Cost-Service Modeling: Theory and Practice

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Recent developments in transportation have increased the need for accurate microeconomic modeling. If it reflects situation-specific data, microeconomic modeling can be a valuable tool for shippers, carriers, and public policymakers. Reebie Associates has developed a unique cost-service modeling technique over the past 10 years. This paper outlines its theoretical structure and a recent application. The model described simulates carrier and shipper economics. The trade-off between cost and service is essential to both. A brief description, at the theoretical level, is given of the relationship between production costs and the service level for the carrier and that between transportation costs and distribution costs for the shipper. A graphic presentation is developed to describe them and their interrelationship. The theoretical construct is then employed to describe a recent market research project (conducted for the New York State Department of Transportation) that examined the feasibility of a new intermodal service. Three elements of that study—cost and service modeling, market segmentation, and shipper modal preference—are described briefly and related to the preceding theoretical construct. The paper ends with suggestions for further research.

The transportation environment is undergoing changes that are unprecedented in number, importance, and complexity. Carriers face increasingly stiff intermodal and intramodal competition. The increased importance of transportation- and distribution-related costs for many manufacturers has made the traffic department a key management function. Deregulation is another complicating factor in this increasingly uncertain environment for both carriers and shippers. This increased uncertainty can result in added risk, a very real cost felt by those unprepared to deal with the new environment (and indirectly by the rest of the economy as well).

Although economic regulation is being relaxed, direct government involvement in transportation is increasing. The continued instability of some modes and the growing awareness of the importance of a sound transportation infrastructure for regional economic competitiveness are catalysts for this development. Increasing direct government involvement has generated new areas of responsibility for public policy planners, responsibilities for which many are not prepared. Thus the uncertainties that concern the transportation market are now shared by public officials as well as private carriers and shippers.

Increased complexity and uncertainty in the transportation market have created a clear need for better understanding of transportation economics by shippers, carriers, and public policy planners. Applications-oriented microeconomics can be used by carriers to test their competitive environment; pricing and service strategies can be more effective if they are based on a solid understanding of demand sensitivity. Shippers armed with an understanding of carrier economics (and their own) can be better prepared for rate negotiations and better able to make short-term modal choice and longer-term facility planning decisions. Government policy planners, entrusted with major public expenditures for operating subsidies and transportation system investments, can be greatly assisted by microeconomic modeling, which can base their decisions more firmly on the marketplace and so ensure more-effective resource allocation.

Although the value of microeconomic modeling is evident, the area has not yet been adequately investigated. Several transportation researchers have attempted to model the transportation marketplace. However, theory often falls short of a reasonably accurate reflection of reality. Furthermore, practical applications of theory have tended to be at the higher policy levels rather than the operating level of decision making. Previous efforts in the field, such as those by Friedlaender (1) and by Meyer and others (2), focused on comparisons of simulated operating costs of competing modes. Considerable effort was given to defining the finest details of highly mechanized cost models. However, since they are based on broad system and nationwide averages, these models are frequently inappropriate for specific situations, which are often the cases where decision makers most need modeling support. Perhaps a more serious flaw of cost-oriented models is the slight consideration given the critical factor, service. Transportation is a service industry. Product quality is often more important than quantity. Although service is intangible, it is, nonetheless, a necessary component of a comprehensive model of the transportation marketplace.

More-recent models differ from their predecessors in that they attempt to incorporate service in the demand and supply equations. Roberts and his associates at the Massachusetts Institute of Technology (3) have modeled the shipper's purchase decision with their logistics analyzer. By pairing this simulator of shipper economics with carrier cost models, many transportation decisions can be simulated. This method has recently been used in the Federal Railroad Administration's Intermodal Freight Systems Study. Although service is an integral part of this modeling technique, the difficulties of relating nationwide averages to local situations remain. Another problem with this mechanized simulation of the shipper's transportation purchase decision is the assumption that the shipper's decision making is guided by a precise understanding of the economics. In fact, in decisions such as modal choice, a shipper's perceptions and biases are often more important than the actual logistics economics.

The cost-service model discussed in this paper builds on the research conducted in the past. The model differs from its predecessors in several respects. In recognition of the fact that a carrier or mode can offer a range of products to the market, the cost model has been used to estimate carrier cost profiles for several levels of service, i.e., several differentiated products. By incorporating the service capabilities of competing modes and carrier costs into the model, a more-complete representation of the supply equation is presented. By using survey techniques, shipper behavior is examined directly. Not only does this provide a more accurate picture of shipper preferences that actually drive the purchase decision, but it also ensures better applicability of the model to local situations.

