University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Bureau of Business Research Publications | Bureau of Business Research

4-1-2008

Evaluating Roads as Investments: A Primer on Benefit-Cost and Economic-Impact Analysis

Eric Thompson
University of Nebraska - Lincoln, ethompson2@unl.edu

David Rosenbaum
University of Nebraska - Lincoln, drosenbaum1@unl.edu

Arthur Hall
University of Kansas

Follow this and additional works at: http://digitalcommons.unl.edu/bbrpub

Part of the Entrepreneurial and Small Business Operations Commons

Thompson, Eric; Rosenbaum, David; and Hall, Arthur, "Evaluating Roads as Investments: A Primer on Benefit-Cost and Economic-Impact Analysis" (2008). *Bureau of Business Research Publications.* Paper 5.
http://digitalcommons.unl.edu/bbrpub/5

This Article is brought to you for free and open access by the Bureau of Business Research at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Bureau of Business Research Publications by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

KU SCHOOL OF BUSINESS
The University of Kansas

THE CENTER FOR
APPLIED ECONOMICS

Supporting Regional Economic Development through Analysis and Education

EVALUATING ROADS AS INVESTMENTS

A PRIMER ON BENEFIT-COST AND ECONOMIC-IMPACT ANALYSIS

Eric Thompson
Director
Bureau of Business Research
College of Business Administration
University of Nebraska-Lincoln

David I. Rosenbaum
Professor of Economics
College of Business Administration
University of Nebraska-Lincoln

Arthur P. Hall
Executive Director
Center for Applied Economics
School of Business
University of Kansas

TECHNICAL REPORT 08-0425
April 2008

About The Center for Applied Economics

The KU School of Business established the Center for Applied Economics in February of 2004.

The mission of the Center for Applied Economics is to help advance the economic development of the state and region by offering economic analysis and economic education relevant for policy makers, community leaders, and other interested citizens.

The stakeholders in the Center want to increase the amount of credible economic analysis available to decision makers in both the state and region. When policy makers, community leaders, and citizens discuss issues that may have an impact on the economic development potential of the state or region, they can benefit from a wide array of perspectives. The Center focuses on the contributions that markets and economic institutions can make to economic development. Because credibility is, in part, a function of economic literacy, the Center also promotes economics education.

Kansas and neighboring states spend billions of dollars on roads. Do the huge expenditures represent good investments? The taxpaying public will never know because public decision makers rarely analyze road projects as investments. A disciplined use of benefit-cost analysis can close this knowledge gap.

Roadways constitute an economically vital form of transportation infrastructure that have the potential to contribute to the productivity and economic growth of state economies—if the economic benefits of the roadways exceed their cost. Benefit-cost analysis totals the annual user benefits derived from road projects and compares these benefits with the total costs related to construction. The analysis, therefore, identifies road projects that have an acceptable or unacceptable return on investment. Consistent and appropriate use of benefit-cost analysis could allow states to allocate road spending to only the highest valued projects, thereby helping to assure that taxpayers' money generates an acceptable return on investment.

BENEFIT-COST ANALYSIS VERSUS ECONOMIC-IMPACT ANALYSIS

Investment analysis usually relies on the availability of measurable (or forecastable) cash flows—in-coming cash flows and out-going cash flows. Roadways without self-financing tolls do not generate in-coming cash flows similar to that of typical private-sector investments. This situation creates the primary challenge associated with valuing most road projects.

Economic analysis strives to create measures that act as substitutes for in-coming cash flows. The analysis usually takes one of two different forms: benefit-cost analysis or economic-impact analysts. The two forms of analysis generate fundamentally different types of information. Benefit-cost analysis attempts to explicitly measure the investment value of a road project. Do the benefits for users of the road exceed the costs associated with building the road? Economic-impact analysis attempts to measure the residual economic activity that takes place as a result of a road project. What number of net new jobs or net new types of income-generating activities result from building the road?

Despite their differences, these two forms of analysis have a connection—almost like two sides of the same coin: A road project that offers benefits in excess of costs will generate a positive net economic impact, and vice versa. The notion of a *net* economic impact is all-important. Often, economic impact analyses related to roads focus too narrowly on a specific geography to adequately capture the *net* impact on the larger economy.[1] The result, in the absence of a sound benefit-cost analysis, can generate a "false positive" with regard to the investment value of the road. Consequently, road projects should rely on benefit-cost analysis for making investment decisions and use economic-impact analysis as a secondary technique to generate supplemental information.

