Subsidies And External Costs In U.S. Surface Freight Transportation

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ABSTRACT*

The domestic surface freight transportation system is privately operated, but government strongly influences its performance. Government builds and operates roads and waterways; regulates pollutant emissions, truck size and weight, safety, and other aspects of the industry; and collects fees and taxes from freight firms. Government actions in these areas may subsidize some freight movements and penalize others; affect competition among the modes; influence the distribution of costs and benefits of freight activities; and ultimately affect the efficiency of the freight industries.

Efficiency is also affected when freight activities generate external costs--for example, pollution and congestion--which the public must bear, but for which the purchasers of freight services are not directly responsible.

Inconsistencies in the effects of government actions and in the magnitudes of external costs are often cited as justifying changes to policies affecting freight transportation. Examples are proposals regarding user fees, weight limits, rail labor laws, emission controls, urban truck restrictions, and public infrastructure investment. Decisions about such proposals should be made with knowledge about the extent to which current policies foster efficient use of the freight system.

This paper describes a scoping study being conducted by the Transportation Research Board to examine subsidies in surface freight transportation. The scoping study will not provide definitive estimates; rather, it is to explore the potential usefulness of a comprehensive analysis that would measure subsidies and assess their consequences. The scoping study will produce estimates, for a small number of case-study freight movements, of subsidies in freight transport; and guidance to governments on the proper methods of estimating subsidies and on how to apply estimates in making decisions on user fees, infrastructure investment, and regulations.

*The conclusions of this paper are those of the author and do not necessarily represent those of the Transportation Research Board or the National Research Council.

INTRODUCTION

The price that a shipper pays for freight transportation can be lower than the social cost of providing the freight service because of government subsidies or because of external costs. A government subsidy is a payment to an industry or its customers or government provision of a service at below cost; a subsidy would occur, for example, if the cost of providing roads for trucks were less than the taxes trucks paid for road use. External costs are costs that result from the production or consumption of a good or service and that are not borne by the producers or consumers of the good or service. External costs of freight transportation include air pollution, noise, traffic congestion, and accidents, to the extent that these costs are not borne by the carriers or shippers whose actions cause them. An external cost is, in effect, a subsidy, paid by the public directly rather than through government.

Subsidies can lead to inequities because they are transfers of wealth from the public to particular groups, and because they can favor one freight mode to the detriment of firms offering or using other modes. These distributional effects, especially effects on competition between truck and rail and the division of the tax burden for maintaining highways between trucks and automobiles, have motivated much of the historical debate over freight transportation policy. Whether any redistribution that occurs as a result of a public policy is fair or unfair is a matter of political judgment.

Subsidies also encourage inefficient use of transportation services. If shippers are not responsible for the full cost of freight services they purchase, then some purchases will be worth less to the shipper than they cost society as a whole to produce. If shippers and carriers were responsible for all costs, they would find ways to reduce the infrastructure, congestion, and pollution costs of freight.

The Transportation Research Board's (TRB) Committee for the Study of Public Policy for Surface Freight Transportation is examining subsidies affecting the U.S. surface freight industries (truck, rail, and barge). The study is sponsored by the U.S. Department of Transportation and by the state departments of transportation. The committee's tasks are to define the economic framework for such an analysis; roughly assess the scale of subsidies and external costs and their effects on the use of freight and on efficiency; and examine the relevance of such estimates for public policy questions regarding taxation, public investment, and regulation. The committee is to judge whether a comprehensive analysis would be feasible, given current understanding of costs and available data, and recommend whether such an analysis of these issues would be useful.

Freight transportation is a fundamental activity in the U.S. economy. Efficient freight service benefits the public through lower prices and higher living standards. The purpose of examining freight subsidies is to search for opportunities, falling within the sphere of public sector responsibility, to promote economically efficient freight transportation through adjustments to policies on taxation, investment, and regulation. Private sector firms will be able to find the least-cost ways of moving freight as long as markets provide them with information about costs. The concern that gave rise to this study is that certain costs, including the cost of providing public infrastructure and environmental costs, may not now be fully taken into account in private sector decisions regarding freight.

