

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM



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# NCHRP Report 418

## Research on the Relationship Between Economic Development and Transportation Investment

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Transportation Research Board  
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AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation

# Report 418

## Research on the Relationship Between Economic Development and Transportation Investment

APOGEE RESEARCH, INC.  
Bethesda, MD

and

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## NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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# FOREWORD

*By Staff  
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This report contains the findings and results of a study on the research needs into the relationship between transportation investment and economic development. The study findings are based on a review of current literature and research on the subject and on the results of a 2-day expert panel workshop that included a cross section of stakeholders from the public and private sectors, academia, and other transportation interest groups. The participants identified and discussed information requirements, the need for improved analytic tools, and decision-making support mechanisms that can improve the accuracy and understanding of the interrelationships between economic development and transportation investments. The report should be of use to transportation professionals in state DOTs, MPOs, federal agencies, and academia interested in the status of research into the economic effects of transportation development decisions.

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Transportation-infrastructure investment has played a key role in the development of the nation's economy. The manner in which transportation investment affects economic productivity has been the subject of many recent studies, and while the findings of these studies indicate a strong causal relationship, they have also generated substantial debate and controversy regarding their implications. As a result, this debate has limited direct use of these findings in shaping transportation policy or specific investment decisions at the national, state, or local level. There is a need to assess recent transportation economics research to determine the likelihood that it can be extended and adapted to provide practical assistance to transportation practitioners, decisionmakers, and transportation stakeholders in evaluating transportation investment proposals. There is also a need for a cost-effective, multiyear, multifaceted research agenda that can assist in the development of accurate and practical tools for assessing the relationships between transportation investment and economic development and productivity.

Under NCHRP Project 2-19, *Research on the Relationship Between Economic Development and Transportation Investment*, Apogee Research, Inc., of Bethesda, Maryland (since merged into Hagler Bailly, Inc.), in association with Greenhorne & O'Mara, Inc. of Greenbelt, Maryland, formed the research team to accomplish the following: identify stakeholders; analyze, describe, and critique pertinent research; identify contradictions and inconsistencies in information; and prepare a list and descriptions of research projects that should be undertaken.

The report provides an overview of economics and transportation research, identifies gaps, and presents a recommended research agenda in the form of research problem statements with timing and cost estimates included. This report will assist researchers and agencies to direct research funds to most effectively develop tools for transportation professionals and decisionmakers to better understand the linkages and interactions between transportation investment and economic productivity.



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Dr. Richard R. Mudge, Chairman of the Board, Apogee Research, Inc., was the principal investigator. The other authors of this report

include Shaurav Sen, Director of Transportation Economics Group at Apogee; Dr. Porter Wheeler and Eric Beshers, Senior Consultants at Apogee; Roxanne Bruder, Transportation Analyst at Apogee; and Barbara Barnow, Senior Manager at Greenhorne & O'Mara.

The work was done under the general supervision of Dr. Mudge with the assistance of Shaurav Sen. Ms. Barnow was the supervisor for all work undertaken by Greenhorne & O'Mara.

# RESEARCH ON THE RELATIONSHIP BETWEEN ECONOMIC DEVELOPMENT AND TRANSPORTATION INVESTMENT

## SUMMARY

Transportation is in the midst of an analytical revolution. The need for a new understanding of the impacts of transportation investment, including its consequences on economic development and productivity, comes at a time when public interest in improved transport services has resurfaced. Transportation planners and decisionmakers have long been concerned with how transport investments and transportation services shape economic development. The understanding of this linkage has gone through several significant changes. From the earliest days of U.S. history, transportation investment was assumed to play a direct and strong role in stimulating development and influencing where and how this development took place. Although many individual projects were economic failures, the resulting belief in the vital role of transportation in stimulating and shaping economic growth helped spur public and private investment in transportation networks, including a network of post roads, canals, ports, and the transcontinental railroad system.

Recent research efforts by NCHRP, federal and state agencies, the Federal Reserve Board, and academic institutions have begun to focus on national or regional impacts of transportation and on long-term effects, including the role of transportation in stimulating productivity improvements. Much of this research has forged a new way of thinking about the role of transportation in a post-modern economy. The new findings are intriguing and exciting and, at the same time, controversial and confusing. As a result, they have stimulated debate and disagreement, but limited direct results in shaping transportation policy or specific investments at the national or local level. This project, NCHRP 2-19, seeks to:

- Assess the state of the art in this new wave of research;
- Determine the likelihood that the research can be extended and adapted so that it will provide practical help for transportation planners, in particular, and the broad range of stakeholders with an interest in transportation and economic activity; and
- Develop an appropriate cost-effective, multiyear, multifaceted research agenda on the relationship between transportation investment and economic development.

Development of a line of rigorous economic research that will lead to accessible analytical tools and that is also applicable to practical policy issues is not a simple task.

Accessibility is not achieved by having one group conduct analysis and then having another group work out the interpretation for nonspecialists. From the beginning, research should be structured to develop a line of analysis that can be expressed in common-sense terms, to offer intuitive findings to the nonspecialist, and to provide substantial help to planners and decisionmakers. Recognizing these needs, the project was divided into three phases with an opportunity for review by the panel. Phase I, which included Tasks 1, 2, and 3, was comprised of two components: (i) identification of stakeholders and (ii) review of literature. The objective of Phase II, which included Tasks 4 and 5, was to organize expert panel discussions to obtain participation and input from representative stakeholders identified in Phase I. The underlying objective of organizing the expert panels was to reach out directly to the various stakeholders to identify their information and research needs. Phase III, which included Tasks 6, 7, and 8, involved the development of research project statements that aim to fill gaps in past and current research on understanding the linkages between transportation and economic development.

This report consolidates the work done in the three phases of the study. Phase I identified an exhaustive list of stakeholders in the fields of economic development and transportation investment and developed a review of relevant literature. The research team developed a framework within which to organize the stakeholders. The framework includes decisionmakers, groups directly affected by transportation decisions, and groups whose concerns or agendas are indirectly affected. The framework is organized into six major categories:

- Transportation policy, regulatory and funding;
- Transportation design and construction;
- Transportation users;
- Non-user transportation interests;
- Nontransportation regulatory agencies and their constituents; and
- Academia/research.

The review of the literature identified the lines of research most likely to be useful to public sector decisionmakers, and a range of other stakeholders, interested in how investments in transportation infrastructure influence gains in economic productivity. The review assessed the current state of understanding of the links between infrastructure investment and productivity, noting areas of uncertainty, technical shortfalls, and work needed to provide greater relevance for transportation decisions and policy.

The research team also reviewed the strengths and weaknesses of the current research methodologies and how researchers and decisionmakers judge analytical methods by different criteria. Analytical specialists are usually concerned with the validity of a method and the relative ease with which it can be applied. Validity is important for decisionmakers, but they also have many other concerns.

In addition to clarity and defensibility, the nature of the information supplied is also important for public officials and other stakeholders. For example, an economist might be satisfied with knowing that a given set of investments would yield productivity gains of some amount for firms in a region. A decisionmaker would like to know what that means in terms of standard of living or employment. Expression of abstract economic findings in ways that have concrete and immediate meaning for nonspecialists is an important requirement and a difficult challenge.

The focus of Phase II was to organize a series of expert panel sessions to elicit and encourage discussion on the specific information gaps that currently exist and to understand, from the stakeholders' perspectives, what kind of research would facilitate their current understanding of transportation's role in economic development. The goal was

to bring together a diverse group of people (policymakers, planners, and researchers) to discuss the need for new research on transportation investment and productivity. The 2-day conference, held in November 1995, provided valuable input of the information needs of the stakeholders for the development of a series of tailored research project statements.

In Phase III, the information collected during the panel sessions was assimilated, organized, and used to create 15 specific research project statements (RPSs) that will help expand the understanding of the link between transportation investment and economic development. In addition to the 15 RPSs, Phase III also resulted in a significant number of useful research questions and issues that could be developed into additional RPSs in the future.

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## CHAPTER 1

# INTRODUCTION

Transportation planners and decisionmakers have long been concerned with how transportation investments and services shape economic development. The understanding of this linkage has gone through several significant changes. From the earliest days of U.S. history, transportation investment was assumed to play a strong role in stimulating development and influencing where and how this development took place. Although many individual projects were economic failures, the resulting belief in the vital role of transportation in stimulating and shaping economic growth helped spur public and private investment in transportation networks, including a network of post roads, canals, ports, and the transcontinental railroad system.

In more recent decades, transportation planners, and the public in general, have demanded more analytical answers to questions about the role of transportation in economic development. This research is not an academic exercise. It offers direct help in identifying cost-effective projects and helps to justify the value of transportation investment. The research can also help point the way to alternative sources of financing.

The link between transportation investment and economic development can be made at different levels of spatial and program detail. Until recently, most efforts to analyze the economic development effects of transportation focused on individual projects with the greatest weight given to near-term benefits. A national perspective, for example, will require different assumptions, models, and data from an analysis of state and regional impacts, and different inputs from what is needed for individual projects. Similarly, consideration of the long-term or structural impacts of transport changes will require different types of data and include different levels of uncertainty.

Recent research efforts by NCHRP, federal and state agencies, the Federal Reserve Board, and academic institutions have begun to focus on national or regional impacts of transportation and on long-term effects, including the role of transportation in stimulating productivity improvements.

### OBJECTIVE

Much of this research has begun to forge a new way of thinking about the role of transportation in a post-modern economy. The new findings are intriguing and exciting and, at

the same time, controversial and confusing. As a result, they have stimulated debate and disagreement, but limited direct results in shaping transportation policy or specific investments at the national or local level. NCHRP Project 2-19 aims to:

- Assess the state of the art in this new wave of research;
- Determine the likelihood that the research can be extended and adapted so that it will provide practical help for transportation planners, in particular, and the broad range of stakeholders with an interest in transportation and economic activity; and
- Develop an appropriate cost-effective, multiyear, multifaceted research agenda on the relationship between transportation investment and economic development.

Recent work in this area has been intellectually stimulating to researchers as well as a source of debate within the transportation community. To date, however, new findings and techniques have not resulted in practical tools that can be applied by transportation decisionmakers or planners. A 1990 AASHTO publication (1) provided an important step in the right direction. Although it provides a clear description of cost-benefit analysis and how it can be extended to include logistics, it falls short of providing an applied set of analytical tools that can be used effectively by practitioners.

This project focuses on research that meets three criteria:

- Do the techniques and methodologies meet high technical standards and produce results convincing to economists and others with technical expertise in this field?
- Can this research offer results accessible to stakeholders, including nonspecialists?
- Most important, can the techniques and methodologies be adapted to support transportation planning and investment decisions?

### FRAMEWORK OF ANALYSIS

Development of a program of rigorous economic research that will lead to accessible analytical tools and is applicable to practical policy issues is not a simple task. Accessibility is not achieved by having one group conduct analysis and then having another group work out the interpretation for

nonspecialists. From the beginning, research should be structured to develop a line of analysis written in common-sense terms, to offer intuitive findings to the nonspecialist, and to provide substantial help to planners and decisionmakers. Recognizing these needs, the project was divided into three phases (see Figure 1).

### Phase I (Tasks 1, 2, and 3)

In Phase I, the research team developed two pieces of information: an identification of stakeholders and a review of the literature.

The research community has dominated the recent wave of research on transportation investment and economic development, with some involvement by state and federal DOTs. Identification of a broader group of stakeholders helps ensure that future research is accessible to a wider audience, and it should ease the implementation of new methodologies.

Everyone has some stake in an efficient and effective national transportation system. These stakeholders include users of the system, service providers, policymakers, and

even non-users (both as beneficiaries of economic productivity and as those who feel the negative externalities transportation can create). Just as different groups have their own interest in transportation and their own role in shaping transport policy, they also have different information needs. The first part of Phase I identified and categorized the various stakeholders into manageable groups.

To design an effective agenda for future research, it was imperative to first gain an understanding of the state of current research and its strengths and limitations. In the second part of Phase I, the research team developed an overview of the pertinent literature covering the ways in which transportation investments affect economic productivity. Initial analysis of the literature review indicated that current tools were either too narrow (e.g., cost-benefit analysis), or too broad (e.g., production function approaches) in meeting the needs of the practitioners. An appropriate level of analysis is required to bridge the current gap between the narrow (micro) and broad (macro) approaches typically found in the literature.

### Phase II (Tasks 4 and 5)

Phase II involved participation and input from representative stakeholders identified in Phase I. The underlying objective of organizing the expert panels was to meet with the various stakeholders to identify their information and research needs. The panel referred to the literature review to identify and evaluate the information gaps, contradictions, and inconsistencies in the existing research.

The conference was held in Reston, Virginia, on November 15–17, 1995. The 2-day event consisted of a plenary session, four breakout groups with oral summaries of findings for the reconvened group, and two panel discussions.

Following the conference, a written report detailed the various research ideas generated during the conference and organized them under 10 broad topic areas. The document highlighted the major components of research gaps identified by the participants and provided five brief research project statements based on the findings of the conference. These research statements were for illustration purposes only and were not presented in a detailed format.

### Phase III (Tasks 6, 7, and 8)

In Phase III, the research team developed a formal framework for organizing the research ideas and presented 15 detailed RPSs that address the relationship between transportation investment and economic development. The framework prioritizes the research needs based on short-, medium-, and long-term application needs of the practitioners. A significant degree of flexibility is incorporated into this framework

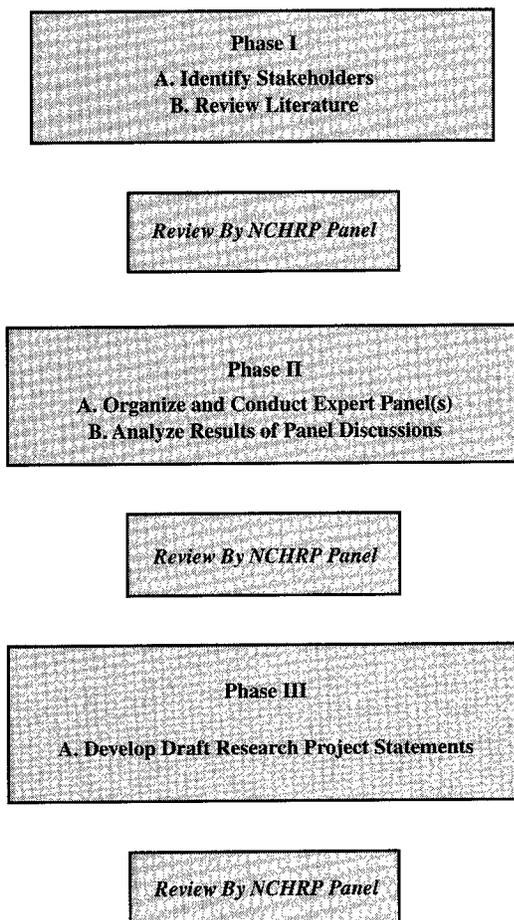


Figure 1. Overall research plan.

to allow for future modification of the research agenda based on the changing needs of transportation practitioners.

The discussions generated by the expert panels in Phase II were an important ingredient in designing the overall research agenda. The panel members' participation ensured that research objectives were targeted and developed specifically for stakeholder groups. As a result, stakeholders should be in a position to effectively apply the results of the proposed research.

The research agenda is presented in the form of several evaluations that state the merits and requirements of prospective projects and programs. Each evaluation includes:

- A *problem statement*, outlining the specific information gap that the research will address;
- A list of *research needs*, including key questions related to the topic area that the researcher must address;
- *Application* of the research output, including the identification of potential stakeholders that may benefit from the research findings; and
- Expected *budget* and *time frame* in undertaking the proposed research.

## ORGANIZATION OF THE REPORT

Chapter 2 identifies and describes the stakeholders who have an interest in, a need for, or are affected by transportation investment and economic development. Chapter 3 provides a detailed summary and review of the existing literature on the link between transportation and economic development and highlights the major information gaps that currently exist. In Chapter 4, the 2-day workshop and the expert panel sessions are described, including a description of the specific sessions and a list of conference participants. Chapter 5 focuses on the description of information gaps that were identified by the stakeholders during the workshop. It sheds important light on the current needs of a wide group of stakeholders and summarizes the critical research needs of transportation planners, policymakers, and other decision-makers. Chapter 6 presents a series of research project statements that are designed to meet the gaps in existing research and to contribute to a better understanding of the role of transportation investment in influencing economic development and productivity. Finally, Chapter 7 provides a sum-

mary and conclusion and identifies the next steps that will lead to the overall goals of this project.

## A NOTE ON ECONOMIC DEVELOPMENT AND PRODUCTIVITY

The concepts of economic development and growth in productivity are often used interchangeably. Although closely related, the two concepts are different. Broadly speaking, economic development is an increase in total output. This increase can be due to greater quantity of production inputs and improvements in the productivity with which society uses these inputs. Economic development occurs when output increases due to an increase in the supply of labor, the amount of capital available, improvements in technology, the level or quality of materials, or some combination of these factors. Productivity improvements occur when a *given* level of inputs is used to produce a higher level of output. In other words, productivity describes a more efficient use of the inputs of production.

Generally, the rates of population growth in most developed countries have slowed, rates of capital investment have stabilized, and the cost of adding to the supply of raw materials has increased. As a result, improvements in the productivity—how labor, capital, and raw materials are used—will be the key to future economic growth and to improvements in the standard of living.

Transportation improvements affect both economic development and productivity. “Pure” economic development effects are usually regional in nature and result from improved access to labor pools or to larger markets. Productivity improvements, on the other hand, are more difficult to isolate because the changes occur within the production process (e.g., cost savings resulting from “just-in-time” inventory methods).

In a modern economy, with few underdeveloped resources, these productivity gains may be more significant than the classic economic development improvements. Productivity gains, however, are more likely to be recognized at a national or large regional scale of activity.

Most of the existing literature on transportation impact focuses on the economic development aspect, in part, because it is most relevant for specific projects and is easier to measure. This project focuses on the growing body of new research on transportation and productivity, including transportation's role in shaping long-term structural changes in the economy.

## CHAPTER 2

# IDENTIFICATION OF STAKEHOLDERS

### OBJECTIVE

In Task 1, the researchers identified the stakeholders who have an interest in, a need for, or are affected by transportation investment and economic development. Determining who the stakeholders are provided a guideline for assembling an expert panel (Task 4) and later for developing applied research statements on transportation investment and economic development.

### STAKEHOLDERS

This chapter identifies major stakeholders and describes their roles in decision making and their interest in the economic development aspects of transportation infrastructure. The list of stakeholders is presented in a two-step hierarchy:

- *A framework of stakeholders.* An inclusive list of the major categories of stakeholders (Table 1); and
- *Highlighted stakeholders.* Selected stakeholders within each category based on their role in decision making, their representation in the process, and the direct or indirect effect on transportation investment decisions.

### FRAMEWORK OF STAKEHOLDERS

To help organize the review of stakeholders, the research team developed a framework that includes decisionmakers, groups affected by those decisions, and groups whose concerns or agendas are affected. Ultimately, every group or individual who travels, works, or purchases goods is a stakeholder in transportation investment and its related economic development, even though the level of impact or interest will vary. For simplicity, the framework of stakeholders is organized into six major categories:

- Transportation policy, regulatory and funding;
- Transportation design and construction;
- Transportation users;
- Non-user transportation interests;
- Nontransportation regulatory agencies and their constituents; and
- Academia/research.

Within each category, stakeholders are organized according to whether they are public or private entities (where those categories apply), and then according to four characteristics:

- *Group representations.* These are specific entities and organizations that fall into the stakeholder category, yet each may have slightly different interests or perspectives;
- *Spatial interest.* Each stakeholder typically emphasizes a certain jurisdiction (national, state, regional, or local);
- *Role in transportation decision making.* This characteristic identifies the decisionmakers, the types of decisions they make, and those who hope to influence those decisions; and
- *Interest in economic development.* This characteristic identifies the stakeholder's particular interest in economic development and transportation investment.

### HIGHLIGHTED STAKEHOLDERS

The framework identifies the major stakeholder categories, but it does not provide a context for understanding how those groups relate to economic development and transportation infrastructure. The research team selected four aggregations of important stakeholders based on the stakeholders' perspective or participation in the decision-making process:

- *Decision-making stakeholders for government investment in transportation.* Stakeholders that are actively making decisions on funding transportation programs, prioritizing projects, and maintaining or constructing transportation systems.
- *Under-represented stakeholders.* Stakeholders who are disconnected from the decision-making process, even though their interests may be dramatically affected by transportation investment decisions. These members are typically in economically depressed areas and historically limited in their access to economic advantage and development.
- *Directly affected stakeholders.* The private entities that are directly affected by transportation investment decisions. This group consists of investment banks, construction companies, shippers, and other users.

