UTCM

Improving the Quality of Life by Enhancing Mobility

University Transportation Center for Mobility™

DOT Grant No. DTRT06-G-0044

Refining a Methodology for Determining the Economic Impacts of Transportation Improvements

Final Report

David Ellis, Brianne Glover and Nicolas Norboge

Performing Organization
University Transportation Center for Mobility™
Texas Transportation Institute
The Texas A&M University System
College Station, TX

Sponsoring Agency
Department of Transportation
Research and Innovative Technology Administration
Washington, DC

Texas Transportation Institute

UTCM Project #11-00-68
July 2012

1. Project No. UTCM 11-00-68	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Refining a Methodology for Determining the Economic Impacts of Transportation Improvements		5. Report Date July 2012 6. Performing Organization Code Texas Transportation Institute
7. Author(s) David Ellis, Brianne Glover, and Nicolas Norboge		8. Performing Organization Report No. UTCM 11-00-68
9. Performing Organization Name and Address University Transportation Center for Mobility™ Texas Transportation Institute The Texas A&M University System 3135 TAMU College Station, TX 77843-3135		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTRT06-G-0044
12. Sponsoring Agency Name and Address Department of Transportation Research and Innovative Technology Administration 400 7th Street, SW Washington, DC 20590		13. Type of Report and Period Covered Final Report November 2010-May 2012 14. Sponsoring Agency Code

15. Supplementary Notes

Supported by a grant from the US Department of Transportation, University Transportation Centers Program

16. Abstract

Estimating the economic impact of transportation improvements has previously proven to be a difficult task. After an exhaustive literature review, it was clear that the transportation profession lacked standards and methodologies for determining economic impact from transportation investments. As a result, Texas Transportation Institute (TTI) researchers sought to fulfill this need.

This project examined the current and historical economic impact assessment programs utilized by four state departments of transportation. Researchers evaluated these programs based on three outcomes: increased business and industry competitiveness, strengthened long-term regional and local economies, and enhanced household well-being. Researchers found that promoting transparency and flexibility and involving as many stakeholders as possible were key elements to economic program success. Based on these successful program elements, TTI professionals developed a new economic determination method to incorporate into the existing Transportation Revenue Estimation and Needs Determination System (TRENDS).

The results from this study were also used to educate the public on the impacts transportation improvements, or lack of improvements, have on communities.

17. Key Word	18. Distribution Statement
Transportation Economics, Planning and Forecasting, Economic Modeling, TRENDS Model	Public distribution

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	44	n/a

Refining a Methodology for Determining the Economic Impacts of Transportation Improvements

by

David R. Ellis, PhD
Research Scientist
Texas Transportation Institute

Brianne Glover, JD
Associate Transportation Researcher
Texas Transportation Institute

and

Nicolas Norboge
Assistant Transportation Researcher
Texas Transportation Institute

UTCM 11-00-68

Sponsored by the
University Transportation Center for Mobility™

July 2012

Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843-3135

Disclaimer

Acknowledgments

Support for this research was provided in part by a grant from the U.S. Department of Transportation, University Transportation Centers Program to the University Transportation Center for Mobility™ (DTRT06-G-0044).

The authors would like to thank the Texas Transportation Institute and University Transportation Center for Mobility™ for providing support for this research. We also would like to extend our gratitude to the four department of transportation agencies that provided information for this research.

Table of Contents

List of Tables

Executive Summary

Methodologies for determining the economic impacts associated with transportation investment are numerous. This presents a problem—especially when it comes time to establish a consistent standard. Having too many economic assumption standards encumbers the process of comparing projects across states or even within regions. In an era characterized by dwindling transportation resources and deteriorating infrastructure, the need to direct limited transportation resources has never been so great.

While there are no nationally mandated standards for performing economic impact analyses, many states' departments of transportation (DOTs) have created useful baseline standards. The Kansas, Michigan, Indiana, and North Carolina DOTs are four examples of states with such standards. First, all four DOTs have developed or are in the process of developing methodologies that factor in objective economic and traveler data to project decision-making. Next, all four programs present a transparent process of analysis that is available to the public. This is important for research purposes and for improving transportation decision-making. Finally, these processes have generally gained widespread public support. In Kansas, political leaders successfully argued for a large funding package to finance transportation improvements based on an economic impact analysis performed by the state DOT. The outcome of each state's program was also significant. Three out of the four case studies examined saw increased business and industry competitiveness, strengthened long-term regional and local economies, and enhanced household well-being as a result.

Consistent elements essential to program success were prevalent in each case study. Study area, study period, and analysis method (such as a specific computer model) were chosen through consultation with public officials, stakeholders, and the public. From this approach, robust, tenable economic information was presented that could easily be trusted by the public.

Based on this process, the Texas Transportation Institute (TTI) economics and finance research team is developing an economic impact component for the State of Texas that will tie into the existing Transportation Revenue Estimator and Needs Determination System (TRENDS) model. This updated web-based module will be made available to Texas policymakers and the public for better, more informed decision-making. As the model enters its final stages of development, TTI will develop web-based online seminars and slideshows to demonstrate model capability to decision-makers at the metropolitan planning organization (MPO) level throughout the state of Texas.

This project accomplished three goals set out by the research team. First, a refined methodology was established using four successful case studies that will provide guidance to transportation officials throughout the U.S. This project also provided the backbone for the current development of the economic impact component to the existing TRENDS model. Finally, this project will guide communication on the important role transportation plays within our society. This research will help contribute to better transportation investment decision-making.

Introduction

For much of our nation's history, transportation professionals and elected officials have justified transportation project investment because transportation is critical to national and international competitiveness. Over the past decade, declining revenue, due in part to increased fuel efficiency, has led to an unsustainable future for funding the nation's transportation infrastructure.

Today's economic climate brings additional unforeseen challenges for transportation. Consecutive back-to-back quarters of negative economic growth have resulted in millions of unemployed Americans. Some economists are predicting that it could take until 2016 for the economy to recover fully from job losses that have occurred since 2008.[1] Short-term construction jobs from large, capital-intensive transportation projects could be a needed vehicle to help put millions of unemployed Americans back to work. However, the capacity at all levels of government to borrow more funds for transportation is dwindling. The need to develop a targeted, consistent process for efficiently allocating limited transportation investment dollars toward projects that make economic sense is critical.

Research Problem and Study Purpose

Research Problem

Estimating the economic impact of transportation improvements has previously proven to be a difficult task for several reasons. First, empirical economic impact analysis has been used very little to date. Many times, public officials will tout the economic benefits of transportation without backing up the information with credible, empirical analysis. Second, transportation professionals find it difficult not only to calculate economic impacts of transportation investment but also to communicate that information in terms the public can understand. Finally, there are inconsistencies surrounding transportation impact measures. These agencies tend to provide a wide variety of metrics with no consistency across regions or states. For example, many transportation agencies use different models, which results in a wide array of assumptions. This makes it difficult to make an appropriate comparison on the relative benefits for projects across agencies. Major challenges have encumbered the development of a robust, usable, and consistent economic impact determination system for transportation agencies to adopt.

Given the discrepancies between transportation needs and the revenue stream, developing a robust, consistent standard by which to analyze the impacts of possible gap-shrinking solutions would be a significant contribution to the transportation profession. First, developing such a standard would ensure that more significant decision-making would occur. Such an approach would grant decision-makers and the public a more complete portrayal of possible outcomes of various roadway improvement options. A new method would incorporate direct, indirect, and induced effects on economic development. Second, a consistent process would make economic methods easier to implement and use. There are many available models that vary in their input requirements. Developing a consistent standard for all data inputs and outputs would improve the process. Cost-benefit ratios that include not only safety and engineering factors but also economic impact factors would help contribute to the decision-making process.

Purpose and Goal

This report accomplishes three goals. First, it provides an overview on the current policy background regarding transportation and economic productivity and an update on the currently available literature on the topic. This section provides a chronological account of early transportation policy, its evolution in the post-interstate era, and current federal policy directions regarding economic considerations. Next, it explains the research approach used to extract relevant findings from four successful state case studies. Major themes that demonstrate appropriate advancement in transportation policy are also explored. Finally, a consistent methodology is developed based on successful elements from the literature review and the four successful case studies. This redefined methodology is used to build a new model for metropolitan planning organizations (MPOs) in Texas to determine the economic impacts associated with transportation investment.

Literature Review

Link between Transportation Investment and Economic Development

Over the years, the linkage between transportation investment and economic impact has been strengthened through subsequent literature reviews and empirical analyses. The first quantitative study on the economic impacts associated with transportation occurred concurrent to the development of the Interstate Highway System in the 1950s.[2] Numerous empirical bypass studies, economic predictive studies, interview studies, and primitive models were developed during this era. By the 1950s and 1960s, as automobile use became much more common, there was a growing need for a more extensive transportation system. The post-war economy had grown rapidly and needed an infrastructure capable of handling the rapidly increasing demand.[3] Since the demand was already established, there was a high rate of return on the early highway system. Until the 1960s, highway investment was still viewed by the government as a way to aid growth in income by facilitating customer markets, labor, and materials. Primitive studies have helped to prove the link between transportation and economic development.

The literature does vary on the extent to which transportation effects can be examined on a national scale. Gramlich and Holtz-Eakin argued that the appropriate response is not to increase infrastructure spending across the board but rather to continue only careful project selection.[4,5] Typically, a new highway helps to improve access throughout the entire transportation network. A new road improves the usefulness of the entire network and creates positive spillovers for everyone in that network. However, Giuliano found that a new road built in an area where roads already existed did not substantively improve mobility and accessibility. This implies that as the transportation network matures, additional investment in the transportation network is likely to decrease.[6] Holtz-Eakin and Schwartz found that highway benefits do not spill over across state borders. However, other studies have found this spillover effect does exist.[7]

There is also significant evidence linking accessibility with modern projects, but it too varies significantly. Fujita found a close relationship between transportation improvements and land use. [8] Other studies, such as those by White and Wieand, largely support this claim.[9,10] Similar to other findings, Giuliano found that the impact of transportation appears to be decreasing over time. Studies demonstrate that after the majority of the interstate system was completed in the 1970s, additional highway spending did not lead to significant economic productivity gains.

The literature largely justifies the need for mechanisms to effectively predict and target limited transportation funding only toward projects that would earn the greatest return on investment based on economic considerations. Holtz-Eakin and Schwartz found that since network economies are now less important, due to the wide availability of transportation currently offered as opposed to availability at the beginning of the interstate era, a focus on project analysis is critically important. However, some research reports, such as the one by Forkenbrock and Foster, argue that the economic benefits should not be included in the project selection process mainly because the economic effects have not been made clear.[11]

Transportation Economic Impact Modeling

Economic Simulation Modeling

Complementary to research conducted on the connection between transportation and economic development, computer modeling has also increased as a means for predicting the impacts of such investment. By the 1960s and 1970s, transportation modeling also began to focus on a much more regional level. More predictive studies as well as modeling studies began to emerge throughout the United States.