Clearly, this is not the ultimate model. Many elements require further refinement. This paper will outline briefly the model's theoretical structure and its recent application in a research study conducted for the New York State Department of Transportation (NYSDOT).

COST AND SERVICE: THEORY

Models of the transportation environment are designed to replicate, in a simplified format, the choices available in the marketplace. As such, these models must simulate service and cost for the economics of both carriers and shippers. For the carrier, the service component represents the range of products that can be offered to the market. The cost component describes the carrier's costs associated with the production of those various levels of service, or products. In this model, shipping costs have been separated to isolate those directly paid to the carrier (i.e., transportation rates) and those implicit in the quality of the product purchased (e.g., inventory holding costs and packaging costs). The former describe the shipper's cost component; the latter, the service component.

Service Definition

On the simplest level, movement is the product of the transportation industry. How this movement is produced, packaged, and sold can vary markedly among modes. Furthermore, the importance of the quality of this movement varies among market segments as well. There are several components in the concept of service. Among them are transit speed, protective handling, delivery appointments, and billing procedures. Since the perceptions of capability and value for each component are so varied, each has a different level of importance for each shipper and carrier. For example, one shipper's purchase decision may take into account several elements of service--transit time, protective handling, and customer service. On the other hand, the entire strategy of a carrier may be focused on one service element, for example, fast transit time. Although service is an area of extreme complexity that is difficult to model, it cannot be ignored. To define the critical service dimension, it is necessary to introduce certain simplifying assumptions.

In numerous shipper surveys one factor, reliability, has repeatedly emerged as the most important determinant in modal choice. Reliability must be viewed separately, since it encompasses all elements of service, such as variability of transit time and levels of loss and damage. If a carrier establishes a service standard such as third-morning delivery, delivery appointments, and no more than 5 percent loss and damage, reliability will be measured by whether the performance meets these standards. Because of its importance, reliability should be given separate consideration in the development and application of service models.

In the discussion that follows, service has been portrayed as an aggregation of service elements on a one-dimensional continuum from low service to premium service. Low service level implies the minimum market-acceptable level for each service element; the premium level implies the maximum acceptable level. The intermediate service levels assume a graduated increase in each service element. In this context, low service should not be confused with poor service. Low service still implies an efficient operation. The low standards for such service elements as transit time and cargo handling are established by the carrier and clearly understood by the shipper. Although placing service on one dimension is a simplification, it enables many transportation decisions to be modeled and described by a two-dimensional graphic representation. For conceptual simplicity, an ordinal ranking from 1 (low) to 6 (premium) will be used to demarcate different levels of service.

Simulating Carrier Economics

Each carrier has a unique relationship between production costs and level of service generated--the trade-off between production cost and service level. Barge carriers, for example, can provide a low-service product (slow transit time, minimum cargo protection) at extremely low unit costs. However, the technological limitations of a barge operation would produce extremely high costs at substantially higher levels of service (for example, one that implies a 40-mile/h average transit speed). Conversely, the cost structure of motor carriers enables them to better serve customers who require higher levels of service. However, truckers cannot match the low unit costs of barges at the lower levels of service. Figure 1 gives conceptual curves that represent the contrasting cost-service tradeoffs of four modes: barge, rail, motor, and air.

The curves in Figure 1 are (of course) simplified. Not all carriers within any mode will have the same profile in a given situation. Moreover, the profile for any particular carrier can vary substantially in different markets. The value of these profiles is in the definition of the range of levels of service that a carrier (or mode) can produce. A carrier's product-line capability establishes the parameters of competitive capability. By referring again to the ordinal ranking of service levels, barge operators can produce service at levels 1, 2, and 3 before their costs become prohibitively high. However, their costs, even at level 3, are much higher than those for rail. Clearly, barge operators can compete only for market segments that will accept the lowest standards of service. Rail carriers, on the other hand, have a distinct advantage at level 3. However, they are on the margins of competitiveness at levels 2 and 4; these are the parameters of this mode's competitive capability. The identification of competitive parameters in terms of both production costs and service is vital to a carrier's real-world marketing strategy; it is also necessary in the construction of a representative model.

Simulating Shipper Economics

Each shipper has a set of distribution costs associated with different levels of service. (In this discussion, transportation costs are viewed separately from other distribution costs such as inventory-holding, lost-sales, and packaging costs. Total costs, including both transportation and distribution costs, are defined as total logistics costs.) For most commodities, an increase in transportation service can, to a point, be translated into a decrease in distribution costs. Delivery appointments can reduce labor costs at receiving facilities, faster transit time can lower inventory-holding costs, and better cargo handling can eliminate many packaging costs. The unique characteristics of each commodity and shipper mean that improved service can have quite different impacts on distribution costs from one situation to the next. For example, fast transit time in special protective equipment will have much more importance to a shipper of perishable goods than to one of plastics.