TABLE 1 Framework of stakeholders

Stakeholder (Direct)	Group Representations	Spatial Interest	Role in the Transportation Decision-Making Process	Interest in Economic Development
<b>Transportation Policy, Regulatory and Funding</b>				
<b>Public Entities</b>				
State DOTs/Transportation Commissions	Fifty states, District of Columbia and Puerto Rico	Statewide; Regional	<ul style="list-style-type: none"> <li>Develop state transportation policy</li> <li>Provide transportation systems</li> <li>Improve access to public and private capital</li> <li>Allocate state funds to projects/modes</li> </ul>	<ul style="list-style-type: none"> <li>Decision-making to improve state's transportation services and economy</li> </ul>
State Legislatures	Town, County and District Representatives	Statewide	<ul style="list-style-type: none"> <li>Influence and implement national policy</li> </ul>	<ul style="list-style-type: none"> <li>Decision-making to improve state's transportation services and economy</li> </ul>
Local DOTs/Counties and Municipalities	Local Jurisdictions	Local/Regional	<ul style="list-style-type: none"> <li>Allocate funds to projects/modes</li> <li>Develop local transportation policy</li> <li>Operate transportation systems and roads</li> <li>Influence and implement national/state policy</li> </ul>	<ul style="list-style-type: none"> <li>Decision-making to ensure access and improve region's economy</li> </ul>
Toll roads, port, rail, airport and transit authorities		Local	<ul style="list-style-type: none"> <li>Provide transportation facilities</li> <li>Collect user fees, finance construction and operation</li> <li>Influence and implement national/state policy</li> <li>Develop local transportation policy</li> </ul>	<ul style="list-style-type: none"> <li>Decision-making to ensure access and improve transportation services</li> </ul>
U.S. Department of Transportation	Federal Highway Administration Federal Aviation Administration Federal Transit Administration Federal Railroad Administration Federal Maritime Administration	National; international	<ul style="list-style-type: none"> <li>Enforce Federal Laws</li> <li>Develop national transportation policy and regulation</li> <li>Allocate funds to DOT programs</li> </ul>	<ul style="list-style-type: none"> <li>Make informed transportation policy decisions</li> <li>Develop National Transportation System which facilitates movement of people and goods nationwide</li> </ul>
Congress	House of Representatives Senate	National	<ul style="list-style-type: none"> <li>Pass laws directly or indirectly affecting transportation</li> <li>Authorize federal funds and set appropriations and obligation ceilings</li> </ul>	<ul style="list-style-type: none"> <li>Balance federal programs to ensure national economic productivity and growth</li> </ul>
<b>Private Entities</b>				
Investment Banks	Issuer	Project specific	<ul style="list-style-type: none"> <li>Sell bonds for infrastructure projects</li> <li>Help provide equity capital</li> </ul>	<ul style="list-style-type: none"> <li>Issuer</li> <li>Assess project risks and potential revenues</li> </ul>
<b>Transportation Design and Construction</b>				
<b>Public Entities</b>				
State DOTs	Fifty states, District of Columbia and Puerto Rico	State	<ul style="list-style-type: none"> <li>Prioritize projects at the state level deciding between which projects best serve the infrastructure needs</li> </ul>	<ul style="list-style-type: none"> <li>Construction directly affects the state's economy</li> <li>New or improved facilities affect the states economy or production (difficulty measuring)</li> </ul>
Local DOTs, Counties and municipalities	Local Jurisdictions	Local	<ul style="list-style-type: none"> <li>Prioritize construction projects to meet local needs</li> </ul>	<ul style="list-style-type: none"> <li>Assess and prioritize projects that will improve service, access and local economy</li> </ul>

(continued on next page)

TABLE 1 (Continued)

Stakeholder (Direct)	Group Representations	Spatial Interest	Role in the Transportation Decision-Making Process	Interest in Economic Development
Rural Counties	Rural Jurisdictions	Rural	<ul style="list-style-type: none"> <li>Ensure adequate service and representation for rural areas access</li> <li>Decision-making to prioritize projects that extend and improve service</li> </ul>	<ul style="list-style-type: none"> <li>Access to service and jobs</li> <li>Implement projects that will improve access and service</li> </ul>
Port, rail, airport, and transit authorities		Regional		
<b>Private Entities</b>				
Construction and related industries directly affected by transportation policy decisions	American Builders and Contractors American Public Works Assoc. American Road & Transportation Builders Assoc. American Concrete Pavement Assoc. American Consulting Engineers Council Associated General Contractors of America Construction Industry Manufacturing Assoc. National Asphalt Pavement Assoc. National Ready Mixed Concrete Assoc. National Stone Assoc. Dulles Toll Road Euro Tunnel	Regional	<ul style="list-style-type: none"> <li>No direct decision-making</li> <li>Influence legislation and regulation that affect the construction of infrastructure</li> <li>Influence allocation of funding to develop and maintain transportation systems</li> </ul>	<ul style="list-style-type: none"> <li>Increase opportunities for business</li> <li>Ease legal requirements of operating</li> <li>Improve quality of transportation (related) products</li> </ul>
Private Sector Developers		Project level	<ul style="list-style-type: none"> <li>Influence regional projects to provide for development opportunities</li> <li>Creates need for new infrastructure or capacity of supporting infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Creates economic development, attracting businesses</li> <li>Community involvement varies</li> </ul>
AAASHTO	Fifty states, District of Columbia and Puerto Rico	National/Regional	<ul style="list-style-type: none"> <li>Set Standards</li> <li>Conduct applied research (NCHRP)</li> </ul>	<ul style="list-style-type: none"> <li>Links between transportation investment and economic development</li> </ul>
<b>Transportation Users</b>				
Motorists	American Automobile Assoc. Motor Vehicle Manufacturers Assoc. Highway Users Federation for Safety and Mobility Auto, bus, truck, container, railroad aircraft and other equipment manufacturers American Trucking Assoc. Package Carriers American Bus Assoc. Shippers	National National National National National	<ul style="list-style-type: none"> <li>Influence transportation improvement policies</li> <li>Influence opportunities to provide users with additional equipment with the minimum legal requirements</li> <li>Influence policy for user rights and safety</li> <li>Influence policies that would increase opportunities to provide additional equipment</li> <li>Influence policies that would improve use and flow of road and air transportation systems</li> <li>Influence legal requirements for shipping goods</li> </ul>	<ul style="list-style-type: none"> <li>Provide better use and access for members</li> <li>Increase need for automobiles</li> <li>Improve use and safety with minimum economic cost</li> <li>Increase need for equipment</li> <li>Identify the most cost effective method and route to ship materials</li> <li>Have access to high quality transportation facilities</li> </ul>

(continued on next page)

Stakeholder (Direct)	Group Representations	Spatial Interest	Role in the Transportation Decision-Making Process	Interest in Economic Development
	Airline industry members Air Transport Assoc.	National	<ul style="list-style-type: none"> <li>Influence policies that would improve use of the air transportation system</li> </ul>	<ul style="list-style-type: none"> <li>Identify the most cost effective methods to fly goods and passengers</li> </ul>
	American Railroad Assoc. Container freight carriers National Freight Transportation Assoc.	National	<ul style="list-style-type: none"> <li>Influence policies that would improve use of the rail transportation system</li> </ul>	<ul style="list-style-type: none"> <li>Identify the most cost effective methods to route goods and passengers</li> </ul>
Organized Labor	Teamsters	National/Regional	<ul style="list-style-type: none"> <li>Influence national/regional policy</li> <li>Influence decision-making on regional projects</li> </ul>	<ul style="list-style-type: none"> <li>Seek full employment of members at good wages</li> </ul>
Public		Project level	<ul style="list-style-type: none"> <li>Influence local policy and transportation projects to mitigate the impact</li> </ul>	<ul style="list-style-type: none"> <li>Improve use of the transportation system without altering the quality of life</li> </ul>
<b>Private Non-user Transportation Interests</b>				
Private Associations	National Governors Association/Staff Advisory Committee		<ul style="list-style-type: none"> <li>Develop transportation agendas and influence federal policies</li> </ul>	
	Washington Roundtable		<ul style="list-style-type: none"> <li>Discuss implications of transportation policies</li> </ul>	
<b>Private Entities</b>				
Motorists	American Assoc. of Motor Vehicle Administrators			
Business Associations	Chambers of Commerce	National, Regional, Local	<ul style="list-style-type: none"> <li>Influence transportation policies that would improve economy of the nation, region or town</li> </ul>	<ul style="list-style-type: none"> <li>Transportation projects that would directly affect the economy</li> </ul>
	Resort and event operators Other tourism elements	Regional	<ul style="list-style-type: none"> <li>Influence access to resort or event</li> <li>Creates demand for new or improved transportation system</li> </ul>	<ul style="list-style-type: none"> <li>Assess if the area or market is large enough to support business</li> </ul>
	National Assoc. of Manufacturers	National	<ul style="list-style-type: none"> <li>Influence distribution policies to provide access to markets</li> </ul>	<ul style="list-style-type: none"> <li>Assess the cost effectiveness to distribute and sell goods</li> </ul>
Environmental/Community Agencies	National Conference for Urban Economic Development	Cities	<ul style="list-style-type: none"> <li>Assure adequate representation and access transportation systems in the cities for all neighborhoods</li> <li>Evenly develop neighborhoods</li> </ul>	<ul style="list-style-type: none"> <li>Effect of transportation systems on neighborhoods</li> </ul>
	Audubon Society		<ul style="list-style-type: none"> <li>Influence policies that adversely affect the environment (positively or adversely)</li> </ul>	
	Conservation Law Foundation	Northeast	<ul style="list-style-type: none"> <li>Control/limit adverse environmental impacts of transportation policies and projects</li> </ul>	
	Sierra Club	Environment; National	<ul style="list-style-type: none"> <li>Influence policies that adversely affect the environment (positively or adversely)</li> </ul>	<ul style="list-style-type: none"> <li>Preserving the environment</li> </ul>
	Economically disadvantaged communities	Lower socio-economic neighborhoods	<ul style="list-style-type: none"> <li>Influence policies that affect economically disadvantaged communities</li> </ul>	<ul style="list-style-type: none"> <li>Providing access to disadvantaged communities and how the improved access could increase the potential for income</li> </ul>
	Environmental Defense Fund	Environment; National	<ul style="list-style-type: none"> <li>Influence policies that adversely affect the environment</li> </ul>	<ul style="list-style-type: none"> <li>Preserving the environment</li> </ul>

(continued on next page)

TABLE 1 (Continued)

Stakeholder (Direct)	Group Representations	Spatial Interest	Role in the Transportation Decision-Making Process	Interest in Economic Development
Public Interest and Consumer Groups				
<b>Non-transportation Regulatory Agencies and Their Constituents</b>				
Federal Agencies	Department of Commerce	National/Regional	<ul style="list-style-type: none"> <li>Influence transportation policies to improve economy</li> </ul>	<ul style="list-style-type: none"> <li>Transportation projects that improve the economy</li> </ul>
	Environmental Protection Agencies	National/Regional	<ul style="list-style-type: none"> <li>Influence transportation policies to protect the environment</li> </ul>	<ul style="list-style-type: none"> <li>Assess impact of transportation policies</li> </ul>
	U.S. Corp of Engineers	National/Regional	<ul style="list-style-type: none"> <li>Influence transportation policies to improve the economy</li> </ul>	<ul style="list-style-type: none"> <li>National productivity effects of infrastructure investment</li> </ul>
	U.S. Fish and Wildlife	National/Regional	<ul style="list-style-type: none"> <li>Influence transportation policies to protect fish and wildlife</li> </ul>	<ul style="list-style-type: none"> <li>Impacts of transportation construction projects</li> </ul>
	Department of Agriculture/ Forestry	National	<ul style="list-style-type: none"> <li>Assess impact of transportation policies</li> <li>Operate forest service roads</li> </ul>	<ul style="list-style-type: none"> <li>Improve transportation services for agricultural businesses</li> <li>Sustain national forests</li> </ul>
	National Park Service	National Parks	<ul style="list-style-type: none"> <li>Compliance to national policy</li> <li>Bridge National Park and Federal policy</li> </ul>	<ul style="list-style-type: none"> <li>Preserve parks and access to parks</li> <li>Ensure environmental and safety compliance in parks</li> </ul>
	Native American Governments	Reservations	<ul style="list-style-type: none"> <li>Develop reservation's transportation system</li> </ul>	<ul style="list-style-type: none"> <li>Provide access to employment and facilitate income generation</li> <li>Preserve reservation land</li> <li>Direct and attract beneficial development</li> </ul>
	U.S. Department of the Interior Bureau of Land Management	National	<ul style="list-style-type: none"> <li>Operate specific service roads</li> <li>Provide vehicle access to National Parks and other interior facilities</li> </ul>	<ul style="list-style-type: none"> <li>Assess impact of transportation policies</li> <li>Operate specific service roads</li> <li>Provide vehicle access to National Parks and other interior facilities</li> </ul>
	Department of Health and Human Services	National	<ul style="list-style-type: none"> <li>Influence policies that affect health and human services</li> </ul>	<ul style="list-style-type: none"> <li>Protect health of national public</li> </ul>
State Agencies	Redevelopment agencies Interstate Commerce Commission State Public Utility (Public Service) Commissions State environmental oversight agencies	National/Regional	<ul style="list-style-type: none"> <li>Affect transportation policies</li> </ul>	<ul style="list-style-type: none"> <li>Assess impact of transportation policies</li> </ul>
<b>Researchers</b>				
Federal DOT Research groups	National Highway Institutes and other FHWA research	National	<ul style="list-style-type: none"> <li>Conduct Transportation and other research</li> </ul>	<ul style="list-style-type: none"> <li>Develop applied and basic research (Federal agencies will generally focus on basic research more than other researchers)</li> </ul>
State DOT Research departments	Department of Defense	Worldwide/National State	<ul style="list-style-type: none"> <li>Conduct Transportation and other research</li> </ul>	<ul style="list-style-type: none"> <li>Develop applied research</li> </ul>
Academia	Universities, Transportation Research Centers	National/Regional	<ul style="list-style-type: none"> <li>Conduct Transportation and other research</li> </ul>	<ul style="list-style-type: none"> <li>Develop applied and basic research</li> </ul>
Research Institutes/Thinktanks	NCHRP, The Urban Institute ...	National/Regional	<ul style="list-style-type: none"> <li>Conduct Transportation and other research</li> </ul>	<ul style="list-style-type: none"> <li>Develop applied and basic research</li> </ul>

- *Indirectly affected stakeholders.* Stakeholders whose interests are indirectly affected by transportation investment decisions. This category includes environmental or community groups and businesses for which efficiency improvements may result from opportunities that relate to transportation investment. For example, investment in transportation allows for “just-in-time” practices and related techniques that improve the efficiency of business. Related techniques may allow firms to reduce product cycle times, thus coming closer to the needs of their customers.

**Decision-Making Stakeholders for Government Investment in Transportation**

This group is highlighted because transportation investment and economic development affect many stakeholders, but only a few of these people make the actual investment decisions. Decisionmakers are responsible for considering the interests of other groups, including those directly or indirectly affected and the under-represented. Decisionmakers must weigh all factors, such as the environment, community access, regional economy, business interests, and many others, when evaluating transportation investment issues. Decisionmakers for government investment in transportation include practitioners and legislators at all levels (federal, state, and local).

<b>Decision Making for Government Investment in Transportation</b>	
<b>Stakeholder</b>	
State DOTs/Transportation Commissions	
Legislators and Treasurers (national, state or local)	
U.S. DOT	
Local DOT	
Port, Rail, Airport and Transit Authorities	
MPO	
Chamber of Commerce	
EPA	

**Under-Represented Stakeholders**

The under-represented stakeholders are an important, but hidden, element in the equation. Under-represented stakeholders include (1) groups that would benefit from transportation investments that decisionmakers choose not to

undertake and (2) groups for whom the adverse effects of transportation investment outweigh the benefits of economic development. In urban and rural areas, minority groups and economically disadvantaged communities may lack information on the potential benefits of transportation investment or possess limited resources to lobby for projects in their own interest.

<b>Under Represented</b>	
<b>Stakeholder</b>	
Rural Jurisdictions and Areas	
Economically disadvantaged—Inner-city	
Economically disadvantaged—Rural	
Native Americans	
Disabled and Aging	

Future decisions on transportation investment could provide the under-represented with opportunities for economic development, including access to employment or the potential to attract business development to new areas.

**Directly Affected Stakeholders**

Directly affected stakeholders are closely tied to transportation investment decisions. Some are linked directly to the investment by providing funding or actually constructing the project, while others use transportation facilities for travel or shipment of goods. Many of these groups are actively represented in the decision-making process, yet their perspectives are confined to the best methods to conduct their business and not the potential economic opportunities for the region. Again, the decisionmakers must weigh interests of the directly affected with the under-represented or the indirectly affected.

<b>Directly Affected</b>	
<b>Stakeholder</b>	
Transportation Construction and Design	
Transportation Users	
Carriers and Shippers	
Investment Banks	
Developers	
Manufacturers (employ shippers)	

**Indirectly Affected Stakeholders**

Indirectly affected stakeholders are not primarily interested in the transportation investment but are concerned about the ramifications of transportation investment decisions. For example, environmental groups seek to preserve the environment and decrease the negative impacts that cars, buses, and trucks can have on the environment. Community groups may be concerned about environmental effects of a project and/or the potential division of the community that may result from a project. Other indirectly affected stakeholders include general business groups who may change the way they do business to include more productive and economical methods. Generally, when businesses improve the way they do business, it is difficult to determine how their improvements relate to specific transportation investments.

<b>Indirectly Affected Stakeholder</b>
General Business Groups
Community Groups
Other Federal and State Agencies
Consumer Groups
Environmental groups
Public



## CHAPTER 3

# REVIEW OF LITERATURE

### OBJECTIVE

This chapter identifies the lines of research most likely to be useful to public sector decisionmakers and a range of other stakeholders interested in how investments in transportation infrastructure influence gains in economic productivity. The review assesses the current understanding of the link between infrastructure investment and productivity, noting areas of uncertainty, technical shortfalls, and work needed to provide greater relevance for transportation decisions and policy. Current research that may help address these concerns is also included. This report provided background material for the NCHRP Panel and helped the participants assess the potential value of new research to improved planning and decision making.

### SCOPE OF THE LITERATURE REVIEW

The scope of this review differs from that of standard literature reviews. The review is not intended to provide an exhaustive documentation of all published research on transportation impacts or to be a technically oriented review of different methodologies. Instead, this review provides a synthesis of the research and describes the different methodologies used to assess the relationship between transportation investment and long-term economic development and productivity. The review focuses on applied research and points out the usefulness and limitations of existing techniques for the analytical and decision-making needs of the stakeholders. For in-depth coverage of the literature in this area, see reports published by FHWA (2) and NCHRP (3).

Table 2 summarizes the most relevant and useful research papers identified in this review. The table highlights the approaches used by the individual authors of 33 papers and provides an overview of the relevance of each study to the decision-making process. The table also identifies the primary information gaps, both theoretical and empirical. Much of this project will focus on how future research might best address these information gaps and the value of this new research to transportation decisionmakers and stakeholders.

### OVERVIEW

Figure 2 shows an organizing framework for current and potential future research on this topic. This framework divides research on the economic impacts of transportation infrastructure investment into two broad approaches: microanalysis and macroanalysis. Each approach has strengths and weaknesses when estimating the effects on economic productivity; each offers different relevance for transportation decision making; and each has different degrees of acceptance within the economics community. In general, the research in macroeconomics has generated the most controversy. This research offers the greatest potential for measuring the productivity and long-term economic impacts of transportation and offers the greatest challenges in adapting to the needs of transportation planners.

Macroanalysis examines the relationship between infrastructure services and productivity in the economy as a whole. Most examples of macroanalysis have used statistical techniques, such as production functions or cost functions, to estimate the relationship between infrastructure investment and productivity and long-term economic activity.

Microanalysis reflects the traditional methods developed by transportation economists and planners. It focuses on the economic effects of a particular project or the effect of transportation improvements on the transportation costs to individuals or firms without significant shifts in how they live their daily lives or how they do business. Microeconomic analysis usually involves a cost-benefit analysis of a project. Case studies represent an alternative, but less theoretically rigorous, way to assess the impacts of transportation improvements on the structure and efficiency of individual firms or plants. They can provide useful insights into how the private sector reacts to changes in transportation.

The strength of cost-benefit analysis is that it is explicit and transparent. To carry out the calculations of benefit and cost, it is first necessary to go through an analytical process that traces the causal links between a project and its economic effects. When dealing with the direct effects of a project, where the causal links are readily discernible, this approach works well. On the most basic level, for example, construction and maintenance costs of a highway project can be readily identified, as well as effects on speed (travel time), vehicle operating costs, and accidents.

TABLE 2 Review of selected literature

Author	AASHTO	Allen, Baumei & Forkenbrock	Apogee Research, Inc
Year of Publication	1990	1994	1991
Approach	Micro (case study)	Micro (cost benefit)	Micro (case study)
Source	American Association of State Highway and Transportation Officials (AASHTO)	Journal of Transportation Economics	Apogee Research, Inc.
Purpose	Identifying and classifying the private sector's productivity gains from highway infrastructure.	Expanding the benefits of an investment project by incorporating logistical cost savings.	[1] Illustration of different productivity impacts on private corporations. [2] Implications for transportation policy and for research.
<b>Relevance To:</b>			
Aggregate National Investment	X	X	X
Aggregate Regional/State Investment	X	X	X
Individual Project Appraisal	X	X	X
Ranking of Projects	X	X	X
Timing of Investment	X	X	X
Location Decisions	X	X	X
Financing Decisions	X	X	X
<b>Future Research Directions</b>			
Theoretical Issues	This work should assist in refining the macro model production functions, (especially inter - input technical elasticity).	Incorporating the concepts and methodologies of this work into the theoretical framework of applied cost benefit models.	Modeling the role of public infrastructure in a firm's decision process.
Empirical Issues	NA	Estimation of logistical cost savings engendered by public infrastructure in transportation.	Separating the effect on productivity of different causal agents (infrastructure, technology, management techniques, regulatory policy, etc.).
Data-Related Issues	[1] Quantitative estimation of firm level gain in productivity from transportation (public) infrastructure. [2] Isolated benefit from individual projects.	[1] For making this work applicable, new data sets need to be created. [2] Primary survey method suggested.	[1] Case studies of corporations in the service sector. [2] Estimating productivity impacts at different levels of economic activity (firm or industry).

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TABLE 2 (Continued)

<i>Author</i>	<i>Aschauer</i>	<i>Aschauer</i>	<i>Aschauer</i>	<i>Aschauer</i>	<i>Aschauer</i>	<i>Aschauer</i>	<i>Aschauer</i>	<i>Aschauer</i>	<i>Aschauer</i>
<i>Year of Publication</i>	1993	1994	1994	1994	1994	1994	1994	1994	1994
<i>Approach</i>	Macro	Macro	Macro	Macro	Macro	Macro	Macro	Macro	Macro
<i>Source</i>	Federal Reserve Bank of Chicago	Federal Reserve Bank of Chicago	Army Corps of Engineers	Army Corps of Engineers	Department of Transportation, California				
<b>Purpose</b>	Defending the macro estimates of high output elasticity of public infrastructure.	Defending the macro estimates of high output elasticity of public infrastructure.	[1] An endogenous and an exogenous growth model incorporating public capital & taxes. [2] Suggestion of ways by which future research could be sensitive to the critiques made of macro-econometric research.	[1] An endogenous and an exogenous growth model incorporating public capital & taxes. [2] Suggestion of ways by which future research could be sensitive to the critiques made of macro-econometric research.	Effect of a slowdown in the growth of highway stock on private sector capital productivity, and on total factor productivity.	Effect of a slowdown in the growth of highway stock on private sector capital productivity, and on total factor productivity.	Effect of a slowdown in the growth of highway stock on private sector capital productivity, and on total factor productivity.	Effect of a slowdown in the growth of highway stock on private sector capital productivity, and on total factor productivity.	Effect of a slowdown in the growth of highway stock on private sector capital productivity, and on total factor productivity.
<b>Relevance To:</b>	Low	Moderate	High	High	High	High	High	High	High
Aggregate National Investment		X							X
Aggregate Regional/State Investment		X							X
Individual Project Appraisal	X								
Ranking of Projects	X								
Timing of Investment	X								
Location Decisions	X								
Financing Decisions	X								
<b>Future Research Directions</b>									
Theoretical Issues	An econometric specification to check for the effect of omitted variables (i.e., degree of bias potentially introduced into the estimates due to exclusion of some relevant variables).								
Empirical Issues	[1] Omitted variable test. [2] Empirical studies with disaggregated public infrastructure.								
Data-Related Issues	NA								

[1] Public capital stock disaggregated by state and by infrastructure components.  
[2] Private capital stock.