During this time, companies began to develop and refine primitive computer models to analyze the importance of transportation infrastructure projects. More importantly, many transportation officials perceived such models as a superior means for solving transportation problems. In the field of transportation, computers enabled urban transportation network models to emerge as tools to forecast and allocate future trips among alternative routes on an urban road network. In the field of economic development, computers enabled economists to construct input-output models that allocated flows of dollars between product suppliers and buyer industries. Together, these two approaches provided a structure for calculating the economic effects of transportation infrastructure improvements.[12,13] Notable studies further began to suggest that the relationship between highway improvement projects and increased economic productivity was strong. One pioneering economic research study in 1958 found dramatically higher job growth in areas with interstate highway access.[14] Another study commissioned in 1974 also examined the social and economic effects of highways and presented groundbreaking research on the topic. However, because economic estimation methodologies remained primitive and little effort was made to develop practical and useful economic impact analyses, transportation officials seldom incorporated economic benefits into the transportation project evaluation process.

The slowing rate of return seen in recent years is thought to be a result of a mature highway system that has met all the initial needs and demands that prompted its original construction. By the 1980s, computer simulation models were attempting to forecast the regional economic growth and the economic development associated with transportation projects. The Regional Economic Impact Model for Highway Systems (REIMHS) was initially developed in 1988 by Politano and Roadifer and included a series of calculations to translate capital investment and travel cost savings into expected increases in the flow of household and business income.[15] An input-output model was also applied to this model to calculate the total value of jobs, wages, and additional business output. By the 1990s, some analytical work was beginning to emerge on the link between highway improvements and economic development.[16] Concepts surrounding economic growth and economic growth development also found their way into transportation authorization legislation. For the next 10 years, Congress made a number of economic-development-related earmarks in various discretionary programs and other parts of the United States Department of Transportation (USDOT) budget, as well as provided economic development guidance language. In 1980 Regional Economic Models, Inc. (REMI) was founded, and the REMI Policy Insight Model emerged as a simulation model that was intended to forecast year-by-year impacts of policies affecting cost factors, such as tax, wage, and transportation cost changes. Numerous state transportation officials began to adopt the model after realizing that existing state highway models often grossly underestimated potential benefits of transportation projects.[17]

Despite the development of the REMI and other economic forecast models, many of the early studies on the economic impact of transportation improvement projects still relied heavily on business and expert opinion surveys to gauge the economic implications of improving access and connectivity for various industries. Many transportation officials began to realize that the REMI model could not automatically forecast the additional business growth and attraction that the highway network was capable of producing. It did not take into account the industry's expanded delivery market, enhanced logistics/warehousing efficiencies, or new tourism markets that were resultant of the highway network interconnections.

Today, economic modeling software has been built specifically to evaluate transportation improvement projects at the federal, state, regional, and local level. More comprehensive software models, such as the Transportation Economic Development Impact System (TREDIS), are applicable for all modes, including highway, bus, rail, aviation, and marine projects, as well as multimodal projects. This enables transportation planners and consultants to conduct economic development impact evaluations and cost-benefit analyses for transportation investments for all modes of transportation, allowing for a more holistic assessment of public and private investment funds. See Table 1 for more information on the capabilities of major economic modeling software used for determining impacts of transportation investment. See the Appendix for more information regarding several states that have implemented economic modeling software for transportation investment.

Table 1: Major Economic Impact Computer Software Used for Transportation

						BEA	EDR	TTI		FHWA												UT			
	AASHTO MANUAL	CDSS	EMME3	IMPLAN	REMI	RIMS II	TREDIS	HEEM-III	MicroBENCOST	HERS-ST	TELUS	TELUM	FHWA HWY 1	SCRITS	SMITE	SPASM	STEAM	REIMHS	REIMS	MEPLAN	PECAS	RUBMRIO	HEAT	TEIM	LEAP
TYPE OF PROJECT USED FOR:																									
Upgrade Existing	X						X	X	X	X	X	X			X						X				
Maintain Existing							X	X	X								X	X			X	X			
New Construction	X						X	X	X		X	X				X	X	X		X	X	X	X		
SCALE:																									
Specific Site				X								X				X				X					
Specific Corridor	X							X	X	X	X	X			X	X	X	X							
Region						X		X		X	X	X	X				X				X	X	X		
USER IMPACTS:																									
Money cost of travel	X							X	X	X	X				X			X			X		X		
Travel time	X	X	X				X		X	X	X					X	X						X		
Safety	X						X		X	X				X			X								
Comfort																									
Traffic volumes and average speed			X				X			X				X			X								
Calculation of delay savings							X										X				X		X		
Accident reduction savings	X							X	X	X															
Calculation of motorist benefits over the analysis period							X	X													X				
Highway improvement cost	X									X					X	X		X			X		X		
Summary of benefits and costs	X						X	X		X				X	X	X					X		X		
ECONOMIC IMPACTS:																									
Employment					X		X				X	X	X							X	X	X	X		
Wages		X			X		X				X	X	X							X	X	X	X		
Property values, prices or rents	X											X								X	X	X	X		
Business sales volume						X	X															X	X		
Value added						X	X				X									X					
Business profit						X															X	X	X		
Improved efficiency in public and private services															X	X	X			X		X	X		
Health and safety improvements														X											
Tourism spending			X																				X		
Number of establishments (new, existing, dislocated)												X										X			
Population/growth rate																									
Capital investment						X									X		X			X	X		X		
Building permits, construction activity																							X		
Value of oil and gas production																									
Usable parking spaces																									
Number of customers per day																									
Parking capacity influences on gross sales impacts																									
GOVERNMENT FISCAL IMPACTS																									
Public revenue/ taxes					X	X	X				X						X	X			X	X			
Public expenditures					X											X				X	X	X			
OTHER IMPACTS:																									
Air quality	X				X											X	X								
Social conditions	X				X		X							X	X					X	X	X			

Descriptions of several economic models are provided in detail below:

- **IMPLAN** (Impact Analysis for Planning): This is a computer-based regional economic analysis system that utilizes social accounting, multipliers, and trade-flow estimations. IMPLAN creates a complete set of regional social accounts, or social accounting matrices

(SAMs).[18] These social accounting matrices include non-market transactions where traditional input-output models do not. SAMs can be used to create multiplier models that examine the industry-related impact of changes specified by the user. By estimating trade flows, IMPLAN also allows the user to track regional purchases.[19]

- **REMI**: The REMI model is able to translate the results of an analysis of the transportation impacts of a project into regional economic performance via its effects on business costs and productivity. The REMI model is a dynamic forecasting and policy analysis tool that can be referred to as an econometric model, an input-output model, or even a computable general equilibrium model. REMI integrates several modeling approaches, pulling from their strengths and overcoming their limitations. The REMI model is a structural economic forecasting and policy analysis model. It integrates input-output, computable general equilibrium, econometric, and economic geography methodologies. The model is dynamic, generating forecasts and simulations annually. The model also generates behavioral responses to compensation, price, and other economic factors.[20]

- **RIMS II** (Regional Input-Output Modeling System): RIMS II is a model developed by the Bureau of Economic Analysis (BEA) for estimating regional input-output multipliers. RIMS II multipliers can be estimated for any region and for any industry or group of industries. To use the multipliers for economic impact analysis, users must provide geographically and industrially detailed information on the initial changes in output, earnings, or employment. The framework model is used for a wide variety of public sectors, including defense and transportation. [21]

- **HEEM-III** (Highway Economic Evaluation Model): Originally developed in 1976 by the Texas Transportation Institute (TTI), the Highway Economic Evaluation Model analyzes capacity improvements in a defined corridor. This model has been updated several times since then, with the latest version being released in 1990 by Dr. Jeffery Memmot. While this model is used little today due to its limitations in functionality, it set the precedent for modern economic transportation models in use today.[22]

- **MicroBENCOST**: MicroBENCOST is a planning tool for determining the benefits and costs for highway improvements. Through user-provided data inputs, this software is capable of performing lifecycle analyses for highway infrastructure projects. This approach tends to be most appropriate for situations where projects have only isolated impacts. As a result, this tool is limited in its functionality and versatility and is used relatively little in the United States today.[23]

- **HERS-ST** (Highway Economic Requirements System for States): Designed by the Federal Highway Administration (FHWA), HERS-ST is a tool used to evaluate the most cost-effective mix of improvements for a system-wide implementation. Similar to MicroBENCOST, this tool uses benefit-cost analyses to optimize high investments. However, this tool allows users to prioritize economically worthwhile improvement options and selects the best project for implementation. In 1999, FHWA adapted this model so that it could be usefully applied at the state level. Since that time, FHWA has issued multiple updates to this model.[24]

- **TELUM** (Transportation, Economic, and Land-Use Model): Released in 2006, TELUM is an interactive modeling system used to evaluate the effects of transportation improvements. The benefit of this software is its ability to examine relationships between transportation and land-use planning. This software is primarily used to help MPOs examine which projects to include in their regional transportation improvement plans (TIPs). This software package provides significant capabilities for evaluating transportation decision-making and significantly improves the ability of transportation professionals to examine economic data and make better decisions as a result.[25]

- **SMITE** (Spreadsheet Model for Induced Travel Estimation): SMITE is an Excel-based sketch-planning application developed to calculate the effects of induced travel. SMITE's simple spreadsheet application allows it to be used in instances where four-step urban travel demand data are unavailable. SMITE is helpful to policymakers when evaluating proposals to add highway capacity.[26]

- **SPASM** (Sketch Planning Analysis Spreadsheet Model): SPASM is an Excel model developed by Cambridge Systematics that focuses on sketch-planning screening-level analysis. This model is used when travel demand data needed to run the Surface Transportation Equity Analysis Model (STEAM) are not available. It is a simple first-cut analysis that produces costs, benefits, and air quality and energy impacts. This comprehensive model provides estimates on the effectiveness of highway improvements (e.g., high occupancy vehicle [HOV] improvements, auto use disincentives) and transit improvements (e.g., transit system route optimization). However, this model lacks the capacity to examine improvements on other modes.[27]

- **STEAM**: In the 1990s, FHWA developed this model to make detailed corridor and system-wide analyses easier. Using travel demand data, STEAM calculates the value of the mobility and safety benefits of transportation projects. STEAM 2.02 reports benefits at the district level, allowing users to compare the impacts of transportation investments across many different areas. STEAM also has an accessibility feature that creates employment estimates within an area designated by a user-defined travel-time threshold. These two features help gauge the social impacts of transportation investments.[28]

Policy Background

1950-1990: Early Transportation Policy

For much of the early 20th century, elected leaders expressed the importance of a national transportation system for promoting commerce and enhancing national competitiveness. During this time, transportation engineers invented some of the first engineering-based performance measures and incorporated them into the project selection process. However, little thought went into incorporating economic considerations into the selection process. Generally, the public assumed that any spending on transportation infrastructure was worth the investment.

It was not until the development of the Interstate Highway System in 1956 that state and local transportation agencies considered researching the economic development benefits from transportation investment. In 1963, a pioneering study examined long-term employment trends and found dramatically higher job growth in areas with interstate access. Beginning in the 1960s and lasting all the way through the 1990s, state and local governments performed numerous studies on the Interstate Highway System and on bypass roads. DOTs also performed several predictive studies and interview studies on the long-term economic returns from transportation investment. While these studies were interesting to national policy consideration, they did not result in the practice of incorporating economic considerations into the transportation planning process. As the understanding of economic considerations continued to move forward, succinct goals for shaping federal transportation policy around economic considerations slowly took shape.

