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HIGHWAY AND TRANSIT INVESTMENTS

Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results

GAO-05-172

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GAO Accountability·Integrity·Reliability

Highlights

Highlights of GAO-05-172, a report to congressional committees

Why GAO Did This Study

Mobility is critical to the nation's economy. Projections of future passenger and freight travel suggest that increased levels of investment may be needed to maintain the current levels of mobility provided by the nation's highway and transit systems. However, calls for greater investment in transportation come amid growing concerns about fiscal imbalances at all levels of the government. As a result, careful decisions will need to be made to ensure that transportation investments maximize the benefits of each federal dollar invested.

In this report GAO identifies (1) the categories of benefits and costs that can be attributed to new highway and transit investments and the challenges in measuring them; (2) how state, local, and regional decision makers consider the benefits and costs of new highway and transit investments when comparing alternatives; (3) the extent to which investments meet their projected outcomes; and (4) options to improve the information available to decision makers. To address these objectives, we convened an expert panel, surveyed state departments of transportation and transit agencies, and conducted site visits to five metropolitan areas that had both a capacity-adding highway project and transit project completed within the last 10 years. DOT generally agreed with the report's findings and offered technical comments, which were incorporated as appropriate.

www.gao.gov/cgi-bin/getrpt?GAO-05-172.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Katherine Siggerud, (202) 512-2834, siggerudk@gao.gov.

What GAO Found

A range of direct and indirect benefits, such as savings in travel time and positive land-use changes, and costs can result from new highway and transit investments. The extent to which any particular highway or transit investment will result in certain benefits and costs, however, depends on the nature of the project and the local economic and transportation conditions where the investment is being made. In addition, measuring project benefits and costs can be challenging and is subject to several sources of error. For example, some benefit-cost analyses may omit some benefits or double-count benefits as they filter through the economy.

Officials we surveyed and visited said they considered a project's potential benefits and costs when considering project alternatives but often did not use formal economic analyses to systematically examine the potential benefits and costs. Even when economic analyses are performed, the results are not necessarily the most important factor considered in investment decision making. Rather, our survey responses indicate that a number of factors, such as public support or the availability of funding, shape transportation investment decisions. Officials we interviewed indicated that they often based their decision to select a particular alternative on indirect benefits that were often not quantified in any systematic manner, such as desirable changes in land use or increasing economic development.

Available evidence indicates that highway and transit projects do not achieve all projected outcomes; in addition, our case studies and survey show that evaluations of the outcomes of completed projects are not frequently conducted. A number of outcomes and benefits are often projected for highway and transit investments, including positive changes to land use and increased economic development. These projected outcomes were often cited as reasons why the projects were pursued. However, because evaluations of the outcomes of completed highway and transit projects are not typically conducted, officials have only limited or anecdotal evidence as to whether the projects produced the intended results.

Several options exist to improve the information available to decision makers about new highway and transit investments and to make analytic information more integral to decision making. These options, such as improving modeling techniques and evaluating the outcomes of completed projects, focus on improving the value this information can have to decision makers and holding agencies accountable for results. Even if steps are taken to improve the analytic information available to decision makers, however, overarching issues, such as the structure of the federal highway and transit programs, will affect the extent to which this information is used. Nevertheless, the increased use of economic analysis, such as benefit-cost analysis, could improve the information available, and ultimately, lead to better-informed transportation investment decision making.

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Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AMPO	Association of Metropolitan Planning Organizations
BEA	Bureau of Economic Analysis
DOT	Department of Transportation
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
ISTEA	Intermodal Surface Transportation Efficiency Act
MPO	Metropolitan Planning Organization
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
OMB	Office of Management and Budget
TEA-21	Transportation Equity Act for the 21st Century
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
ROW	Right-of-way

GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, D.C. 20548

January 24, 2005

The Honorable Thad Cochran
Chairman
The Honorable Robert C. Byrd
Ranking Member
Committee on Appropriations
United States Senate

The Honorable Jerry Lewis
Chairman
The Honorable David R. Obey
Ranking Member
Committee on Appropriations
House of Representatives

Mobility—that is, the movement of passengers and goods through the transportation system—is critical to the nation's economic vitality and the quality of life of its citizens. Mobility provides people with access to goods, services, recreation, and jobs; provides businesses with access to materials, markets, and people; and promotes the movement of personnel and material to meet national defense needs. However, increasing passenger and freight travel has led to growing congestion in the nation's transportation system; and projections of future passenger and freight travel suggest that this trend is likely to continue. Several strategies exist for addressing this congestion, including improving operations and system management, or managing system use through pricing or other techniques. One of the key strategies is to invest in new capacity in the transportation system. In 2002, capital outlay from all levels of government for highways was about $68.2 billion, with $26.5 billion specifically for new or expanded capacity. For transit, 2002 capital outlay was about $12.3 billion from all levels of government, with $8.7 billion specifically for new capacity. The Department of Transportation (DOT) estimated that about $90 billion in capital spending on average will be required each year to maintain the condition and performance of the nation's highway and transit systems through 2020 and approximately $127 billion in capital spending to improve the conditions of these systems.[1]

[1]U.S. Department of Transportation, *2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, Report to Congress* (Washington, D.C.: 2002). Estimates are in 2000 dollars.

Calls for increased transportation investments come amid growing concerns about the size of federal and state budget deficits, the long-term viability of financing the nation's highway and transit systems through motor-fuel taxes, and the future mandatory commitments to Social Security and Medicare that will consume a greater share of the nation's resources. Given these fiscal challenges, careful decisions will need to be made to ensure that transportation investments maximize the benefits of each federal dollar invested and achieve projected outcomes. As we have noted previously, there are no mechanisms in the federal-aid highway program that link federal funding to project performance.[2]

The House Appropriations Committee report, accompanying the fiscal year 2004 Departments of Transportation and Treasury and Independent Agencies Appropriations Bill, requires that we review the costs and benefits of the different modes of transportation.[3] We limited our review to the costs and benefits of new highway and transit investments. Accordingly, this report (1) describes the categories of benefits and costs that can be attributed to new highway and transit investments and the challenges in measuring these benefits and costs; (2) identifies how state, local, and regional decision makers consider the benefits and costs of new highway and transit investments when comparing alternatives; (3) examines the extent to which select capacity-adding highway and transit investments meet their projected outcomes; and (4) describes options to improve the information available to decision makers about new highway and transit investments.

To address these objectives, we convened, in collaboration with the National Academy of Sciences, an expert panel of transportation economists and practitioners, conducted an extensive literature review, and interviewed officials from the Federal Transit Administration (FTA) and Federal Highway Administration (FHWA) as well as representatives from various industry associations, think tanks, and academic institutions. We also surveyed all 50 state DOTs and the 30 largest transit agencies about the type of economic analysis they use when considering transportation alternatives and how such analysis is used in decision making, and we

[2]GAO, *Federal-Aid Highways: Trends, Effect on State Spending, and Options for Future Program Design*, GAO-04-802 (Washington, D.C.: Aug. 31, 2004).

[3]H.R. 108-243.

received responses from 43 state DOTs and 20 transit agencies.[4] In addition, we developed case studies by conducting site visits to five metropolitan areas across the nation that had both a capacity-adding highway project and transit project completed within the last 10 years.[5] During these site visits, we reviewed project documents and interviewed officials from the respective transit agency, metropolitan planning organization, and state DOT. We conducted our work from February 2004 through January 2005 according to generally accepted government auditing standards.[6]

Results in Brief

The categories of benefits that transit and highway projects may produce include two types of direct benefits—those to users, such as savings in travel time, and those to users and nonusers alike, such as reductions in the adverse environmental impacts of transportation. These direct benefits can in turn produce indirect benefits, such as economic development, although indirect benefits are harder to accurately estimate. For example, by creating changes in how nearby land is used or developed, such projects can increase productivity or spur economic growth, but some of this benefit may represent a transfer of economic activity from one area to another. Although transfers can represent real benefits for the jurisdiction making the transportation improvement, from a national perspective, they do not represent net benefits. The costs against which these direct and indirect benefits must be weighed are likewise varied. They include costs to build, operate, and maintain the project, as well as less obvious items such as traffic delays caused by the project's construction or the effects of unmitigated changes to the environment. These benefits and costs can vary greatly, depending on the specifics of the project and on local economic and transportation conditions. Experts and practitioners identified several

[4]We surveyed state DOTs about capacity-adding highway projects and transit agencies about New Starts transit projects because these agencies are typically project sponsors and responsible for identifying and evaluating specific project alternatives.

[5]Specifically, we visited the Baltimore, Dallas, Miami, Denver, and San Jose metropolitan areas. All of these metropolitan areas are among the top 25 most congested areas, as measured by the Texas Transportation Institute. These projects should not be considered representative of all transportation projects but are rather illustrations of experiences with specific types of projects.

[6]See appendix I for a complete description of our scope and methodology, appendix II for our survey instrument and results, and appendix III for profiles of the panelists from our expert panel.

challenges in measuring these benefits and costs. One set of challenges involves limitations in the methods themselves—for example, limitations in the ability of forecasting models to anticipate changes in traveler behavior or changes in land use. Another set of challenges involves sources of error that can be introduced into benefit-cost calculations, such as omitting some benefits or double-counting benefits as they filter through the economy. These challenges can make it difficult to comprehensively and accurately consider all the various benefits and costs associated with a project.

The majority of local, regional, and state transportation officials we surveyed and interviewed told us they consider various benefits and costs of projects when evaluating transportation alternatives; but they often do not use formal economic analytical tools, such as a formal benefit-cost analysis, to do so. If they use formal analyses, they tend to do so more often on transit projects than on highway projects. Local and state officials noted that these formal analyses are done more often for transit projects because of the New Starts requirements. For example, the New Starts program requires that project sponsors calculate the cost-effectiveness of their proposed transit projects. In contrast, there are no similar federal requirements for economic analysis of highway projects, because highway projects are funded under a formula program, and there is no federal approval of project economic worthiness. However, regardless of the type of project, our survey responses indicated that such analyses were just one factor considered and not necessarily the most important factor in deciding whether to proceed with a project. Similarly, officials at the locations we visited indicated that they often based their decision about whether to proceed primarily on the project's perceived indirect benefits, such as desirable changes in land use or economic development, which are difficult to forecast and were generally not quantified or systematically analyzed in the planning documents we reviewed.

The available evidence indicates that highway and transit projects often do not meet projected outcomes such as cost and usage, while other projected outcomes such as economic development or land-use impacts are not regularly evaluated. Results from our case studies, as well as analyses conducted by others, show that completed highway and transit investments often result in higher than expected costs and usage that are different from what was projected. For example, a study of over 250 transportation projects found that costs were 28 percent higher on average

than projected costs.[7] FTA has implemented a number of measures to improve usage and cost estimates for New Starts projects, including holding senior executives accountable for project cost overruns and assessing the risks related to the project schedules and budgets. In addition to projections about usage, a number of other outcomes and benefits were projected for the 10 highway and transit projects we reviewed, including positive changes to land use, increased economic development, improved travel time, and reduced emissions. According to transportation officials we interviewed, these projected outcomes were important reasons that the projects were pursued. However, we found that evaluations of the outcomes of completed highway and transit projects are typically not conducted. Because these evaluations are not regularly conducted, officials only have limited or anecdotal evidence of whether the projects produced the intended results. For example, in several areas we visited, transportation officials discussed development occurring in the area around the transportation improvement, although the benefit of such development was not quantified; and it is unclear whether such development would have occurred in the area or elsewhere if the project was not constructed. Because outcome evaluations are not usually completed, transportation agencies miss an opportunity to learn from the successes and shortcomings of past projects to better inform future planning and decision making and increase accountability for results. To identify lessons learned for future projects and hold transit agencies accountable for results, FTA recently instituted a new requirement for before and after studies of transit projects funded under its New Starts program.

There are several options to improve the information available to decision makers about new highway and transit investments and to make analytic information more integral to decision making. These options focus on improving the value that this information has to decision makers and holding agencies accountable for results. They range from improving the quality of data, modeling, and analytic tools to evaluating the results of completed transportation projects. These options could be implemented through incentives or mandates, although each of these approaches has its own degree of difficulty in implementation, time required, and impacts on federal programs and resources. Any attempt to implement these options,

[7]Bent Flyvbjerg, Mette Skamris Holm, and Soren Buhl, "Underestimating Costs in Public Works Projects: Error or Lie?,"*Journal of the American Planning Association*, Vol. 68, No. 3 (2002).

however, needs to be tempered with the knowledge that overarching issues, such as the structure of the federal programs or legislative earmarks, will affect the extent to which this information is used. For example, the Transportation Equity Act for the 21st Century (TEA-21) requires local, regional, and state transportation agencies to consider a number of factors in their planning, such as economic vitality, safety, accessibility, and environmental issues. Consequently, these statutorily defined factors can be more important than the results of a benefit-cost analysis in selecting a transportation project for funding. These overarching issues could also steer decision makers away from the most cost-beneficial projects. Nevertheless, the increased use of economic analytical tools, such as benefit-cost analysis, could improve the information available to decision makers and, ultimately, lead to better-informed transportation investment decision making.

We provided copies of the draft report to DOT, including FTA and FHWA. Overall, DOT said that the report presented a clear and useful assessment of the status of economic analysis in its application to evaluating transportation projects. DOT offered a number of technical comments, which were incorporated as appropriate.

Background

The scope of the nation's transportation system is vast and increasingly congested. Two key components of the transportation network are the nation's highways and transit system. There are approximately 4 million miles of highway in the United States, which serve to provide mobility to millions of passengers and millions of tons of freight each day. In addition, over 600 transit agencies provide a range of transit services to the public,

including rail and bus service.[8] Each workday, about 14 million Americans use some form of transit.

Over the last 20 years, all levels of government, including the federal government, have spent hundreds of billions of dollars on the nations' highways and transit systems to enhance mobility as well as meet other needs. Despite these expenditures, increasing passenger and freight travel has led to growing congestion. For instance, annual delays per traveler during rush hour have almost tripled, increasing from 16 hours in 1982 to 46 hours in 2002.[9] According to DOT forecasts, passenger and freight travel will continue to increase in the future.[10] There are a number of strategies, such as preventive maintenance, improving operations and system management, and managing system use through pricing or other techniques, which can be taken to help address the nation's mobility challenges. One of the key strategies is to invest in new physical capacity in the transportation system. While such investment is the subject of this report, as we have noted in the past, a targeted mix of these strategies is needed to help control congestion and improve access.[11] (See app. IV for additional information about the level of usage of and investment in the nation's highway and transit systems.)

[8]There are several types of rail transit, including commuter, heavy and light rail. The National Transit Database defines commuter rail as a transit mode that is an electric or diesel propelled railway for urban passenger train service consisting of local short-distance travel operating between a central city and adjacent suburbs. Heavy rail is defined as a transit mode that is an electric railway with the capacity for a heavy volume of traffic. It is characterized by high speed and rapid acceleration passenger rail cars operating singly or in multicar trains on fixed rails, separate rights-of-way (ROW) from which all other vehicular and foot traffic are excluded, sophisticated signaling, and high-platform loading. Light rail is defined as a transit mode that typically is an electric railway with a light volume traffic capacity, compared with heavy rail. It is characterized by passenger rail cars operating singly (or in short, usually two-car trains) on fixed rails in shared or exclusive ROW, low- or high-platform loading, and vehicle power drawn from an overhead electric line via a trolley or a pantograph.

[9]David Schrank and Tim Lomax, *The 2004 Urban Mobility Report* (College Station, TX: Texas Transportation Institute, September 2004).

[10]U.S. Department of Transportation, *Conditions and Performance Report.*

[11]GAO, *Surface and Maritime Transportation: Developing Strategies for Enhancing Mobility: A National Challenge*, GAO-02-775 (Washington, D.C.: Aug. 30, 2002).

The funding for new transit and highway projects comes from a variety of sources, including federal, state, and local governments; special taxing authorities and assessment districts; and user fees and tolls. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and TEA-21 continued the use of the federal Highway Trust Fund as the mechanism to account for federal highway user-tax receipts that fund various highway and transit programs.[12] Once Congress authorizes funding, FHWA makes federal-aid highway funds available to the states annually, at the start of each fiscal year, through apportionments based on formulas specified in law for each of the several formula grant programs. Ninety-two percent of the federal-aid highway funds apportioned to the states in fiscal year 2003 were apportioned by formula.[13] According to DOT officials, the majority of federal-aid highway funds are used for maintenance purposes, not new investments. FTA also uses formulas to distribute federal urbanized and nonurbanized funds for capital and operating assistance to transit agencies and/or states. FTA also has discretionary transit programs, including the New Starts program. The New Starts program provides funds to transit providers for constructing or extending certain types of transit systems and is the primary source of funding for new transit capacity.

FTA generally funds New Starts projects through full-funding grant agreements, which establish the terms and conditions for federal participation in a project, including the maximum amount of federal funds available for the project. To compete for a full-funding grant agreement, a transit project must emerge from a regional planning process. The first two phases of the New Starts process—systems planning and alternatives analysis—address this requirement. The systems planning phase identifies the transportation needs of a region, while the alternatives analysis phase provides information on the benefits, costs, and impacts of different corridor-level options, such as rail lines or bus routes. The alternatives analysis phase results in the selection of a locally preferred alternative—which is intended to be the New Starts project that FTA evaluates for funding. After a locally preferred alternative is selected, the project is

[12]P.L. 102-240 and P.L. 105-178, respectively. In 1983, the Highway Trust Fund was divided into two accounts: a Highway Account and a Mass Transit Account. The Highway Account mainly funds federal highway programs, and the Mass Transit Account funds federal transit programs.

[13]The remaining highway program funds were distributed through allocations to states with qualifying projects. For more information about the structure of the federal-aid highway grant program and formulas, see GAO-04-802.

eligible for entry into the New Starts process. FTA oversees the management of projects from the preliminary engineering phase through construction and evaluates the projects for advancement into each phase of the process,[14] as well as annually for the New Starts report to Congress. FTA's New Starts evaluation process assigns ratings on the basis of a variety of statutorily defined criteria, such as mobility improvements, and determines an overall rating. FTA uses the evaluation and ratings process, along with its consideration of the state of development of the New Starts projects, to decide which projects to recommend to Congress for a full-funding grant agreement.[15]

ISTEA and TEA-21 also established an overall approach for transportation planning and decision making that state, regional, and local transportation agencies must follow to receive federal funds. This approach includes involving numerous stakeholders, identifying state and regional goals, developing long- and short-range state and regional planning documents, and ensuring that a wide range of factors are considered in the planning and decision-making process. For example, transportation officials must consider safety, environmental impacts, system connectivity, and accessibility, among other things. While the federal requirements specify a wide range of factors that must be considered when selecting a project from alternatives,[16] they generally do not specify what analytical tools, such as benefit-cost analysis, transportation officials should use to evaluate these factors. Instead, local, regional, and state agencies are largely responsible for selecting the methods used to analyze these factors. Federal requirements also do not mandate that local, regional, and state agencies choose the most cost-beneficial project. Rather, transportation officials at these agencies have the flexibility to select projects on the basis of their communities' priorities and needs. Even in the more structured New Starts program, state, regional, and local agencies have discretion in selecting the preferred alternative, although, according to FTA, these agencies are likely to consider New Starts requirements in the decision making process.

[14]The phases of the New Starts process are preliminary engineering, final design, and full-funding grant agreement.

[15]For more information about FTA's New Starts program, see GAO, *Mass Transit: FTA Needs to Better Define and Assess Impact of Certain Policies on New Starts Program*, GAO-04-748 (Washington, D.C.: June 25, 2004).

[16]Although the law requires that these factors be considered, failure to consider all of these factors in the long-range planning process is not reviewable in court.

Various analytical approaches, including benefit-cost, cost-effectiveness, and economic impact analyses, have been refined over time to better calculate the benefits and costs of transportation investments and provide decision makers with tools to make better-informed decisions. (Table 1 describes the purposes of the different economic analyses.) The Office of Management and Budget (OMB), DOT, and GAO have identified benefit-cost analysis as a useful tool for integrating the social, environmental, economic, and other effects of investment alternatives and for helping decision makers identify projects with the greatest net benefits. In addition, the systematic process of benefit-cost analysis helps decision makers organize and evaluate information about, and determine trade-offs between, alternatives.

Table 1: Types and Purposes of Economic Analysis

Type of analysis	Purpose
Benefit-cost analysis	To identify the alternative with the greatest net benefit to the locality, region, or nation by comparing the monetary value of benefits and costs of each alternative.
Cost-effectiveness analysis	To identify the lowest cost alternative for achieving a level of benefit by comparing the costs of each alternative.
Economic impact analysis	To identify the impact of alternatives on the local, regional, or national economy by measuring the effects derived from each alternative.

Source: GAO.

