of its use in certain specified areas. We anticipate more comprehensive cost-finding coverage with the pending installation of an IBM 7070 computer by our company. This installation will make available more cost information on a regular basis, replacing cost finding resulting from specific requests by interested departments.

It is my belief that existing cost ascertaining procedures provide a valid base for improved comparisons between rail and truck cost of operation; however, large areas of motor carrier cost information,vis.contract carriers, private carriers, and exempt carriers, are not available because reports to regulatory bodies are non-existent or the information provided is inadequate. Cost information on barge operations and air transportation is practically non-existent. If the basic information for these non-regulated or inadequately reported areas of transportation were available, the next step - that is, design of costing systems - would be relatively simple. Then valid cost comparisons between different types of transportation would be more adequate.

It has been my general impression that the rail out-of-pocket expenses, considered by the ICC Cost Section to average 80% for railroads and 90% for motor carriers, are within the target range. However, the 80% for rails appears to be somewhat on the high side and would be applicable only to the higher density railroads. In a recent case, where SP, ATSF and NWP costs were used, out-of-pocket expenses including operating expenses and rents but excluding ad valorem taxes, Federal income taxes and return on investment were found to be approximately 75% variable on SP, 70% variable on ATSF, and 50% variable on the NWP. I do not agree that out-of-pocket costs should include the 100% of a stated percentage return on investment in equipment and 50% of a stated return on investment in road property. Because of the significant effects of imbalance and seasonality of traffic, I am of the opinion that the railroads have, during the greater portion of any given year, considerable excess capacity in equipment and motive power. In only few locations and on few occasions are situations encountered where road property is utilized to capacity.

In other words, inclusion as variable costs of a significant amount for return on investment overstates the true variable cost of particular traffic. Data available to me indicates that the 90% variability of motor carrier operating expenses, rents and taxes, is reasonable. SP has made numerous variability studies utilizing statistical techniques. These studies have been used in formal proceedings where SP costs have been submitted.

As previously mentioned, the Commission's out-of-pocket portions are unsatisfactory because of the inclusion of ad valorem taxes, Federal income taxes and return on investment. They are also less than adequate when costing out specific movements. As an example, the 80% variable figure applied to a movement of rock, sand or gravel to a dam site or a highway job which traffic is handled on a lightly loaded branchline local train generally would overstate the marginal or added cost of handling this traffic because; under these conditions train miles would not be affected by the added traffic. On the other hand, a movement of general commodities over the heaviest density line on our railroad could show variability greater than 80%. Specific differences in individual circumstances involving the handling of traffic under study could lead to faulty decisions if 80% is used blindly.

One further thought on this subject, each individual expense account for each operation has its own unique variability characteristics. While it would be impractical to develop individual variable factors for each account for each operation, it is practical to determine variability of groups of expense accounts. To further refine cost information when an individual situation noticeably different than average is encountered, a special study may be made to determine the variability of the unique items for the specific operation.

This generally is the basic concept of SP cost finding. As an example, while we ordinarily consider train and engine crew wages as 100% variable with traffic handled, in the previously cited example of rocks, sand or gravel traffic the variable percentage of crew wages applicable to this traffic could be zero. Therefore, except when looking at system operations as a whole, I would hesitate to use an unchanging percentage variable.

The BTR cost system is, in part, based on statistical analysis. Determination of variability rests heavily on simple and multiple regression techniques. Also, we have used correlation techniques applied to switching study data to develop estimates of switching times at locations where studies have not been made. In many other areas of our cost finding we utilize statistical and sampling approaches. Because of the tremendous number of variables involved in rail cost finding, I do not believe the statistical approach valid when applied to an individual movement or to a small segment of traffic. However, if general levels of cost are being determined I believe that the approach is valid and the most practical to use.

While we have used ICC Form A cost scales I do not believe that they are generally adequate for our cost ascertainment requirements. The cost scales have been used to determine an upper limit of out-of-pocket costs for longer than average movements. Our experience shows the cost scales tend to understate the actual expenses incurred in shorter than average movements.

To have reliable information for decision making for each railroad system should develop costs applicable to its unique operations. Volume of traffic has significant effect on cost variability. Physical characteristics encountered in operations bear heavily on the level of maintenance and fuel cost. Regional or individual labor agreements cannot be reflected properly in district, regional, or system average costs. Train tonnages over various engine districts can differ because of scheduling, imbalance of traffic, or physical characteristics of the line. Distances between terminals affect line haul costs. Switching in a large terminal is very different than switching in a small terminal. In my opinion each road should develop a system of costs which allows it to reflect its significant cost differences in its operations because Rail Form A costs do not adequately reflect cost differences encountered under different operating conditions.

While we are not completely satisfied with the data, we do use- except in unusual circumstances - system average Maintenance of Way and Structures expenses and system average locomotive and car maintenance expenses. However, our locomotive maintenance costs are influenced by the fact that we consider these maintenance expenses variable with fuel consumption, rather than gross ton miles or locomotive miles.

BTR costs include factors based on SP empty return ratios rather than the Commission's empty return ratios. While there is still a considerable amount of work to be done in refining SP's empty return ratio data, we feel that the SP figures reflect our operations much more closely than the district or national average ratio would.

Other aspects of transportation economics which I believe require clarification are in the use of costs in rate making procedures. The competitive situation in which the railroads find themselves requires more concentrated efforts for each railroad to know its cost and the cost to the shipper of alternative modes of transportation. To successfully compete the railroads must have freedom to set rates at the point which will maximize the contribution above out-of-pocket cost of any segment of traffic. This means that the railroad must not only know its cost but also have a good estimate of its demand function.

I have been concerned recently by pronouncements of certain Commissioners to the effect that the lowest full cost transportation agency should be the agency which sets competitive rates. If this philosophy is followed the most efficient use of our transportation facilities will not be realized.

My position in this matter is adequately covered by testimony of Dr. Dudley F. Pegrum and C. B. Nines in I&S 7034, ICC 32543 and ICC-32546 as summarized in supplemental Brief of Respondent Southern Pacific Company.

Lastly, clarification is necessary on the question of which costs are to be considered out-of-pocket costs in a rate proceeding. In I&S 6933 the majority decision stated that ad valorem and Federal income taxes, depreciation on road property and return on investment should be considered out-of-pocket costs. Our philosophy disagrees with

are
that of the majority. We contend that these/basically overhead items of cost. The railroads are benefited to the greatest extent, as is the economy as a whole, when rates are set so that the contribution of the traffic in question, i,e., the difference between total revenue for the traffic and total out-of-pocket costs (excluding ad valorem and Federal income taxes, road property depreciation and return on investment) is maximized. A clear paraphrasing of my opinions can be obtained in Commissioner Webb's dissent to the decision in I&S 6933. To my way of thinking, this dissent is a landmark in transportation economics.

Yours very truly,

PRESENT AND FUTURE AREAS WHERE COST
DATA HAS BEEN AND WILL BE USED

I - Use of cost ascertainment

A - Present cost applications

1. Rate negotiations and proceedings
2. Evaluation of proposed capital expenditures
3. Evaluation of operating alternatives
4. Station closing evaluation and proceedings
5. Line abandonment evaluation and proceedings
6. Passenger train evaluation and proceedings
7. Evaluation and negotiation of inter-company charges
8. Evaluation of traffic solicitation efforts. (Sporatic)

B - Future cost applications

1. Evaluation of traffic solicitation efforts (comprehensive)

(a) Differentiate by

(i) Freight traffic district
(ii) Commodity
(iii) Movement
(iv) Consignor and consignee
(v) Routing

2. Evaluation of equipment acquisition priorities.