1991-2008: ISTEA, TEA-21, and SAFETEA-LU

From 1991 to 2009, transportation authorization bills offered platitudinous goals about the importance for economic productivity but relatively few strategies or processes for how to achieve them. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), signed into law under President George H.W. Bush, was a step forward for economic impact considerations. The goal of this authorization bill (among others) was to "develop…a system that is economically efficient" and that will "provide the foundation for the nation to compete in the global economy and will move people and goods in an energy efficient manner." [29] Unfortunately, little effort was made to implement a tenable process for how economic efficiency or how building a foundation for the nation to compete would be measured.

Signed by President Bill Clinton in 1997, the Transportation Equity Act for the 21st Century, or TEA-21, established a national framework for transportation decision-making. Similar to ISTEA, this act also did not include economic development considerations. Under TEA-21, there were very few federal requirements for economic evaluation of highway investment costs and benefits. Federal-aid highway projects received funding largely through a formula program based on vehicle miles traveled, population, and other engineering-related considerations.[30] Federal-level economic evaluation and an approval process were not required for most surface transportation projects.

On August 10, 2005, President George W. Bush signed into law the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). This law built on the decision-making foundation established by TEA-21 by refining the programmatic framework for investments needed to maintain and grow the nation's transportation infrastructure.[31] Unfortunately, SAFETEA-LU still lacked mandates for rigorous economic analysis and contained no programs for distributing funding based on economic need. A Government Accountability Office (GAO) report published in 2008 found that SAFETEA-LU surface transportation programs often did not employ the best tools and approaches for determining whether a project makes smart, practical sense. In a recent survey, only eight DOTs around the nation said the ratio of benefits to costs based on economic considerations was a driving factor for transportation investment decisions.

2009-Present: Economic Considerations Take Shape

Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grant Program

In 2009, federal policymakers made a significant effort to incorporate long-term economic productivity considerations into the transportation decision-making process. In response to the 2009 economic downturn, Congress passed the American Recovery and Reinvestment Act (ARRA) as a way to preserve and create jobs, promote economic recovery, and invest in transportation infrastructure in a way that would provide long-term economic benefits. Title XII of ARRA appropriated $1.5 billion for supplementary discretionary grants for the national surface transportation system and authorized the USDOT to award competitive grants to transportation agencies that demonstrated their projects could have a significant impact on the nation or region.

USDOT established economic project criteria based on these broad legislative requirements. The agency incorporated economic considerations into the TIGER grant selection process in two important ways. In its interim notice, the department created two types of primary selection criteria: (1) long-term outcomes, and (2) job creation and economic stimulus. USDOT measured long-term economic competitiveness by assessing how a transportation project would contribute to growth in employment, production, or other high-value economic activity, including the efficient movement of both workers and goods. USDOT gave priority consideration to projects that:

- Improved long-term efficiency or reliability.
- Improved cost competitiveness in the movement of workers and goods.
- Increased economic productivity of land, capital, or labor.

The TIGER program was a significant step forward in several ways. First, the department went through a rigorous project selection process that involved a selection committee charged with carefully examining the economic benefits of each project. For the first TIGER program, over 1,400 TIGER grant applications requested nearly $60 billion. After initial evaluations, 166 highly rated projects, or 11 percent of the total, were advanced for further review. An economic analysis team, chaired by the department's chief economist, presented a cost-benefit analysis for each advanced project. TIGER grant requests were not approved if the economic analysis team concluded that project costs exceeded public benefits.[32]

The department gave priority to projects that demonstrated short-term job creation and economic stimulus. USDOT assessed whether a project promoted the short- or long-term creation and preservation of jobs and whether the project rapidly promoted new or expanded business opportunities during construction of the project or thereafter. Applicants were encouraged to provide information to assist the department in making these assessments, including the total amount of funds expended during a project's construction phase. USDOT also placed priority on applicants that identified business enterprises created or helped by the project during construction. Finally, USDOT gave priority to projects that demonstrated readiness to proceed rapidly upon receipt of TIGER grant funds. This move demonstrated a broadening recognition to incorporate results-driven economic considerations into the final transportation process.

Transportation Infrastructure Finance and Innovation Act (TIFIA) Bonds

In 1998, the Transportation Equity Act for the 21st Century established the Transportation Infrastructure Finance and Innovation Act (TIFIA), authorizing USDOT to provide secured (direct) loans, lines of credit, and loan guarantees to public and private applicants for eligible surface transportation projects of regional or national significance. Highway, passenger rail, transit, and intermodal projects (including intelligent transportation systems [ITSs]) are eligible to receive credit assistance under TIFIA. The maximum amount of TIFIA credit assistance to a project is 33 percent of eligible project costs. Each project seeking TIFIA credit assistance must identify a dedicated revenue source to repay the TIFIA loan, and each private applicant must receive public approval for its project.

Similar to TIGER grants, lawmakers intended for TIFIA to give priority to projects that have an impact through economic determination factors. The most important criteria for receiving a grant is the extent to which a project "is nationally or regionally significant, in terms of generating economic benefits, supporting international commerce, or otherwise enhancing the national transportation system." [33] One of the considerations for these criteria includes "contributing to the economic competitiveness of the U.S. by improving the long-term efficiency and reliability in the movement of people and goods."[34] Economic competitiveness contributes up to 20 percent of total project selection. By expanding and enhancing the current TIFIA program, economic competitiveness can help to ensure that transportation loans are directed toward projects that make the most sense.

Reflecting and Looking Forward

Since the era of the interstate in 1956, broadening program goals and diverse eligibility requirements have given states and local governments more discretion for allocating most highway infrastructure funding. This has caused a shift away from establishing a clear, cohesive federal transportation role. To incorporate additional environmental, societal, and public health goals, federal surface transportation programs have grown in number and complexity, while federal accountability for how transportation funds are spent has declined. Yet federal transportation goals have expanded and spending has increased. SAFETEA-LU was a significant step toward establishing a more performance-based funding approach. While significant federal policy strides have been made to increase the importance of economic decisions into the decision-making process, there is still much diversity in application, with no consistent, standardized performance measures.

Research Approach

Case Study Research Method

Best practices, as defined by the GAO, are "processes, and/or systems identified in organizations widely recognized for major improvements in their performance and efficiency in a specific area."[35] Since best practices are important to consider when developing a consistent methodology, the case study research method was used to examine several approaches used around the U.S. The goals, processes, inputs, and outputs used by case examples can serve as a consistent framework to help guide and inform federal decision-making. Such a method emphasizes detailed contextual analysis in order to determine relationships. Comparing the four successful case studies helped guide researchers as they looked for plausible policy recommendations in developing a tenable, consistent methodology to employ.

Case Study Selection Criteria

There are several states around the U.S. that perform some form of economic impact analysis. According to a report published by TTI, over 16 states use some form of economic valuation study. Yet, few states have developed comprehensive programs that are robust enough to be included actively in the decision-making process. (See Appendix for more information on the states featured in this study.)

To be considered for this study, case studies had to have successfully demonstrated the following criteria:

- **Clearly Outlined Economic Determination Process:** Each case study had to offer a clear, methodical process for determining economic effects from transportation investment. Current federal formula and discretionary grant programs are criticized for lacking a tenable, systematic method for determining these impacts.

- **Data-Driven:** Each economic impact analysis case study had to be based on empirical economic data. Federal programs are often criticized because decisions are made based on political considerations rather than empirical proof of economic benefit. Thus, case studies needed to incorporate readily available travel demand data and an economic modeling process into the final transportation analysis.

- **Transparent Methodology:** Next, it was important that the methodology be transparent to the public. The federal TIGER II program has been criticized by many due to its lack of transparency and failure to seek public input. Some state DOTs have been criticized for not clearly publishing how they have based their project selection process on economic need. Thus, only case studies that clearly outlined how they determined economic benefits were included.

- **Widespread Public Support:** Finally, it was important that the public generally supported the process. If stakeholders or the public felt the process was ineffective, unfair, or unclear, the case study was excluded from this analysis. This was important for two reasons. First, it was important for information to be widely available on the process and assumptions used for the study. Second, it was important to help guide a desirable program where public outreach is an integral component to the determination process.

Economic Outcome Objectives

There are several reasons why strategically prioritizing transportation investment based on long-term economic productivity returns is important. According to a recent Carnegie Foundation report, federal surface transportation programs have direct oversight over only 20 percent of total federal funding distributed to states.[36] In a fiscal environment where every dollar matters, a strategic, long-term, accountable approach is necessary for positive long-term economic impact outcomes.

Empirical evidence suggests that targeting transportation investment toward projects that best promote economic competitiveness leads to the following outcomes:[37]

- **Increased Business and Industry Competitiveness:** A strong transportation network reduces costs of production and distribution. It also lowers barriers to mobility, giving the manufacturing and retail sectors better access to specialized and productive sources of labor. These cost savings allow businesses to spend more on research, hire more workers, and raise worker wages. Businesses and corporations that have the ability to better control their flow of information tend to be more productive.

- **Strengthened Long-Term Regional and Local Economies:** Targeted transportation spending benefits federal, regional, and local economies. Transportation spending also helps energize city centers, break the isolation of rural areas, and increase overall long-term employment. The Interstate Highway System constructed from 1956 to 1991 is the most visible and well-known example of such a concept.

- **Enhanced Household Well-Being:** A strong transportation network gives households access to a broader range of higher-paying jobs, a wider selection of competitively priced consumer goods and housing options, and a convenient selection of health and human services. Improved roadway design and capacity expansion can reduce vehicle repair costs and reduce traffic congestion. Efficient public transport networks reduce costs associated with driving and automobile ownership.

Case Study #1: Kansas DOT Expanded Highway Selection Program

Background and Purpose

In 2003, a reform effort led by Kansas Secretary of Transportation Deb Miller called upon the Kansas Department of Transportation (KDOT) to be more responsive to the public when making project selection decisions. As a result, KDOT developed a comprehensive methodology where engineering judgment was combined with economic criteria and local consult scores to help select transportation expansion projects. Analysts assessed total job and gross regional product data for each new transportation project contained in the state's long-range transportation plan. Points were allocated based on outputs generated using the TREDIS model. These outputs included (a) anticipated change in study area jobs by 2030, and (b) anticipated change in net present value of study area gross regional product and safety benefits by 2030.

Kansans and KDOT began first by drafting a long-range transportation plan. This plan called for a more "flexible and responsive approach to decision-making" and a "stronger focus on economic growth."[38] In August 2008, Governor Sibelius convened a statewide task force to develop a set of recommendations to "frame a new strategic approach to future transportation needs."[39] After comments were gathered and meetings were held, the statewide task force affirmed the importance of transportation by saying that "while previous investments in transportation have provided significant benefits, more attention must be paid to the interaction between transportation investments, jobs retention, and growth of the Kansas economy."[40] The task force also called for the use of an economic impact analysis during project selection. See Table 2 for more information on important components of this program.