Because the federal-aid highway program is funded under a formula program and projects are therefore not subject to an evaluation process at the federal level, there are no federal requirements for economic evaluation of highway investment costs and benefits—except that FHWA does ensure that federal highway funding is being spent on an eligible roadway for eligible purposes.[17] In contrast, FTA's New Starts program is discretionary, and FTA is authorized to establish various requirements that sponsors of transit capital investments need to meet in estimating a project's benefits and costs, including calculating the cost-effectiveness of a proposed project and providing information on expected land-use effects, to obtain

[17]Some federal regulations encourage states to conduct life-cycle cost analysis or benefit-cost analysis for highway projects, although TEA-21 prohibits the Secretary of Transportation from requiring a state to conduct a formal life-cycle cost analysis. See 23 C.F.R. 627, and section 5204(j)(1) of TEA-21.

federal funding.[18] However, transit agencies are not required to conduct a formal benefit-cost analysis, and FTA is prohibited by TEA-21 from considering the dollar value of mobility improvements in evaluating projects, developing regulations, or carrying out any other duties.[19] FTA officials noted that the New Starts evaluation process results in greater federal oversight and scrutiny for New Starts projects, compared with the level of federal oversight for federally funded highway projects.

Benefits and Costs of Highway and Transit Investments Depend on Local Circumstances, Though Measuring and Properly Counting Some Benefits and Costs Can Prove Difficult

The types of direct benefits that transit and highway projects may produce include user benefits, such as travel-time savings, and benefits that accrue to users and nonusers alike, such as reductions in the adverse environmental impacts of transportation. These direct benefits can in turn produce indirect benefits, such as economic development and employment that affect the regional or local economy; however, these indirect benefits may constitute transfers of economic activity from one area to another or are a result of the direct benefits filtering through the economy. Although these indirect benefits represent real benefits for the jurisdiction making the transportation improvement, they represent transfers and not real economic benefits, from a national perspective. Transportation investments also produce costs, including the direct costs to construct, operate, and maintain the project as well as other potential social costs resulting from the construction and use of the facility, such as unmitigated environmental effects. The potential benefits and costs of any specific highway or transit investments will depend on the specifics of the project being considered and the local economic and transportation conditions. However, measuring all the potential benefits and costs of proposed highway and transit investments can be challenging and subject to several limitations and sources of error. For example, in current practice, benefit-cost analysis and economic impact analysis may not include all potential benefits. In addition, there are many limitations in being able to accurately predict changes in traveler behavior, land use, or the use of nearby roadways or alternative travel options resulting from a new investment. Sources of error can also include double counting of benefits and not comparing a project to a viable alternative or improperly defining the "do-nothing" case for comparison.

[18]Guidance for evaluating land-use effects can be found in FTA's Office of Planning "Guidelines and Standards for Assessing Transit-Supportive Land Use" (May 2004).

[19]Section 3010 of P.L. 105-178.

Highway and Transit Investments Can Result in a Range of Benefits and Costs

The key categories of potential direct user benefits from highway investments include travel-time savings, reductions in accidents, and reductions in vehicle operating costs.[20] These user benefits are historically included in benefit-cost analysis of such investments. The *User Benefit Analysis for Highways Manual* developed by the American Association of State Highway and Transportation Officials (the *AASHTO Manual*) provides guidance on how these benefits should be estimated.[21] In addition to benefits that accrue solely to users, social benefits such as reductions in environmental costs—including reduced emissions, noise, or other impacts—are also potential sources of direct benefits of highway projects. However, these benefits are more difficult to quantify and value; and as a result, they are less often included in benefit-cost analyses of transportation investments. Guidance from FHWA's Office of Asset Management, the *Economic Analysis Primer*, discusses these benefits along with user benefits.[22] Experts we consulted also cited improvements in travel-time reliability as a major source of potential direct-user benefits, particularly for freight transportation, although officials at FHWA stated that this benefit is complex and the best means to incorporate it into benefit-cost evaluations has not been resolved.[23]

For transit investments, direct benefits include improving travel times for existing transit users, improving travel times for autos and trucks on alternative roadways, lowering user and environmental costs of auto use by attracting riders out of their vehicles, and providing a back-up or future option for nonusers of transit. These types of benefits are described in guidance on conducting benefit-cost analysis for transit projects published by the Transit Cooperative Research Program (TCRP) (this report is known

[20]This section is limited to a brief overview of the major categories of benefits and costs. Additional discussion of benefits can be found in appendix V.

[21]American Association of State Highway and Transportation Officials, *User Benefit Analysis for Highways Manual* (August 2003).

[22]U.S. Department of Transportation, Federal Highway Administration, Office of Asset Management, *Economic Analysis Primer* (Washington, D.C.: August 2003).

[23]As part of our review, we convened an expert panel in collaboration with the National Academy of Sciences. See appendix I for information about the design of the expert panel and appendix III for profiles of the panelists. We refer to the panelists as "experts" in this report.

as the *Transit Manual*).[24] Another TCRP report on transit benefits describes other types of potential benefits, which may result from the project but may be more difficult to include in a benefit-cost analysis, such as improved job accessibility for individuals who are dependent on transit and those who do not or cannot drive a car.[25] See Table 2 for the categories of direct benefits described in the *AASHTO Manual*, the *Economic Analysis Primer*, and the TCRP reports.

Table 2: Types of Direct Benefits and Costs to Use in Evaluating Proposed Highway and Transit Projects

Type of investment	Source of guidance	Direct benefits	Costs
Highway investments	*AASHTO User Benefit Analysis for Highways*	• Savings in travel time • Savings in user operating expenses • Reductions in injury, morbidity, and mortality	• Project costs • Costs of operating and maintaining the project • User travel delay incurred during project construction
	FHWA Economic Analysis Primer	• Reductions in travel time and delay • Reduction in costs of crashes • Reductions in vehicle-operating costs • Reduction in emissions • Reductions in noise and other impacts	• Project costs • Costs of operating and maintaining the project • Mitigation (e.g., noise barriers) • User costs associated with work zone

[24]ECONorthwest and Parsons Brinckerhoff Quade & Douglas, Inc., *Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners*, TCRP Report 78 (Washington, D.C.: National Academy Press, 2002). TCRP is a cooperative effort of FTA; the National Academies, acting through the Transportation Research Board; and the Transit Development Corporation, a nonprofit, educational, and research organization established by the American Public Transportation Association. TCRP provides free research tools for the transportation industry and identifies real-life solutions to address the technical and operations challenges facing the industry's service providers, consultants, and suppliers.

[25]Cambridge Systematics, with Robert Cervero and David Aschauer, *Economic Impact Analysis of Transit Investments: Guidebook for Practitioners*, TCRP Report 35 (Washington, D.C.: National Academy Press, 1998).

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Type of investment	Source of guidance	Direct benefits	Costs
Transit investments	*TCRP Report 78 (the Transit Manual)*[a]	• Reductions in transit travel times, including waiting and transfer time • Reductions in transit accident and crime costs • Reductions in travel times for autos and trucks • Reductions in vehicle operating and ownership costs (including parking costs) • Transit option value[b] • Reductions in environmental impacts from improvement, such as air and water quality • Reductions in roadway accidents	• Any changes in fare costs to users • Project construction costs • Costs of operating and maintaining the project • Increases in transportation support services
	T*CRP Report 35*	• User benefits, such as travel time reductions • External benefits, such as reduced environmental costs • Job accessibility benefits • Reduced parking costs	Costs are not discussed in this report.

Source: FHWA, AASHTO, TCRP.

[a]*The Transit Manual* breaks down what we refer to as direct benefits into primary and secondary benefits. The manual classifies reductions in transit travel times, transit accident and crime costs, travel times for autos and trucks, and vehicle operation and ownership costs as primary benefits. The remaining three direct benefits are classified as secondary benefits.

[b]Option value refers to the benefit that some nontransit users receive by having transit service as an option for the future or in certain circumstances.

In addition to direct benefits, a number of indirect benefits are also attributed to highway and transit investments. Lowering transportation costs for users and improving access to goods and services enables new and increased economic and social activity. Over time, individuals, households, and firms adjust to take advantage of those benefits, leading to several indirect impacts. These indirect impacts include changes in land use and development, changes in decisions to locate homes and businesses in areas where housing and land are less expensive or more desirable, and changes in warehousing and delivery procedures for businesses in order to take advantage of improved speed and reliability in the transportation system. These impacts then lead to increased property values, increased productivity, employment, and economic growth. Economic impact analysis is generally used to estimate the extent to which direct benefits translate into indirect economic impacts. Table 3 shows the types of indirect benefits that are included in economic impact analysis.

Table 3: Types of Indirect Benefits to Use in Evaluating Proposed Highway and Transit Projects

Type of investment	Source of guidance	Indirect benefits
Highway investments	*FHWA Economic Analysis Primer*	• Economic productivity and growth • Changes in property values and employment • Multiplier effects on the regional economy from transportation spending
	AASHTO User Benefit Analysis for Highways	According to the manual, while these types of effects are important to consider, they are outside the scope of the manual.
Transit investments	*TCRP Report 78 (the Transit Manual)*	• Increases in regional productivity and benefits of urbanization • Enhanced employment accessibility • Increases in property values • Employment, output, and income effects due to construction
	TCRP Report 35	Generative Impacts • Higher density development, resulting in agglomeration and urbanization benefits, i.e., clustering of offices, retail shops, hotels, entertainment centers, and other land uses around rail-transit stops that enable higher productivity Redistributive Impacts • Land development • Employment and income growth Transfer Impacts • Regional employment and economic growth related to construction, operation, and maintenance of the transit system • Joint development income • Property tax income

Source: FHWA, AASHTO, TCRP.

The extent to which these indirect benefits are relevant depends to some degree on whether the project is viewed from a local or a broader perspective. These economic impacts may represent transfers of economic activity from one area to another; and, while such a transfer may represent real benefits for the jurisdiction making the transportation improvement, it is not a real economic benefit from a national perspective because the economic activity is simply occurring in a different location. For example, a highway improvement in one county may induce businesses to relocate from a neighboring county, bringing increased tax revenue and providing jobs; but the neighboring county then loses that tax revenue and employment.

Indirect benefits may also represent capitalization of the direct user and social benefits, and therefore should not be added to the direct benefits. For example, a project's transportation benefits, in terms of improved travel times, can lead to increased demand for more remote properties, and thus lead to increases in those property values. In this instance, the users

are transferring their travel benefits to property owners through a higher purchase price. Including the increased property value and the travel-time benefit in an overall project evaluation would constitute counting the same benefit twice. However, some experts we consulted and literature we reviewed indicated that there could be some residual benefit from these indirect effects that is not accounted for in travel-time benefits or other direct impacts and argue that this portion should be incorporated into a comprehensive estimation of project benefits and costs.[26]

Transportation investments also produce costs—such as the costs to construct, operate, and maintain the project; traffic delay costs during construction of the project; and other potential social costs, resulting from the construction and use of the facility—such as unmitigated environmental effects or community disruption. For example, while a project may have an indirect benefit of increasing some land values, it may also reduce land values elsewhere due to negative impacts from noise and emissions that may result from the improved roadway or transit line. In addition, a transportation improvement can entail costs for some regions if it diverts economic activity away from a particular area.

Benefits and Costs Depend on the Local Conditions and the Type of Improvement

The size and type of benefits and costs that will manifest from highway and transit investments depend critically on local conditions, such as existing travel conditions and the extent of congestion, economic conditions and development patterns, and the extent of the existing road and transit networks. In addition, the type of project, its design, and other specifics will also affect the types of benefits and costs the project may produce. Each particular project must be evaluated on its own merits, in comparison with any other viable alternatives to address the transportation and other goals of the region.

For example, research indicates that transit projects can result in peak period, travel-time savings for users of alternative roadways when those roadways are heavily congested, the transit project has a separate ROW and a fixed schedule, and door-to-door travel times on the transit line are competitive or lower than door-to-door travel times on the roadway in peak

[26]For more discussion, see Kenneth A. Small, "Project Evaluation," In *Essays in Transportation Economics and Policy—A Handbook in Honor of John R. Meyer*, J. Gomez-Ibanez, W.B. Tye, and C. Winston, eds. (Washington, D.C.: Brookings Institution Press, 1999).

periods for some road users.[27] Building a rail line alongside a road that is not frequently traveled will clearly not result in similar benefits. Similarly, the extent to which a highway investment will result in reductions in travel times and the extent to which new travelers will return the highway to previous levels of congestion and delay, depend on the level of congestion on alternative routes, the extent of the local transit system, and local economic conditions.

Research further indicates that to realize desired land-use changes and higher density development, transit investments need to be coordinated with supportive local land-use policies and that impacts need to occur more readily in rapidly growing regions with demand for high-density development.[28] In a similar fashion, the extent to which highway investments will result in improvements in freight productivity will depend on economic conditions; the amount of freight traffic on the local network; the presence of alternative freight modes, such as rail or waterways; and various other locally specific factors. In addition, specific projects will also affect different areas and groups differently. A transportation project that is projected to produce large benefits may cut through one neighborhood and provide excellent access to another, thereby imposing costs on one area and creating benefits for another or providing service to wealthy areas at the expense of lower income areas.

The costs of highway investments and various transit alternatives can vary significantly, based on the location and specifics of the project. For example, according to a 2002 report from the Washington State DOT, average construction costs for a lane mile of highway range from $1 million to over $8 million across 25 states the department surveyed,[29] with some

[27]See David Lewis and Fred Laurence Williams, *Policy and Planning as Public Choice: Mass Transit in the United States* (Brookfield, VT: Ashgate, 1999). See also, Martin J.H. Mogridge, *Travel in Towns: Jam Yesterday, Jam Today, and Jam Tomorrow?* (London, England: The Macmillan Press, Ltd., 1990).

[28]See Kaveh V. Vessali, "Land Use Impacts of Rapid Transit: A Review of the Empirical Literature," *Berkeley Planning Journal 11* (1996).

[29]Washington State DOT, "Highway Construction Cost Comparison Survey: Final Report," (April 2002).

projects costing far more than these averages suggest.[30] In a recent study on different transit modes, we found that light rail construction costs vary from $12.4 million per mile to $118 million per mile.[31] As with construction costs, the costs to operate and maintain highway and transit systems also vary significantly, based on the specific project and area. For example, according to the National Transit Database, operating costs per-vehicle revenue mile for heavy rail systems ranges from about $5 to about $15, whereas for light rail, these costs range from a little over $5 to over $20 in some locations.

Measuring and Forecasting Benefits and Costs Subject to Several Difficulties and Sources of Error

Experts we consulted and literature we reviewed cited several limitations in current practice, and some major sources of error in evaluating transportation projects that can lead to over or underestimation of a project's benefits and costs.[32] The following sections discuss some of these limitations and sources of error.

Challenges in Predicting Changes in Travel Behavior and Land Use with Current Models and Data

One of the key challenges in measuring and forecasting benefits and costs is the inability to accurately predict changes in traveler behavior, land use, or the usage of nearby roadways or alternative travel options resulting from a highway or transit project using current travel models.[33] For example, according to FHWA guidance, travel models do not generally anticipate the impact of a transportation improvement on travelers who change their time of travel or make entirely new trips in response to the relatively lower trip cost resulting from the improvements. Current transportation demand

[30]For example, the 7.5 mile Central Artery/Tunnel project may cost as much as $14.6 billion, or over $90 million per lane mile, as of 2002. See Alan Altshuler and David Luberoff, *Mega-Projects: The Changing Politics of Urban Public Investment* (Washington, D.C.: Brookings Institution Press, 2003).

[31]GAO, *Mass Transit: Bus Rapid Transit Offers Communities a Flexible Mass Transit Option*, GAO-03-729T (Washington, D.C.: June 24, 2003).

[32]For more discussion of these sources of error, see Peter Mackie and John Preston, "Twenty-One Sources of Error and Bias in Transport Project Appraisal," *Transport Policy* 5 (1998).

[33]DOT has not issued standards on the development of forecasting models, which generate the data to calculate potential project benefits. Thus, localities generally have the latitude to develop their own traffic forecasting models, which may lead to varying quality of the estimates of future traffic demand. However, DOT officials noted that, while the state of modeling is inadequate, the agency does review models used to produce measures for the New Starts criteria to ensure that the model reflects good practice.

models are also unable to predict the effect of a transportation investment on land-use patterns and development, since these models take land-use forecasts as inputs into the model. Nonetheless, expected land use and development impacts are often the major drivers of transportation investment choices.[34] In addition, the effect of a highway or transit investment on alternative roadways or on other modes is rarely taken into account and is difficult to forecast. In fact, according to the DOT Inspector General, transit's effect on alternative roadways is not reliably estimated by local travel models,[35] although this effect can be a major source of benefits in some cases.[36] These same models are also used in making highway investment decisions.

Compounding these shortcomings is the considerable variation in models used by local transportation planning agencies. The federal government gives local transportation planning agencies the flexibility to choose their own transportation models without being subject to minimum standards or guidelines. This flexibility reflected varying local conditions and expertise in applying these models. However, one expert pointed out that this strategy has had the unintended consequence of making local planning agencies very dependent on outside expertise because they usually contract with independent consultants who have their own software packages. This strategy also has produced significant variation in forecast quality and limited the ability to assess quality against the general state of practice.

[34]FTA's New Starts program requires project sponsors to evaluate the land-use impacts of their project. However, FTA guidelines suggest measurements of the extent of land use that is supportive of the transit project, such as new developments occurring near potential station locations, but do not suggest methods for valuing the benefits that arise from land-use changes. FTA is currently considering changes in the New Starts land-use criteria, although there is no time frame established for when new criteria may be developed.

[35]"The Rating and Evaluation of New Starts Transit Systems," Statement of the Honorable Kenneth M. Mead, Inspector General, U.S. Department of Transportation before the Committee on Appropriations, Subcommittee on Transportation, Treasury and Independent Agencies, U.S. House of Representatives, April 28, 2004.

[36]One study, using recently developed modeling tools, showed that congestion-related benefits of building a light rail line in Cincinnati constituted 63 percent of the project's total projected benefits. For more detailed information see HLB Decision Economics, Inc., "Moving Forward: The Economic and Community Benefits and Investment Value of Transportation Options for Greater Cincinnati," prepared for the Metropolitan Mobility Alliance (April 2001).

Data quality is a pivotal concern to the challenges in modeling, as the available data provide critical input for travel models. For example, data about traffic flow throughout the day, rather than at a single time, are crucial to produce valid representations of travel needs and problems. However, reliable and complete data are not always available—which can result in forecasting errors. Collecting the data needed for modeling is growing more expensive and difficult. For instance, a home survey of travel habits, which identified basic transportation needs and travel patterns of a region and is the foundation of transportation modeling, is now beyond most local transportation agencies' annual budgets, according to experts. Moreover, obtaining data through telephone surveys is difficult and willingness to participate is declining.

Omitting Certain Benefits and Ignoring Impacts on Different Groups

Experts we consulted and literature we reviewed also indicated that benefit-cost analysis and economic impact analysis often do not include all potential benefits, some of which are very difficult to quantify. For example, according to one expert we consulted, transit projects are often put at a disadvantage in terms of estimating benefits and costs relative to highway projects because several types of benefits specific to transit are not typically evaluated and are difficult to quantify. A review of economic analyses conducted for over 30 transit projects found that these analyses routinely omitted benefits to noncar owners, often did not include environmental benefits, and often did not evaluate the economic development benefits related to the project.[37] Experts we consulted also highlighted the importance of taking account of which groups benefit from a project and which bear the costs, although these distributional impacts are commonly ignored in evaluation of a project's benefits and costs. In theory, a benefit-cost analysis could take such considerations into account, but the outcome of a benefit-cost analysis is a net value, which under standard assumptions eliminates any distinction between groups who benefit and groups who do not.[38]

Double Counting and Counting Costs as Benefits

Project appraisals often double count benefits and count certain project expenditures as benefits. As previously discussed, for the most part,

[37]HLB Decision Economics, Inc., in association with ICF Consulting and PB Consult, "Economic Study to Establish a Cost-Benefit Framework for the Evaluation of Various Types of Transit Investments" (January 2002).