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TABLE 2 (Continued)

Author	Bayliss	Bell and McGuire	Bernardeau, Mudge and Politano
<b>Year of Publication</b>	1992	1994	1989
<b>Approach</b>	Macro (Transportation models)	Macro	Literature review of all approaches
<b>Source</b>	The World Bank	NCHRP and The Johns Hopkins University	Federal Highway Administration (FHWA)
<b>Purpose</b>	Placing transport models in the context of policy making. A comprehensive transport model suggested. The use of such a comprehensive model in testing policy strategies is demonstrated.	[1] Assisting transportation policy decision making by improving understanding of the economic impacts of transportation infrastructure. [2] Data base development.	Relation between highway investment and economic development, with an emphasis on highway infrastructure's impact on development.
<b>Relevance To:</b>	Low	Low	Low
	Moderate	Moderate	Moderate
	High	High	High
<b>Aggregate National Investment</b>	X	X	X
<b>Aggregate Regional/State Investment</b>	X	X	X
<b>Individual Project Appraisal</b>	X	X	X
<b>Ranking of Projects</b>	X	X	X
<b>Timing of Investment</b>	X	X	X
<b>Location Decisions</b>	X	X	X
<b>Financing Decisions</b>	X	X	X
<b>Future Research Directions</b>	NA	Formulating an industry - specific production function with public capital disaggregated by type.	[1] Incorporating the financial impacts (of infrastructure investment) into productivity studies. [2] Incorporation of supply side economic considerations.
<b>Theoretical Issues</b>			
<b>Empirical Issues</b>	Using simulation models to assist in policy and planning analysis. Subsequently, performing an evaluation of the potential benefits - to policy and planning - of using a comprehensive transportation (and land use) model.	[1] Explanation of differences in state employment growth rates using industrial mix and public capital. [2] Estimation of demand for transportation services by mode (and forecasting of this demand).	[1] effect of transportation infrastructure on international competitiveness. [2] Use of flow variables (instead of stock variables) in estimation. [3] Use of data on changes in output (and in other variables).
<b>Data-Related Issues</b>	Case-specific data needed.	[1] Maintenance of data base developed in this paper. [2] Extensions and refinements to this data base.	[1] Disaggregated data on infrastructure, highways, airports. [2] Specific industry's dependencies on highways and other modes. [3] Quality indices. [4] Private capital stock of non-manufacturing sectors.

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TABLE 2 (Continued)

Author	Craghtney	Delaney	Garcia-Mila and McGuire			
Year of Publication	1993	1995	1988			
Approach	Micro (cost benefit)	Micro (Logistics)	Macro (production function)			
Source	The World Bank	Cass Information Systems	Universitat Autònoma de Barcelona, and Northwestern University			
Purpose	[1] Surveys the experience of the World Bank in analyzing productivity impacts. [2] Suggests a continued use of cost benefit analysis.	Explanation of the derivation of demand for freight transportation services from the integrated business logistics system.	State production functions used to analyze the economic impacts of highway investment and human capital (education) in order to investigate the (relative) efficiency of highway investment.			
Relevance To:	Low	Moderate	High	Low	Moderate	High
Aggregate National Investment	X				X	
Aggregate Regional/State Investment	X				X	
Individual Project Appraisal		X				X
Ranking of Projects		X				X
Timing of Investment	X					X
Location Decisions		X				X
Financing Decisions		X			X	
Future Research Directions	NA					
Theoretical Issues	NA		NA			Theoretical exposition of the relative importance of different (types of) public infrastructure in causing/enabling changes in economic productivity.
Empirical Issues	[1] Location decisions of multinationals. [2] Business location decisions (in an impact analysis which includes cost benefit as one of the analytical tools).		NA			[1] Extending the comparative analysis to other components of public capital and human capital (management technology, health, etc.). [2] Testing the use of education as a proxy for human capital.
Data-Related Issues	NA		NA			[1] Highway capital stock disaggregated by state. [2] Human capital stock (or it's proxy).

(continued on next page)



TABLE 2 (Continued)

<i>Author</i>	Holtz-Eakin	Holtz-Eakin & Schwartz	Holtz-Eakin & Schwartz			
<i>Year of Publication</i>	1992	1994	1995			
<i>Approach</i>	Macro (production)	Macro	Macro (production)			
<i>Source</i>	National Bureau of Economic Research	National Bureau of Economic Research	National Bureau of Economic Research			
<i>Purpose</i>	Include a state specific control variable in a macro-econometric study (study uses state production functions).	State level productivity analysis using a neoclassical growth model, with an explicit incorporation of infrastructure's impact on economic and productivity growth.	Refutes the following: "spatial spillovers explain the discrepancy between productivity measures at different levels of geographic aggregation."			
<i>Relevance To:</i>	Low	Moderate	High	Low	Moderate	High
Aggregate National Investment		X			X	
Aggregate Regional/State Investment		X			X	
Individual Project Appraisal	X		X	X		
Ranking of Projects	X		X	X		
Timing of Investment	X			X		
Location Decisions	X			X		
Financing Decisions	X			X		
<i>Future Research Directions</i>						
Theoretical Issues	Microeconomic linkage between public infrastructure and the production process.					
Empirical Issues	Similar incorporation of state specific variables to re-evaluate other macro productivity studies (especially those studies which infer a large impact of public infrastructure on economic productivity).					
Data-Related Issues	State specific data, especially private capital stock.					
	[1] Growth rates of factors. [2] Mobility of inputs.					
	Joint determination of output, private capital and (disaggregated) public capital within a growth framework.					
	Data on use of one state's highway infrastructure services by residents and businesses of other states (these data are needed to estimate the effect of spatial spill-overs).					
	Similar spillover analysis at different levels of comparative aggregation of industries/sector.					
	Specifies spatial spillover externalities.					

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TABLE 2 (Continued)

<b>Author</b>	<b>Year of Publication</b>	<b>Approach</b>	<b>Source</b>	<b>Purpose</b>	<b>Relevance To:</b>
					Low Moderate High
Hütten	1984	Macro/Micro	Army Corps of Engineers	[1] Description of the theoretical approaches towards analyzing the impact of public capital on the economy. [2] Framework to construct a Computable General Equilibrium (CGE) model.	Low Moderate High
Hütten & Albright	1984	Macro/Micro	Apogee Research, Inc.	Examine linkages between macro and micro economic methodologies.	Low Moderate High
Lewis	1991	Micro (cost benefit)	NCHRP and Hickling Corporation	[1] Guide to applying cost - benefit analysis such that economic productivity impacts from the proposed investment are maximized. [2] A technical primer for this analysis.	Low Moderate High
<b>Future Research Directions</b>					
<b>Theoretical Issues</b>				Formal modeling of the Computable General Equilibrium model.	Low Moderate High
				Proposes simulation approach rather than econometric forecasts.	Low Moderate High
<b>Empirical Issues</b>				Running simulations using the CGE model; comparing these simulations with the forecasts of the macro and micro approaches.	Low Moderate High
				Re-examine productivity work using simulation techniques.	Low Moderate High
<b>Data-Related Issues</b>				[1] First, information is needed on the data needs of a general equilibrium model. [2] Then, this data has to be collected (if needed).	Low Moderate High
				Disaggregated public capital.	Low Moderate High
				Data on use of one state's highway infrastructure services by residents and businesses of other states (this data is needed to estimate the effect of spatial spill-overs).	Low Moderate High

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TABLE 2 (Continued)

Author	Lew and Lew	Lindberg	Martinsen, Odeck & Sandvick			
Year of Publication	1980	1995	1995			
Approach	Macro (transportation)	Micro (cost benefit)	Micro (cost benefit)			
Source	Transportation Research Board	Center for Research in Transportation, Sweden	Norwegian Public Roads Administration			
Purpose	Look at impact of infrastructure on regional economies, using an input-output model in which the input-output coefficients are sensitive to input costs.	Extends cost benefit analysis by incorporating the external impacts of a project on other transportation modes, other links in the same transportation mode.	Describes an impact analysis approach that has a broader scope than cost/benefit. This approach incorporates two types of analysis: monetized analysis (cost benefit) and a qualitative impacts scale (of 1-9).			
Relevance To:	Low	Moderate	High	Low	Moderate	High
Aggregate National Investment	X			X		
Aggregate Regional/State Investment			X	X		
Individual Project Appraisal		X			X	
Ranking of Projects		X			X	
Timing of Investment	X					X
Location Decisions		X				X
Financing Decisions	X			X		
Future Research Directions						
Theoretical Issues	Evaluation of the relevance of input output models to future research on productivity impacts of infrastructure.					
Empirical Issues	Extension of the model by using a non-linear production function (that is, letting the elasticity of input to output share differ from one).					
Data-Related Issues	[1] Prices of outputs and inputs. [2] Effective tax rates. [3] Transportation costs of firms. [4] Input coefficients. [5] Technology constraints.					
	[1] Effect (on efficiency) of using a decision tool which incorporates cost benefit and qualitative analysis. [2] Efficiency of using a qualitative analysis based on revealed preferences - of decision makers - between projects.					
	[1] Traffic forecasts. [2] Induced demand. Both with an intermodal emphasis.					
	Economic valuation of time. NA					

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TABLE 2 (Continued)

Author	Minkin	Murphy	Nadiri
Year of Publication	1995	1990	1994
Approach	Micro (cost benefit)	Macro (production)	Macro
Source	Institute of Transport Economics, Norway	Federal Reserve Bank of Boston	Army Corps of Engineers
Purpose	[1] Suggest a framework to devise a methodology to optimally choose transportation investment when there are interdependencies between projects. [2] Suggestions to make this solution feasible.	State-level impacts of infrastructure investment (after constructing state level private capital estimates).	[1] Comparing the cost and production function approach and their results. [2] Estimating the effect of public capital on specific industries (describes an econometric - cost function - framework to do so).
Relevance To:	Low Moderate High	Low Moderate High	Low Moderate High
Aggregate National Investment	X	X	X
Aggregate Regional/State Investment	X	X	X
Individual Project Appraisal	X	X	X
Ranking of Projects	X	X	X
Timing of Investment	X	X	X
Location Decisions	X	X	X
Financing Decisions	X	X	X
Future Research Directions			
Theoretical Issues	Detailed theoretical formulation of the methodology implied by this paper.	NA	NA
Empirical Issues	[1] Tests of the above formulation: on existing project networks and on proposed projects. [2] Comparison of these results with standard cost benefit results.	[1] Causality test to validate the model. [2] Specification of conditions under which private and public capital are complements or substitutes.	Comparing cost and profit function estimates using the same data.
Data-Related Issues	Creation of (case - specific) data sets for application of this model.	[1] State specific data, especially capital stock. [2] Other disaggregated data.	NA

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TABLE 2 (Continued)

<i>Author</i>	<i>Year of Publication</i>	<i>Approach</i>	<i>Source</i>	<i>Purpose</i>
Nadiri & Maimonias	1994	Macro (cost function)	New York University	[1] Productivity analysis at disaggregated industry level. [2] Theoretical exposition & defense of cost function approach.
Pederson	1990	Macro	Department of Transportation, Maryland	Practitioners opinion on practical use and usefulness of cost benefit analysis.
Pederson	1990	Macro	Princeton University	Using political considerations to explain sub-optimal provision of public infrastructure.

<i>Relevance To:</i>	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Aggregate National Investment		X		X					X
Aggregate Regional/State Investment		X		X					X
Individual Project Appraisal	X					X			
Ranking of Projects	X				X				X
Timing of Investment	X			X					X
Location Decisions	X			X					X
Financing Decisions	X				X				X

<i>Future Research Directions</i>	NA	NA
Theoretical Issues	[1] Using different cost function specifications. [2] Using industry - specific cost functions.	Modeling policy making and referenda mechanisms in the U.S.

Empirical Issues	[1] Similar disaggregate analysis at state level. [2] Comparison of this with national level. [3] Explicit calculation of technical change.	NA	NA
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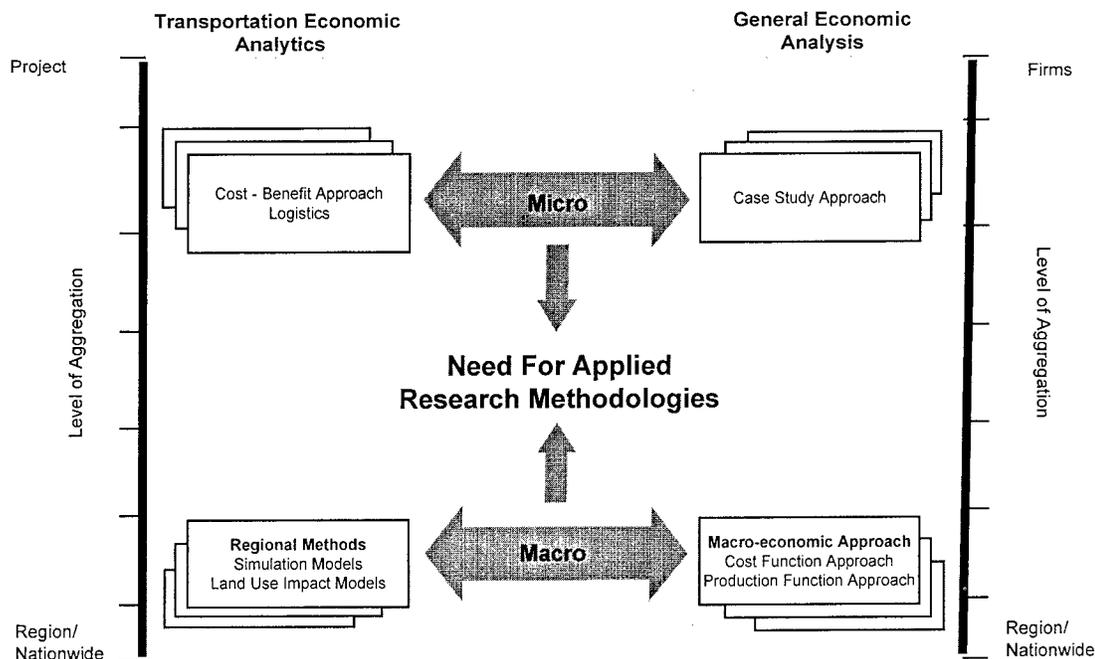
  

Data-Related Issues	[1] Capacity utilization rate(s). [2] Industry specific dummy values to account for industry-specific differences.	[1] Primary survey of practitioners for opinions on the applicability of cost-benefit and the problems with cost benefit.	Quantitative impacts of spillover effects.
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TABLE 2 (Continued)

Author	Year of Publication	Approach	Source	Purpose	Relevance To:
					Low Moderate High
Small, Winston and Evans	1990	Macro	Brookings Institution	The services (a flow) provided by infrastructure should be financed by appropriate user charges. Doing so ensures greater economic efficiency in the provision and use of infrastructure services.	Low Moderate High
Wildenthal, Buffington & Merrinot	1994	Micro (cost benefit)	Transportation Research Record	Obtaining the benefit to cost ratio of a highway widening project.	Low Moderate High
Tatom	1993	Macro	Policy Studies Journal	Conceptual and methodological attack on the macro empirical work of Aschauer, Munnell et al.	Low Moderate High
Aggregate National Investment					X
Aggregate Regional/State Investment					X
Individual Project Appraisal					X
Ranking of Projects					X
Timing of Investment					X
Location Decisions					X
Financing Decisions					X
<b>Future Research Directions</b>					
Theoretical Issues	NA			Using a model with strong theoretical foundations: time trend & causality direction issues have to be explicitly modeled.	Inclusion of induced demand and other induced economic changes.
Empirical Issues	NA			[1] Test other macro work for direction of causality. [2] Effect of time savings on productivity and real wage.	Improved estimation procedures for certain parameters: value of time; speed; accident reduction valuation.
Data-Related Issues				[1] Calculation and apportioning of benefits from highway infrastructure use to individual user groups. [2] Cost of evaluating externality impacts.	[1] Evidence on crowding out. [2] First-differenced data.



*Research on the relationship between transportation-infrastructure investment and economic productivity is, generally, conducted at the level of projects or individual firms (micro) or the state, national, or regional level (macro). Both approaches have strengths and weaknesses; but neither has yet produced really strong conclusions about the magnitude of productivity effects from transportation investment. Future work should be focused on improving methods and making sure they produce information useful to stakeholders, planners, and decision-makers.*

**Figure 2.** *Research on transportation investment and economic development: Current status and future requirements.*

As effects become less direct and more diffuse, however, the simple links to a specific project become harder to trace. If capacity is expanded on a segment, it is easy to relate that capacity expansion to a speed change on that segment. It is difficult, however, to relate that speed change to a gain in productivity in the region. Conceptually, improvement in speed or reduction in congestion-induced delays will have a positive effect on productivity of firms in the region that depend on the transportation system. But the amount of the increase due to a particular project, or set of projects, or level of investment is difficult to estimate, and probably impossible using microeconomic techniques.

The strength of the statistical methods of macroanalysis is that all measurable effects may be captured. These methods compare national trends in economic activity (including productivity) with levels of total public-infrastructure investment, introducing other factors that are expected to affect productivity. The result is an assessment of the impact of investment on productivity. There is a weakness inherent in these broad statistical methods; the analysis shows relationships among different sets of data, but these relationships do not necessarily demonstrate causality. In other words, statis-

tical analysis can show how various data series are related to each other, but it may not tell the analyst why they are related or how to take advantage of the relationship. Most of the controversy about the usefulness of macroanalysis revolves around this point.

Microanalysis and macroanalysis methods have the same point of weakness: lack of a solid understanding of the mechanisms by which transportation investments influence structural changes in a developed economy, including the productivity impacts and related changes in long-term economic activity. Although some useful concepts about the ways in which transportation improvements affect productivity have been developed, the concepts have not been expressed in a quantitative form that is accurate, convincing, and clear. Ongoing research, however, shows promise of overcoming the weaknesses in existing methods.

#### **CURRENT WORK: MICROANALYSIS**

Two lines of recent research offer some potential for improving the microanalytical understanding of productivity

effects. First, case studies ignore the effects of a particular project and the level of investment; instead, the analyst attempts to understand and describe the effects of transportation on changes in distribution practices and, in turn, on the internal organizational structure and market orientation at individual firms or plants. Second, investigators have begun to extend the traditional transportation-oriented techniques of cost-benefit analysis to capture logistical effects, including some of those identified in the case studies.

### Case Studies

Case studies provide anecdotal evidence. To date they have been primarily qualitative and descriptive. Nonetheless, they provide information that is not available through more formal, quantitative methods. Most important, they show the character of the changes that companies have made in their operations as a consequence of transportation improvements. These changes include the now familiar effects on inventory costs that stem from just-in-time deliveries but also include a broader set of effects that form the broader goals of reduced cycle time. Studies, such as those by AASHTO (1), FHWA (4), and the American Trucking Associations (ATA) (5), show clearly that, from the perspective of freight movement, increases in reliability of delivery times are much more important than reductions in transit times. Anecdotal evidence also exists to show that service-oriented firms have similar gains from reliable access to labor pools (i.e., productivity is not just a result of freight and highways or railroad movements).

Case studies show that improved transportation often leads to changes in how firms structure themselves to meet customer needs. These changes often result in even greater sources of economic gains. Improved transportation can accomplish more than just enabling firms to engage existing physical plants and business processes at lower cost. Transportation improvements can create a "cascade" of productivity and organizational benefits that influence activities well beyond transportation and logistics.

Koley's Medical Supply, Inc., provides such an example (1). Koley's is the wholesale distributor for a coalition of hospitals in Omaha, Nebraska, and southwest Iowa that has converted to a stockless purchasing system. In the hospital industry, stockless purchasing goes further than just-in-time delivery by offering pick-and-pack operations in addition to frequent deliveries of medical products to hospitals. In the Omaha area, Koley's packs items in their proper units of issue and delivers them in bins several times a day to user departments in the hospitals. Koley's makes daily deliveries to the smaller hospitals in Iowa. Adequate transportation access makes such frequent deliveries efficient and reduces costs along the hospital materials supply chain, from the manufacturer to the patient. Completion of the Storz freeway improved Koley's access to its more distant customers in

Iowa. As shown in Figure 3, through streamlining operations, stockless purchasing reduces inventory storage and handling costs for the hospitals.

Transportation improvements can lead to new markets, new methods, changes in the technology used in a process, and even to innovation in technology to suit new processes. Gains in productivity stemming directly from scale increases and cost reductions in existing processes are hard enough to capture. These "second-round" effects are even more difficult to link back to a specific improvement or set of improvements.

Case studies also have shown that impacts on efficiency of firms are not limited to freight transportation. Improvements in passenger transportation (e.g., better commuting highways) have allowed firms to reach out to larger labor pools (or allowed workers to select more desirable housing). FHWA (6,7) discusses the full range of positive impacts of transportation improvements.