The TRB study is still in progress, and the study committee's report will be published in the summer of 1995. The following sections describe the origin of the study, identify possible uses of estimates of subsidies in freight transportation, and present preliminary results of estimates of subsidies for four case-study freight movements that were prepared for the committee. The committee may make adjustments in the case study methods or estimates before releasing its report.

STUDY ORIGIN

The policy questions underlying this study--how to set highway user fees for trucks, how best to control the pollution and accidents generated by freight, whether waterways subsidies can be justified, how to plan highway capacity to accommodate trucks, and others--are among the oldest, most consequential, and most controversial transportation issues that legislatures, Congress, and public transportation agencies have to deal with. Aspects of these issues have been addressed in many past analyses. The TRB activities that led to the present study were three reports: *Twin Trailer Trucks*[1] and *Truck Weight Limits: Issues and Options*[2], (both conducted in response to Congressional requests) and *New Trucks for Greater Productivity and Less Road Wear*[3] (conducted for the state transportation departments). These three studies all reached similar conclusions--that certain liberalizations of truck size and weight limits would produce freight productivity benefits much greater than any resulting increases in highway maintenance costs, and without significant effects on highway safety, congestion, or pollution. The two most recent TRB studies also recommended changes in truck taxes to make taxes correspond more closely to highway maintenance costs generated by use of particular truck types.

The TRB studies received criticism on grounds that they had underestimated certain costs of truck travel and that their recommendations were politically impractical. More fundamentally, the studies have been subject to the criticism that their recommendations are for incremental changes in a system that may be severely distorted because of subsidies, and that these incremental changes could move the freight system in a direction (toward a greater market share for trucks) that might be the opposite of the direction in which the system would move if the necessary fundamental changes to remove the large market distortions were made. The implication of this criticism is that baseline knowledge about the overall efficiency of the freight transportation system is necessary to set the context for policy decisions about particular incremental changes in regulations, taxes, or other policies that affect freight costs and competition.

TRB initiated the present study of Public Policy for Surface Freight Transportation in response to the need, indicated by the response to past analyses of narrow issues such as weight regulation, for a more comprehensive or strategic perspective on freight transportation policy issues. Support has been received from the National Cooperative Highway Research Program (a joint research program of the state departments of transportation) and from the Federal Highway Administration, Federal Railroad Administration, and Federal Maritime Administration of U.S. Department of Transportation.

Several studies over the past 20 years have estimated social costs of highway transportation and, in some studies, competing modes. These studies have brought to prominence the question of whether highway users are paying their way.

Examples of this growing body of literature include an appendix to the U.S. DOT's 1982 highway cost allocation study report[4], which estimates efficient user fees related to the costs of pavement damage, congestion, air pollution, and noise. *Road Work*[5], a Brookings Institution study, estimates, in an economically rigorous framework, congestion costs and road wear costs for trucks and for cars; and proposes a major change in highway finance and investment that would introduce road-wear pricing, congestion pricing, and a policy of optimal investment in highway durability. *The Going Rate*[6], by the World Resources Institute, estimates aggregate subsidies and external costs for U.S. highway transportation. Costs considered are highway construction, maintenance, and operation; parking; air pollution; the national security cost of energy consumption; accidents; congestion; and noise.

Outside the U.S., *Getting the Prices Right*[7], a study funded by the European Commission, three European

governments, and Swedish State Railways, estimates costs per freight ton and per passenger-km of air pollution, noise and accidents, and proposes a scheme of European user charges to internalize these external costs. *Directions*[8], the report of a Canadian government commission charged with recommending a national passenger transportation policy, deals solely with intercity passenger transport, but its approach is noteworthy--it employs consistent definitions of costs, attempts to include all private and social costs, considers all transportation modes, and examines who bears the cost burden. *Transport and the Environment*[9], a report of a British government commission, exhaustively reviews environmental impacts of transport, freight and passenger, and recommends actions by which the "development of transport can be made environmentally sustainable."

