

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. FHWA/TX-91/1228-1		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle State Highway Investment and Economic Development: State-of-the-Art Review				5. Report Date October 1990	
7. Author(s) E.J. Washington, N. Pinnoi, R.W. Stokes				6. Performing Organization Code	
				8. Performing Organization Report No. Research Report 1228-1	
9. Performing Organization Name and Address Texas Transportation Institute Texas A&M University System College Station, Texas 77843-3135				10. Work Unit No.	
12. Sponsoring Agency Name and Address Texas State Department of Highways and Public Transportation; Transportation Planning Division P.O. Box 5051 Austin, Texas 78763				11. Contract or Grant No. Study No. 2-10-90-1228	
				13. Type of Report and Period Covered Interim: September 1989 August 1990	
14. Sponsoring Agency Code				15. Supplementary Notes Research performed in cooperation with DOT, FHWA. Research Study Title: Role of SDHPT in Statewide Economic Development.	
16. Abstract <p>This report presents a review of the literature, a survey of current practices regarding policies used to foster economic development through intercity highway improvements and the identification of current analytical techniques for assessing the economic development impacts of highways. The review contains extensive documentation of economic development programs in other states which should be useful to the State Department of Highways and Public Transportation (SDHPT) in developing guidelines for evaluating the economic development potentials of highway expenditures in Texas. However, the precise impact of a particular transportation improvement, often times is difficult to assess. The results of a preliminary survey indicate that 9 state DOTs give some consideration to, or use the promotion of economic development as part of their long range statewide highway planning criteria. The objectives of these efforts range from the mere completion of a statewide four lane network to the development of a process specifically intended to increase the competitive advantage of the states communities by funding certain types of highway improvement.</p>					
17. Key Words Economic Development, Highway Development, Industrial Parks, Tourism, Cost-Benefit Analysis, Economic Development Funds/Bonding, Highway/Transportation Expenditures			18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 75	
				22. Price	

**STATE HIGHWAY INVESTMENT AND ECONOMIC DEVELOPMENT:
STATE-OF-THE-ART REVIEW**

By

Earl J. Washington
Assistant Research Planner
Nat Pinnoi
Research Associate
and
Robert W. Stokes
Associate Research Planner

Research Report 1228-1
Study Number 2-10-90-1228
Role of SDHPT in Statewide Economic Development

Sponsored by

Texas State Department of Highways and Public Transportation
in cooperation with the
U.S. Department of Transportation
Federal Highway Administration

Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843

October 1990

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
--------	---------------	-------------	---------	--------

LENGTH

in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km

AREA

in ²	square inches	645.2	centimetres squared	cm ²
ft ²	square feet	0.0929	metres squared	m ²
yd ²	square yards	0.836	metres squared	m ²
mi ²	square miles	2.59	kilometres squared	km ²
ac	acres	0.395	hectares	ha

MASS (weight)

oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

VOLUME

fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft ³	cubic feet	0.0328	metres cubed	m ³
yd ³	cubic yards	0.0765	metres cubed	m ³

NOTE: Volumes greater than 1000 L shall be shown in m³.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
----	------------------------	----------------------------	---------------------	----

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
--------	---------------	-------------	---------	--------

LENGTH

mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi

AREA

mm ²	millimetres squared	0.0016	square inches	in ²
m ²	metres squared	10.764	square feet	ft ²
km ²	kilometres squared	0.39	square miles	mi ²
ha	hectares (10 000 m ²)	2.53	acres	ac

MASS (weight)

g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T

VOLUME

mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m ³	metres cubed	35.315	cubic feet	ft ³
m ³	metres cubed	1.308	cubic yards	yd ³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F
----	---------------------	-------------------	------------------------	----

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	v
IMPLEMENTATION STATEMENT	vii
DISCLAIMER	vii
SUMMARY	ix
1. INTRODUCTION	1
1.1 Background	1
1.2 Study Objectives	2
1.3 Organization of the Report	3
2. HIGHWAY INVESTMENT AND ECONOMIC DEVELOPMENT	5
2.1 General	5
2.2 Literature Review	5
2.3 The Role of Economic Development in State Highway Planning	8
2.3.1 Review of Selected State Programs	8
2.3.2 Summary	29
2.4 Summary of Models/Procedures to Quantify Economic Impacts	33
2.4.1 Classes of Economic Models	33
2.4.2 Description of Selected Models	36
3. SUMMARY AND RECOMMENDATIONS	39
REFERENCES	45
APPENDIX	49

ABSTRACT

This report presents a review of the literature, a survey of current practices regarding policies used to foster economic development through intercity highway improvements and the identification of current analytical techniques for assessing the economic development impacts of highways. The review contains extensive documentation of economic development programs in other states which should be useful to the State Department of Highways and Public Transportation (SDHPT) in developing guidelines for evaluating the economic development potentials of highway expenditures in Texas. However, the precise impact of a particular transportation improvement, often times is difficult to assess. The results of a preliminary survey indicate that 9 state DOTs give some consideration to, or use the promotion of economic development as part of their long range statewide highway planning criteria. The objectives of these efforts range from the mere completion of a statewide four lane network to the development of a process specifically intended to increase the competitive advantage of the state's communities by funding certain types of highway improvements.

IMPLEMENTATION STATEMENT

Recently, interest in using highway improvements to encourage economic growth and development in Texas has increased. This concept has created the need to develop procedures and/or policies to evaluate the economic development potentials of projects of SDHPT. This study is intended to assist the SDHPT by providing guidelines concerning the appropriate role(s) of the Department in the use of highway improvements to encourage economic growth and development, and by providing for an objective and systematic assessment of the potential economic development impacts of proposed highway improvements.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas State Department of Highways and Public Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

SUMMARY

In recent years, many state departments of transportation have begun to expand their mission to include the use of highway expenditures to encourage statewide economic growth and development. Highway improvements, either in the form of a new highway or the upgrading of an existing one, can generate changes in the functioning of an economy. Economic effects can be beneficial, where accessibility is improved, travel time and cost are reduced, or land values rise; or they can be adverse, where land values decrease or congestion on feeder roads increases.

This report presents a review of the literature, a survey of current practices regarding policies used to foster economic development through intercity highway improvements, and the identification of current analytical techniques for assessing the economic development impacts of highways. Additionally, this report contains extensive documentation of economic development programs in other states which should be useful to SDHPT in developing guidelines for evaluating the economic development potentials of highway expenditures in Texas.

Economic development may be promoted through highway improvements in one of two ways: 1) as part of the statewide planning criteria; or 2) as part of the normal programming process. The results of a preliminary survey indicate that 9 state DOTs give some consideration to, or use the promotion of economic development as part of their long range statewide highway planning criteria. These states and their program name(s) are shown below:

Table S-1. Highway Economic Development Plans

State	Program Name
Arkansas	Economic Development Corridor Program
Florida	Highway System Plan
Georgia	Developmental Highway System
Iowa	Commercial and Industrial Network
Michigan	Priority Commercial Network
Nebraska	Priority Commercial System
Pennsylvania	Priority Network System
South Dakota	Highway System Study
Wisconsin	Corridors 2020

The objectives of the programs range from the mere completion of a statewide four lane network to the development of a process specifically intended to increase the competitive advantage of the state's communities by funding certain types of highway improvements. Thirty-six states explicitly take economic development into account in their highway programming activities. Of these states, 14 incorporate economic development objectives into their normal programming process but do not have special funds or programs for the specific purpose of fostering economic development. The methods used range from informal petitions on the part of local governments for priority programming to point systems for ranking projects. A surprisingly large number of states, 22, have categorical funding or bonding authority for economic development. Florida, Iowa, Massachusetts, Michigan, and Washington report extensive efforts in this approach. Eleven state programs mainly are oriented toward making industrial parks more accessible. These programs supplement local and private funding sources in financing the construction of such improvements as interchanges, frontage roads, or other access roads.

Economists have long been aware that transportation facilities such as highways, expressways, waterways, or railways contribute to regional growth by influencing industrial and trade structures in the benefitted regions. Recent interest in transportation planning has focused on developing an accurate, workable model for evaluating the economic impact of transportation facilities on the surrounding regional economies. Economic researchers have utilized a number of models to measure the economic effect of the transportation facilities. The modeling effort may be classified into three groups: 1) regional econometric models, 2) spatial equilibrium models, and 3) multiregional input-output models.

Regional econometric models are useful in estimating industrial output, income, and employment in regional and in industrial detail. Spatial equilibrium models divide an economy into several geographic regions. Multiregional input-output models can illuminate detailed sectoral relationships for several economic variables: industrial output, income, and employment at the county level, for example.

The overall goal of this research is to develop procedures and/or guidelines to assess the economic impacts of intercity highways. This research has identified three sets of techniques which show promise as candidate procedures which could be applied in Texas.

A benefits matrix model was developed for evaluating proposed urban highway projects that can serve as a framework for establishing statewide construction priorities. The model consists of five elements designed to provide the decision maker with relevant project evaluation information that directly relates to transportation planning objectives. These five elements are user benefits, cost, economic development potential, environmental impact, and relationship of the project to the state arterial system. Evaluation of the model indicates that it can be used at both the local and state levels to analyze a wide range of highway projects. The model can also be used to evaluate rural highway projects and, with some modifications, projects involving other transportation modes.

The Regional Economic Impact Model for Highway Systems (REIMHS) estimates the economic benefits that are related to monetary savings resulting from improvements in operating efficiency, mobility, and safety of vehicular travel. These benefits are in turn translated in terms of industrial output, earnings by employees, and employment generated in selected regional industries. The methodology for applying the interindustry model to highway construction takes the form of: (1) distributing the monetary investment among the relevant highway industries of the region, (2) translating the efficiency, safety, and mobility improvements to equivalent monetary benefits, (3) using these investments and monetary benefits as inputs to the interindustry multiplier matrices, and (4) observing the resulting impacts on the region's total economy.

Regional Economic Models Inc. developed the REMI model to conduct a comprehensive evaluation of potential economic development benefits associated with a proposed major regional highway project, and apply those findings for cost-benefit analysis. The model allows analysis of a series of alternative design levels for alternate highway routes and consists of a set of interacting transportation and economic analysis models. These models are used to evaluate the alternatives in terms of potential for greater business

expansion, new business attraction and tourism, as well as auto passenger user benefits. A rigorous cost-benefit evaluation framework, designed to avoid double counting, is used to rank the alternatives for public policy decision making.

The REIMHS model shows promise as a candidate procedure which could be applied in Texas. Since the needed data is available in a usable format it is recommended that the REIMHS model be calibrated on a selected corridor of the Texas Trunkline System as part of the second year effort. The work plan includes the following general tasks: (1) Identification of travel corridors; (2) Compilation of data; (3) Application of REIMHS model; and (4) Documentation. The final detailed plan will be developed based on discussions with SDHPT personnel.

1. INTRODUCTION

1.1 BACKGROUND

The Texas State Department of Highways and Public Transportation (SDHPT) has received several requests to conduct intercity route studies in recent years. The requests for these studies frequently come from local governments and/or the private sector and are typically promoted on the basis that the new routes would result in improved movement of people and goods and produce economic benefits. The proposed new roadway in the Austin-San Antonio corridor, for example, has been advocated as a means to accommodate recent and projected traffic growth in the I-35 corridor between Austin and San Antonio. The proposed roadway would also improve the accessibility of thousands of acres of undeveloped land and foster additional development and economic growth in the corridor. Similarly, the proposed new roadway in the Austin-College Station corridor is being promoted on the basis of its ability to improve the quality of the highway system serving the two cities and to stimulate additional cooperative efforts between Texas A&M University and the University of Texas.

At the present time, SDHPT is developing a statewide trunkline system, but does not have a formalized intercity highway plan. Instead it relies on feasibility/route studies which are generally oriented toward traffic volumes/cost relationships. In addition, the Department does not currently have procedures in place for systematically assessing the traffic and economic development impacts of proposed intercity highways. As a result, requests for intercity route studies are addressed on a case-by-case basis. This approach to responding to these requests requires a great deal of SDHPT staff time and resources.

The state of the art in modeling the relationships between transportation and its physical, social, and economic environments is largely "one-dimensional." For example, the number of trips produced and attracted by an area can be estimated from information describing the socioeconomic characteristics of the area. However, the problem of estimating the nature and magnitude of the socioeconomic impacts that result from

improvements in the transportation system is much more complex and is not understood nearly as well as the relationships between economic activity and travel demand. As a result, the various interest groups that may be involved in highway improvement projects that are intended to promote economic growth and development often have very different perceptions of the potential magnitude of the economic impacts of highway improvements.