Table 2: Kansas DOT Highway Selection Program

Program Components	Kansas DOT Highway Selection Program
Type of Economic Study	Examination of statewide impacts from transportation investment
Program Purpose	Determination of economic impact considerations to prioritize worthwhile projects (economic impact considerations calculated, scored, and ranked)
Geographic Study Area	Statewide and regional
Program Study Time Period	30 years
Impact Measures Used	Gross state product, direct and indirect employment, traveler benefits
Analysis Model	TREDIS economic model
Data Used to Calculate Economic Benefits	Data from local sponsors and KDOT district engineers
Public Outreach Process	Posted final project rank list on website and held public outreach meetings throughout the state

Program Methodology

An advisory work group convened by Deb Miller recommended appropriate economic impact measures to use. This work group suggested that KDOT transportation analysts focus on impacts to jobs and income growth. Once the economic impact measures were selected, an analysis method was developed. Upon recommendations received by the State Economic Impacts Working Group in 2008, KDOT used projections from KDOT engineers about changes in congestion, travel times, travel times, or accessibility. These estimates were provided as inputs to the TREDIS model. For each project, information on local economic conditions collected by KDOT's area engineers from local officials and economic development experts was also included.

Program Strengths

Several elements in the KDOT Highway Selection Program are worthy of considering for adopting a new federal-level approach. These include:

- **Transparent:** KDOT officials used an open, transparent process in both the design of the highway selection program and the process itself. KDOT presented values for long-term employment and income growth for each transportation project on its public information website. In addition, KDOT officials disseminated this project list to district traffic engineers, public information meetings, and elected officials. Personnel were available to answer any questions members of the public may have if they wanted a more in-depth examination of the process. In order to facilitate increased participation, KDOT launched its first-ever online community to provide timely and transparent information. The agency encouraged the use of Twitter and Facebook. In addition, KDOT staff created YouTube videos to explain the progress made.[41] As a result of these efforts, the economic process developed by KDOT received broad support by the Kansas public. This was due in part to the transparency and excellent communication on behalf of KDOT professionals. More than 400 Kansans participated in meetings held around the state, and most supported selecting projects based on long-term economic growth.

- **Flexible:** KDOT transportation professionals developed a system that was flexible enough that it could be changed when faced with unintended consequences. For example, when some stakeholder groups complained that the project selection process unfairly selected urban transportation projects, the program was adjusted to take into account all project sizes, both large and small. For a federal economic impact selection program to be effective, it will need to remain flexible in order to deal with unforeseen challenges.

- **Collaborative:** KDOT transportation professionals worked closely with local communities and district engineers throughout the design and implementation of the economic determination process. Local government stakeholders also provided input on meaningful economic results. Overall, KDOT program administrators determined that the economic analysis program was successful because they sought input and feedback on which model to use.

- **Innovative Economic Impact Weighing Score**: Kansas DOT officials developed an economic impact score to help weigh transportation impacts, which in turn helped to quantify and rank projects based on economic considerations. Scores were based on how well a project addressed relevant criteria, such as engineering needs, regional priorities, and economic development initiatives. Economic scores factored into 25 percent of the formula developed. Economic score components were calculated based on empirical economic data, which in turn helped to ensure that economic outputs were as accurate as possible. As a result, it was clear to all stakeholders the precise value and weight each transportation project possessed.

- **Long-Term Economic Study Period:** Kansas DOT officials also measured economic considerations based on a far-reaching study period. This ensured that economic impacts over a long period were calculated. Points for economic scores were awarded based on anticipated change in study area jobs by 2030 and anticipated change in net present value of study area gross regional product by 2030.

Program Outcomes

After more than two years of local consultation, including more than 60 meetings with over 850 attendees, it became clear that Kansans wanted to help grow and promote their economy through transportation investment. After more than six years in development, KDOT transportation professionals developed a program that largely fulfilled three major economic outcomes: increased business and industry competitiveness, strengthened long-term economies, and enhanced household well-being. How well the Kansas DOT Highway Selection Program meets these policy outcomes is described in Table 3 below.

Table 3: Kansas Highway Selection Program Outcomes

Desired Outcome	Kansas DOT Highway Selection Program
Increased Business and Industry Competitiveness	Business expansion and attractiveness criteria incorporated in the process led to effective communication of transportation impacts to industry stakeholders; use of social media and community outreach program helped to gain efficient input from industry needs. This will be important in the future—the Kansas Dept. of Commerce predicts growth in transportation and logistics industries over the next 5-10 years.
Strengthened Long-Term Economies	KDOT was committed to developing a selection process that directed transportation investment toward long-term economic growth, not short-term construction jobs.
Enhanced Household Well-Being	While it is too early to gauge accurate assessment, travel times dropped as a result of strategically focused investment, which will likely result in greater discretionary funds available to Kansas households. Access to health care facilities and other essential programs in Kansas' urban areas improved.

Outcomes include:

- **Increased Business and Industry Competitiveness:** Effective transportation is determined by how well it can increase business and industry competitiveness. The KDOT transportation staff worked diligently to involve as many stakeholders as possible, including those from business and logistics companies. In part, as a result of this new and improved project selection program, Kansas is gaining a reputation within the business community as a facilitator of transportation and logistics companies, and for good reason—despite previously poor economic conditions during the past few years, the transportation and warehousing sectors of the Kansas economy are poised to grow 15 percent over the next six years.[42] A study from the Kansas Department of Commerce found that this program will likely improve the confidence in businesses that infrastructure is being targeted efficiently and effectively. Businesses are slowly migrating to Kansas because they see the potential that the state economy can provide from a logistics perspective. The money saved goes directly into profit, which is reinvested directly back into Kansas firms.[43]

- **Strengthened Long-Term Economies:** This program is a strong example of a transportation agency that focused only on the long-term economic impacts associated with transportation investment. For example, KDOT chose to report only long-term jobs because stakeholders indicated that their primary interest was what makes a lasting difference in the Kansas economy. Short-term construction impacts were therefore excluded from the final analysis, and there are several examples of projects selected through this process that resulted in greater long-term economic value and benefitted the Kansas economy. For instance, the Parsons US 400 Bypass added $56 million in economic value, more than twice the project cost of $27 million. It is likely that continued transportation investment focused strategically on projects that gain the greatest return will have a long-term positive impact on the Kansas economy.

- **Enhanced Household Well-Being:** There were also several efforts to focus on enhancing household well-being. A major criteria component incorporated in the KDOT project selection process was the extent a project reduced overall travel times. This reduction in travel time resulted in greater savings to the traveling public, allowing households more available discretionary spending.

Case Study #2: Indiana Major Corridor Investment Analysis Program

Background and Purpose

Transportation professionals in Indiana needed to explore economic implications from proposed major corridor improvements to US 31 in Central Indiana. However, some state leaders initially scoffed at the large price tag for the project. Design plans called for an overhaul of the existing four-lane corridor in order to meet interstate design standards. Analysts at the Indiana Department of Transportation (INDOT) accomplished two major objectives: (1) evaluate the regional economic impacts of transportation improvements to the US 31 corridor in Central Indiana, and (2) compare economic benefits to implementation costs, thereby ensuring effective public sector investment.

This study performed by INDOT helps to illustrate Indiana's use of its unique Major Corridor Investment-Benefit System (MCIBAS) to explore the benefits of improvements along one single corridor. MCIBAS consists of a travel demand model, a user benefit-cost analysis system, and an economic impact analysis system. The economic impact analysis system (EIAS) is a series of linked models used to estimate the economic impacts of the long-range plan. The system consists of three components: a benefit-cost savings module, a business attraction module, and a REMI model. While other studies examined economic studies system wide, this analysis focused only on the economic impacts from improvements to the US 31 corridor. Ultimately, INDOT used the MCIBAS process to weigh the benefits (i.e., personal auto user benefits, economic benefits) with the costs (i.e., construction, operations, and maintenance) to come up with a final benefit-cost ratio. This study used all of the steps and processes outlined in the refined methodology used above. See Table 4 for a brief summary of the MCIBAS economic determination program.

Table 4: MCIBAS Investment Analysis Program

Program Components	MCIBAS Economic Determination Process
Type of Economic Study	Corridor analysis
Economic Study Purpose	Public information and decision-making
Geographic Study Area	Corridor-level, regional and statewide
Program Study Time Period	30 years
Impact Measures Used	Disposable income change, employment, business sales
Analysis Method/Model	Cost-benefit analysis, Net_BC, REMI economic model
Data Used to Calculate Economic Impacts	Statewide travel demand data (traffic volumes and travel times)
Public Outreach Process	Posted finings and process online and held stakeholder meetings along US 31 corridor

Program Methodology

INDOT transportation professionals began by first determining the purpose for the analysis. The purpose was to determine what the impacts would be from the construction of the 122-mi US 31 corridor between Interstate 465 in Indianapolis to the US 20 bypass in South Bend. Since the goal for this study was to ensure effective public sector investment, a cost-benefit analysis tool was used to examine benefits to the traveling public. An economic model was also used to examine the broader impacts that transportation improvements to US 31 could have on the Indiana economy as a whole.

After INDOT transportation professionals established the purpose, they then created a base-case (no-build) and an alternative (build) transportation scenario. The base-case scenario served as a realistic representation of past, current, and future conditions if no improvements took place on the US 31 corridor. The alternative case assumed that planned improvements on US 31 occurred. Transportation analysts used the Indiana statewide transportation model to generate projections of traffic volumes and travel times on the US 31 corridor and throughout the rest of the state for both the base-case and alternative scenario.

For this study, it was determined that proposed improvements under the build scenario would increase vehicle free-flow speed from 50.3 mph up to 60.3. Adjusting for the elimination of signalization, the total decrease in travel times would be roughly 35 minutes along the entire corridor. Average daily traffic (ADT) would also increase. Average daily trips would decrease on many of the north-south parallel routes due to more drivers taking US 31 as an alternative.

Next, INDOT transportation professionals determined the geographic area to study. The study corridor runs from the northern suburbs of Indianapolis to the South Bend and Elkhart metropolitan areas in the north. US 31 is the primary north/south route through North Central Indiana. At the time of the study, it was a four-lane divided highway with varying levels of access control. Since US 31 was a major arterial for the state, INDOT analysts focused on what impact US 31 improvements could have on Indiana. While the area immediately surrounding the

US 31 project improvement area would receive the greatest benefits from transportation improvements, Indiana taxpayers would be responsible for bearing the initial costs from road improvements. Therefore, effects due to resource shifting (i.e., trucking distributors choosing to move from other areas in the state toward the US 31 corridor as a result of improvements) were analyzed. If a more localized geographic area were selected, this business shift would have been accounted for in the analysis as an overall net economic benefit, when this was in fact simply the relocation of a business. By using a statewide approach, business expansion and business relocations from outside to inside the state were seen as a net economic benefit, but shifts within the state were not seen as a net overall benefit. Then, a 30-year study period was established for this analysis. The period for the study was determined by both the type of project and the purpose for the analysis.

Next, user impact benefits were calculated. Since the purpose for this study was to examine both user and economic impacts from US 31 improvements, user benefits were calculated first. Analysts used a user cost-benefit analysis model called NET_BC to utilize traffic volumes and times generated earlier to calculate total costs on the US 31 corridor. Build and no-build costs were compared to estimate user benefits associated with improvements. See Table 5 for more information on projected travel time reductions from data generated from the Indiana statewide transportation model for the no-build and build scenarios.