Most past studies differ in approach from the present TRB study, even to the point of defining basic concepts like external costs differently. The present study may also be distinguished from past studies by its focus on freight, its inclusion all surface modes (except pipeline), and its consideration of all costs, external as well as infrastructure costs. The study committee has attempted to advance the state of the art in analyzing some costs (in particular, accidents), address skepticism within the highway community about the relevance of marginal cost and efficiency concepts to practical problems, and address the implications of uncertainty.

IMPORTANCE OF SUBSIDIES

The existence of subsidies degrades efficiency because the market is not providing shippers and carriers incentive to find the best trade-off between the costs and benefits of freight services. A hypothetical example can illustrate this problem. Suppose a truck operator can choose between an Interstate and a non-Interstate route to perform a specific haul. The Interstate route is longer, and from the standpoint of the truck operator costs $30 per trip more for driver labor, fuel, and other operating costs. Therefore, the carrier will always pick the non-Interstate route. Suppose on the non-Interstate route, an added trip generates $30 in highway agency costs, $20 in congestion delay costs, and $20 in accident costs, *above and beyond* the cost the truck operator itself incurs per trip in added road user fees, accident costs, and delay. On the Interstate route, the corresponding costs are $10 highway agency, $5 congestion, and $5 accidents. The costs are different in this hypothetical example because the Interstate has heavier pavements, less congestion, and lower accident rates. (This example refers to the cost consequences of a carrier's route choice, but the choice could be truck vs. rail, day vs. night, one truck configuration vs. another, or any other technological or organizational option open to shippers or carriers.)

From the standpoint of society as a whole, the Interstate route is $20 cheaper than the non-Interstate route ($30 in added truck operator costs; less $20 in highway agency savings, $15 in delay savings, and $15 in accident cost savings). Every trip the truck takes the non-Interstate route is a missed opportunity for society as a whole to save $20.

The government highway agency has at least three policy alternatives to attempt to realize some of this potential savings:

- regulations: for example, require trucks to take the Interstate instead of the non-Interstate road;
- user fees: charge trucks for all their actual costs on both routes, including the accident, congestion, and road wear costs that they are not now paying. Then it would be in truck operators' economic interest to choose the cheaper road.
- investment: improve the capacity, geometry, and pavement of the non-Interstate road so that costs on that road are as low as they are on the Interstate.

Specifying the policy alternatives in practical detail and selecting the best ones are difficult tasks; but governments must make such choices whenever they make decisions about investment, regulation, or fees. The present TRB study is a start at providing the framework and part of the information the government would need to make better choices.

THE FRAMEWORK FOR ANALYSIS: MARGINAL COST

To examine how subsidies affect efficiency, this study has adopted the perspective of marginal cost. The marginal cost of producing a good or service is the increase in total production costs that would result from producing one additional unit of output of the product above the level being produced. The marginal cost of a freight shipment depends on the particular circumstances--time, place, route, equipment, and other factors.

Comparing marginal cost to the price paid is a test of whether the resources devoted to freight transportation are being used efficiently. If a user is charged less than the marginal cost of producing the service used, waste results, because some users value the service at less than the cost of producing it and because producers lack incentive to control some costs. The freight industries would operate most efficiently if the marginal subsidy--the difference between what a shipper pays and the marginal cost of producing service for the shipper--were zero.

The marginal perspective differs from traditional approaches to government cost analysis such as cost allocation studies. The traditional analysis compares aggregate fees paid to aggregate costs of groups of transportation users over an extended time period, rather than comparing costs to prices for individual purchases. For example, in a highway cost allocation study, highway agency costs of all truck travel in a specified weight range, as a class, are compared to fees paid by that class. These comparisons have been made historically to judge the fairness of the user fee scheme. It is likely, however, that the

aggregate comparisons conceal disparities in the relationship of marginal cost to price paid for individual freight shipments; therefore they give incomplete information about how the user fee system is affecting efficiency. Requiring total fee revenues to add up to total cost ensures government cost recovery but provides no guarantee that the fee system is promoting efficiency.