Transportation planners and engineers can employ a number of "standard" procedures (e.g., benefit-cost analysis) to assess the relative cost-effectiveness of alternative transportation improvements. However, benefit-cost analyses, and most of the other traditional economic analysis procedures, typically do not address the complete spectrum of social and economic impacts of highway improvements. In addition, there are several methodologies for quantifying the economic development potentials of transportation improvements within individual travel corridors.

This research report focuses on the relationships between the State's transportation expenditures for intercity highways and economic development. The relationships between economic development and changes in accessibility, travel time, or land values that result from intercity highways are not explicitly addressed. However, the results of this research could provide a useful point of departure for future research efforts directed at quantifying the relationships between changes in accessibility, travel time or land values and economic development.

1.2 STUDY OBJECTIVES

The overall goal of the proposed research is to develop procedures and/or guidelines to assess the economic impacts of intercity highways. Specific study objectives are:

- 1) Review procedures used by other states to identify, prioritize, and select intercity highway improvements that are intended to foster economic development.

2) Identify current analytical techniques for assessing the economic development impacts of expenditures on intercity highways.

3) Develop data bases needed to calibrate and implement these procedures for use in selected travel corridors in Texas.

4) Develop guidelines for use in assessing the economic development impacts of expenditures on intercity highways in Texas.

5) Develop procedure(s) for incorporating these guidelines into the state's existing planning and decision-making process.

1.3 ORGANIZATION OF THE REPORT

This report presents a review of the literature, a survey of current practices regarding policies used to foster economic development through intercity highway improvements, and the identification of current analytical techniques for assessing economic development impacts of intercity highways. Specifically, this report addresses study objectives 1 and 2. The results of this phase of the research should prove useful in those phases of the study directed at the primary objectives (i.e., objectives 3, 4, and 5).

In addition to this introductory section, the report consists of the following major sections:

- Previous Research. This section of the report focuses on literature which discusses and analyzes the relationship between transportation expenditures and economic development.
- Survey of Current Practices. This section of the report describes the policies and procedures used by other states to promote economic development. Current practice consist of two approaches: 1) those states which include the promotion

of economic development as part of their long range statewide planning criteria; and 2) states which simply incorporate economic development objectives into their normal programming process and do not have special funds or programs for the specific purpose of fostering economic development.

- Models/Procedures to Quantify Economic Impacts. A summary of available models/procedures is presented. This summary includes the application, a description of the model, the identification of data needs, and a discussion of any known limitations.
- Summary/Recommendation. This section of the report summarizes: 1) the relationship between economic development and transportation expenditures; 2) the roles of various State Departments of Transportation in the promotion of economic development; and 3) a discussion of a model or procedure recommended for calibration as part of the second year effort.

2. HIGHWAY INVESTMENT AND ECONOMIC DEVELOPMENT

2.1 GENERAL

In recent years, many state departments of transportation have begun to expand their mission to include the use of highway expenditures to encourage statewide economic growth and development. Highway improvements, either in the form of a new highway or the upgrading of an existing one, can generate changes in the functioning of an economy. Economic effects can be beneficial, where accessibility is improved, travel time and cost are reduced, or land values rise; or they can be adverse, where land values decrease or congestion on feeder roads increases. This section of the report reviews the relationship between transportation expenditures and economic development.

2.2 LITERATURE REVIEW

The connection between highway improvements and economic development is both obvious and elusive. Conventional wisdom holds that ample, well maintained highways, streets, and roads are important to an area's development potential because they provide access to resources, goods, and markets. In any form of economic activity, accessibility is a critical need. However, the precise impact of a particular transportation improvement, often times is difficult to assess. Also, a variety of external factors complicate an understanding of this linkage. Some of these are availability and cost of land, labor, and capital; relative tax rates; environmental and general life quality; and the presence of needed services and other types of infrastructure. A reasonable supposition is that good transportation is a necessary but not sufficient condition for economic development to occur. Put another way, transportation facilities contribute significantly to a competitive advantage of an area. The stronger the overall competitive advantage an areas has, the more likely employment - generating investment is to occur (1).

The role of highway development in economic growth is the subject of considerable analysis. Briggs (2) demonstrates, using regression analysis, that the location of interstate

highways has a positive effect on economic growth through population migration and employment change. Siccardi (3) documents the legislative history of federal attempts to stimulate growth through transportation improvements. Siccardi concludes that economic growth is promoted by increasing accessibility to meet specific objectives, such as improving access to airports, hospitals and other community service functions. Additionally, he points out that population receives beneficial growth effects from highway improvements, and this will, in fact become a positive stimulus to prosperity.

Lichter and Fuguitt (4) concur in their examination of demographic response to the interstate highways in non metropolitan areas stating:

The presence of good transportation appears to be a necessary part of any adequate explanation of nonmetropolitan population growth generated by immigration. This effect is posited to operate through employment change in manufacturing, non local trade and services, and tourist related activity.

The effect of highway development on improved accessibility also has a positive impact on property values. Miller (5) discussed the concept of accessibility and the resulting appreciation of property. He asserts that the relative location of a piece of property is a key factor in enhancing property values. Using time series and regression techniques, Langley (6) and Palmquist (7) demonstrate how proximity to major thoroughfares increases adjoining property values. Specifically, Palmquist predicts a 15 to 17 percent increase in property values resulting from being directly accessible to a highway segment. Grossman and Levin (8) examined the effects of highways on distressed or redevelopment areas and suggest that good highway transportation is at least as important in distressed manufacturing centers as in any other urban area; in addition, there are a number of instances of smaller urban centers so located that their economies can be directly stimulated by an improvement of their connections to a nearby, larger metropolitan area with a stronger, more diversified economy. Improved highway transportation is a potentially vital factor in combating the effects of economic decline in a major distressed area. Grossman and Levin (8) also suggest that high quality highways are one of the most important elements in economic development in modern American communities. Although good highways alone are not sufficient to insure economic improvement in competition with other areas, they are a necessity to any area to insure its attractiveness to new industry, its ability to retain existing industry, and its overall efficiency as a place to live and work.

A National Cooperative Highway Research Program study (9) points out that highway improvements, either in the form of a new highway or the upgrading of an existing one, unquestionably generate changes in the functioning of an economy. To some extent the welfare and/or income position of some individuals and/or firms will be altered. Economic effects can be beneficial (positive), where travel time and cost are reduced or land values rise; or they can be adverse (negative), where land values decrease or congestion on feeder roads increases. Rarely is an economic impact clearly all beneficial or all harmful within a community.

Some research results minimize the significance of the role of transportation facilities in the promotion of economic development. For example, Mills (10) examined the effects of beltways on the location of residences and selected work places and reported that beltways and probably transportation facilities in general are, at most, one of many influences on the pattern of urban development and that policies to support revitalization of central cities might be better implemented by using beltways or other transportation facilities to support measures such as land use controls that bear more directly on urban development.

Eagle and Stephanedes (11) addressed the causality relationship between highway improvements and economic development and concluded:

Increases in highway expenditures do not in general lead to increases in employment other than temporary increases in the year of construction. However, in locations that are economic centers of the state, highway expenditures do have a positive long term effect, that is, employment increases more than it would for the normal trend of the economy.

Baird and Lipsman (12) contested the significance of the relationship between highway transportation and economic development stating:

Clearly, major highway system changes promote change in local and regional economies, but whether transportation infrastructure investment causes long-term economic development remains in question.

Wilson (13) reports similar findings in an examination of the role of transportation in regional economic growth. The author concluded:

Transportation improvements have been cited as having important effects on political unity, social cohesion, economic growth, specialization, and price stability, as well as an attitudinal change. Yet ... precisely opposite effects are equally plausible.

2.3 THE ROLE OF ECONOMIC DEVELOPMENT IN STATE HIGHWAY PLANNING

Economic development may be promoted through highway improvements in one of two ways: 1) as part of the statewide planning criteria; or 2) as part of the normal programming process. The results of a preliminary survey of all fifty states indicate that 9 state DOTs give some consideration to, or use the promotion of economic development as part of their long range statewide highway planning criteria. These states and their program names are shown in Table 1.

The program objectives range from the mere completion of a statewide four lane network to the development of a process specifically intended to approach the problem of increasing the competitive advantage of its communities by funding certain types of highway improvements. This section of the report summarizes the policies and procedures used by other states intended to promote economic development.

2.3.1 Review of Selected State Programs

Arkansas

The Arkansas State Highway and Transportation Department proposed connecting all cities projected to have a population of 10,000 or more with a four lane highway, and linking all cities projected to have a population over 5,000 within twenty years, to the four lane arterial system. As a part of the proposal, a tourist and commodity flow network would be established to enhance access to major tourist generators and commodity producers. The proposal is currently limited to a single corridor known as the White River Planning and Development District which comprises a ten county area situated in North Central Arkansas.

The process used to determine the impact of this proposal on the social/economic environment was to examine changes that occurred in two rural Arkansas areas within the

Table 1. Highway System Plan Criteria

State	Criteria					Program Name
	Promote Economic Development	Network Continuity	Commerce Routes	Proximity to Population Centers	Access to Trade/Activity Centers	
Arkansas	X	X	X	X	X	Economic Development Corridor Program
Florida	X	X				Highway System Plan
Georgia	X	X	X	X	X	Developmental Highway System
Iowa	X	X	X	X	X	Commercial & Industrial Network
Michigan	X		X	X		Priority Commercial Network
Nebraska	X	X	X	X	X	Priority Commercial System
Pennsylvania	X		X	X	X	Priority Network System
S. Dakota	X	X	X	X	X	Highway System Study
Wisconsin	X	X	X	X	X	Corridors 2020

Source: (14).

last twenty five years, which saw four lane highway development take place. Population, per capita income, and employment data were compiled for the areas, from at least one decade or more prior to the completion of the improvement to the present time.

A regression analysis was run on the data elements for those time periods prior to completion of the highway to determine the growth rate for future periods that would likely result as a continuation of past growth activity. This trend was projected forward to the next analysis period after the improvement was completed and a base line value of growth established.

The specific benefits projected for the White River Planning and Development District are:

- Economic growth, as measured by population, employment and income increases, will increase at a compounded annual rate of approximately 2.36 percent above trend for the first ten years, and approximately 1.50 percent above trend for the following years.

Specific impacts for the District are as follows:

- Population in 2005 will be some 65,000 greater, and in 2010, some 84,000 greater than it would have been without the highway impacts.
- Total employment will be almost 25,000 greater in 2005 and almost 35,000 greater in 2010 than without the highway impacts.
- Total personal income will be increased by about \$1.7 billion in 2005, and over \$2.8 billion in 2010 above the historical trend.
- State revenues will be increased by some \$119 million in the year 2005, and \$188 million in 2010, above what they would have been without the highway impacts (15).

Florida

The Economic Development Transportation Fund is available to local governments in need of financial assistance for transportation projects to facilitate economic development. The local governmental body must apply on behalf of a company that is considering an expansion or location of new facilities and that has an existing or anticipated transportation problem. A transportation fund award must be used to induce the company to locate or expand in the local government's jurisdiction. The objective of the program is to facilitate economic development in Florida through joint, public-private sector efforts that result in new employment opportunities for the citizens of Florida (16).

Minimum Standards

1. Only one new or expanding company may be identified in the application.
2. There must be an existing or anticipated transportation problem.
3. The proposed expansion or location of the company must be conditioned on the transportation improvements. This means that the company will not locate or expand if the transportation project is not completed.
4. The transportation facility must be fully owned and maintained by the applicant.
5. There must be new permanent full-time employment opportunities resulting from the company's proposed facility expansion (16).

Evaluation Criteria

Funding recommendations are based on the following criteria:

1. Number of new jobs created relative to the amount of funds requested.

2. Amount of new capital investment committed by the company relative to the amount of transportation funds requested.
3. The importance of the transportation project to the company's decision to locate or expand.
4. The average monthly wage rate for jobs created.
5. The location of the transportation project.
6. The absence of other funds to carry out the project within a reasonable time frame.
7. The amount of Division of Economic Development funds requested relative to the total cost of the transportation project.
8. Any other consideration which would have an economic development impact. For example, the applicant's unemployment/poverty rate, a recent outmigration of businesses, the benefits of the project to other businesses in the area, etc.

Awards are made on a first-come, first-serve basis.

Georgia

The Developmental Highway System is expected to enhance Georgia's competitive position with states in the southeast in terms of the percentage of four lane primary road mileage. Despite having one of the largest road systems in the southeast (106,599 miles in 1987), Georgia has the smallest percentage of rural four-lane primary mileage (6.5 percent in 1987). Traffic on Georgia highways is also increasing. Since 1980, traffic has increased by 38 percent.