Since each shipper has a distinctive set of distribution costs that result from different levels of service, the willingness of each to pay for those services in increased transportation rates varies accordingly. In each purchase decision, there is a transportation-cost--distribution-cost trade-off. The objective of the rational traffic manager is to minimize total logistics costs (the sum of transportation and distribution costs). However, many traffic managers, with only a partial understanding of the distribution-cost implications of different levels of service, make trade-off decisions based on intuitive perceptions of total logistics costs rather than on precise economic comparisons. Allowances must be made in the research technique for such behavioral characteristics and for other factors such as imperfect information.

Figure 1. Curves that represent contrasting modal cost-service trade-offs.

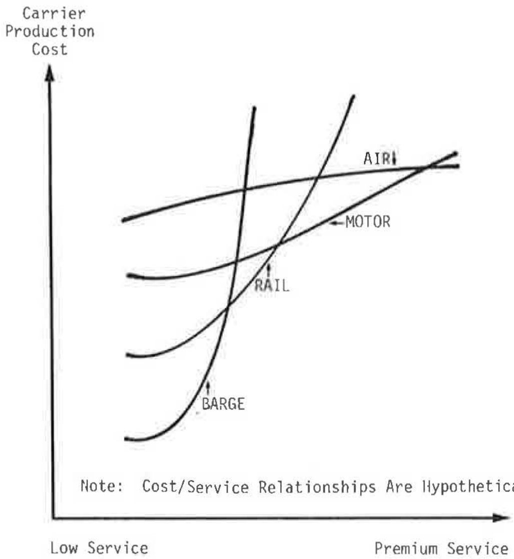
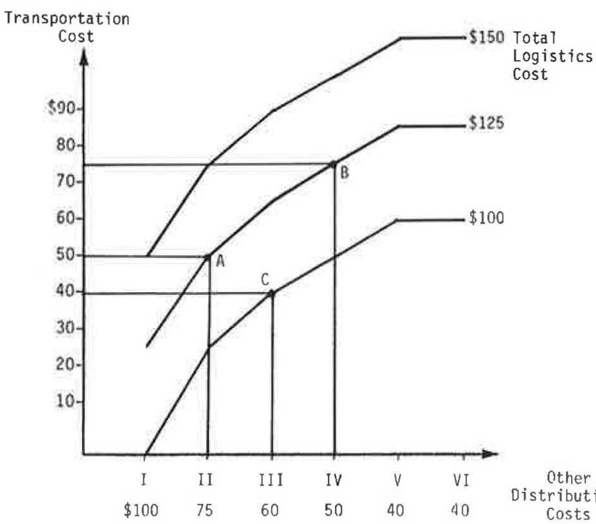


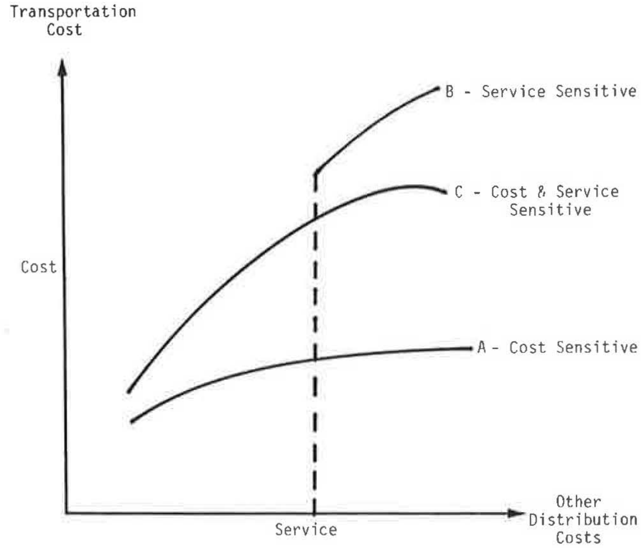
Figure 2. Family of isototal-logistics-cost (ITLC) curves for one hypothetical shipper.



Because there is a trade-off between transportation costs and distribution costs, total logistics costs can be identical for a number of combinations of transportation costs and service level. Figure 2 portrays the isototal-logistics-cost (ITLC) curves for one shipper. Each curve represents different combinations of transportation and distribution costs that produce the same total logistics cost. A rational shipper should be indifferent, over the long run, to any particular combination of cost and service that produces the same total logistics cost. These curves can be drawn for an infinite number of total logistics costs to form a family of indifference curves. The objective of the traffic manager should not be to hire a premium-service carrier without regard to cost nor to find the lowest rate. Rather the best combination of rate and service for the situation should be acquired and thus implicitly the move to the lowest possible ITLC curve will be made.