KEY STEPS FOR CONDUCTING BENEFIT-COST ANALYSIS

Benefit-cost analysis can be distilled down into a set of specific steps that analysts must include in an effective analysis. These steps use information regularly developed and accessible to most state transportation agencies, or otherwise readily available from government sources. *Exhibit 1* summarizes the steps discussed below.

ESTIMATE CHANGE IN TRAVEL PATTERNS

The first step in conducting a benefit-cost analysis is to model traffic flows both with and without the highway investment. The investment will typically attract more traffic to the new or improved road but also change traffic flows on other roads. Modeling the change in traffic patterns, along with the known speeds and accident rates on different types of roads (based on factors such as the number of lanes, width of roadway shoulders, or number of intersections) is what allows the calculation of the total travel time saved due to the highway improvement, and the types of accidents avoided.

Typically, modeling is done with a computer simulation that evaluates current usage, projected usage growth, congestion, speed limits, alternate routes and other factors to project where and how traffic will flow over time. The second step is to model where and how traffic will flow after the highway improvement. Travel efficiencies are the difference between travel under the existing road configuration and the alternative configuration. As an example, an improved highway may facilitate better traffic flows as drivers are able to avoid lower speeds, congestion, indirect routes and stop lights.

The highway department of each state typically has a traffic model that it uses to forecast future traffic flows as population and the economy grows. The model can be used to forecast traffic flow with the proposed highway investment, and without it (i.e., the baseline or "no change" scenario). These models typically are developed by consultants but then operated by either the state or the consultant. Such models will produce consistent results as long as key assumptions such as annual growth in travel miles and traffic generation by type of attractor (industrial, business, or household) remain unchanged in alternative scenarios.

Exhibit 1

How to Conduct a Benefit-Cost Analysis	
Step	**Approach**
Estimate Change in Travel Patterns	Use a state traffic model
Estimate Change in Travel Time & Accidents	Use a state traffic model & comprehensive accident studies
Value Time Savings	Follow Federal Highway Administration guidelines
Estimate Value of Accidents	Follow Federal Highway Administration guidelines
Estimate Change in Vehicle Operating Costs	Use simulation model like MicroBenCost (Texas A&M)
Calculate the Present Value of Road-User Benefits	Follow Federal Highway Administration guidelines
Estimate Present Value of Construction Period Road User Costs	Simulation models & Federal Highway Administration guidelines
Calculate Present Value of Construction Costs	DOT engineering plans & past-project comparisons
Benefit-Cost Comparison & Sensitivity Analysis	Develop sensitivity tests & seek projects with a benefit-cost ratio consistently above one.

ESTIMATE CHANGE IN TRAVEL TIME AND ACCIDENTS

Average travel speeds vary by traffic volumes and by the characteristics of roads, such as the number of lanes and the number and type of intersections or access points to the road. Once the traffic model is used to develop the change in traffic flows on various roads with the proposed highway investment, highway engineers would be able to estimate the total change in travel time. Accident rates on existing roads also can be used to predict the change in accidents by type. Accident rates also would change on the road that is improved with the highway investment.[2]

VALUE TIME SAVINGS

Time savings are valued by multiplying the number of hours of travel time saved due to the investment by the value of time per hour. Federal Highway Administration guidelines call for the value of time to be calculated according to national average mean value for hourly wages and benefits. In particular, the hourly value of automobile travel at work is assigned as the mean average hourly wage and benefits of all occupations, while hourly value of time at work by truck drivers is equal to that occupation's mean wages and benefits. Leisure travel is based on car occupancy, with the time of occupants valued at 50% of the average wage.[3] Average vehicle occupancy rates for leisure travelers are available in the *National Travel Survey*. (These valuations of time are guidelines, not absolutes. The important point is to develop a consistent set of measures so that project evaluations use the same set of comparable standards.)

VALUE ACCIDENTS

The value of each accident is calculated based on the severity of the accident, with major categories including property damage only accidents, injury accidents, and fatal accidents.[4] This is done because data on accidents is kept according to severity, and there is a great difference in accident costs based on severity. For example, in 1991, according to the Federal Highway Administration the cost per fatal accident was $2.7 million, while the cost of the average property damage only accident was $4,000. These costs should be updated to the current year using the producer price index. (No one will ever be satisfied with placing a monetary value on a human life. Yet important issues related to insurance and government regulation have generated a rich body of research related to the valuation of a "statistical life." The ultimate goal is consistency of comparison among road projects.)