Another objective of the Program is to stimulate continued economic growth within the state. One component of this objective focuses on tourism, which is growing faster than the overall economy. A study of the economic impact of tourism in Georgia indicates expenditures grew by 7.1 percent in 1987. Additionally, Georgia tourism employs over one quarter of a million people directly or indirectly, while tourists purchased in excess of \$1 billion in motor fuel in 1987. Based on experiences of the Georgia Department of Industry and Trade, if two cities are competing for an industry, the city closest to a four-lane highway will get the industry in most instances. This can be very significant in view of the fact that comparative economic data over an 18-year period from 1965-83 show counties located on or near a freeway (within 25 miles) had increases of 12.2 to 129.1 percent over non-corridor counties in key economic indicators such as population, employment, income and taxable sales. In addition, it is estimated that a new industry which brings 100 jobs to an area generates nearly \$2 million in annual personal income, \$1.47 million in annual retail sales, and will create 64 non-manufacturing jobs.

The final objective of the Program involves safety. This objective is based on the premise that multi-lane divided roads are safer than two-lane roads, especially at higher traffic volumes. In rural areas, accidents occur about three times more often on two-lane highways than on multi-lane divided highways. Safer driving conditions also translate into cost savings. Multi-lane divided highways reduce the number of accidents and thereby reduce the overall cost of all accidents annually by over \$100,000 per mile (17).

Iowa

As part of its attempts to improve the climate for economic diversification and expansion, the Iowa General Assembly established in its 1985 session what has become known as the RISE (Revitalize Iowa's Sound Economy) program.

RISE is funded by a dedicated two-cent per gallon motor fuel tax that is expected to generate approximately \$27.5 million to \$30 million per year. The legislation establishing RISE stipulates that program funds are not to be used to support normal road maintenance,

rehabilitation and development functions, but are to be used to directly facilitate and encourage economic development within the state (1).

In administering the program, the Iowa DOT is to consider the following:

- Proportion of matching funds a political subdivision will provide.
- Proportion of private funds to be provided.
- Total number of jobs to be created.
- Level of need.
- Impact of the proposed project on the economy of the area affected.

To qualify, an applicant city or county must be in the process of negotiating a location decision with a developer or firm. No restrictions are placed on the types of economic activities that are eligible (i.e., they can involve retail trade as well as industrial activities). The firm must be able to provide assurance that the job creation or retention in question would not take place in Iowa without the RISE investment. The local government must demonstrate how all other infrastructural needs are or will successfully be met. Finally, a minimum 20 percent funding match for RISE funds from the private firm or the local government is required (1).

Initially, the Transportation Commission decided against utilizing performance measures as formal standards for evaluating project viability. After several months' experience and reviewing other states' experiences, two performance measures now are being used as key indicators:

- Cost effectiveness: a desirable upper limit of RISE funding per job created or retained is \$3,000.
- Capital leveraging: the ratio of non-RISE total (private and public) capital investment to that provided by the program should be a minimum of five to one.

Michigan

Michigan's legislature, the State Transportation Commission, and other interested parties established a special transportation economic development fund to respond to the changes in Michigan's economy and to meet the demands placed on Michigan's transportation infrastructure. Legislation creating Michigan's Transportation Economic Development Fund was enacted in December, 1987. The fund is administered by the State Transportation Commission through the office of Economic Development.

The fund is available for local transportation jurisdictions and the State to use for immediate highway needs relating to a variety of economic development issues. The fund provides an option for meeting the often critical and urgent demands of economic development on the transportation system.

The economic development fund is structured to provide for a broad variety of funding needs. The types of projects eligible for Transportation Economic Development Fund assistance are:

- Category A - Highway projects related to economic development opportunities in agriculture or food processing, tourism, forestry, high technology, research, manufacturing, or eligible office center developments.
- Category B - Additions to the state trunkline system.
- Category C - Reduction of congestion on primary county roads and major city streets within counties with a population greater than 400,000.
- Category D - Road improvements in counties with a population of 400,000 or less to create an all-season road network.

- Category E - Construction or reconstruction of roads essential to the development of commercial forests in Michigan.
- Category F - Road and street improvements in cities in counties with a population of 400,000 or less.

The above six categories complement each other toward achieving the overall program mission of the fund to enhance the ability of the state to compete in an international economy, to serve as a catalyst for economic growth of the state, and to improve the quality of life in the state. Additional information detailing the specific fund categories are shown in Table 2 (18).

Nebraska

Economic development efforts in Nebraska consist of two elements: (1) Commercial and Industrial Development program; and (2) Public works projects community development block grant. Key points of each are summarized below.

Commercial and Industrial Development

- This is a Department of Roads' revolving fund from which state-aid may be made available to municipalities or counties to promote commercial and industrial park development within or near municipalities having a population of 10,000 or less. The municipal population will be based on the most recent estimate of the U.S. Bureau of the Census. The park must be adjacent to a state highway and the access to the park must be a municipal street or county road, as defined by Nebraska Statutes.
- To be eligible for state-aid from this fund, there must be at least two separately-owned business units in the park and these businesses must derive or have the potential to derive, a substantial portion of their gross revenue from the sale of products or services to non-Nebraska customers.

Table 2. Michigan's Transportation Economic Development Fund Highlights

Category	Objectives	Eligibility Requirements
A. Economic Development Road Projects	<ol style="list-style-type: none"> 1. Systemwide and Area Service <ol style="list-style-type: none"> (a) Reduce transportation user cost associated with economic development opportunities. (b) Provide new or improved roads to enhance accessibility to markets. (c) Provide or improve roadways essential to travel and shipping demands. 2. Site Accessibility <ol style="list-style-type: none"> (a) Provide accessibility essential to economic development opportunities. (b) Direct transportation investments to maximize the use of existing facilities. (c) Provide highway improvements that promote safe and efficient travel. 3. Jobs <ol style="list-style-type: none"> (a) Direct transportation investments toward economic development opportunities that attract or retain permanent employment. (b) Use transportation investments to support economic development opportunities in areas of high unemployment. 4. Tax Base and Policy <ol style="list-style-type: none"> (a) Direct transportation investments toward opportunities which maximize developmental potential. (b) Encourage cooperative projects that maximize the impact of TEDF investments. (c) Direct transportation investments toward projects which support the economic development policies of the State of Michigan. (d) Ensure the maximum benefit of TEDF investments by encouraging the maximum levels of non-TEDF financing. 	<ol style="list-style-type: none"> 1. A particular transportation need must be shown to exist. 2. The project must create or retain permanent jobs. 3. The project must increase the tax base of the local unit of government. 4. Negotiations between an appropriate agency and developers shall be in progress regarding a location or retention decision. 5. Non-transportation infrastructure and support services necessary to support the economic development project are currently underway or have been committed. 6. Applications must be accompanied by a "Resolution of Support" from the appropriate unit(s) of government. 7. The project must relate to a specific target industry. 8. Matching funds of at least 25% of the cost of the transportation improvement are required. 9. The transportation improvement must relate to an immediate and non-speculative economic development project.

Source: (18).

Table 2. Michigan's Transportation Economic Development Fund Highlights

Category	Objectives	Eligibility Requirements
B. State Trunkline Service	<ol style="list-style-type: none"> 1. Provide for an integrated network of state trunklines linking cities and larger towns. 2. Provide for spacing of trunklines to commensurate with demand. 3. Provide a trunkline network to serve long distance interstate and regional travel. 4. Provide service to major state and regional activity centers. 5. Provide for state trunkline service essential to economic activity. 	<ol style="list-style-type: none"> 1. Demonstrate a particular transportation need. 2. Enhance economic activity. 3. Satisfy travel demands appropriate to state trunkline designation.
C. Urban Congestion Relief	<ol style="list-style-type: none"> 1. Improve the operational level of service in heavily congested areas. 2. Reduce the accident rate on heavily congested roadways. 3. Improve the surface and base condition of heavily congested roadways. 4. Improve the social, economic, and environmental conditions of areas adjacent to heavily congested roadways. 	<ol style="list-style-type: none"> 1. The project must reduce urban congestion. 2. The project must be within an urban county. 3. A particular transportation need must be shown to exist. 4. The road must be on the federal system. 5. Project is limited to adding travel and left turn lanes, or intersection improvements. 6. Project cost be limited to construction and pre-construction cost. 7. Matching funds of at least 25% of the cost of the project are required.
D. Secondary All-Season Road System	<ol style="list-style-type: none"> 1. Complement the existing state trunkline system with improvements on connecting local routes that have high commercial traffic. 2. Minimize disruptions that result from seasonal load restrictions. 3. Increase the interchange potential between modes. 	<ol style="list-style-type: none"> 1. A particular transportation need must be shown to exist. 2. The project must be within a rural county. 3. The road must be on the federal aid secondary system. 4. The project must be for improvements on hard surface roads. 5. Project cost must be limited to construction cost. 6. Matching funds of at least 25% of the cost of the transportation project are required.
E. Forest Roads	<ol style="list-style-type: none"> 1. Increase access to forest resources harvestable over the next five years. 2. Increase the safety and efficiency of forest raw material transport. 	<ol style="list-style-type: none"> 1. The project must be located in one of the 47 eligible counties. 2. The project must be for road construction or reconstruction.
F. Cities in Rural Counties	<ol style="list-style-type: none"> 1. Improve access to the state all-season system, including the Priority Commercial Network. 2. Improve safety and all season capabilities on routes having high commercial traffic. 3. Increase the interchange potential between transportation modes. 	<ol style="list-style-type: none"> 1. Projects must be for county road and city/village street improvements on the federal-aid-urban system.

Source: (18).

- The population of the municipality closest to the park will determine the number of jobs that must be created. The "closest" municipality will be determined by the distance from the driveway of the park to the municipal limits via a state highway. For a municipality having a population of 5,000 to 10,000, the combined total of new jobs created in a commercial and industrial park must be at least 50. For a municipality with a population of less than 5,000, the combined total of new jobs created in a commercial and industrial park must be at least 25.
- New jobs created by an existing business unit moving into a new park will be based on the average of the total number of full-time equivalent permanent employees on the payroll of the business unit over the preceding two years. The "full-time equivalent" shall be equal to the total annual employee hours divided by 2,080. The job quota must be met within 18 months after a business begins operation in the park.
- The following types of businesses in commercial or industrial parks will not qualify for this fund: restaurants, service stations, and convenience stores. Other retail businesses may qualify if they meet the criteria set forth in the preceding paragraphs.
- On two-lane highways, development funds may only be used for the construction of deceleration and acceleration lanes. On four-lane highways, funds may only be used for median crossovers, turning lanes, and deceleration lanes. The municipality, county, or developer must provide the funds to construct the driveway from the edge of the travel lane or the end of the radii. If a deceleration lane is constructed with development funds, the driveway will begin at the outer edge of the deceleration lane and extend to the right-of-way line or property line.
- The Department of Roads will provide the design standards for the deceleration lanes, accelerations lanes, median crossovers, turning lanes, and fly-by lanes based

on the amount of traffic generated by the park and the present and forecast average daily traffic of the adjacent state highway.

- All materials used in constructing the improvements within the state highway rights-of-way must meet the requirements of the Nebraska "Standard Specifications for Highway Construction."
- State-aid will be allocated on a first-come, first-served basis. Each application by a municipality or county must contain adequate documentation to substantiate the volume of traffic to be generated by the park and that the required number of jobs will be created within 18 months.
- The municipality or county will be required to enter into a written agreement with the Department of Roads. The agreement will include, but not be limited to the following items: (19)
 - Contractor liability insurance
 - Work area traffic control
 - Compliance with the Nebraska "Standard Specifications for Highway Construction"
 - The scope of work and specific items to be constructed.
 - The data and amount of state-aid to the municipality or county.
 - Pay-back to the department from the municipality or county shall begin two years after the date that the completed work is accepted by the state's district engineer.
 - The maximum pay-back period is five years after the date that the completed work is accepted by the state's district engineer.
 - Pay-back schedule.

Funds Set Aside for Public Works Projects

- All counties and municipalities of less than 50,000 are eligible.
- Eligible activities are: water system improvements, including distribution, course, or storage; street, curb, gutter or sidewalk improvements; sanitary or storm sewer system improvements; flood or drainage improvements; or electrical system improvements, including distribution and transmission. Acquisition/easements, demolition and clearance are eligible when done in support of the eligible activities.
- Funds are reserved from June 1 to December 31, 1989. After that, all Economic Development funds will be pooled and made available for public works, loans, loan guarantees, job training, equity financing.
- Funds will be awarded as grants on first-come/first-served, non-competitive basis.
- The maximum grant is generally \$500,000, and no more than 50% of the total public improvement costs or \$20,000 per job provided, whichever is less.
- Projects must meet the national objective of creating or retaining jobs, i.e., 51% benefit to low- and moderate-income (LMI) people.
- Jobs are computed on full-time equivalencies (2080 hours) and must be in place within 18 months after the public improvements are completed.
- Projects must meet the state objective of generating new wealth; commercial and retail projects are generally ineligible.
- An engineering feasibility study is required to determine the need for and the cost-effectiveness of the public improvements.
- Any costs for oversizing will be borne by the city and will not count toward its 50% match.
- The national objective applies to any business locating in the area served by the public improvements for a minimum three-year period following their completion.
- When the public improvements also serve a residential area, at least 51% of the residents must be LMI (19).