In Figure 2, point B describes a combination of a transportation cost of $75 and level 4 service that

Figure 3. Contrasting ITLC curves for three shippers.



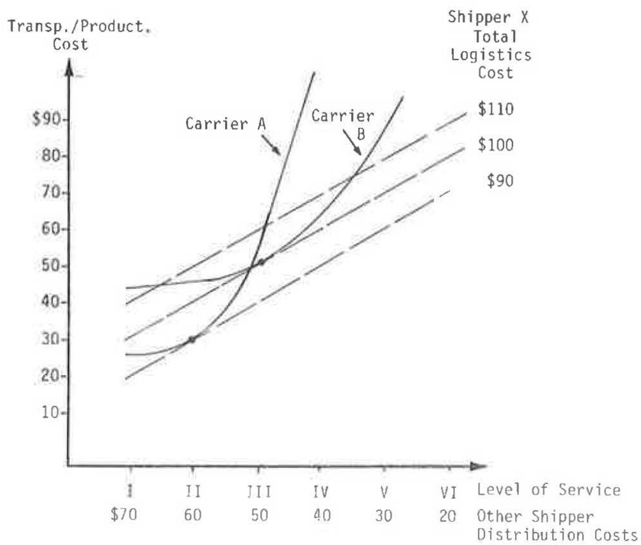
has distribution costs of $50 for this shipper. Total logistics cost is $125. At point A, the shipper has a lower transportation cost of $50, but higher distribution costs of $75. The total logistics cost at B ($125) is identical to that at A. The various combinations of transportation cost and service that produce the total logistics cost of $125 (including points A and B) describe an ITLC curve. On the other hand, point C has transportation and distribution costs that total $100. Logically, the shipper would prefer to be on the ITLC curve that includes point C.

Each shipper has a family of identically sloped ITLC curves. Yet the exact shape of each shipper's curve is unique. This reflects the differing impacts of service on each shipper's distribution costs. Figure 3 shows a few representative curves. Shipper A manufactures a bulk commodity and has little need for more than base-level service; for this shipper, transportation cost is paramount. Shipper B ships perishable goods and finds low levels of service unacceptable; for B, premium service can be translated into substantially reduced spoilage and an increased market price. Shipper C represents the majority of the transportation market--improved service can reduce distribution costs but only to a point. Beyond that point, increased rates are not justified by lower distribution costs.

MATCHING SHIPPER AND CARRIER ECONOMICS

By themselves, the cost-service trade-off relationships of carriers and shippers have limited value. A carrier may have the advantage over competitors of producing much lower costs at all except the lowest levels of service. Yet, if the market in question is made up of shippers who are relatively service insensitive, that competitive advantage is diminished. Therefore, the trade-off between production cost and service level for carriers and the trade-offs between transportation cost and distribution cost for shippers must be combined into a single analytic framework. The X-axis of Figures 1 and 2 represents the service and distribution cost parameters for carriers and shippers, respectively. They can be placed on an equivalent basis by assuming (as was discussed earlier) that, as service levels change, shippers' total distribution costs are proportionately (although inversely) affected. How-

Figure 4. Comparison of shipper and carrier cost-service trade-off curves.



ever, since each shipper's value of service is unique, the proportion will vary accordingly.

Matching the Y-axis parameters of Figures 1 and 2 implicitly assumes that carrier rate levels (shipper transportation costs) are equivalent to their production costs. This is frequently not the case in the short run because of competitive pressure, regulatory constraints, market strategy, or an inaccurate cost measurement. Over the long run, however, carriers must earn sufficient revenues to cover their costs, which include an adequate return, if they are to continue to provide satisfactory service. If they are making excessively high earnings, other competitors can be expected to enter those markets (although this process may be slowed or limited by regulatory constraints) and bid the price down to a level nearer the cost of production. This long-run orientation is quite consistent with the planning functions for which the cost-service modeling is most effectively employed. As such, the equivalence of rates and carrier costs can be seen as a reasonable simplifying assumption.

By following these assumptions, the trade-offs for carriers and shippers shown in Figures 1 and 2 can be combined onto a single set of axes. Figure 4 gives the comparison of the requirements of one shipper (X) with the capabilities of two carriers (A and B).