ESTIMATE CHANGE IN VEHICLE OPERATING COSTS

The improvements resulting from the highway investment often will effect congestion or travel speeds on the road. The improvements will effect travel time, but they also might affect vehicle operating costs. Generally speaking, travel at a consistent speed will use less fuel and depreciate a vehicle less quickly. The Texas Transportation Institute at Texas A & M University developed a model called MicroBenCost which can be used to estimate changes in vehicle operating costs.

CALCULATE THE PRESENT VALUE OF ROAD-USER BENEFITS

Analysts must add together road user benefits due to travel time savings, fewer accidents, and reduced vehicle operating costs to calculate total road-user benefits. Total annual road user benefits in future years are then discounted to the present value of a base year, using a consistent discount rate and analytical time frame.

The Federal Highway Administration recommends the use of a seven percent real (inflation-adjusted) discount rate. Such a discount rate reduces the value of benefits by half each decade. Therefore, the present value of a $10 million benefit 10 years in the future would be $5 million, while the present value of a $10 million benefit 20 years in the future would be $2.5 million, and just $1.25 million 30 years in the future.

The Federal Highway Administration does not recommend a particular time-frame in which to measure benefits, but many studies use a 30-year time frame. In any case, the importance of this decision is mitigated when an appropriate discount rate is used. If an appropriate discount rate is used, researchers would add relatively little to the present value of project benefits by choosing to extend project benefits beyond 30 years. But, for consistency purposes, a 30-year time frame for benefits is preferred.

The Basics of Benefit-Cost Analysis

As its name implies, benefit-cost analysis compares the expected benefits of a project to the expected costs over the projected life of the project. Because the benefits and costs occur over time, standard financial procedures are used to create a "present value" of both costs and benefits.

Benefits:

- Travel time savings
- Vehicle operating cost savings
- Accident avoidance (fatalities, injuries, property damage)

Costs:

- Dollar cost of construction
- Road-user costs during construction, including accidents

Benefit-Cost Ratio = Present Value of Benefits/ Present Value of Costs

A ratio greater than one indicates that benefits exceed costs.

CONSTRUCTION PERIOD ROAD-USER COSTS

The increase in accidents and slower travel during highway construction creates road-user costs. State traffic engineers can readily measure these costs by evaluating data from similar road projects to see how accident rates increased during construction. Travel time and accidents

could be valued according to the procedures discussed above. For construction projects that last more than one year, annual construction period road-user costs should be discounted back to the base year and summed to get the present value, using the same discount rate used for benefits.

The analytical significance of road-user costs during construction interacts with the discounting process. Road-user costs during the construction period have a lower discount than the benefits which accrue much later in time. This means that road-user costs may weigh significantly in benefit-cost analysis.

CONSTRUCTION COSTS

Construction costs include planning and design, land purchases, construction, and, in some cases, costs for moving utility lines. Total costs are estimated as part of transportation planning efforts. For construction projects that last more than one year, analysts should discount annual construction costs back to the base year, using the discount rate used for benefits.

In many cases, state highway departments calculate construction costs based on the costs of recent, similar projects. This approach has the advantage of being based on real rather than theoretical costs. It also would reflect cost overruns that sometimes occur with projects. The difficulty with this approach can occur when there has been no similar project in the state in recent years. In that case, engineers can secure cost information from a nearby state with similar topography and cost of living.

BENEFIT COST COMPARISON AND SENSITIVITY ANALYSIS

Once analysts have calculated the present value of all benefits and costs associated with a road project, they can divide benefits by costs to calculate a benefit-cost ratio. A ratio greater than one indicates that estimated benefits exceed estimated costs.

To gain clarity about the strength or consistency of a benefit-cost ratio, analysts should subject it to sensitivity analysis. The Federal Highway Administration guidelines recommend testing benefit-cost ratios under a set of alternative assumptions. For example, alternative scenarios could include optimistic and pessimistic assumptions for travel time and accident reductions, as well as factors such as project costs or discount rates. The calculations under alternative assumptions are meant to demonstrate the amount of uncertainty that exists around the "baseline" benefit-cost ratio.

A vivid example of sensitivity analysis took place for a road project in Kentucky. This road project expected to link to another road project in Indiana, the neighboring state. The "baseline" benefit-cost ratio for the project amounted to 1.096—indicating a barely acceptable return on investment. *Table 1* below indicates the benefit-cost ratio under alternative scenarios. Any cost overruns or overestimation of benefits made the project suspect. If Indiana failed to develop the road on its side of the state line, the project clearly represented a bad investment.