Pennsylvania

In the fall of 1985, the Pennsylvania Department of Transportation launched an Industrial-Commercial Access Network (I-CAN) pilot study. The purpose of the study was to identify a network of roads most important to industry which were not presently identified as part of other priority networks. Roadway obstructions which force trucks to take lengthy detours and increase the operating cost were to be identified for programming consideration by the Department and local governments. With the Department's goal to develop an integrated system of economic development highways, all priority planning networks were reviewed and rationalized to determine if the roadways were functioning as identified, or if a reclassification to another network was appropriate.

The Pennsylvania Department of Transportation has undertaken three major transportation initiatives which have improved Pennsylvania's infrastructure by removing obstructions to the movement of goods which is important to commerce. These initiatives include the Priority Commercial Network, the Agri-Access Network, and Billion Dollar Bridge Bill I.

Priority Commercial Network

In 1982 the Priority Commercial Network (PCN) was developed. This system of highways carries heavy volumes of trucks and serves as the economic backbone of the Commonwealth. The PCN represents approximately 12,000 miles of highway in the state which typically carries traffic of greater than 500 trucks per day or are connector roads for regional industries such as coal. Included in the PCN are the Interstate System, the Tandem-Truck Network, and the Core Coal Haul Network. The PCN was identified by the Department in cooperation with county/regional planning agencies and economic development authorities (20).

Billion Dollar Bridge Bill I

Also in 1982, the Pennsylvania General Assembly and the Thornburgh Administration made a concerted effort to help resolve the Commonwealth's most critical bridge problems by enacting Billion Dollar Bridge Bill I. The program includes 979 projects for a total cost of \$1.4 billion. The main funding sources include the Pennsylvania Axle Tax, Federal Critical Bridge funds and local funds. This is the largest bridge restoration and replacement program in the nation. As of June 30, 1986, 551 projects for a total cost of \$773 million have gone to construction or have been completed. This program is helping to eliminate bridge impediments on the priority networks, ultimately saving millions of dollars in transportation cost. Elimination of weight-restrictions on the Priority Commercial Network alone will save the trucking industry over \$200 million annually in avoided detour costs when the program is completed. The program will also result in operational savings to many school districts and provide shorter and safer routes for emergency vehicles (20).

Agri-Access Network

In 1984 the Agri-Access Network (AAN) was developed. The AAN includes approximately 11,800 miles of rural roads which provide access to Pennsylvania's agricultural areas. The network includes 1,000 miles of locally owned roads. These roadways provide key links between the farming communities or agri-business establishments and the main commercial highways, the PCN. The AAN was identified through a cooperative effort between transportation planners, extension agents, farmers, agri-business, and local government representatives (20).

The work program for the I-CAN pilot study was developed by the Bureau of Strategic Planning with input and approval from both the I-CAN steering and work committees. The entire study effort centered around the completion of six tasks, these task being:

- 1) Preparation of Base Maps: the initial task was the preparation, for each pilot county, of a map depicting the key priority transportation networks. Those networks identified are the Priority Commercial Network (PCN) and the Agri-Access Network (AAN). These previously identified routes provide the focus with which to link the most significant industrial access roadways within each county (20).
- 2) Establish Criteria and Identify Major Industrial-Commercial Users: before plotting I-CAN networks, major generators of truck traffic had to be identified. Each pilot county developed its own criteria to do so based upon methods or sources of information most appropriate for each unique county situation (20).
- 3) Identify Preliminary Industrial-Commercial Access Highway Obstructions: weight-restricted bridges, posted or bonded roads, and other obstructions to industrial truck traffic were then identified and plotted on the base maps for each of the pilot counties. These obstructions impede the direct flow of industrial traffic from point of generation to and from the PCN, proving time-consuming to the industry and costly to the consumer. It is an important element of the pilot study that these obstructions be identified and mapped to determine their impact on the networks and the flow of truck traffic (20).
- 4) Review and Refine Industrial-Commercial Access Network: the products of the first four work tasks were refined through a variety of methods. Both the District Office and the Planning Commission staffs performed field views to confirm whether the preliminary I-CAN routes did indeed display the characteristics as defined by the criteria utilized. For that matter, all previously defined networks (PCN and AAN) were reconfirmed based on field views. Truck volumes were also used as criteria to determine/confirm the character of the roadways initially identified as preliminary I-CAN. In conjunction with the field views and use of truck volumes, rationalization meetings were conducted in each pilot county involving the District Office, the Planning Commission, and the Bureau of

Strategic Planning representatives. The PCN, AAN and I-CAN were reviewed as a unified and comprehensive system and appropriate reclassifications and removals were made (20).

South Dakota

The state trunk highway system is delineated by state statute. Because of this fact, the state highway system has never been analyzed systematically by the Department of Transportation to determine if the overall function provided by the entire state highway system makes sense. In the past, decisions to add or delete roads from the state system have not been based upon a uniform set of criteria. As a result, many state highways actually function as local highways and the state does not have the resources to address both local and state needs (21).

This hampers the ability of the state to serve statewide economic development, tourism, and the marketing of agricultural products. This process is intended to allow the state to make the additions to and deletions from the state highway system more systematic and based upon a uniform set of decision making guidelines or criteria (21).

The focus of this state's efforts is to provide transportation services linking significant locations within the state. Significant locations refer to locations in the state which provide an important service justifying a state transportation link. These important locations include county seats, population centers of 2,500 or greater, major trade centers, state facilities and public recreational access areas.

Wisconsin

Corridors 2020 is Wisconsin's long range highway improvement program designed to enhance future economic development and to meet future mobility needs.

The Corridors 2020 network is composed of two elements:

- A backbone system of multilane divided highways connecting all major population and economic centers to each other and to the national transportation system; and
- A system of two- and four-lane connectors directly linking other significant economic and tourism centers to the backbone system.

Together, these components will create a 3200 mile continuous network linking Wisconsin communities to the nation's interstate and multilane highway systems. While this network comprises only 27 percent of the state highway system, it carries 55 percent of all traffic on the system. Nearly all cities and villages in Wisconsin with a population over 5,000 will be within five miles of either a backbone or connector route (22).

Seven criteria were used to determine the backbone system. Each criterion is identified and described below.

1. Capacity improvements. Included as candidates for the backbone system were highway segments with projected traffic volumes sufficient to require additional lanes by 2020, as determined by the 1988 state highway plan update process.
2. Efficient capacity improvements. Highway segments were given additional weighting where the benefits of the prospective capacity improvements would exceed the construction cost. Benefits included in the analysis were travel time savings, accident savings, and changes in vehicle operating cost.
3. Service to population centers. Included as candidates for the backbone system are highways interconnecting population centers with more than 50,000 people (today or projected for 2020).
4. Service to trade centers. In an effort to identify Wisconsin's most important trade centers, DOT has classified communities into five categories (Metropolitan,

Regional, District, Area, and other) according to their current and future economic influence. The following measures were used in this classification:

- population
- employment
- full property valuation
- retail sales
- wholesale sales
- selected service sales

Those highways interconnecting the most significant trade centers (Metropolitan and Regional) become backbone candidates.

5. Truck volume. Truck traffic is a measure of the extent to which a highway serves regional industrial and agricultural needs. Included as candidates for the backbone system are highway segments with average daily truck volumes greater than 1000 in 1988 or greater than 2300 by 2020.

6. Service to manufacturing centers. The manufacturing sector employs by far the largest number of Wisconsin residents and is expected to remain an important sector in Wisconsin's economy. Therefore, providing high quality service to the manufacturing centers of the state is an important consideration in determining the backbone system. DOT has classified into three groups (Tier 1, Tier 2, and Tier 3) all Wisconsin counties (and nearby counties in bordering states) according to their manufacturing significance today. Three factors were used in this classification:

- Number of manufacturing businesses
- Number of manufacturing employees
- Value added by manufacturing

Highways considered as candidates for the backbone system are those connecting the most important manufacturing centers (tier 1) to their major market areas.

7. Service to recreation/tourism centers. Recreation and tourism, major factors in Wisconsin's economy, are highly dependent on highway transportation for safe and convenient travel to the recreational attractions and vacation areas. Therefore, service to the state's most significant concentrations of recreation/tourism is an important factor in determining the multilane backbone system. To identify these centers, DOT classified Wisconsin counties (and nearby counties in neighboring states) into three groups (tier 1, tier 2, and tier 3) according to their importance for tourism. Ten factors are used:

- Number of recreation/tourism related businesses
- Number of recreation/tourism related employees
- Number of lodging establishments
- Number of lodging rooms
- Number of campgrounds
- Number of campsites
- Number of seasonal dwellings
- Private tourism attraction and state park visitations
- Number of downhill ski runs
- Cities with sports teams of statewide significance.

Included as backbone candidates are highways connecting the most important recreation/tourism (tier 1) counties to the greatest source of visitors (cities with populations greater than 100,000).

The connector system is intended to tie the next level of economic and tourism centers to the backbone system. Therefore, similar criteria were used in the evaluation of candidates for connector routes. Connector segments are required to serve a corridor (or

larger) trade center and also meet the requirements for one of the following criteria: truck volume, service to manufacturing centers, or service to recreation/tourism centers.

1. Service to trade centers. Connectors are chosen in order to serve corridor centers as well as any Metropolitan or Regional centers not served by the backbone corridor system.
2. Truck volume. Included as connector candidates are highway segments with average daily truck volumes greater than 500 in 1988 or 1,150 by 2020.
3. Service to manufacturing centers. The connector routes are intended to provide direct service to the second tier of manufacturing counties, both in the state and in nearby counties of adjacent states, as well as any Tier 1 counties not served by the multilane backbone system.
4. Service to recreational/tourism centers. Connector candidates provide direct service to tier 2 counties (in Wisconsin and in nearby counties in neighboring states) as well as only tier 1 counties not served by the backbone routes (22).

2.3.2 Summary

Many states simply incorporate economic development objectives into their normal programming process and do not have special funds or programs for the specific purpose of fostering economic development. The following paragraphs summarize information from all 50 state transportation agencies regarding programs tied to economic development.

The nature of involvement in economic development-related activities by state transportation agencies is presented in Table 3. Thirty-six states explicitly take economic development into account in their highway programming activities. Of these states, 14 incorporate economic development objectives into their normal programming process but do not have special funds or programs for the specific purpose of fostering economic

development. The methods used range from informal petitions on the part of local governments for priority programming to point systems for ranking projects (1).

A surprisingly large number of states, 22, have categorical funding or bonding authority for economic development. Iowa, for example, has a dedicated two-cent motor fuel tax, the proceeds of which flow into a special fund. Programs vary in scale from Maine's \$400,000 industrial park matching program (to supplement private sector funds) to more extensive efforts, such as those in Florida, Iowa, Massachusetts, Michigan, and Washington (see Table 4).

Eleven states' programs mainly are oriented toward making industrial parks more accessible. These programs supplement local and private funding sources in financing the construction of such improvements as interchanges, frontage roads, or other access roads. In their industrial park programs, some states specify funding limitations based on the amount of local or private funds contributed or on the number of jobs created. South Dakota for example, requires:

- A commitment to actual construction of the industrial facility in the near future.
- A committed capital investment of at least five times the required state participation costs.
- Total employment for all facilities in the industrial park of at least 50.
- Local participation in funding of industrial park roads of at least 20 percent of the approved state project construction budget.
- Dedication of the roadway and adjacent right-of-way to public use.
- State participation limited to roads within the industrial park that are one mile or less in length.