Congestion provides an example of the difference between the marginal and aggregate points of view. Each user of a congested road imposes a cost on all other users, because each user's presence delays all others on the road. This cost is external, and therefore a probable source of economic waste, because when deciding to make a trip, each user considers only his own time cost and disregards the cost to others. Yet, as a class, all road users taken together bear nearly the full costs of congestion delay. From this aggregate perspective, congestion might be judged as not unfair, although the marginal perspective reveals that it probably is wasteful of resources.

In fact, the traditional cost allocation approach does not directly consider congestion as a cost at all; costs are defined as average annual government outlays in a historical period. In contrast, the approach of this study considers all costs including external costs.

OBJECTIONS TO THE FRAMEWORK: EXTERNAL BENEFITS, EQUITY, REVENUE ADEQUACY

Government officials have often expressed skepticism about the relevance of the marginal cost framework for deciding questions of public infrastructure finance or management. For example, the 1982 federal highway cost allocation study stated:

> "...efficiency-based cost assignment methods...are not recommended for this Federal Study. First, the legislative language focuses on equity...Second, the total user charge receipts are to equal the Trust Fund dollar requirements...Third, the user charges set by State and local governments...bear little relationship to efficient charges, and thus changes in the Federal user charge structure aimed at achieving efficiency would be thwarted. Fourth, and most important, Federal user charge instruments could not be developed and implemented that vary geographically and by time of day--a requirement for efficient prices.[10]

As this quotation points out, efficiency in the transportation market certainly is not the only objective of government transportation investment, user fee, and regulatory programs. Objectives often are stated in terms of broad economic development goals, equity concerns, or revenue requirements. However, the existence of these other objectives does not lessen the value of understanding subsidies.

Governments undertake investments in roads and waterways in part to provide the public benefits of improved freight transportation, for example, lower prices and job opportunities. Should these public benefits not be regarded as external benefits, offsetting the external costs generated by freight? An external benefit of freight transportation would be one which carriers had little incentive to provide or to enhance, because it had little effect on their profits or competitiveness. The undeniable public benefits of freight efficiency improvements are not external benefits in this sense; rather, they are the factors that drive the demand for freight services and motivate carriers to improve. Carriers know that to remain competitive they must control costs, adopt innovations, and provide services demanded by shippers.

The user fees needed to encourage efficiency are not necessarily the same as those needed to fund agency budgets. This discrepancy can occur if social costs which do not appear on agency budgets, such as pollution, are included, if the agency's costs do not vary in direct proportion to output, or if the agency has excess or insufficient capacity. Often, revenue needs will determine the average level of user fees. Nonetheless, user fee schemes can collect the required revenue while maintaining some efficiency incentives. Governments need information about marginal cost to design such schemes.

Equity is a key criterion, in addition to efficiency, guiding government provision and finance of transportation services. Governments sometimes provide services that cannot be justified on cost-benefit grounds alone, in order to attain a distribution of benefits that is regarded as equitable (for example, roads in areas of low population density). However, in designing policies to meet this kind of equity objective, governments need to be able to take into account the efficiency costs of the subsidies provided.

APPLICATIONS TO PRACTICAL POLICY PROBLEMS

Public administrators and legislators can use information about subsidies to make freight transportation more efficient. The government policies that most strongly affect freight transportation efficiency are user fees; public investment; environmental, motor vehicle size and weight, and safety regulation; and programs providing direct aid to transportation industries.

One standard policy prescription for improving transportation efficiency is for the government to impose charges on transportation activities that equal the difference between marginal private and social cost. Congestion pricing is an example of this kind of policy. Such pricing proposals have met with objections from public administrators and affected industries on the grounds noted in the previous section, and also because they are seen as complex to administer, because they lack public acceptance, and because no consensus exists that the present structure of taxes and regulations has so many failings that the risks of fundamental change would be justified.

These reservations are valid in many cases, and radical change in the existing systems of infrastructure finance or safety and environmental regulation may not occur soon. Nonetheless, analysis of subsidies would lead to practical applications, outlined below.