Table 1

Benefit-Cost Ratios for Western Segment of Northern Kentucky Outer Loop (I-74)

Alternative Assumptions	Benefit-Cost Ratio
Baseline	1.096
Project Cost 15% More	0.953
Project Benefit 15% Less	0.931
10% Real Discount Rate (rather than 7%)	0.725
Highway Not Built in Adjacent State (Indiana)	0.188

Source: *The Economic Feasibility of the Northern Kentucky Outer Loop (I-74), 2002*. American Consulting Engineers, Inc.

KEY STEPS FOR CONDUCTING ECONOMIC-IMPACT ANALYSIS

The Federal Highway Administration (and economists in general) views economic-impact analysis as a secondary complement to benefit-cost analysis. The direct measurement procedures of benefit-cost analysis offer superior practical steps for evaluating road projects as investments. Measuring the indirect, net economic development benefits of a road project over time and across geography runs a greater risk of producing measurement error.

By practical necessity, economic-impact analysis must prospectively evaluate a road project using a before-versus-after framework. Yet proper investment analysis recommends a with-or-without framework—a framework that is inherent in benefit-cost analysis. A with-or-without framework better captures the full array of opportunity costs associated with an investment decision.

With those analytical caveats, *Exhibit 2* illustrates the basic steps involved with conducting an economic-impact analysis. Generally, measurement of the economic impact of a road project takes one of two approaches: (1) examination of past projects to examine the change in economic activity before and after a project or (2) examination of use changes in traffic flow, travel times, and safety to predict changes in economic activity and comparative advantage in the region.

CONSTRUCTION PERIOD IMPACT

A local economic impact typically occurs during the construction phase of a highway investment. This impact occurs due to payments of the construction company to local suppliers of building materials or services as well as the salaries of construction workers. The difficulty with all such analyses is that a road project, like an investment of any type, comes at the expense of other uses of the same funds. This implies that the positive economic impact of road construction in one locality may come at the expense of economic activity in another locality; the net impact for the state may be zero, positive, or negative. An analysis that neglects these alternate outcomes—and it is a common neglect—is incomplete and misleading.

DEFINE GEOGRAPHIC REGION OF IMPACT

Beyond construction impacts, road investments can have an annual economic impact due to increased travel through a region, or because the highway enhances the access and competitive position of the region. Since the goal of a thorough economic-impact analysis is to identify a net impact across geography, the analysis must identify the appropriate geographic scope to analyze. For example, in the Plains states commuters often travel to job centers from two counties away.

SELECT APPROPRIATE CONTROL GROUPS

Many studies assess the economic impact of road investments by comparing the change in economic activity before and after the investment. These assessments have more validity when analysts also consider changes in control geographies during the same period. Changes

Exhibit 2

How to Conduct an Economic-Impact Analysis	
Step	**Approach**
Estimate Construction Period Impact	Define the extent to which impacts are local not statewide
Define Geographic Region of Impact	Estimate the extent to which local impacts come at the expense of other nearby regions
Select Appropriate Control Groups	Control groups must be similar to the target community on multiple measures and have similar growth history as the target community before the road is built.
Estimate Economic Impact	Establish before and after comparisons between target community and control groups.

in control geographies give the analyst an estimate of what might have happened in the target geography receiving the road investment if the investment had not been made.

Two steps guide the selection of appropriate control geographies. First, the target and control geographies should have similar characteristics, such as size, industrial structure, and demographics. Second, the target and control geographies should have similar histories related to the rates of economic growth.[5] Evidence that the target and control geographies had such similarities in the period before the road investment would raise confidence that any differences found after the road investment were due to the road rather than some secondary cause. [6] (The use of complex regional economic models can help alleviate some of the challenges associated with properly identifying appropriate control geographies. However, these models have built-in assumptions that raise many of the same issues and uncertainties related to this discussion.)

The Basics of Economic-Impact Analysis

Economic-impact analysis attempts to quantify the economic effects that a road project has on a particular region. The impact may be new economic activity created by the project, or simply economic activity attracted into the region because the road improves the region's competitiveness. Each of the positive impacts may derive from a negative impact elsewhere.

