

# Decision issues and research priorities in intercity freight transportation: a U.S. perspective

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## INTRODUCTION

The intercity freight transportation system in the United States is characterized by its high degree of development, with respect to both its civil works infrastructure and its technology and operating capabilities. The essential completion of the 43,000-mile system of Interstate and Defense Highways and the rapidly expanding and extensive use of those facilities by all sectors of the motor truck industry has virtually eliminated the differential economic advantage heretofore enjoyed by industries and localities with preferred access to rail freight transportation. With very few exceptions, moreover, the U.S. system of improved navigation facilities has also reached its full, geographic extent; so that there is little further economic advantage to be conferred upon industries and localities with ready access to low-cost water transportation.

Thus, at the end of the second century of U.S. history, the essential issues which we confront in the further articulation of our intercity freight transportation system are no longer ones of economic advantage and economic development, but rather ones merely of economic efficiency. Since most of the resources and virtually all of the operations of this highly-developed system are in the hands of private entrepreneurs, the stimulus of commercial competition for increasing market shares and profits encourages steady improvements in efficiency throughout that system. The inhibitions to such improvements in efficiency lie, directly or indirectly, in the hands of our State and Federal governments. Governments intrude upon the natural workings of the system through the decisions they make regarding the provision of civil works infrastructure and through their regulation of the commercial practices of the private operating companies.

The important research tasks in U.S. freight transportation derive largely from this interaction between government decisionmaking and the steady drive to more and more efficient freight transportation operations.

This paper examines some of the research requirements growing out of these government decision problems. The most important areas of needed research lie in

- 1) improving our ability to model the workings of the intercity freight market,

- 2) accounting more carefully for the direct public costs and indirect social costs of freight transportation operations,

- 3) assessing alternative technological futures, and

- 4) more carefully structured theoretical and empirical work on the effects of commercial regulation. Overriding most of these research tasks are the special requirements for the development of more comprehensive, continuing programs of data collection on both the characteristics of the intercity freight transport market and the operations which serve it.

## THE CHANGED ECONOMICS OF INTERCITY FREIGHT TRANSPORT

All of the developments in intercity freight transportation must be viewed against the background of steady and significant changes in the structure of the intercity freight market. These changes derive from a steady growth in the service sectors of the U.S. economy, as well as from above-average rates of growth in both population and industrial activity in the Southern and Western portions of the continental United States relative to the older, more industrialized Northeastern region. These changes in the market have been extensively reported on in the work of A. L. Morton and others.<sup>1</sup> Their net effect has been to confer steadily increasing market advantage upon the motor truck industry, whose technology is more readily adaptable to service-quality sensitive markets than the railroad technology which is its principal modal competitor.

All things considered, however, the dramatic, long-term improvement in the cost and performance of our intercity motor truck industry has been more important than the changes in market competition which have stimulated its development. A number of factors have contributed to this overall improvement, but none has been more significant than the development of our Interstate Highway System. That system of trunk highways, intended to link all communities of 50,000 population and above, is now essentially complete. Its capability to provide uninterrupted, high-speed truck operations over long distances may one day be recognized as an even more important contribution to the development of our country than its ability to facilitate personal automobile travel. The reductions it has made in the time and cost of line-haul truck operations have permitted high-quality trucking service to penetrate virtually every freight transportation market of any importance.

Less obvious has been the impact of this highway system and of low-cost, high-capacity diesel road tractors upon the relative costs of railroad and truck transportation. The dramatic narrowing of the gap between rail and truck costs has removed the overwhelming competitive advantage enjoyed by railroads in all long-haul markets since that technology was developed to replace the horse and wagon.<sup>2</sup> In the late-19th century U.S. railroads enjoyed a cost advantage over pre-motor truck road haulers on the order of one of ten. In the super-highway, diesel tractor era of the 1970's that cost advantage has shrunk to no more than 1 to 1.5 on all but bulk, large-volume commodities, such as coal.