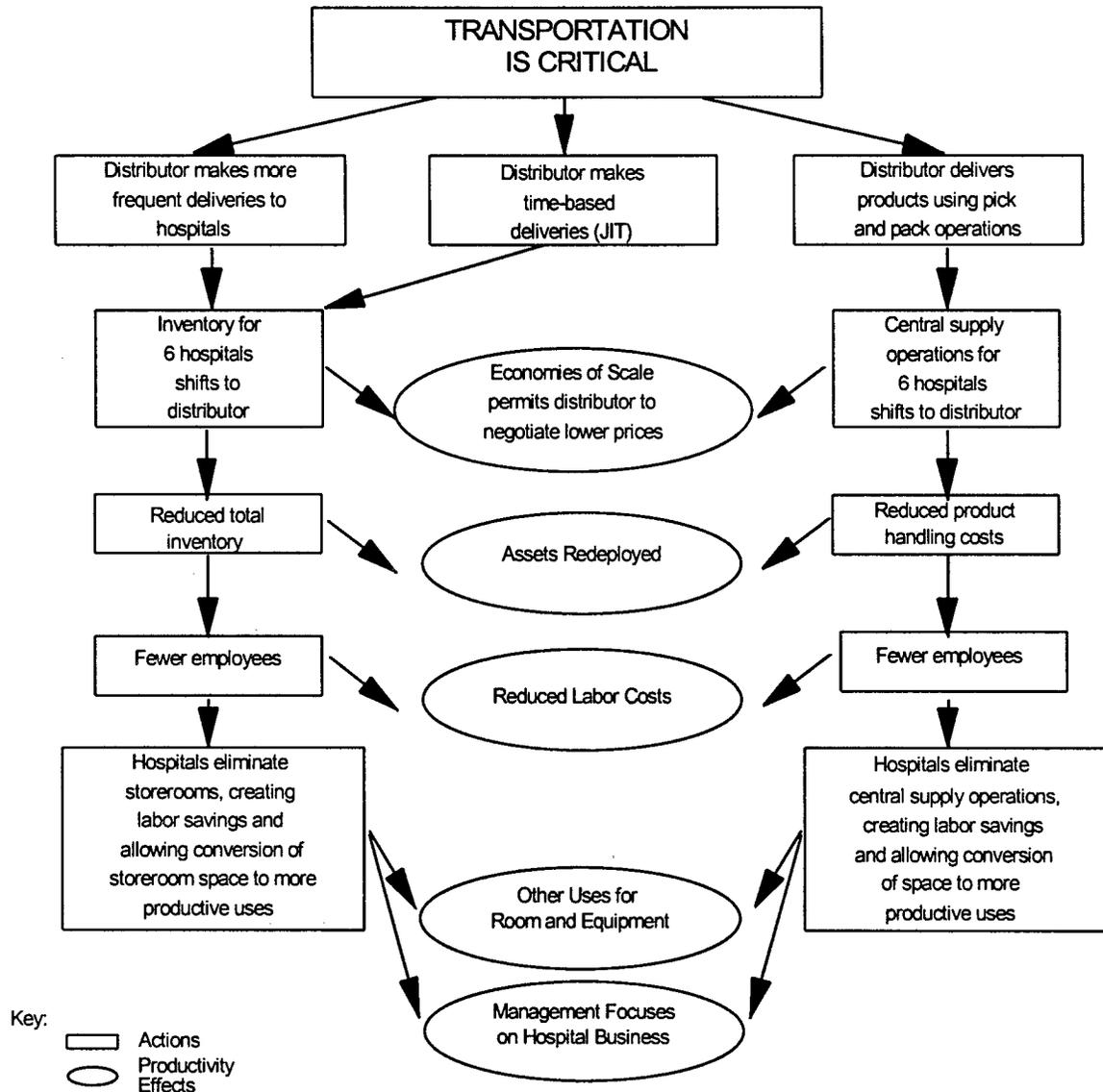
### Analysis of Logistics Gains

In reaction to the interest in productivity impacts, some investigators have tried to make logistics impacts an explicit element of cost-benefit analysis. Lewis (8) gave an up-to-date summary of cost-benefit analysis and its possible extension to logistics and productivity. Allen et al. (9) advanced the concept of using reduction in logistics costs instead of reduction in truck travel time. In effect, the reduction in variance in delivery times largely replaces absolute reduction in travel time. This appears to be a step in the right direction, but it still leaves unresolved the issue of how to estimate logistics gains, especially the second-round effects from changes in process.

Research on more general problems with cost-benefit analysis could also be relevant, although it is not focused directly on estimating economic productivity. For example, analyzing single projects separately could give misleading results if several projects are done in the same region or network. The outcome for several projects together will likely differ from the sum of the outcomes for each project analyzed individually. Each improved part of the network will have some effect on the volume of use, congestion, and so forth on the other improved links. Analysis of the economic effects of improving any single link in a network is not complete without some consideration of the impact of that improvement on the rest of the network.

### CURRENT WORK: MACROANALYSIS

In recent years, a number of economists (mostly with little or no formal training in transportation economics or planning) have employed statistical analysis of national data to estimate the effects of public sector infrastructure on productivity. Although there has been considerable debate about which is the best econometric technique to use, in general, the approach



Source: Transportation: Key to a Better Future, The Relationship of Transportation Investments to Economic Growth, AASHTO, 1990.

Figure 3. Productivity gains for hospitals using stockless purchasing.

has been to incorporate transportation (or public works) into one of the proven techniques used to describe the economy as a whole. Traditional macroeconomic analysis has lumped transportation and infrastructure under government spending as a whole, assuming there were no special impacts.

Some of the earlier studies, such as Munnell (10), adapted traditional economywide production functions as the basis for analysis; more recent work has used cost functions (11). Proponents of cost functions maintain that while the data requirements are more severe than that needed by the single-equation production function, their equations more closely capture the real-world behavior of firms seeking to minimize costs as the relative prices of inputs, including transportation, change. Cost functions also may be easier to adapt to industry-

level detail, even though the meaning of their outputs is less intuitively obvious.

The technical differences between these approaches are, however, of limited interest to nonspecialists. What is of interest is the striking difference between the findings of Munnell and the critics. Munnell finds a strong, positive effect of public investment on private sector productivity. Some critics, however, find the effect to be statistically insignificant or negative. Other critics find that although the impacts are statistically significant, the order of magnitude is much closer to that implied by more traditional analytical techniques.

The argument reflects one of the basic difficulties with statistical analysis—uncertainty about the presence of causality or its direction. Some critics argue, for example, that the true

causality may be the reverse of what Munnell has suggested, which is that the decline in productivity in the private sector led to a decreasing demand for public investment in infrastructure. Others have suggested that there may be no causality at all, but rather, that the period examined by Munnell was one in which private productivity and public investment were both declining, but independently of one another. Munnell, of course, has not failed to defend her conclusions. It is beyond the research team's ability in this report to offer an opinion about which side of the debate has the stronger case.

The debate, however, does exist. Practitioners are using aggregate, statistical analysis of productivity effects and finding divergent results. This does not mean that this line of research is not worth pursuing. It does illustrate a weakness of this approach, which is the difficulty of adapting general, economywide models to more everyday decisions. A related weakness is that, to a large extent, the technical issues are comprehensible only to specialists. In part, the inapplicability of past macroanalysis to decisionmakers' needs arises from the different goals of academic economists, whose primary interest has been strict research, not the creation of decision tools. Current work by Nadiri for FHWA offers one attempt to combine this research orientation with the more practical objectives of a transportation decisionmaker (11).

Single-equation statistical analysis could be quite useful for national decisions on aggregate investment levels and could also be useful to states in the same way. At the regional or project level, however, its usefulness as a stand-alone approach disappears. Its strength is that it allows an attempt at quantitative estimates of effects on productivity without having precise knowledge of the causal links between transportation improvement projects and the decisions made by the managers of affected firms.

## OTHER APPROACHES

Some other methods, typically employed at the regional level, are input-output analysis and simulation models. Neither, however, is of any great help to understanding productivity effects of transportation improvements. The typical input-output model is based on fixed assumptions about how firms operate (or did operate because collecting and compiling data creates a lag of 5 to 10 years). Because those assumptions cannot change as the analysis is conducted, such a model provides limited information about effects on productivity. Some more advanced input-output models incorporate changes in inputs as relative prices change; but this approach is still based on fixed assumptions about future technology and the changes in the processes used by firms.

Transportation simulation models have been employed to forecast regional economic impacts of alternate investment decisions. These models have often attempted to model the interactions among transportation, economic activity, and land use. But such models require assumptions about pro-

ductivity effects as input too. Models alone cannot add to the understanding of transportation's impact on productivity.

## CONCLUSIONS

The last decade of research on the interactions between transportation and the economy, in general, and productivity, in particular, has yielded new insights. With few exceptions, the techniques that provide most of these new insights have yet to be adapted to everyday use. These failures are possibly attributable to two reasons: (1) the difficulty of analytically incorporating nonlinear effects into a set of planning methods that rely on assumptions of linearity and (2) research has been conducted outside the paradigm used by most transportation planners and economists (see Figure 2).

From an analytical point of view, it makes sense to persist with efforts to incorporate productivity effects as an explicit component of cost-benefit analysis of individual projects or sets of projects. It is also worthwhile to press ahead with efforts to improve the ability of cost-benefit analysis to deal with sets of project network effects. It also makes sense to keep improving the methods for aggregate, statistical analysis, particularly if they can be integrated into the more practical problems of transportation planning and decisions.

These research efforts are likely to be worthwhile, even if they fail to significantly enhance the power of formal analytical techniques, such as cost-benefit analysis or the statistical methods. The process of trying to improve these techniques, will reveal more about the links between transportation improvements and productivity enhancement. Through this research, ideas about major variants of existing techniques, or some altogether new approaches, may be developed.

It is possible, however, to exaggerate the importance of making any single technique answer all questions. Any approach that is developed will require thoughtful handling, and it is likely that ad hoc combinations of several techniques will result in the most satisfactory results.

Finally, there are important differences in the viewpoints of economists or other specialized analysts versus the viewpoints of public decisionmakers and other significant stakeholders. The goal of the analyst, which may or may not be achieved, is to find a theoretically rigorous and accurate method for estimating the effects of transportation investments. The decisionmaker or stakeholder has another requirement. Significant decisions about public investments are often controversial. Public officials and other proponents of a particular strategy have to be able to defend their choices in the open arena of political debate.

For this purpose, analytical methods have to be more than just rigorous and accurate; they should be clear and defensible. In public debate, the anecdotal evidence developed from case studies could have a far more powerful effect than any amount of econometric analysis. Analysis that is strong and convincing for specialists may turn out to be a weak argument in public debate.

TABLE 3 Evaluation of current research methodologies

<b>Approach</b>	<b>MICRO</b>			<b>MACRO</b>		
<b>Methodology</b>	Cost Benefit	Cost benefit with logistics	Case study	Aggregate productivity production function	Aggregate productivity cost function	Transportation/Land-use models
<b>Criteria</b>	<b>Representative example</b>					
	<i>Wildenthal, Buffington &amp; Memmott (1994)</i>	<i>Allen, Baumol, &amp; Forkenbrock (1994)</i>	<i>Apogee: Coca-Cola case study (1991)</i>	<i>Munnell (1990)</i>	<i>Nadiri (1994)</i>	<i>Liew and Liew (1980)</i>
<b>Technical Features</b>						
Ability to analyze productivity impacts						
Flexibility of application						
Economic reliability of methodology						
Ability to forecast						
Simplicity of data needs						
Reliability for quantitative analysis						
<b>User Features</b>						
Relevance to decision makers						
Ease of use by non-specialized staff (minimum training in analytical methods)						
Usefulness in decision making for policy making						
Relevance for analysis and decision making at national level						
Relevance for analysis and decision making at local level						
<b>Future Scope</b>						
Future scope for use as a policy or decision making tool						
Further research needed						
Need for more data collection						

High	Medium	Low	Not Applicable
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Table 3 summarizes the relative strengths and weaknesses of the reviewed methods and shows how researchers and decisionmakers will judge analytical methods by different criteria. Analytical specialists will always be concerned with the validity of a method and the relative ease with which it can be applied. In this report, validity of a method refers to scientific practice that is careful not to extrapolate beyond the strict assumptions of a theoretical or mathematical model. Application of a theory or model to a real-world situation, in which the initial conditions do not exactly duplicate the model's assumptions, is not strictly "valid." Life seldom mirrors theory exactly but decisionmakers often must apply the-

ory to real situations, knowing that the model does not perfectly match these conditions.

Besides clarity and defensibility, the nature of the information supplied is also important for public officials and other stakeholders. For example, an economist might be satisfied with knowing that a given set of investments would yield productivity gains of some amount for firms in a region. A decisionmaker would like to know what that means in terms of standard of living or employment. Expression of abstract economic findings in ways that have concrete and immediate meaning for nonspecialists is an important requirement as well as a difficult challenge.

## CHAPTER 4

# CONFERENCE PROCEEDINGS

On November 15–17, 1995, a conference was held in Reston, Virginia, to identify specific issues and challenges in relating transportation investment to economic development. The 2-day conference was designed to obtain input from representative stakeholders identified in Phase I of this project. The goal of the conference was to identify the stakeholders' information and research needs and the major gaps in current research on transportation investment and economic development.

The conference brought together a diverse group of select individuals with interests in transportation and economic development. Invitations were sent out to approximately 75 people from the stakeholder groups identified in Task 1; 38 attended. Participants came from a variety of locations across the United States and represented transportation agencies at all government levels, government agencies with primary functions other than transportation, various business sectors, and research institutions.

The first section of this chapter is an overview of the conference. The second section contains a more detailed description of the conference proceedings.

### CONFERENCE OUTLINE

This section describes the expert panel discussions, the purpose of conducting the workshop, the preparation of the conference, and the methodology employed in the meetings.

#### Purpose of the Conference

In Phase I of this project, the stakeholders and available analytical tools were identified. In Phase II, the research team sought to understand the stakeholders' needs and their potential applications for research on the link between transportation investment and economic development. The objective of the expert panels was to bring together representatives from the various stakeholder groups to discuss their needs for information and analysis. In the following phase, input from the panels guided recommendations for a new body of research.

The theme of the expert panel discussions was "Research on the relationship between economic development and transportation investment: What are the needs and applica-

tions and how can the research be made useful for stakeholders?" The expert panels were designed to generate open debates and discussions focusing on these key issues:

- Major strengths and weaknesses of current research methodologies,
- Ability of current research methods to meet stakeholder requirements,
- Additional information and research needs of stakeholders, and
- Application of research results.

#### Preparation of the Conference

When compiling the list of invitees, the research team solicited the input of the NCHRP Project 2-19 panel members. A briefing handbook was mailed to each invitee, and the consultants conducted a telephone interview with each person prior to the panel meeting in November. The handbook contained briefing material to prepare the participants for the expert panel discussions, including:

- Objective statement for the panel discussions,
- Educational material informing the participants of the current state of research,
- List of topics to be discussed,
- Final agenda for the meeting, and
- Travel and accommodation information.

Each member received a personalized invitation letter, along with the handbook. The letter highlighted the specific purpose of selecting that individual to attend the meeting and outlined the major areas of discussion to which the individual would be able to contribute.

The telephone interviews were conducted after the briefing handbooks were mailed out to further acquaint the members with the scope of the expert panel discussions and provide an opportunity for the consulting team members to become familiar with the participants. The interview also presented an opportunity for the panel members to clarify their individual roles in the panel meetings and any other matters pertaining to the meeting.

## Methodology Used in the Conference

The conference engaged the expert panel members and observers in two morning sessions, two afternoon sessions, and one evening session. The sessions gathered information from the participants using three primary methods:

- Breakout sessions,
- Expert panels, and
- Open discussions.

## Conference Schedule

*Location: Dulles Hilton Hotel, Reston, Virginia*

*Schedule:*

*Wednesday, November 15, 1995*

Arrival of Panel Members  
Informal Dinner Meeting

*Thursday, November 16, 1995*

Plenary Session  
Breakout Groups  
Lunch  
Breakout Group Reports  
Expert Panel One  
Open Discussion

*Friday, November 17, 1995*

Expert Panel Two  
Open Discussion  
Departure of Panel Members

## Breakout Sessions

Breakout sessions were used to facilitate small group discussions by individuals within a stakeholder group. The conference participants were divided into four breakout groups of 7 to 10 people and organized according to the following divisions:

- Group 1: Transportation decisionmakers and suppliers,
- Group 2: Researchers and academics,
- Group 3: Agencies and entities with community interests, and
- Group 4: Transportation users and private industry.

Each group was asked to develop a list of issues, needs, or problems that they face when considering decisions on transportation investment related to economic development. They met concurrently for 1½ hours on Thursday morning, November 16, and then rejoined the entire group after lunch, where a spokesperson from each group presented the findings.

## Expert Panels

Two expert panels comprised of about eight individuals convened to discuss the essential issues raised in the breakout sessions. The panels were held on Thursday afternoon, November 16, and Friday morning, November 17. The panel members represented a broad mix of perspectives that offered a great opportunity for interaction and divergent points of view. The consulting team and the NCHRP Project 2-19 panel members deemed this arrangement more effective than panels organized by stakeholder categories or by research “providers” versus “consumers.”

Panel One analyzed the issues raised in the breakout sessions, using a general framework to incorporate the concerns of all stakeholder groups. Panel Two evaluated the issues from the focus of the academic or researcher. The panel assessed whether the needs can be addressed by applying an existing methodology, adapting a current methodology, collecting additional data, or developing new approaches.

## Open Discussions

Following the evaluation by each expert panel, discussion was opened to the entire conference audience. Panel members addressed questions from the audience, provided further clarification, and prompted the entire group for ideas.

## CONFERENCE PROCEEDINGS

The following section includes the highlights of the meetings and summarizes the predominant research themes identified by the participants.

## Plenary Session

The conference opened with a short plenary session. Mr. Ronald McCready, TRB’s Senior Program Officer for NCHRP Project 2-19, provided a brief background on economic research efforts undertaken since the 1989 Workshop on Research Needs in Transportation and Economic Development [NCHRP Project 2-17(2)], held in New Orleans. He reaffirmed AASHTO Secretaries’ continuing interest in methodologies for linking transportation investment with economic development on the basis of statements they submitted at the AASHTO Annual Meeting in November 1995.

Dr. Richard Mudge, President of Apogee Research and Principal Investigator for the project, observed that existing economic tools are not being used to any considerable degree and emphasized the importance of developing methodologies that are rigorous, technically sound, applicable, and understandable to nonspecialists.

The plenary program concluded with a presentation from Dr. Susan Binder, Division Administrator for the Maryland

office of FHWA. Dr. Binder gave an overview of the recent related research and a summary of the strengths and weaknesses of current methodologies. Dr. Binder also suggested issues that have not been addressed sufficiently in the research. Many of these issues were subsequently considered in the breakout and expert panel sessions.

The definitional issues included the need to:

- Broaden the concept of infrastructure to include more than highways, and
- Redefine the ultimate user as the one who receives the goods.

The conceptual issues included the need to:

- Recognize that quality of life issues, both perceived and real, influence labor markets, particularly, location decisions;
- Isolate commercial demand characteristics to appreciate the role of freight movements in economic development scenarios;
- Evaluate, through cost-benefit analysis, the integrated system rather than stand-alone projects and providing quantifiable measures of the trade-offs of decisions;
- Recognize that there may be different economic findings for public transportation policy appropriate for various levels of government; and
- Develop mechanisms to translate economic findings to practitioners, decisionmakers, the business community, and the public.

### Breakout Sessions

The assessment of the state of applied research, presented in the plenary session, established a common ground for the diverse groups of participants and served as an impetus for discussions in the four breakout group sessions that followed. The following key points were identified in each of these sessions:

- *Major gaps and issues in existing information.* This category includes points relating to terms, assumptions, methodologies, applications, and other aspects that research has not addressed sufficiently to date.
- *Key needs of transportation stakeholders.* This category refers to the desired features that stakeholders and decisionmakers would like to see in an economic impact methodology (i.e., what the methodology would look like, what it would do).
- *Obstacles to developing solutions.* This category covers perceived and actual obstacles to developing appropriate and useful methodologies or tools and may include institutional, informational, and methodological barriers.
- *Other.* This category includes any other comments that help define the issues and parameters of future research.

Each group identified features and parameters for desirable economic methodologies. There was repeated recognition that multiple tools are needed to address a range of conditions and that these tools need to be understood and respected by the public. There was also some discussion on definitional and conceptual issues that are important for advancing better communication as well as a better understanding of economic priorities among transportation stakeholders. Private industry issues were raised in each group with regard to their needs, costs incurred, and benefits received.

Following the breakout sessions, the entire group reconvened to present findings from each of their sessions to all conference participants. Comments from each breakout session are summarized below.

#### *Group 1: Transportation Decisionmakers and Suppliers*

For the most part, this group focused on large-scale, macro-oriented economic considerations. Participants included:

- Stephen Andrie, TCRP, TRB
- Susan Binder, FHWA
- George Boulineau, Georgia DOT
- Barry F. Driscoll, Vermont Agency of Transportation
- Mary Reichert, Maryland DOT
- Roger Schrantz, Wisconsin DOT
- Teresa Smith, FHWA
- Anne Strauss-Weider, A. Strauss-Weider, Inc., Westfield, NJ
- David G. Williams, Oregon DOT
- Ronald McCready, NCHRP, TRB
- Shaurav Sen, Apogee Research, Inc., Bethesda, MD

The major gaps that were identified included the need to:

- Produce economic analyses that expand their focus to highway systems, especially when considering the benefits to a community.
- Create new economic approaches and models that consider issues such as:
  - Changes in the economy that affect prioritization,
  - Changes in the planning climate,
  - Prioritization strategies, and
  - Consideration of freight movements.
- Consider the relationship between job location and mobility.

The key needs of transportation stakeholders included:

- Decision-making tools for prioritizing investments in transportation projects. This issue referred to evaluations of reinvestment in deteriorating systems versus investments in new systems, using economic rather than engineering criteria.

- A tool kit for economic methodologies, including a generalized framework as well as a guide for understanding the applications and limitations of various models.

### *Group 2: Researchers and Technicians*

Interestingly, the concerns identified by this group concentrated on the key needs of transportation stakeholders. The group also offered some insight into barriers to implementation or research. Participants included:

- David Aschauer, Bates College, Lewiston, ME
- Kazem Attaran, CALTRANS
- Michael Bell, Institute for Policy Studies, Johns Hopkins University
- Jake Jacoby, FHWA Research, U.S.DOT Office of Policy Development
- Amy O'Leary, VA Transportation Research Council
- Kenneth Opiela, NCHRP, TRB
- Ben Orsbon, Planning and Data Analysis, South Dakota DOT
- Mary Lynn Tischer, Policy Office, Virginia DOT
- Martin Weiss, Office of Planning, FHWA, U.S.DOT
- Hal Worrall, Orange County Toll Authority, California
- David Albright, Apogee Research, Inc.
- Richard Mudge, Apogee Research, Inc.

Group 2 identified one major gap: The need to establish a broader base of acceptance for common economic terms (e.g., productivity, economic development).

The key needs included:

- New economic methodologies that are responsive to the quick turnaround time needed by decisionmakers;
- Measurement of benefits that identifies not only what will be measured but also who will benefit; and
- Economic methodologies to assist in decisions related to:
  - Investing in projects versus programs, and
  - Analyzing the costs and benefits of intermodal projects.

Two obstacles were identified:

- Political factors that overshadow the weight of economic analysis, and
- The need to understand how to increase the use of current economic tools.