Positive Impacts:

- Regional income generated by construction activity
- Additional income-generating activities made possible by improved transportation or lower-cost access

Negative Impacts:

- Road construction dollars not available for alternative investments or uses
- New road draws economic activity away from existing areas of commerce

Net Economic Impact =
Positive Impacts – Negative Impacts

ESTIMATE ECONOMIC IMPACTS

By using the controls discussed above, it is possible to identify the economic impact of highway investments on economic measures such as jobs, population, and income.[7] The approach would be to estimate the change in the economic measure during the period from just before the investment is made until after the investment is made. The change in economic activity is then compared between the treatment and control geographies.[8] In other words, the approach would be to measure whether employment or population grew differently in the geography receiving the highway investment than in the control geography. Further, if faster (or slower) growth is identified in the geography receiving the highway investment, the researcher must examine whether this difference is statistically significant. In other words, the difference should be sufficiently large so that it could not have arisen simply by chance.[9]

A CRITICAL REVIEW OF PAST ROAD STUDIES

Based on a thorough search of state archives and interviews with personnel at departments of transportation, few road investments in Kansas and select surrounding states have been subject to economic analysis. In those cases where states have conducted an economic analysis of road projects, the projects relied more on economic-impact analysis (often after the fact) rather than the preferred approach of benefit-cost analysis—as recommended by Federal Highway Administration guidelines.[10] *Table 2* provides a summary critique of the road analyses discovered and evaluated, based on the criteria discussed herein.

For the analysis, we identified studies from a group of six states located in the middle portion of the country: Iowa, Kansas, Kentucky, Missouri, Nebraska, and South Dakota. The research team contacted state historic libraries and transportation agencies to gather reports that contained economic analysis of specific transportation projects. The number of reports to choose from was limited. However, interest in economic analysis of road projects seems to have grown in recent years. The research team identified a total of 14 reports: four from

Kansas, three from Nebraska, three from Iowa, two from Kentucky, one from Missouri, and one from South Dakota.

Reports were split between more comprehensive benefit-cost analyses of highway investments and studies that were principally focused on economic-impact analysis.

Figure 1

Six States Included in the Review

There were seven studies that included a benefit-cost analysis. These seven typically also included an economic-impact analysis. There were seven studies that only examined economic impacts.

The benefit-cost analyses reviewed in *Table 2* typically follow most of the steps required for a sound benefit-cost analysis. Most of the studies used appropriate and unbiased assumptions for key factors such as projected growth in traffic flow.

However, the studies generally lacked rigor in at least three ways. First, they failed to measure construction period road-user costs. Second, many studies did not use a sufficiently stringent benefit-cost ratio threshold. Third, many studies did not use a comprehensive list of alternative scenarios in sensitivity analysis.

Regarding the economic-impact analyses, the critical review found that half of the studies failed to appropriately identify control geographies for the analysis. Many studies also failed to sufficiently establish metrics related to before-and-after scenarios for the road projects under study.

Based on these critiques, as summarized in *Table 2*, the main challenge related to improving the evaluation of roads as investments is to encourage states to conduct more benefit-cost analysis. The prioritization of transportation funds—usually among the largest line items in state and local government budgets—would improve substantially if decision makers established rigorous and reliable benefit-cost analysis protocols.