The impact of this shrinking cost advantage on rail-truck competition and on the profit levels of our still privately-owned railroad companies is well-known. What is less appreciated and more important is that this narrowed cost gap has eliminated geographic advantage from the economic landscape of intercity freight trans-

portation, except in the purely length-of-haul dimension. That is, freight transport costs are now determined within a relatively narrow band as a function only of the distance which a commodity must be transported, and not as a function of whether the shipper has convenient access to railroad transportation.

The narrowed cost gap has led to this result not only because of its direct effect upon rail-truck movement alternatives, but also because of its indirect effect upon the rate levels which railroad companies can charge for movements originating or terminating in different regions of the country. The rail-competitive trucking industry, composed as it is of a large number of independent, one-man operations, is characterized by internal competition which keeps rates at generally uniform levels. The gap between these rates and the direct cost of rail transportation is sufficiently small that railroad companies, notwithstanding any regulatory constraints, have little room within which to manipulate rates for the purpose of conferring or maintaining any locational economic advantage.

The picture is similar in rail-water competition for the transportation of bulk commodities, in that the system of navigable waterways in the U.S. is almost fully mature. While bulk shippers who have ready access to water transportation enjoy locational advantage over those who do not (because of the significantly lower cost of modern inland marine operations), there seems little possibility that this existing pattern of geographic advantage can be altered significantly by any future public or private actions. Again, the economics of the water transport industry are such that extensive intra-modal competition keeps rates at relatively stable levels determined largely by length-of-haul and the navigation facilities involved. With railroad rate levels constrained within narrow bounds by truck competition, neither private nor public decisions seem likely to perturb the pattern of economic advantage which has already developed.

The U.S. freight transportation system has thus (the out-dated notions of politicians and regulators to the contrary notwithstanding) lost any real usefulness as an instrument of geo-politics and social change. That is, we can no longer promote differential economic growth through the construction of railroads or the exercise of public restraints on the prices charged by freight transportation operating companies. The range of economic impact which can thus be manipulated is simply too narrow. Every one in the continental U.S. has, in effect, equal access to freight transportation whose price and quality are determined almost wholly by the distances over which shipments must be made. These new economic facts of life render unimportant many of the decision issues which have historically occupied the attention of those who study and report on our intercity freight transportation system. Improving the efficiency of this economically and geographically mature system will be the focus of our concerns from this point forward.

#### THE PAST AND PRESENT ROLES OF GOVERNMENT

Government has played a crucial role since the founding of our country in the evolution of its freight transportation system. This role has taken two forms: (1) the direct and indirect provision of financial assistance for the development of the civil works infrastructure of our system of railroads, highways, and improved waterways (2) the establishment of constraints on the commercial practices of private transportation companies, constraints intended to maximize the availability of freight transportation to all sections of the country and to promote the economic development of those which were otherwise disadvantaged. While state governments have

participated extensively in both of these areas, the role of the Federal government has been overriding.

In its role as a provider of financial assistance, government has conferred differential advantage on one type of freight transportation technology or another at various times throughout the 19th and 20th centuries. It has also conferred differential advantage on communities and regions through these same financial assistance policies as applied both to individual modes and technologies and as between modes.

The role of government in providing financial assistance continues today in its ownership and management of the civil works infrastructure of our highway, waterway, and air transportation systems. It has acquired some small share of the U.S. railroad infrastructure, moreover, through the recent purchase by Amtrak (a government-owned corporation) of the Northeast Corridor trackage formerly owned by the Penn Central Transportation Company. In this role as owner and manager of transportation infrastructure, government can affect the efficient allocation of transportation resources (and markets) through its policies for the allocation of cost and assessment of user charges to the transportation companies which make use of those facilities.

In its second role as a regulator of the commercial practices followed by the private operating companies, government has had a profound impact upon the way those operations have developed and thus on the allocation of the intercity freight market to the various modes of transportation competing to serve it. At the Federal level, a pattern of railroad regulation evolved at the turn of the century which was a reflection of the dramatic cost advantage enjoyed by railroad transportation at that time. That pattern of regulation has been applied to a greater or lesser extent to other modes of freight transportation as they have evolved, the very different economic characteristics of those modes and the changing economics of the freight transportation landscape notwithstanding. We thus have a pattern of regulation which was not wholly appropriate when it was fully applied to the intercity freight transportation system by 1940, but one which has also failed to adjust to the different circumstances which have resulted from the recent developments in the intercity motor truck industry discussed above. It is a pattern of regulation, moreover, which was designed importantly to deal with problems of differential economic advantage and not one intended to promote efficiency in freight transportation as our present circumstances dictate.