Similarly, Virginia stipulates that unmatched state highway funding shall not exceed 10 percent of the total private capital investment in the assisted development. Florida requires that for expansions of existing facilities, at least 100 new positions must be created

Table 3. Summary of State DOT Transportation Agency Involvement

State	Economic Development Objectives in Programming ¹	Special Economic Development Funds/Bonding ²	Industrial Park Road Program ³	Quick-Response Capabilities ⁴
Alabama	*	*	*	
Alaska		*		
Arizona				
Arkansas	*	*	*	
California	*			
Colorado	*			
Connecticut	*			
Delaware	*			
Florida		*		
Georgia	*			
Hawaii	*			
Idaho	*			
Illinois	*	*	*	
Indiana	*			
Iowa	*	*		*
Kansas	*	*	*	
Kentucky	*	*		*
Louisiana	*	*		
Maine	*	*		
Maryland			*	
Massachusetts	*	*		*
Michigan	*	*		
Minnesota	*	*		*
Mississippi			*	
Missouri				*5
Montana				
Nebraska				
Nevada	*			
New Hampshire				
New Jersey				*
New Mexico	*			
New York	*	*		
North Carolina	*	*		
North Dakota				
Ohio	*			
Oklahoma	*	*	*	
Oregon	*			
Pennsylvania	*			
Rhode Island				
South Carolina				
South Dakota	*	*	*	
Tennessee	*		*	
Texas	*			
Utah	*			
Vermont				
Virginia	*	*		
Washington	*	*		
West Virginia	*	*	*	*
Wisconsin	*	*		*
Wyoming	*	*	*	

Source: (1).

- Note:
1. "Economic Development Objectives in Programming" means that the state specifically takes economic development into account in its capital programming process or has special highway programs to encourage economic development.
 2. "Special Economic Development Funds/Bonding" means that the state has a categorical funding source or bonding authority for economic development or industrial park roads.
 3. "Industrial Park Program" means that the state has a special program dedicated to constructing this type of road.
 4. "Quick-Response Capabilities" means that the state has the ability to expedite economic development-related road projects.
 5. Expedites environmental review for economic development projects (1).

Table 4. Details of Special Economic Development Highway Funds/Bonding Authority

State	Approximate Annual Budget Budget (\$ Million)	Program Name/Description
Alabama	No annual budget	Single-bond issue of \$25 million
Alaska	No annual budget	State economic development program
Arkansas	Not reported	Industrial access roads
Florida	\$10.0	Economic Development Transportation Fund
Illinois	\$4.4	Five-year average. Part of "Build Illinois"
Iowa	\$7.5	Six-year average. "RISE" program
Kansas	\$3.0	Economic Development Fund
Kentucky	No fixed budget	Industrial access road program
Louisiana	No fixed budget	Discretionary funds
Maine	\$0.4	Federal funds
Massachusetts	\$10.00	Public Works and Economic Development Program
Michigan	\$13.3	Three-year average. Economic Development Program
Minnesota	No annual budget	Municipal bonding, reimbursed by state
New York	\$5.0	Industrial Access Program
North Carolina	\$2.0	State Economic Development Program
Oklahoma	\$1.6	Industrial Access Road Program
South Dakota	\$0.5	Industrial Park Construction Program
Virginia	\$3.0	Industrail Access Fund
Washington	\$10.0	Community Economic Revitalization Board
West Virginia	No fixed budget	Contingency funds
Wisconsin	\$4.9	Proposed "AHEAD" Program
Wyoming	\$1.0	Industrial Road Program

Source: (1).

if the initial grant request is \$100,000 or more. The motivation for specifying match rates is to use limited state funds to leverage as much local and private funding as possible. Even states that do not have specific percentage limits have indicated that they place considerable emphasis on the relative size of the non-state funding share (1).

Because private sector development decisions often are made in a compressed time frame, eight states' programs include the capability for a "quick response" to funding requests for development-related highway projects. Quick-response program features apply when a development is being negotiated between a local government and private sector investors and highway facilities are a significant issue. The nature of these quick-response capabilities varies from expedited environmental review procedures in Minnesota to readily-available capital, as in Florida and Iowa and in Wisconsin's proposed program (1).

Because most states only recently have established transportation programs intended to bolster economic development, limited information on impacts is available. In their responses, however, three states noted specific impacts. In North Carolina road

improvements costing \$4.5 million were instrumental in attracting a major office headquarters with an initial investment of over \$50 million that will employ 2,000 persons. Over the past three years, Michigan has invested \$40 million in economic development-related projects; it is believed that these improvements have been instrumental in retaining 18,000 jobs and attracting 6,300 new jobs (1).

2.4 SUMMARY OF MODELS/PROCEDURES TO QUANTIFY ECONOMIC DEVELOPMENT IMPACTS

Public investment, economic development, and their relationship have long been recognized as one of the premier economic issues. The principal question addressed in this study is how economic development and transportation investment are related to each other. Facing limited resources, it is crucial for a policy maker to undertake the most efficient investment project. In recent years, economists and engineers have attempted to address this issue from their individual perspectives.

This section of the report provides an overview of the state of the art in economic modeling. The review focuses on the models which have been successfully calibrated and applied in studies of the relationship between transportation investment and economic development. Additional information on these models can be found in the Appendix.

2.4.1 Classes of Economic Models

A study of the relationship between transportation investment and economic development should begin with a description of two variables. The transportation investment can be clearly defined as an investment that improves, maintains, or adds transportation infrastructure. However, the concept of economic development is not universally agreed upon. One may think of increased employment as economic development whereas others may consider expanded total industrial output as the development of the economy. Hence, economic development should be perceived as the total improvement of a given economy in terms of output, employment, earnings, and standard of living of its

inhabitants. An economic model, explaining the relationship between transportation investment and economic development, should take this information into account.

Four broad types of economic models are described in this subsection. These are: econometric base model, input-output base model, time-series analysis, and cost-benefit framework.

Econometric Base Model

The collection of economic theory and statistical inference is included in the econometric base model. For example, the question of how transportation investment and economic development relate to one another can be answered with the assistance of economic theory. The estimation of a single equation and a system of simultaneous equations is often utilized in order to obtain empirical results. In the past, an econometric model was capable of analyzing only time-series or cross-section data. However, thanks to advancements in econometric modeling, both time-series and cross-section data can be combined and explained by the econometric method, regardless of the type of equations at hand (e.g., a single equation or a system of equations).

Input-Output Base Model

The input-output framework has been applied in several different economic fields, ranging from econometrics to urban planning. Input-Output (I/O) models were initially intended to be used at the national level to analyze the interdependency among industries in an economy, however, I/O models have been extended to cope with smaller units of the economy. For example, regional and multiregional economic issues can be analyzed using an I/O framework. The I/O methodology can be separated into two major schemes:

Simple Input-Output Model

Total outputs of all industries can be computed given technical and trade coefficients which are assumed to be constant and the final demand. This simple model is best suited for analyzing a short-term impact of policy change.

Variable Input-Output Model

The information on changes in output and input prices are taken into consideration. Therefore, the values of the multipliers can be updated upon receiving the price signals.

Autoregressive Time-Series Analysis

The basic idea of autoregressive time-series analysis is that the future behavior of a variable of interest will be governed by its history. The model was made famous by Box and Jenkins (23). Autoregressive Moving Average (ARMA) and Vector Autoregression (VAR) models are parts of such analysis. ARMA models assume that a variable in question depends on its past values and past random errors. VAR, on the other hand, assumes that a column vector of the combined dependent and independent variables is a linear function of a column vector of this past value and an error term. Thus, the VAR model is capable of forecasting a column vector of variables consisting of responding variables and driving variables.

Cost-Benefit Analysis

Most transportation projects are evaluated in terms of their costs and benefits to assist the policy maker in identifying the most efficient project. The cost-benefit framework relies basically on the measurement of costs and benefits of a given project. However, a good cost-benefit analysis must take into account the importance of an opportunity cost of the project in question. The opportunity cost is the cost of forgoing the best alternative program in which available funds may be invested.

2.4.2 Description of Selected Model

Despite the theoretical and structural differences between the models reviewed in this report, the general outputs are fairly similar. An investment in transportation infrastructure will not only directly benefit automobile users but will also bring about the development of the economy (no matter how we define economy) as a whole.

Brief descriptions of selected economic models are given in this subsection. Additional details can be found in the Appendix.

TRIM

The Transportation Impact Model (TRIM) evaluates the economic impacts of a given capital investment. The model was calibrated with a 43-commodity input-output table for the province of Ontario in Canada. TRIM calculates the values for labor income, Gross Domestic Product (GDP), employment, gross sales, tax revenue, imports from other provinces and abroad, and primary energy consumption. These numbers are representative of economic development as a result of the transportation investment. The results from the model indicate that an initial transportation expenditure of 1 dollar would bring about 1.4 dollars in total GDP for the province of Ontario (24).

Aschauer

Aschauer (25) has examined the role of public expenditures including an investment in the national infrastructure as a means to foster national economic growth. A generalized Cobb-Douglas production function¹ is estimated by nonlinear least squares and instrumental variables techniques. Aschauer shows that a 1% increase in the "core" infrastructure will

¹ A production function can be characterized as a mathematical relationship of input and the maximum feasible level of output. A generalized Cobb-Douglas production function can be written as $Y = AL^\alpha K^\beta G^\gamma$ where Y, L, K, G denote private output, labor, private capital, and government capital, respectively. Parameters are represented by A, α , β , and γ .

create 0.24% increase in the output-capital ratio for the private sector, given everything else constant.

Cambridge Systematics, Inc.

The economic forecasting and simulation model developed by the Regional Economic Models, Inc. (REMI) was utilized in a study of proposed highway improvements in Wisconsin. Using both national and Wisconsin economic data, an input-output base model was constructed to forecast the impact of trucking costs reduction on the Wisconsin economy. A benefit-cost analysis was performed in order to evaluate the proposed highway construction plan. The overall benefit included direct auto user benefits and economic development benefits. The direct auto user benefits consisted of accident reduction, travel time saving, and reduced operating cost. The economic development benefits are business attraction and expansion, tourism effects, and induced benefits from the expansion of existing firms and the addition of new firms. Application of the model in Wisconsin showed that constructing and maintaining a given freeway will generate a total benefit-cost ratio of 1.5 (26).

Eagle and Stephanedes

In this study, a time-series analysis was applied in order to evaluate the causality between highway construction expenditures and employment. The direct Sim's test² was applied to the combined time-series and cross-section data for all counties in Minnesota. Using structural plots³, Eagle and Stephanedes (11) found that 108 new jobs could be created over a 15 year period as a result of a \$1 million increase in highway expenditures.

² The direct Sim's procedure tests whether or not a variable x causes variable y.

³ The structural plot assumes a specific structure (e.g. linear functional form) so that a dependent variable (employment) depends on predetermined variables (highway expenditure and employment lagged for a certain period of time). Then the structural equation was estimated using VAR. Finally, the employment variable can be forecasted.

Lemmerman

A cost-benefit model is utilized with a nomograph to determine the difference between estimated highway construction costs and the cost to operate and travel before and after the completion of such project. The difference represents the benefit of undertaking the transportation improvement plan. The benefit-cost ratio is shown to be about 0.5 for a given project. However, the benefits of such highway construction were not related to economic development (27).

Liew and Liew

A multiregional variable input-output framework was employed in their study of the economic impact of the Arkansas navigation system. The model provides estimates of the percentage change in industrial outputs and prices before and after a reduction of transportation cost. Liew and Liew (28) found that a 5% reduction in transportation costs in region 1 and 2 will boost region 1 non-manufacturing production by 2.989 percentage points.

REIMHS

The Regional Economic Impact Model for Highway Systems was developed by Politano and Roadifer in 1988 (29). REIMHS calculates the benefit of operating efficiency, mobility, and safety savings from standard highway data. The results are then transformed by regional multiplier matrices, obtained from RIMS II⁴ which is provided by the Bureau of Economic Analysis. Consequently, the effects of highway investment on output, earnings and employment are calculated by REIMHS. In applications in the Dallas/Ft. Worth area, the model estimated that a \$17.6 million increase in total regional outputs is the result of a \$10 million investment in transportation infrastructure.

⁴ RIMSII stands for regional input-output modeling system developed by the Bureau of Economic Analysis. Total multipliers for output, earnings, and employment by industry can be obtained from RIMS II.

3. SUMMARY AND RECOMMENDATIONS

The relationship between highway improvements and economic development is the subject of considerable debate. The results of some research suggest that high quality highways are one of the most important elements in economic development in modern American cities. Other study results question the intrinsic ability of highways to induce economic development and recommend that priority be given to improving those links which connect rapidly growing central cities. It is generally agreed, that at the very least good highways are a necessity to any area seeking to insure its attractiveness to new industry, its ability to retain existing industry, and its overall efficiency as a place to live and work.

The inclusion of economic development as a criteria for statewide highway planning is becoming increasingly popular. With impending needs to rehabilitate existing highway systems and a shortage of available funds, new construction must be sufficiently justified. Increasing the competitive advantage for attracting employment generating activities and leveraging private sector involvement are key features of these emerging programs.