### *Group 3: Agencies and Entities with Community Interests*

The individuals in this group summarized the nature of their research gaps as broadening existing themes. Participants included:

- Scott Bernstein, Center for Neighborhood Tech, Chicago
- Jill Claybour, Community Development Agency, St. Louis, MO
- Ed Hall, Bureau of Indian Affairs, Washington, DC
- Robert Kochinowski, Pennsylvania Regional Planning Commission, Pittsburgh Metropolitan Planning Organization (MPO)
- Shawn Pensoneau, Navajo Nation, Washington, DC
- Sherry Roanhorse, Navajo Nation
- Louis Schmitt, Phoenix MPO
- Bill Schreiber, Office of Intergovernmental Policy, Minnesota DOT
- Anne Stubbs, CONEG, Washington, DC
- Steve Wilke, Bureau of Indian Affairs
- Barbara Barnow, Greenhorne & O'Mara, Greenbelt, MD
- Lowell Jackson, Greenhorne & O'Mara

Group 3 identified four major gaps, including the need to

- Understand the diverse frameworks of analysis that weigh economic impacts differently, for example,
  - Officials versus community,
  - Public good versus profit,
  - Urban versus rural, and
  - Short-term versus long-term returns.
- Expand terminology to enhance communication effectiveness. For example,
  - Shifting the emphasis from the facility to the user, where the user refers to voters or tax and bond supporters for transportation investments; and
  - Improving cost-benefit models that measure job creation only in terms of project-specific construction jobs.
- Modify economic analytical tools that fall short of capturing nontangible (quality of life) concepts. The term "life extension investments" was used to reflect those nontangibles.
- Develop models that identify and adjust for the social costs of an investment.

The key needs included:

- Models that are credible and accepted by the public by including quality of life measures/factors and by recognizing that these vary under different scenarios,
- Multiple tools for use in different scenarios,
- Recognition that the type of outcome wanted in a community depends on the stakeholders,
- Methodologies that not only accommodate DOT decisionmakers but also address community needs for credibility in economic tools, and
- Models that reflect asking decisionmakers and users what they need to know and why existing models are insufficient.

#### *Group 4: Transportation Users and Private Industry*

Many of the topics raised in this session dealt with the transportation of goods. Participants included:

- Ray Chamberlain, American Trucking Associations, Alexandria, VA
- Larry Duff, Walmart, Inc., Bentonville, AR
- Robert Gallamore, Union Pacific Railroad, Omaha, NE
- Gary Giddings, Business Logistics, Pennsylvania State University
- Steve Lockwood, PB Farradyne, Inc., Rockville, MD
- Roland Ouelette, Strategic Business Services, Waterford, VA
- Ed Settle, Manugistics, Inc., Atlanta
- Signe Furlong, Apogee Research, Inc.
- Porter Wheeler, Apogee Research, Inc.

Group 4 identified two major gaps, including the need to

- Adopt a whole system approach rather than a modal investment approach, and
- Incorporate multiple value items (e.g., safety, productivity, and efficiency) in economic assessments by recognizing the costs related to standards and protocols that vary by location.

The group identified these key needs:

- Prioritizing projects, such as intermodal connectors, that directly support private industry along with the more traditional projects; and
- Producing tools to educate the public on logistical decision making.

#### **Expert Panels and Open Discussions**

Two expert panel sessions were held to further evaluate the issues identified in the four breakout groups. Following each panel discussion, the floor was opened to the entire group for comments and questions.

##### *Expert Panel One*

Panel One was charged with summarizing the issues previously raised in the breakout sessions. The panel consisted of eight individuals representing various stakeholder groups:

- Stephen Andrle, TCRP, TRB
- Scott Bernstein, Center for Neighborhood Tech
- Susan Binder, FHWA
- Ray Chamberlain, American Trucking Associations

- Gary Giddings, Business Logistics, Pennsylvania State University
- Bob Kochinowski, Pennsylvania Regional Planning Commission, Pittsburgh MPO
- Ed Settle, Manugistics, Inc., Atlanta
- David Williams, Oregon DOT

*Framework for analysis.* The panel expressed solid interest in the importance of a “framework for analysis” as a reference for any economic analysis in order to establish a specific context for connecting economic objectives with transportation investment.

The panel reintroduced what some consider to be a basic tenet regarding economic analysis methods: there needs to be a select framework associated with analysis to generate information that reasonably reflects the needs and expectations of the “actors” or stakeholders. Specifically, this framework must address questions such as:

- Who are the actors representing?
- What are the goals?
- What are the performance standards?
- What are the bottom-line expectations?
- What are the perceptions of the decisionmakers?

Two perspectives on this framework were offered. Some individuals proposed that the framework needs to incorporate jurisdiction-specific goals of government agencies, namely national, regional, state, and local priorities for economic growth. On the other hand, other individuals noted the value in producing a generalized framework for analysis.

*Importance of perceptions.* The panel noted that particular attention should be focused on the need for dealing with perceptions as well as realities. One member cited the case in which current economic indicators suggest a strong economy, while much of the general public is experiencing poor economic conditions. Ideally, this framework will create a context for considering the broader implications that transportation has on quality of life.

The panel members discussed the need to assess the perception of different audiences to identify what information stakeholders need and use, specifically in the areas of definitional issues, sets of ideas about basic research, and process issues related to institutional acceptance and adoption.

As part of the discussion on the need to quantify other qualitative values, including quality of life variables, the example was cited that mobility is one of the conventional measures in economic analysis, but there is a need to quantify accessibility and proximity to economic opportunities as well. Conversely, there is a need to consider the cost of sprawl, land use, water, and transportation in relation to the delivery of services.

*Broad program evaluation.* Panelists identified the importance of expanding the concept of a framework to a program rather than a project level exercise.

*Expansion of focus beyond infrastructure.* The panel members reiterated that investments should not refer only to infrastructure (e.g., capacity expansion) but also to operations, maintenance, and other transportation actions. A variation on this theme was raised: Is it a paradigm that increasing capacity improves either economic development opportunities or productivity?

*State-level needs.* The panel members identified three needs from the state-level perspective: (1) methods for determining the necessary size of transportation funds and how to invest them; (2) methods for determining trade-offs between quality of life factors and productivity, especially in urban areas; and (3) methods for determining the sharing of risks and benefits in public-private partnerships.

*Use of case studies.* Addressing the issue that existing economic tools are not being used, the panel members suggested the use of anecdotes to demonstrate the usefulness of economic analysis. Case studies would provide a basis for generalities that could guide the development of rules of thumb.

*Public-private partnerships.* The panel members agreed that public-private partnerships are an important component of future policy and financing strategies and that research would be helpful to address the distinct issues of costs and benefits for the private and public sectors.

*Social impacts.* Another recurring theme was the need to represent social impacts or externalities, including an expanded definition of costs, benefits, and social costs. The panel members expressed the need to identify these variables and recognized that these factors would vary, depending on individual community values. The aspect of measuring the social impacts was generally endorsed in relative or comparative terms rather than absolute values, so decisionmakers can work with a range or magnitude.

*Features for economic models.* In addition to the research topics that were generated, the panel members suggested several desirable features of economic models, including:

- Clarity in terminology;
- Straightforward application procedures so that nonspecialists can employ tools;
- An effort to communicate economic principles and outcomes to a broad-based audience; and
- Representation of economic costs and benefits over time.

#### *Expert Panel Two*

This panel focused on developing a research framework to address the issues identified earlier. Panelists included:

- David Aschauer, Bates College
- Kazem Attaran, CALTRANS
- Larry Duff, Walmart, Inc.
- Robert Gallamore, Union Pacific Railroad
- Charles Hulten, University of Maryland
- Jake Jacoby, FHWA Research
- Louis Schmitt, Phoenix MPO
- Kenneth Opiela, NCHRP, TRB
- Ben Orsbon, South Dakota DOT
- Roger Schrantz, Wisconsin DOT

Each panel member had an opportunity to select items for a research agenda. The items covered the following research areas:

- Desirable features of economic methodologies,
- Framework for analysis of issues, and
- Research to support the development of methodologies.

*Desirable features of economic methodologies.* Three aspects of a desirable economic methodology include:

- A methodology must consider the distinction between different kinds of highway projects and investments. The effects of different kinds of improvements—physical, traffic system management, and enhancements—and their scales could affect the methodology.
- A methodology must recognize differences in the various sectors of the economy—not only in relation to elasticity and other measures but also to geographic differences that reflect the quantity and quality of the infrastructure and ultimately its effect on private sector freight requirements.
- A methodology must have latitude in understanding that transportation investments are not limited to physical solutions but also include legislative changes, for example, that could produce greater economic benefit than investments in infrastructure.

The panel members identified deficiencies in existing economic tools. Other comments about the tools included:

- There is a need for simplistic tools that compensate for the lack of available detailed data.
- A methodology cannot produce a single value estimate if it is sensitive to geographic and industrial sector differences. It is important to define “ranges of effect.”
- It is important to consider simultaneous uncertainty.

The panelists discussed research approaches, emphasizing the need for a specific focus on transportation and its effects on economic development and productivity. A panelist proposed basic research (macro-micro) related to existing analytical tools, such as productivity functions, cost functions, and requirements to input-output models, but isolating transportation.

Decisionmakers need to be able to calibrate the methodology with a range of values and an error factor in the estimation of costs and benefits of investment, such as jobs created and earnings. The importance of representing a time stream for the arrival of benefits was also identified.

The panelists referred to the deficiencies in existing methodologies several times. One panelist introduced the concept of mesoeconomics, a middle ground between microeconomics and macroeconomics. Discussion followed on the economic principles that give rise to location choices, including location theory and central place theory.

Discussion of economic methodologies covered traditional approaches for linking cost-benefit analyses with macro approaches and cost function analyses with micro approaches. The panelists identified trends that are challenging the traditional approaches, including shifts away from static analyses to dynamic orientations that rely on a broader growth framework (i.e., long-term effects). Shifts from cost function analysis to production function at higher levels of disaggregation are occurring, with the interest supporting representations of externalities and the effectiveness of an entire network operation.

One suggestion was to simulate a model using equilibrium analysis, which raised the problem of such methodologies relying on significant amounts of data on network costing to test variations. The panelists identified other concerns related to data collection, such as a tendency to overspecify the type of data that is necessary.

The panel raised the concern that the current analytical approaches are historically based and do not address new technology, such as intelligent transportation systems (ITS). Individuals who noted that the transportation picture is changing, both in terms of supply and demand, reiterated this point.

Some members wanted to see more emphasis on methods for investing in projects, particularly private facilities (e.g., railroads). For example, there was interest in seeing expenditure levels for maintenance as part of the equation. The panelists noted the importance of calculating benefits in public-private partnerships and determining risk-sharing features.

Other panelists noted the importance of truck safety statistics and the fact that more methods are needed to measure the role of transportation in urban labor market efficiency.

*Framework for analysis of issues.* The panel discussed the importance of establishing a framework for analysis to (1) represent the diverse values, perceptions, and goals of the individuals impacted by investment decisions and (2) identify the common elements among the various groups.

The development of a generalized framework was supported by many of the panelists. Such a framework would include a discussion of where the research was done, an assessment of the effectiveness of economic tools, and a perspective on freight versus passenger issues.

Fundamental questions for decisionmakers using economic tools include the following:

- Will the results be used to promote a project or prioritize a list of projects?
- Will the tool be used with existing projects to establish benchmarks for future projects, or will it be used to evaluate new projects?
- What is the turnaround time needed to produce an economic analysis?
- Is a massive database necessary to produce such an analysis, or are indicators sufficient?

Various types of information that would assist the private sector in making investment decisions indicated include:

- A vision of transportation in the future, including types of vehicles and types of freight;
- Growth projections based on volumes;
- Prospects for national standards for freight requirements; and
- Analysis of safety statistics by region.

A diagram was presented that linked the influences, or factors, that need to be represented in any basic economic tool and their relationship to one another. This schematic was driven by land use, and included transportation, air quality, highway improvements, and economic evaluations coupled with priority lists.

*Research to support the development of methodologies.* Two research topics were discussed:

- Issue studies dealing with, for example, congestion, truck-only routes, intermodal and freight issues; and
- Project level studies concerned with determining the economic impacts of specific projects.

One panelist suggested that cost-benefit analysis be promoted for adoption in the next reauthorization bill. With tribal roads, such an analysis needs to incorporate more than the traditional measures of costs and benefits, with consideration to the relationship of Native American communities to the cities and counties around them.

The panelists discussed reauthorization, raising two points: the relationship of economic value to the over 30 associations that receive funding from the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the inclusion of economic contribution and benefits in the allocation formula.

Members called for compatible standards between highway and railroad interests, particularly for equipment identification. Also, concerning railroads, the panelists identified the need for more information on at-grade crossing devices to improve traffic management strategies.

## **SUMMARY**

The 2-day conference provided a unique opportunity for stakeholders to express their opinions on the use of current research methodologies and provide valuable insights on

developing a research agenda that will meet the practical needs of transportation practitioners in the future. The participants discussed a wide range of topics, from the economics of evaluating individual projects and multibillion dollar programs to the analysis of intangible issues, such as quality of life and community impacts of transportation projects. The participants identified a number of gaps in information and existing research that will serve as valuable input for developing a cost-effective, multifaceted research agenda to meet the needs of stakeholders. Chapter 5 summarizes the key information gaps identified by the conference participants.

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## CHAPTER 5

### INFORMATION GAPS

This chapter summarizes the gaps identified by the conference participants in information available to decision-makers and stakeholders necessary to making appropriate investment determinations. The participants were concerned about the availability and application of appropriate evaluation methods as well as the ability to incorporate such methods into the planning process. The latter represents primarily a process issue (i.e., how to encourage and implement the use of techniques that are currently available and incorporate existing data). The former concern focuses on the applicability of existing techniques and data to the needs of the stakeholders. This chapter summarizes various aspects of this debate, categorized by broad issue areas, including:

- Individual project evaluation;
- Large, multibillion dollar project evaluation;
- Overall program evaluation;
- Identification and measurement of nonquantified effects; and
- Evaluation of multimodal facilities.

The issues and recommendations identified in each area are not exclusive of those found in other areas. Measurement issues related to small projects might be common to those of large projects; incorporation of intangible effects might prove equally difficult with different methodologies and project sizes. Therefore, these categories should be evaluated together in the development and incorporation of empirical methods in the public investment decision process. The old adage that the whole is greater than the sum of its parts is particularly applicable here.

#### INDIVIDUAL PROJECT EVALUATION

Individual project evaluation is probably the most common type of analysis performed prior to making transportation, or virtually any public works, investment decision. The detail and scope of the analysis will depend on the level of investment being considered and, most important, the amount of time and resources available to perform the analysis. The participants expressed concern regarding the potential barriers to the use of evaluation techniques, particularly the availability of necessary data. The burden of collecting additional

data above that already required by federal and local authorities may be prohibitive. Thus, if appropriate data are not available, what limits does this impose on the application and reliability of selected analytical tools?

The most common and generally accepted technique for individual project analysis is cost-benefit analysis. Other techniques, however, may be considered as well, depending on the project size and available resources, to perform the study. These techniques include input-output based techniques and regional simulation models. The following questions represent the information gaps related to these approaches:

- Which is the appropriate metric for evaluating individual projects—net benefits, benefit-cost ratios, economic growth, or productivity? If all aspects are important, is there a single methodology that evaluates these measures?
- What are typical long- and short-range benefits and costs that need to be considered during the evaluation of such projects?
- Are there standard or common guidelines regarding the time frame over which benefits are assumed to accrue?
- When are multisector input-output models or simulation models applicable for individual project analysis; for example, when should regional considerations be incorporated into the analysis?
- Are different techniques or methods applicable for evaluating investments that involve private sector facilities (e.g., railroads) where operating benefits may differ (e.g., freight car utilization) from typical public works projects? Is the information available for evaluating such projects better or more reliable than for public sector investments (e.g., rate of return of private capital)?
- Do examples exist that demonstrate the effectiveness of these evaluation tools in the decision-making process?
- Are retrospective evaluations of actual project outcomes useful for revealing inadequacies in current methodologies and for improving future studies?
- Can current methods be adapted to the evaluation of multiple projects within a particular mode or across multiple modes?
- Can current methods be standardized to some degree, with regard to both methodology and data input requirements, and made more accessible to the nontechnical user?

- Can these methods incorporate regulatory compliance factors, such as ISTEA traffic congestion mitigation, air quality, and various safety objectives?

Other issues considered in the selection and use of empirical methods to evaluate investment options include:

- Development of a standard set of transportation-related costs and benefits considered common to all such investment decisions;
- Capability to account for social impacts;
- Allowance for multimodal investment decisions;
- Ability to evaluate comprehensive long-term, system-wide economic impacts; and
- Analysis directed toward ISTEA's 15 considerations.

### **LARGE, MULTIBILLION DOLLAR PROJECT EVALUATION**

Large, multibillion dollar projects are likely to involve considerations that differ from smaller projects. For example, large projects may have effects on the economy that can reasonably be ignored under small project evaluations. These effects can include longer-term direct effects of the project while under construction as well as greater development and growth potential once completed. Major projects could provide significant improvement and expansion to the transportation system, or network, resulting in effects beyond the local economy. These issues should be considered when determining the appropriate evaluation tool as well as the level and scale of analysis:

- Are the short- and long-term productivity and growth effects of major projects different from those of smaller projects in ways other than just project scale? For example, are system capacity and network effects more important for large-scale projects? Are there any guidelines that suggest local versus regional level of analysis?
- Are some evaluation tools more appropriate for large versus small public investment decisions? Are the data requirements different as well?
- Are case studies available that indicate structural realignment of the economy has occurred, with its consequent impact on productivity and growth? If so, how can this information be incorporated into an overall economic analysis?
- Different transportation projects generate different transportation activities that may have varying effects on the local/regional economy. Do available techniques account for these differences?
- Can current methods be improved by incorporating more reliable measures of safety, economic productivity, and mobility?

Other research ideas and questions include:

- Distinguish between appropriate macro or micro methodology.
- How does one evaluate network impacts of large projects?
- What is the relationship between project accessibility and economic growth?
- Evaluation methods should distinguish between comprehensive impacts and system-based impacts.
- Do extra steps need to be considered given the higher level of risk of large projects?

### **OVERALL PROGRAM EVALUATION**

While individual project evaluation remains the predominant approach to evaluating investment decisions, increasing interest has been focused on the ability to evaluate investment in overall programs, such as transportation, water, and waste generation and disposal. Such an approach becomes more critical as state and local governments must rely less on federal assistance in these areas and become more knowledgeable in the allocation of program funds across various alternatives.

Related to the ability to evaluate program performance is the decision to invest in new capacity versus maintenance of the existing system. To make these decisions, appropriate data are required. The following issue areas address these concerns:

- Are there methodologies for establishing state highway preservation and maintenance programs?
- A review of state-of-the-art methodologies may be useful information in today's political climate with special emphasis on reviewing pavement durability, optimum investment cycles, etc.
- Further research on the impact of major rehabilitation/replacement of facilities versus regular maintenance is required.
- What are the effects of facility closures or limited access while maintenance and rehabilitation takes place on businesses? For example, do businesses relocate due to such inconveniences, or do they otherwise change the way they do business?
- What methods are available to evaluate the impact of national regulations or standards on individual means of transportation and for the transportation system as a whole? For example, what is the impact of national truck size and weight standards not only on the trucking industry, but also on railroads, the environment (air quality), urban congestion, etc., all of which are targets of other federal programs?
- Are there tools available to assist states in developing long-term development, or investment, planning

programs? How have the economies of states that have implemented such tools fared?

- Can the results of individual project analyses be aggregated into an overall project evaluation; that is, under what circumstances is it appropriate to aggregate results across individual project analyses?

### **IDENTIFICATION AND MEASUREMENT OF PREVIOUSLY NONQUANTIFIED EFFECTS**

Considerable interest is now being given to the capabilities of empirical methodologies to incorporate and measure impacts of public investment that have not traditionally been measured. These include environmental effects as well as general health and welfare effects. Many of the questions revolved around the ability of current techniques to capture these effects or the prospects for the development of such measurement techniques. The conference attendees suggested that a manual be prepared that identifies all relevant nonquantifiable and external impacts (whether considered benefits or costs), categorized by type of effect (e.g., safety and productivity, which are not necessarily mutually exclusive). The manual should also provide potential ways of measuring these effects or noting those that cannot yet be reasonably measured. General questions raised included the following:

- What methods are available for the identification of these nonquantified effects and are general levels of magnitude available from existing analyses?
- How does one balance these effects against the traditional measurable effects?
- How can the effects of projects on community cohesion (and similar socioeconomic variables) be estimated and measured?
- How should community effects (if measurable) affect project selection in combination with other economic considerations?
- In evaluating the magnitude of such effects, what is the causal relationship between the nonquantified, or external, effect and the investment decision?
- What methods exist for determining the relative magnitude of these external effects, focusing only on the most important ones?
- Which of these effects can be measured and forecast now, and which ones might be possible to develop in the future?

### **EVALUATION OF MULTIMODAL FACILITIES**

Consistent with efforts to evaluate transportation investments in the context of the overall system is an interest in evaluating multimodal effects of transportation investments. Transportation systems have long been designed to make the best use of alternative modes of travel for transporting goods

and services. The methods to evaluate such interactions have not kept pace, however, with the expansion of the various modes. In addition, institutional arrangements may have relegated multimodal considerations to a secondary level. This is changing as there are current demands for methods to incorporate multimodal effects into the investment decision process. The following issues were identified:

- There is a need for explicit goals and standard evaluation methodologies and data for multimodal and cross-modal facilities. For example, evaluation of road-rail grade crossing exposure versus other road safety hazards currently tends to fall through the cracks. Evaluation methods need to incorporate such effects.
- How can the economic productivity/growth effects of, say, highways and transit be translated into the same metric for comparison?
- There is a need to educate the public and decisionmakers on the “system effect” in cross-modal comparisons.

### **VALUATION MEASURES AND DEFINITIONAL ISSUES**

As mentioned earlier, a key issue in the evaluation of public investment is the determination of the project, as well as program, goals. Establishment of appropriate and realistic goals helps determine the relevant evaluation criteria. These criteria can, in turn, provide assistance in the selection of evaluation technique. To assist decisionmakers in this area, the participants suggested that common terminology be developed that (1) is accessible to a broad audience and (2) reflects the common goals of the investment policy. Other issues included the following:

- Define the concepts of economic growth, productivity, and development, and determine how they relate to each other and may reflect similar or different program goals. The concepts should be defined in easy-to-understand terms for those in business and household communities.
- Measures of program performance should be developed for each transportation mode as well as for the transportation system as a whole. Decisionmakers should consider whether the service may be more efficiently provided by the private sector, or whether it is truly a responsibility of the public sector.
- If traditional public services are considered for privatization, methodologies for risk analysis of public-private partnerships need to be identified.