#### DECISION ISSUES IN INTERCITY FREIGHT TRANSPORTATION

The important decision issues in intercity freight transportation center around the present and prospective inhibitions to improved efficiency which are created by government in its roles as owner and manager of infrastructure and as regulator of commercial practices. For example, while the highway infrastructure is essentially complete in its geographic dimensions, the growing use of that infrastructure by intercity motor freight operators raises questions about the suitability of both the design of the system and the rules for its use. There has been steady pressure from the trucking industry for increasing the allowable axle and vehicle weights on the system, even as concern has been growing among the state agencies responsible for the highways over rapidly increasing civil works maintenance budgets. These problems raise questions concerning the detailed tradeoffs between construction cost, maintenance costs, truck operating efficiency, safety and equity among the operators of large commercial vehicles on the one hand and automobile users of the highways on the other.

There are also questions about the present schedule of user fees paid by the various classes of highway users. These fees are generally intended to cover the cost of highway construction, maintenance, and management,<sup>1</sup> but there is increasing question as to whether such charges ought not also to defray the social costs of the highway system flowing from such phenomena as noise and air pollution. Furthermore, the allocation of the total of these direct and indirect costs between the various classes of users is a matter of particular importance to the commercial operators of heavy motor trucks. If, as recent studies have suggested, a larger share of these costs might logically be assigned to these heavier vehicles, the ultimate impact upon the overall cost of the intercity trucking could be significant.<sup>3</sup>

At the same time, there are problems with the long-standing government policy of providing improved navigation facilities at no cost to the ships and barges which use them. That policy has its origins in a program designed to develop a modern marine transportation system; but this policy of intentional interference with the market allocation of resources in intercity freight transportation continues long after the basic development of that system has been completed. Indeed, despite theoretical lip service to the need for economically rational decisions on further capital improvements to that system, there continues to be no meaningful commercial test of what is and is not built with government funds. The increasing financial difficulties of the U.S. railroad system have finally called these policies into open question and may yet compel a reform of the decision process associated with both investment in and operation of improved navigation facilities.

Government faces even more difficult decisions in its role as a regulator of the commercial practices of all of the railroad companies, the companies handling about half of the intercity motor freight, and a handful of the companies handling inland waterway traffic. Here again, policies intended to facilitate the orderly development of a system which is now fully mature and to control the pricing practices of railroad companies are inappropriate to a time when railroad pricing practices have become narrowly constrained by the capabilities of competing technology. Those policies thus stand as obstacles to improved efficiency, while they are no more than monuments to past transportation development goals. The essential question regarding railroad regulation is whether there is any useful purpose in continuing such regulation at all. Increasingly, the existence of such regulation is seen as a major factor in the inability of our railroads to adapt to changing technological and market circumstances and thus a proximate cause of the financial problems which have led to repeated calls for government financial assistance to the railroads.

Current questions regarding the efficacy of continuing to regulate the commercial practices of the roughly fifty percent of our intercity trucking industry also derive from a growing concern that this regulation inhibits economic efficiency and serves little other purpose. The principal counterargument is that continued regulation is necessary to stabilize an industry composed of a very large number of separate companies whose unrestrained entry and exit into markets would threaten a disruption of service, in particular to shippers in small localities. The issue of efficiency has also received additional attention since the energy crisis of three years ago, in as much as present regulations are seen to cause less efficient use of fuel than would be the case if motor truck operators were more free to carry goods without any geographic constraints on their operations.

More generally, government faces a series of questions on reforming its policies relative to railroad trans-

portation. While looking at its policy on financing highway and waterway infrastructure, it must now consider whether and to what extent there is a need to finance railroad infrastructure. It confronts unresolved questions concerning present and future technological capabilities of both the railroads and their competitors, as well as questions about incentives to improved performance of the various modes which might result from a relaxation of regulation.