Table 5: Projected Changes in Travel Time from US 31 Corridor Improvements, 2020[44]

	Travel Time (minutes)[1]			
US 31 Link	**No-Build**	**Build**	**Difference**	**% Change**
I-465 to SR 431	8.22	6.06	-2.16	-36%
SR 431 to SR 26	35.3	28.61	-6.69	-23%
SR 26 to US 35[2]	12.53	14.09	1.56	11%
US 35 to US 24	14.43	12.03	-2.4	-20%
US 24 to US 30	46.64	39.43	-7.21	-18%
US 30 to US 20 (Bypass)	22.79	18.97	-3.82	-20%
IH-465 to US 20 Bypass	**143.17**	**121.91**	**-21.26**	**-17%**

[1] Travel times assume free-flow speeds. Actual travel times in the no-build scenario are higher due to signalization.
[2] Data shown are for the existing US 31 realignment, which will continue to represent the shortest path through the metropolitan area. Projected number of average daily trips on the eastside bypass is 9,900.

Direct economic benefits were then calculated. A system of economic benefit models were linked together to calculate the direct economic benefits to businesses. The changes in customer and labor market size were estimated based on the travel time changes and applied in a business location model to identify the types of industries that might have be attracted to the study area as a result of US 31 improvements. Additional jobs created for each industry were also calculated.

Next, secondary economic benefits were calculated. The REMI regional economic simulation model was used to forecast indirect and induced impacts of direct economic impacts. The REMI model is a sophisticated type of economic analysis model known as input-output. Input-output models estimate the effects of transportation construction and spending on business activity and employment. They yield economic multipliers that are used to calculate the full jobs, income, and output generated per dollar of spending on various types of goods and services in a study area.

Finally, direct, indirect, and induced impacts were aggregated, discounted over time, and compared to the stream of capital and operating costs to determine an overall benefit-cost ratio for the US 31 project. A cost-benefit assessment for the proposed US 31 expansion involved comparing the entire stream of benefits resulting from the construction of a project with the entire stream of costs over that same period. Discounting compensated for differences in the timing of benefits and costs over the period. The analysis period for this study is from 2005 (when construction was proposed to begin) until 2034.

Program Strengths

The MCIBAS program features several elements that make it an excellent case study for adopting robust standards:

- **Broad Study Scope:** The MCIBAS program includes regional and statewide impacts, assuring that all economic components are considered. Job shifts away from the study area will be included in the final study, which will ensure a more robust and accurate economic determination process. Transportation professionals wanted to examine the economic effects that would occur throughout the region at a statewide, regional, and local level. In this way, localized effects could easily be compared with long-term effects.

- **Incorporation of Long-Term Economic Effects into Cost-Benefit Analysis Process:** This study included a comprehensive cost-benefit process that took into account long-term economic effects. User and direct/indirect economic impacts were assessed through this method. A standardized cost-benefit method was also employed for this program.

- **Data Driven:** This project based its user impact information on actual travel demand data. The MCIBAS system incorporates travel demand information readily available to the user. This case study examined user benefits, direct benefits, and secondary benefits into the overall analysis.

Program Outcomes

The MCIBAS program is intriguing because it was developed in the late 1990s, well before the other case studies featured in this analysis. This allows for more time to explore long-term economic changes and to see how and to what extent INDOT professionals modified this program. Similar to the other case studies, this program resulted in three major outcomes: increased business and industry competitiveness, strengthened long-term economies, and enhanced household well-being. The MCIBAS process was so successful that it was used for assessing the economic outcomes of several more transportation projects throughout Indiana. How well the MCIBAS program meets desired policy outcomes is described in Table 6 below.

Table 6: MCIBAS Program Outcomes

Desired Outcome	MCIBAS Program
Increased Business and Industry Competitiveness	Business expansion and attractiveness criteria incorporated in the process led to effective communication of transportation impacts to industry stakeholders.
Strengthened Long-Term Economies	State connectivity improved, the project selection process targeted planning funds more efficiently, and information indirectly allowed planners to argue for a state gas tax increase.
Enhanced Household Well-Being	Travel times dropped as a result of strategically focused investment, which resulted in more discretionary funds available for other, non-transportation purposes.

Outcomes include:

- **Increased Business and Industry Competitiveness:** This program largely achieved this outcome. Unlike some of the previous economic impact analysis assessments, the MCIBAS program factored business expansion and business attraction criteria into the process. Business attraction criteria were incorporated to determine long-term economic effects of reduced travel-related costs for businesses and individuals. They were also used to determine the long-term economic effects on industrial operations beyond those associated with travel time savings. Together, these criteria were incorporated into the process to help decision-makers and transportation professionals make better decisions on how to target investment so that it would increase business and industry competitiveness. By distinguishing these factors, transportation professionals could logically understand the effects that transportation impacts had on business productivity in Indiana. As a result of this comprehensive effort, INDOT professionals used the MCIBAS model for many more projects, using it as a tool to decide whether or not more extensive engineering and planning for a project should be pursued in the first place.

- **Strengthened Long-Term Economies:** This program also helped to strengthen the long-term economy. This program was one of the first programs in the United States where comprehensive economic modeling and analysis of transportation investment took place. The success of the first corridor led to its repetitive use in the future; the system was developed and used to critically evaluate which projects were worthy of pursuing and which ones were not, helping to invest limited tax dollars toward only those investments that strengthened the state's long-term economy. The continued use and development of the MCIBAS model proved so successful that it indirectly contributed to bolstering the argument (backed by the Indiana logistics and transportation industry) for a gas tax increase in 2003.[45]

- **Enhanced Household Well-Being:** Finally, this project largely fulfilled the outcome of enhancing household well-being. Through performing a process of evaluating user impacts in depth, this process helped distinguish the user impacts associated with residents who lived near or were affected by the potential transportation project. Many project stakeholders were pleased to see the effects of such an in-depth analysis for their project. Travel times were significantly reduced through the construction of multiple projects within Indiana. Many prominent political leaders praised the INDOT program and its ability to strategically evaluate and target investment toward only projects that made the most sense. Both commercial and personal users of the Indiana transportation network saw major reductions in travel times. This reduction in travel times resulted in greater household savings and enhanced well-being.

Case Study #3: Michigan DOT 2010-2014 Highway Analysis Program

Background and Purpose

Michigan Department of Transportation (MDOT) staff needed a way to estimate the economic impacts of its fiscal year (FY) 2010-2014 five-year transportation plan. In order to communicate the benefits of such a system to the public, MDOT staff collaborated with the University of Michigan to create several specialized tools and one consistent methodology that helped ensure transportation spending was directed in a way that promoted the state economy. DOT officials utilized generally accepted methods of estimating travel efficiency gains, and the resulting economic impacts of transportation impacts were the basis for the study. See Table 7 for a brief summary of the program components used.

Table 7: MDOT 2010-2014 Highway Analysis Program

Program Components	MDOT 2010-2014 Highway Analysis Program
Type of Economic Study	Regional study, highways
Economic Study Purpose	Public information
Geographic Study Area	Statewide, regional
Program Study Time Period	Five years, 2010-2014
Impact Measures Used	Employment data by industry, gross state product, cumulative income effects
Analysis Method/Model	MI-BEST travel demand calculation tool, REMI
Data Used to Calculate Economic Impacts	MDOT sufficiency database and statewide travel demand data
Public Outreach Process	Posted final project rank list on website

Program Methodology

MDOT transportation staff began by first deriving a list of viable projects to pursue. They identified projects from a master list of projects compiled from three major state databases and used objective criteria and expert transportation knowledge to select which transportation projects to pursue.

MDOT economists then selected transportation computer-aided design (TransCAD) software to create a transportation network, and designated build and no-build scenarios were created for each year. Once these calculations were finished, the resulting vehicle miles traveled (VMT) and vehicle hours traveled (VHT) values for trip purpose savings were directly input into spreadsheet templates that were easily read by a tool developed for specific use in Michigan, known as the MI-BEST tool. The MI-BEST tool included the following steps:

- Step 1: conversion of the impact of investment on traffic data to meet direct user benefits and translation of those benefits into REMI policy variables.

- Step 2: estimation of investment cost by category of spending and translation of those costs into REMI policy variables.

- Step 3: estimation of investment funding by new revenue sources and translation of those sources into REMI policy variables if required.

After the MI-BEST tool generates calculations, it passes the policy variable adjustments and investment-level inputs into the REMI model. The REMI model makes calculations and assessments with regard to the economic impact data and user benefit data used. This process ultimately compares the output data of the MI-BEST tool as it reflects the results of different funding scenarios.[46]

Program Strengths

Several elements in the MDOT 2010-2014 Highway Analysis Program are innovative and worthy of consideration at the federal level. These include:

- **Data Driven:** First, this model is one of the best examples of the comprehensive use of a data-driven economic analysis. This study used the TransCAD and the REMI economic modeling software to perform the analysis. This analysis also provided employment benefits from MDOT's five-year program by industry in the state. Additionally, cumulative effects on real income were calculated under this program.

- **Analysis Performed with Funding Limitations:** This study took into account projects based on federal and state funding availability. One of the major motivations driving this study was fear that federal-matching aid might be cut if state funding were reduced. Therefore, this analysis featured the economic effects from projected cuts in federal funding to present a worst-case scenario to legislators.

- **Collaborative:** Michigan DOT officials worked with local stakeholders, local communities, and the public to gather data and assess which projects should be examined for the study.

Program Outcomes

The Michigan 2010-2014 program resulted in several notable outcomes that are important to consider. Michigan is an especially important case study because the state has been affected by the 2009 economic recession. The state's unemployment rate increased from 7.1 percent in 2007 to as high as 14 percent in 2009 before falling to 11 percent in 2011. The call for quick construction jobs was the most tempting solution for lawmakers to pursue. However, state leaders and transportation professionals remained focused on the long-term economic impacts associated with transportation and finding ways to best target transportation investments. Their efforts resulted in a comprehensive program that helps transportation planners better align limited transportation funding toward helping to grow the state's economy for the long-term (critically important with the logistics demands from the state's automotive industry). The program proved so successful that the Pew Center on the States recently cited Michigan as leading the way in promoting jobs and commerce through transportation investment.[47] Table 8 shows how the MDOT program has helped the state achieve these three outcomes.

Table 8: MDOT 2010-2014 Highway Analysis Program Outcomes

Desired Outcome	MDOT 2010-2014 Highway Analysis Program
Increased Business and Industry Competitiveness	Business expansion and attractiveness criteria incorporated in the process led to effective communication of transportation impacts to industry stakeholders. This program also helped to avert funding cuts to transportation from the Michigan State Legislature.
Strengthened Long-Term Economies	State connectivity improved and the project selection process targeted planning funds more efficiently, addressing calls by publicly elected leaders for process reform.
Enhanced Household Well-Being	Travel times dropped as a result of strategically focused investment, which resulted in more discretionary funds available for other, non-transportation-related purposes. Access to critical services (such as health care) improved.