### **RURAL AND TRIBAL COMMUNITIES**

Transportation investment and planning decisions tend to overlook the need of the rural and tribal communities to be

linked to the overall transportation system. The needs of these communities should not be lost in the drive to indicate large economic gains from investment decisions. In fact, the social and equity concerns are important when evaluating the effects of investments in these areas, as well as safety and health issues. Decisionmakers should

- Identify methods and approaches that consider general access and social equity in the analysis;
- Pay more attention to the effects of transportation investments in lower density areas. Research and analysis tends to focus primarily on higher density areas; and
- Identify the most important outcomes of the transportation system for these communities and determine how these outcomes differ from those in urban or higher density environments.

### **PUBLIC-PRIVATE PARTNERSHIPS**

Public-private partnerships represent a rapidly growing means of sharing cost and risk with the private sector. The partnerships provide a potentially lower cost means of providing traditional public services in a more efficient manner. State governments, however, are still learning how to evaluate when such an arrangement is beneficial and effective. Case studies of other jurisdictions' experience in this area could prove invaluable in preventing costly misadventures as well as reducing public concerns about the shift of some services to the private sector.

These arrangements place the local government in the position of the regulator and the promoter of the private sector. Because this is a relatively new area for local governments, several questions should be addressed:

- How should state funds be allocated between public-private partnerships and purely public endeavors?
- What can be said about the level of expected return necessary to attract private sector participation?
- How does one compare investment strategies at the corridor level?
- What methodologies are available for determining risk and benefit sharing between public and private partners?
- What metric(s) should be used to evaluate public-private partnerships individually and in comparison to one another?
- How should the public sector validate potential private partner claims of job creation from proposed partnerships?
- What does the local government want transportation to do and what is the best way to do it?
- Will data be limited due to their proprietary, firm-specific nature?

### **COMPLEMENTARY ACTIONS BY PUBLIC AND PRIVATE GROUPS**

While the public sector provides significant funding for capital expansion and improvements of the transportation system, the private sector is primarily responsible for the actual delivery of goods and services through the system. As a result, the needs of the private transportation sector should be considered in the evaluations of system investments.

- Current methods such as cost-benefit analysis should incorporate the needs of, for example, private freight haulers into the analysis, as they represent the primary link between the transportation system and delivery to the final market.
- The private sector component of the transportation system raises the issue of who should pay for what share of expenditures. Should shares be based on anticipated or realized economic benefits of projects? If so, can these benefits be estimated in a tractable manner?
- What level of involvement is appropriate for the public sector? Should the public sector limit itself to the provision of the basic infrastructure on public welfare grounds and leave the private sector the balance? How should responsibilities be distributed over different levels of government (i.e., among the federal, state, and local authorities)?
- Methods should be used to identify potential ways to anticipate and support private sector requirements and incorporate them into the project or program evaluation.
- What institutional/administrative/regulatory changes need to be made to speed up public evaluation, decision making, and implementation of low-cost/high-return traffic-operation related network improvements?
- There is a need to develop easier ways for private sector companies to relate to the MPO, statewide transportation improvement plan (STIP), and TIP processes.
- How do you estimate the level of public funds that should be tied up in private sector transportation enhancement (i.e., industrial policy)?
- Analysis should blend national and international private sector considerations with regional impacts and needs.
- How can public agencies gain a better understanding of the impacts on logistics costs related to transportation investments?

### **OTHER COMMENTS AND IDEAS**

The conference generated numerous ideas and suggestions for information that would be useful for decisionmakers in their evaluations of the effects of transportation investment on economic activity. The purpose of soliciting this input was to establish a research agenda that will respond to the needs considered most important. This section presents some of the broader issues not covered in the previous sections.

- When identifying where the need for information is the greatest, researchers should question appropriate public and private sector individuals.
- The goal of the project is development of a research agenda.
- Elements that are difficult to quantify, such as quality of life, may not need to be part of this research agenda, because other disciplines are working on them.
- Traditional urban transit and, to a lesser degree, highway investment were driven by supporting access to the central business district (CBD). As jobs and housing have spread to the suburbs and congestion has increased, the question of what impact this is having on labor market efficiency seems relevant even in the face of data suggesting average commute times remain relatively constant. Understanding of this issue at the state and MPO level is low; a synthesis report would be useful. Also, a look at performance measures that get at the heart of the evaluation or underemployment due to lack of access/mobility would be useful. Current “access to jobs” measures ignore the problem by only considering the geographic distribution of jobs, regardless of type, and people, regardless of income, education etc., across the urban area.
- The issue of truck safety statistics was addressed with regard to truck size and weight policy and the matching of vehicle, driver, and roadway.
- Improvements in truck productivity to be gained by the increase from 48- to 53-ft trailers raises another concern about accelerating the disinvestment cycle in central cities. It is impossible to adapt older areas en masse to accommodate such vehicles. Anyone who lives or works in such areas observes daily examples of delivery and shipment causing traffic problems and significant damage. For example, huge trucks enter primarily residential streets to service street-front commercial establishments. Similar situations arise where cities have developed around older warehouses or manufacturing plants. Trucks must now navigate their way through a tight urban maze to service these locations. Addressing this issue does not require going back to break-bulk, etc., but the disinvestment needs to be calculated and cannot legitimately be considered as an “intangible.”
- Is there a need to examine the way business travel time should be evaluated in the future? Will business travel-

ers continue to use their automobiles to conduct business while traveling (e.g., via car faxes, phones, and laptops)?

- Any analysis performed should be easily understood by nonspecialists. The lack of credibility will continue to dog public sector analyses whenever a proposed investment is controversial because there will be findings to suit all parties.
- The transportation sector needs a national standard and a national network to facilitate equipment identification. Standards should be common (inter-operable) across freight modes. The network should provide a clearinghouse for collection and use of identification data (e.g., states might benefit from standardization of toll tags).
- Analysis should make use of the developing ITS architecture to address intermodal needs, such as freight movement across modes and railroad crossing emergency HAZMAT response.
- Further research should be done on the relationship between transportation and economic activity (i.e., linking micro- and macroeconomic analysis).
- A central issue frequently ignored is the need to incorporate externalities in the analysis. Transportation investments are very complex. There is a need to assess which externalities are deemed important and can be measured in understandable and usable terms.
- Tools need to be developed to help with situations where assessments depend on variables with relative changes over time, rather than focusing on statistical accuracy.
- To the greatest extent possible, economic analysis must be intellectually honest and not be used to prove a pre-selected conclusion; analysis must be free of politics.
- The common factor across all economic analyses may not be methodology as is generally assumed, but rather standards of cost and benefit calculations and methods of calibrating qualitative, methods intangible factors.

This chapter has identified a list of information gaps and research needs that were generated during the 2-day workshop. The objective in the final phase of this project (Tasks 7 and 8) is to transform these issues into an organizing framework and develop a list of prioritized research project statements that will effectively meet the needs of transportation practitioners and decisionmakers.

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## CHAPTER 6

# RESEARCH AGENDA

The fundamental goal of this project was the development of a research agenda (comprised of several research project statements) designed to facilitate the understanding of the link between transportation investment and economic development. Chapters 1 through 5 of this report have described the steps that the research team took toward achieving this goal. From the beginning, the strategy for this project has been to encourage participation and input from a diverse group of stakeholders to better understand their needs for applied research on the relationship between transportation and productivity.

A key goal in developing this agenda is to identify research projects that can help answer very important questions that also have policy implications. The proposed projects described in this chapter can be completed at a relatively modest cost. This does not imply low cost, since over the past several years numerous reviews and syntheses of research have been completed, and the potential payoff from low-cost synthesis is limited. Rather, modest cost refers to cost in comparison with the importance of the answers for future investment and policy decisions related to transportation infrastructure.

Another primary objective of the research agenda is to build a comprehensive body of knowledge with regard to the linkages between transportation investment and economic development. This body of knowledge must recognize the variation across different geographic scales (urban, suburban, and regional) and different degrees of certainty that can be associated with each conclusion. Because one set of linkages may be more defensible than another does not imply that the less defensible ones are less important or that they should be ignored until complete evidence is available.

The objective of this chapter is to develop a research agenda that is not only tailored to meet the information requirements of the stakeholders who participated in the workshop, but also to build on the body of existing research and fill the critical gaps that currently exist in the literature. Throughout the workshop and the course of the project, many research ideas were introduced and discussed. After careful evaluation of all the potential research topics, the research team selected 15 specific research project statements that are designed to answer specific concerns and information gaps identified by the stakeholders. The strategy was to develop a concise and flexible research agenda that

would determine the likelihood that it can be extended and adapted so that it will provide practical help for transportation planners, in particular, and the broad range of stakeholders with an interest in transportation and economic activity.

It is beyond the scope of this project to develop different lists of projects for each stakeholder category. In Chapter 5, however, the research team summarized an extensive list of research questions and issues that were brought up during the workshop. Each of these ideas potentially can be developed into a research project statement tailored to meet the interests of specific stakeholder groups.

To convey the proposed research agenda, this chapter is organized into two parts. The first part is an overview of some broad categories of research needs that were identified by a cross section of the stakeholders. This section highlights a few key areas that future research should focus on to better understand the link between transportation and economic development. The latter segment of this chapter builds on the first part and identifies 15 specific research project statements that will serve to provide the necessary tools, methodologies, and outputs to better understand the link between transportation investment and economic development.

### OVERVIEW OF RESEARCH AREAS

As described in the earlier chapters, the 2-day conference produced a wealth of valuable input from a wide range of transportation stakeholders. In almost every session of the workshop, participants raised a significant number of research questions and needs, most of which were useful in developing the general framework of the research agenda. These questions included:

- What are the impacts of different types of transportation investments or services in different situations on urban economies and on other measures?
- What is the relative and absolute importance of different types of secondary impacts—environmental, economic, social, etc.?
- What return does society receive from money spent on transportation? What can be done to improve these returns?

- What are the impacts of different levels of investment? What types of tools and methods are available to compare different scales of investment?
- What information is needed so that decisions on highway and public transportation investments in urban areas can be made in accord with consistent criteria and consistent procedures for project evaluation?
- What are the impacts of public transportation on economic and social opportunities for the disadvantaged?

### **Need for Handbook or “Toolkit”**

The practitioners in the field expressed a strong desire for a practical guide to the techniques available for measuring economic development impacts. These needs ranged from getting definitions straight (in the practical, applied sense), to having a guide outlining what to measure, to looking for default parameters. The handbook should provide a framework for meeting the applications needs, laying out clearly the decision-support tools available. Handbook aspects and contents could include the following:

- Framework for assembling decision-support tools and information;
- Presentation of real, immediate products;
- General outline of techniques and an account of how each really works;
- Explanation of economic analysis tools and models;
- Description of when the tools should and should not be used;
- Limitations associated with analytical tools and models and other reliability issues;
- Default parameters for “quick” applications; and
- Retrospective on the identifiable linkage to economic activity.

### **Need for Basic Research**

Workshop participants developed and strongly endorsed a new conceptual approach: examining the “meso-level” aspects of economic development impacts. They expressed a need to push the search for and development of applications to the “middle ground,” somewhere between direct impacts of transport investment projects and broader outcomes, such as measuring quality of life. Participants all saw the need for measuring impacts on the meso level but were generally uncomfortable with current tools and models available to them. Topical secondary effects warranting investigation included the following:

- Examine how to enhance the understanding of the meso level,
- Build and refine the tools needed to estimate secondary impacts,

- Undertake new research to build understanding of tangible secondary and intangible impacts,
- Determine what controls are available or needed to translate the analytical findings into better improvement decisions,
- Outline how and when to bring other impacts to the table (e.g., land use impacts),
- Develop better models to predict air-quality impacts and implications for other state and local services, and
- Use results of basic research and develop next steps for practical applications at the meso level.

### **Importance of Communication**

The workshop discussions often turned to issues of communication. The relationship between transportation investment and economic development is not well understood by the public, at large, whereas the perceived benefits of other government programs can be quite high (e.g., education and healthcare). Participants expressed a need for assistance in understanding and framing opinions, among decisionmakers and the public. The following ideas for better communication were discussed by the participants:

- Communicate, educate, and translate—transportation planners need to do this better and more often;
- Identify the relevant audience—who planners and decisionmakers should communicate with;
- Determine through market research what type of information is desired;
- Determine the perceptions about the impact study findings and the preconceptions, if any, that need to be dealt with; and
- Perform outreach and identify established channels for disseminating impact findings.

### **Explore and Expand Private Sector Roles**

There was general agreement among participants that the role of the private sector, and its interaction with the traditional public sector’s leading role in infrastructure investments, required reexamination. In particular, two topical areas dominated the discussion: (1) sharing costs through private participation, and (2) identifying and possibly capturing private, commercial benefits associated with infrastructure investments.

Needs were identified for better, more detailed data about trip making and it enhanced understanding of the benefits associated with use of the infrastructure network. The dollar linkages between beneficiaries and payment schemes can enhance or distort the incentives to the private sector. Indeed, if incentives were reconfigured, then many complements and substitutes for capacity enhancements

may arise. For example, improved applications of ITS could result in enhanced capacity if proper pricing mechanisms could be established for peak-hour facility use. Special needs exist in freight and goods movement that are not well understood by current analysts or decisionmakers. Privatization aspects could include the following:

- Encourage private sector interaction with public decisionmakers;
- Privatization models and implementation issues—identify the most appropriate private sector roles and implementation structures;
- Identify private recipients of economic benefits (special needs in freight sector);
- Refine tools to help establish sharing of costs with private sector beneficiaries;
- Identify data needs and propose solutions; and
- Find new tools with which to create public-private partnerships, state infrastructure banks, etc., and to enlighten decisionmakers about the available innovative tools.

### Explore New Options for Dealing with Congestion and Sprawl

Workshop participants also discussed the subject of congestion and sprawl. To the extent that expansions will be limited in the future, for instance, if no new highway lanes will be added in certain areas or jurisdictions, then new, noncapacity methods for dealing with congestion and sprawl are the real issues.

Participants discussed the need to look carefully at the evaluation tools and new financing approaches toward building incentives, so facility and system users have information to make proper decisions without the regulatory guidance. Similar arguments apply for policymakers and legislators who also need more financing tools, coupled with a better understanding of investment impacts, to make the proper decisions. There is also a need to develop a basic meso-level research approach: concentrate on what is known and identify what is not known. Research topics could include the following:

- Develop better understanding of the full cost of congestion and sprawl; identify elements that need to be measured and develop techniques;
- Examine the role of population density and its relationship to automobile dependence;
- Identify the options for dealing with congestion and sprawl (e.g., explore tax sharing among jurisdictions, impact fees, more finely tuned user charges, and other options); and

- Examine quality of life issues, such as how congestion and sprawl relate to quality, and identify the information and techniques that will show the linkages.

The next section presents 15 different research projects. Figure 4 shows the levels of analysis that describe the project statements: a) data needs, b) tools and methodology, and c) application. Table 4 summarizes the 15 research project statements. Some of the research projects identified address the overall context for considering major issues and aim to provide broad answers. Some projects fill in the gaps with regard to particular values needed to assess specific plans or policies. It is neither necessary nor desirable to fill in every gap, however, before developing a more comprehensive framework of the link between transportation and economic development. “The big picture” helps to define a policy direction that is filled in as details develop over time. Therefore, the research team recommends that some of the more general research, as identified above, be undertaken in tandem with the more specific research discussed in the project statements.

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## RESEARCH PROJECT STATEMENT 1

### Economic Implications of Congestion

#### *Problem Statement*

Congested transport facilities raise the cost of moving people and goods within, into, and out of regions and states. Congestion occurs on highways, on railways and at airports. Congestion on highways and at airports is often related to specific times of day. Railway facilities in or near major metropolitan regions with commuter rail service may also be affected by urban peaking patterns. However, not all congestion occurs on a predictable basis. Some observers believe as much as half of highway congestion is incident based (i.e., caused by accidents, breakdowns, or other incidents that are not predictable). For this reason, congestion affects both trip times and the reliability of trip-time predictions; both are costly to travelers and shippers. Without question, such costs reduce the productivity of economic activities in a region. Reducing congestion costs will increase productivity, but to what degree and in what manner does the productivity increase occur?

#### *Research Needs*

- Analyze the nature of the costs that congestion imposes on businesses. This should include implications of work-trip congestion for employees and impacts of delays and unreliability in freight movement, both local and intercity.

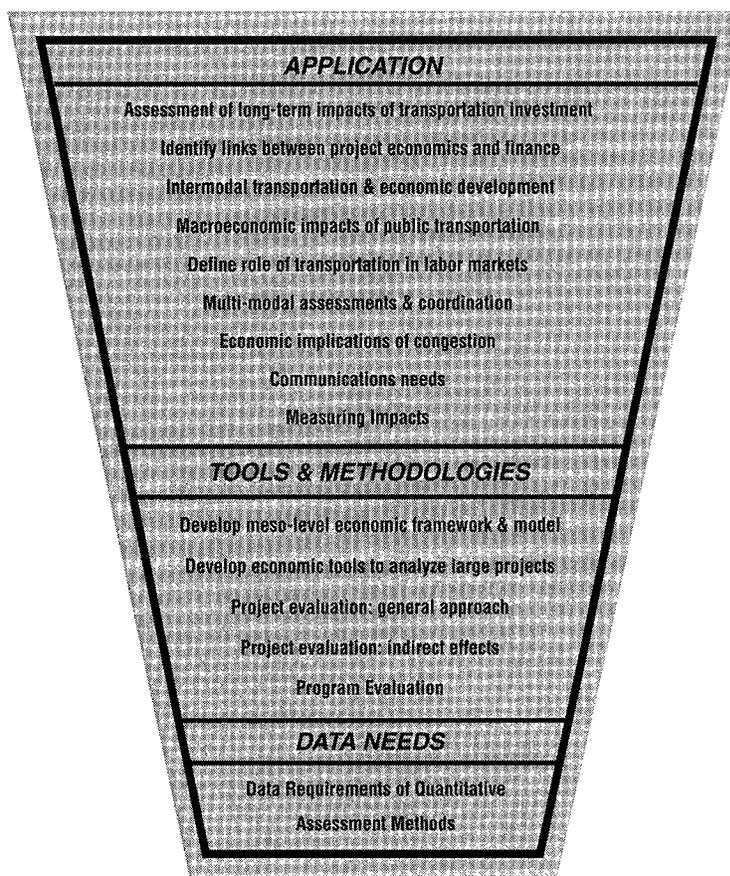


Figure 4. Proposed research topics.

- Analyze the relative impacts of predictable and unpredictable congestion on the costs of doing business.
- Analyze the effects of congestion reduction on economic productivity and growth in a region.
- Determine the implications of the foregoing analyses for measures that state DOTs should take to reduce congestion.
- Consider the implications for measures that require little capital (ITS, pricing, incident management, etc.).

#### *Application*

State DOTs will never have enough capital to address all of the deficiencies in their transport systems. They have to set priorities and select projects carefully. They have to be alert to opportunities for using solutions other than major investments in infrastructure. The research suggested in this RPS will help officials choose congestion strategies that make sense for economic development and make the most effective use of scarce resources.

*Budget:* \$200,000

*Time Frame:* 12–20 months

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## RESEARCH PROJECT STATEMENT 2

### Communications Needs

#### *Problem Statement*

The NCHRP Project 2-19 workshop discussions often turned to issues of communication. The rationale for transportation investment and its links to economic development are not well understood by the public, at large, whereas the perceived benefits from other government programs (e.g., healthcare) are high. As a result, transportation improvements risk being deferred or deleted without good public understanding of the positive economic values that they can create. DOTs need assistance in advancing understanding of transportation's role in economic growth among their decisionmakers and the general public.

#### *Research Needs*

- Market research can help determine what the decisionmakers and the public already believe about the economic value of transportation improvements.

TABLE 4 Summary of research project statements

Priority	Project Number	Research Project Statement	Budget	Time Frame
X X X	1	Economic Implications of Congestion	\$200,000	12-20 months
X X X	2	Communication Needs	\$200,000	12 months
X X X	4	Project Evaluation--General Approach	\$100,000	9 months
X X X	6	Program Evaluation	\$200,000	12 months
X X X	7	Develop Meso-Level Economic Framework and Model	\$850,000	39 months
X X X	12	Data Requirements of Quantitative Assessment Methods	\$275,000	9-18 months
X X	3	Macroeconomic Impacts of Public Transportation	\$200,000	18-20 months
X X	5	Project Evaluation--Indirect Effects	\$250,000	18 months
X X	11	Project Evaluation--Intermodal Transportation and Economic Dev	\$225,000	20 months
X X	13	Assessment of Long-term Impacts of Transportation Investment	\$150,000	12 months
X X	14	Define Role of Transportation in Labor Markets	\$975,000	42 months
X X	15	Identify Links between Project Economics and Project Finance	\$250,000	18 months
X	8	Multi-Modal Assessment and Coordination	\$250,000	16-20 months
X	9	Measuring Social Costs	\$125,000	8 months
X	10	Develop Economic Tools to Analyze Large Projects	\$500,000	24 months

X X X High priority (critical path-output would feed into other research)

X X Medium priority

X Low priority (but important to undertake)

- Based on information about preconceptions, the researchers would examine what the “story” should consist of and build a framework of key ingredients. What does each audience want to know? How much new information are they able to retain?
- What level of economic values, benefits and costs, should be communicated, and how should the technical detail vary, if at all, depending on audience?
- Is the current information base adequate for the communications job? Are accomplishments being measured adequately (e.g., potholes filled, lives saved, jobs created, costs avoided, mobility enhanced)? What other areas need development for the message to be cogent? Is the “do nothing” scenario understood well enough?
- How can outreach be better incorporated, and what are the most effective channels to disseminate findings and results? What are the most effective methods of communicating with various audiences? How much does the answer vary according to subject matter and audience?

#### Application

This research will result in a guide for DOTs that outlines how to communicate transportation programs and choices; what ingredients to communicate to each audience; and what information elements need developmental attention. This guide will be a tool for proactive communication, moving

DOTs away from defensive posture and/or crisis response. This guide will also show how to structure ongoing planning efforts so they provide the inputs needed for more successful communications efforts.

*Budget:* \$200,000

*Time Frame:* 12 months

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### RESEARCH PROJECT STATEMENT 3

#### Macroeconomic Impacts of Public Transportation

##### *Problem Statement*

Research in other areas of infrastructure improvement, notably highways, indicates that economic impacts of infrastructure investments on the productivity of the overall economy may be substantial. Investments in public transport may have similar impacts for urban regions and even for the nation as a whole. This project should assess relationships between public transportation investments and services and more macroeconomic measures of performance, such as productivity and economic competitiveness. The analytical techniques used would depend on the extent and type of available data.