[38]For more information on the practical challenges of conducting benefit-cost analysis, see GAO, *Surface Transportation: Many Factors Affect Investment Decisions*, GAO-04-744 (Washington, D.C.: June 30, 2004).

indirect benefits are more correctly considered capitalization of direct user benefits or transfers of economic activity from one area to another.[39] Therefore, estimating and adding such benefits to direct benefits would constitute double counting and lead to an overestimation of a project's benefits. Some evaluations of particular transportation projects also cite jobs created, or the economic activity resulting from the construction of the project, as benefits of the project. Experts we spoke with indicated that job creation from transportation spending would only be a true benefit if the person getting the job would otherwise be unemployed, and thus the reduction in unemployment benefits could be considered a benefit of the project. Nonetheless, local decision makers generally view such expenditures as producing benefits for their jurisdiction.[40] In some evaluations decision makers also count the avoided cost of some other alternative project as a benefit of the project under consideration. For example, in some evaluations, decision makers have considered the foregone expense of improving the highway as a benefit of a transit project, or the foregone expense of adding general-purpose lanes as a benefit of adding high-occupancy vehicle lanes. Instead, those costs should be included in the benefit-cost analysis of the alternative and then compared with the benefits and costs of all other alternatives. In some appraisals, such cost savings have been the largest source of project benefits.[41]

Not Discounting Future Benefits and Costs Properly

Another expert we interviewed stated that state departments of transportation often do not discount future benefits into present values. Benefits and costs incurred in the future have lower values than those incurred in the present because, in the case of benefits, the benefits cannot be enjoyed now; and in the case of costs, the resources do not need to be expended now. Benefits and costs are worth more if they are experienced sooner because of the time value of money. Failure to discount future

[39]For a more detailed discussion of transfers and double counting, see Herbert Mohring, "Maximizing, Measuring, and *Not* Double Counting Transportation-Improvement Benefits: A Primer on Closed- and Open-Economy Cost-Benefit Analysis," Transportation Research Part B: Methodological, Vol. 27 (1993).

[40]Anthony Boardman, Aidan Vining, and W.G. Waters, II, "Costs and Benefits through Bureaucratic Lenses: Examples of a Highway Project," *Journal of Policy Analysis and Management*, Vol. 12, No. 3 (1993).

[41]See Robert J. Harmon & Associates, Inc., Westside LRT MAX Extension: *User Benefit-Cost Analysis* (Portland, OR: 1988). See also, Russell H. Henk, Daniel E. Morris, and Dennis L. Christiansen, *An Evaluation of High-Occupancy Vehicle Lanes in Texas, 1994*, sponsored by the Texas Department of Transportation (College Station, TX: November 1995).

benefits or using an inappropriate discount rate can severely affect the results of a benefit-cost analysis. Not discounting at all will greatly overestimate a project's benefits. An unreasonably high discount rate will underestimate a project's benefits. OMB provides guidance on choosing appropriate discount rates for different types of investments.[42]

Unreasonably Bad Conditions Expected Without the Project

Another source of error when calculating transportation projects' potential benefits and costs occurs because current travel demand models tend to predict unreasonably bad conditions in the absence of a proposed highway or transit investment.[43] Travel forecasting, as previously discussed, does not contend well with land-use changes or effects on nearby roads or other transportation alternatives that result from transportation improvements or growing congestion. Before conditions get as bad as they are forecasted, people make other changes, such as residence or employment changes to avoid the excessive travel costs. In one area we visited, local officials told us that the "do-nothing" scenario for a particular project evaluation predicted that travel delays would grow to almost 80 minutes for a typical commute after 20 years, and impacts on travel-time reductions were then calculated for the proposed investment. However, officials noted that traffic did not degrade as they had predicted in the years leading up to construction—with delays of 13 minutes by 1999, although they had predicted delays of 40 minutes or more by that time. The officials noted that generally, commuters only stand for a certain amount of delay before they shift their own behavior to avoid the delay.

Lack of Comparison to Viable or Modal Alternatives

In addition, experts indicated that projects are often not compared to viable alternatives, or to projects in other modes, to enable adequate comparisons of investment alternatives. We found in our case studies of five New Starts projects and five highway projects that the transit projects we reviewed were compared with other transit modes, such as increased bus service, but not to new highway investment alternatives; and none of the highway projects we reviewed were compared with a transit alternative. However, in some cases, differently designed alternatives can

[42]OMB, *Circular A-94 Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (Washington, D.C.: 2002). For a more detailed discussion of discount rates see Mark A. Moore, et al, "'Just Give Me a Number!' Practical Values for the Social Discount Rate," *Journal of Policy Analysis and Management*, Vol. 23, No. 4 (2004).

[43]See Patrick DeCorla-Souza, Jerry Everett, Brian Gardner, and Michael Culp, "Total cost analysis: An alternative to benefit-cost analysis in evaluating transportation alternatives," *Transportation* 24 (1997).

prove to be a superior option. For example, one study of transportation decision making in Houston found that, if the bus alternatives to the preferred light rail system were designed to cost as much as the light rail option, the resulting bus system would carry more passengers and be more cost-effective than the rail option; however, local planners and decision makers did not consider such an alternative.[44] Another recent evaluation compared a transit and a highway project with common economic yardsticks—such as a benefit-cost ratio and a rate of return—and found that under certain circumstances, transit can perform favorably compared with a highway alternative.[45]

Analysis of Benefits and Costs Not Usually Systematic, and Results of Analysis Are Only One Factor Among Many Considered in Investment Decision Making

According to our survey results and case studies, although the costs and benefits of projects were almost always considered in some way, formal analyses such as benefit-cost analysis were not usually conducted when considering project alternatives, and they were completed less frequently for proposed highway projects than transit projects. Additionally, officials reported that the results of formal economic analyses were just one factor among many considered in project selection, and it was not necessarily the most important factor. Other important factors included qualitative assessments of the potential land use or economic development benefits of the project, public opinion and political support, and funding availability.

Costs and Benefits of Highway and Transit Investments Are Considered but Not Always Systematically

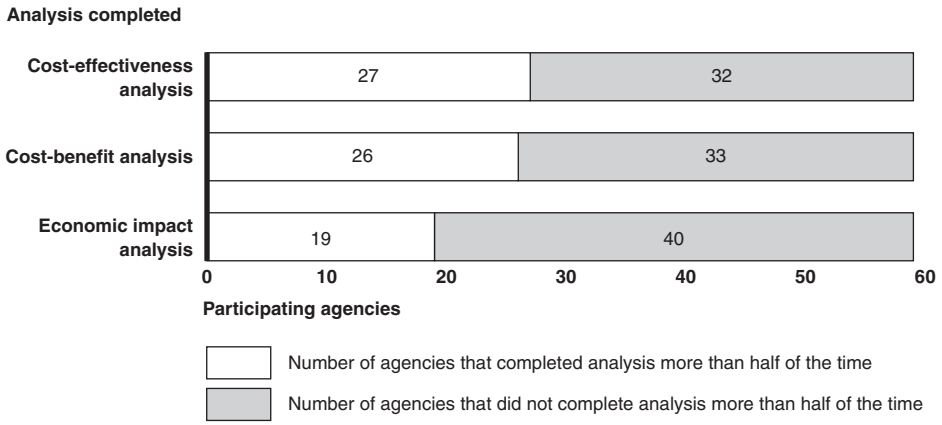
Most state DOT and transit agency officials that responded to our survey said that when alternatives are considered for a proposed project, they complete some analysis of either costs or benefits of the various alternatives, but they complete a formal benefit-cost analysis, economic impact analysis, or cost-effectiveness analysis less frequently (see fig. 1). These results indicate that many state and local transportation agencies are not consistently using formal economic analysis as part of their investment decision-making process to evaluate project alternatives. In addition, in the

[44]John F. Kain, "The Use of Straw Men in the Economic Evaluation of Rail Transport Projects," *American Economic Review*, Vol. 82, No. 2 (May 1992).

[45]HLB Decision Economics, Inc., "Moving Forward."

locations that we visited, we did not find any examples of completed benefit-cost analysis for the 10 projects that we examined.

Figure 1: Survey Responses of Frequency of Economic Analysis Completed for Proposed Project Alternatives by State DOTs and Transit Agencies



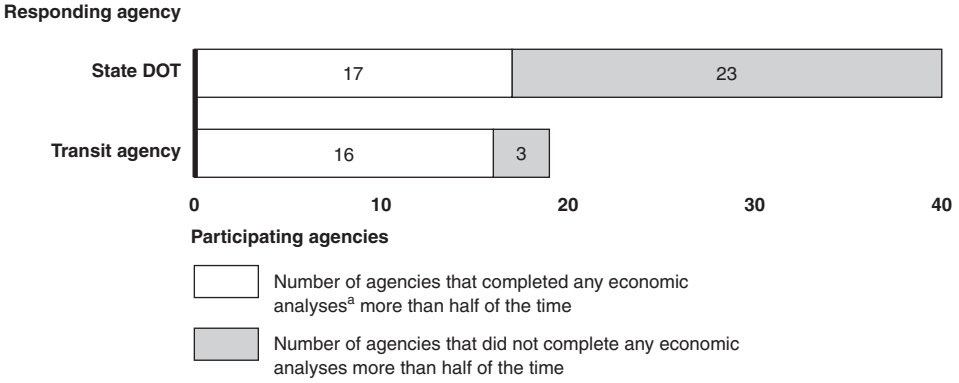
Source: GAO survey of state DOTs and transit agencies, October 2004.

More Analysis Is Completed for Proposed Transit Projects

According to our survey results, when comparing alternatives for proposed projects, economic analyses were more likely to be conducted for transit projects than highway projects (see fig. 2). We saw a similar pattern in our case studies. For instance, a cost-effectiveness analysis was completed for all five transit projects that we examined in our case studies.[46] We also found additional studies for the transit projects that included qualitative examination of such potential project impacts as regional economic development opportunities, distribution across social groups, increased transit reliability, and increased transit ridership. For the highway projects we studied, we found that project documents contained little, if any, economic analyses on the various alternatives. We did find that for some highway projects, safety and environmental impacts were quantified, but not put into dollar terms.

[46]For each transit project, these analyses included a cost-effectiveness ratio for at least one alternative, but the project sponsors were not required to choose an alternative based on the most favorable cost-effectiveness ratio. However, according to FTA, once selected as a locally preferred alternative, a New Starts project must go through a rigorous national competition before it is funded.

Figure 2: Survey Responses of Completed Economic Analyses When Evaluating Project Alternatives



Source: GAO survey of state DOTs and transit agencies, October 2004.

[a]Economic analyses include cost-effectiveness, benefit-cost, or economic impact analysis.

Local and state officials noted that these economic analyses are done more often for transit projects because of the New Starts requirements. For example, FTA requires project sponsors to calculate a project's cost-effectiveness in order to be eligible to receive New Starts project funding—and the results of this analysis are used in FTA's evaluation of the project.[47] In contrast, there are no similar federal requirements for economic analysis of highway projects because highway projects are funded under a formula program, and there is no federal analysis of project economic worthiness. In addition, because New Starts projects may require a higher local funding share compared with federally funded highway projects,[48] officials suggested that more economic analysis is generally completed for transit projects, especially if a special taxing authority is required or the project becomes controversial and subject to public scrutiny.

[47]This requirement has changed over time. The current cost-effectiveness measure used by FTA to evaluate candidate New Starts projects is defined as incremental cost divided by transportation system user benefits.

[48]In general, the federal share for most highway projects is 80 percent. By statute, the federal share of a New Starts project cannot exceed 80 percent of the project's net cost; however, in fiscal year 2004, FTA instituted a preference policy favoring projects that seek a federal New Starts share of no more than 60 percent of the total project cost in its recommendations for full-funding grant agreements. As a result, the nonfederal share of a New Starts project must be at least 40 percent of the total cost for the project to be competitive for New Starts funding.

Many Factors Are Considered in Selecting Transportation Projects

In our past work, we found that numerous factors shape transportation investment choices and that factors other than those considered in analyses of projects' benefits and costs can play a greater role in shaping investment choices.[49] Some of the factors considered reflect local or regional priorities and needs; others are required to be considered in the decision-making process by federal legislation. For example, as a result of the National Environmental Policy Act (NEPA) of 1969, transportation officials must make project decisions that balance engineering and transportation demands with the consideration of social, economic, and environmental factors, such as air quality and impacts on communities. Some of these factors may not be easily considered in traditional benefit-cost analysis.[50] Similarly, TEA-21 requires local, regional, and state transportation agencies to consider a range of factors in their planning, including environmental compliance, safety, land use, and public input.

Our case studies also demonstrated that officials often place value on a variety of indirect impacts that may be difficult to estimate and are often not quantified in project analyses. For example, we found that many of the projects we examined were expected to result in desirable changes in land use and economic development in the region, although these types of impacts were not quantified or systematically analyzed in the planning documents we reviewed for both highway and transit investments. For example, one proposal discussed the light rail transit project's potential for attracting new businesses and developers to the surrounding low-income community, but it did not present projections of the potential impact or estimates of the types of benefits these impacts might produce. Transportation officials indicated that these factors were just as important,

[49]GAO-04-744.

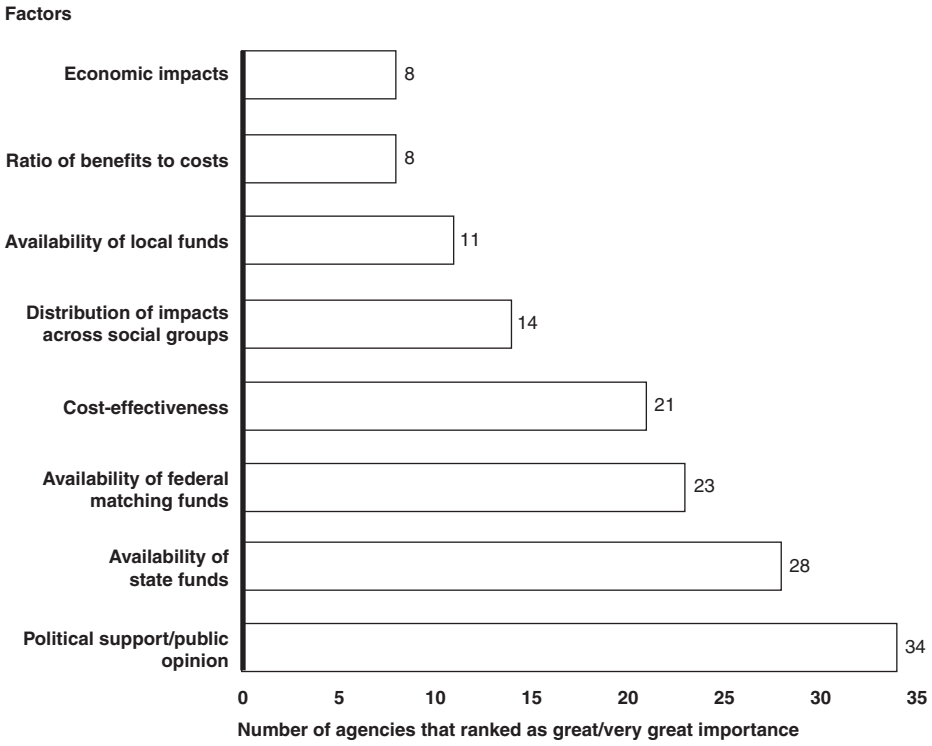
[50]The NEPA process is designed to ensure that possible adverse economic, social, and environmental effects related to any proposed project have been fully considered in developing such a project. To comply with NEPA, agencies are required to prepare an Environmental Impact Statement for large transportation projects, among other things. An EIS is a full disclosure document that details the process through which a transportation project was developed, includes consideration of a range of reasonable alternatives, analyzes the potential impacts resulting from the alternatives, and demonstrates compliance with other applicable environmental laws and executive orders. The Senate-proposed reauthorization bill that was considered by the 108th Congress in 2004 would require that all project alternatives considered as part of the environmental review process meet the stated purpose and need of the investment—that is, the transportation objectives or other objectives intended to be achieved by the project—and that the alternatives be made available for public comment. See S. 1072, 108th Cong. Sec. 1511(g) (2004).

if not more important than the results of their cost-effectiveness analysis in the decision to pursue the project.

Similarly, our survey of transit agencies and state DOTs also showed that the results of economic analysis of a project are not necessarily the most important factor considered in highway and transit investment decision making. For highways, political support and public opinion, the availability of state funds, and the availability of federal matching funds were ranked most often as important factors in highway project decision making within state DOTs (see fig. 3). Thirty-four state DOTs said that political support and public opinion are factors of great or very great importance in the decision to recommend a highway project, whereas only eight said that the ratio of benefits to costs was a factor of great or very great importance.[51]

[51]This relationship holds true, although to a lesser extent, when combining responses for the three types of economic analysis. Twenty-two state departments of transportation ranked at least one of the three types of economic analysis as being of very great importance or great importance in the decision to recommend a project from among its various alternatives.

Figure 3: State DOTs' Survey Responses of Factors of Great or Very Great Importance in the Decision to Recommend a Highway Project

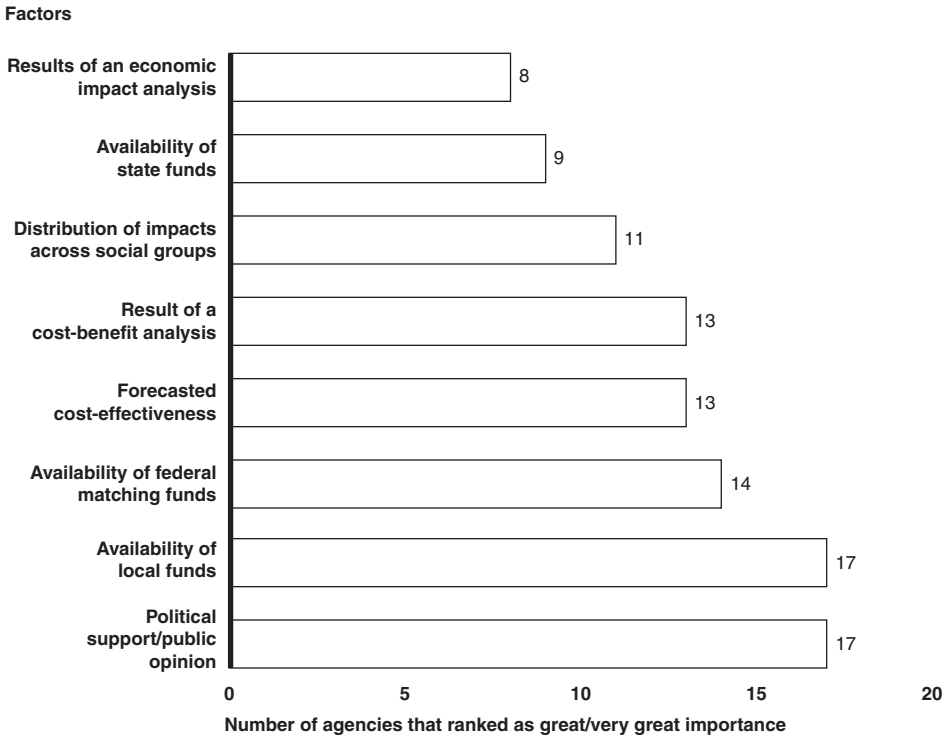


Source: GAO survey of state DOTs, October 2004.

Note: Forty state DOTs responded to each survey question that asked about the relative importance of different factors. See appendix II for the survey instrument and complete results.

For transit, results from our survey showed that the factors ranked with "great or very great importance" most often included political support/public opinion, the availability of local funds, and the availability of federal matching funds. Specifically, of the 19 transit agencies that responded to these survey questions, 17 said that political support/public opinion and the availability of local funds were factors of great or very great importance in project decision making (see fig. 4).

Figure 4: Transit Agencies' Survey Responses of Factors of Great or Very Great Importance in the Decision to Recommend a Transit Project



Source: GAO survey of transit agencies, October 2004.

Note: Twenty transit agencies responded to each survey question that asked about the relative importance of different factors, except for the question that asked about the relative importance of the availability of federal matching funds. Nineteen transit agencies responded to this question. See appendix II for the survey instrument and complete results.

Survey respondents also provided a number of examples of other factors that figure into the decision-making process. For example, one state DOT highway survey respondent mentioned that in the respondent's state, projects are often built as a basic public good, regardless of the relative benefits and costs. Another state DOT highway survey respondent said that the geographic distribution of funds plays a large role in determining the priority of highway projects. One transit agency survey respondent commented that comprehensive, long-range planning is a major component in evaluating and selecting projects, and the criteria are not solely based on economic factors; other typical considerations include population growth, land-use projections, environmental factors, and housing.

To further analyze the relationship between the results of economic analyses of transportation projects and decisions made in selecting the project, we conducted a regression analysis of the relationship between the results of benefit-cost analyses completed for state transportation projects in California and the subsequent decisions to program construction funds for projects in the Statewide Transportation Improvement Plan. The benefit-cost analyses used by California considered travel-time savings, vehicle operating cost reductions, and safety benefits. In our analysis, we found that projects with higher benefit-cost ratios had a higher probability of receiving funding for construction. However, the analysis explained little of the overall variation—for example, some projects with high benefit-cost ratios received funding while others with relatively lower ratios also received funding, indicating that other factors were likely considered in the decision.

Costs and Usage Outcomes of Highway and Transit Investments Are Often Different from Projected; and Other Expected Outcomes Are Not Usually Evaluated

Results from our literature review and case studies indicate that both completed highway and transit investments result in higher than expected costs and in usage that is different from what was projected. Transportation officials we interviewed generally contend that completed projects have achieved other outcomes that were projected to flow from the highway and transit investments, such as positive changes in land use and economic development. In most cases, however, these outcomes of highway and transit projects are not regularly quantified or evaluated after the projects are completed. Rather, transportation officials relied on limited and anecdotal evidence to support their statements about the impacts of the projects. Officials we met with cited several reasons that evaluations of completed projects are not regularly conducted, including lack of funding and technical challenges.