Establishing a Benchmark A comprehensive analysis of subsidies in freight transportation would indicate whether a major economic payoff could be expected if the technical, administrative, and political obstacles to eliminating the subsidies and internalizing the external costs could be overcome. It is possible today to predict qualitatively that if shippers and carriers paid prices closer to the marginal cost of freight shipments then the social cost of freight transportation would decline and economic welfare would improve. But, on the basis of existing information, it cannot be judged whether the gains would be great or small relative to the total cost of freight, or whether the gains would be great enough to justify a major effort at reform of user fees and regulations, considering other competing priorities for government attention. A comprehensive analysis that estimated the magnitudes of subsidies and projected how freight markets would respond if subsidies were eliminated would yield an estimate of the loss to the economy caused by the existence of subsidies.

Refining Existing User Fee Structures Government is already using prices to a limited extent to finance highways and waterways and incidentally to regulate their use and wear. Trucks pay various federal and state highway user fees, and tow operators pay a fuel tax whose revenues contribute to the capital cost of the waterways. New toll roads are being developed, and proposals for congestion pricing to manage urban road use are receiving more serious attention. Existing user fees often depart greatly from the ideal of marginal cost pricing; truck fees do not vary with the level of congestion or the strength of the pavement on the roads the truck uses, for example. But the fees are tied to use of transport services and may contribute to more efficient freight transportation, especially compared with the alternative of charging no user fees. Refinements within the established user fee scheme might lead to much greater efficiencies.

Although highway and waterway cost allocation studies generally do not consider the implications of alternative tax and financing systems for economic efficiency, many of the tax changes to which these studies' results lend support (for example, more steeply graduated registration fees with vehicle weight or weight-distance taxes) might increase incentives to use highway resources more efficiently, and so yield economic benefits for the public as a whole. The decision whether to adopt any of these tax changes ought to depend in part on how great this economic payoff would be. In a debate dominated by arguments about fairness, however, the question of public economic benefits often is obscured. The public interest would be clearer if analysis of the effects of alternative user tax schemes on overall economic efficiency in the freight industries were incorporated in cost allocation studies. This analysis would entail comparing marginal costs to user fees and projecting how facility users would respond to changes in the fees.

Evaluating Proposed Capacity Expansion Evaluation of a capacity expansion proposal should assess the feasibility and likely effects of pricing to internalize the external costs of congestion, as an alternative to expansion or to finance expansion. Waterways investment planning provides an example. Government cost-benefit analysis of proposed capital improvements to the inland waterway system has concluded that cost savings from reduced delay at locks would be great enough to justify substantial investment in increased capacity[11]. Because delay costs are largely external, however, public investment to expand capacity may not be the most economically beneficial response. It is possible that, if waterways users were given the incentive, through some form of congestion pricing, they would find ways to reduce delay costs by changes in schedule, equipment, routing, or freight mode, thereby reducing the magnitude of economically justifiable government capital investment.

Cost-Effective Regulations While pricing already plays a role in the finance and management of public infrastructure, regulation has been the principal public response to external safety and environmental costs. Programs to manage these costs through pricing may not be implemented any time in the near future. Nonetheless, assessing whether freight transportation users pay their way can help in design of cost-effective regulations by revealing how marginal cost varies with circumstances among individual shipments or categories of shipments.

The case study cost estimates developed during this study illustrate how greatly marginal external costs can vary with geographical area, the route selected, vehicle characteristics, time of day, and other factors. Safety and environmental regulations that targeted circumstances where marginal external costs are relatively high, would (assuming regulatory compliance costs are uniform) be more cost-effective than indiscriminate regulations. An example of such an analysis, in the case of emissions regulations, would be comparison of the effects of controls targeting extreme emitters in densely populated areas with controls applied more uniformly.