Table 2

	Iowa	**Kansas**	**Nebraska and South Dakota**	**Kentucky**	**Nebraska**
Project	Highway 20 Corridor (Wilbur Smith, 1992)	Impact of Highways Bypasses (Burress, 1996)	Heartland Expressway (Wilbur Smith, 1995)	I-74 Outer Loop American Consulting Engineers, 2002)	Northeast Corridor (Wilbur Smith, 2000)
Conducted Benefit Cost Analysis	YES	YES	YES	YES	YES
Conducted Economic Impact Analysis	YES	YES	YES	YES	YES
Critique	• Accurate prediction of traffic growth • Used FHWA recommended method for valuing travel time and accident costs • Used FHWA recommended discount rate of 7% • Failed to account for road-user costs during construction • Assumed all construction costs occurred in year-1 of project rather than discounted over multiple years.	• No valuations for accidents • Insufficient documentation of traffic growth predictions • Deviated from FHWA recommended method for valuing travel time • Used per-hour rather than per-mile estimates for projecting change in vehicle operating costs • Did not use the appropriate discounting procedures, thereby overestimating benefits • Failed to account for road-user costs during construction • Failed to conduct a sensitivity analysis around different scenarios	• Conservative prediction of traffic growth • Used FHWA recommended method for valuing travel time and accident costs • Used FHWA recommended discount rate of 7% • Failed to account for road-user costs during construction • Assumed all construction costs occurred in year-1 of project rather than discounted over multiple years.	• Used FHWA recommended method for valuing travel time, but may have overstated growth in the value of time. • Unbiased estimates of projected change in vehicle operating costs • Used FHWA recommended discount rate of 7% • Failed to account for road-user costs during construction • Failed to emphasize that economic impacts could come at the expense of other regions	• Conservative prediction of traffic growth • Used FHWA recommended method for valuing travel time and accident costs • Used FHWA recommended discount rate of 7% • Failed to account for road-user costs during construction • Assumed all construction costs occurred in year-1 of project rather than discounted over multiple years.
Traffic Model	Computerized corridor region traffic procedure	Developed own model and measured drive time savings using existing bypasses	Computerized corridor region traffic procedure	Developed by outside consulting firm	Computerized region and multi-state traffic procedures
Driving Time Costs	FHWA guidelines	Median Kansas wages and literature review on the ratio between wages and value of time	FHWA guidelines	US DOT guidelines	FHWA guidelines
Accident Costs	Iowa DOT guidelines	Did not include	FHWA guidelines	US DOT guidelines	FHWA guidelines
Vehicle Operating Costs	FHWA cost data	Used hourly costs rather than costs per mile	FHWA cost data	Texas Transportation Institute model	FHWA cost data
Discount Rate	7% based on FHWA requirement	Did not include- only calculated annual benefits	7% based on FHWA requirement	7% based on FHWA requirement	7% based on FHWA requirement
Time Period	30 years	Did not include- only calculated annual benefits	30 years	30 years	20 years
Construction Cost of Road	Used estimates based on past projects—lumped in year 1	Used estimates based on past projects— lumped in year 1	Used estimates based on past projects—lumped in year 1	Used estimates based on past projects—discounted over 7 years	Used estimates based on past projects—lumped in year 1
Road-User Costs during Construction	Did not include	Did not include	Did not include	Did not include	Did not include
Economic Impacts	Proprietary Regional economic impact model	Comparisons of retail sales and employment in bypass and control counties and cities	Proprietary Regional economic impact model	Proprietary Regional economic impact model	Proprietary Regional conomic impact model

Table 2 *(continued)*

	Nebraska	Nebraska	Iowa	Iowa and Minnesota	Kentucky
Project	Antelope Valley Improvement (Rosenbaum, 2000)	US Highway 18 Feasibility Study (Wilbur Smith, 1995)	Primary Road Bypass Study (Snyder and Associates, 1999)	Impact of Rural Bypasses (Otto and Anderson, 1993)	Impact of New Bypass Route (Thompson, Miller and Roenker, 2001)
Conducted Benefit Cost Analysis	YES	YES	NO	NO	NO
Conducted Economic Impact Analysis	YES	NO	YES	YES	YES
Critique	• Used FHWA recommended method for valuing travel time • Unbiased estimates of projected change in vehicle operating costs • Combination of lower discount rate (6%) and long time period may overestimate benefits • Failed to account for road-user costs during construction • Failed to conduct a sensitivity analysis around different scenarios	• Used FHWA recommended method for valuing travel time, accidents costs, and vehicle operating cost savings • Failed to account for road-user costs during construction	• Failed to emphasize that economic impacts could come at the expense of other regions • Only used population size, rather than a fuller set of criteria, when selecting controls • Used control groups when examining the impact of bypasses on population growth • Did not use control groups when examining the impact of bypasses on retail sales, traffic volumes, and other measures	• Failed to emphasize that economic impacts could come at the expense of other regions • Used a fuller set of criteria for identifying control counties – population, traffic counts, and proximity to metropolitan areas • Used controls but failed to make before and after comparisons between highway and control counties. No way to determine whether highway was source of any differences	• Failed to emphasize that economic impact could come at the expense of other regions • Used a fuller set of criteria for identifying control counties. • Did make before and after comparisons between highway and control counties to evaluate impact of highway on economic growth
Traffic Model	Regional travel model	Computerized corridor region traffic procedure	N/A	N/A	N/A
Driving Time Costs	FHWA methodology	FHWA guidelines	N/A	N/A	N/A
Accident Costs	National Safety Council, Estimating the Cost of Unintentional Injuries	FHWA guidelines	N/A	N/A	N/A
Vehicle Operating Costs	Local estimates	FHWA guidelines	N/A	N/A	N/A
Discount Rate	6% based on Local bond issue	7% based on FHWA requirement	N/A	N/A	N/A
Time Period	50 years	30 years	N/A	N/A	N/A
Construction Cost of Road	Used estimates based on past projects— lumped in year 1	Used estimates based on past projects— lumped in year 1	N/A	N/A	N/A
Road-User Costs during Construction	Did not include	Did not include	N/A	N/A	N/A
Economic Impacts	Construction Impacts Only	Did not include	Examined impact of bypasses on population, retail sales, school enrollment, traffic volumes, and property valuations. No construction impacts	Examined impact of bypasses on per capita retail sales. No construction impacts	Examined impact of bypasses on manufacturing and commercial activity, and downtown vacancy rates. No construction impacts