Highway and Transit Projects Are Subject to Inaccurate Forecasts of Costs and Usage

A number of studies have shown that both completed highway and transit investments often result in outcomes that are different from what was projected. The following examples highlight such problems for both highway and transit projects.

- A study of over 250 transportation projects in Europe, North America, and elsewhere found that costs for all projects were 28 percent higher than projected costs at the alternatives analysis stage, on average. Rail projects showed the highest cost escalation, averaging at least 44.7 percent, while road projects averaged escalations of 20.4 percent.[52] This study further found that cost underestimation has not improved over time, indicating systematic downward bias on costs.

- Initial results from an ongoing study of New Starts projects by FTA show that nearly half of the 19 projects, for which ridership was reviewed, will achieve less than two-thirds of forecast ridership by the forecast year. In addition, costs escalated on 16 of the 21 projects reviewed from the alternatives analysis stage, where decisions are made to go forward with a preferred alternative, to the completion of the project—with 4 of those projects experiencing increases of between 10 and 20 percent and 9 projects with increases over 20 percent.[53]

- In a 1997 report, we collected and analyzed data for 30 highway projects costing $100 million or more. We found that cost growth occurred on 23 of 30 projects when comparing actual costs to costs estimated at the alternatives analysis stage, with about half of the projects experiencing increases of more than 25 percent.[54]

[52]Flyvbjerg, Holm, and Buhl, "Underestimating Costs in Public Works Projects."

[53]Other evaluations of New Starts projects show similar results, although the FTA study shows improvements have been made in projections of ridership. See Don Pickrell, "Urban Rail Transit Projects: Forecast Versus Actual Ridership and Costs," prepared for Office of Grants Management, Urban Mass Transportation Administration (October 1990); and Jonathan Richmond, "A Whole System Approach to Evaluating Urban Transit Investments," *Transport Reviews*, Vol. 21, No. 2 (2001).

[54]GAO, *Transportation Infrastructure: Managing the Costs of Large-Dollar Highway Projects*, GAO/RCED-97-47 (Washington, D.C.: Feb. 27, 1997). To calculate the cost growth for these 30 projects, we examined the initial cost estimates contained in the project's draft environmental impact statements.

- A 1996 study that compared actual toll-road revenues to forecasted revenue streams, found that 10 out of the 14 projects studied fell short of projections by 20 to 75 percent, while a majority of the projects missed or are likely to miss revenue forecasts in the second year by 40 percent or more.[55]

We found similar patterns for our case studies of 10 transit and highway projects in 5 metropolitan areas.[56] Table 4 provides descriptions of the projects we reviewed in each metropolitan area.

Table 4: Description of Five Highway and Five Transit Projects Selected for Review

Location	Highway project	Transit project
Baltimore	Construction of a new segment of road	Extensions to existing light rail system
Dallas	Widening a segment of an existing road	Construction of an original segment of light rail system
Denver	Widening and modifying a segment of an existing road	Extension to existing light rail system
Miami	Adding travel lanes and grade separation to a segment of road	Extension to elevated people-mover system
San Jose	Modifying major interchange	Construction of an original segment of light rail system

Source: GAO summary of project documents.

Note: According to FTA, the Miami People Mover is not typical of most New Starts projects. In particular, FTA officials noted that there are only three other people-mover projects in the United States.

In summary, we found the following:

- Comprehensive data on the projected and actual costs and usage of all the highway projects we examined were not readily available. In particular, we were not able to obtain estimates of the projects' costs at a consistent point in the project development cycle (e.g., alternatives

[55]Robert H. Muller, "Examining Toll Road Feasibility Studies" *PW Financing* (1996).

[56]These projects should not be considered representative of all transportation projects but are rather illustrations of experiences with specific types of projects. In particular, FTA noted the people-mover is a unique project; there are only three other people-mover projects in the United States. For more information about the projects, and the selection methodology we used for our case studies, see appendix I.

analysis). As a result, it is difficult to draw overall conclusions on how the projected costs compared with the actual costs for the five projects. However, the limited cost data we were able to obtain suggest that at least two of the five highway projects experienced cost escalation. In one case, the capital costs were originally budgeted in the state's capital funding program at approximately $62.7 million (in inflation-adjusted 1999 dollars); but the actual expenditures for the project, in 1999, approached about $94.4 million, 50 percent higher than the estimate. In another case, construction costs for the preferred alternative, at the alternatives analysis phase, were estimated at $16.6 million (in inflation-adjusted 2001 dollars), while actual construction costs in 2001, according to officials, approached $25.4 million, a 53 percent increase. In addition, in at least two locations, traffic after the improvement was greater than had been expected after project completion, leading to less congestion relief than had been expected. FHWA is working to improve the cost estimates of federal-aid highway projects. For example, in June 2004, FHWA issued guidance for developing cost estimates, including steps for producing more realistic early estimates. FHWA also established help teams that travel to states that ask for assistance in developing better estimates.

- The five New Starts transit projects we reviewed had more extensive information on the projected costs of the projects and had estimates from several different points in the project development process. When comparing as-built costs to cost estimates at the alternatives analysis stage—where decisions are made on the preferred alternative but the project is likely not at final design—three out of five New Starts transit projects we reviewed had actual costs in excess of projected costs by more than 10 percent. When comparing costs from the Full-Funding Grant Agreement stage—where the preferred alternative has been selected and the project is at its final design—only two projects had costs escalate, one by 6 percent and one by over 40 percent.[57] At the time ridership figures were reviewed, the forecast years—that is, the years for which the ridership projections were made in the project's planning documents—for four of the five New Starts projects remained in the future; therefore, final conclusions about whether the projects exceeded or fell short of ridership projections are premature. Currently,

[57]According to FTA, the full-funding grant agreement is a fixed public record of the project sponsor's and FTA's specific objectives against which to measure project performance and outcomes.

only one of the projects achieved the ridership levels projected; however, four of these five projects have surpassed 50 percent of the projected level of ridership for the forecast year. According to FTA, the agency has introduced a number of measures since these projects were planned and developed to improve ridership and cost estimates. For example, FTA is more rigorously examining ridership forecasts of projects, requiring before and after studies for all new projects, and conducting risk assessments of select projects to identify all significant risks related to the project's schedule and budget and to ensure that mitigation measures or contingencies are in place, among other things. In addition, FTA is currently examining the projected and actual ridership of New Starts projects that opened in the last 10 years to assess whether these projects achieved their estimated ridership levels and to improve the reliability of forecasting procedures. FTA also instituted a pilot program in 2003 to hold FTA senior executives accountable for project outcomes. Specifically, FTA's senior executive service team bonuses are tied, in part, to project cost control—that is, New Starts projects with full funding grant agreements must not exceed their current baseline cost estimate by more than 5 percent.[58]

Transportation officials offered several reasons that the actual costs and levels of usage differ from those projected. For example, transportation officials from one metropolitan area we visited attributed lower than expected transit ridership to a severe economic downturn and slower than anticipated development around transit stations. The economic downturn also affected the highway project in this area, resulting in less traffic than expected. This had the effect of reducing congestion, although the transit project was credited with contributing to congestion reduction as well. In addition, inflation, changes in the project's scope, and changes in costs of building materials could also explain differences between the projected and actual costs of the project. For example, officials commented that estimated costs of a project always change as the project moves through the planning, design, and construction processes—becoming more accurate as more specifics about the project are known. When the cost of the project is initially estimated, sponsors do not know exactly how the scope/design of the project may change or what environmental problems

[58]For more information about FTA's efforts to improve ridership and cost estimates, see FTA Administrator Jennifer L. Dorn's testimony statement before the U.S. House of Representatives, Committee on Appropriations, Subcommittee on Transportation and Treasury, and Independent Agencies, Hearing on the Rating and Evaluation of New Fixed Guideway Systems (Apr. 28, 2004).

may arise. However, by the time the New Starts project has reached the Full Funding Grant Agreement stage, or the highway project has had construction funds programmed, much more about these costs are known. Comparing costs from this stage to actual costs will reveal less variance than comparing costs with estimates from earlier stages in the process, such as the alternatives analysis stage. However, it is important to note that estimates from these earlier stages are generally used by project sponsors to select the preferred alternative.[59]

Evaluations of Highway and Transit Projects Are Not Usually Conducted

Outcome evaluations of completed projects are not usually conducted to determine whether proposed outcomes were achieved. For most of the highway and transit projects we reviewed, several of the proposed outcomes were not defined in any measurable terms in the project planning documents we reviewed. Moreover, officials stated that many of the projected outcomes were not usually quantified, tracked, or evaluated after the projects were complete. Of the 10 projects we reviewed, 6 did not have any type of outcome evaluation completed. Before and after studies for four projects had been completed or were being conducted—three for transit projects, and one for a highway project. Although these studies provide a description of corridor conditions before and after the project, they do not compare or evaluate actual outcomes with projected goals. Results from our survey also indicate that outcomes are not typically evaluated, although evaluations for transit projects tend to be conducted more so than for highway projects. In particular, 16 of 43 state DOTs reported that they have analyzed completed highway projects to determine whether proposed outcomes were achieved, while 13 out of the 20 transit agencies reported that they have conducted such evaluations.

Although evaluations were not often conducted, officials we interviewed provided some limited evidence as to the outcomes resulting from the projects we reviewed. Table 5 shows the types of outcomes that project officials and planning documents cited for each project and the extent to which these outcomes were measured.[60] As table 5 indicates, the projects were often expected to result in indirect impacts that are difficult to forecast and measure, such as positive changes to land use, and economic

[59]See Pickrell, xiiii; see also, Flyvbjerg, Holm, and Buhl, 279-291.

[60]One official commented that it may be possible to measure several of the outcomes included in table 5 although it is not typically done for specific projects.

development, among other things. According to project officials, these outcomes, while not forecasted in measurable terms, were important reasons that the projects were pursued.

Table 5: Summary of Key Projected and Observed Outcomes of Highway and Transit Projects

Project	Projected outcome	Measured outcomes
Baltimore light rail extensions	Expand ridership—average weekday boardings and alightings on the extensions were predicted to be about 11,800 by 2005	Boardings and alightings on the extensions in 2001 were 8,272.
	Attract growing reverse commuter population—two of the extensions combined were expected to carry over 4,000 reverse commuters	No measurement of reverse commuters.
	Reduce travel-time—savings of 10 to 12 minutes for one extension were expected, and 11 to 24 minutes for another	No measurement of changes in travel times.
	Support future development	No measurement of benefits of development, but local officials showed increases in employment and households around transit extensions.
Baltimore highway addition	Reduce congestion on nearby roads	Before and after study showed that congestion was reduced in some areas and traffic increased in others.
	Attract new industry	No measurement of the extent to which new industry was attracted, but local officials showed increases in employment in the area.
	Increase tax revenues from increased property values and additional employment	No measurement of increases in tax revenues, but officials provided data on increases in employment in the area.
	Accommodate planned regional and local industrial and residential growth	Local officials showed that number of households grew around new highway.
Dallas light rail segment	Expand ridership—average weekday boardings on the segment were predicted to be 34,800 by 2005	26,884 average weekday boardings in 2002.
	Maximize transit potential in the city and improve overall transit travel	Before and after study for the entire system showed overall annual transit ridership increased by 7 percent and annual passenger miles of travel increased by 8 percent 2 years after opening.
	Improve travel times from various points within the corridor to the central business district	Before and after study for the entire system showed that overall, the light rail offered better travel time, as compared with local bus routes, but limited bus express routes offered a better travel time.
	Create land-use changes throughout the corridor	Before and after study for the entire system showed that mixed results have been observed throughout corridor, but areas in the southern sector of Dallas, where there are high levels of poverty and unemployment, have seen less development despite city incentives to develop the area.

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Project	Projected outcome	Measured outcomes
Dallas lane widening	Improve existing and future congestion	Traffic counts are taken, but no measurement of changes in traffic levels and congestion, although officials noted fewer complaints of congestion.
	Enhance safety	No measurement of safety improvement.
Denver light rail expansion	Expand ridership—average weekday boardings on the expansion were predicted to be 22,000 by 2015	19,083 average weekday boardings in 2002.
	Relieve mounting congestion on alternative roadways with less traffic expected versus the no-build alternative	Before and after study showed that daily traffic on one road in the corridor declined between 2000 and 2001—a survey on the light rail line also indicated that 38 percent of the weekday riders were likely former drivers.
	Contribute to the attainment of regional air quality objectives	No measurement of air quality impacts.
	Influence land use and economic opportunity within the corridor	No measurement of benefits of land-use changes or development, but local officials cited changes to zoning and increases in development around stations.
	By 2015, potential savings in bus operational costs	No measurement of changes in bus operating costs.
Denver lane widening	Reduce increasing congestion and improve level of service	No measurement of congestion reduction, but officials noted that improvements are self-evident.
	Decrease the rate and number of accidents by eliminating signalized intersections and numerous turning movements	No measurement of accident reduction, although project did result in elimination of signalized intersections.
	Business conditions may improve with improved accessibility	No measurement of changes in business conditions.
	Regional emissions would be reduced	No measurement of changes in emissions.
Miami Metromover extensions	Expand ridership—average weekday boardings on the extensions were predicted to be 20,404 by 2000	4,158 average weekday boardings in 2002.
	Promote land use and economic development	No measurement of benefits of land use changes or development, but officials noted some development occurring around stations.
	Minimize duplication of public transportation services	No measurement of benefits resulting from less duplication, but officials noted that bus service within downtown had been replaced by the Metromover.
Miami highway expansion and interchange	Improve overall levels of service, solve congestion at particular bottlenecks	Traffic counts were taken, but were not comparable with projections due to different data collection methods—officials indicated that congestion has returned to levels similar to before the improvement was made because of greater than expected development in the area.
	Reduce accident rates	No measurement of accident reductions.
	Accommodate existing development and planned future development	No measurement of benefits of changes in development, but officials noted that development has increased at a greater rate than was expected.

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Project	Projected outcome	Measured outcomes
San Jose light rail extension	Expand ridership—average weekday boardings on the extensions were predicted to be between 5,800 and 7,400 by 2005	6,366 average weekday boardings in July 2000—although ridership fell to 3,800 in July 2004.
	Reduce congestion on area roadways	No measurement of congestion reduction, but a 2000 survey of riders found that 46 percent of riders would drive if light rail were not available and 55 percent of riders were new to transit (in other words, riders were taken off the highway network, thereby lowering congestion levels).
	Improve travel time	No measurement of changes in travel times, but officials noted that transit travel times are competitive with auto travel times.
	Support the development plans of local cities, such as higher density development	No measurement of benefits of land use changes or development, but officials noted that many local businesses had located around transit stations, and one business had financed a station.
San Jose interchange	Improve congestion at interchange	Eastbound afternoon delay decreased from 13 minutes to 4 minutes, and westbound morning delay decreased from 6 to 3 minutes.
	Promote land use and economic development	No measurement of benefits of land-use changes or development, but officials noted that many local businesses had located in the area around the interchange.

Source: GAO summary of information collected through case studies of each project.

For some outcomes, as table 5 indicates, transportation officials only had anecdotal or qualitative pieces of evidence about whether the projects achieved their proposed outcomes. For example, in one area, transportation officials cited personal experiences and public comments about reduced congestion on nearby roadways. In other areas, officials showed us developments that had been constructed around stations, or areas near the improvements where development was expected to occur as evidence of the projects' impacts.

Transportation Officials Cite Several Reasons for Not Conducting Outcome Evaluations

Transportation officials we spoke with offered several reasons why they do not typically conduct evaluations of the outcomes of highway and transit projects. In particular, transportation officials and experts agreed that there is little incentive to direct available funding toward doing outcome evaluations. Because state and local funding is limited and these studies can be costly and difficult, local officials indicated that studies of completed projects were not as high a priority as pursuing and conducting studies on future projects. Several transportation officials stated that once a project is completed, it is considered successful; and planners then turn

their attention to other projects. Some officials also noted that these projects inherently improve safety, mobility, and economic development and that evaluation of these outcomes is not needed. Thus, project evaluations for completed projects do not fare well in competition for limited planning funds. The Senate-proposed bill (S. 1072) to reauthorize federal surface transportation programs, which was considered by the 108th Congress in 2004, would increase funds available to support local transportation planning. The funds provided under such a provision could potentially be used to fund outcome evaluations.

Experts and transportation officials we spoke with also stated there were many technical challenges to designing and completing outcome evaluations. For example, experts stated that it is very difficult to determine the economic impacts that can be attributed to a transportation project, given the multitude of other factors that can influence development. According to experts and transportation officials, once transportation investments are completed, they become a part of an entire transportation system; and, therefore, the effects of the individual project become difficult to isolate, evaluate, and attribute to the individual project.

Finally, experts and transportation officials contend that a major disincentive to doing outcome evaluations is that the benefits of doing the analysis may be smaller than the potential risks. Transportation projects are concrete and cannot be easily redesigned or adjusted once completed, so some officials believe there is little incentive to find out that a project is not providing the intended benefits. Therefore, agencies tend to declare success once the project begins operating.

Options for Increasing Use of Information on Project Benefits and Costs to Better Inform Decisions and Instill Accountability

There are options for providing state, regional, and local decision makers with more and better analytic information for making investment choices. These options focus on improving the value of this information for decision makers to make more fully informed choices and in helping ensure that projects can be evaluated on the results they produce. At the federal level, these options could be implemented either through incentives or mandates. However, each of these implementation approaches has a degree of difficulty in such matters as the time required and the impacts on federal programs and resources. In addition, any attempts to increase the use of such information should be tempered with the knowledge that other factors, such as the structure of federal programs and the requirements of legislative earmarks, will affect the extent to which such information can

be used. These other factors often have a strong effect on decisions about which projects are funded.

Options Exist to Improve Analytic Information and Its Use in Transportation Investments

The experts who served on our panel provided a variety of options for improving information available to decision makers and potentially giving such information a greater role in highway and transit investment decisions. The options are of three main types: (1) improving the quality of data and transportation modeling, (2) improving the quality and utility of benefit-cost analysis methods and tools, and (3) evaluating the results of completed transportation projects. These options focus on making the analytic information more useful and relevant to investment decisions, according to experts. Experts noted two important caveats in considering these options, however. First, no single analytic tool can answer all questions about the impacts of transportation investment choices. Second, even when benefit and cost information is available, it may play a relatively limited role in investment decisions. As a result, the best information and analysis may not result in the most beneficial highway and transit investments.

Improve the Quality of Data and Transportation Modeling

Local and state transportation agencies require valid, reliable data and transportation models in order to conduct analyses, including benefit-cost analysis. Yet, experts have expressed concerns about the quality of local data and transportation models and have proposed improvements in both areas.

Several options have been proposed to improve data and modeling quality. For example, TRB, with DOT sponsorship, is undertaking a study to gather information and prepare a synthesis of local planning agencies' current modeling state of practice so that this baseline can be used to identify data that these models require. In addition, an expert proposed adopting an approach used outside the transportation sector—that is, accept existing data but specify the degree of uncertainty associated with the data. This approach is based on the idea that consistent data and measures are more important than perfect data and measures.

To improve the accuracy of local travel models used to support New Starts projects, FTA introduced new reporting and analysis software—"Summit"—in the fiscal year 2004 rating process. Summit is intended to produce a computation of user benefits from locally developed forecasts, as well as standardized analytical summaries of both the forecasts and user benefits. According to FTA, these reports and summaries have provided

both FTA and transit agencies a means to (1) identify and diagnose travel forecasting problems related to assumptions regarding fare and service policies, regional transportation networks, land use, and economic conditions as well as (2) help ensure that the local forecast is utilizing comprehensive and up-to-date data on travel behavior and local transportation systems. As evidence of the impact of Summit, FTA officials noted that they required 22 of 29 projects rated in the fiscal years 2004 and 2005 rating cycles to correct flaws in their underlying local forecasting models. Despite these improvements, however, forecasting of transit user benefits currently has a critical shortcoming. FTA has discovered that current models used to estimate future travel demand for New Starts are incapable of estimating reliable travel time savings as a result of a New Start project. According to DOT's Inspector General, this limitation is due to unreliable local data on highway speeds. FTA is studying ways to remedy this problem.

Improving the Quality and Utility of Benefit-Cost Analysis Methods and Tools

Experts said local, regional, and state transportation officials could have more reason to use benefit-cost analysis if it produced information more relevant to the investment choices that they face. In this regard, they cited various steps that could be taken to make benefit-cost analysis more accessible to these officials without making it more complex. Table 6 describes the improvements they identified.