For clarity, shipper X's ITLC curves have been made linear. Carrier A has a strong low-cost capability. However, A's competitiveness sharply deteriorates at higher levels of service. Carrier B is most competitive at higher levels of service. Of critical concern to both shipper and carrier are the points of intersection at which shipper X's ITLC curves cross each competing carrier's cost-service curves. Naturally, if only one carrier's curve crosses a lower ITLC curve, that carrier will have a significant competitive advantage. In this case, carrier B is capable of providing a product with total logistics costs of $100 for shipper X. Carrier A can offer shipper X a product on the $90 ITLC curve. This places carrier A in a dominant position for X's traffic and gives carrier A a wide margin of pricing flexibility.

As briefly described, one might conclude that the model is amenable to quantitative analysis. However, finding the fit in this discussion required several simplifications and assumptions. Cost-service trade-offs vary from shipper to shipper and from carrier to carrier. The use of nationwide, regional, and industry averages to simulate these trade-offs reduces the applicability of the model in specific situations. Furthermore, as a carrier's perception of competitive capability and a shipper's perception of the value of different levels of service may not be based on adequate information or a proper assessment of the information available, data on these behavioral characteristics that cannot be modeled mathematically must be introduced directly into an analysis. The theoretical framework has not been designed as an end in itself but rather as a guide for the conduct of a number of market-research assignments by Reebie Associates.

TRANSLATING THEORY INTO PRACTICE

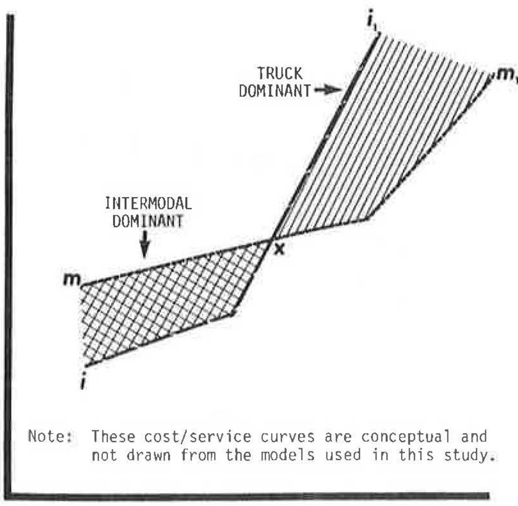
Many elements of cost-service modeling have been developed and tested in a number of Reebie Associates research and consulting projects. Since the principal objective of these studies was to analyze specific market situations to develop policy alternatives and recommendations and not simply to build elegant microeconomic models, not every facet of the cost-service trade-offs could be replicated in the fullest detail. However, the essence of its theoretical structure was preserved in recent applications. Cost-service modeling was a central element of a study conducted for the NYSDOT, which is a good example of the applicability and limitations of this technique.

This study was initiated to evaluate the economic feasibility of a new intermodal service to the New York City area, east of the Hudson River. Although intermodal service was available in New Jersey, its attractiveness for New York shippers is limited because of the low standard of reliability and long drayage hauls required. The state wished to know whether such a service would provide improvements in transportation costs and service for New York shippers and receivers, so that government investment, subsidy, or both would be justified. Cost-service modeling was used to estimate the potential economic viability of such a service. Although the feasibility of a project of this nature would also be determined by socioeconomic and environmental considerations, which are beyond the scope of this kind of modeling, the comparison between costs and service of competing modes describes the central economic question and therefore represents one of the most important tests for such a project.

In this analysis, two competing modes were examined--intermodal rail and motor carrier services, with the latter subdivided into a number of segments (regular and irregular-route common carriers and private and exempt-load truckers). Geographically, the base market was limited to that part of metropolitan New York City to the east of the Hudson River. Because of intermodal rail's inherent economics, the target market of the study was limited to New York's 25 largest traffic lanes (ones that were more than 400 miles long).

The analysis was conducted in three steps. The first established the nature of supply by identifying the cost and service characteristics of intermodal rail and motor carriers in New York and defined the zone of intermodal rail-truck competitiveness. To describe demand, the second step segmented the New York transportation market to isolate that traffic for which both modes could be competitive. In the final step, the demand characteristics of this competitive traffic base were measured against the capabilities of intermodal rail and motor carriers in New York, and the market potential for an intermodal rail service was projected.

Figure 5. Modal competitiveness: zones of dominance.