#### A FIRST RESEARCH PRIORITY ESTIMATING DEMAND

Most of the decision issues confronting government turn in one way or another upon an understanding of how the market for intercity freight transportation will respond to changes in the performance of one part of the system or another. It is precisely in this respect that our knowledge is most deficient. For example, virtually all of the possible changes in the existing patterns of government regulation of the commercial practices of transportation companies would have some impact upon both their rates and their service. Depending upon how the market responded to those changes, various groups of operating companies would be advantaged or disadvantaged and, possibly, some groups of freight shippers would be advantaged or disadvantaged. Without some reliable means of estimating market elasticities, these shifts in advantage cannot be assessed, nor can the claims and counter-claims of various interest groups be tested in any explicit way.

Similarly, some of the decision issues confronting government in its role as an owner and manager of civil works infrastructure foreshadow changes in transportation system performance that could produce significant shifts in the use of one mode of transportation vis-a-vis another. For example, the imposition of user fees on the inland waterway system, by increasing the rates charged by inland waterway carriers, will predictably have an impact upon rail-water competition for certain major markets, such as the movement of coal. The extent of that impact is important to government decisions on future investments in the inland waterway infrastructure, as well as to questions of prospective financial aid to railroad companies. Without a more competent set of demand-estimating models, the magnitude and character of such impacts cannot be estimated with any assurance.

Research into the development of competent freight demand models has lagged far behind the highly developed procedures for estimating urban passenger travel. It has only been within the past few years that serious work has begun on this problem, which is in important respects more complex than the passenger demand estimating problem.

Despite the somewhat greater difficulty which seems to attend the problem of estimating demand in a very non-homogenous market such as that for freight transportation, the best work now underway borrows directly from the latest thinking in the passenger demand forecasting area. Specifically, the work of Roberts, Ben-Akiva, et al to develop a disaggregate, behavioral system of freight demand estimating models shows great promise as a procedure to assess the market impacts of government policy options in all areas of intercity freight transportation.<sup>4</sup> That work suffers as all previous work has, however, from an inadequate supply of data describing the movements which take place under existing institutional arrangements.

An important part of this demand-modelling problem lies in the development of better level-of service models for the various modes. These level-of service characteristics are important explanatory variables in the market

response process and have become increasingly so as the overall structure of the market has shifted over the past thirty years.

Leaving the special problem of data aside, much research is needed before we can be comfortable with our ability to explain the present market, let alone predict the response of that market to possible future changes such as those which pending public and private decisions might produce.

#### A SECOND RESEARCH PRIORITY- THE ALLOCATION OF PUBLIC COSTS

The direct cost of publicly-provided highway infrastructure and the indirect social cost associated with the use of that infrastructure are fundamental considerations in any rationalization of intercity motor truck operations. That is, a system of highway use charges is needed that will maximize (in all dimensions), the efficiency of our intercity freight transportation system, recognizing that motor truck operations produce about 75% (in value) of all such transportation in the U.S. Our present procedures for estimating social costs and for allocating direct infrastructure costs are not yet competent to give us an adequate basis for structuring such a user charge system.

As for the direct costs, such work as has been done to follow up the findings of the AASHO road tests of the early 1960's has not fully bridged some of the important gaps in our knowledge that must ultimately be filled. In particular, there has been too little empirical work to link the physical degradation of highway structures to the cost associated with their design and repair. In part because that work has not been done, there has been too little work on the explicit optimization of highway design for various classes of highway use, lacking which work options with regard to vehicle size and use regulations can be only imperfectly assessed.

With the growing recognition that heavy truck operations are taking an increasing share of the traffic necessary to provide adequate financial support for our still-extensive system of freight-carrying railroads, the question of truck sizes and the proper assessment against those trucks of their reasonably-allocable share of direct infrastructure cost has become a matter of importance. If the overall efficiency of the intercity freight transportation system can be improved through the more extensive use of heavy truck operations, even when those operations are made to bear their full share of infrastructure cost, then present policy support for the rehabilitation and modernization of the freight-carrying railroad system needs careful review.