Table 6: Experts' Suggestions for Improving the Quality and Utility of Economic Analysis

Improve land-use measures and incorporate more fully into analysis	The impacts of transportation investments on land use are an important factor in decision making. As a result, analyses that predict the impacts of transportation investments on land use, or the impact of changes in land use and employment on travel behavior and transportation choices, are critical to local transportation decision makers, according to experts and local officials we interviewed. Nevertheless, benefit-cost analysis and other types of economic analysis usually pay limited attention to land-use issues, according to experts. Moreover, land-use impacts—as well as other indirect benefits—are difficult to estimate, and the inclusion of such impacts must be done in a manner that captures the complexity of other factors that work in conjunction with access issues.[a] Noting that transportation planners generally find it difficult to adapt economic analysis to debates about population density and sprawl and lack economic analytic tools to forecast land-use impacts, experts described this as a situation that discredits economic analysis.
Consider distribution of projects in analysis	Distribution of transportation investments' benefits and costs is a critical, local concern that frequently is not considered adequately in economic analysis. Improving analytical tools and attention to how transportation benefits and costs are distributed across social and income groups and geographic areas could be important to local officials and the public, experts emphasized. At the same time, these issues often are treated as having secondary importance in economic analysis. By not fully addressing these issues, local transportation planning agencies can be open to charges—both from the public and judges in courts of law—of conducting a less than a comprehensive project assessment. One expert stated that these distributional issues are a key reason for conducting economic analysis—that is, the analysis can help referee situations where investments produce real differences in outcomes for various groups.

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Improve understanding of travel patterns	Travel patterns are changing as the number of people using the transportation system increases and the demographics of the traveling public changes. The travel market is growing and diversifying and travelers' demands are changing. For example, experts point to significant differences between men's and women's travel patterns in use of different transport modes, and journey purpose and destinations, among other things. Understanding the implications of these passenger and freight travel patterns is important in meeting local, regional, and state needs, and supporting reasonable and accurate economic analysis, since travel demand models produce the information that is then used to estimate economic benefits.[b] Transportation financing and service delivery also is changing—and some changes are generating the need for analytic tools to help predict travel patterns. For example, to the extent that more private firms build toll highways, their need for analyses to support required revenue bonds and insurance becomes greater. Highway expansion projects that are done with toll financing rather than highway trust funds will not advance without good models of travel patterns. This need for analysis to help predict how people will react to the project and respond to various prices is far more important, according to an expert.
Explore innovative approaches in using and communicating analysis	State, regional, and local officials who might be comparing a transit project with a highway widening project need information that is useful and better documented. Several paths could lead toward this result, according to one expert. Economic analysis could be reinvented to facilitate decision by discussion because it can be a powerful tool to discuss values—increasing jobs, reducing emissions, etc.—that are associated with certain investment choices. The use of risk assessment and probability analysis in conjunction with economic analysis could also be expanded. For example, weather forecasters talk about the probability of rain rather than suggesting that they can accurately predict what will happen. This approach could illustrate that projects with similar rates of return have very different risk profiles and different probabilities of failure.[c]

Source: GAO analysis of expert panel discussion.

[a]FTA's New Starts program requires project sponsors to assess the extent to which a New Starts project may affect land use.

[b]FTA requires that project sponsors describe the travel patterns of forecast project users as part of the submittal of information to support project ratings in the New Starts evaluation process.

[c]FTA currently requires risk analysis on the capital costs of all projects as a prerequisite for approving the project into final design in the New Starts program.

Evaluating the Outcomes of Completed Projects

A third set of options suggested by the experts dealt with conducting more analyses of completed projects. Information about the outcomes of completed highway and transit projects can be used not only to better determine what a particular project accomplished, but also to improve decisions on other projects. For example, a study of how federal agencies use outcome information indicates that this information can help decision makers maximize project effectiveness by identifying "best practices" and better allocate limited resources.[61] However, as noted previously, the outcomes of completed projects are not typically evaluated. Experts noted that such studies are more regularly conducted in other sectors, such as health and education programs. Such evaluations provide an opportunity to

[61]Harry P. Hatry, Elaine Morley, Shelli B. Rossman, and Joseph S. Wholey, "The Managing for Results Series of the IBM Endowment for the Business of Government and National Academy of Public Administration," *How Federal Programs Use Outcome Information: Opportunities for Federal Managers* (Washington, D.C.: May 2003).

increase accountability in the planning process by documenting and measuring the results of projects. Outcome evaluations also offer the opportunity for officials to learn from successes as well as the shortcomings of past projects.

FTA has recently adopted a requirement for project sponsors to complete before and after studies for New Starts projects.[62] In particular, sponsors seeking federal funding for their New Starts project must submit to FTA a plan for the collection and analysis of information that addresses how the project's estimated costs, scope, ridership and operating plans prepared during planning and project development compared with what actually occurred. According to FTA officials, this requirement is intended to hold transit agencies accountable for results and identify lessons learned for future projects. The Senate-proposed bill to reauthorize federal surface transportation programs, which was considered by the 108th Congress in 2004, would codify this requirement.[63] Neither the House nor Senate reauthorization bills that were considered in 2004, or FHWA regulations, would require similar studies for most highway projects, although the Senate bill provides for evaluating projects funded by the Congestion Mitigation and Air-Quality program.[64]

Incentives or Mandates Could Be Used to Increase Use of Analytic Information

Incentives, mandates, or a combination of both, could be used to increase decision makers' use of analytic information and improve accountability for investment choices. Each strategy has factors that affect its feasibility—the difficulty of implementation, time required, and impacts on federal programs and resources. Each strategy also has its unique advantages and disadvantages, according to experts. Several experts also emphasized that the question of strategy is important because, although many ingredients for benefit-cost analysis already are in place as a result of local agencies' compliance with extensive environmental and clean air analytic requirements, they have not taken the extra step toward this analysis.

[62]49 C.F.R., Part 611 (2003).

[63]Section 3011(g) of the Safe, Accountable, Flexible, and Efficient Transportation Equity Act of 2004 (S. 1072), 108th Congress.

[64]S. 1072 and the Transportation Equity Act: A Legacy for Users (H.R. 3550), 108th Congress.

Incentives could be used to increase state, regional, and local agencies' utilization of analytical information and tools. For example, funding could support additional analysis; training for state, regional, and local agency personnel in using the analytical tools; and performance incentives. Using incentives would also be consistent with what one expert described as the appropriate federal role—supplying funds to improve data and modeling practices, providing guidance regarding best practices, and evaluating completed transportation projects. State, regional, and local transportation agencies also may view the use of incentives—as opposed to a new federal mandate—as giving them more flexibility to respond to their stakeholders' interest in how modal and distributional trade-offs are made. However, using incentives to increase the use of economic analytical tools, such as benefit-cost analysis, would be reasonably labor intensive for the respective federal agencies and require strong program management; clear strategies for setting goals and practices; and a workable method to ensure that state, regional, and local transportation agencies have good analytical tools, according to experts. FTA and FHWA are working to provide incentives that encourage greater use of analytical tools. For example, FTA and FHWA have collaborated to establish the Transportation Planning Capacity Building program, which provides training and technical assistance to state, regional, and local transportation officials on using analytical tools in the decision-making process.

Federal mandates could also be used to increase state, regional, and local transportation agencies' use of analytical tools, such as benefit-cost analysis. However, in some cases, mandates would require legislative change. For example, benefit-cost analysis cannot currently be required as a condition of receiving highway funds because the federal government does not have exclusive approval power over the worthiness of these projects, and states maintain the sovereign rights to determine which projects shall be federally funded.[65] In addition, it would also be necessary to change TEA-21's prohibition on placing dollar values on transit mobility improvements in order to require a benefit-cost analysis as part of the New

[65]23 U.S.C. 145 (2003).

Starts process.[66] As a strategy based on compliance with rules, mandates are comparatively simple to implement. However, detecting mistakes and enforcing mandates as well as creating mechanisms for sanctioning noncompliance would require considerable attention for effective oversight.

Factors that Work Against Greater Use of Analysis in Investment Decisions

As our survey responses showed, decisions about transportation investments are based on many things besides the results of economic analyses of a project's benefits and costs, such as the availability of funding or public perception about a project. Improving the quality of information about projects does not make these other matters disappear. Experts, other transportation researchers, and our past work have identified several overarching factors that can affect the extent to which additional analytical information may be used in making decisions about projects. Four such factors, each discussed below, would likely continue to affect the extent to which analytic information, even significantly improved, would be used as the dominant factor in making investment decisions.

- *Structure and Funding of Federal Programs:* According to several experts, the highly compartmentalized structure and funding of federal highway and transit programs work against an advantage of benefit-cost analysis—the ability to evaluate how well alternative investments meet transportation problems. Separations between federal programs and funds give state, regional, and local agencies little incentive to systematically compare the trade-offs between investing in different transportation alternatives to meet passenger and freight travel needs because funding can be tied to certain programs or types of projects, according to several experts.[67] For example, only fixed guideway transit projects, such as rail projects, are currently eligible for New Starts

[66]FTA officials noted that this prohibition does not preclude local, regional, or state agencies from conducting benefit-cost analysis of their New Starts projects. However, FTA officials acknowledged that the New Starts evaluation criteria usually set the bar for the type and amount of analysis that is performed for New Starts projects. Rather than a benefit-cost analysis, the New Starts evaluation process requires a project's cost-effectiveness, as defined by FTA, to be measured.

[67]See also, Jianling Li and Martin Wachs, "The Effects of Federal Transit Subsidy Policy on Investment Decisions: The Case of San Francisco's Geary Corridor," *Transportation* 31 (2004).

funds.[68] As a result, certain bus rapid transit projects, which have compared favorably with the per-mile costs of light rail projects, are not eligible for New Starts funds.[69] Both the Senate- and House-proposed bills (S. 1072 and H.R. 3550) to reauthorize federal surface transportation programs, which were considered by the 108th Congress in 2004, would allow certain nonfixed guideway transit projects (e.g., bus rapid transit operating in nonexclusive lanes) to be eligible for New Starts funding. The Transportation Research Board reported that most local agency staff continues to be in a single transportation sector "silo."[70]

Federal funding of highway and transit projects is also not linked to performance or the accomplishment of goals or outcomes. As a result, the federal government misses an opportunity to use financial incentives to improve performance and to hold agencies accountable for results. In a previous report, we identified possible options for how the federal highway program could be restructured to increase flexibility and accountability, including linking funding with performance and outcomes.[71]

- *Legislative earmarks:* Legislative earmarks target transportation funds to specific local uses. As a result, these designated projects do not compete for funding against other alternatives, which removes the reason and incentive for transportation agencies to conduct benefit-cost analyses.

- *Multiple federal requirements:* Federal legislation and regulations place many demands on state, regional, and local transportation agencies' analytic resources and—in some cases—give them compelling reasons

[68]Fixed-guideway systems use and occupy a separate ROW for the exclusive use of public transportation services. They included fixed rail, exclusive lanes for buses and other high-occupancy vehicles, and other systems.

[69]Bus rapid transit projects are designed to provide major improvements in the speed, reliability, and quality of bus service through barrier-separated busways, high-occupancy vehicle lanes, or reserved lanes or other enhancements on arterial streets. For more information about the potential costs and benefits of bus rapid transit projects, see GAO-03-729T.

[70]Transportation Research Board, *Transportation Agencies Meet Fiscal Challenges: The Transportation Research Board's 2003 Field Visit Program* (Washington, D.C.: Feb. 2004).

[71]GAO-04-802.

to dedicate their analytic resources to areas other than benefit-cost analysis or to choose an alternative that is not the most cost beneficial. For example, one expert emphasized that local transportation agencies have especially strong incentives to focus their modeling and analytic resources on achieving air-quality goals, as mandated by federal statute. Demonstrating that these goals are met is a high priority because failing to do so creates the very tangible risk that transportation project funding could be blocked. In addition, TEA-21 requires local, regional, and state transportation agencies to consider a number of factors in their planning that are not easily quantified.[72] As a result, these statutorily defined factors, which are considered in a more qualitative manner, can be more important than the results of a benefit-cost analysis in selecting a transportation project for funding.

- *Expense of analysis:* Experts told us that analysis can be quite expensive. For example, a formal benefit-cost analysis can typically cost over $100,000 for a multimodal urban corridor that is several miles long. The high cost of such analyses puts pressure on local agency budgets that are already stretched to meet other competing demands and poses a significant disincentive to using benefit-cost analysis or conducting outcome evaluation. As noted earlier, the Senate proposed bill (S. 1072) to reauthorize federal surface transportation programs that was considered by the 108th Congress in 2004 would increase funds to support local transportation planning, and those additional funds could presumably be used to support economic analyses.

Concluding Observations

With growing concerns about the size of federal and state budget deficits, combined with the future mandatory commitments to Social Security and Medicare set to consume a greater share of the nation's resources, the prospects of future fiscal imbalances are a certainty. Given the current and long-term fiscal challenges, careful decisions need to be made to ensure that transportation investments systematically consider the benefits of each federal dollar invested.

Through federal regulations, laws, and guidance, a framework has been established for transportation planning that state, local, and other decision

[72]TEA-21 requires that metropolitan and state projects that are proposed for federal funding address seven criteria including economic vitality, safety, accessibility, environment, transportation system integration, efficiency, and system preservation.

makers must follow to receive federal transportation dollars. Although the framework identifies factors for consideration during transportation investment decision making, it does not specify analytical tools to be applied for evaluating project merits—nor does it require that the most cost-beneficial project be chosen. Furthermore, many of the factors that are required to be considered are not easily incorporated in economic analysis, and methods for estimating dollar values associated with those factors may not be readily accepted. This results in some factors being considered more qualitatively and thus weighted differently than those factors that can be more easily incorporated in an economic analysis. Academic institutions, research organizations, and experts in the field continue to seek new methods and tools for estimating transportation project benefits and costs. Such advancements could help federal funding recipients improve their project analyses and thus improve the information available to decision makers, although these methods should be appropriately tested and vetted within the transportation community.

Throughout this report, we have acknowledged the very tangible difficulty of comprehensively and accurately estimating the benefits and costs of transportation projects, which, in part, leads to the relatively infrequent use of benefit-cost analysis in determining which projects to pursue. Further, we have recognized that transportation investment decision making does not occur in a vacuum. State, regional, and local officials consider a variety of factors in making transportation investment decisions, including the community's needs and priorities as well as federal requirements—and these factors can play a greater role in shaping investment choices than the analysis of a project's benefits and costs. In addition, overarching factors, such as the funding compartmentalization of federal transportation programs and legislative earmarks that target transportation funds to specific uses, inhibit more widespread use of benefit-cost analysis. Nevertheless, the increased use of systematic analytical tools such as benefit-cost analysis, and the continued improvement of such tools through dissemination of new methods and advancement of existing techniques, can provide important additional information that can be used to inform discussions about community needs and values, which could then lead to better-informed transportation investment decision making.

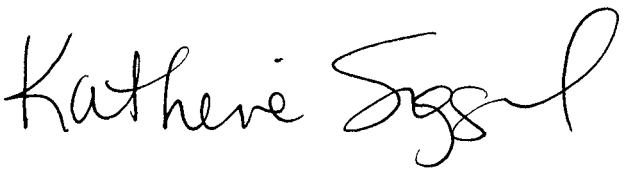
Agency Comments

We obtained comments from DOT, including FTA and FHWA. Overall, DOT said that the report presented a clear and useful assessment of the status of economic analysis in its application to evaluating transportation projects. While recognizing the utility of economic analysis for maximizing benefits

associated with public investment in transportation capacity, DOT agreed with the limitations associated with the use of these techniques that we described in our report. DOT indicated that a combination of factors, including difficulties in measuring and forecasting benefits, along with local political, land use, and public support factors can limit the practical utility of formal economic analysis in making local transportation decisions. Nonetheless, at the federal level, representatives from FTA said that it had made significant strides incorporating state-of-the-art analytical tools into its New Starts Program. For example, as described in our report, FTA developed software capable of calculating transportation user benefits, based on locally originated data, and grantees are required to use it in making statutorily required New Starts submissions. Representatives from FTA also said that FTA is more rigorously reviewing ridership forecasts, requiring before and after studies for all new projects, and is conducting risk assessments to identify significant risks to project budgets and schedules, as described in our report. Finally, both FTA and FHWA offered a number of technical comments, which have been incorporated in this report, as appropriate.

We are sending copies of this report to the Secretary of Transportation, Administrators of the Federal Highway Administration and Federal Transit Administration, and interested congressional committees. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you have any questions about this report, please contact me at siggerudk@gao.gov, or (202) 512-2834. Key contributors to this report are listed in appendix VI.



Katherine Siggerud
Director, Physical Infrastructure

Scope and Methodology

To identify the categories of benefits and costs that can be attributed to highway and transit investments and the challenges in measuring these benefits and costs as well as options to improve the information available to decision makers, we reviewed the economics literature, academic research, and transportation planning studies containing evaluations of various economic analytical tools, with an emphasis on benefit-cost analysis. A GAO economist reviewed these studies, which were identified by searching economics literature databases and consulting with researchers in the field, and found their methodology and economic reasoning to be sound and sufficiently reliable for our purposes. We also reviewed federal laws, regulations, and guidance on the transportation planning process in order to determine the extent to which considerations of project benefits and costs are required or encouraged. In addition, we interviewed federal transportation officials in the Department of Transportation's (DOT) Office of the Inspector General, Federal Highway Administration (FHWA), Federal Transit Administration (FTA) and the Volpe Transportation Center, as well as representatives from think tanks, consulting firms, academic institutions, and the Transportation Research Board's Transit Cooperative Research Program and National Cooperative Highway Research Program.

We also contracted with the National Academy of Sciences (NAS) to convene a balanced, diverse panel of experts to discuss the use of benefit-cost analysis in highway and transit project decision making and gather views about options to improve the information available to decision makers. The NAS Transportation Research Board (TRB) identified potential panelists who were knowledgeable about benefit-cost analysis, transportation policy and planning, highway and transit use, and transportation decision making. We worked closely with TRB to select panelists who could adequately respond to our general and specific questions about conceptualizing, measuring, improving, and using benefit and cost information in investment decisions (see app. III for more information about the panelists). In keeping with NAS policy, the panelists were invited to provide their individual views, and the panel was not designed to build consensus on any of the issues discussed. After the expert panel was conducted on June 28, 2004, in Washington, D.C., we used a content analysis to systematically analyze a transcript of the panel's discussion in order to identify each expert's views on key questions.

To determine how state, local, and regional decision makers consider the benefits and costs of new highway and transit investments and the extent to which select capacity-adding highway and transit investments met their

projected outcomes, we conducted a survey and a series of case studies. Specifically, we conducted a self-administered e-mail survey of all state DOTs (excluding the District of Columbia and Puerto Rico) and the 30 largest transit agencies in the United States. We sent the survey to state DOT planning officials and transit agency general managers and asked them to coordinate responses with agency officials most knowledgeable about particular issues raised in the survey.

Although we did not independently verify the accuracy of the self-reported information provided by these agencies, we took a series of steps, from survey design through data analysis and interpretation, to minimize potential errors and problems. To identify potential questions, we spoke with numerous transportation experts, agency officials, and officials at organizations relevant to transportation planning and decision making, including, the American Association of State Highway and Transportation Officials (AASHTO), the American Public Transportation Association, and the Association of Metropolitan Planning Organizations (AMPO). To verify the clarity, length of time of administration, and understandability of the questions, we pretested the questionnaire with 12 transit agencies, state DOTs, and metropolitan planning organizations (MPO). We also had the questionnaire reviewed by a survey expert and AMPO staff. In addition, we examined survey responses for missing data and irregularities. We analyzed the survey data by calculating descriptive statistics of state DOT and transit agency responses.[1] A copy of the Survey of State Department's of Transportation and Transit Agencies—The Costs and Benefits of Transportation Projects can be found in appendix II.

We used AASHTO's standing committee on planning to identify state highway officials in each state. We also used the National Transit Database to identify the top 30 transit agencies nationwide as well as obtain contact

[1]We also surveyed state DOTs about the analysis of benefits and costs of transit projects, and the importance of different factors in decision making, for capacity-adding transit projects in their states. However, based on the inconsistencies and irregularities of the survey responses, low response rate, and telephone conversations with survey respondents, we concluded that the information from this survey was not sufficiently reliable for our purposes. Therefore, we did not use the information from this survey in our analysis or include it in the report.

information for the general managers of the agencies.[2] We also interviewed officials from several MPOs on the types of analysis they used in planning, but we did not include them in the survey population because MPO officials told us that state DOTs and transit agencies are typically project sponsors and are responsible for identifying and evaluating specific project alternatives. While MPOs are involved in the project planning process, we decided to limit our survey to those agencies that most likely had completed project specific analyses.