Cost and Service Models

The first step of this analysis was designed to determine the production-cost--service-level trade-offs for intermodal rail and motor carriers. Figure 5 shows the conceptual representation of the cost-service trade-off curves for intermodal rail ($i-i_1$) and motor carriers ($m-m_1$). These curves describe, in general terms, the cost-service characteristics of each mode as found in this and previous studies. Intermodal rail, if operating at a high level of efficiency, can provide a superior cost profile at the lower levels of service. Because of the greater flexibility inherent in the highway mode, motor carriers tend to be more cost competitive at higher levels of service. These zones of dominance are defined in Figure 5 by the areas ixm for intermodal rail and i_1xm_1 for motor carriers. These zones describe price-service packages that cover a carrier's production costs yet are lower than any package offered by competing carriers.

To apply this relationship to the New York situation, models of carrier production costs and service capabilities, tailored to the specific transportation characteristics of the region, were developed. Although the costing model described only two modes, its construction remained a complex task. In this effort, a building-block approach was used. That is, each major cost component was developed by aggregating many subelement costs.

The carrier service model was (of necessity) simpler than the detailed cost model. Because of its overriding importance, reliability at the current truck standard was assumed for the new intermodal service. It was understood that unless an intermodal rail service provided such reliability, its prospects of success in New York would be minimal. To act as the surrogate for all other elements of service, transit time was made the key variable. (As identified in this and other studies, superior transit time seems to be closely correlated to superior performance for other service elements.) The service model produced transit times to the key markets for several variations of intermodal rail and truck service.

As noted previously, carriers' competitive capabilities will be influenced by their perceptions and biases. This behavioral consideration was not incorporated into this study, since there is not at present an intermodal carrier that serves New York City directly. If that had been the case, the intermodal cost and service models would have been modified appropriately. The results of the motor carrier models were tested in a survey of area truckers (and confirmed by area shippers).

By combining the results of the cost and service models, the boundaries of the competitive market were defined geographically. This market is made up of those traffic points at which intermodal rail is either currently competitive (to the west of Chicago) and points at which it could be potentially competitive with increased efficiency (primarily in the Midwest). Although the cost and service models indicated that there is a large potential zone of competitiveness, the true test is the market.

Market Segmentation

The New York transportation market is large and extremely complex. A fully comprehensive survey with an appropriate level of follow-up of the thousands of shippers in the city and its surrounding area was beyond the resources of this study. Reduction of the size of the survey to manageable proportions by focusing on that part of the New York transportation market for which intermodal and motor carriers could most directly compete was considered the most appropriate way to meet the demands for an adequate degree of market coverage and the budgetary constraints of the project. By using a comprehensive mail and telephone survey, those noncompetitive segments of the market were identified. This enabled a much more detailed in-person survey of the New York shippers who could use either intermodal or motor carrier service.

The New York transportation market was divided into three segments, each of which is displayed graphically. Figure 6 shows the relatively service-sensitive segment of the market that has a high standard of minimum service. In New York, this figure describes most less-than-truckload (LTL), short-haul, and damage-prone freight. Figure 7 represents the more cost-sensitive shippers, who do not significantly benefit from the higher-priced, premium-service alternatives. Since New York manufacturing is dominated by light industry, this segment is relatively small. In both cases, the shape of the ITLC curve is such that it passes through only one mode's zone of dominance. Thus, the shippers represented in Figure 6 will almost invariably rely on motor carriers (or a premium-service mode such as air cargo) because intermodal carriers cannot provide the minimum level of service required. The market segment represented in Figure 7 would rarely use motor carriers, since intermodal carriers (or another low-cost mode such as carload rail) can provide adequate service at lower cost than can motor carriers. These two groups of shippers represent those parts of the market that would be unlikely to divert between intermodal carriers and truckers.

Some New York shippers with economics similar to those in Figure 7 now use motor carriers or New Jersey intermodal carriers because there is not yet a New York-based intermodal service. Since these shippers would almost certainly divert to a new intermodal service, they were considered part of the intermodal service's assured market potential. Conversely, cost- and service-sensitive shippers (Figure 8) who would not use a new intermodal service were also not included in the later, more-detailed parts of the survey. Figure 8 shows the shipper with an ITLC curve that can cross both zones. This shipper was made the focus of the competitive analysis.

Figure 6. New York transportation market: service-sensitive shippers.