In all of this, the procedures used for allocating the largely-common costs of a highway infrastructure used by passenger as well as freight-carrying vehicles poses a difficult and unresolved set of conceptual and analytical issues. The current level of research into this difficult set of problems is inadequate to support the decisions confronting both state and Federal governments in this area.

Research into the related problem of the unrecovered social cost of highway operations has also lagged behind the developing importance of that problem as perceived by the public. Research is needed into both the estimation of these costs and into administratively-feasible and equitable procedures for the assessment of such costs against the highway users themselves.

#### A THIRD RESEARCH PRIORITY- COMMERCIAL REGULATION

The literature on the pros and cons of the commercial regulation of our intercity freight transportation companies is voluminous. Starting with the landmark work by Meyer, Peck, Stenason, & Zwick, a whole series of

transportation economists has examined the classical theories of freight transport regulation in a new methodological framework.<sup>5</sup> Despite this extensive body of work, much remains to be done.

This work has been flawed most importantly because of its failure to confront the changing character and economics of the intercity motor truck industry. This failure has been partly the result of a lack of adequate data on this sprawling and atomistic industry. For reasons discussed earlier in this paper, however, the dramatic changes in this industry have necessarily put the question of regulation in a new light. In particular, the cost and performance of the unregulated sectors of this industry have received too little attention. As a result (other methodological shortcomings notwithstanding), the extensive efforts to estimate the economic dead loss associated with the inefficiencies introduced by regulatory constraints is largely worthless. Lacking any competent means to estimate market response to changes in the efficiency of various types of motor truck operations, moreover, the ultimate effects of any amended regulatory policy cannot be reliably estimated.

At the same time, the potential effects of significant changes in the regulation of railroad commercial practices cannot be assessed rationally on the basis of any of the analytical work done to date. This inadequacy is compounded by changes in the internal economics of railway operations undetected by these same economic researchers. Work to analyze the more competent data sets on railroad markets and operations which are now available has only just begun, and it is work which will inevitably lead to a reformulation of questions posed by the U.S. Congress in its omnibus railroad legislation of a year ago.

All in all, the new era in transport regulatory economics ushered in by the work of Meyer et al must now give way to yet another body of work which is only in its beginning stages. Much research is needed before this new body of work can be given its appropriate direction.

#### A FOURTH RESEARCH PRIORITY- TECHNOLOGICAL CAPABILITIES

Despite extensive studies of inland freight transportation technology conducted by various government agencies and outside research groups over the past few years, there remain lingering uncertainties regarding the future technological capabilities and possibilities for various modes of intercity freight transportation. With specific respect to the U.S. railroad industry, the Congress has mandated a number of studies which are only now getting underway. These studies will look at questions regarding the possibility for improved railroad operating efficiency through restructuring of railroad network operations, through improvements in performance of railroad terminals, through improvements in the utilization of railroad freight equipment, and other related questions. These studies, however, still promise to leave unanswered questions regarding the possibilities for significantly different railroad freight vehicle technology, as well as the reconfiguration of railroad operations which might be facilitated by major changes in the structure of existing railroad labor contracts.

Important questions regarding the possibilities for technological change which would improve the performance of the intercity motor truck industry also require further research. Our ability to do that research is constrained by both the lack of adequate data on the industry and the lack of supporting work on the economics of the highway infrastructure which have already been mentioned. Possibilities for improved energy efficiency in this industry are of particular interest, but have received only preliminary attention, thus far.

The possibilities for the transportation of solids by pipeline are also important. While much research has been done into this relatively new technology (and some solids pipelines installation are already in operation), the ultimate usefulness of such technology is still unclear. Government already faces important decisions concerning legal steps to facilitate the development of this technology, decisions which call for a more credible assessment of the economics of such technology.

Beyond questions relating to the technology of individual modes of transportation there lies a more general set of questions concerning the technological tradeoffs associated with the steadily increasing cost of energy. These call into question, for example, the possibilities for improving the technology of trailer and container on flatcar transportation, a mixed mode of transportation which can potentially reduce the overall energy requirement for some part of the freight transportation job. Similarly, there is increasing interest in the economics of railroad electrification and the extent to which a program of investment (not heretofore justified by relative energy costs and the better-than-average performance of North American diesel locomotives) could assist in reducing the requirement for petroleum-based fuels.