DEALING WITH UNCERTAINTY

Any estimates are bound to include uncertainties or errors. Some of these uncertainties probably can be reduced by future research, although progress on some topics has proven difficult. Nevertheless, the fact that estimates are uncertain does not mean that it is impossible to use them responsibly. The key is to be mindful of the degree and character of the uncertainties involved. Explicit estimates of whether freight users pay their way, even if very uncertain, are needed because the only alternative is that government transportation policy decisions will be based on unstated, implicit estimates of social costs and benefits. Assumptions, stated or unstated, about whether users are paying their way are central to all important policy debates in freight transportation. Without explicit estimates, policy makers and the public have little basis on which to judge arguments on issues such as truck size and weight. Yet choices are eventually made among the policy options and these choices imply that government authorities accepted one set of assumptions about costs as more plausible than the others.

Explicit estimates subject assumptions about costs to scrutiny, debate, and refinement. The range of disagreement is likely to be narrowed or, if not, at least the source of the disagreement will be clearer so that others can make more reasonable judgments about whose figures are more plausible.

ESTIMATES CAN BE MISUSED

In the preceding sections it has been argued that estimates of subsidies in freight transportation ought to be useful to policy makers. Before results of estimates conducted for this study are presented, it also should be noted that estimates of subsidies can easily be misinterpreted or misapplied. The most common misapplication is to attempt to argue in favor of a regulatory intervention or public expenditure solely on the basis of an estimate of an apparently substantial external cost associated with a transportation service. The British study cited above, *Transport and the Environment*, is an example of the propensity to make premature policy recommendations. After thoroughly documenting external costs and subsidies in transportation in the U.K, the report recommends that "Transport policy...[give] priority to minimising the need for transport and increasing the proportions of trips made by environmentally less damaging modes." [12] Regarding freight, the report concludes that "An essential element in any sustainable transport policy is to move as much freight as possible by the less damaging modes"[13] and goes on to recommend quantitative mode share targets for rail, highway, and water. Yet no analysis is presented in the report to demonstrate that such policies would, on net, improve economic welfare or be the least costly means to attain environmental objectives.

The existence even of large external costs is no assurance that intervention to suppress travel or subsidies to favor particular modes would improve efficiency or be the most cost-effective practical responses. Proponents of such policies often overlook the possibility that the value of the current service might be so high that users would be more than willing to pay the full cost, even though they are not now being asked to do so; or that, in other cases, carriers or shippers might be able to easily and cheaply reduce an external cost if they were held responsible for it. Poorly targeted policies may discourage beneficial uses of the transportation system or encourage additional wasteful uses, and so reduce economic welfare rather than increase it.

PRELIMINARY CASE STUDY RESULTS

This section presents summary results of subsidy estimates for case study freight movements that were prepared for the TRB study committee. Documentation of the methods of producing the estimates is beyond the scope of this paper. The methods will be presented in the forthcoming report of the TRB Committee for the Study of Public Policy for Surface Freight Transportation.

The case studies illustrate methods of estimating whether shippers pay the marginal social costs of specific freight movements. The objectives of the estimates are to reveal the practical difficulties of defining subsidies, examine the limitations of available models and data, identify the main sources of uncertainties, indicate the categories of subsidy and the kinds of freight activities that may be most important, and judge the feasibility of a more definitive analysis. Estimates were made for case studies, rather than for nationwide aggregates, to ensure inclusion of critical local or industry-specific factors that influence the magnitudes of external costs and subsidies, but which would tend to be obscured in an aggregate analysis.

The cases are as follows:

1. Shipment of grain from a Minnesota elevator to a Mississippi River port (Walnut Grove, Minn. to barge terminal at Winona, Minn.):

   1A: truck via U.S. 14
   1B: truck via Interstate 90 (a more circuitous route over better roads)
   1C: shortline railroad between the same points

2. Shipment of grain from Walnut Grove to New Orleans by rail and barge:

   2A: rail to Winona; barge from Winona to New Orleans
   2B: rail to St. Louis; barge from St. Louis to New Orleans

3. Container freight from Long Beach, California to Chicago

   3A: truck via fastest Interstate route
   3B: rail linehaul with truck drayage

4. A day-long trip of a grocery distribution truck from a warehouse to retail stores in metropolitan Hartford, Conn.

The cases were selected arbitrarily to represent a variety of circumstances. They are not necessarily typical and do not provide a basis for generalizations.