Outcomes include:

- **Increased Business and Industry Competitiveness:** The MDOT program has largely helped to focus transportation investment on increased business and industry competitiveness. Similar to Indiana's MCIABAS system, the MDOT Five-Year Transportation Program takes into consideration impacts from business and industry competitiveness. Transportation investments will help preserve the Michigan economy for months and years to come. This program has established a framework that has helped state officials identify data needs, establish economic performance measures, and set goals.

- **Strengthened Long-Term Economies:** Long-term impacts were considered and long-term decisions were made as a result of this study. In 2007, Michigan used the program to compare the economic impact of four different strategies for transportation investment.

Only scenarios with the best long-term approaches were used. This tool was also used to rule out any projects that were considered unnecessary, allowing investments based only on current funding projections to be targeted. This focus has led to a more disciplined approach toward measuring and focusing transportation investment on performance metrics and emphasizing transportation investments. The Research Seminar in Quantitative Economics predicts that Michigan will grow moderately over the next several years. Transportation infrastructure improvements will help facilitate that growth.[48]

- **Enhanced Household Well-Being:** Similar to the INDOT MCIBAS program, the MDOT economic determination process also takes into consideration travel time costs for both commercial and personal drivers. However, the MDOT program is unique in that it analyzes projects based on different transportation funding scenarios. This allows decision-makers to see the effects of what might happen if they decide not to fund transportation investments. Reduction in travel times would translate into significant transportation savings—as much as $20 billion under the optimal investment strategy.[49]

Case Study #4: North Carolina DOT Prioritization 2.0 Program

Background and Purpose

Stakeholders and transportation professionals in North Carolina recently called for a greater need to incorporate more factors outside of engineering considerations into the project selection process. In response to these requests, the North Carolina DOT (NCDOT) recently implemented a new approach to project selection. This is important because in North Carolina, NCDOT is responsible for more than three-quarters of state roadways.[50] The NCDOT Strategic Prioritization Process 1.0 was the state's first attempt at creating a clearly defined process for prioritizing transportation projects. Under this new process, each project is classified under one of the department's three primary goals: safety, mobility, and infrastructure health.

In 2011, NCDOT was in the process of rolling out Prioritization 2.0, an updated program intended to enhance and build upon successful elements from its first program. This new program will expand selection criteria based on relevant stakeholder input. This program also matures the process and offers a long-term outlook for project prioritization, examining total project benefits from 2018-2022.[51]

One of the new factors built into the scoring criteria is an innovative economic competitiveness component. This addition is in response to a public survey where over 60 percent of respondents stated economic impact considerations (e.g., job creation, increased wages, economic benefits) should be considered in the project selection process.[52] Like many of the previous case studies, this project selection process uses a robust input-output economic model to calculate economic factors such as created jobs, increased wages, and increased productivity. This modeling software generates economic calculations, which are converted to a final weighing factor.[53] See Table 9 for a brief summary of the economic process.

Table 9: NCDOT Prioritization 2.0 Program Components

Program Components	NCDOT Prioritization Program
Type of Economic Study	Statewide and regional economic study
Economic Study Purpose	Decision-making
Geographic Study Area	Regional MPO/RPO level
Program Study Time Period	Four years, 2018-2022
Economic Impact Measures	Economic score generated based on wage increases, job growth, and increased productivity factors
Analysis Method/Model	TREDIS economic modeling software
Data Inputs Used	Change in VHT based on state travel demand data and project information from MPOs and local officials
Public Outreach Process	Post final project rank list on DOT website and present findings at local stakeholder meetings

Program Methodology

The North Carolina Prioritization 2.0 program is a work in progress. After NCDOT transportation officials developed the prioritization program, they held outreach and education meetings across the state. Public opinion concerning economic factors was mixed, yet mostly positive. Some stakeholders were concerned that such a program might unfairly penalize rural areas. Stakeholders in urban areas largely supported such a method, arguing that in an era of limited resources, it makes sense to improve congestion first. Input was taken into consideration for incorporation into the final project prioritization program.

Similar to the Kansas Highway Selection Program, projects are based on a scoring process that takes into account quantitative economic data, local input, and multimodal options. Economic competitiveness scores are generated through the TREDIS economic model. North Carolina transportation professionals input predicted change in vehicle hours traveled (which is calculated from travel time savings). The output from this modeling software is value added based on percent change for each DOT division. This metric includes jobs created, wages increased, and productivity gained.

After projects that are consistent with the draft plans have been selected by the state regional planning organizations (RPOs) and MPOs, mobility projects are scored according to three tiers. The statewide tier consists of a score that is made up of the following components: 20 percent congestion, 20 percent cost-benefit, 10 percent safety, 10 percent pavement condition, 10 percent economic competitiveness, and 30 percent local input. For regional and sub-regional projects, just 5 percent of the score consists of economic competitiveness criteria. Scores generated through TREDIS mentioned earlier are then input for each project and weighted.

From October to November 2011, MPOs, RPOs, and divisions ranked projects, and by late fall of 2011, a listing of project rankings were released. NCDOT, MPOs, and RPOs then held investment strategy summits throughout the state and used the input generated therein to develop a draft 10-year work program. In May of 2012, a draft work plan was released.

Program Strengths

Several strengths are evident with the NCDOT Prioritization 2.0 Program. These include:

- **Built from the ground up from public input:** This process addresses previous criticism faced by NCDOT officials regarding how projects were selected. The department held listening sessions where input from MPOs, RPOs, and the public were incorporated into designing the final project selection process. Among other interesting finds, this survey found that nearly 60 percent of respondents felt that economic considerations should be incorporated into the decision-making process. Economic competitiveness criteria were then incorporated into the weighing and selection of mobility projects.

- **Data Driven:** In order to determine economic outputs, NCDOT transportation professionals used input-output economic software to determine the economic effects of transportation improvements. TREDIS economic software is one of the most usable and accurate modeling software programs available to determine economic impacts.

- **Transparent:** During the Prioritization 1.0 process, NCDOT officials involved stakeholders as much as possible to ensure that methods and outcomes were effectively communicated. Similar to the KDOT program, public and stakeholder input was incorporated into every major step of the project selection process. The NCDOT Prioritization 2.0 process will involve the largest number of stakeholders among all of the case studies examined in this analysis. It was clear that NCDOT officials wanted the public to be a part of the transportation selection process and clearly understand how the economic selection criteria assumption and calculations were determined.

- **Collaborative:** The Prioritization 2.0 process was designed to be highly collaborative. NCDOT transportation professionals have provided TREDIS economic software to 17 of the state's MPOs and 30 RPOs. At the time of this writing, two have sought additional support because they see the benefit in selecting transportation projects based on economic consideration criteria.

Program Outcomes

The North Carolina Prioritization Program is currently in the implementation stages, so no tangible outcomes have been determined. However, this program will likely lead to investments that are strategically directed toward enhancing the long-term growth of North Carolina.
Table 10 shows how the NCDOT Prioritization 2.0 Program has and will help the state achieve these three outcomes.

Table 10: NCDOT Prioritization 2.0 Program Outcomes

Desired Outcome	NCDOT Prioritization 2.0 Program
Increased Business and Industry Competitiveness	Increased productivity criteria incorporated into final economic determination process.
Strengthened Long-Term Economies	Project selection process targets planning funds more efficiently and includes jobs created and wages increased that will lead to greater long-term strengthened economy for North Carolina, thereby gaining buy-in from elected officials.
Enhanced Household Well-Being	Household transportation costs will decrease, mobility in rural and urban areas will improve, and access to critical facilities (i.e., health care) will increase.

Outcomes include:

- **Increased Business and Industry Competitiveness.** This process will help direct transportation investment toward projects that ensure greater business and industry competitiveness. Transportation professionals at NCDOT sought to ensure that the needs of the business community were well represented within the economic competitiveness program. Stakeholder input was highly incorporated into the design of the final economic determination process.

- **Strengthened Long-Term Economy:** The new Prioritization 2.0 Program has long-term economic impacts. This program will likely result in a push toward economic efficiencies and a greater focus on the return on investment. Initial estimates suggest that local community leaders and transportation authorities largely support the Prioritization 2.0 process.

- **Enhanced Household Well-Being:** Benefits and costs were appropriately measured for this analysis. Travel time savings for a planning period of up to 30 years were calculated and incorporated into the final project selection process. This reduction in travel time savings will eventually result in significant time savings by all drivers using North Carolina roadways. Investment in state transportation will be targeted only to those projects that generate the greatest return on investment.

General Findings

There are several major themes that existed among all of the sampled case studies. For example, most, if not all, of the case studies exhibited the following traits:

- **Consistent Standards:** First, all of these case studies used several consistent standards for determining the economic impacts from transportation investment. For example, all of these projects developed a regional and statewide study area. For direct employment, they all examined job growth in terms of direct and indirect jobs generated over a 20- to 30-

year time period. Comprehensive discount methods were also employed through this process.

- **Relatively Cost Effective:** Next, three out of the four case studies were relatively low cost and focused on reasonable assessments. They generally employed methodologies that were cost effective. In all four of the case studies examined, none of the project designers or implementation teams complained about the high level of costs associated with incorporating economic impacts into the decision-making process. It is likely that federal requirements that mandate projects to perform a comprehensive economic analysis will not be too burdensome for the project sponsor.

- **Long-Term Study Period:** Next, all four case studies established a relatively lengthy study period. This is important because it helps to ensure a robust analysis that studies long-term considerations. A study period of generally 30 years is a standard used by most economic determination programs. This is important, especially when assessing long-term economic impacts from transportation investment.

- **Transparent Selection Process to Stakeholders and the Public:** All four case studies actively involved the public throughout the entire process. Public outreach meetings were held frequently, and economic methodologies were clearly explained to the public. It is likely that this was a significant reason why the final processes developed were so popular with the public.

- **Robust Economic Modeling Software:** Next, all four case studies used some form of sophisticated economic modeling software that incorporated the use of economic determination methodologies. For three out of the four case studies presented, TREDIS economic software was used to determine these impacts. This sophisticated modeling software provides economic impact analysis for transportation projects and programs. Others utilized the REMI transportation model to help formulate and model economic impacts, rather than using a simple sketch-planning method.

Building a Refined Model: TRENDS Economic Impact Component

Background and Problem

Innovative financing mechanisms add complexity to the transportation decision-making process. Without a way for decision-makers to access real-time financial forecasting information, poor project planning and decision-making can result. Consequently, the Texas Department of Transportation (TxDOT), state MPOs, and state elected officials called for a more user-friendly, web-based tool that can forecast transportation revenues and expenses.

In 2008, TxDOT contracted with TTI to create the TRENDS model. This model allows the user to manipulate over 70 variables related to assumptions regarding statewide transportation needs, population growth rates, fuel efficiency, federal reimbursement rates, inflation rates, taxes, fees, and other elements. The TRENDS model also includes a local option sub-model for each of Texas' 25 metropolitan planning organizations. Through the local option model, the user can analyze changes in local revenues by creating or adjusting a local fuel tax, local vehicle miles traveled tax, local vehicle registration fee, or local fuel efficiency rates.[54]

TTI is currently in the process of pairing economic impact information with the revenue outputs of the TRENDS model. Once users have received the estimated revenue forecast, they can proceed to select a MPO region and apply the revenue slated for construction activities to the region's local economy.