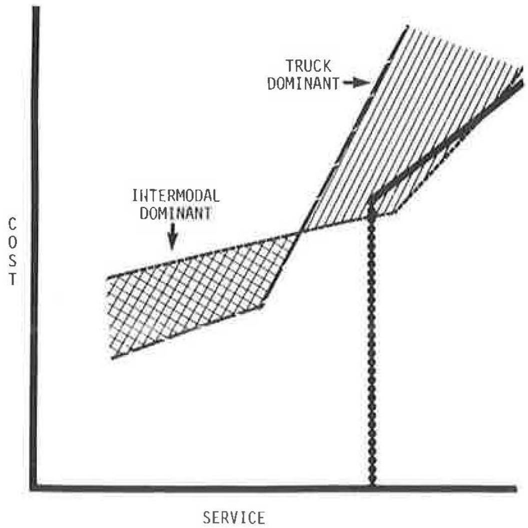


Figure 8. New York transportation market: cost- and service-sensitive shippers.

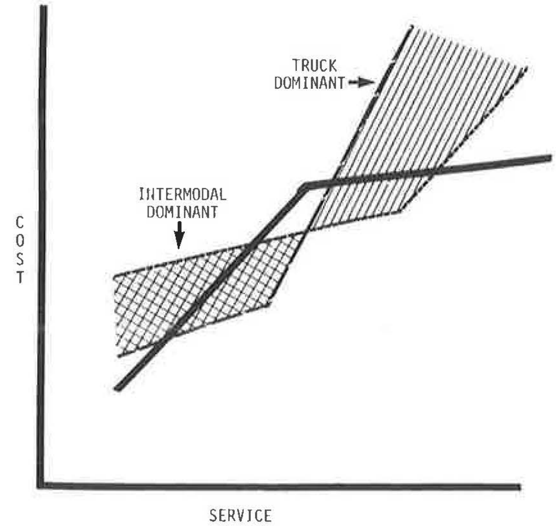
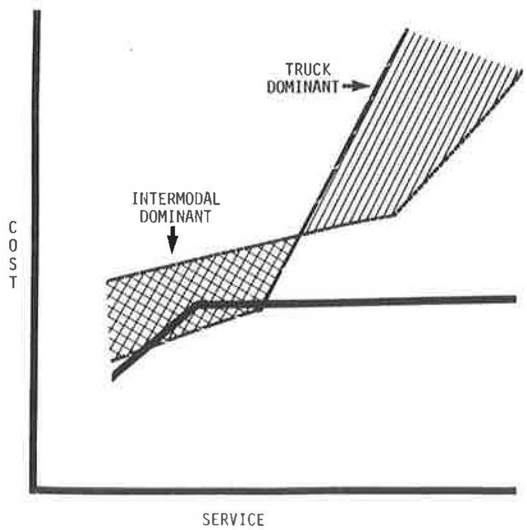


Figure 7. New York transportation market: cost-sensitive shippers.



Competitive Analysis

In the New York study area, the competitive traffic base consists of not more than 200 major shippers and receivers. In the survey, almost every major shipper of outbound traffic and most important receivers were contacted. An emphasis was placed on outbound traffic because of the relatively intense competition for this traffic. New York's inbound-imbalance ratio of 2.5:1 makes this traffic crucial for a transportation service's success.

A diversion analysis technique (developed in earlier studies) was employed to estimate the shape of each target shipper's ITLC curve. In personal interviews, shippers were asked to estimate the diversion of traffic from their present carrier (almost invariably a motor carrier) to a new service and what this diversion would be for several different combinations of transit-time performance and transportation cost. Inherently, a significant diversion implies that the shipper is describing an indifference curve that is either equal to or lower than that of the carrier being used. The analysis was not designed to dissect the nature of the shippers' cost-service trade-off nor to understand their behavioral motivation. Rather it was intended to measure shippers' acceptance of a new modal option by asking them to simulate their cost-service trade-off decision. In this way, the reactions of shippers with widely varying distribution patterns could be aggregated. Furthermore, as biases, perceptions, and misinformation inevitably influenced the shippers' responses in the interviews, these unquantifiables were incorporated directly into the diversion analysis.

The survey identified many shippers (in the trucker's zone of dominance) who were unwilling to divert to intermodal service unless a substantial cost reduction or service improvement was promised. Others needed assurance of only a small cost reduction to switch their modal allegiance. These shippers represent the cost-sensitive market segment that should probably use any reliable intermodal service rather than motor carriers if there is one available. Several shippers were identified who would accept slower (although still reliable) transit time for a relatively small rate reduction. These shippers represent that part of the market served equally well by either intermodal or motor carriers.

The diversion analysis results indicated that a New York intermodal rail service could gain a significant share of the competitive market. Many New York shippers (within the target sample) have perceived ITLC curves that would seem to be best served by the cost-service profile that could be produced by an efficient intermodal alternative. A New York service could capture a substantial share of traffic to the Midwest, and market dominance in traffic lanes to the West would be likely. This projected traffic potential was the basis for the conclusion that an intermodal service could be a viable competitive force in the New York market.