### Research Needs

The research should review related work completed or underway for other infrastructure areas, and identify a methodology to assess the impacts of public transportation investments on local productivity and competitiveness (including improved access to labor and larger potential markets caused by reduced congestion). Interviews with economic development experts and case studies of particular industries would yield further evidence and supplement the results of econometric analysis. Implications for the level of investment and the type of investment should be developed based on the findings. The research should be coordinated, when possible, with similar research for other modes, including ongoing NCHRP research.

A synthesis should be prepared about the impacts of alternative types and levels of public transportation investment on productivity, competitiveness, and other relevant economic measures. When possible, guidelines should be prepared to help planners incorporate these techniques into the regular development and assessment of transit investments.

### Application

The research findings will shed light on the linkage between transit investment and economic development. In recent years, with congestion levels increasing on the nation's highways, transportation planners and decisionmakers are looking at existing and new alternatives to address the growing demand for travel. Public transportation investments represent a key alternative to improving a region's transportation situation. Techniques for examining the impact of transit investment and its relationship to economic growth and productivity will facilitate decision making for transit planners and developers.

*Budget:* \$200,000

*Time Frame:* 18–20 months

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## RESEARCH PROJECT STATEMENT 4

### Project Evaluation: General Approach

#### Problem Statement

A sound, overall approach to project evaluation is important to state and local governments' efforts to use transportation investments to foster economic development. It is not sufficient to look only at transport projects' effects on productivity of businesses and on costs of operating businesses in a particular region or state. Wise choices in transport investments will help governments to make the most effective use of the limited resources available to them. A good transportation system is an important part of making a city or

region a desirable place to live and to do business, apart from direct effects on firms' costs and modes of operation. Analysis specifically targeted at productivity and the economic development effects of transport improvements is very important, but transportation investment brings with it a broader area of benefits and costs. State and local decisionmakers also have to become familiar with practical, usable methods for overall economic analysis of transport projects.

### Research Needs

Complete evaluation of a project requires that productivity effects and the full spectrum of indirect effects be considered. These problems, however, are addressed in other research projects specifically focused on these areas. This research project should result in a manual on the fundamentals of project evaluation and investment analysis. Such a manual would provide state and local decisionmakers with basic guidance on the strengths, weaknesses, and limits of cost-benefit analysis and related techniques. Previous NCHRP projects have provided a good theoretical view of cost-benefit analysis and a computer model. This project will provide a practical explanation of cost-benefit analysis so that decisionmakers will have a better understanding of when cost-benefit is relevant and how best to interpret its results.

In particular, the manual would cover the following areas:

- *Issues that project evaluation can address.* This section would define the basic paradigm of investment analysis. It would explain and illustrate the meaning of benefits and costs, direct and indirect effects, short- and long-term effects, and related concepts. In general, it would show the kinds of questions that investment analysis can, and cannot, answer.
- *Direct effects.* This section would list and explain the principal direct effects of a transport project and the indicators ordinarily used to measure them. Among other points, this would address capital and operating costs, other costs to governments (e.g., administrative costs), and user effects, such as time savings, vehicle operating costs, etc.
- *Indirect effects.* This section would list the indirect effects, particularly those that are not readily treated in the framework of ordinary investment analysis. Beyond the list, there would be a brief explanation of why these effects cannot be dealt with easily. The problem of how to treat them would be addressed elsewhere.
- *Tools.* This section would give an elementary explanation of discounting and discount rates, sensitivity analysis, and other basic tools.
- *Relationship to Economic Development.* This part would provide a brief explanation of why good decision making about investments in transport projects is an

important basis for economic development, in addition to more immediate effects on business productivity.

#### *Application*

This manual would give state and local decisionmakers a starting point in understanding project evaluation and what it can and cannot do for them. Perhaps it would be most useful as a first chapter in a handbook on how state and local officials can make transport investment decisions that will have a strong effect in fostering economic development.

*Budget:* \$100,000

*Time Frame:* 9 months

### **RESEARCH PROJECT STATEMENT 5**

#### **Project Evaluation: Indirect Effects**

##### *Problem Statement*

In some ways, indirect effects, such as social and environmental impacts, are among the greatest problems for non-specialists trying to understand the application and usefulness of investment analysis. This may be especially true for decisionmakers in state and local governments. Both elected and appointed officials will be interested in a wide range of effects; most of which are not estimated by conventional techniques of analysis. The list of such effects is long: social impacts, environmental effects such as noise and air pollution, employment, regional economic development, etc. Employment, productivity, and other economic development effects are dealt with in other research projects. This project is concerned with the effects that fall under the headings of environmental and social impacts.

##### *Research Needs*

Perhaps the greatest need of state and local decisionmakers is to know which effects are not considered by standard techniques and whether there are other ways to bring these effects into the decision calculus in a systematic manner. The need exists for a more systematic, and accessible, understanding because claims about social and environmental effects are easy to make, but relatively difficult to debate. A corollary of this is that officials also need to understand the areas in which there is no substitute for their own subjective judgments. This research project should result in a short manual, or section of a larger manual, providing basic guidance on these issues.

*Listing and classification.* The first step is a list of social and environmental effects in a basic classification scheme.

Such a scheme might well take the form of a matrix showing, for example, environmental versus social effects along one dimension and quantifiable versus nonquantifiable effects on the other. (This is a preliminary suggestion; closer inspection of the matter might show that some other arrangement is preferable.)

*Quantifiable effects.* This part should show the specific ways in which effects can be quantified. For example, some vehicle emissions can be estimated in tons per day. Modes of quantification should be clearly indicated, together with a discussion of any possibilities for dollar valuation. Indeed, a significant point to be developed here is the difference between physical quantity and dollar valuation (perhaps another row in the classification matrix).

*Nonquantifiable effects and trade-offs.* This part should make the point that, for some effects, the subjective judgments of the decisionmakers are the best method for assessing the value of the impact and comparing it with quantifiable effects. Simple matrices should be developed to show methods for trade-offs between quantifiable and nonquantifiable effects. For example, officials could be shown that the key trade-off on a project decision is between the dollar value of time savings and the social costs (not quantifiable) of disrupting the spatial fabric of a small community.

#### *Application*

This manual, or section of a manual, should make the issues in dealing with indirect effects more understandable for state and local officials and should also show that many of the problems are more manageable than they may first appear.

##### *Budget:*

*Analytic framework:* \$100,000

*Quantification and examples:* \$150,000

*Total:* \$250,000

##### *Time Frame:*

*Analytic framework:* 6 months

*Quantification and examples:* 12 months

*Total:* 18 months

### **RESEARCH PROJECT STATEMENT 6**

#### **Program Evaluation**

##### *Problem Statement*

In a time of general fiscal stringency, state and local transportation officials may often find themselves facing a serious

challenge when defending transportation investment budgets within the executive branch or before the legislature. Transportation projects must compete with education, health care, and other important programs. Transportation officials have to make a clear and rigorous case that improvement of transport infrastructure will have large net benefits. They also have to make the case that transport improvements can lead to stronger economic development, creating, in the longer run, more resources for other programs. State and local officials need to know how to create a strong and objective evaluation of their own programs that will be convincing to skeptical budget officials and legislators.

### *Research Needs*

Program evaluation is less well defined, in terms of established techniques, than project evaluation. This research project will require some effort in developing concepts in addition to the organization and presentation of existing material. Program evaluation at, for example, the state level, must draw more heavily on macroeconomic statistical analysis, such as that recently carried out by Ishaq Nadiri, in cooperation with Apogee Research. Productivity and economic development effects will be significant underpinnings of program evaluation.

It will be necessary to develop a basic framework for program evaluation. The ideal would be to incorporate productivity and the effects of economic development into a single metric along with the direct effects of transportation improvement projects. But this is conceptually difficult and beyond the scope of this research project. The next best approach would be to develop a framework for presenting a variety of different benefits that cannot be summed.

*Array of benefits.* This would be a listing and classification, likely in the form of a simple matrix. Its purpose would be to convey the character of the benefits of transportation improvement projects to nonspecialists. This matrix would include productivity effects, development effects, direct impacts on users, and other effects, such as environmental impacts, positive or negative, would be included in the same matrix.

*Distribution of benefits.* A critical point in program evaluation and justification is to give an accurate picture of how the benefits of transportation are distributed through a state or metropolitan region. Many benefits are widely dispersed throughout society. Everyone is a transportation user in some way. Nonetheless, the paths of these effects should be traced, especially for productivity and development, so that officials, legislators, and decisionmakers outside the transportation community can clearly see how widespread the effects are and how all elements of a community benefit from them.

*Quantitative measures.* Some quantitative indicators can be used in a general way. They could be used in a more specific way if a state DOT, for example, were equipped in terms of data and analytical devices to offer estimates of the net benefits of project investments together with aggregate estimates of returns due to productivity gains. These values would not be additive, as already noted, but they could still be useful for making a case for transportation programs.

### *Application*

This project should be immediately useful to state DOTs and MPOs that have to present a case to a larger political audience that transportation improvements are essential to maintain and enhance the economic well-being of a state or region that supports vital programs in health, education, and other social areas.

*Budget:* \$200,000

*Time Frame:* 12 months

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## **RESEARCH PROJECT STATEMENT 7**

### **Develop Meso-Level Economic Framework and Model**

#### *Problem Statement*

Potential transportation investments vary in size and type. Economic evaluation techniques have been developed that fit most individual projects. In recent years, however, more attention is being paid to groups of transport investment projects. These groups may form part of a state DOT's long-range plan, an MPO's regional plan, or part of a program designed to attract legislative support for increased revenues.

In recent years, considerable success has been achieved in developing macro techniques that assess the economic values created by systems of investments, such as the work by Ishaq Nadiri using cost functions. Although both micro- and macro-oriented approaches need additional technical improvements, the largest gap in knowledge occurs at a middle or "meso" level of detail. This middle level of analysis refers to regional or statewide levels of analysis rather than national or individual projects. More of transportation's key investment decisions will be made at this level, yet economists and planners have only crude and often misleading analytical models to shed light on decisions.

At this level, more changes than simply the geographic scale. Rather, the level of industrial detail changes from considering entire industries at the national level and individual plants at the project level to clusters of firms and plants that have inter-connections with other firms and plants, inside or outside the region. The nature of hard and soft data differs significantly as well, with published data

often being limited compared with the amount available at the national level, and yet the costs for full surveys may be beyond the resources available for many studies.

In some areas, meso takes on a different context, meaning impacts between the specific direct impacts of transportation and the broader, somewhat nebulous, concepts of quality of life. In this context, meso may be interpreted to mean a fuller understanding of the secondary impacts of transportation and is addressed in another project statement. The spatial and industry levels of detail aspect will be emphasized in this RPS.

### *Research Needs*

The assumptions that underlie the microeconomic and macroeconomic approaches to transportation evaluation differ significantly. Micro-based models (cost-benefit analysis is the prototype approach) take a project-based view that uses linear assumptions to identify and trace the costs and benefits associated with a particular transportation change. When executed correctly, such an approach offers decisionmakers considerable confidence that an accurate (perhaps even conservative) assessment will be produced. In contrast, macroeconomic models ignore individual projects and examine the influence of entire transport systems on other major components of the economy. When executed correctly, such models incorporate some feedback effects that recognize the ability of price and service changes to cause shifts in the level and nature of overall demand. This is a form of nonlinear analysis that can measure the benefits from broader systemwide network effects, such as impacts on productivity and efficiency.

The transportation community needs

- An analytic/theoretical framework to assess these problems. This framework should be consistent with economic theory, yet recognize the specific characteristics of regional and subregional economies;
- A conceptual model that could be used to track these impacts;
- An assessment of the data needs, including ideas on how best to adapt or make do with existing data;
- An application of this new technique to a small handful of regions;
- An assessment of the potential policy and investment implications of this result; and
- A handbook that describes the best way to implement this new set of techniques.

### *Application*

This research will fill perhaps the most significant current gap in transportation economics. Success will provide DOTs, MPOs, and their various constituents with a tool that will greatly enhance the evaluation and selection of urban,

regional, and statewide systems of investments. A focus on the long-term, dynamic impacts of subnational systems will provide a practical tool to reawaken interest in regional and long-term transportation planning.

### *Budget:*

<i>Analytic and theoretic framework and conceptual model:</i>	\$250,000
<i>To apply to two regions:</i>	\$500,000
<i>To assess general implications and provide handbook:</i>	\$100,000
<i>Total:</i>	\$850,000

### *Time Frame:*

<i>First phase:</i>	15 months
<i>Application:</i>	18 months
<i>Handbook:</i>	6 months
<i>Total:</i>	39 months

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## **RESEARCH PROJECT STATEMENT 8**

### **Multimodal Assessment and Coordination**

#### *Problem Statement*

ISTEA called for expanded efforts to make transportation investments in the context of an overall system. Methods to evaluate multimodal proposals and determine the most beneficial use of alternative modes for transporting goods and people, however, have not kept pace with the increased stress on intermodal planning. Agencies need new, application-friendly tools to contend with multimodal trade-offs. In addition, modally oriented institutional arrangements have hampered multimodal considerations.

#### *Research Needs*

- How should DOTs best incorporate multimodal features into standard evaluation methodologies, and what is the appropriate level of detail?
- What is the best way to identify the data needs for multimodal facilities and intermodal coordination? (Public data on trip-making behavior and purpose have not kept pace; however, commercial logistics firms have made advances in proprietary freight movement information.)
- What information is required by decisionmakers to make intermodal tradeoffs and is this the same information needed to educate the public on cross-modal comparisons?
- What information should be developed for use in (1) identifying and possibly capturing private, commercial benefits

associated with multimodal investments and (2) sharing costs through private sector financial participation?

- How should economic development and growth effects of intermodal choices be forecast (e.g., between highway and transit), translated into the same metric, and compared?

#### *Application*

DOTs will know the appropriate information base and will have an analytical framework for decisions addressing the best use of alternative modes for transporting goods and people. A more coherent understanding of the economic benefits associated with the multimodal infrastructure network, and the dollar linkages between beneficiaries and payment schemes, will clarify the appropriate incentives for the private sector. Special needs in freight and local goods movement, and the appropriate private share of development costs, can then be more rationally addressed by decisionmakers, allowing more appropriate application of new financing tools such as partnerships, infrastructure banks, etc.

*Budget:* \$250,000

*Time Frame:* 16–20 months

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## RESEARCH PROJECT STATEMENT 9

### Measuring Social Impacts

#### *Problem Statement*

Critics of quantitative assessments of economic impact of transportation projects argue that existing techniques are unsuitable for evaluating the qualitative effects. In the NCHRP Project 2-19 workshop, a number of practitioners, including state DOTs and MPOs, emphasized the need for tools to measure social impacts. In their view, the ability to evaluate the impact of highway projects on the quality of life for a given community will supplement the quantitative approaches in obtaining support from local community groups.

Varying viewpoints dominate this debate over measuring and incorporating social impacts in the project evaluation process. Economists would like to place a value on these factors, but many argue that the concept of quality of life is too vague and broad to lend itself to analytical rigor. They worry that reliance on an inherently limited and incomplete process may distort practitioners' ultimate decision-making capability. On the other hand, transportation decisionmakers contend that existing quantitative tools, such as cost-benefit models, fail to account for a wide range of human factors that play a critical role in the decision-making process.

#### *Research Needs*

A primer on incorporating social impacts in the transportation investment decision-making process is needed. The primer would address a number of issues including:

- What are the key social impacts a decisionmaker must identify when evaluating transportation projects? Is there a way to prioritize such social impacts?
- How does one define quality of life? Are there unarguable characteristics that comprise quality of life (such as employment opportunities, poverty levels, land use patterns and growth, quiet and solitude)? Alternatively, is quality of life based entirely on community perceptions and values? (For example, some may view small-town solitude as enhancing quality of life and, thus, reject new development; whereas, others may value entertainment sites, tourism, and new large-scale developments.)
- To what extent can different views of what constitutes quality of life be reconciled?
- How does one measure quality of life and changes in quality of life? Are there any quantitative indicators, and if so, what are they? How can public involvement be used to measure quality of life? Do qualitative approaches allow for a consistent and accurate measure of quality of life? Can these approaches be refined to be more useful? Is there a hierarchy of preferable approaches—overlaps, comparisons, etc.?
- Can and should standard economic analytical tools be modified to incorporate social impacts? Or are other social science approaches, such as opinion research, better suited to deal with such qualitative issues?

#### *Application*

This research will provide a critical first step in gaining a better understanding of how to measure quality of life issues and other social impacts. Analytical methods capable of assessing quality of life issues will supplement existing analytical tools available to state DOTs for evaluating transportation projects.

*Budget:* \$125,000

*Time Frame:* 8 months

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## RESEARCH PROJECT STATEMENT 10

### Develop Economic Tools to Analyze Large Projects

#### *Problem Statement*

In recent years, DOTs have continued to express interest in large-scale projects, such as outer beltways or new regional

transit systems. Some proposals extend beyond the boundary of a single state, as with some interstate corridor improvements. Other proposals are located within one state, but offer significant benefits to regional and national transportation networks. For example, the Alameda Corridor freight improvements to the ports of Los Angeles and Long Beach, California, are local projects with far-reaching benefits.

These projects may create significant long-term shifts in the nature and level of the regional economy and, perhaps, even of several state economies. The cost savings and service improvements that these large projects generate may be large enough to create a cascade of other far-reaching economic and social effects. Potential results include shifts in the nature of existing industry, attraction of new mixes of business, and the rapid development of underutilized portions of a metropolitan region.

The existing portfolio of techniques used to analyze the economic and social impacts of transportation investments are most practical and reliable for smaller scale projects, such as widening an existing road or adding a connection to an existing developed network. These analytic techniques include cost-benefit analysis and its variations and various economic impact models. While these methods can be “scaled up” to handle larger databases and regional impacts, under what circumstances might such an extrapolation lead to potential distortions? Are the methods appropriate for projects that may have a multistate or national significance?

Although financial constraints often limit the number of such large projects that DOTs are likely to consider, a more reliable set of tools to estimate their economic value may help identify which ones are worth pursuing and thus help build political and financial support for them. The cost, complexity, and experimental nature of cost functions and related macro models make them impractical for these types of problems. A new set of tools, or modifications to existing ones, appears necessary to develop more realistic assessments of the long-term impacts of large projects. Similar concerns arise concerning groups of medium-sized projects that form part of a DOT’s or MPO’s program of long-range investments.

### Research Needs

Research needs were grouped into two categories:

- A set of guidelines on where and when traditional models work well. What scale and type of projects require modifications to existing techniques?
- When changes are needed, what modifications are needed? How do these different methodological needs vary with different types of macro projects? When does a program of medium-scale projects create some of the same analytic problems that a single large project imposes?

### Application

This research should provide a series of significant benefits to DOTs:

- It should provide guidance on when to rely on standard, existing analyses.
- For those projects whose size or regional importance requires a more complex analysis, guidance will be provided concerning the most appropriate methodology, including the most cost-effective way to modify existing techniques.
- It should also provide guidance on how best to incorporate economic analysis into a state’s or region’s long-range investment program.

### Budget:

<i>Guidance on existing methods:</i>	\$150,000
<i>Development and documentation of improvements:</i>	\$350,000
<i>Total:</i>	\$500,000

### Time Frame:

<i>Guidance:</i>	8 months
<i>Development and documentation of improvements:</i>	24 months
<i>Total:</i>	32 months

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## RESEARCH PROJECT STATEMENT 11

### Project Evaluation: Intermodal Transportation and Economic Development

#### Problem Statement

ISTEA emphasized the development of an intermodal transportation system. Methods to evaluate multimodal development proposals, however, have not kept pace with the increased stress on intermodal planning, and implications of this policy shift for state and regional economic development at all levels, although foremost to most chief executives, have not been explicitly addressed. Tools for the decisionmaker and new analytical constructs are needed to understand the development implications, in addition to multimodal facility inventories and emphasis on modal connectivity.

#### Research Needs

Agencies need new, application-friendly tools to grapple with the relationship between multimodal trade-offs and economic development. Making better transportation investments in the context of an overall system requires several complementary assessment tools. These include:

- A better understanding of which development patterns are compatible with which modal mixes;
- Recognition of the role of goods movement in economic development levels and patterns;
- A review of the land use or travel control measures that have been tried and their effectiveness to date;
- Increased understanding of when and how to control developmental impacts, or alternatively, recognition that commerce and travel dictate transport investments; and
- Evaluation of tools that identify the circumstances under which alternative passenger and freight improvements can generate long-term net benefits.

In addition, regional modally oriented institutional arrangements and planning processes have hampered economic development and multimodal considerations. This research will undertake a small number of case studies of the interface between economic development and transportation agencies to identify examples of ineffectiveness and will provide suggestions for institutional reorganization.

The following list divides the project into logical work steps.

- *Modal mix.* Identify qualitative tradeoffs of modal investments with development patterns. What, if anything, is known about this juncture?
- *Intermodal management systems.* Review six states and identify the three or four best suited for more detailed examination of how quantitative tradeoffs were established for the mix of multimodal investments and how linkages to economic development are accounted for, if at all.
- *Economic development activity.* Review economic development activities for each of the three states and examine linkages to transport investment level and mix.
- *Public-private roles.* For the selected states, identify the public and private roles for transport and economic development decisions and investments. What is the current nature of the partnership? Who bears what costs?
- *Foreign cases.* Analyze two foreign cases where economic and modal development decisions have been linked, summarize the outcomes, and comment on the transferability to the U.S. situation. For example, Manchester, England, has stressed public transit in its modal mix, engaged private employers in a partnership, established new sharing of financial burdens for development and transit costs, and spurred redevelopment of a target region.
- *Report.* Prepare a report on the findings, identifying promising approaches and other recommendations.

#### *Application*

Develop information and tools so decisionmakers can be more informed and explicit about whether an investment

under consideration is being made to serve, to hold, or to attract economic development. Provide an initial approach for use in (1) identifying and possibly capturing private, commercial benefits associated with multimodal investments, (2) sharing costs via private sector financial participation, and (3) understanding how modal mix intersects with development.

These findings will strengthen states' approaches to the most important issues faced by the decisionmakers, regarding projects related to economic development. They will also enhance the public-private partnership and identify analytical constructs that enable officials to encourage strong economic development and performance through their transportation investment decisions. The findings will help decisionmakers assess the level of commitment or flexibility that is required on the part of the public and private parties and develop key implications for transport investment decisions related to economic development.