Table 2 *(continued)*

	Missouri	**Kansas**	**Kansas**	**Kansas**
Project	Collins Route 13 Location Study (MidWest Research Associates, 1992)	Southeast Kansas: Wichita to Joplin (Catlett, 1987)	Employment Impact of Highway Construction & Maintenance (Babcock, Emerson, Prater and Russell, 1996)	Economic Impact of Comprehensive Transportation Program (Babcock, 2004)
Conducted Benefit Cost Analysis	NO	NO	NO	NO
Conducted Economic Impact Analysis	PARTIAL	YES	PARTIAL	PARTIAL
Critique	• Analysis speculated on the benefits of alternative locations for a bypass rather than identifying impacts through a highway and control group comparison	• Failed to emphasize that economic impacts could come at the expense of other regions • Only used non-urban status, rather than a fuller set of criteria, when identifying control counties • Either 1) Used controls but failed to make before and after comparisons, or 2) made before and after comparisons but failed to use a control. With either approach, there is no way to determine whether highway was source of any differences	• Only evaluated construction-period impact • Failed to emphasize that construction period impacts would come at the expense of other regions	• Only evaluated construction-period impact • Failed to emphasize that construction period impacts would come at the expense of other regions
Traffic Model	N/A	N/A	N/A	N/A
Driving Time Costs	N/A	N/A	N/A	N/A
Accident Costs	N/A	N/A	N/A	N/A
Vehicle Operating Costs	N/A	N/A	N/A	N/A
Discount Rate	N/A	N/A	N/A	N/A
Time Period	N/A	N/A	N/A	N/A
Construction Cost of Road	N/A	N/A	N/A	N/A
Road-User Costs during Construction	N/A	N/A	N/A	N/A
Economic Impacts	Focused on difference in economic impact from different locations for a bypass	Examined impact of a proposed 4-lane highway on population, employment, income, and retail sales in a 14 county Kansas region. Included construction period impact	Included construction period impact	Included construction period impact

REFERENCES

Agent, Kenneth, Len O'Connell, Eric Green, Doug Kreis, Jerry Pigman, Neil Tollner, and Eric Thompson, 2003. *Development of Procedures for Identifying High Crash Locations and Prioritizing Safety Improvements.* Kentucky Transportation Center Research Report KTC-03-15/SPR250-02-1F.

American Consulting Engineers. 2002. *Conceptual Feasibility of Northern Kentucky Outer Loop (I-74)*. Prepared for Kentucky Transportation Cabinet.

Babcock, M., 2004. *Approximation of the Economic Impacts of the Kansas Comprehensive Transportation Program*. Kansas State University. Prepared for the Kansas Department of Transportation. (December).

Babcock, M., J. Emerson, M. Prater, and E. Russell, 1996. *Employment Impact of Highway Construction and Maintenance Activities in Kansas.* Kansas State University. Prepared for the Kansas Department of Transportation (February). K-TRAN Project KSU-95-3.

Burress, D., 1996. *Impacts of Highway Bypasses on Kansas Towns*. Institute for Public Policy and Business Research, University of Kansas. Prepared for the Kansas Department of Transportation. (October).

Catlett, Robert B., 1987. Southeast Kansas Turnpike/Freeway, Wichita to Joplin: Economic Impact and Benefits Study: Task Force Report. Pittsburgh State University (January).

Chandra, A. and E. Thompson, 2000. "Does Public Infrastructure Affect Economic Activity? Evidence from the Rural Interstate Highway System," *Regional Science and Urban Economics* 30 (2000), pp. 457-490.

Miller, T. 1989. *The Value of Time and the Benefit of Time Saving*. Developed by the Urban Institute for the Office of Safety and Traffic Operations R&D, Federal Highway Administration.