We conducted the survey from August through October 2004. We initially contacted state DOT and transit agency officials via telephone, and we then sent the survey via e-mail to each official. To maximize response rates, we sent periodic e-mail reminders with copies of the survey to nonrespondents in September 2004. Each of these messages contained instructions for completing the survey and contact information to submit questions. We extended the initial deadline from September 15, 2004 to October 8, 2004, to allow additional agencies to submit completed questionnaires. Finally, we telephoned officials that had not yet responded between September 22, 2004, and September 28, 2004, to remind them to complete the questionnaire. Overall, 43 of the 50 state DOTs responded to our survey and 20 of the 28 transit agencies.

We supplemented our survey data with in-depth information from state and local transportation officials about 10 highway and transit projects in five major metropolitan areas: Baltimore, MD; Dallas, TX; Denver, CO; Miami, FL; and San Jose, CA. We chose these five metropolitan areas because they each had both a New Starts project and a capacity-adding highway project completed within the last 10 years and were identified by the Texas Transportation Institute as among the top 25 most congested areas in the United States. (Table 7 provides a description of each project.) In these locations, we interviewed officials from transit agencies, MPOs, and state DOTs in order to understand the type of analysis that was completed for the highway and transit projects, the factors that drove project decision

[2]The largest 30 transit agencies were identified based on total passenger miles traveled. We later eliminated 2 transit agencies from the study population because 1 reported that it was privately owned and operated, and the other received no federal funds, making the survey population 28 rather than 30 agencies.

making,[3] and the types of project outcomes that were achieved and tracked. We also analyzed available planning and project documents, such as Environmental Impact Statements and Project Study Reports. We also collected available cost and usage information from the planning and project documents or from project officials.

Table 7: Description of Five Highway and Five Transit Projects Selected for Review

Location	Highway project description	Transit project description
Baltimore	This project completed a 5-mile section of Maryland Route 100, located between U.S. Route 29 and Interstate Route 95 in eastern Howard County Maryland. This project was opened to traffic in 1999.	This project included three distinct extensions to the Baltimore Central Light Rail Line. The Hunt Valley extension was to be 4.6 miles with five stations, the Penn Station extension was to be 0.3 miles, and the BWI extension was to be 2.4 miles with two stations. The extensions were opened to service in 1997.
Dallas	This project widened a 4-mile stretch of State Highway 66, between the cities of Rockwall and Rowlett, from two lanes to four lanes, and replaced an existing bridge with twin bridges. The project was completed in 2003.	This project is a 9.6 mile segment of a 20-mile light rail starter system. Traffic conditions within the South Oak Cliff Corridor were not severely congested, so this project was intended to provide dependable, fast, and convenient transit access to employment opportunities for residents. Initial revenue service began in June 1996. The final segment opened for service in May 1997.
Denver	This project included widening Parker Road (State Highway 83) by one through lane in each direction, modifying the I-225 interchange ramps, completing a grade separation and access roads at Vaughn Way and a half-urban interchange at Hampden Avenue, eliminating three signalized intersections, and constructing a flyover ramp from northwest bound Parker Road to southwest bound I-225. The project was completed in 2001.	This project was an 8.7 mile light rail line extending from I-25 and Broadway just south of downtown Denver to Mineral Avenue in Littleton, Co. The project is grade separated and generally follows the South Santa Fe freight rail corridor. Revenue operation began in 2000.

[3]Several of the factors we identified during our in-depth interviews with state and local transportation officials, such as land-use changes, were not specifically included in our survey. See appendix II for a copy of our survey instrument.

(Continued From Previous Page)

Location	Highway project description	Transit project description
Miami	This project was one of several expansion projects planned for Biscayne Blvd., from downtown Miami to the Broward County line. It included adding travel lanes in both directions and a grade separation at the intersection of NE 203rd St. and Biscayne Blvd. This project was completed in 2001.	This project was an extension to the existing Miami Metromover system—an elevated downtown people-mover system. It was designed to provide downtown distribution for the Metrorail system and for general circulation around downtown Miami. The extensions added 2.5 miles of additional guideway north and south of the initial 1.9-mile loop. The extensions began service in 1994.
San Jose	This project consisted of modifications to the existing Route 237 and I-880 interchange, including providing a direct freeway-to-freeway connector between Route 237 and I-880, separating freeway traffic from eastbound and westbound local street traffic on Calaveras Blvd., providing for the expansion of I-880 to accommodate a 10-lane freeway, and converting the existing full cloverleaf interchange to a partial cloverleaf interchange. Construction of the interchange was completed in 2002.	This project was the first 7.6 mile phase of a 12-mile light rail line running across the Tasman Corridor—a major travel corridor that covers the City of San Jose in the east and the City of Mountain View in the west in northern Santa Clara County. The Tasman West light rail line was constructed to connect to the existing Guadalupe light rail line for connections to downtown San Jose. Operations began in 1999.

Source: GAO summary of project documents.

To examine the relationship between benefit-cost ratios computed for state transportation projects in California and the subsequent decisions to program construction funds for those projects in the Statewide Transportation Improvement Plan, we used a logit model. This model is one of the most commonly used statistical techniques for estimating problems involving outcome variables that take discrete values---in this case, the outcome variable is that the projects either received funding or they did not. The data for this analysis were provided to us by the California DOT. In the statistical analysis, we also included population density and total employment to both account for plausible effects from these demographic factors and to check for the sensitivity of the estimated relationship. These county-level demographic variables, obtained from Census Bureau's 2000 census, were matched to counties in which the projects were to be constructed.

Finally, to determine trends in public expenditure, capacity, and usage for highway and transit systems over a 20-year period (1982 to 2002), we analyzed information from FHWA's Highway Statistics, FTA's National Transit Database, and DOT's Conditions and Performance Report. We adjusted expenditures to 2002 dollars using the price index for state and local government gross fixed investment in highways and streets estimated by the Bureau of Economic Analysis (BEA) of the Department of Commerce. The adjusted expenditures using the BEA index will be slightly different from expenditures calculated by FHWA using its bid-price index because BEA adjusts the FHWA bid-price index. We used BEA's index

because it uses a 12-quarter phasing pattern that more consistently captures expenditure patterns for capital highway projects. To determine the reliability of the data, we (1) reviewed available documentation about these databases and the systems that produced them and (2) interviewed knowledgeable agency officials. We determined that the data were sufficiently reliable for the purposes of this report.

Survey Results

United States Government Accountability Office

The Costs and Benefits of Transportation Projects

Introduction

The U.S. Government Accountability Office, an agency of Congress, is conducting a study of the costs and benefits of federal investments in transportation projects. As part of this study, we are surveying officials at State DOTs about analyses of costs and benefits conducted when comparing alternatives in planning and developing highway projects.[1] Please help us to inform Congress about this important issue by responding to this brief questionnaire.

Your responses to this survey are critical in helping Congress to understand the costs and benefits of transportation investments. Without your responses, we cannot provide meaningful information to Congress about this important issue.

Instructions

Please complete this questionnaire and return it to GAO before September 15, 2004. This questionnaire should take approximately 20 minutes to complete. If you have any questions regarding this survey, please contact either Andrew Von Ah (by phone at 213-830-1011 or by email at vonaha@gao.gov) or contact Heather MacLeod (by phone at 206-654-5574 or by email at macleodh@gao.gov).

Thank you for participating in this survey.

[1]For transit agency surveys this statement read as follows, "As part of this study, we are surveying officials at the 30 largest transit agencies about analyses of costs and benefits conducted when comparing alternatives in planning and developing transit projects."

Section 1: Analysis of Highway/Transit Projects

For highway: *In this section of the survey, please consider only highway projects that used **federal funds** and that were designed to **expand the physical capacity** of the highway system, such as adding HOV lanes, reconfiguring interchanges, and constructing new roads. Do not consider operations, maintenance, or rehabilitation projects such as signal timing or road repaving.*

For transit: *In this section of the survey, please consider only transit projects that used **federal funds** and that were designed to **expand the physical capacity** of public transit systems. Please consider public transit systems to include buses, subways, light rail, commuter rail, monorail, passenger ferryboats, trolleys, and inclined rails. Do not consider operations, maintenance, or rehabilitation projects.*

1. **When alternatives are considered for a proposed highway/transit capacity-adding project, does your agency complete any analysis of either the benefits or the costs of the various alternatives?** *Please check your response.*

Type of agency	Yes	No *(Skip to question 6)*	Don't know *(Skip to question 6)*	Total
DOT highway	40	3	0	**43**
Transit agency	19	1	0	**20**
Total	**59**	**4**	**0**	**63**

2. **How often does your agency complete a Cost-Effectiveness Analysis when evaluating alternatives for proposed highway/transit capacity-adding projects?** *Please consider a cost-effectiveness analysis to be the determination of the annualized capital and operating costs divided by some unit of output for each project, such as cost per passenger mile of travel or cost per hour of travel time savings. Please check your response.*

Type of agency	Never or almost never	Less than half of the time	About half of the time	More than half of the time	Always or almost always	Don't know	Total
DOT highway	19	7	3	3	8	0	**40**
Transit agency	0	3	0	0	16	0	**19**
Total	**19**	**10**	**3**	**3**	**24**	**0**	**59**

3. **How often does your agency complete a *Cost-Benefit Analysis* when evaluating alternatives for proposed highway/transit capacity-adding projects?** *Please consider a cost-benefit analysis to be the process of identifying, quantifying, and summing in dollars to the extent possible the value of the direct costs and benefits (including construction costs, travel time savings/delays, emissions reductions, and safety improvements) over the life of the project. Please check your response.*

Type of agency	Never or almost never	Less than half of the time	About half of the time	More than half of the time	Always or almost always	Don't know	Total
DOT highway	12	13	3	5	7	0	**40**
Transit agency	1	4	0	0	14	0	**19**
Total	**13**	**17**	**3**	**5**	**21**	**0**	**59**

4. **How often does your agency complete an *Economic Impact Analysis* when evaluating alternatives for proposed highway/transit capacity-adding projects?** *Please consider an economic impact analysis to be a determination of a project's indirect economic impacts – such as job creation, economic development, or gains in economic productivity – to users, nonusers, and the region. Please check your response.*

Type of agency	Never or almost never	Less than half of the time	About half of the time	More than half of the time	Always or almost always	Don't know	Total
DOT highway	13	16	4	5	2	0	**40**
Transit agency	0	5	1	1	11	1	**19**
Total	**13**	**21**	**5**	**6**	**13**	**1**	**59**

5. **Would you like to mention anything else about the analyses your agency conducts of the costs and benefits of the alternatives to proposed highway/transit capacity-adding projects?** *Please use the space below to write your comments.*

<<OPEN-ENDED COMMENTS – NOT SHOWN>>

Section 2: Choosing Among Highway/Transit Project Alternatives

6. **Typically, how much importance would you say that *cost-effectiveness* has in your decision to recommend a project from among its various alternatives?**[2] *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very Great importance	No basis to judge	Total
DOT highway	3	3	14	20	1	2	**43**
Transit agency	0	0	7	8	5	0	**20**
Total	**3**	**3**	**21**	**28**	**6**	**2**	**63**

7. **Typically, how much importance would you say that *the ratio of benefits to costs* has in your decision to recommend a project from among its various alternatives?**[3] *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very great importance	No basis to judge	Total
DOT highway	2	5	22	8	0	6	**43**
Transit agency	0	0	6	8	5	1	**20**
Total	**2**	**5**	**28**	**16**	**5**	**7**	**63**

8. **Typically, how much importance would you say that *economic impacts* have in your decision to recommend a project from among its various alternatives?**[4] *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very great importance	No basis to judge	Total
DOT highway	2	7	25	8	0	1	**43**
Transit agency	0	2	10	4	4	0	**20**
Total	**2**	**9**	**35**	**12**	**4**	**1**	**63**

[2]For the transit agency survey this question was worded as follows, "*forecasted cost-effectiveness.*"
[3]For the transit agency survey this question was worded as follows, "*the result of a cost-benefit analysis.*"
[4]For the transit agency survey this question was worded as follows, "*projected economic impacts.*"

9. **Typically, how much importance would you say that *political support and public opinion* have in your decision to recommend a project from among its various alternatives?** *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very great importance	No basis to judge	Total
DOT highway	0	0	9	25	9	0	**43**
Transit agency	0	0	3	8	9	0	**20**
Total	**0**	**0**	**12**	**33**	**18**	**0**	**63**

10. **Typically, how much importance would you say that *the distribution of impacts across social groups* has in your decision to recommend a project from among its various alternatives?** *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very great importance	No basis to judge	Total
DOT highway	3	3	23	12	2	0	**43**
Transit agency	0	3	6	8	3	0	**20**
Total	**3**	**6**	**29**	**20**	**5**	**0**	**63**

11. **Typically, how much importance would you say that *the availability of federal matching funds* has in your decision to recommend a project from among its various alternatives?** *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very great importance	No basis to judge	Total
DOT highway	4	5	10	15	8	1	**43**
Transit agency	0	3	2	7	7	0	**19**
Total	**4**	**8**	**12**	**22**	**15**	**1**	**62**

12. **Typically, how much importance would you say that *the availability of state funds* has in your decision to recommend a project from among its various alternatives?** *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very great importance	No basis to judge	Total
DOT highway	1	4	10	19	9	0	**43**
Transit agency	4	5	1	5	4	1	**20**
Total	**5**	**9**	**11**	**24**	**13**	**1**	**63**

13. **Typically, how much importance would you say that *the availability of local funds* has in your decision to recommend a project from among its various alternatives?** *Please check your response.*

Type of agency	Very little or no importance	Little importance	Moderate importance	Great importance	Very great importance	No basis to judge	Total
DOT highway	9	4	18	7	4	1	**43**
Transit agency	0	2	0	6	11	1	**20**
Total	**9**	**6**	**18**	**13**	**15**	**2**	**63**

14. **Would you like to mention anything else about the factors your agency considers when recommending a project from among its alternatives?** *Please use the space below to write your comments.*

<<OPEN-ENDED COMMENTS – NOT SHOWN>>

Section 3: Performance of Highway/Transit Projects

15. **During the past 10 years, did your agency typically analyze individual highway/transit capacity-adding projects to determine in retrospect whether specific proposed outcomes were achieved?** *Please consider all sources of analyses in your answer, including those completed by other state or local agencies or consultants. Please check your response.*

Type of agency	Yes	No	Don't know	Total
DOT highway	16	25	2	**43**
Transit agency	13	6	1	**20**
Total	**29**	**31**	**3**	**63**

Thank you for participating in our survey!

Panelists

The names and backgrounds of the panelists are as follows. Brian Taylor of the University of California, Los Angeles, served as moderator for the sessions.

- **David J. Forkenbrock** is Director of the Public Policy Center, Director of the Transportation Research Program, Professor in Urban and Regional Planning, and Professor in Civil and Environmental Engineering at the University of Iowa. His research and teaching interests include analytic methods in planning, and transportation policy and planning. From 1995 through 1998, Dr. Forkenbrock chaired a National Research Council-appointed committee to review the FHWA's Cost Allocation Study process. He is a member of the College of Fellows, American Institute of Certified Planners and a lifetime National Associate of the National Academies. He is chairman of the TRB Committee for Review of Travel Demand Modeling by the Metropolitan Washington Council of Governments and a member of the TRB Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance. In 2004, he received the first ever TRB William S. Vickrey Award for Best Paper in Transportation Economics and Finance for his work on mileage-based road user charges. He received the Michael J. Brody Award for Excellence in Faculty Service to the University and the State, from the University of Iowa in 1996. He earned a Ph.D., from the University of Michigan; a Master of Urban Planning from Wayne State University; and a B.A., from the University of Minnesota.

- **José A. Gómez-Ibáñez** is Derek C. Bok Professor of Urban Planning and Public Policy at Harvard University's John F. Kennedy School of Government and Graduate School of Design. His research interests are primarily in the area of transportation policy and urban development and in privatization and regulation of infrastructure. He has served as a consultant for a variety of public agencies. His recent books include *Regulating Infrastructure: Monopoly, Contracts, and Discretion; Regulation for Revenue: The Political Economy of Land Use Exactions* (with Alan Altshuler*); Going Private: The International Experience with Transport Privatization* (with John R. Meyer); and *Essays on Transport Policy and Economics* (ed.).

- **Ronald F. Kirby** is Director of Transportation Planning for the Metropolitan Washington Area Council of Governments. He began his career in the United States as a Senior Research Associate with Planning Research Corporation. He joined the Urban Institute as a Senior

Research Associate and became a Principal Research Associate and Director of Transportation Studies. He has served on several TRB committees and is currently a member of the TRB Executive Committee. He has a B.S. and a Ph.D., in applied mathematics, from the University of Adelaide, South Australia.

- **David L. Lewis** is President and CEO of HLB Decision Economics. His credits include a range of widely adopted applications in cost-benefit analysis, productivity measurement, risk analysis, and approaches to establishing public-private investment partnerships. He has authored three books, including *Policy and Planning as Public Choice: Mass Transit in the United States* (Ashgate Press), 1999. His past positions include Partner-in-Charge, Division of Economics and U.S. Operations, Hickling Corporation; Chief Economist, Office of the Auditor General of Canada; Executive Interchange Program and Principal Analyst, U.S. Congressional Budget Office, Congress of the United States; and Senior Economist and Director of the Office of Domestic Forecasting, Electricity Council. He has a Ph.D., and an M.S., in economics from the London School of Economics and a B.A., in economics from the University of Maryland.

- **Michael D. Meyer** is Professor of Civil and Environmental Engineering at the Georgia Institute of Technology. Prior to coming to Georgia Tech in 1988, he was the Director of the Bureau of Transportation Planning and Development at the Massachusetts Department of Public Works for 5 years. Prior to his employment at the Massachusetts Department of Public Works, he was a professor in the civil engineering department of the Massachusetts Institute of Technology. His research interests include transportation planning and policy analysis, environmental impact assessment, analysis of transportation control measures, and intermodal and transit planning. He is a Professional Engineer in the State of Georgia, and a member of the American Society of Civil Engineers and the Institute of Transportation Engineers. He has chaired TRB's Task Force on Transportation Demand Management, the Public Policy Committee, the Committee on Education and Training, and the Statewide Multimodal Transportation Planning Committee. He is a former member of the National Research Council policy study Panel on Statistical Programs and Practices of the Bureau of Transportation Statistics. Currently, he is a member of TRB's Executive Committee and Standing Committee on Statewide Multimodal Transportation Planning.

- **Donald Pickrell** is DOT's Volpe Center's Chief Economist. Prior to joining DOT, he taught economics, transportation planning, and government regulation at Harvard University. While at the Volpe Center, he also was a lecturer in the Department of Civil Engineering at Massachusetts Institute of Technology. He has authored over 100 published papers and research reports on various topics in transportation policy and planning, including transportation pricing, transit planning and finance, airline marketing and competition, travel demand forecasting, infrastructure investment and finance, and the relationships of travel behavior to land use, urban air quality, and potential climate change. He received his undergraduate degree in economics and mathematics from the University of California at San Diego, and Master's and Ph.D. degrees in urban planning from the University of California at Los Angeles.

- **Kenneth A. Small** is Professor of Economics at the University of California at Irvine, where he served 3 years as chair of the Department of Economics and 6 years as Associate Dean of Social Sciences. He previously taught at Princeton University and was a Research Associate at The Brookings Institution. He has written numerous books and articles on urban economics, transportation, public finance, and environmental economics. He serves on the editorial boards of several professional journals in the fields of urban and transportation studies and has served as coeditor or guest editor for four of those boards. In 1999, he received the Distinguished Member award of the Transport and Public Utilities Group of the American Economic Association. During 1999 to 2000, he held a Gilbert White Fellowship at Resources for the Future. He has served on two TRB policy study committees—the Committee for a Review of the Highway Cost Allocation Study and the Committee for a Study on Urban Transportation Congestion Pricing.

- **Brian D. Taylor (Moderator)** is Associate Professor of Urban Planning and Director of the Institute of Transportation Studies at University of California at Los Angeles as well as Vice-Chair of the Urban Planning Department. His research centers on transportation finance and travel demographics. He has examined the politics of transportation finance, including the influence of finance on the development of metropolitan freeway systems and the effect of public transit subsidy programs on system performance and social equity. His research on the demographics of travel behavior has emphasized access-deprived populations including women, racial-ethnic minorities, the disabled, and the poor. He also has explored relationships between

transportation and urban form, with a focus on commuting and employment access for low-wage workers. Prior to coming to University of California at Los Angeles in 1994, he was Assistant Professor in the Department of City and Regional Planning at the University of North Carolina at Chapel Hill. Prior to that, he was a Transportation Analyst with the Metropolitan Transportation Commission in Oakland, California.

- **Martin Wachs** is Professor of Civil and Environmental Engineering and City and Regional Planning, and Director of the Institute of Transportation Studies at the University of California at Berkeley. He was formerly Professor of Urban Planning and Director of the Institute of Transportation Studies at the University of California at Los Angeles where he served three terms as Head of the Urban Planning Program. His research interests include methods for evaluating alternative transportation projects; relationships among land use, transportation, and air quality; and fare and subsidy policies in urban transportation. Most recently, he chaired the Transportation Research Board policy study Committee for the Study on Urban Transportation Congestion Pricing. He is the former Chairman of the TRB Executive Committee. He holds a Ph.D., in transportation planning from Northwestern University.