*Budget:* \$225,000

*Time Frame:* 20 months

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## RESEARCH PROJECT STATEMENT 12

### Data Requirements of Quantitative Assessment Methods

#### *Problem Statement*

Current fiscal conditions demand a greater ability to evaluate the performance of individual project investments as well as overall transportation programs. There are a variety of quantitative methods available for evaluating the relationship between transportation investments and economic activity. As demands for implementing existing quantitative methods increase, so do the consequent demands on the quantity and quality of the data that form their foundation.

The NCHRP Project 2-19 workshop participants expressed a need that data reporting requirements not be too burdensome on the providers or on the states and localities collecting and processing the information. Therefore, additional data collection and reporting requirements should be justifiable by providing improved decision-making capabilities.

#### *Research Needs*

There are immediate data assessment needs as well as specific data requirements to be addressed, including:

- Determination of basic data requirements for various quantitative methods. The data needs of individual methods differ. A description of the data requirements of individual methodologies would provide a useful shortcut in determining the feasibility of such methods.

- Assessment of currently available data. States collect and maintain relevant information to different degrees of detail (both geographically and by sector), over different periods of time. This is true at the national level as well. The purpose of this assessment is to identify information that is consistently available. A mapping of quantitative data requirements with generally available information will identify specific areas for further data collection by states.
- Creation of a data series for private capital at state levels. Specific data needs have already been identified for use in macroeconomic methods, such as cost and production function approaches. These methods have been used to evaluate broad economic growth and productivity implications of transportation investments. To apply at the national, regional, or state levels, they require information on individual factors of production and their unit prices, including labor and private capital. Currently, however, a data series for private capital at the state level by industry sector is not available for all sectors of the economy.

#### *Application*

State DOTs and planners need to make quantitative evaluations in a reliable and comprehensive manner. The product of this investigation will provide them with information to obtain consistent data that is necessary to perform quantitative assessments appropriate for their needs.

Quantitative methods could then begin to evaluate the effect of transportation investments in greater detail, allowing for variations, for example, across states and industries. The effect of transportation investments on regional economic growth and productivity could be reasonably assessed.

#### *Budget:*

<i>Handbook on data needs:</i>	\$75,000
<i>Database on private capital:</i>	\$200,000
<i>Total:</i>	\$275,000

#### *Time Frame:*

<i>Handbook on data needs:</i>	3–6 months
<i>Database on private capital:</i>	6–12 months
<i>Total:</i>	9–18 months

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### **RESEARCH PROJECT STATEMENT 13**

#### **Assessment of Long-Term Impacts of Transportation Investment**

##### *Problem Statement*

Economic impacts and development on a national level resulting from investment in transportation have been a focus

of numerous studies over the past several years. To date, many useful research projects focusing on productivity gains and the economic multiplier have been conducted. These studies do not, however, necessarily help states and localities assess the potential economic impacts resulting from transportation investment. Impacts on a national level cannot necessarily be translated into similar effects at the state or local level, particularly with regard to macroeconomic effects such as productivity, competition at the firm level, and job creation. For example, the economic effects of transportation investment may vary considerably between states and may not be comparable to a composite, nationwide transportation multiplier. DOTs and MPOs need guidance in determining how best to quantify the long-term economic effects of transportation investment.

##### *Research Needs*

- Methodology for creating a unique transportation multiplier at the state level;
- Guidance in assessing customized data collection needs;
- Guidance for determining customized economic performance indicators; and
- Information on how economic impact studies on a national level are conducted.

#### *Application*

This research will result in a guide for DOTs and MPOs that outlines a methodology for creating unique transportation multipliers and discussing the types of data and economic performance indicators they might want to focus on. The research will help DOTs assess the long-term economic impact of transportation investment at the state level, as opposed to using estimates from a national level. DOTs can then use this information in budgeting decisions.

*Budget:* \$150,000

*Time Frame:* 12 months

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### **RESEARCH PROJECT STATEMENT 14**

#### **Define Role of Transportation in Labor Markets**

##### *Problem Statement*

A key historic economic role for transportation has been the journey to and from work. This role was most obvious in the 19th century and the first half of the 20th century when the focus of urban areas and urban transport systems was on the CBD, which remains a key purpose of many transit operations. Current analysis of transportation investment and labor markets is usually limited to the effect on travel time

and costs or, perhaps, to the role of transportation in providing job access for low-income or minority populations. As congestion has increased, as jobs and housing have spread to the suburbs and beyond, and as many central cities decline in economic and social vitality, the question remains as to how both highway and transit transportation can best serve this dispersed pattern of jobs and residential locations.

What is the value to the general economy of reliable and broad access to labor? Most existing economic models still use, directly or indirectly, assumptions that reflect a freight-oriented world. As the economy continues to become dominated by service businesses and light manufacturing, the quality, cost, and reliability of labor inputs should also increase in importance. Can existing economic models be adapted to provide more accurate and comprehensive assessments of the economic role of labor access to the economy?

Although the emphasis is on quantitative impacts, all of these issues will shed further light on broader issues, such as the importance of transportation in serving a dispersed urban form; the role of sprawl in today's economy; how and where group transportation (transit, carpools, etc.) functions best; and how transportation can help revitalize urban centers.

#### Research Needs

Based on this discussion, three research areas stand out. First, determine the current state of information about transportation and the journey to work. This would provide a more economic-oriented companion piece to *Commuting in America II* (12). Emphasis would be placed on the information needed to provide a full description of the labor needs for different industries, the location patterns of major industries, and how these locations contrast with housing and residential locations and with current transportation corridors. Once this framework of desirable data has been established, the researchers would attempt to apply it for a representative sample of metropolitan areas. A guide for completing the collection of data would also be prepared.

Second, a similar review would be prepared concerning job access by the underemployed. The researchers would also develop an ideal database and attempt to apply it in a sample of metropolitan areas. Also, a set of performance measures would be developed that could be used by transportation planners to assess alternative ways to provide access/mobility.

Third, an analytic framework would be developed to assess the role of labor access in helping to generate cost savings or productivity gains in private industry. A conceptual model would then be developed (perhaps building on the cost function work just completed by Ishaq Nadiri or the new work underway by Randall Eberts). Based in part on the data collected and analyzed in answering the two previous research needs, the new model would be tested and applied.

These three dimensions would be summarized in a single handbook that contains what is currently known about the

contribution of transportation to labor markets and the best way to analyze the impact of transportation investments on labor markets in the future.

#### Application

This project would provide DOTs and MPOs with knowledge about the role of transport investments in meeting the needs of urban travel markets. It also would ensure a more even-handed set of analytical tools to support service and light manufacturing industries.

#### Budget:

<i>General descriptive piece:</i>	\$150,000
<i>Description and development of performance measures on access for underemployed:</i>	\$150,000
<i>Development of new labor access economic model:</i>	\$600,000
<i>Summary document:</i>	\$75,000
<i>Total:</i>	\$975,000

#### Time Frame:

<i>First two sections, developed in parallel:</i>	12 months
<i>Last section:</i>	24 months
<i>Summary document:</i>	6 months
<i>Total:</i>	42 months

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## RESEARCH PROJECT STATEMENT 15

### Identify Links Between Project Economics and Project Finance

#### Problem Statement

In recent years, significant change has occurred both in the understanding of the economic effects of transport investment and in the array of tools that DOTs have available to help finance these projects. Many of these new finance tools focus on individual projects and seek to tap into the benefits that they generate for users and non-users (land owners, for example). Thus, successful applications will require more detailed, believable, and cost-effective ways to identify beneficiaries of transport improvements. Because many of the new finance tools are linked to long-term debt, the ability to assess long-term effects of individual projects is particularly valuable.

In the past, economics and finance have played separate, but complementary, roles in shaping DOT programs. In the future, they are likely to be more closely intertwined, as DOTs

deal with financially constrained STIPs and TIPs and the realities of budget limitations and as they seek to make full use of these “innovative” tools. Next ISTEA is likely to follow in the footsteps of ISTEA and the NHS Act in expanding the toolbox of available financial options. The economic tools should keep pace with these new opportunities as well as the knowledge level of DOT planners and decisionmakers.

#### *Research Needs*

- How can DOTs make fuller use of information provided by the current array of economic tools?
- How should these models be modified to provide more direct support for DOTs (and other project sponsors) as they develop financial plans?
- Which financial tools are best suited to benefit from economic data?
- How might the growing toolbox of innovative finance tools be modified to take advantage of better knowledge about project benefits and beneficiaries?

- What implications, if any, are there for project sponsorship, including, for example, the role of public-private partnerships and SIBs?
- Can the new economic tools (productivity models, in particular) be modified to provide more direct support for developing financial plans?

#### *Application*

This research will provide practical tools to help DOTs (and project sponsors in general) to implement the new financial tools. This, in turn, will make it possible to move ahead on more projects than traditional financial resources allow. It will also help to provide a clear and tangible incentive to ensure that the economic tools remain practical and flexible.

#### *Budget:*

*Set of case studies and handbook:* \$250,000

*Time Frame:* 18 months

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## CHAPTER 7

# CONCLUSIONS

The economic value of transportation was taken for granted throughout most of U.S. history. In some ways, the Interstate Highway System and the Highway Trust Fund represented the last major transportation decision in this country that was based on a general belief that transport investment was good for the nation.

Since 1956, several trends in society have begun to affect transportation decisions in a profound way. Because of limited resources, expenditures in one area must be considered in terms of trade-offs in spending elsewhere. This trend has increased the reliance on analytic techniques to help justify investments, resulting in the growth of economic impact methodologies and faith in cost-benefit techniques. There has been a growing skepticism among the public regarding the costs and benefits associated with transportation decisions. This skepticism manifests itself in demands for more complete justification of proposed projects by a more aware and aggressive group of stakeholders. In many ways, these stakeholders are not asking for more complex analytic methods, but rather more accuracy and completeness in the analyses that lead to decisions.

Few large public actions have narrow impacts, especially transportation investments. For many years, the costs of transportation were underestimated, largely in terms of the impacts on the environment. Although the recognition has been slower to develop, the benefits of transport were also underestimated, particularly the interaction between public and private investments, and between good transportation and growth in economic productivity.

Beginning in the late 1980s, there was a burst of new research, much of it conducted by experts with limited experience in formal transportation economics. As a result, they adapted techniques that had long been used to assess broad, macroeconomic changes. The results of this work have been intellectually stimulating to the research community and have triggered active debate. Little of the work, however, has resulted in practical tools that can be applied by transportation decisionmakers or planners. The first of the NCHRP Project 2-17 reports (8) is a step in this direction. While these efforts have only begun to move toward methods that could be implemented, they show some promise of providing a “common sense” understanding of how and why transport investments generate economic benefits. Additionally, they

may link the micro-level cases studies and the more macro-level econometric studies.

Much of the research to date has been primarily providing a better understanding of the underlying factors that affect the interaction between transportation and economic development. While many practitioners have been at the table while research options have been discussed, they have yet to play more than an observer’s role. The general public and their representatives (those elected and those in interest groups) have been almost completely missing as well. NCHRP Project 2-19 offers an opportunity to correct these problems by

- Assessing the new wave of research;
- Encouraging the participation of a wide range of stakeholders to determine their research needs; and
- Developing an appropriate cost-effective, multiyear, multifaceted research agenda on the relationship between transportation investment and economic development.

The project was organized in three distinct phases. Phase I focused on the identification of key stakeholders that have a strong interest in transportation investment decisions and potential impacts. It also included a detailed review of the literature on the relationship between transportation and economic development. In Phase II of the project, a 2-day conference, “Transportation, Productivity and Growth,” was held to obtain input from stakeholder representatives, identified in Phase I, on current gaps in available analytical tools and techniques for evaluating the impact of transportation investment on the economy. In Phase III, the researchers organized and assimilated the information gathered during the earlier phases to develop a research agenda designed to meet the information gaps identified and cost-effective, practical tools for transportation planners and other stakeholders to facilitate their decision-making process.

The research team made the following conclusions about the existing research on the relationship between transportation investment and economic development:

- Most of the currently available analytical tools tend to focus on either broad macroeconomic impacts of transportation investment or on specific micro-level project analysis. There has been very little focus on meso-level

analysis that bridges the gap between large program evaluations and small projects.

- The scale of analysis is limited geographically (often to a single corridor) and over time, so that the full impacts of transportation investments are hard to identify. This means that the economic and environmental risks of inadequate investment are likely to be missed or understated.
- There is very little “what if” analysis. Few studies have looked ahead 20 years and asked what would happen if a project is or isn’t done. No attention is given to what the urban area and its economy would be like with and without a public transport system, a particular major project, or a regional policy.
- In the case of both highways and transit, very little time series data have been compiled and saved other than those for expenditure and usage. Thus, it is difficult or sometimes impossible to determine economic relationships through the readily available data.

The research agenda in Phase III addressed these gaps and other information needs that were identified by the stakeholders. New studies suggest a strong linkage between investment in transportation and economic development. A complete understanding of the tools described in these studies and the communication of available methodologies to transportation decisionmakers are urgently needed. In addition, the proposed research agenda aims to develop and identify new state-of-the-art analytical techniques to facilitate a deeper understanding of the role transportation plays in the economy. It identifies a broad range of research topics (both short and long-term) that may be explored through qualitative (case studies) or quantitative (econometric) methodologies. Each of these projects has been tailored to meet a specific information need or gap, and the output from the research is expected to provide transportation decisionmakers with practical tools and guidelines for assessing the impacts of transportation investment decisions.

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## APPENDIX A

### REFERENCES

1. American Association of State Highway Transportation Officials (AASHTO), "Transportation: Key to the Future-Relation between Transportation Investment and Economic Growth." Washington, D.C. (1990).
  2. Apogee Research, "Current Literature on Highway Investment and Economic Development." Federal Highway Administration, Washington, D.C. (1989).
  3. Bell, Michael E., and McGuire, Therese J., *NCHRP Report 389*, "Macroeconomic Analysis of the Linkages between Transportation Investment and Economic Performance." Transportation Research Board, National Research Council, Washington, D.C. (1997) 89 pp.
  4. Federal Highway Administration, "Case Studies of the Link between Transportation and Economic Growth." Washington, D.C. (1991).
  5. Apogee Research, "The Economic Importance of the National Highway System." American Trucking Associations (ATA), Alexandria, VA (1994).
  6. Apogee Research, "Benefits and Costs of Highway Improvement." Federal Highway Administration, Washington, D.C. (1994).
  7. Apogee Research, "Cost Benefit Analysis of Highway Improvement Projects." Federal Highway Administration, Washington, D.C. (1994).
  8. Lewis, David, *NCHRP Report 342*, "Primer on Transportation, Productivity and Economic Development." Transportation Research Board, National Research Council, Washington, D.C. (1991) 135 pp.
  9. Allen, Benjamin J., Baumel, C. Phillip, and Forkenbrock, David J., "Expanding The Set of Efficiency Gains of a Highway Investment: Conceptual, Methodological, and Practical Issue." *Transportation Journal* (1994).
  10. Munnell, Alicia, "How Does Public Infrastructure Affect Regional Economic Performance?" Federal Reserve Bank of Boston, pp. 69-194 (1990).
  11. Nadiri, M. Ishaq, "Infrastructure Capital and Productivity Analysis: Cost and Profit Function Approaches." Infrastructure in the 21st Century Economy, Volume Two, U.S. Army Corps of Engineers, Institute for Water Resources, Fort Belvoir, VA (1993).
  12. Pisarski, Alan, *Commuting in America II: National Report on Commuting Patterns and Trends*. Eno Transportation Foundation, Washington, D.C. (1996)
-

## APPENDIX B

### BIBLIOGRAPHY

- Adler, Hans, "Economic Appraisal of Transport Projects: Manual with Case Studies." World Bank (1987).
- Allen, Benjamin J., Baumel, C. Phillip and Forkenbrock, David J., "Expanding The Set of Efficiency Gains of a Highway Investment: Conceptual, Methodological, and Practical Issue." *Transportation Journal* (1994).
- Apogee Research, "The Economic Importance of the National Highway System." Trucking Research Institute (February 1994).
- Apogee Research, "Cost Benefit Analysis of Highway Improvement Projects." Federal Highway Administration (FHWA) (1994).
- Apogee Research, "Case Studies of the Link between Transportation and Economic Productivity." FHWA (January 1991).
- Apogee Research, "Transportation: Key to a Better Future—The Relationship of Transportation Investments to Economic Growth." American Association of State Highway and Transportation Officials (AASHTO) (December 1990).
- Aschauer, David A., "Public Capital, Productivity, and Macroeconomic Performance: A Literature Review." *Infrastructure In The 21st Century Economy, Volume Two*, U.S. Army Corps of Engineers, Institute for Water Resources (1994).
- Aschauer, David A., "Genuine Economic Returns to Infrastructure Investment." *Policy Studies Journal*, Vol. 21(2), pp. 380–390 (1993).
- Aschauer, David A. and Munnell, Alicia H., "Does Public Infrastructure Affect Economic Performance?" (1990).
- Attaran, Kazam and Auclair, Philippe, "Highway Stock and Productivity Growth." California Department of Transportation (1989).
- Bayliss, Brian, "Transport Policy and Planning: An Integrated Analytical Approach." World Bank Publications, Economic Development Institute Technical Materials (1992).
- Bell, Michael E., and McGuire, Therese J., *NCHRP Report 389*, "Macroeconomic Analysis of the Linkages Between Transportation Investments and Economic Performance." Transportation Research Board, National Research Council, Washington, D.C. (1994).
- Bernardeau, Christine, Mudge, Richard, and Politano, Arturo, "Current Literature on Highway Investment and Economic Development." FHWA, presented at The International Conference on Transportation and Economic Development, Transportation Research Board, National Research Council, Williamsburg, Virginia, November 6–8 (October 1989). [This FHWA document provides in-depth coverage of published research on transportation impacts.]
- Berndt, Ernst R. and Hansson, Bengt, "Measuring the Contribution of Public Infrastructure in Sweden." National Bureau of Economic Research, Cambridge, Massachusetts, Working Paper Number 3842 (1991).
- Creightney, Cavelle D., "Transport and Economic Performance: A Survey of Developing Countries." World Bank Technical Paper Number 232 (1993).
- Delaney, Robert V., "Integrated Business Logistics: Doing What is Good for the Country." Cass Information Systems, St. Louis, Missouri (1995).
- Eno Transportation Foundation, "Transportation in America." Washington, D.C. (1993).
- Garcia-Mila, Teresa and McGuire, Therese J., "The Contribution of Publicly Provided Inputs to States' Economies." Universitat Autònoma de Barcelona, Spain, and Northwestern University, Evanston, Illinois (1988).
- Gramlich, Edward M., "Infrastructure Investment: A Review Essay." *Journal of Economic Literature*, Vol. 32, pp. 1176–1196 (1994).
- Greenhorne and O'Mara, "NCHRP Project Number 2-17(2)," *Workshop on Research Needs in Transportation and Economic Development*. Transportation Research Board, National Research Council, Washington, D.C. (1990).
- Haughwout, Andrew, "Infrastructure and Central Cities." Princeton University, New Jersey (1994).
- Holtz-Eakin, Douglas and Schwartz, Amy Ellen, "Spatial Productivity Spillovers from Public Infrastructure: Evidence from State Highways." National Bureau of Economic Research Working Paper Number 5004 (1995).
- Holtz-Eakin, Douglas and Schwartz, Amy Ellen, "Infrastructure in a Spatial Model of Economic Growth." National Bureau of Economic Research, Cambridge, Massachusetts, Working Paper Number 4824 (1994).

- Holtz-Eakin, Douglas, "Public Sector Capital and the Productivity Puzzle." National Bureau of Economic Research, Cambridge, Massachusetts, Working Paper Number 4122 (1992).
- Hulten, Charles and Albright, David, "Infrastructure and Economic Growth: Modeling The Micro-Macro Linkages." Apogee Research, Inc., Bethesda, Maryland, Unpublished (1994).
- Hulten, Charles, "Public Capital and Economic Growth: The Micro-Macro Linkages." Infrastructure In The 21st Century Economy, Volume Two, Army Corps of Engineers, Institute for Water Resources (1994).
- Lewis, David, *NCHRP Report 342*, "Primer on Transportation, Productivity and Economic Development." Transportation Research Board, National Research Council, Washington, D.C., (1991).
- Liew, Chong K. and Liew, Chung J., "Use of Multiregional Variable Input-Output Model to Analyze Economic Impacts of Transportation Costs." *Transportation Research Record 747* (1980).
- Lindberg, Gunnar, "Benefit-Cost Analysis in a Multimodal Planning Process." Center For Research in Transportation and Society, Stockholm, Sweden (1995).
- Martinsen, Jan A., Odeck, James, and Sandvik, Kjell Ottar, "The Application of Benefit-Cost Analysis to Norwegian Transportation Infrastructure Planning." Norwegian Public Roads Administration, Oslo, Norway (1995).
- Minken, Harald, "Interdependencies between Projects in a Corridor." Institute of Transport Economics, Sor-Trondelag, Norway (1995).
- Munnell, Alicia H., Discussion Paper, "How Does Public Infrastructure Affect Regional Economic Performance?" Federal Reserve Bank of Boston Conference Series (1990).
- Nadiri, M. Ishaq and Mamuneas, Theofanis P., "Highway Capital and Productivity Analysis at Disaggregated Level." Department of Economics, New York University, New York (1994).
- Nadiri, M. Ishaq, "Infrastructure Capital and Productivity Analysis: Cost and Profit Function Approaches." Infrastructure in the 21st Century Economy, Volume Two, U.S. Army Corps of Engineers, Institute for Water Resources (1993).
- Pedersen, Neil, "Benefit-Cost Analysis: A States' Perspective." Maryland Department of Transportation, Annapolis (1995).
- Peterson, George E., "Is Public Infrastructure Undersupplied?" Federal Reserve Bank of Boston Conference Series (1990).
- Small, Kenneth A., Winston, Clifford, and Evans, Carol A., "Road Work: A New Highway Pricing and Investment Policy." The Brookings Institution, Washington, D.C. (1990).
- Tatom, John A., "The Spurious Effect of Public Capital Formation on Private Sector Productivity." *Policy Studies Journal* (1993).
- Wildenthal, Marie T., Buffington, Jesse L., and Memmott, Jeffery L., "Application of a User Cost Model to Measure During and After Construction Costs and Benefits: Highway Widening Project." *Transportation Research Record 1450*, Transportation Research Board, National Research Council, Washington, D.C. (1994).
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