Despite the similarity of their missions, the transportation related economic development programs of the various states differ in several respects. Some are restricted to developing industrial parks and some include funding limitations based on the amount of private funds contributed or on the number of jobs created. A limited number of programs are able to make quick funding commitments to improve the changes of a successful project. The amount of funds available in most states is limited, but the trend appears to be toward greater involvement (1).

Economic development may be promoted through highway improvements in one of two ways: 1) as part of the statewide planning criteria; or 2) as part of the normal programming process. The results of a preliminary survey indicate that 9 state DOTs give some consideration to, or use the promotion of economic development as part of their long range statewide highway planning criteria. These states and their program summaries are shown in Table 5.

Table 5. Highway Systems Plans (Summaries)

State	Objective	Application	Annual Cost	Measurable Benefit
Arkansas	To allow all areas of the state to compete effectively for new industry.	Four lane trunk line system connecting all cities with 10,000+ population and all major commodity flow routes.	-	Population per capita income employment.
Florida	To facilitate economic development through joint, public-private sector efforts that result in new employment opportunities.	Local governmental agencies apply for grants on behalf of a company considering expansion or location of new facilities that has an existing or anticipated transportation problem.	10.0 million	Employment opportunities.
Georgia	To enhance Georgia's competitive position with states in the southeast in percentage of four lane primary road mileage.	Provide four-lane highways in every section of the state.	-	Population employment income taxable sales.
Iowa	To improve climate for economic diversification and expansion.	Local governments are eligible to apply for RISE funding for road projects. Private firms and developers are encouraged to work with local governments.	27.5 million	Employment opportunities.
Michigan	To enhance the ability of the state to compete in an international economy, to serve as a catalyst for economic growth of the state, and to improve the quality of life in the state.	Applications for funding are made through local government units. Developers must work with one or more eligible applicants to access funding.	13.3 million	Employment tax base.
Nebraska	Generating new wealth through commercial and retail projects.	Commercial and industrial development program. Public work projects.	-	Employment for low and moderate income (LMI) people.
Pennsylvania	To identify a network of roads most important to industry which are not presently identified as part of the state.	-	-	-
South Dakota	To allow the state to make additions to and deletions from the state highway system more systematic and based upon a uniform set of decision making guidelines or criteria.	-	-	Access between cities and recreational areas. Tourist expenditures.
Wisconsin	The development of an improved, efficient highway network can enhance the economic vitality of the state in the 21st century by creating an attractive environment in which business, industry, agriculture and tourism can grow.	A 3,200 mile network comprised of two elements: a multilane backbone system and a two-and-four lane connector system.	68 million	Improved safety, increased tourism, employment income.

The program objectives range from the mere completion of a statewide four lane network to the development of a process specifically intended to approach the problem of increasing the competitive advantage of its communities by funding certain types of highway improvements.

Economist have long been aware that transportation facilities such as highways, expressways, waterways, or railways contribute to regional growth by influencing industrial and trade structures in the benefitted regions. Recent interest in transportation planning has focused on developing an accurate, workable model for evaluating the economic impact of transportation facilities on the surrounding regional economies. Economic researchers have introduced a number of interesting models to measure the economic effect of the transportation facilities. The modeling effort may be classified into three groups: 1) regional econometric models, spatial equilibrium models, and multiregional input-output models (25).

Regional econometric models are useful in estimating industrial output, income, and employment in regional and in industrial detail. Spatial equilibrium models divide an economy into several geographic regions. Each region has market demand and market supply equations which represent its economic behavior. Multiregional input-output models can provide sufficient detail for almost every spatial disaggregation level: industrial output, income, and employment at the county level, for example.

Table 6 summarizes the characteristics and applicability of selected models/reports which were reviewed as part of this undertaking. Additional details can be found in the Appendix. One technique which shows promise as a candidate procedure which could be applied in Texas is the Regional Economic Impact Model for Highway Systems (REIMHS).

REIMHS estimates the economic benefits that are related to monetary savings resulting from improvements in operating efficiency, mobility, and safety of vehicular travel. These benefits are in turn translated in terms of industrial output, earnings by employees, and employment generated in selected regional industries. The methodology for applying

Table 6. Summary of Selected Models/Reports

	TRIM	Aschauer	Cambridge Sys. Inc.	Eagle & Stephanedes	Lemmerman	Liew & Liew	REIMHS
Year of Publication	1988	1989	1989	1987	1984	1985	1989
Model Characteristic	I/O Model	Econometrics	Econometrics & I/O	Time-Series	Cost-Benefit	I/O Model	I/O Model
Calibrated Area	Ontario	National Level	Wisconsin	Minnesota	New York	Arkansas & Regional	Dallas/Ft. Worth Area
Type of Transportation Infrastructure	Various Highways	General Transportation	Freeway & Expressway	General Highways	Various Highways	Navigation System	Various Highways
Data Type	I/O Table	Macro Data	I/O Table Cross-Section	Time-Series	Cross-Section	I/O Table & Cross Section	I/O Table
Years of Available Data	1979	1949-1985	1986	1964-1982	Case Dependent	1972	1986
Endogenous Variables	GDP & Employment	Productivity & Output/Capital	Disposable Personal Income	Employment	Operating Cost Savings & Travel Time Savings	Industrial Outputs, Prices & Trade Coefficients	Total Output, Earnings, & Employment
Exogenous Variables	I/O Coefficients & Highway Expenditures	Nonmilitary Govt. Expenditures	I/O Coefficients and Project Costs	Transportation Expenditures	Typical Traffic Data and Project Cost	I/O Coefficients and Final Demand	I/O Coefficients & Project Costs
Results	GDP Multiplier Equals to 1.4	1% Increase in Govt. Exp. - 0.49% Increase in Productivity	% of Total Economic Development Benefits from Total Benefits was Approximately 50%	\$1 Mill. Increase in Highway Exp. - 108 New Jobs	Benefit-Cost Ratio was 0.5477	5% Decrease in Trans. Cost - 2.989% Increase in Output	\$10 Mill. Proj. - \$17.6 Mill. in Total Output
Practicality	Very Practical	Very Practical for National Data	Practical if the model is made available	Practical	Practical	Not Practical	Very Practical
Comment	Frequently Update I/O	Disaggregate Data	Include Opp. Cost	Simultaneity Problem	Include Econ. Benefit	Frequently Update I/O	Include Long- Term Effects

the interindustry model to highway construction takes the form of: (1) distributing the monetary investment among the relevant highway industries of the region, (2) translating the efficiency, safety, and mobility improvements to equivalent monetary benefits, (3) using these investments and monetary benefits as inputs to the interindustry multiplier matrices, and (4) observing the resulting impacts on the region's total economy.

In fact, REIMHS has already been used in the Dallas/Ft. Worth area. Since the needed data is available in a usable format it is recommended that the REIMHS model be calibrated on a selected corridor of the Texas Trunkline system as part of the second year effort.

A general outline of the second year research effort is shown below:

Task 1: Identification of Travel Corridors

In selecting travel corridors in the Texas Trunkline System for the test applications, special consideration will be given to those corridors in which an intercity route has been proposed. The specific procedures and travel corridors used in the test applications will depend upon data availability.

Task 2: Compile Data

The data required to run REIMHS are given below:

- **General Transportation Data:** Facility type, year of analysis, general traffic data (e.g. annual daily vehicle miles of travel, percentage truck, initial running speed before and after highway improvement, and distribution of vehicles), and accident data.
- **Project Cost Data:** project type, type of improvement, year the project was completed, and project cost.

Task 3: Apply REIMHS

In this stage of the research, REIMHS will be applied to the available data on a selected corridor. This will include modifications and refinements of REIMHS to best fit the Texas data. Also, Aschauer's model (30) may be evaluated on an exploratory and preliminary basis.

Task 4: Documentation

The second year report including software (if any) will provide a detailed discussion of the results of the test applications in the Texas Trunkline System and present the recommended guidelines for use in identifying the economic development impacts of intercity highway expenditures.

The final detailed plan of the second year study will be developed based on discussions with SDHPT personnel.

REFERENCES

1. Forkenbrock, D.J. and D.J. Plazak. State Transportation Programs to Foster Economic Development, RISE Technical Report II. Office of Advance Planning, Planning and Research Division, Iowa Department of Transportation, February 1986.
2. Briggs, R. "Interstate Highway System and Development In Non-metropolitan Areas." Transportation Research Record 812. 1981, pp. 9-12.
3. Sicardi, A.J. "Economic Effects of Transit and Highway Construction and Rehabilitation." Journal of Transportation Engineering. Vol. 112 (1), 1986, pp. 63-75.
4. Lichter, D.F. and G.V. Fuguitt. "Demographic Response to Transportation Innovation: The Case of the Interstate Highway." Social Forces. Volume 59, Number 2, 1980, pp. 493-512.
5. Miller, S.F. Jr. "Effects of Proposed Highway Improvements on Property Values." National Cooperative Highway Research Program Report 114. 1971, 42pp.
6. Langley, C. John Jr. "Highways and Property Values: The Washington Beltway Revisited." TRB, Transportation Research Record 812. Transportation Research Board, Washington, DC, 1981, pp. 16-21.
7. Palmquist, R.B. "Impact of Highway Improvements on Property Values." TRB, Transportation Research Record 887. Transportation Research Board, Washington, DC, 1982, pp. 22-29.
8. Grossman, D.A. and M.R. Levin. "Area Development and Highway Transportation." Highway Research Record Number 16. Highway Research Board, Washington, DC, 1963, pp. 24-31.
9. Gamble, H.B. and T.B. Davinroy. "Beneficial Effects Associated with Freeway Construction: Environmental, Social, and Economic." National Cooperative Highway Research Program Report 193. 1987, 110pp.
10. Mills, F. "Effects of Beltways on the Location of Residences and Selected Workplaces." Transportation Research Record 812. Transportation Research Board, Washington, DC, 1981, pp. 26-33.
11. Eagle, D. and Y.J. Stephanedes. "Dynamic Highway Impacts on Economic Development." Transportation Research Record 1116. Transportation Research Board, Washington, DC, 1987, pp. 56-62.

12. Baird, E.A. and M.A. Lipsman. The Role of Non-Interstate Highway Transportation in Enhancing Economic Development in Iowa: Development of an Economic-Based Methodology for Programming Highway Improvements. Iowa Department of Transportation, prepared for presentation at the International Conference on Transportation and Economic Development, Colonial Williamsburg, VA, November 1989.
13. Wilson, F.R., A.M. Stevens and T.R. Holyoke. "Impact of Transportation on Regional Development (Abridgement)." Transportation Research Record 851. 1982, pp. 13-16.
14. Texas State Department of Highways and Public Transportation, Telephone Survey conducted by D-10P, 1989.
15. Arkansas State Highway and Transportation Department. An Economic Impact Study 1990/2010: Interstate Corridor System.
16. Florida Department of Commerce. Economic Development Transportation Fund Guidelines. Division of Economic Development, Tallahassee, Florida.
17. Georgia Department of Transportation. The Governor's Road Improvement Program.
18. Michigan Department of Transportation. Michigan Transportation Economic Development Fund. Program Summary, March, 1988.
19. Nebraska Department of Roads. 1989 Nebraska Highway Needs Study: Volume I Study Report. Lincoln, NE.
20. Lebo, D.E. and T.L. Adams. "Development of An Industrial-Commercial Access Network: A Pennsylvania Pilot Study." Transportation Research Record 1124, Transportation Research Board, Washington, DC, 1987, pp. 1-7.
21. South Dakota Department of Transportation. Highway System Study. Pierre, SD.
22. Wisconsin Department of Transportation. Corridors 2020: Wisconsin's Connections to the 21st Century. Madison, WI, March 1989.
23. Box, G.E. and G. Jenkins. Time-Series Analysis. Holden-Day, San Francisco, CA, 1970.
24. Allen, B.L., D.W. Butterfield, A. Kazakov, M.L. Kliman, A.A. Kubursi, and J.D. Welland. "Measuring Economic Stimulation from Capital Investment in Transportation." Transportation Research Record 1197. 1988, pp. 49-55.
25. Aschauer, D.A. "Is Public Expenditure Productive?" Journal of Monetary Economics. March 1989, pp. 177-200.

26. Cambridge Systematics, Inc., Donohue and Associates, Inc., and Regional Economic Models, Inc. Highway 29/45/10 Corridor Study: Economic Development Benefits and Cost-Benefit Evaluation. Final Report. March 1989.
27. Lemmerman, J.H. Quick Benefit-Cost Procedure for Evaluating Proposed Highway Projects. Transportation Research Record 984. 1984, pp. 11-22.
28. Liew, C.K. and C.J. Liew. Regional Economic Development Impact Model: Phase I Study. Report No. 1 WR-CR-85-C-4, Oklahoma University, Norman, OK, Nov. 1985.
29. Politano, A.L. and C.J. Roadifer. Regional Economic Impact Model for Highway Systems (REIMHS). Transportation Research Record 1229. 1989, pp. 43-52.
30. Aschauer, D.A. Highway Capacity and Economic Growth. Economic Perspectives. 1990, Vol. 14, pp. 14-24.