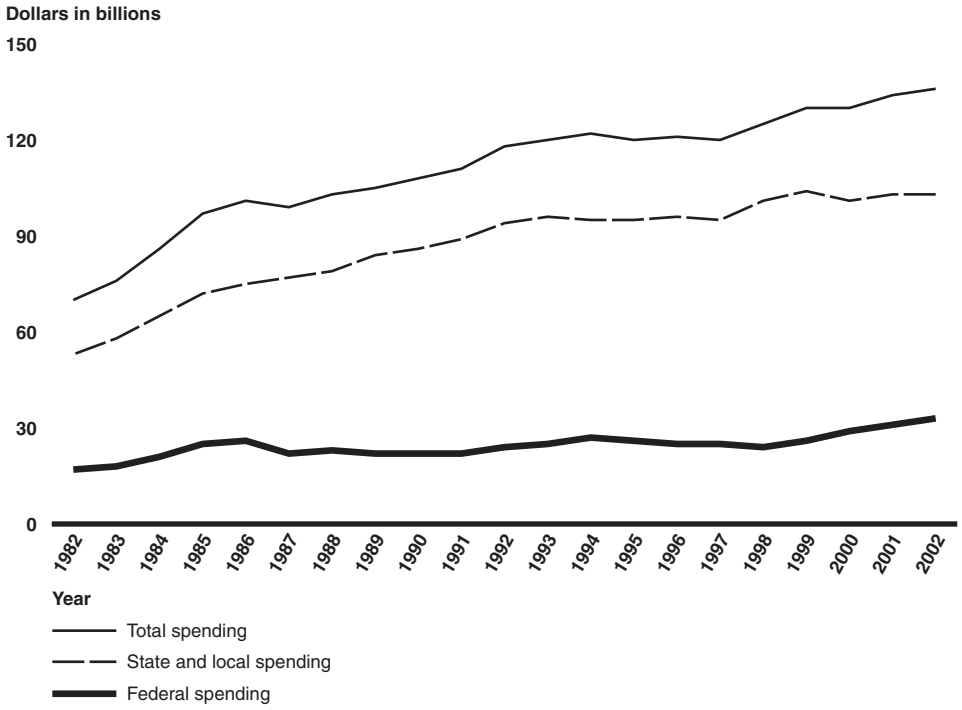
Trends in Highway and Transit Expenditures, Usage, and Capacity

Public Expenditures

Expenditures by all levels of government for both highways and transit have grown substantially from fiscal year 1982 through 2002, at an average annual rate of about 3.4 percent for both highway and transit spending. Figures 5 and 6 show trends in federal, and state and local spending for highways and transit in inflation-adjusted 2002 dollars. In 2002, total highway expenditures reached almost $136 billion while over $26 billion was spent on transit, with the bulk of funding coming from state and local governments for both highways and transit systems. For highways, total federal expenditures have risen at a faster rate since the enactment of TEA-21 in 1998 than have state and local expenditures, with federal expenditures rising at about 8.4 percent per year, on average, from 1998 through 2002, and state and local expenditures rising at about 0.5 percent per year, on average, over the same period. For transit, the converse is true, as state and local expenditures have increased at a faster rate than federal spending since 1998, with state and local expenditures rising at an average annual rate of about 7.5 percent per year, as opposed to 5.8 percent per year for federal expenditures.[1]

[1]Average annual increases since 1998 reported throughout this appendix were calculated using 1998 as a base year. Therefore, the figures represent an average of four annual increases. We report annual increases since 1998 to show recent trends under current law. We do not mean to imply that there is a direct causal link between the enactment of TEA-21 and the resulting trends, as many factors have affected the level of investment in both highways and transit.

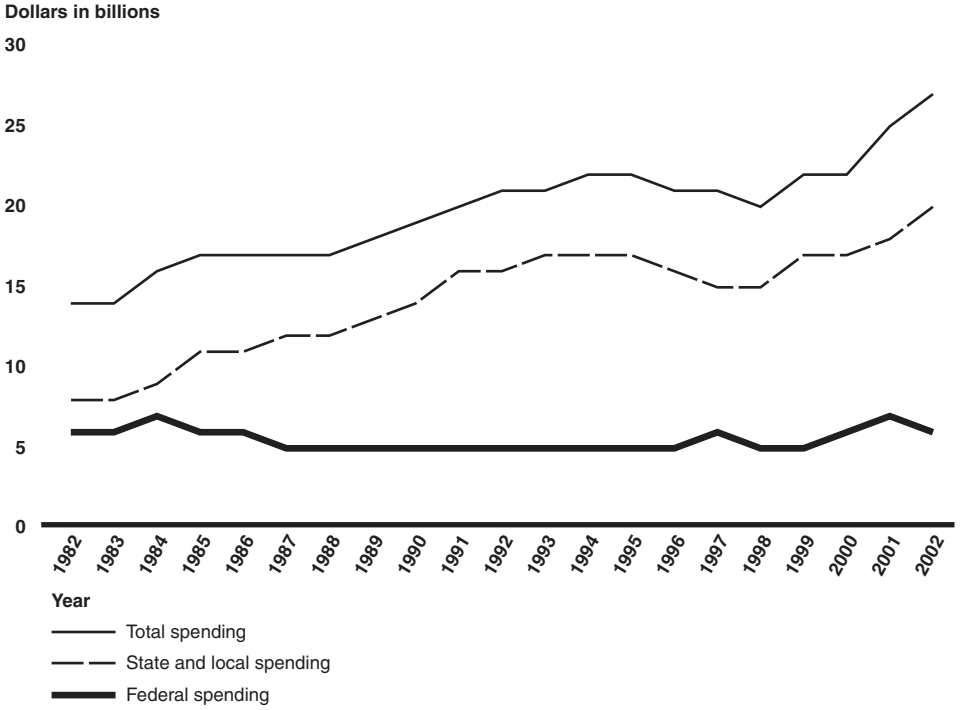
Figure 5: Total Public Spending on Highways, 1982–2002



Source: U.S. DOT, FHWA, and *Highway Statistics*, 1982-2002.

Note: Amounts are presented in 2002 dollars.

Figure 6: Total Public Spending for Transit, 1982–2002



Source: U.S. DOT, FHWA, and National Transit Database, 1982–2002.

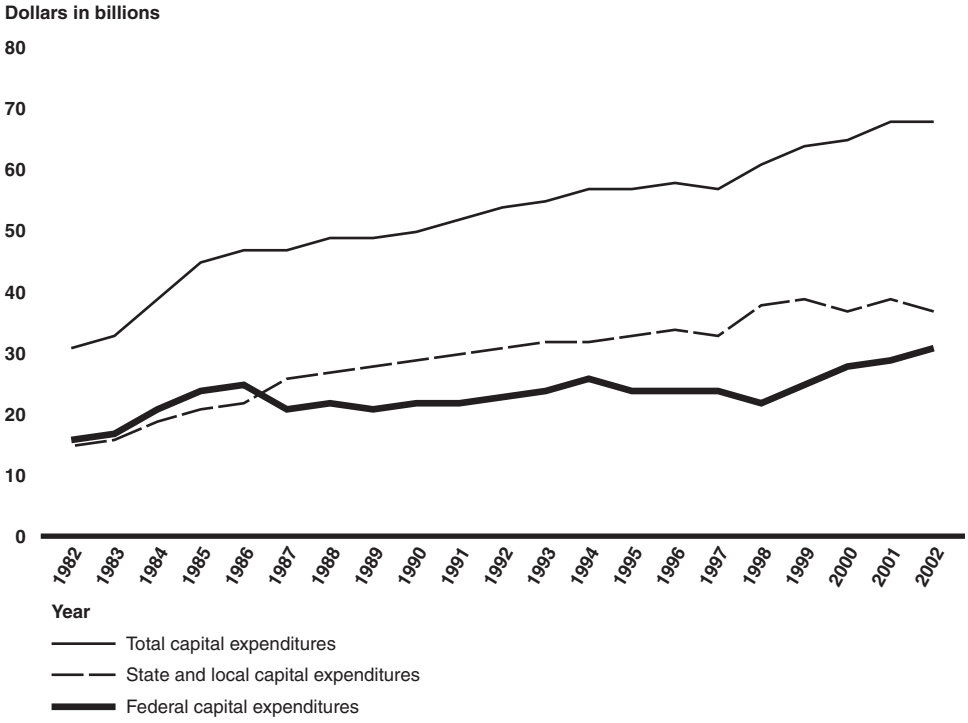
Note: Amounts are presented in 2002 dollars.

Investment in highway and transit capital, which represents investment in new capacity as well as rehabilitation of existing assets,[2] has also increased. Figure 7 shows trends in federal, and state and local capital spending from 1982 through 2002 in inflation-adjusted 2002 dollars. The bulk of federal funding for highways goes toward capital outlays, with about 96 percent of all federal funding going to capital outlays in 2002, as compared with 36 percent of state and local funds. In addition, since the passage of TEA-21, federal capital spending has increased at a faster rate than state and local capital spending for highways. From 1998 through 2002, federal capital spending on highways increased an average of about 8.8 percent per year in inflation-adjusted dollars, while state and local

[2]Also included in highway capital expenditures are highway improvements, such as land acquisition and other right-of-way costs, and installation of traffic service facilities such as guardrails, fencing, signs and signals.

capital spending decreased at about 0.8 percent per year, on average, in inflation-adjusted dollars.[3]

Figure 7: Public Highway Capital Expenditures, 1982–2002



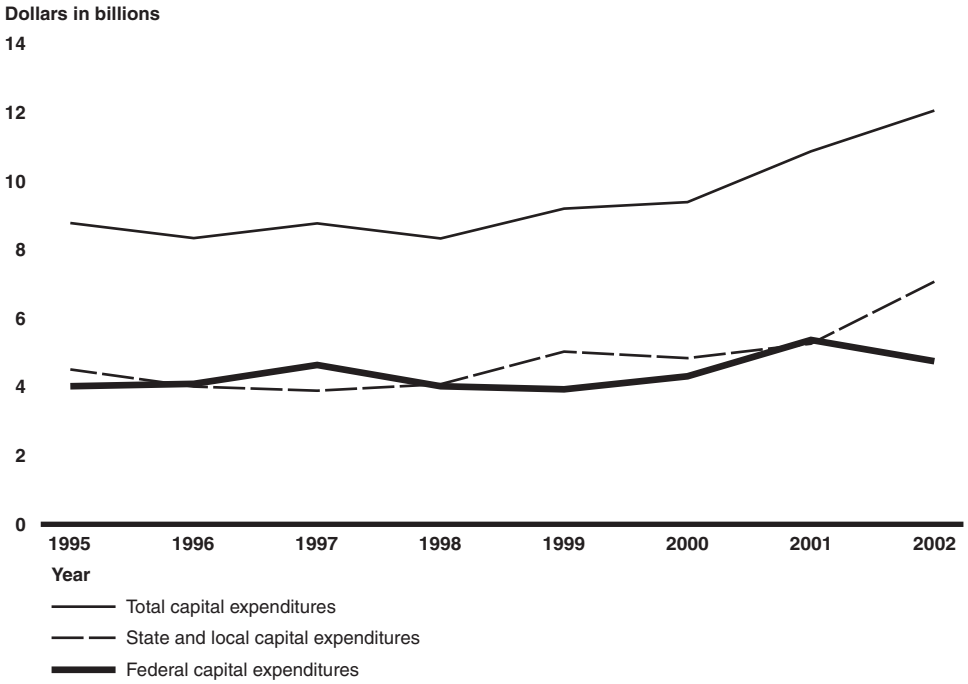
Source: U.S. DOT, FHWA, and *Highway Statistics*, 1982-2002.

Note: Amounts are presented in 2002 dollars.

[3]We previously reported that state and local capital outlays had decreased by 4 percent from 1998 to 2002 (see GAO-04-802). Since GAO-04-802 was released, FHWA has provided us with adjusted data for 2002. In addition, the Bureau of Economic Analysis revised their price indexes on March 12, 2004, and August 5, 2004. Using the adjusted data, the overall percentage decrease in spending from 1998 to 2002 is 3.5 percent.

Figure 8 shows trends in federal, and state and local capital spending for transit from 1995 through 2002 in inflation-adjusted 2002 dollars.[4] Data prior to 1995 are not reported because comparable data with those available in the National Transit Database are not available. In contrast to highway capital spending, since the passage of TEA-21, state and local capital spending has increased at a faster rate than federal capital spending for transit. From 1998 through 2002, federal capital spending on transit increased an average of about 4.9 percent per year in inflation-adjusted dollars, while state and local capital spending increased almost 15 percent per year on average in inflation-adjusted dollars.

Figure 8: Public Transit Capital Expenditures, 1995–2002



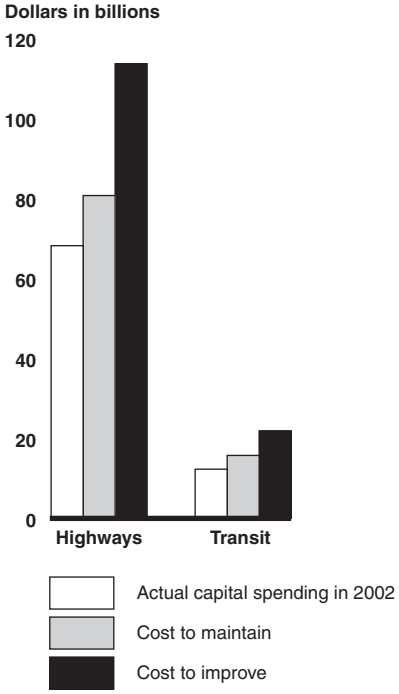
Source: U.S. DOT, FTA, and National Transit Database, 1995-2002.

[4]Capital expenditures include funds for design and construction of New Starts projects, the modernization of fixed assets—including fixed guideway systems (e.g., rail tracks), terminals and stations, as well as maintenance and administrative facilities—and the acquisition, renovation and repair of rolling stock—which includes buses, rail, cars, locomotives, and service vehicles.

Note: Amounts are presented in 2002 dollars.

According to DOT's 2002 Conditions and Performance report, capital investment by all levels of government remains well below DOT's estimate of the amount needed to maintain the condition of the highway and transit systems.[5] As a result, according to DOT, the overall performance of the system declined, thus increasing the number of highway and transit investments needed to address existing performance problems. Figure 9 shows DOT's estimates of capital investment needed from all levels of government to maintain and to improve the highway and transit systems, compared with actual capital spending in 2002.

Figure 9: Cost to Maintain and Improve Highways and Transit, 2001–2020[a]



Source: GAO analysis of DOT data.

Note: Amounts are presented in 2002 dollars.

[5]U.S. Department of Transportation, *2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, Report to Congress* (Washington, D.C.: 2002).

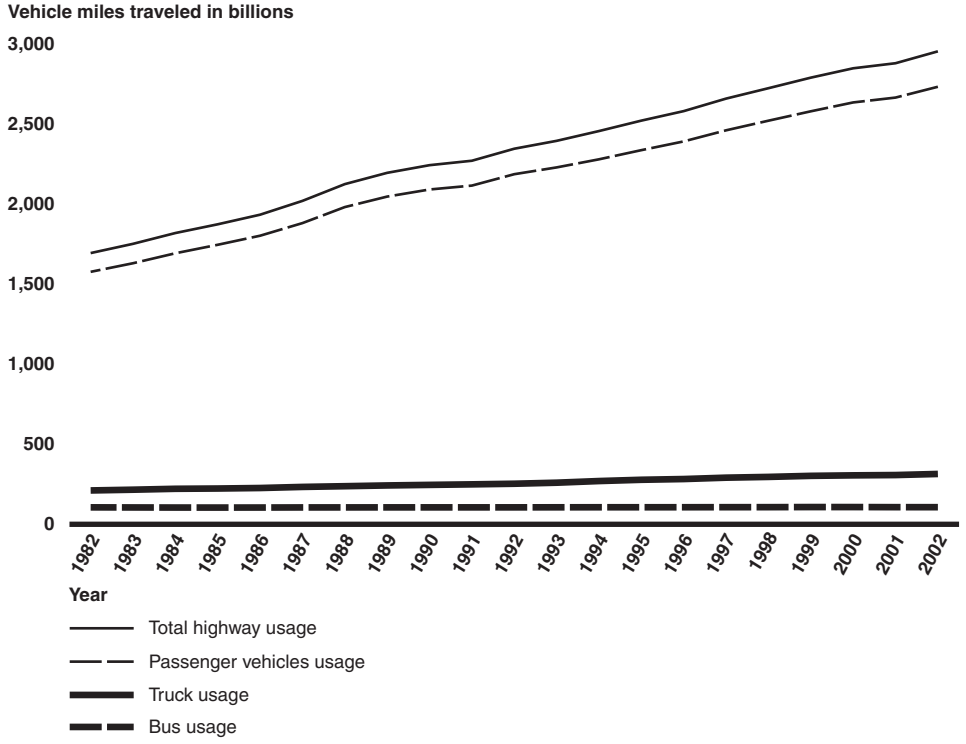
[a]Investment requirements for highways and bridges are drawn from the Highway Economic Requirements System (HERS), which estimates highway preservation and highway and bridge capacity expansion investment. Transit investment requirements, except those for rural and special service transit, are estimated by the Transit Economic Requirements Model (TERM). All projections are based on 2000 data.

Usage of Public Highways and Transit

Travel on highways and transit has increased steadily from 1982 through 2002. For highways, the level of usage has increased at an average annual rate of about 3 percent per year. By 2002, Americans traveled on highways more than 2.8 trillion vehicle miles annually. Figure 10 shows trends in usage of public highways from 1982 through 2002. Although most highway lane miles are rural, the majority of highway travel occurs in urban areas. For example, in 2002, 61 percent of highway travel occurred in urban areas. Passenger vehicles account for the bulk of vehicle miles traveled on public highways, although usage by trucks has increased more over the period. Highway usage by trucks increased by 92.5 percent, as opposed to 78.3 percent by passenger vehicles.[6] Conversely, the level of usage of public highways by buses only increased 17.6 percent from 1982 through 2002.

[6]Trucks include single unit 2-axle, 6-tire or more and combination trucks. Passenger vehicles include passenger cars and other 2-axle, 4-tire vehicles.

Figure 10: Level of Usage of Public Highways by Mode, 1982–2002



Source: U.S. DOT, FHWA, and *Highway Statistics*, 1982-2002.

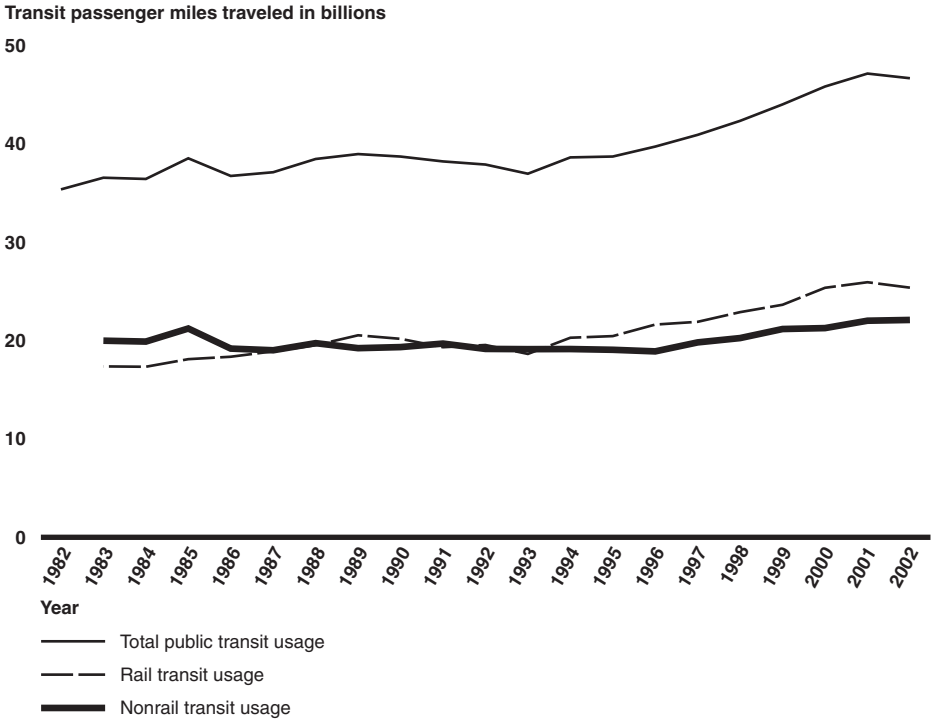
The level of usage of public transit, measured in passenger miles traveled, has increased an average of 1.5 percent annually from 1982 through 2002, although usage has increased more rapidly since passage of TEA-21.[7] Figure 11 shows trends in rail and nonrail transit usage over this period. Since 1998, rail transit has seen an 11.2 percent increase in usage,[8] while nonrail forms of transit, including demand response, ferry-boat, jitney, motor bus, monorail, publico, trolley bus, and van pools, experienced a

[7]Passenger miles traveled are the total number of miles traveled by passengers in transit vehicles.