#### THE SPECIAL PROBLEM OF DATA

Overhanging most intercity freight transportation research questions are long-standing problems of inadequate data. The data collection programs of Federal and state governments relating to both the demand and supply sides of this system are fragmentary, unduly constrained by present statutory and administrative restrictions, and inadequately funded. While some additional data are available to the private operating companies in various sectors of the system, the proprietary nature of these data has precluded their availability to those who are researching questions essential to the public decision issues discussed above.

On the demand side, data describing past and present intercity freight traffic flows are simply incomplete. As has been suggested above, this deficiency derives most importantly from a general lack of such information for the traffic being handled by the unregulated sectors of the motor truck industry which account for 35% to 40% of the transportation value produced in the entire intercity freight system. Surveys conducted once every five years by the U.S. Bureau of the Census provide some fragmentary data on these traffic flows, but at a level of detail insufficient to support demand-estimating models competent to deal with the characteristics of specific markets and the competition for those markets between various modes and types of freight transportation operations. Much of the demand-related data that is available lacks important dimensions, moreover, such as that of the actual freight charges paid by shippers whose traffic flows are otherwise reported on. Again, the lack of these dimensions inhibits the development of competent demand models; but it also renders incomplete any assessment of the overall economics of freight transportation such as that essential to many important decision issues.

On the supply side, and not unrelated to the demand side, existing data sets do not provide an adequate pro-

file of the cost and performance of many sectors of the freight transportation business. Again, data on unregulated trucking are virtually non-existent. Such data as we do have often lacks important dimensions, such as the service quality dimension (e.g., transit time and transit time reliability) of the transportation being produced by all modes. As to the modes, themselves, our data on rail transportation are most nearly complete and our data on unregulated truck transportation the most incomplete.

The need for greatly improved and expanded programs of data collection poses significant research issues in its own right. The scale and complexity of the intercity freight transportation business is an important barrier to its development. Research is needed into more automated and reliable data collection techniques. Research is also needed to develop more carefully structured samples which can adequately describe the universe of transportation activities at reasonable cost.

Politics has also played a role in delaying the development of better data collection programs, the need for which has been pointed out repeatedly by transportation researchers over the past twenty years. Because of the cost and complexity of the data collection job and the need for explicit research in this area, the time constants for such a program are very long. Responsible government officials have been less enthusiastic about major government expenditures on projects whose value to those officials is prospectively low, concerned as they are with issues that lie largely in the present and the immediate future.

All in all, this data collection requirement is the most important problem which confronts intercity freight transportation research in the U.S. While much can be done in the important research areas outlined above, and while the quality of the decisions which we confront can be improved by work already underway, the lack of adequate data has seriously affected both the quality and quantity of research done in the past few years. There are many in the U.S. who feel that the most exciting and important research in transport problems turns on the availability of data which we could have but have not yet started to collect. Perhaps the important missing dimension of this problem has been inadequate research into the data collection problem, itself. Fortunately, some new initiatives are being discussed in this area, but too much remains to be done.

#### FOOTNOTES

1. See especially, A. L. Morton, "Freight Demand" unpublished Ph. D. dissertation, Harvard University, January 1973.
2. See D. D. Wyckoff and D. H. Maister, *The Owner-Operator: Independent Trucker* (1975).
3. See, for example, K. Bhatt, R. McGillirray, M. Beesley, and K. Neels, "Congressional Intent and Road Payments", The Urban Institute, Washington, D.C. (1977).
4. See P.O. Roberts, Jr., "Forecasting Freight Flows Using a Disaggregate Freight Demand Model", paper presented at the 56th Annual Meeting of the Transportation Research Board (1977).
5. See J. R. Meyer, M. J. Peck, J. Stenassen, and C. J. Zwick, *The Economics of Competition in the Transportation Industries* (1958). See also work by Friedlaeder, Moore, and others.