APPENDIX

ECONOMIC DEVELOPMENT MODELS

- A-1. Allen, B.L., et.al., "Measuring Economic Stimulation from Capital Investment in Transportation." *Transportation Research Record 1197*, Transportation Research Board, Washington, D.C., 1988, pp. 49-55.

Objective:

The goal of this research is to develop a model to evaluate the economic impacts of a capital investment in transportation facilities.

Model:

An economic impact is described as a summation of changes in all sectors of the economy as a result of a capital investment. Within the Ontario input-output table for 1979, the Transportation Impact Model (TRIM), a microcomputer program constructed by Econometric Research Ltd., estimates the impact of such an investment on seven key economic indicators specifically, gross domestic product, employment, gross sales, tax revenues, imports from other provinces and abroad, as well as primary energy consumed.

Data:

TRIM utilizes cost data for the transportation project. The data was then broken down into several input categories such as electrical equipment, fuel, nonmetal and metal products, wage payments, and so forth. Then, the cost matrix enters the Ontario 43-commodity input-output table as an input and the economic impacts are forecasted by TRIM.

Results:

Although thirty-five transportation projects were evaluated using TRIM, the results of one particular project are reported. This project can be described as the reconstruction of a 100-meter section of a four-lane collector/arterial road with an initial expenditure of 137,647 Canadian dollars. TRIM estimated the multiplier for GDP, employment, and gross sales to be 1.4, 4.7 and 2.93 Canadian dollars, respectively. In other words, a one dollar investment in transportation facilities will bring about 1.4 dollars in total GDP for the province of Ontario, a gain of 40 cents.

Comments:

This research is based on the input-output table of 1979 to evaluate the investment projects completed in the 1980's. Consequently, the results are questionable in the sense that the coefficients of the input-output table have not been updated to incorporate technology, policy and business climate changes. The multipliers, therefore, may underestimate or overestimate the true values. Furthermore, these multipliers do not represent the net effects of such transportation investment, since the model does not consider the welfare aspect of the investment.

A-2. Aschauer, D.A. "Is Public Expenditure Productive?" *Journal of Monetary Economics*, March 1989, pp. 177-200.

Objective:

This study explores the relationship between productivity in the private sector and the public-sector, including capital accumulation and the flow of government expenditures on goods and services.

Model:

Aschauer employs a generalized Cobb-Douglas production function with the assumption of a constant return to scale across all factors of production. The public expenditures are considered as one of the explanatory variables in the production function, whereas the output-capital ratio and the productivity of the private sector are regarded as the dependent variables. The following log-linear functional forms are estimated using ordinary least squares technique.

$$y_t - k_t = a_0 + a_1 t + a_2(n_t - k_t) + a_3(g_t - k_t) + a_4 c u_t + u_t, \quad (1)$$

and

$$p_t = b_0 + b_1 t + b_2 g_t + b_3 c u_t + e_t, \quad (2)$$

where a 's and b 's are parameters to be estimated. Specifically, a_2 , a_3 , and b_2 are elasticities with respect to a labor-capital ratio, a ratio of government capital to private capital, and a government capital.

Data:

The model utilizes annual data from 1949 to 1985. All variables were transformed into their logarithmic forms. The variables y , n , k , and p represent the private business economy output, private labor input, private capital input, and private business total factor productivity, respectively. These data were available from various issues of *Monthly Labor Review*. Public capital stock and the capacity of utilization rate in manufacturing are respectively denoted by g and cu (time subscripts are left out for the sake of notation simplicity). Data on public capital stock net of depreciation measured in constant 1982 dollars were obtained from *Fixed Reproducible Tangible Wealth 1925-1985*, while the cu data were provided by the *Federal Reserve Bulletin*.

Results:

The following table illustrates two crucial empirical estimates of equations (1) and (2).

Table A-1. Two Crucial Empirical Estimates of Equation 1 and 2

Dependent	Independent Variable						R ²
Variable	time	$n - k$	$kgxm^* - k$	$kgxm^*$	cu	constant	
(1)', $y - k$	0.008 (4.62)	0.35 (4.85)	0.39 (16.23)		0.43 (12.28)	-2.42 (-21.58)	0.976
(2)', p	-0.002 (-1.45)			0.49 (14.54)	0.35 (18.70)	-3.87 (-9.56)	0.993

(t-statistic in parenthesis)

* $kgxm$ denotes nonmilitary public capital.

Equation (1) shows that a 1 % increase in the ratio of the public to private capital stocks brings about 0.39 % increase in the output per unit of the private capital, *ceteris paribus*. The total factor productivity also increases by 0.49 % as a result of a 1 % increase in the net nonmilitary public capital. Furthermore, these two estimates are highly statistically significant. Therefore, there is strong evidence that the nonmilitary public capital is critically vital in influencing private productivity. In addition, Aschauer separated the nonmilitary public capital into five categories, namely, "core" infrastructure, conservation and development, educational buildings, hospitals, and other buildings. A fixed coefficient estimation technique was performed and resulted in remarkable findings. The estimated elasticity for the core infrastructure, consisting of streets and highways, airports, electrical

and gas facilities, mass transit, water system and sewers, equals 0.24 with 5.07 t-statistic. The core infrastructure also accounted for 55 % of the total nonmilitary public capital stocks. Thus, a 1 % rise in the core infrastructure will result in 0.24 % increase in the output-capital ratio for the private sector.

Comments:

The model is well established and conforms with the neoclassical theory of fiscal policy. However, the restrictive assumption of the constant return to scale of the Cobb-Douglas production function can easily be relaxed. A natural alternative would be the constant elasticity of substitution production function. Although, the model provides a very useful tool for analyzing the national issue, it offers little use to examine the problem at the state and/or local areas. This is because the model uses the existing national aggregate data whereas the disaggregate data may not be available in the state and/or local areas. Hence, to investigate the relationship between public expenditures and private productivity, some additional modification of the model should be performed.

A-3. Cambridge Systematics, Inc., Donohue and Associates, Inc., and Regional Economic Models, Inc. *Highway 29/45/10 Corridor Study: Economic Development Benefits and Cost-Benefit Evaluation*, Final Report, March 1989.

Objective¹:

This study conducts a cost-benefit analysis for the construction of a four-lane highway connecting Green Bay and the Fox Valley with the Minneapolis-St. Paul area.

Model:

The investigator allocated the benefits of the proposed highway improvement² in two main categories:

¹ This summary will cover only part A of this report which considers the improvement for Highway 29 and 45, due to the fact that the improvement for Highway 29 and 10 can be examined by the similar method.

² There are five design level alternatives : Freeway, Freeway/Expressway I with 35% freeway, Freeway/Expressway II with 15% freeway, Base Case with four-lane section accounted for 35% of the corridor highways which will be completed by the year 2000.

I) Auto User Benefits:

These include travel time savings, accident reduction and lower operating costs.

II) Economic Development Benefits:

- i) Business attraction and expansion are generated by lower truck cost and market expansion. In other words, new input and output markets are reachable.
- ii) Induced effects are created by the multiplier mechanism which can be explained as follows. Income from newly hired construction factors will be spent on consumer products and services that in turn will stimulate the existing businesses. As a result, additional income will be created until the initial income is completely absorbed by the economy.
- iii) Tourism effects are the additional spending by visitors, from both in and out of the state, who will be using the highways in question to reach their destinations.

The costs of the highway improvement project are defined to be the construction costs over 1989-1999 period with the addition of maintenance and rehabilitation costs over the entire 1989-2020 time period. Thus, the present values of these costs are calculated for the policy maker to compare them with the present values of all benefits. Equipped with the economic forecasting and simulation model, REMI, developed by Regional Economic Models, Inc., both auto user benefits and economic development benefits are estimated in terms of their present values based on 1987 dollars. These estimates are the result of changes in trucking costs and other business attraction factors on relative growth of the state of Wisconsin.

Data:

- i) Tourism data were obtained mainly from the Wisconsin Department of Development, Division of Tourism, the University of Wisconsin Recreation Resources Center and the Center for Survey and Market Research at the University of Wisconsin-Parkside.

- ii) Wisconsin DOT supplied the data on travel cost savings, specifically, the truck cost savings.
- iii) REMI forecasted the economic development impacts using ii) as the input.

Results:

The economic development improvements were evaluated in the following categories:

- i) An increase in business sales.
- ii) The number of extra permanent jobs created by the year 2020.
- iii) An increase in disposable income for Wisconsin residents.

Table A-2. Comparison of Benefits and Costs
(Present value of 1990-2020 Benefits and Costs, in Millions of 1987 Dollars, Compare with No Build Alternative)

	Freeway	Free/Exp I	Free/Exp II	Base Case
Present value of total economic development benefits	\$ 438	\$ 370	\$ 356	\$ 200
Present value of total auto user benefits	\$ 408	\$ 362	\$ 381	\$ 225
Percentage of total economic development benefits from total benefits	52	51	48	42
Present value of total benefits	\$ 846	\$ 732	\$ 737	\$ 481
Present value of total costs	\$ 550	\$ 447	\$ 334	\$ 225
Benefit-Cost ratio	1.5	1.6	2.2	2.1
Net benefit (benefit - cost)	\$ 296	\$ 285	\$ 403	\$ 256

Table A-2 summarizes the results of the analysis. As shown in Table A-2, the Freeway alternative yields the highest total present values of net benefits. However, these benefits are obtained at the expenses of higher operating costs and fuel consumption at high speed. As a result, the benefit-cost ratio is the lowest among four alternatives. The study also shows that the Freeway/Expressway II is the most valued alternative since the benefit-cost ratio is the highest. By the fact that the operating costs and fuel consumption are optimized at a lower travel speed.

Particularly noteworthy, in terms of the objectives of this study, is the contribution of economic development benefits to total benefits. As shown in Table A-2, economic development benefits account for over 40% of total benefits.

Comments:

The model is based on benefit and cost comparisons. The measurements of both costs and benefits are adequately explained. Furthermore, the results are impressively computed. In addition, this model provides a long-term effect of the proposed highway advancement program. However, to be able to implement this method, two vital tools must be available to a policy maker. First, a traffic simulation system must be developed to project the future traffic volumes after the highway improvement. Also, an econometric model forecasting the economic impacts of the transportation expenditures must be constructed.

A-4. Eagle, D. and Y.J. Stephanedes. Dynamic Highway Impacts on Economic Development. *Transportation Research Record 1116*. 1987, pp. 56-62.

Objective:

The study investigates the causality relationship between highway construction expenditures and county employment as a proxy of economic development.

Model:

A time-series analysis including causality tests and structural plots is employed. The model uses the pooled time-series and cross-section data from all 87 counties in the state of Minnesota.

- i) **Granger-Causality test:** This test is based on the direct Sims test. To test whether or not a variable x Granger-causes³ a variable y , x is regressed on past, present and future values of y . If all coefficients of future values of y are zero, then there will be no causality between x and y . The regression equation can be written as

³ Granger's definition of causality can be stated as follows: x is causing y if we are better able to predict y using all available information than if we do not include the information of x .

$$\begin{aligned}
x_{i,t} = & \gamma + a_1x_{i,t-1} + a_2x_{i,t-2} + \dots + a_qx_{i,t-q} \\
& + b_0y_{i,t} + b_1y_{i,t-1} + \dots + b_qy_{i,t-q} \\
& + c_1y_{i,t+1} + c_2y_{i,t+2} + \dots + c_ky_{i,t+k} + \epsilon_{i,t}
\end{aligned}$$

where x and y represent highway expenditures and employment, respectively. The parameters γ , a 's, b 's, and c 's are to be estimated.

- ii) **Structural Plots:** The structural equation explaining the relationship between highway expenditures and employment is defined as

$$\begin{aligned}
y_{i,t} = & \gamma_1 + a_{20}x_{i,t} + a_{21}x_{i,t-1} + \dots + a_{2q}x_{i,t-q} \\
& + b_{21}y_{i,t-1} + b_{22}y_{i,t-2} + \dots + b_{2k}y_{i,t-k} + \epsilon_{i,t}
\end{aligned}$$

where γ_1 , a 's, and b 's are parameters which will be estimated.

A 10% increase in highway expenditures is simulated to examine an impact on future employment. The structural equation is then estimated by vector autoregression technique.