[8]Rail includes automated guideway, Alaska rail, cable car, commuter rail, heavy rail, inclined plane, and light rail.

smaller increase, approximately 9.5 percent, over the same time period.[9] In 2002, passenger miles traveled on rail were 24.6 billion and accounted for about 54 percent of total usage; however, according to the 2002 C&P report, rail accounts for only 5 percent of urban transit route miles.

Figure 11: Level of Usage of Public Transit, Rail/NonRail 1982–2002



Source: U.S. DOT, FTA, and National Transit Database, 1984-2002.

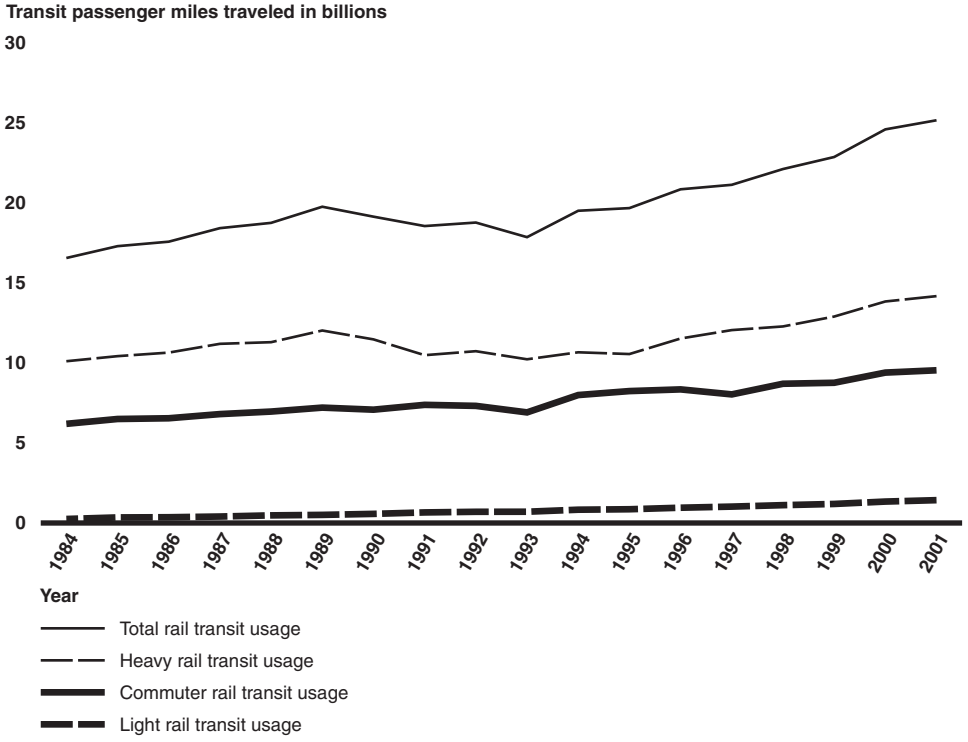
Disaggregating rail usage by commuter rail, heavy rail, and light rail, shows that usage of heavy rail and commuter rail greatly exceeds that of light

[9]According to the National Transit Database, a jitney is a transit mode comprised of passenger cars or vans operating on fixed routes (sometimes with minor deviations) as demand warrants without fixed schedules or fixed stops. A publico is a transit mode comprised of passenger vans or small buses operating with fixed routes but no fixed schedules.

rail.[10] Figure 12 shows trends in usage by rail mode from 1984 through 2001, the years for which the data are available. In 2001, light rail accounted for only 6 percent of the total passenger miles traveled on rail, whereas commuter rail and heavy rail were 38 percent and 56 percent, respectively, of the total passenger miles traveled on rail transit in 2001.

[10]The National Transit Database defines commuter rail as a transit mode that is an electric or diesel propelled railway for urban passenger train service consisting of local short distance travel operating between a central city and adjacent suburbs. Heavy rail is defined as a transit mode that is an electric railway with the capacity for a heavy volume of traffic. It is characterized by high speed and rapid acceleration passenger rail cars operating singly or in multicar trains on fixed rails, separate rights-of-way (ROW) from which all other vehicular and foot traffic are excluded, sophisticated signaling, and high platform loading. Light rail is defined as a transit mode that typically is an electric railway with a light volume traffic capacity compared with heavy rail. It is characterized by passenger rail cars operating singly (or in short, usually two-car trains) on fixed rails in shared or exclusive ROW, low or high platform loading, and vehicle power drawn from an overhead electric line via a trolley or a pantograph.

Figure 12: Level of Usage of Rail Transit, 1984–2001



Source: U.S. DOT, FTA, and National Transit Database, 1984-2002.

Capacity of Highways and Transit

The capacity of the public highway system and the nation's transit system has increased at a slower rate than usage of these systems. For highways, total estimated lane miles have increased an average of 0.17 percent annually from 1982 through 2002, compared with an annual increase of 3 percent for vehicle miles traveled.[11] In 2002, there were approximately 8.3

[11]Highway capacity can be measured by estimating the number of highway lane miles that exist across the functional classification system. The functional classification of roadways is determined according to their primary function: arterials, collectors, and local streets.

million lane miles in the United States, with 76 percent of the total capacity existing in rural areas.[12]

From 1993 through 2002, years for which data are available, total transit system capacity increased 24 percent, while usage increased 27 percent over the same period.[13] The capacity of all rail modes increased 26 percent from 1993 through 2002, while nonrail mode capacity increased 22 percent. Light rail capacity experienced the greatest percentage change of the rail modes over the period, increasing 122 percent. Vanpools experienced the largest percentage change in nonrail capacity, 225 percent.

[12]Urban lane miles increased from 1982 through 2002, while rural lane miles decreased. However, a significant percentage of the increase in urban lane mileage is the result of functional reclassification. FHWA's functional classification system defines areas under 5,000 in population as rural; 5,000 to 49,999 in population as small urban; and 50,000 and over in population as urban. Many previously rural communities have grown above 5,000 in population, and thus, their existing roads have been reclassified as small urban mileage. Likewise, as communities classified as small urban areas have grown above 50,000 in population, their mileage has been reclassified as urban.

[13]Transit system capacity is measured in capacity-equivalent vehicle revenue miles, the distance traveled by a transit vehicle in passenger-carrying revenue service, adjusted by the carrying capacity of the type of transit vehicle. The capacity of a motor bus is used to represent the baseline.

Information on Benefits Attributable to Highway and Transit Investments

Measuring benefits that can potentially result from highway and transit investments can be quite contentious and spur vigorous debates among experts in the field and in literature, although there tends to be more agreement about the nature of the direct user benefits associated with highway and transit investments, as opposed to the wider social benefits or the indirect benefits.

Direct and Social Benefits

Generally, the largest direct benefit from transportation investments, both highway and transit, is the reduction in travel time that results from the investment. When travel time is reduced, additional time becomes available to spend on some other activity and, therefore, people are willing to pay to reduce their travel time. The value of travel-time savings is an estimate of how much people would be willing to pay for reductions in travel time. There is a substantial body of literature consisting of both conceptual analyses of how best to estimate the value of travel-time savings and empirical analyses that estimate values in specific circumstances.[1] Travel-time savings are often divided between work-time savings and nonwork-time savings. Work-time savings—for example, reductions in the time for a repairperson to get from one work site to another during the workday—would allow someone to accomplish more in a day's work. Accordingly, the work travel time that someone saves is generally valued at that person's hourly wage rate because the wage rate represents the value to the employer of having an additional hour of that person's time available for work activities.

The values that travelers place on nonwork travel-time savings depend upon both the benefit that they would receive by spending additional time in some other way and the benefit they receive from reductions in individuals' perceived costs of travel. For example, it is generally accepted that reductions in time spent waiting for a bus to arrive are more highly valued than reductions in riding time because travelers dislike waiting more than riding and, therefore, would receive a greater benefit from waiting time reductions. As a result, the conceptual link between nonwork travel-time savings and the wage rates of the travelers is less direct. Different travelers along the same route with equal wage rates might value

[1]For more detailed discussion of travel-time savings, see P.J. Mackie, S. Jara-Diaz, A.S. Fowkes, "The value of travel time savings in evaluation," *Transportation Research* Part E 37 (2001); and Jay R. Cherlow, "Measuring Values of Travel Time Savings," *Journal of Consumer Research*, Vol. 7 (March 1981).

a given reduction in travel time differently, and any one traveler might value travel-time savings differently in different circumstances. In addition, a large change in travel time may be valued differently per minute than a relatively small change in travel time. Nonetheless, because some empirical studies have identified a relationship between willingness to pay for travel-time reductions and wage rates, DOT guidance for valuing benefits recommends estimating the value of travel-time savings for nonwork travel for both highways and transit as certain fractions of travelers' wage rates.[2] For transit, the recommended value is different for different types of time savings, such as waiting, transfer, and in-vehicle time. It may be possible to obtain more accurate estimates of travel-time savings for a specific investment. This additional precision could be obtained by considering the degree to which the travelers who are affected by this investment are likely to have different values in this circumstance, as compared with previously estimated average values for all travel-time savings. However, obtaining this additional precision entails a cost, which would have to be considered in deciding whether to seek more precise estimates.

In addition to reductions in travel time for people, investment in transportation can reduce the time for freight products to move from one location to another, which is also a benefit from this investment. For highway investment, this effect is more direct; adding a new lane, for example, can increase the speed of highway travel, enabling trucks to reach their destinations more quickly. Although most freight typically does not travel by bus or subway, transit investment can indirectly allow freight to move more quickly to the extent that such investment removes cars from highways and allows trucks to travel at faster speeds.

Measurement and forecasting of travel-time impacts can be complicated by changes in demand resulting from shifts in travel behavior brought about by the highway or transit improvement. Reducing travel times leads to what has been referred to as triple convergence, where traffic on an improved road increases due to (1) travelers switching from less

[2]For monetizing travel time, DOT recommends that analysts use "50 percent of the wage for all local personal travel regardless of the mode employed, 70 percent of the wage for all intercity personal travel, and 100 percent of the wage (plus fringe benefits) for all local and intercity business travel, including travel by truck drivers… In special cases where out-of-vehicle time (access, waiting, and transfer time) on transit trips is isolated as an object of analysis, the value of 100 percent of the wage is adopted." See "Valuation of Travel Time in Economic Analysis," Guidance of U.S. DOT, Office of the Secretary, April 9, 1997, and revised February 11, 2003.

convenient alternative routes to the improved road (although travelers remaining on the alternative routes will benefit from reduced traffic), (2) travelers switching from less convenient times to the peak period, and (3) travelers switching from transit to driving because of the higher speeds and lower travel times.[3] Estimates of this effect vary. One study showed that, over time, a 10 percent increase in road capacity led to a 9 percent increase in travel, while other research finds that these changes in demand may have a smaller effect.[4] This change in demand does not mean travel-time benefits are not realized—only that forecasting future travel-time reductions should take account of increased traffic flows resulting from such shifts in demand, or else travel-time benefits are likely to be overestimated.

For transit investments, the impact of the investment on travel times for highway users can be complicated by what is known as travel-time convergence, whereby travel times on a roadway alternative to a transit line tend to converge to the transit travel time. The convergence of travel times occurs because some drivers are drawn off of the alternative roads to the transit line in search of lower door-to-door travel times. As these drivers leave the road, traffic conditions on the roadway improve, leading to some additional demand on the road and resulting in additional traffic. This process continues until door-to-door travel times on the two modes converge. Several studies bear out the existence of this phenomenon in highly congested urban corridors and suggest that improving the *transit* travel time will lead to improvements in travel times on the alternative roadways.[5]

Another user benefit from transportation investment in both highways and transit related to travel time, concerns reliability, which is generally defined to mean the variability in travel time. Empirical studies suggest that travelers often place a high value on increased certainty of arrival by a specific time, such that they would be willing to pay to reduce their travel time variability even if there was no change in mean travel time. Some

[3]Anthony Downs, *Stuck in Traffic – Coping with Peak-Hour Traffic Congestion* (Washington, D.C.: The Brookings Institution, 1992).

[4]Robert Cervero. "Road Expansion, Urban Growth, and Induced Travel: A Path Analysis," *Journal of the American Planning Association*, Vol. 69, No. 2 (2003).

[5]See Lewis and Williams, *Policy and Planning as Public Choice* and Mogridge, *Travel in Towns*.

investments might accomplish both and would be valued accordingly. For example, improving a bottleneck might not only reduce time on average, but it also might reduce variability by reducing the likelihood of an exceptionally long delay. One study estimates that the value of increased travel time reliability may be as large as the value of travel-time savings on a per minute basis.[6] Not all projects that affect travel-time savings will affect reliability and vice versa.

In addition to benefits related to making travel times shorter and less variable, transportation investment can provide travelers other benefits, such as lower vehicle operating costs and safer and more comfortable travel. Lower vehicle costs can arise from highway investments that improve road quality, thereby reducing wear and tear on vehicles, and from investments that reduce congestion, which can reduce fuel consumption. Estimates exist in the literature of the extent to which highway investment reduces vehicle operating costs. Transit investment can also reduce vehicle operating costs to the extent that such investment reduces congestion by inducing some drivers to switch to transit. Improved safety has often been found to be a major benefit from transportation investment. Improving roadway designs generally contributes to fewer accidents, which implies fewer deaths and injuries and less property damage. As for the value of safety improvements, there is substantial literature—both conceptual and empirical—on how to value lives saved, often referred to as the value of a statistical life. Although different people might be willing to pay different amounts to reduce their likelihood of death, and the same person might be willing to pay different amounts in different circumstances, an average value based on various research studies is generally recommended.[7] Improved comfort is another benefit from some forms of transportation investment. Transit investment that, for example, improves the comfort of a seat or increases the likelihood that a rider will get a seat, creates benefits for which some travelers would be willing to pay.

Transportation investment benefits also include benefits that accrue to the general public, not just to the travelers directly taking advantage of the

[6]David Brownstone and Kenneth A. Small, "Valuing Time and Reliability: Assessing the Evidence from Road Pricing Demonstrations," Working Paper (October 2003).

[7]For benefits resulting from safety improvements, DOT recommends that analysts use a threshold value of $3 million per life saved to determine if a project is worthwhile. See "Treatment of Value of Life and Injuries in Preparing Economic Evaluations," Guidance of U.S. DOT, Office of the Secretary, January 8, 1993, and revised January 29, 2002.

investment. For example, transportation investment can lead to a reduction in environmental damage, which can be a benefit to an entire metropolitan area. Research has indicated that increased roadway congestion increases air pollution. Thus, investments that reduce congestion—including highway investments that directly speed up traffic and transit investments that indirectly speed up traffic by inducing people to switch from driving to using transit—can provide environmental benefits. However, to the extent that transportation investment induces additional travel by reducing expected travel time, the pollution resulting from these additional trips might offset the initial pollution-reducing effects of the investment. As another example, transportation investment that increases mobility for those who currently have limited access to the transportation network for access to jobs, schools, etc., might provide social benefits that go beyond the benefits to the users themselves. Such investment could include both additional transit service and highways that connect residents of lower income areas with job sites to which service and roads do not currently exist.

Another form of public benefit that may result from transportation investment, particularly for transit, is sometimes called option value: nontransit users, for example, might be willing to pay to provide transit service to retain the option to use it in the future. That is, for some people, having the option of transit service available in case circumstances—such as the weather or the price of gasoline—change could have some value, even if they do not currently plan to use it. *The Transit Manual* provides a methodology for estimating the value of this benefit.

Indirect Benefits

The direct user benefits of highway and transit improvements result in individuals, households, and firms acting to take advantage of those benefits. These actions can then lead to several types of indirect benefits, such as increased property values and new development, reduction in the costs associated with other public infrastructure (e.g., water, electricity, etc.) due to more compact development, reduction of production and logistics costs from improved freight efficiency, and overall increases in productivity and economic growth. As was discussed earlier in the report, these benefits largely represent capitalization of direct user benefits or transfers of economic activity from one area or group to another and, therefore, should not entirely be added to direct benefits.

As transportation costs fall and access is improved, incentives are created for households and firms to relocate to areas where housing and land is

less expensive or more desirable. This can result in new development and increases in land values of the areas made more accessible, although improvements can also result in land values falling in other locations, due to changes in relative access, and negative impacts from noise and emissions that may result from the improvement. Most studies show a positive effect on land values from highway improvements, although the effects of improvements to highways, as opposed to new roads, are more localized and tend to be smaller.[8] For transit, several studies have documented that increases in land values and higher-density development can occur around rail transit stations, although these impacts depend highly on local conditions, such as the condition of the local economy, and the extent to which complimentary land-use policies exist.[9] Residents of areas where new transit lines are constructed, or where transit is improved may also value the type of urban development, i.e., high density or mixed use, which typically occurs around transit stations.[10] However, increasing property values around transit stations can also displace low-income households, who may rely on transit.

Transportation investments can also have an impact on how land is used in an urban area. How such changes are valued can depend in large part on individual preferences for more or less compact and dense development. Highways are generally thought to encourage development on the outskirts of urban areas, although transit investments that provide access to those areas can also encourage such development. However, some research indicates that transit-served sites require less public capital than sites on the edges of urban areas.[11] Nonetheless, while investments in transportation infrastructure have had major effects on development and land use in the past, research indicates that future effects are likely to be much weaker due to the already extensive amount of connectivity that

[8]Brian ten Siethoff and Kara M. Kockelman, "Property Values and Highway Expansions: An Investigation of Timing, Size, Location, and Use Effects," Recommended for Publication in the *Transportation Research Record*.

[9]Vessali, "Land Use Impacts of Rapid Transit."

[10]See Lewis and Williams, *Policy and Planning as Public Choice*, for more discussion of transit's value to neighborhoods.

[11]ECONorthwest and Parsons Brinckerhoff Quade & Douglas, Inc., *Estimating the Benefits and Costs of Public Transit Projects*.

exists and shifts in the nature of the U.S. economy from manufacturing to service orientation.[12]

Transportation investments can also reduce freight transportation costs and increase freight reliability, which allows firms not only to move to more desirable locations, but also to reorganize their warehousing and production processes to take advantage of those benefits. This reorganization can result in lower production and inventory costs for firms. Research on this relationship has estimated the benefits on a national level and found that, while the relationship is positive, the returns have been diminishing over time. While diminishing returns are to be expected as the highway and road network becomes more interconnected, the authors of one study also postulate that returns may also be diminishing because highways are inefficiently priced, and highway investment policies do not target the most efficient investments.[13] While investment in highways has a more direct relationship to this benefit, transit investment can also result in such benefits to the extent that it improves conditions on nearby roadways.

Transportation improvements also lead to increased productivity and economic growth, through improving access to goods and services for businesses and individuals and increasing the geographic size of potential labor pools for employers and potential jobs for individuals. Recent research into the relationship between productivity, economic growth, and highway investment shows average annual returns on investment of 13.6 percent between 1990 and 2000, slightly greater than the return on private capital investment.[14] However, this research also supports the notion that returns on highway investment have been declining over time. Transit can also lead to economic growth through encouraging the concentration of economic activity and the clustering of offices, shops, entertainment centers, and other land uses around transit stops, particularly rail transit stops. This concentration of activity leads to more efficient economic interactions, which results in higher productivity and can stimulate economic growth. One study has estimated that a 10 percent increase in

[12]Don Pickrell, "Transportation and Land Use," in *Essays in Transportation Economics and Policy—A Handbook in Honor of John R. Meyer*, J. Gomez-Ibanez, W.B. Tye, and C. Winston, eds. (Washington, D.C.: The Brookings Institution Press, 1999).

[13]See Chad Shirley and Clifford Winston, "Firm Inventory Behavior and the Returns from Highway Infrastructure Investments," *Journal of Urban Economics* 55 (2004).

[14]Theofanis P. Mamuneas and M. Ishaq Nadiri, "Production, Consumption and the Rates of Return to Highway Infrastructure Capital," preliminary draft (September 2003).

transit presence would raise economic growth by about 0.2 percent.[15] Another study on the rate of return of several investments in new transit capacity suggests that these returns can be substantial, depending on the project, with projects ranging from 11.8 percent returns to 92 percent returns.[16]

[15]Office of Policy Development, Federal Transit Administration, U.S. Department of Transportation, *Transit Benefits 2000 Working Papers: A Public Choice Policy Analysis* (Washington, D.C.: 2000).

[16]U.S. Department of Transportation, Federal Transit Administration, *Resource Allocation in Rail Transit: Evaluating the Balance Between New Capacity and Modernization Investments*, final report, October 2004.

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