Methodology

The following is a brief explanation of the adapted TRENDS model methodology.

- **Step 1: Identify and Select a MPO region:** Construction revenue estimates (revenues applied to category 2,3,5,7, and 11 expenses) for the user's selected MPO region as well as any local option revenues selected by the user in the TRENDS model are used as the starting point in the economic analysis.

- **Step 2: Calculate the Economic Effect of Revenue on the Region:** The construction and local option revenues are used to calculate the number of jobs, aggregate income, and aggregate economic impact that the specified funding will have on the region during construction. Also calculated is the total business efficiencies, business profit/ income, and aggregate economic activity that will result during operation of the improved facility.
    - Jobs are calculated by dividing the revenue by an assumed project duration. This number is then divided by a jobs variable.
    - Aggregate Income is calculated by multiplying the number of jobs by an average salary. This number is then multiplied by the assumed project duration.
    - Aggregate Economic Impact is calculated by multiplying the aggregate income by a production multiplier. This number is then multiplied by the assumed project duration.
    - Total Increased Business Efficiencies is calculated by determining the rate of return the construction revenue would produce over the specified period of time.
    - Business Profit/ Income is calculated by multiplying the increased business efficiencies by a business profit percentage.
    - Aggregate Economic Activity is calculated by multiplying the business profit/income by a savings rate defined by the user. The business profit/ income less savings is then multiplied by a region specific aggregate income multiplier.

- **Step 3: Calculate System Performance Improvements:** Next, the model calculates the additional lanes miles and percentage of increase the specified revenue has on the region's roadway system. Also calculated in the model is the reduction in delay costs and wasted fuel that are products of the increase to the system.

- **Step 4: Present Results:** After the model calculates the economic impacts, users see the results for the region in an easy-to-understand format. Cost savings associated with improvements to system performance are also displayed in tabular format.

Conclusion

The TRENDS economic impact module can serve as a tool to help regional public officials plan for future transportation needs based on economic considerations. Public officials from around the state will be equipped with powerful information that will aid in informing the public of the transportation investment outcomes in their area.

Conclusion

There is a growing need for more refined and developed transportation impact standards that can be adopted in order to more effectively target transportation investment. Using the refined approach described in this study, transportation agencies and public policy decision-makers can be better equipped to make important transportation decisions. This approach can lead to a newly adopted federal model for ensuring that limited transportation dollars are spent wisely and effectively in the future. A process such as this that includes a highly transparent, data-driven, and consistent approach will help ensure that transportation investments are better targeted and that transportation projects that provide little economic benefit do not receive sufficient funding. This refined model and process could help to ensure that transportation funds are spent wisely and effectively and that only projects that provide a regional economic benefit are pursued.

This framework could be a major boon to the future of the United States. State DOTs spend millions of dollars each year to improve their modeling techniques for transportation and investment. A more conscious effort toward promoting the economic effects from transportation investment could offer excellent insight into the development of transportation infrastructure investments.

Analysis Limitations and Further Research Needs

Analysis Limitations

The following is a list of limitations.

- **Case Study Method:** Time did not permit for a larger scale, quantitative analysis on states that pursued economic determination analyses. However, interviews with DOT officials who led each of these programs were examined in depth.

- **Highway Spending Focus:** While this analysis sought to explore economic impacts for all modes, limitations in time meant that the researchers' efforts were focused on economic impacts from highway investment only. A transportation economic planning and decision-making process should be designed that includes all transportation modes.

- **Final Economic Outcomes Difficult to Calculate:** It was difficult to examine whether employment and income benefits resulted from the case study programs. Often times, it is unclear to what extent projects lived up to the economic benefits promised. Generally, however, positive job impacts were seen in three out of the four case studies as a result of the economic impact programs. Outcome information is yet to be determined for the

North Carolina Prioritization 2.0 Program because DOT officials are still in the program design stages.

Further Research Needs

The following is a list of further research needs.

- Examine more robust economic determination methodologies used elsewhere around the world.
- Review before-and-after ex-ante studies on the accuracy and effectiveness.
- Conduct polls with Americans on what type of economic priorities Americans would like their transportation infrastructure network to fulfill.
- Examine studies that determine the exact lag time associated with transportation investment and ways to communicate this message effectively to the public.
- Refine the cost-benefit analysis process for transportation investments that incorporates all its goals so that a more effective decision-making process is developed.
- Establish ways to better incorporate government productivity gains resulting from greater transportation investment.
- Conduct a thorough analysis on the successful implementation of the federal-state collaboration process for collecting safety data.
- Explore more effective ways to determine economic impacts from traffic demand management strategies, such as ITSs and incident management.

References

[1] November Hiring. *Slow Growth Likely Fueled Modest November Hiring*. Associated Press, 11 Nov. 2011. Web. 08 Dec. 2011. http://www.google.com/hostednews/ap/article/ALeqM5izavCl263RbBwztdAbnMjDKELEIw?docId=19939d2cf662439aa7dc875b64758e63

[2] Federal Highway Administration. *Economic Analysis Primer*. 01 Jan. 2008. Web. 12 Dec. 2011. http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer.pdf

[3] Gomez-Ibanez, Jose, et al., *Economic Returns from Transportation Investment*, Eno Transportation Foundation, Inc., 1996. Web. 12 Dec. 2011. http://connection.ebscohost.com/c/articles/12132579/eno-transportation-foundation-inc-publications-list

[4] Gramlich, Edward M. *Infrastructure Investment: A Review Essay*. Journal of Economic Literature 32:1176-1196. Sep. 1994. Web. 08. Dec. 2011. http://www1.worldbank.org/publicsector/pe/pfma06/EdwardGramlich.pdf

[5] Holtz-Eakin, Douglas. *State-specific estimates of state and local government Capital*. Regional Science and Urban Economics 23: 185-209. 1993. Web. 12 Dec 2011. http://ideas.repec.org/a/eee/regeco/v23y1993i2p185-209.html

[6] Giuliano, Genevieve. *Research and Policy Review 27: New Directions for Understanding Transportation and Land Use.* Environment and Planning A 21: 145-159. 1989. Web. 12 Dec 2011. http://www.uctc.net/papers/002.pdf

[7] Holtz-Eakin, Douglas. *State-specific estimates of state and local government Capital*. Regional Science and Urban Economics 23: 185-209. 1993. Web. 12 Dec 2011. http://ideas.repec.org/a/eee/regeco/v23y1993i2p185-209.html

[8] Fujita, Masahisa. *Urban Economic Theory: Land Use and City Size*. Cambridge, England: Cambridge University Press. 1989.

[9] White, Michelle J. *Firm Suburbanization and Urban Subcenters*. Journal of Urban Economics 3: 323-343. 1976. (no web version available).

[10] Wieand, Kenneth F. *An Extension of the Monocentric Urban Spatial Equilibrium Model to a Multicenter Setting: The Case of the Two-Center City*. Journal of Urban Economics 21: 259-271. 1987. Web. 12 Dec 2011. http://ideas.repec.org/a/eee/juecon/v21y1987i3p259-271.html

[11] Forkenbrock, David J. and Norman S. J. Foster. *Economic Benefits of a Corridor Highway Investment.* Transportation Research A 24A,4: 303-312. 1990. Web. 12 Dec 2011. http://144.171.11.39/view.aspx?id=312828

[12] Shen, G. *An input-output table with regional weights*. Papers of the Regional Science Association 6: 113-19. 1960. (no web version available)

[13] Schaffer, William. *Estimating regional input-output coefficients*. Review of Regional Studies, v. 2, n. 3, pp. 57-71. 1972. (no web version available)

[14] Weiss, Martin. *Economic Growth from Transportation Improvements*. FHWA, 2 Dec. 2000. Web. 08 Dec. 2011. http://www.fhwa.dot.gov/planning/econdev/econdoes.html

[15] Politano, A.L. and C.J. Roadifer. *Regional Economic Impact Model for Highway Systems (REIMHS).* Transportation Research Record 1229, TRB, Washington, DC, pp. 43-52. 1989. Web. 12. Dec. 2011. http://144.171.11.39/view.aspx?id=308797

[16] Moore, Tyrel G. *Core-Periphery Models, Regional Planning Theory, and Appalachian Development*, Vol 46, No. 3. 24 August 1994. Web. 11. Dec. 2011. http://onlinelibrary.wiley.com/doi/10.1111/j.0033-0124.1994.00316.x/abstract

[17] Weisbrod, Glen. *Evolution of Methods for Assessing Economic Development Impacts of Proposed Transportation Project.* 2006. Web. 11 Dec. 2011.

[18] USDA *Natural Resources Conservation Service: IMPLAN Analysis Site,* Web. 12 Jun. 2012. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/econ/data/?&cid=nrcs143_009732

[19] Alward, Aaron, "What is IMPLAN?"Web. 12 Jun. 2012. http://implan.com/V4/index.php?option=com_content&view=article&id=282:what-is-implan&catid=152:implan-appliance-&Itemid=2

[20] Regional Economic Models, Inc., *Regional Economic Models Inc. Web Site: Home*, Web. 24. July. 2012 http://www.remi.com/

[21] USDOT Bureau of Economic Analysis. *RIMS II Online Order and Delivery System*. Web. 24. July. 2012. http://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf

[22] Lewis, David Leonard. *Road User and Mitigation Costs in Highway Pavement Projects*, National Cooperative Highway Research Program. 1996. Web. 24. July. 2012. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_325.pdf

[23] McFarland, William. *Microcomputer Evaluation of Highway User Benefits*, Transportation Research Board NCHRP 07-12, 30. Dec. 1993. Web. 24. July. 2012. http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=886

[24] FHWA, HERS-ST *Highway Economic Requirements System - State Version -HERS-ST - EEI - Asset Management - FHWA. Asset Management.* 31 Oct. 2011. Web. 08 Dec. 2011. https://www.fhwa.dot.gov/infrastructure/asstmgmt/herswelcom.cfm

[25] TELUS-National. *TELUM (Transportation Economic and Land Use Model), Version 5.0*. Mar. 2005. Web. 08 Dec. 2011. http://www.telus-national.org/products/TELUMUserManual.pdf

[26] US FHWA, *Spreadsheet Model for Induced Travel Estimation*. Web. 18. Apr. 2012. http://www.fhwa.dot.gov/steam/smite.htm

[27] FHWA. *Sketch Planning Analysis Spreadsheet Tool*. 30. Sep. 1998. Web. 18. Apr. 2012. http://www.fhwa.dot.gov/steam/spasmuser.pdf

[28] FHWA, *Surface Transportation Efficiency Analysis Model*, 5. Apr. 2012. http://www.fhwa.dot.gov/steam/

[29] Section 2*, Declaration of Policy, Intermodal Surface Transportation Efficiency Act of 1991. H.R. 2950 (Enrolled Bill)*, Public Law 102 240, 105 Stat. 1914.