Data:

The annual data on state highway system construction expenditures were provided by the Minnesota Department of Transportation for the years 1957-1982. *County Business Pattern* publishes the annual employment data from 1964-1982. The data were collected from all 87 counties of Minnesota. These counties are grouped in the following manner: 1) Statewide, 2) Urban: Counties in the Twin Cities seven-county metropolitan areas and counties consisting of 28,000 or larger population 3) Next-to-Urban: Counties adjacent to the urban counties 4) Regional Center: Counties in the Twin Cities metropolitan area and all counties with the population of 28,000 or larger 5) Next-to-regional center: Next-to-urban counties together with the Twin Cities metropolitan counties other than Hennepin and Ramsey 6) Rural: All counties excluding 2) and 3). The data had been transformed to avoid the problem of bias and autocorrelation before being used by the estimation techniques.

Results:

There is no strong evidence illustrating that the increase in highway expenditures Granger-cause employment to increase. The results of the Sims test show that the coefficients of future levels of employment are not significantly different from zero. As a result, the null hypothesis, stated that construction of highway does not cause additional employment, cannot be rejected. The only exception is the case of the regional center. In this area, the highway expenditures do indeed Granger-cause employment. This result can be explained as the regional center absorbs the increased employment from other regions, since two-thirds of the state workers are employed in the regional center. The structural plot reveals that the employment does increase the number of construction workers which in turn leads to the expansion of the regional economy in the subsequent years. Especially in the regional center, a 1-year, \$ 1 million increase in highway expenditures creates an additional 108 new jobs over a 15 year period (this number is calculated from the area under the structural plot).

Comments:

The present model based on the time-series analysis has several weaknesses. First, the structural equation may have the problem of simultaneity because of the interrelationship nature of the two variables. Next, the highway expenditure variable is not the only variable explaining the behavior of employment. Finally, employment is only one of many representatives of economic development. Total output, earnings and tax bases may be tested for causality as well.

A-5. Lemmerman, J.H. "Quick Benefit-Cost Procedure for Evaluating Proposed Highway Projects." *Transportation Research Record* 984, 1984, pp. 11-22.

Objective:

Lemmerman proposed a quick way to measure costs and benefits of highway improvement program.

Model:

The benefits of a proposed highway project are measured by the difference between operating and travel time costs before and after the completion of the project. To estimate

these benefits, nomographs of various vehicle mixes were constructed. In 1982, it was observed that the truck percentages were 11 % and 26 % on urban and rural interstate highways in the state of New York, respectively. Therefore, Lemmerman chose both 9:1 and 8:2 auto-truck ratios for the nomographs. The procedure is based on the differences in average running speed and congestion following highway improvement. It was believed that such improvement would lead to savings as a result of increased efficiency or decreased travel time. After inputting all the necessary data, the annual time and operating costs over the project life of 10 to 30 years (discounted at 10 %) can be read off the nomograph. The benefits can then be compared with the construction costs to determine whether or not the project should be funded.

Data:

To use this procedure, the following information is needed: 1) Posted and average running speed, 2) traffic (eg. vehicle miles traveled) with some estimate of vehicle mix, and 3) highway section length both before and after the completion of the project.

Results:

Four examples are presented in the paper; however, only results of Example 2 concerning the reconstruction and widening project will be summarized here. It is assumed that the cost of the project is \$ 10 million and VMT per day is 10,000 at the posted speed of 35 mph. The combined operating cost savings and travel time savings over 20 years are estimated to be equal to \$ 5.477 million. Thus, the benefit-cost ratio is 0.5477, meaning that roughly \$ 0.5 is recovered after investing \$ 1 in the highway project.

Comments:

The quick procedure reviewed here considered only the direct user benefits and costs from the highway improvement project. However, accident cost savings and highway maintenance costs were not included in the study. Hence, the results can be underestimated or overestimated. In addition, the link between these benefits which are directly received by the user of the highway (both household and firms) in terms of lower transportation costs and their effects on the economy was not established. To this end, the estimated benefits would definitely be underestimated.

A-6. Liew, C.K. and C.J. Liew. *Regional Economic Development Impact Model: Phase I Study*. U.S. Army Corps of Engineers, Institute for Water Resources, November 1985.

Objective:

The focus of this study is to provide theoretical and empirical research concerning the following issues.

1. How does lower transportation cost stimulate regional economic development?
2. What is the scope of such stimulation?

Model:

The entire U.S. area is divided into three regions:

- i) Region 1: The Arkansas navigation areas.
- ii) Region 2: The West-South central (Texas, Louisiana, Arkansas and Oklahoma) excluding the navigation area.
- iii) Region 3: The rest of the U.S.

These three regions are linked by the Multi Regional Variable Input-Output model (MRVIO). MRVIO model is based on the well known duality theory, of price and production. The price frontier equations for ten different industries are jointly solved providing the equilibrium output prices. A Cobb-Douglas technology⁴ is assumed together with the constant return to scale. The input-output table then receives the output prices as the explanatory variables, to calculate regional technical and trade coefficients. Since the output prices are endogenously determined by the model, the following exogenous variables are required: capital cost, land prices, local tax rates, transportation costs and wage rates. Finally, with an additional exogenous variable, final demands, industrial output, income prices and employment will be computed by MRVIO.

⁴ A Cobb-Douglas technology can be stated as $Y = AX_1^{\alpha_1} \dots X_n^{\alpha_n}$, where Y is total industrial output, and X_i is factor of production. A and α_i are parameters, for $i = 1, \dots, n$. A constant return to scale refers to the assumption that the summation of α_i equals to unity, for $i = 1, \dots, n$

Data:

The study employed the 1972 input-output table provided by the Bureau of Economic Analysis. Employment and payroll data were found in *Employment and Earnings* and *The County Business Pattern*. The gross farm products were estimated using 1974 U.S. Agricultural Census. Mining data available from *The Mineral Yearbooks* and *1972 Census of Mineral Industry*. A private consulting firm provided the estimate of the 1970 final demand. All national data were prorated in order to obtain state and county data.

Results:

It is hypothesized that the introduction of the Arkansas navigation system reduces transportation costs by some specific percentages. In fact, it is assumed the transportation cost of delivering commodities between region 1 and 2 will be 5% lower. It is found that trading between the two regions is intensified. At the same time, regions 1 and 2 reduce the level of trade to region 3, since the transportation costs between regions 1 & 3 and region 2 & 3 are held constant. These results are expected because, after the reduction of the transportation costs, factors within region 1 and 2 can be less expensively purchased, while the cost of buying factors from region 3 remains the same. Table A-3 shows the effects of lower transportation costs on industrial output.

Table A-3. Percentage Change in Industrial Output before and after the 5% Decrease in Transportation Costs

Region	Selected Industries	Region 1 & 2	Region 1&3, 1&2 ⁵	All Regions ⁶
1	Agriculture, Forest & Fisheries	2.941	8.966	9.777
	Mining	2.372	6.568	6.890
	Non-durable Manufacturing	2.989	7.015	7.534
	Durable Manufacturing	2.147	8.559	8.980
2	Agriculture, Forest & Fisheries	0.531	0.717	5.501
	Mining	0.286	0.362	3.404
	Non-durable Manufacturing	0.277	0.345	3.248
	Durable Manufacturing	0.313	0.414	4.857
3	Agriculture, Forest & Fisheries	0.028	0.166	0.783
	Mining	0.002	0.043	0.525
	Non-durable Manufacturing	0.019	0.099	0.562
	Durable Manufacturing	0.010	0.086	0.437

⁵ It is assumed that there is a 5% reduction in the transportation costs between region 1 and 2 as well as region 1 and 3.

⁶ The cost of transportation is lowered for all regions.

This table illustrates that the greatest contribution of the 5% reduction of the transportation costs occurs in region 1 nondurable manufacturing industry, where its output will increase by 2.989 %. Furthermore, region 1 is the largest beneficiary of the lower transportation costs, no matter where the reduction occurs. For example, the output of region 1 will increase by approximately 10 % as a result of a 5 % decrease in the transportation costs in all the regions.

Comments:

This report is one of the most advanced theoretical models reviewed in this subsection. The interrelationship between various industries in different regions is well formulated with the help of the classical duality theory of price and production. Moreover, the restrictive assumption of constant return to scale can be easily relaxed to obtain more general results. However, a large data set is required in order to make use of the model. In addition, the problem of transforming national data, by prorated scheme, into state and county data may introduce bias and error in the measurement. A potential problem with this model is the assumption that a certain percent of transportation costs is reduced in order to forecast the economic impacts. Thus, one may ask how much investment in the transportation improvement will bring about a 5% reduction in transportation cost. Finally, it would be nice if the total economic impacts of lower transportation costs were provided in the report.

A-7. Politano, A.L. and C.J. Roadifer. "Regional Economic Impact Model for Highway Systems (REIMHS)". *Transportation Research Record 1229*, 1989, pp. 43-52.

Objective:

The goal of this paper is to measure the economic impacts of transportation investment on highway systems. In addition, the proposed methodology is empirically tested for the 16-county Dallas/Fort Worth area.

Model:

The transportation expenditures provide not only the direct user benefits such as the increase in mobility savings, operating efficiency savings and safety savings, but also the indirect and induced benefits on the regional economy. The latter benefits consist of lower transportation costs, increased income of construction inputs for labor and materials, and

the multiplier effects of such increased income. The monetary values of both benefits then enter the input-output analysis as inputs. Based on the Bureau of Economic Analysis' multipliers for regional industrial output, earnings of employees in those industries and employment, the authors calculated industrial output, earnings and employment impacts of undertaking or not undertaking highway construction.

Data:

There were six types of highway systems considered, namely, interstate, primary, urban in urban areas, and interstate, primary and secondary in rural areas.

- i) The data on highway construction material and labor costs were obtained from the Federal Highway Administration Form FHWA-47. Highway system type, project type and project length were also available from this form.
- ii) The efficiency savings, consumption data for maintenance and repair, fuel, tire, oil and depreciation were obtained from an unpublished FHWA-sponsored study on operating costs in 1982.
- iii) Mobility savings and running speeds were provided by the Highway Performance Monitoring System (HPMS) Analytical Process, version 2.1.
- iv) The monetary value of time for both trucks and automobiles was available from the American Association of State Highway and Transportation Officials (AASHTO) manual on user benefits updated to represent 1986 prices by using consumer price index and the whole sale price index for industrial commodities.
- v) An FHWA publication, entitled "Alternative Approaches to Accident Cost Concepts - State-of-the-Art" (1984), provided the accident savings data.

Results:

A case study for the 16-county Dallas/Fort Worth area was calibrated by the developed model. It was hypothesized that \$10 million worth of highway improvements (interstate in urban area) would be implemented. This investment will bring about \$17.6 million and \$ 4.6 million in total regional output and total regional earnings, respectively. In other words, an investment of \$1 will result in \$1.76 in total regional output. Also, a total of 203 jobs will be created. On the other hand, without undertaking the highway project,

the Dallas/Fort Worth area will lose \$1.8 million in output, \$0.58 million in earnings and 27 jobs.

Comments:

It is obvious to see that the derived results of the model represent only the short term impacts of a given highway improvement project. The concept of expected present values of future benefits and costs can be incorporated into REIMHS in order to evaluate the effects of the transportation investment over the longer term. Also, the proposed framework must be extended in order to compare the transportation investment with other public investment programs, so public funding can be efficiently utilized.

Sample Runs of REIMHS the Program :

The REIMHS model has been computerized by Garcia-Diaz and Freyre⁷. A PC-compatible program written in MS QuickBasic was developed to calculate the economic impacts of a given transportation investment. This interactive program requires the same data as the original REIMHS. Some sample runs which were designed to examine the effect of a ten million dollar investment on the state economy were performed. The components of the total cost are shown below. The project was classified widening of an urban interstate. The analyses were performed using 1987 data, and assume the project was completed in 1985.

Total cost of materials and supplies	\$4,000,000.00
Final contract amount for signs	\$10,000.00
Final contract amount for lighting	\$10,000.00
Total labor costs	\$4,980,000.00
Total construction costs	\$10,000,000.00

Results:

Table A-4. Economic Impacts

Economic Impacts	Texas	Oklahoma	Louisiana	New Mexico	Arkansas
Output*	23.177	21.036	20.490	19.562	21.310
Earnings*	6.238	5.647	5.536	5.097	5.804
Employment	36.367	34.461	33.861	34.110	40.248

* in million of dollars.

⁷ Garcia-Diaz, A. and G. Freyre. *Relationship between Economic Development and Transportation Investment*. Unpublished Manuscript, Department of Industrial Engineering, Texas A&M University. November 1989.