Miller, T., J. Viner, S. Rosman, N. Pindus, W. Gellert, J. Douglass, A. Dillingham, and G. Blomquist, 1991. *The Cost of Highway Crashes*. Developed by the Urban Institute for the Office of Safety and Traffic Operations R&D, Federal Highway Administration, FHWA-RD-91-055.

Otto, Daniel and Connie Anderson. 1993. *The Economic Impact of Rural Bypasses: Iowa and Minnesota Case Studies.*

Rephann T., and A. Isserman, "New Highways as Economic Development Tools: An Evaluation of Quasi-experimental Matching Methods," *Regional Science and Urban Economics* 24: 723-751.

Rosenbaum, David. 2000. *Antelope Valley Improvement Project: Present Discounted Value of 50-Year Flow of Benefits*. Prepared for the City of Lincoln, Nebraska.

Snyder and Associates. 1999. *Primary Road Bypass Study of Selected Iowa Communities*. Prepared for the Iowa Department of Transportation.

Thompson, E., 2005. "If You Build It, Will They Come? An Examination of Public Highway Investments and Economic Growth," 2005. Bureau of Business Research in conjunction with The Center for Applied Economics, University of Kansas School of Business.

Thompson, Eric, Joseph Miller and Jonathon Roenker, 2001. The Impact of a New Bypass on the Local Economy and Quality of Life. University of Kentucky Center for Business and Economic Research. Prepared for the Kentucky Transportation Cabinet.

U.S. Department of Transportation, Federal Highway Administration, 2007. *Economic Analysis Primer.* http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer.htm

Wilbur Smith Associates. 1992. *U.S. Highway 20 Corridor Development Study.* Prepared for the Iowa Department of Transportation.

Wilbur Smith Associates. 1995a. *Heartland Expressway Study.* Prepared for the Nebraska Department of Roads and the South Dakota Department of Transportation.

Wilbur Smith Associates. 1995. US Highway 18 to Nebraska Highway 12 (via Highway 53 Extension) Feasibility Study. Prepared for the Nebraska Department of Roads.

Wilbur Smith Associates 2000. *Northeast Nebraska Corridor Feasibility Studies.* Prepared for the Nebraska Department of Roads.

ENDNOTES

1 Chandra, A. and E. Thompson, 2000. "Does Public Infrastructure Affect Economic Activity? Evidence from the Rural Interstate Highway System," *Regional Science and Urban Economics*. 30 (2000), pp. 457-490. Thompson, E., 2005. "If You Build It, Will They Come? An Examination of Public Highway Investments and Economic Growth," 2005. Bureau of Business Research in conjunction with The Center for Applied Economics, University of Kansas School of Business.

2 For a summary of recent research into the reduction in accident rates due to over 80 types of highway investments, including adding lanes, adding turn lanes, widening roads, widening shoulders, see Agent, Kenneth, Len O'Connell, Eric Green, Doug Kreis, Jerry Pigman, Neil Tollner, and Eric Thompson, 2003. *Development of Procedures for Identifying High Crash Locations and Prioritizing Safety Improvements.* Kentucky Transportation Center Research Report KTC-03-15/SPR250-02-1F.

3 Miller, T. 1989. *The Value of Time and the Benefit of Time Saving*. Developed by the Urban Institute for the Office of Safety and Traffic Operations R&D, Federal Highway Administration.

4 Costs estimates should include medical costs, emergency services, property damages, lost work, travel delays, and pain and suffering.

5 Formally, there should be no statistically significant difference between treatment and control groups in the period before the highway investment is made.

6 Rephann T., and A. Isserman, "New Highways as Economic Development Tools: An Evaluation of Quasi-experimental Matching Methods," *Regional Science and Urban Economics*. 24: 723-751.

7 It also would be possible to use growth in jobs, population, or income as the economic measure rather than the level of jobs, population or income.

8 This is known as the difference-in-differences approach, comparing the change from before to after in the target geography that receives the highway investment with the change from before to after in the control geography.

9 Standard statistical tests are available to make these evaluations.

10 U.S. Department of Transportation, Federal Highway Administration. *Economic Analysis Primer.* http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer.htm

Center for Applied Economics
University of Kansas School of Business
Summerfield Hall, 1300 Sunnyside Avenue
Lawrence, KS 66045-7585
www.cae.business.ku.edu
(785) 864-5134