For each case, estimates have been made of the subsidies that would be incurred by one additional trip over the route. The subsidies estimated are:

- congestion: the delay cost to others caused by the added trip on a congested road or waterway (rail delay costs were assumed internal);

- accidents: costs of deaths, injuries, and property damage that occur because of the added shipment and are not borne by the freight operator;

- air pollution: costs of the emissions produced by the shipment;

- energy consumption: the difference between the social and private costs of petroleum consumed in the trip that may arise if the market does not properly value the expected costs of macroeconomic impacts of supply disruptions;

- noise: cost of noise exposure caused by the trip;

- public facility subsidies: the increase in costs of the public operating agency caused by the added shipment, less marginal user fees.

Numerous sources of uncertainty affect the estimates of individual cost components. Keeping in mind that the estimates are imprecise and not intended to be representative, the results (Table 1) suggest the following tentative observations:

- the magnitude of the net subsidy in these cases appears often to be not very large compared with private costs. Six of the eight subcases show a net marginal subsidy of between five and 13 percent of average carrier cost.

- The cases do not indicate that subsidies as a percentage of carrier average cost are systematically higher or lower for truck than for rail. If this pattern held generally, eliminating subsidies might have little effect on truck and rail market shares.

- The analysis did not consider how subsidies affect freight markets, so no estimate of the size of economic losses can be made. However, subsidies appear to be significant enough that the potential for improving freight efficiency by mitigating their effects warrants more extensive examination.

- The estimates illustrate that the size of subsidies is highly variable, depending on the location, freight mode, time, and other characteristics of the movement.

- Marginal external costs of accidents and congestion often appear to be among the major sources of subsidy. In the two cases with the highest net marginal subsidy as a percentage of carrier average cost (the truck container movement and the barge movement from Winona, Minn.) congestion delay is the largest category of net marginal subsidy.

Of course, conclusions drawn from just four observations cannot be very credible. The case studies constitute a trial of a possible methodology for an expanded analysis of subsidies in U.S. surface freight transportation that could support firm conclusions. Such an analysis could be conceived as an extension of the case estimates performed for this study, including a representative sample of freight shipment cases and using more detailed and careful estimation methods.

UNCERTAINTIES

The following are important sources of uncertainty revealed in the case studies.

Diesel Particulates In these cases, the health effects of diesel particulates account for a major portion of air pollution costs. Air pollution is never the largest of the external cost categories; however, the uncertainty in the pollution cost estimates is large, and the possibility exists that air pollution costs are much more serious than the mid-range estimates indicate.

Sources of uncertainty include emission rates of vehicles, the relation of emissions to exposure, the dollar value that individuals assign to reducing their risk of premature death, and the relative health effects of particulates generated by diesel engines compared with so-called fugitive emissions such as dust from roadsides and construction sites. The case studies may underestimate pollution costs if diesels often emit pollutants at substantially higher rates than U.S. Environmental Protection Agency models predict, if diesel-generated dust is more toxic than fugitive dust, or if dust is generated from roadsides at the rate that the Environmental Protection Agency estimates and is attributable to the passage of vehicles. They may overestimate the cost if the assumed health effects of particulates or the assumed value of reduced risk are too high.

Accidents Although uncertainties exist in the data on accident frequencies and costs, the major source of uncertainty is the relationship between the truck-car fatal accident rate and truck traffic volume on a road. The marginal cost of accidents depends on how each vehicle's risk of an accident changes as traffic increases. Relationships between accident rates and traffic volume have never been adequately measured.

Congestion The major uncertainty in the highway delay estimates probably is the contribution of non-recurring delay, that is, delay that occurs because of vehicle breakdowns or accidents. So-called recurring delay results from the effect of traffic volume on average speed. The case study estimates assume, based on very limited information, that non-recurring delay costs are larger than recurring delay costs on all roads. If, in fact, non-recurring delay costs are insignificant on many roads, then marginal external delay costs may be less than half the values estimated in the cases.