[30] Federal Highway Administration. *TEA 21—Transportation Equity Act for the 21st Century, Program Information.* 8. Dec. 2011. Web. 18. Apr. 2012. http://www.fhwa.dot.gov/tea21/sumenvir.htm

[31] Federal Highway Administration, *A Summary of Highway Provisions in SAFETEA-LU*, 25. Aug. 2005. Web. 24. Jul. 2012. http://www.fhwa.dot.gov/safetealu/summary.htm

[32] US Department of Transportation, Secretary of Transportation. *Transportation Investments Generating Economic Recovery (TIGER) Discretionary Program*. Web. 12. Nov. 2011. http://www.dot.gov/recovery/docs/tigerprocess.pdf

[33] Federal Register, Vol. 74 No. 231, *Notice of Funding Availability for Applications for Credit Assistance Under the Transportation Infrastructure Finance and Innovation Act (TIFIA) Program.* 3. Dec. 2009. Web. 24. Jul. 2012. http://edocket.access.gpo.gov/2009/pdf/E9-28860.pdf

[34] Federal Register, Vol. 74 No. 231, *Notice of Funding Availability for Applications for Credit Assistance Under the Transportation Infrastructure Finance and Innovation Act (TIFIA) Program.* 3. Dec. 2009. Web. 24. Jul. 2012. http://edocket.access.gpo.gov/2009/pdf/E9-28860.pdf

[35] Government Accountability Office, *Cost Assessment Guide: Best Practices for Estimating and Managing Program Costs*. 13. Aug. 2007. Web. 21. Jul. 2012. http://www.gao.gov/new.items/d071134sp.pdf

[36] Carnegie Endowment for International Peace, *Road to Recovery: Transforming American's Transportation Network*. Web. 18. May. 2012. http://carnegieendowment.org/2011/07/11/road-to-recovery-transforming-america-s-transportation/3e1h

[37] EDR Group and Cambridge Systematics, *Transportation Improvements Grow Wisconsin's Economy: The Economic Benefits of Transportation Investments*. Feb. 2003. Web. 24. Jul. 2012. http://www.tdawisconsin.org/data/publications/cambridgecomplete.pdf

[38] Kansas Department of Transportation. *Kansas T-LINK, Expanded Highway Project Selection Process*, Jan. 2010. Web. 24. Jul, 2012. http://www.kansastlink.com/downloads/Project%20Selection%20Process%20White%20Paper.pdf

[39] Kansas Department of Transportation. *New Approaches for Transportation: Final Recommendations of the T-LINK Task Forc*e, Jan. 2009. Web. 24. Jul. 2012. http://www.kansastlink.com/report

[40] Kansas Department of Transportation. *New Approaches for Transportation: Final Recommendations of the T-LINK Task Forc*e, Jan. 2009. Web. 24. Jul. 2012. http://www.kansastlink.com/report

[41] Lorenz, Julie. *Building Support for a New Transportation Funding and Financing Program*. TRB. 15. Nov. 2010. Web. 24. Jul, 2012. http://amonline.trb.org/12kegq/12kegq/1

[42] Kansas Department of Labor: *Labor Market Information Services. 2006-2016 Kansas Occupational Outlook.* Web. 24. Jul. 2012. http://www.dol.ks.gov/LMIS/doc/2006-2016ExecutiveSummary.pdf

[43] Kansas Department of Commerce. *Employment and Economy Information.* 2010. Web. 24. Jul. 2012. http://www.thinkbigks.com/statistics_and_economic_indicators#transportationDetail

[44] Chart adapted from Kaliski, John G. and Stephen C. Smith. *Major Corridor Investment Benefit-Cost Analysis System*, 1999. Cambridge Systematics and Indiana Dept. of Transportation. http://www.edrgroup.com/pdf/mcibas.pdf

[45] The Council of State Governments: Knowledge Center. *State Motor Fuel Taxes*. Web. 8 Dec. 2011. http://knowledgecenter.csg.org/kc/content/state-motor-fuel-taxes

[46] Wilbur Smith Associates, prepared for the Michigan Dept. of Transportation. *Economic Benefits of the Michigan Department of Transportation's FY 2011-2015 Highway Program: Final Report*. Web. 8. Dec. 2011. http://www.michigan.gov/documents/mdot/MDOT_EcnBen_2011-2015_363646_7.pdf

[47] Pew Center of the States. *Measuring Transportation Investments: The Road to Results.* Web. 11. May. 2011. http://www.pewcenteronthestates.org/initiatives_detail.aspx?initiativeID=85899358927

[48] RSQE Forecasts. *University of Michigan. The U.S. Economic Outlook for 2012-2013.* Web. Nov. 2011. http://rsqe.econ.lsa.umich.edu/Docs/RSQE-US-ForecastSummary%282011.11%29.pdf

[49] Wilbur Smith Associates, prepared for the Michigan Dept. of Transportation. *Economic Benefits of the Michigan Department of Transportation's FY 2011-2015 Highway Program: Final Report*. Web. 8. Dec. 2011. http://www.michigan.gov/documents/mdot/MDOT_EcnBen_2011-2015_363646_7.pdf

[50] Michigan Department of Transportation, *Economic Benefits of the MDOT FY 2010-2014 Highway Program.* Web. Mar. 2011. http://www.pewcenteronthestates.org/initiatives_detail.aspx?initiativeID=85899358927

[51] North Carolina Department of Transportation. *NCDOT—Prioritization 2.0.* Web. 8. Dec. 2011. http://www.ncdot.org/download/performance/Prioritization2March2011.pdf

[52] North Carolina Department of Transportation. *NCDOT—Prioritization 2.0.* Web. 8. Dec. 2011. http://www.ncdot.org/download/performance/Prioritization2March2011.pdf

[53] North Carolina Department of Transportation, *Prioritization 2.0 Outreach Summary*. 7. Dec. 2010. Web. 8. Dec. 2011. http://www.ncdot.org/download/performance/OutreachSummary.pdf

[54] D.R. Ellis, B.A. Glover, N.D. Norboge, Y. Zhi. *Development of the Texas Revenue Estimator and Needs Determination System (T.R.E.N.D.S.) Model: FY 2010 Activities*. 0-6395-TI-2. Texas Transportation Institute, College Station, TX. Jul. 2010. ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/6395.pdf

Appendix

According to a TTI report published in 2004, several states use some form of an economic evaluation model to determine economic impacts. Below is a brief description of states that use an economic modeling process:[55]

- Arizona—Market-Oriented Cost-Benefit Analysis: Arizona DOT proposed a market-oriented approach to assist in highway investment decision-making. A cost-benefit analysis was used to distinguish between roadways generating more user revenues per dollar of highway investment and those generating less user revenues per dollar of highway investment. This analysis was completed on a per-county basis.

- Florida—HERS, REMI: Florida DOT estimated the macroeconomic impacts of its work program for fiscal years 2002-2003 through 2006-2007. A combination of two transportation impact models was used: the Highway Economic Requirements System (HERS) and REMI. The HERS model estimated user highway benefits based on transportation investments, and the REMI model estimated the full economic impact of the reduced cost of doing business in Florida resulting from work program investments that reduce transportation costs over time. The economic impacts from aviation and seaport investments were estimated separately based on other studies done in Florida and elsewhere. Information for the study was obtained from Florida DOT's Roadway Characteristics Inventory (RCI) and its five-year work program for fiscal years 2002-2003 through 2006- 2007. The results of the analysis showed a very strong connection between transportation investments and key macroeconomic benefits including income for Florida residents, employment, and the value of goods and services produced in the state. An economic-based cost-benefit analysis was also conducted using forecasted real disposable personal income.

- Georgia—REMI: Georgia DOT conducted a survey to assess the economic value of interstate highways. Georgia DOT quantified the impacts by linking a highway network model of Georgia (the Integrative Strategic Planning [ISP] Traffic Forecasting Model) to an economic impact model (REMI) that translates transportation impacts, such as user benefits, reliability, and accessibility improvements, into industry cost and competitiveness impacts.

- Iowa—Input-Output: Iowa DOT used an input-output model, fed with data from the Iowa Workforce Development, U.S. Department of Labor, and U.S. Department of Commerce, to assess the economic impacts of aviation. The model provided estimates for total industrial output, total personal income, value added, and jobs.

- Louisiana—Survey: DOT has calculated the economic impact of ports on the state economy and maritime industry: Economic contribution of ports was estimated using direct spending, indirect spending, and induced spending. Information was obtained via a survey and supplemented by Louisiana Department of Labor data and BEA data.

- Maine—REMI Input-Output: Maine DOT used a REMI input-output model to determine the costs and economic benefits relative to the development of an east-west highway in

Maine, linking to the east with the Canadian Maritime Provinces and to the west with the larger markets of Quebec, Ontario, and the Midwestern United States. The basic objective of these studies was to provide policymakers with a sound base of knowledge regarding the costs, benefits, and potential impacts associated with both the improvement of Maine's existing east-west highways as well as the construction of a new four-lane limited access highway.

- Maryland—Input-Output: Maryland DOT conducted several studies to measure the economic impact of highways, aviation, seaports, and current transit. It used an input-output model for all cases and gathered data from numerous sources including interviews, local data, U.S. Bureau of Labor Statistics, Consumer Expenditure Survey, and census data. Its current transit project is expected to be completed this month and will take a retrospective and prospective look at surface transportation.

- Missouri—REMI, RIMS, and IMPLAN: Missouri DOT has used REMI, RIMS, and IMPLAN on a project level for planning analyses. It used in-house data, census reports, BEA data, and state government reports. It is considering using the REMI model for planning and programming analyses. Missouri DOT tried regression modeling originally, but the modeling was complex, and the results were difficult for lay persons to understand.

- South Dakota—REMI Input-Output: South Dakota DOT used the REMI input-output model for corridor and project studies completed over 10 years ago. No statewide studies have been completed to date. BEA data were used in all cases.

- Vermont—IMPLAN, Input-Output: Vermont DOT completed a study to define the impact of the public-use airports in the state on the overall Vermont economy. The IMPLAN model was used to calculate spin-off impacts for each individual airport. An input-output model was developed for assessing impact for the state as a whole. Several sources were used to complete the study. Surveys were sent to airport managers, aircraft owners, airport tenants, passengers, freight forwarders, and airport-dependent businesses. Dun and Bradstreet business records were used for job counts. BEA data of wages and sales per employee were used to approximate payroll and business sales.

- Wisconsin—REMI and IMPLAN, HERS-ST: Wisconsin DOT conducted a study assessing the economic benefits of transportation investments. The study was done in conjunction with Cambridge Systematics (HERS-ST) and used the REMI and IMPLAN models. In addition, the department performed economic impact analyses for specific types of transportation projects (i.e., highway bypasses, bridges, build operate-lease, or transfer study) and for other broad modal impacts (i.e., aviation, rail).

---

[55] D.D. Burke, D. Luskin, D.J. Rosa, T.S. Collier. Transportation and the Texas Economy: Some Interim Results. Technical Report 0-4871-1, June 2005. http://www.tti.com/tamu.edu/documents/0-4871-1.pdf

UTCM

University Transportation Center for Mobility™

Texas Transportation Institute

The Texas A&M University System

College Station, TX 77843-3135

Tel: 979.845.2538 Fax: 979.845.9761

utcm.tamu.edu

Texas Transportation Institute