SUMMARY

The model described in this paper is one of many attempts to apply transportation economics research in specific decision-making situations. Clearly this effort is in its very earliest stages and many of its components need further investigation and refinement.

Market-segmentation techniques employed in the consumer-goods industry can be profitably employed by researchers to tailor analytical techniques, such as the diversion analysis described above, to the unique distribution patterns of different industries and geographical regions. Survey techniques need to be developed in two directions: (a) more-economical and expeditious techniques to permit wider market coverage and (b) more-sophisticated, in-depth techniques to better understand the shippers' purchase decisions and to improve the reliability of survey results. Survey techniques and simulations can be complementary if they are developed in tandem. To realize the most value from both, their most-appropriate applications should be identified and linked. A shipper panel, established on a semipermanent basis along the lines of the Nielsen ratings for television, is one way to regularly gauge the impact of changes in shipper perceptions and environment on the purchase decision.

Product differentiation is becoming an increasingly important concern for both carriers and shippers. Costing techniques should be refined to better estimate the production-cost impact of providing different levels of sevice. Carrier costs have been the focus of a considerable amount of attention (perhaps too much). Costing techniques should be developed to better reflect local operating conditions and, more importantly, the perception of carrier management.

In sum, there are several areas that require further exploration for both cost and service and shippers and carriers. Clearly, this research will be most valuable if it reflects the decisions made in the marketplace and is designed to assist decision makers.

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Measuring Intermodal Profitability

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The profitability of intermodal operations provided by the rail industry and commonly known as trailer-on-flatcar (TOFC), or piggyback, service has been questioned in recent years. Although TOFC loadings have increased, the growth has not been as rapid as many believe possible; the industry's hesitancy to make the necessary investment and the reluctance of other modes to take advantage of rail line haul are indications of this situation. Although railroad-costing methodology has improved in the past decade, difficulties still exist in ascertaining profitability of any one segment of traffic. The difficulty of allocating costs prevents costing officials from accurately determining intermodal costs and hence profitability. It is this situation that confronts management with investment decisions and presents the Federal Railroad Administration (FRA) with problems in the promotion of intermodal operations in the rail industry. Congress provided funding for the FRA to partially offset operating losses in intermodal demonstrations under certain criteria; the most important of these are potentially profitable operations. In view of the problem with railroad-costing methodology, how should the profitability be measured? The FRA is funding research in two phases to develop an Intermodal Management Information System (IMIS). The first phase, an overview of rail information systems and a state-of-the art survey, confirmed the need for an IMIS and identified three modules that could be readily transferred to the industry. In various stages of development and testing are an Intermodal Management Equipment Control System (IMECS), which generates adequate records for detention billing and control of trailers, and a Repetitive Waybilling and Rating System (RWRS), which electronically maintains a comprehensive audit trail of waybill activity. Both these systems (and other sources) provide an automated collection of intermodal records to ascertain profitability for the rail carrier.

Since 1973, the ever-worsening fuel crisis and critical environmental problems have dramatized the need for truly efficient transportation. Each mode of transportation has individual characteristics of cost or service that are superior to those of competing modes depending on the distance and the function. When fuel was abundant and transportation modes were economically healthy, inefficiencies were tolerated in the name of laissez-faire competition. However, it has now become essential to encourage the combining of the best features of each mode into a total system; this cannot be accomplished by any one transportation company restricted to a single mode of operation.

In the case of domestic merchandise and perishable commodities, the ultimate solution may be a refinement of truck and rail piggyback service. This basic concept dates back many years and its use has been growing, but at a rate far slower than the true potential would justify. Investigation has disclosed numerous problem areas that impede the expansion of trailer-on-flatcar (TOFC) and container-on-flatcar (COFC) traffic.

More important than fuel efficiency and environmental problems to the rail industry is that, in the continuing analysis of the industry by the Federal Railroad Administration (FRA), a conclusion was reached that improvement of intermodal services by the railroad industry may be able to recapture a substantial portion of the profitable market that has been diverted to competing modes.

The U.S. Department of Transportation (DOT) position on this issue is illustrated by Secretary Coleman's landmark statement of national transportation policy on September 17, 1975 (1): "The strength of our transportation system lies in its diversity, with each mode contributing its unique and inherent advantages.... A priority for reform is to encourage intermodal joint use of facilities [but] the potential of intermodal services remains for the most part unrealized." A transportation system based on policy outlined in the statement would provide "new, more cost-effective, energy-efficient and intermodal technology." These ideas were basically repeated in