CRITICAL DATA GAPS

The case study results indicate that the following measurements of impacts of freight transportation are among the most critical needs for producing reliable estimates of the efficiency of the freight industries.

- Measurement of the external safety cost of increased truck traffic. This will require measurement of the

Table 1. Summary of preliminary case study estimates.

Case	Net marginal subsidy ($)	Carrier average cost ($)	Subsidy as % of carrier cost	Subsidy truck-load-mi ($)
1. Grain, Minn. to to Miss. river port				
1a. truck	54	450	12	.25
1b. truck via Interstate	44	530	8	.17
1c. rail	12	120	9	.06
2. Grain, Minn. to New Orleans via rail & barge				
2a. rail to Winona; barge to New Orleans	127	440	29	.08
2b. rail to St. Louis; barge to New Orleans	34	590	6	.02
3. Container, LA to Chicago				
3a. via truck	343	2,470	14	.15
3b. via rail linehaul	132	1,050	13	.06
4. Hartford grocery distribution	20	280	7	.36

Note:

The estimates apply only to the cases specified. The estimates are subject to large uncertainties and are not generalizable to freight traffic as a whole.

Definitions:

case: the movement of one truckload of freight over the specified route. For rail and barge movements, the cost is estimated for one additional train or one additional tow, respectively, over the route, and this cost is prorated on the basis of cargo weight to cost per truckload.

net marginal subsidy: the sum of marginal external accident, air pollution, noise, petroleum consumption, and congestion costs, plus the marginal cost of government-provided roads and waterways, less user fees paid to government for the shipment.

carrier average cost: The average freight charge that would be paid by shippers for similar freight movements.

subsidy as percent of carrier cost: 100x(net marginal subsidy)/(carrier average cost)

subsidy per truckload-mi: The net marginal subsidy divided by the number of truckload-mi constituting the shipment. A truckload-mi is the movement of one truckload of freight one mile. One truckload is 48,380 lb of grain in Cases 1 and 2 and one loaded container in Case 3. In Case 4, all fully or partially loaded miles of the truck are counted as a truckload-mi.

relationship between traffic volume and accident rates, and reliably measuring average truck accident rates.

- Measurement of the air-quality effects of a change in freight volume on a road, waterway, or rail line, especially the effect on particulate concentration. Understanding air pollution costs will require collection of in-use emissions data for a random sample of vehicles, statistically valid sample measurements of concentrations, and studies comparing the health effects of particulates from different sources.

- Systematic measurement, for a variety of road environments, of the non-recurring component of highway congestion delay and of truck passenger-car-equivalence ratings.

- Improved measurement of the marginal road wear costs of truck traffic on a site-specific basis: the relationship of truck traffic to bridge fatigue cost, and analysis of the relationship of highway agency maintenance and reconstruction practices to road user and agency costs.

SUMMARY

The principles guiding the TRB study of subsidies in freight transportation may be summarized as follows:

- Subsidies degrade the efficiency of the freight transportation industries and thus reduce overall economic welfare.

- Subsidies also affect the fairness of government transportation programs. The study has emphasized information needs to understand the efficiency effects of policies, because efficiency gets too little attention in policy debates and because policies that score high on the efficiency standard generally will be seen as equitable.

- Judging efficiency requires comparing the prices shippers pay with the marginal social cost of freight transportation, that is, the cost to all members of the public of producing added freight service.

- Information about subsidies would provide a benchmark for determining the overall impact of government transportation programs on freight industry efficiency and for determining whether the current structure of the freight industries is seriously out of balance.

- Information about subsidies would have practical value in guiding government decisions regarding user fees, investment plans, and environmental and safety regulations.

- Estimates of subsidies are easy to misapply. In particular, a finding that some activity is generating a large external cost is not in itself justification for government intervention through regulation, offsetting subsidies, or public spending to reduce the cost.

- The preliminary estimates of this study, while highly uncertain, suggest that subsidies are large enough that the possibility of improving efficiency through reducing subsidies is worth public consideration.

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